

# Ocean Acidification



Presentation to the SCCWRP  
Commission  
March 8, 2013

# Background

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- At the last Commission meeting, I summarized recommendations from Washington's Blue Ribbon Panel on Ocean Acidification
  - Also indicated SCCWRP's growing interest in OA issues
- Commission asked for a more detailed briefing on OA and why they should care
- Commission also asked for CTAG's assessment regarding the importance of this issue

# Outline

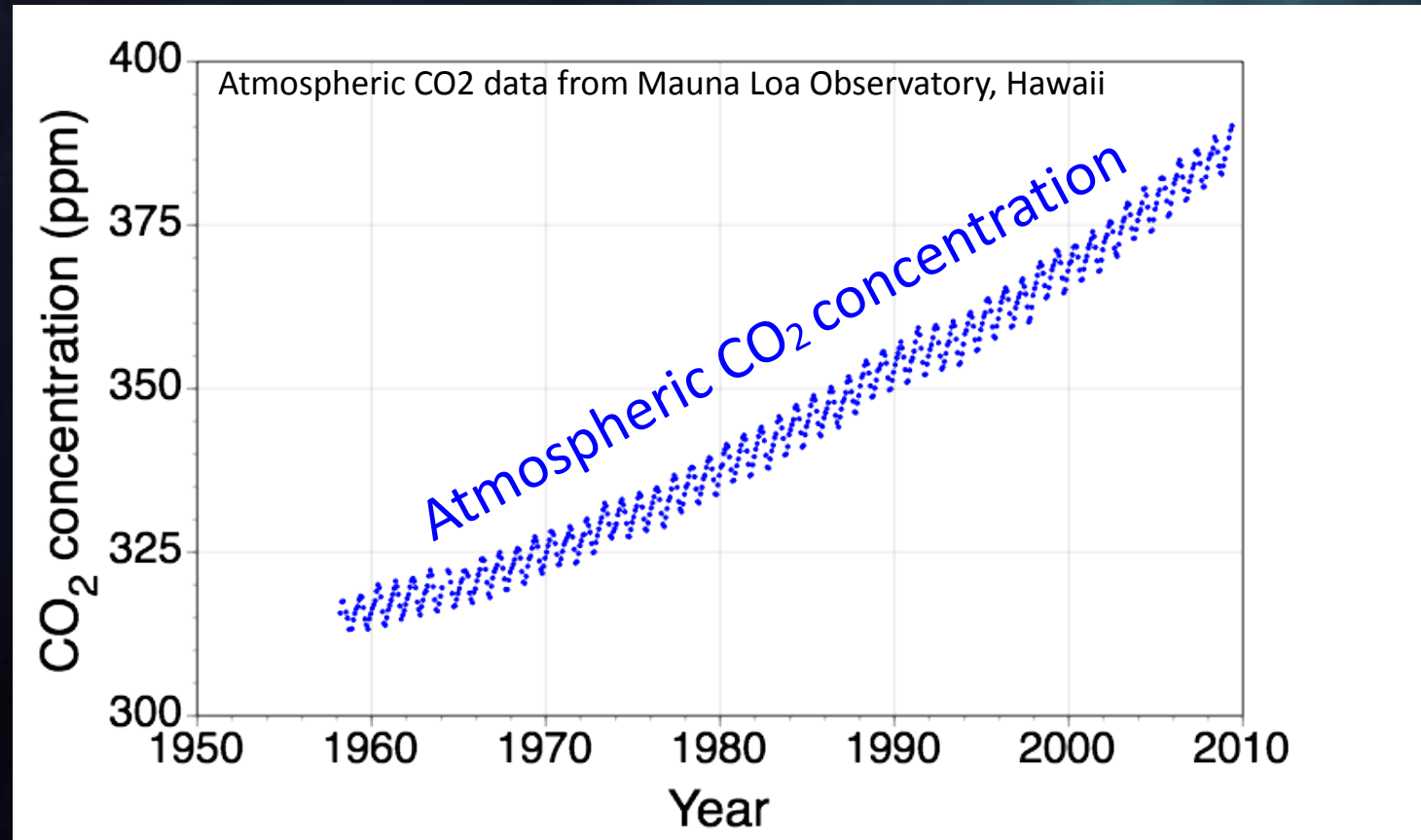
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- What is ocean acidification and why should we care about it?
- What efforts are underway to address the issue?
- What is SCCWRP doing to address the issue?

# What is Ocean Acidification?

CO<sub>2</sub> story you've already heard:

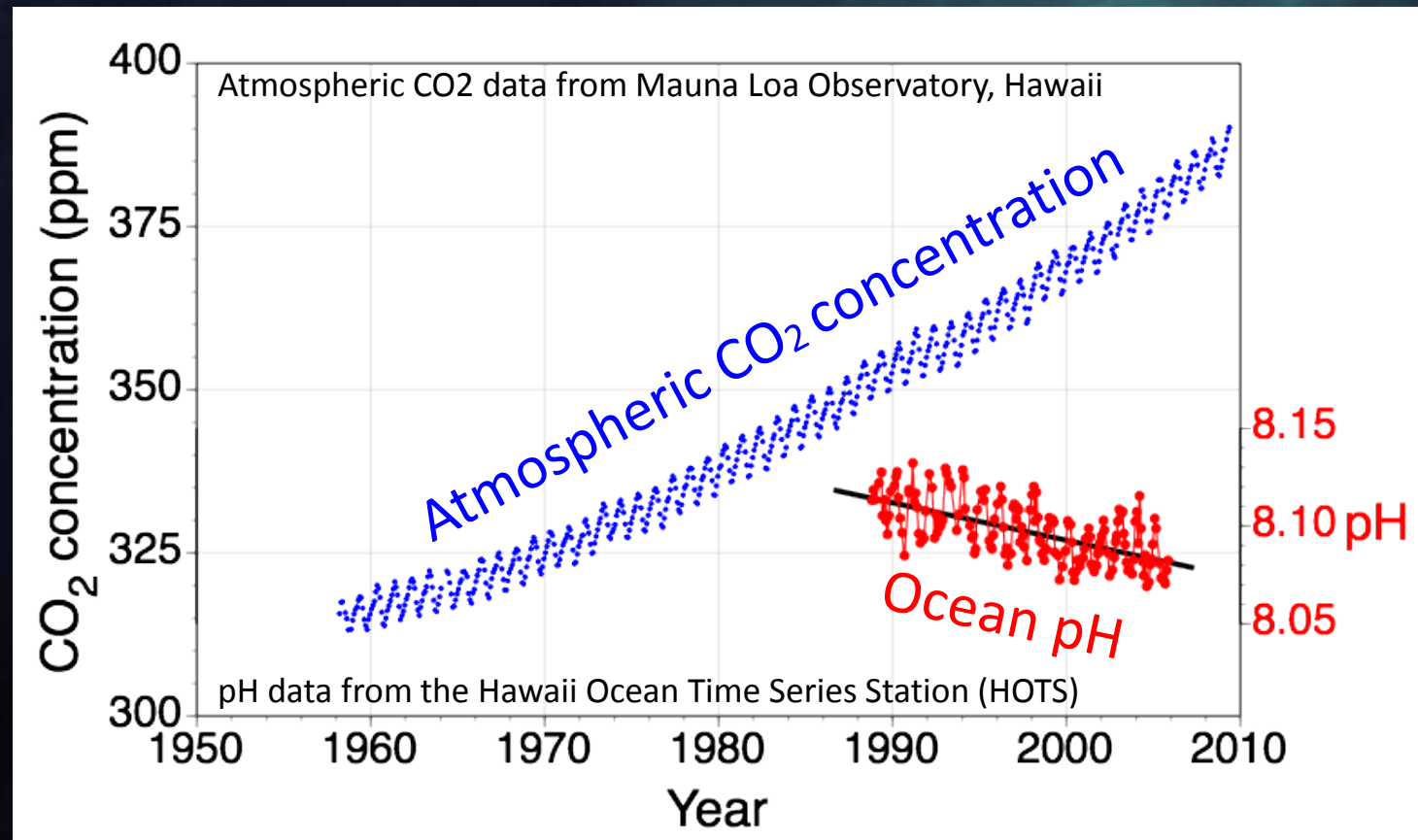
Atmospheric CO<sub>2</sub> concentrations are rising



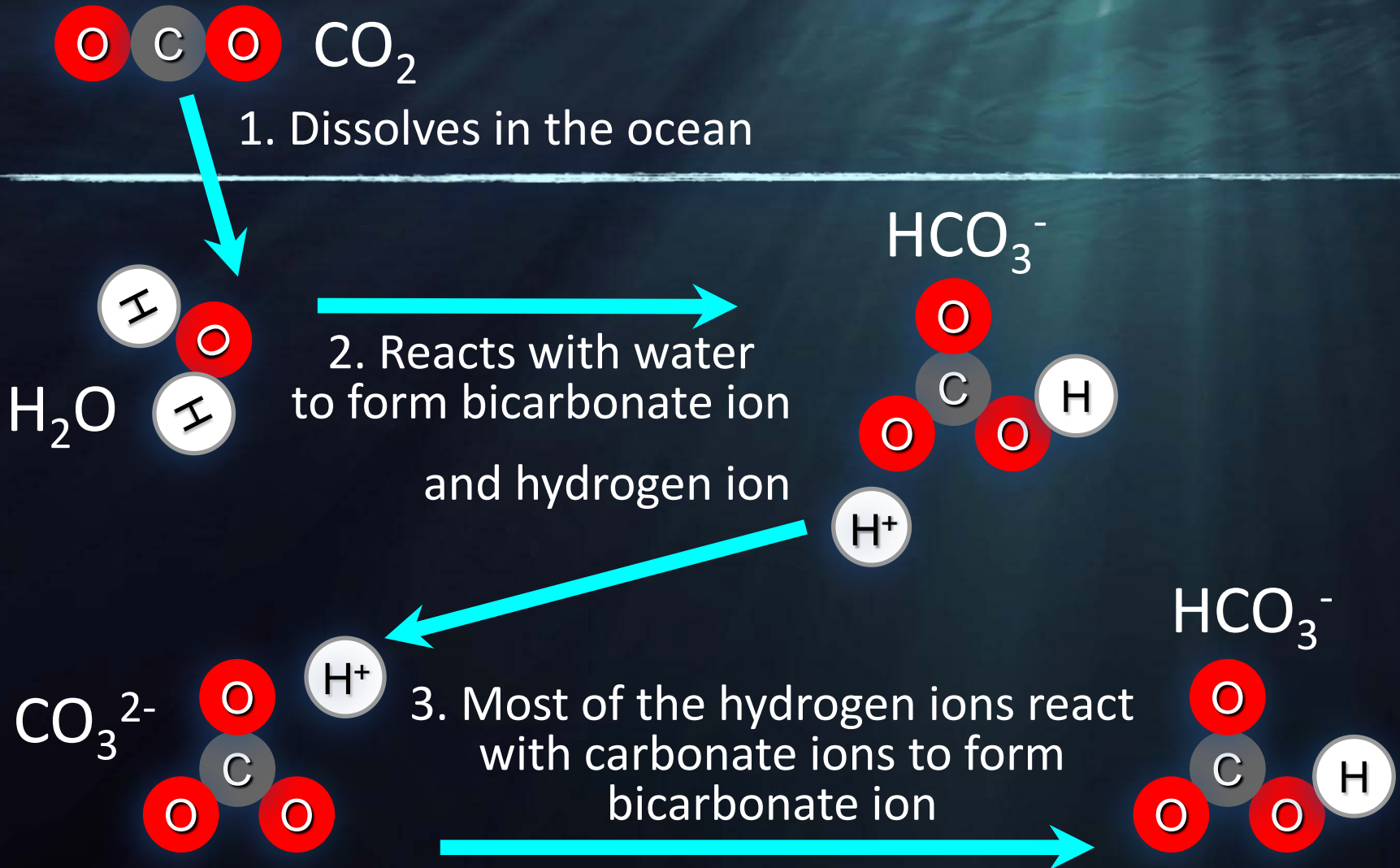
# What is Ocean Acidification?

Ocean Acidification is the “other CO<sub>2</sub> problem”:

Ocean pH decreases when CO<sub>2</sub> dissolves in seawater



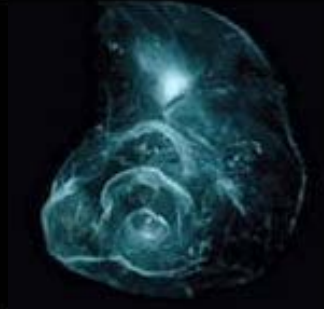
# Effect of Adding CO<sub>2</sub> to Seawater



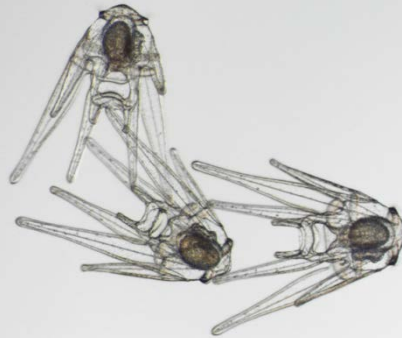
# Aragonite Saturation

- pH is the measure people know....
- But its changes in carbonate chemistry that is the real concern
  - Affects shell-forming organisms
- Scientists use aragonite saturation state to quantify this:
  - $\Omega > 1$  : Shells form
  - $\Omega < 1$  : Difficult to form shells

Pteropod



Urchin



Sea star

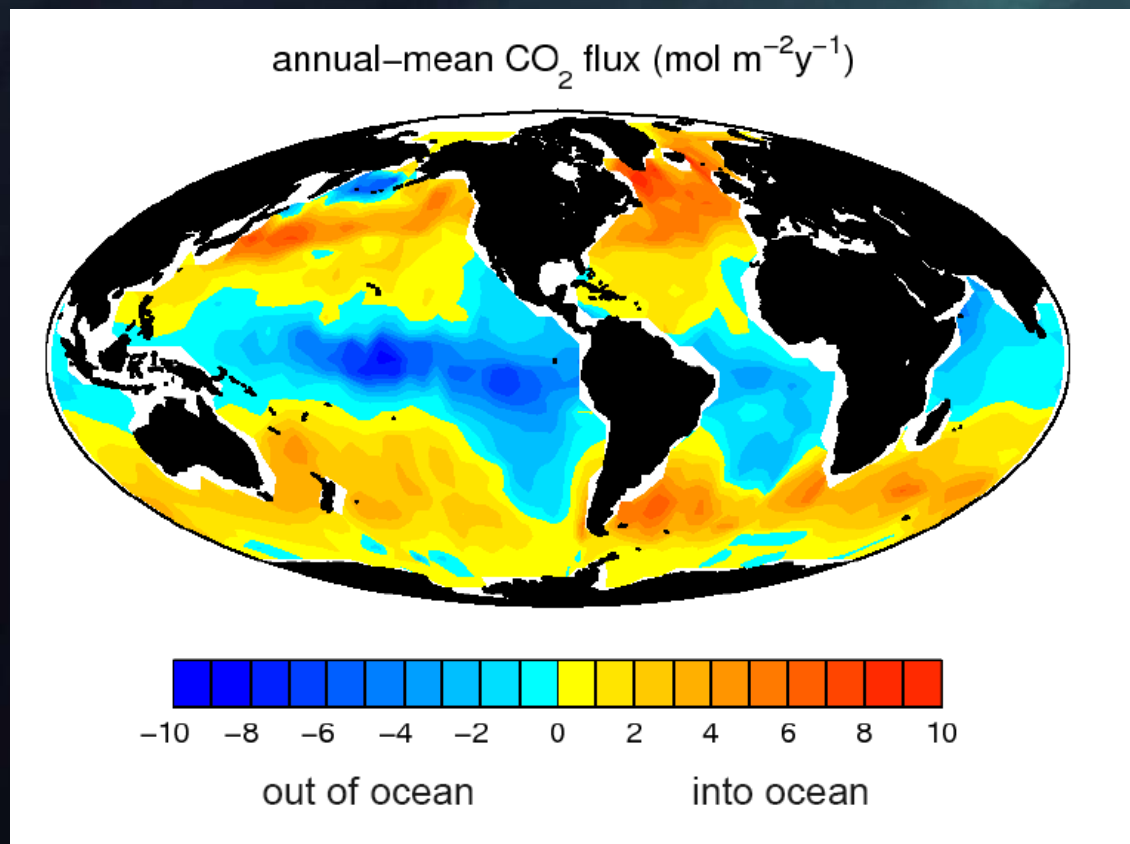


Healthy Organisms

Organisms under  
acidified conditions

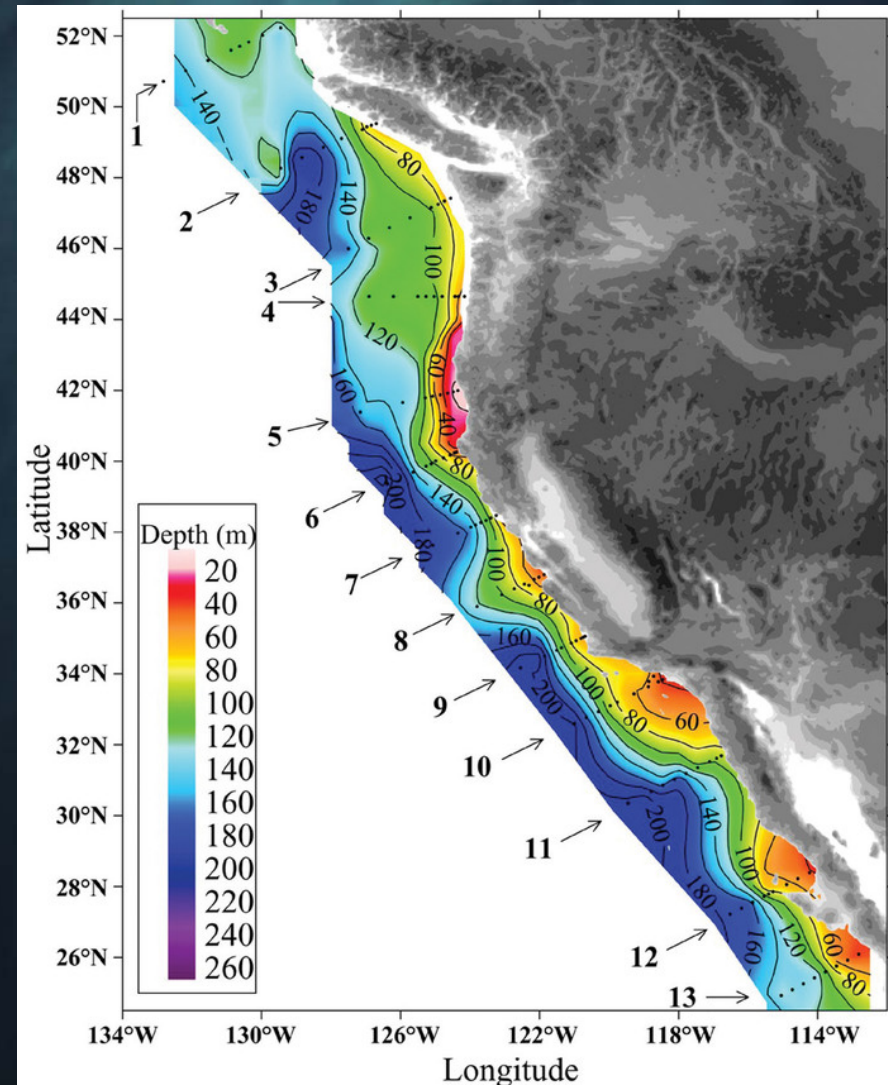
# Most Of The Problem Is In Deep Ocean Water

- CO<sub>2</sub> dissolves most readily in cold waters (high latitudes)
- Cold water sinks, moving CO<sub>2</sub> to depth



# The West Coast Is Particularly Vulnerable

- Our winds stimulate upwelling
  - Brings deep ocean CO<sub>2</sub> waters to the surface
- We have a narrow continental shelf
  - Upwelling occurs close to shore
- Corrosive water already being seen in shallow water close to shore



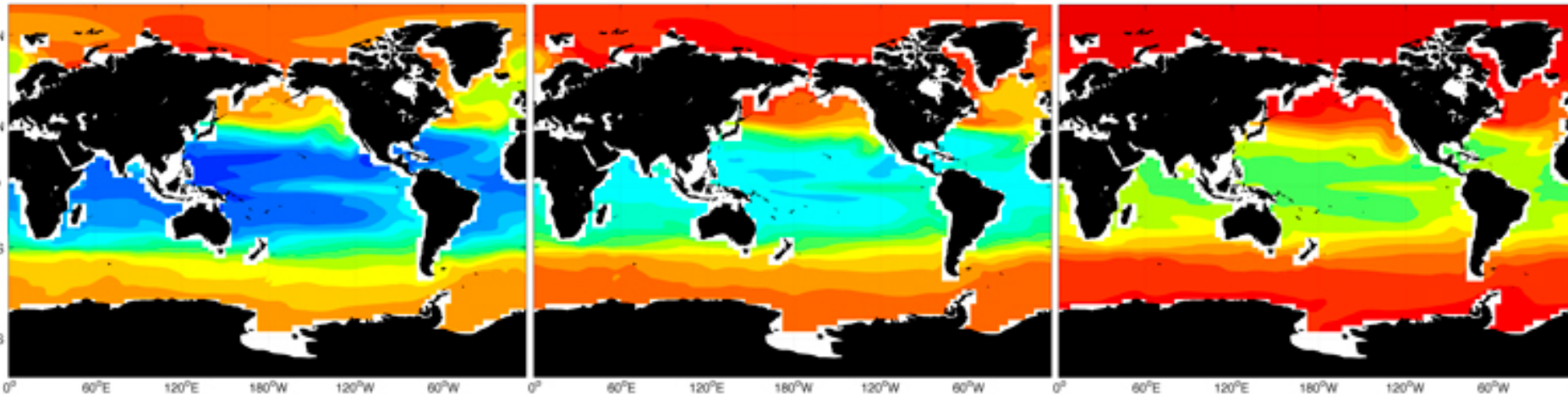
# And It's Going to Get Worse

## Carbonate levels predicted to drop as ocean acidifies

2000

2050

2099



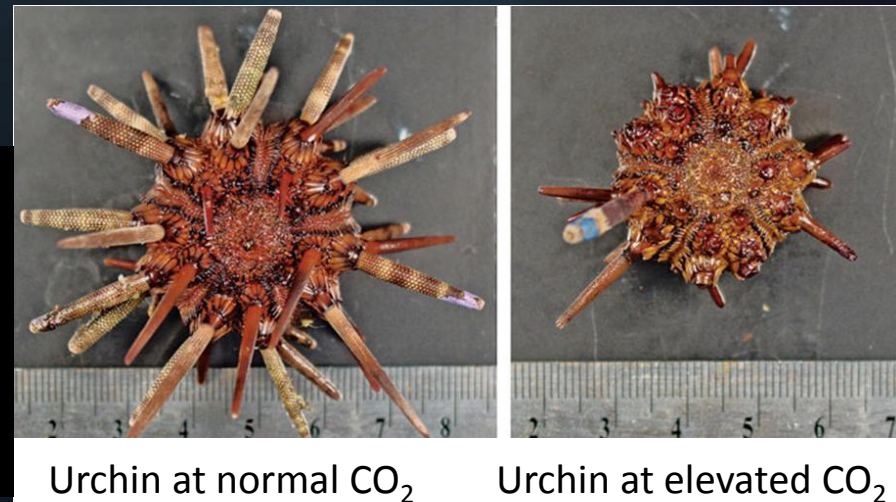
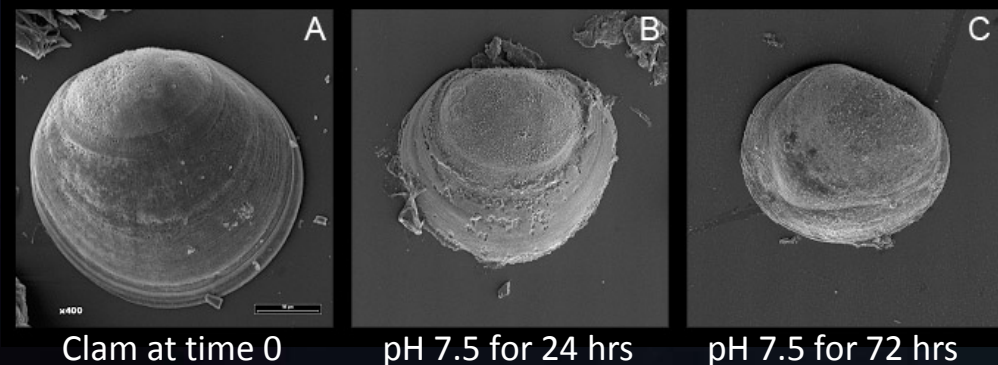
Saturation state of aragonite (a form of calcium carbonate)



Exposed shells and  
skeletons likely to dissolve

# Shellfish Industry is Threatened

- Decrease in aragonite saturation affects shell formation
  - Larval forms are most vulnerable
- Four hatcheries provide >90% of farmed seed and three have suffered acidification-related failures
  - Ability to produce oyster seed is presently throttling the industry



# Media Attention

**SoCal**  
CONNECTED

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5:30 PM AN

SHOWS > SoCal CONNECTED



## Rising Acidity in the Oceans Causing Problems for the Oyster Population

Rising acidity in the oceans, due to an increased presence of CO<sub>2</sub>, is bad news for the oyster population. Madeleine Brand does her field report for "SoCal Connected" on how industrial

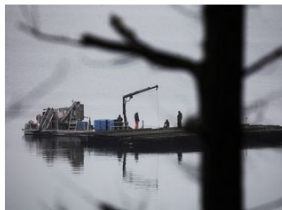
## Changes in ocean put shellfish business in jeopardy

By **Bill Sheets**, Herald Writer

EVERETT -- Between 2005 and 2009, billions of oyster larvae began dying at hatcheries around the state before anyone knew what was going on or could do anything about it.

The state's \$270 million shellfish industry, which employs about 3,200 people, is in danger.

One oyster farm, Goose Point Oysters in Willapa Bay, has begun raising oyster larvae in Hawaii because it can no longer grow them here.



Dan Bates / The Herald  
Penn Cove Shellfish workers on Wednesday harvest mussels, clams and oysters.

## Federal effort on acidification should focus on human impacts - report



A beachgoer harvests oysters near New Kamitchie, Wash. Scientists fear increasing ocean acidification as a result of greenhouse gas emissions could impair the ability of oysters and other sea creatures to grow a shell, impacting the lives and livelihoods of many dependent on the sea. Photo by [cswtvollickr](#).

Jan. 11, 2013

**Research into ocean acidification should focus first on issues with the most human and economic harm, according to a review of a federal program tackling the problem.**

By Brian Benkowsky  
The Daily Climate

A federal plan to tackle ocean acidification must focus more on how the changes will affect people and the economy, according to a [review](#) of the effort by a panel of the National Research Council.

"Social issues clearly can't drive everything but when it's possible they should."

Social issues clearly can't drive everything

## Your Dinner Plate May Be a Sign of Our Changing Oceans

by Cathy Hue  
on January 9, 2013 11:44 AM



A plate of oysters at Den & Louis Oyster Bar in Portland, Ore. Credit: [peppengdeath](#)/iStock/Creative Commons License  
Our ocean is absorbing carbon dioxide at a rapid rate, and the window of opportunity to do something about it is getting smaller and smaller. Madeleine Brand follows how our changing ocean is affecting not only the marine organisms that live in it, but also the west coast shellfish industry and, ultimately, the seafood we eat. (Watch that segment here.)

At L&E Oyster Bar in Silver Lake, we spoke with chef Spencer about the luxurious, sensual, and appetizing appeal of the oyster. But local restaurants are becoming increasingly affected by the lack of local Pacific oyster supplies -- the

RESOURCES  
RESEARCH HIGHLIGHT:  
SCRIPPS SCIENTISTS  
THINK OUTSIDE THE TANK

## Washington is first state to tackle ocean acidification

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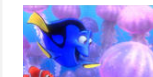


Oystermen harvest oysters in the Puget Sound, an estuary with increasingly acidic water that threatens Washington state's fish industry. (Liz O. Baylen/Los Angeles Times)

we are



mical Imbalance



By Kenneth R. Weiss  
Los Angeles Times  
November 27, 2012 | 5:24 p.m.

Washington Gov. Chris Gregoire on Tuesday ordered state agencies to take initial steps to combat ocean acidification, making it the first state to address problematic changes in ocean chemistry that threaten shellfish farms, wild-caught fish and other marine life.

Gregoire signed the executive order based on the

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## Unleashing Innovation to Save Our Oceans

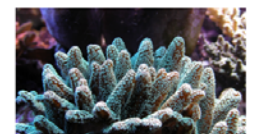
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By Robert K. Weiss, Vice Chairman and President of the X PRIZE Foundation.

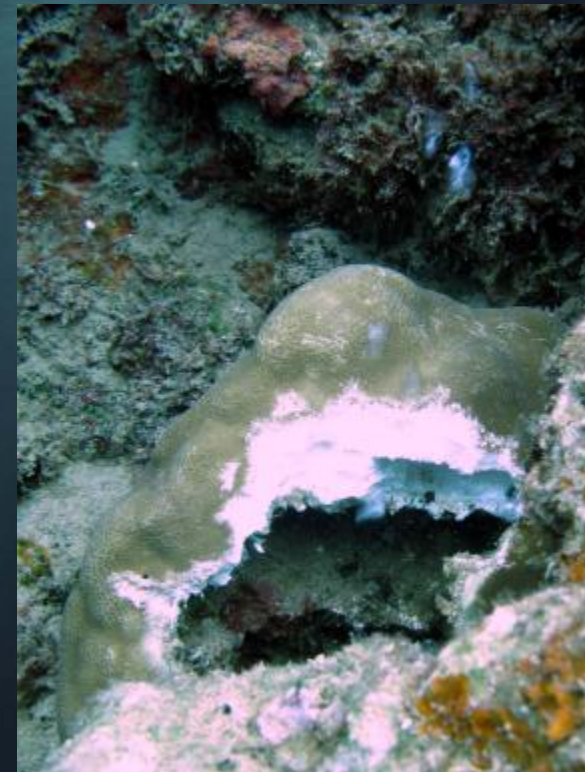
Rapid acidification of our oceans presents a challenge well suited for utilizing the incentivized competition methodology to crowdsource the genius required to create the solutions sorely needed before it's too late.

Our beautiful Blue Planet has another problem with acid in its waters. In the 1980s, "acid rain" was contaminating lakes and rivers across the Northeast. Eventually, a joint effort across state lines helped develop new air-quality standards,



# Coral Reefs

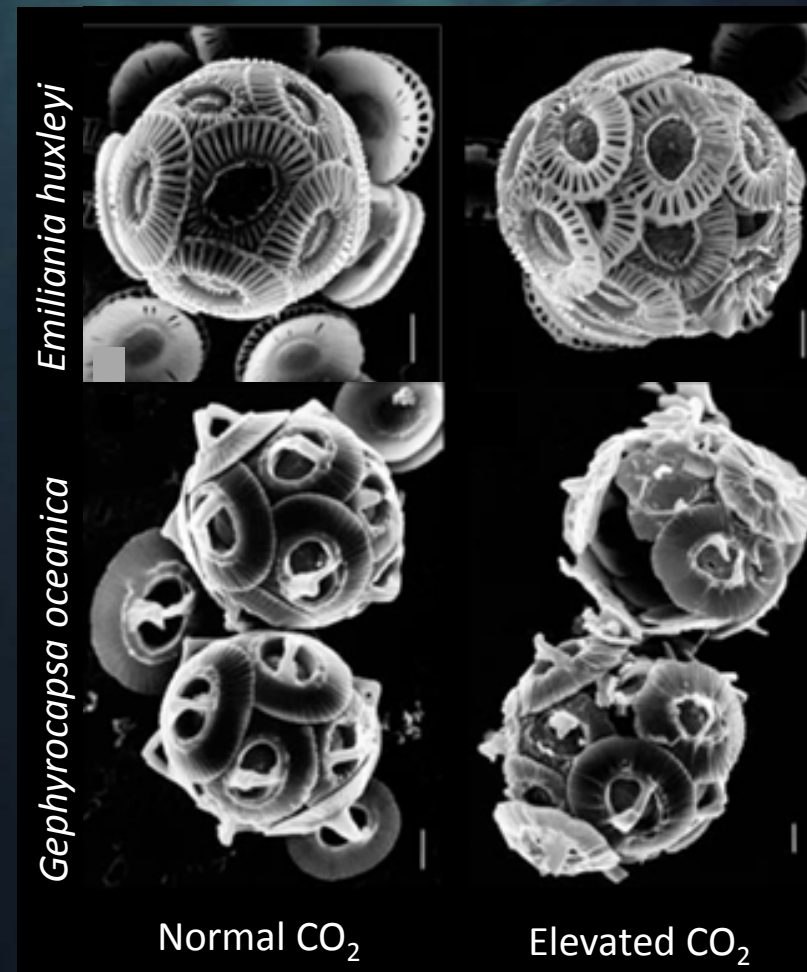
- Coral reefs are sensitive to both warming and acidification
  - High water temperatures cause coral “bleaching”
  - Acidification makes it harder to build their skeletons
  - Warming and acidification are a one-two punch
- At current CO<sub>2</sub> levels, 60% of coral reefs are in waters with suboptimal aragonite saturation state
  - Could increase to >90% in the next 50 years



Coral dissolves in high CO<sub>2</sub> water near a volcanic carbon seep

# Effects on the Base of Marine Food Webs

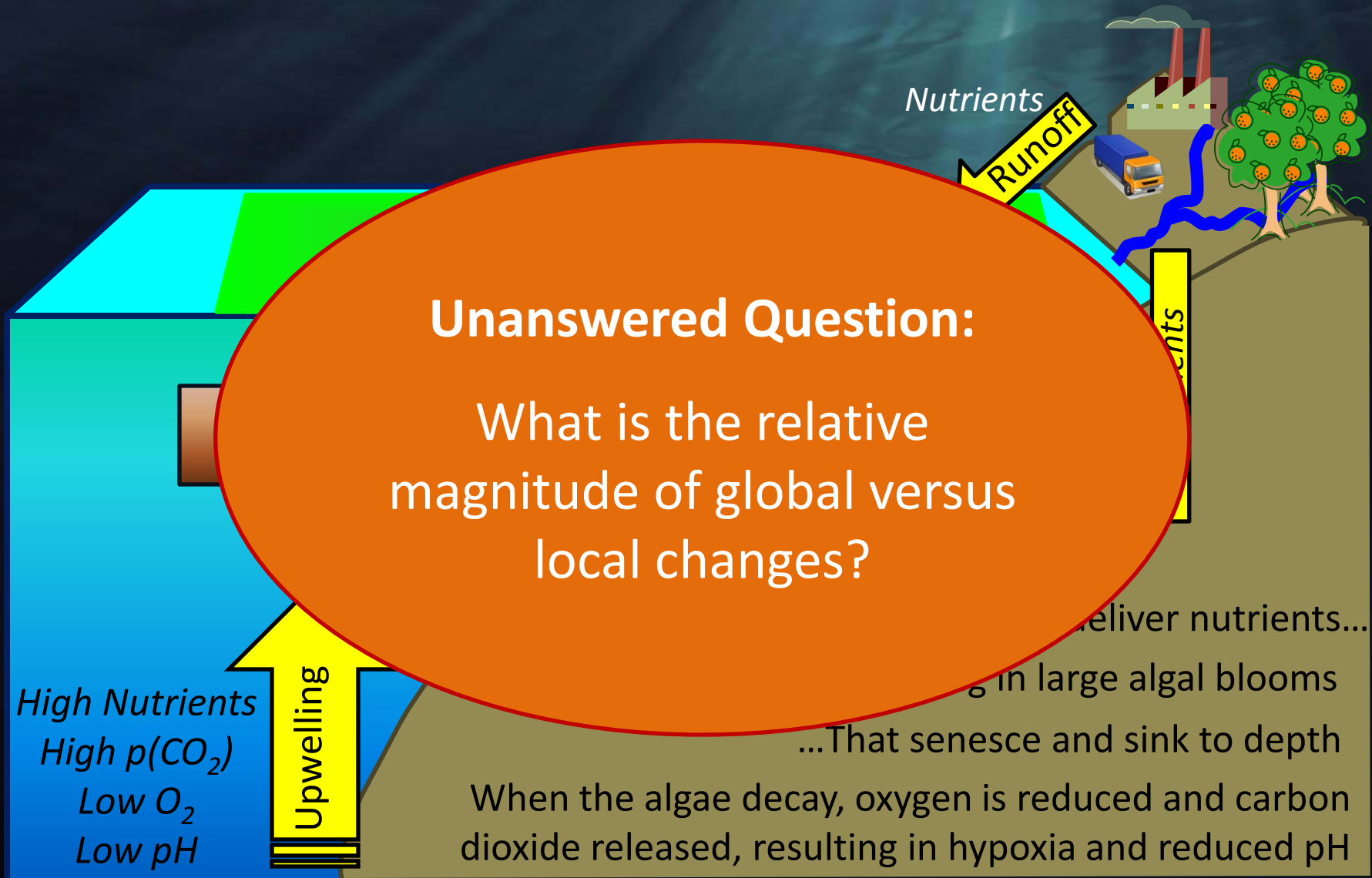
- Plankton are the base of marine food webs
- Under ocean acidification there will be winners and losers
  - More CO<sub>2</sub> means less energy for photosynthesis (life is easier)
  - Lower pH affects uptake of essential metals (life is harder)
  - For calcifying plankton, reduced calcium carbonate saturation impairs shell formation (life is impossible)



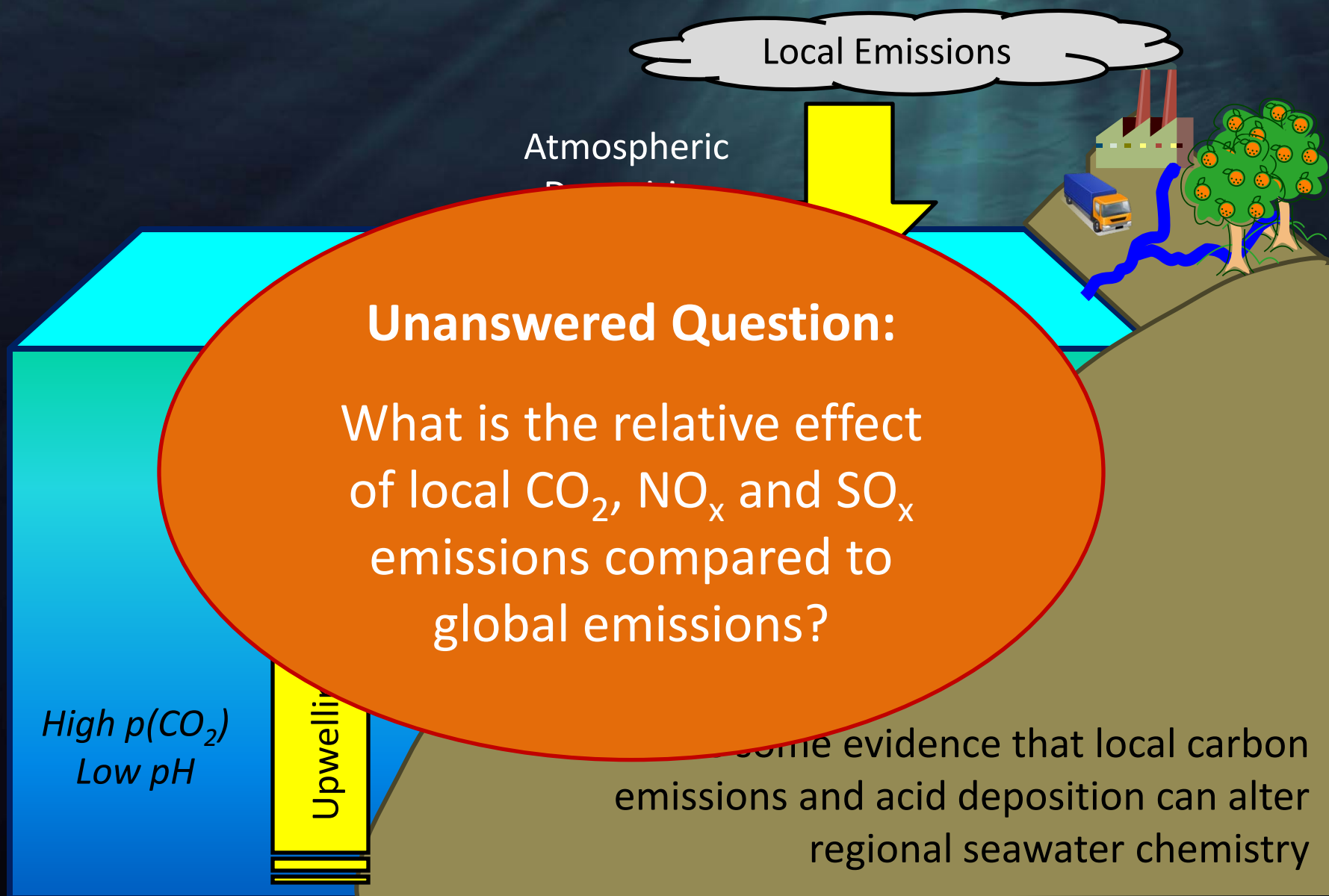
An underwater photograph showing sunlight rays (tyndall effect) filtering through the water, creating a serene and deep blue environment. The rays are prominent, extending from the top right towards the center and left.

# Why Should the California Water Quality Management Community Care?

# Nutrient Inputs May Exacerbate Issue



# Atmospheric Inputs May Exacerbate Issue



# California Ocean Plan


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- “pH shall not be changed at any time more than 0.2 units from that which occurs naturally”
- The pH probes you presently use are not sensitive enough to make this assessment
  - Your data has substantial quality issues
  - The manufacturer’s stated accuracy is only 0.2 pH units
  - In fairness, there aren’t a lot of off-the-shelf alternatives

# 303(d) listings

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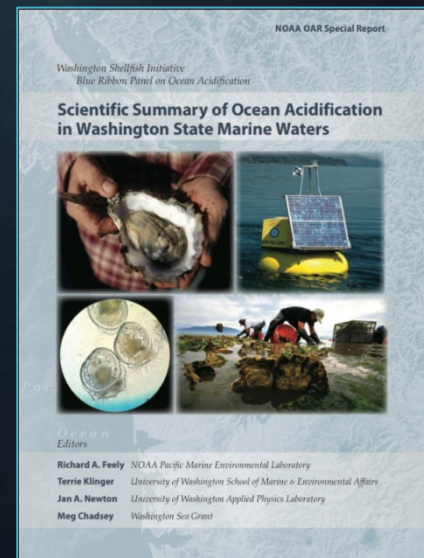
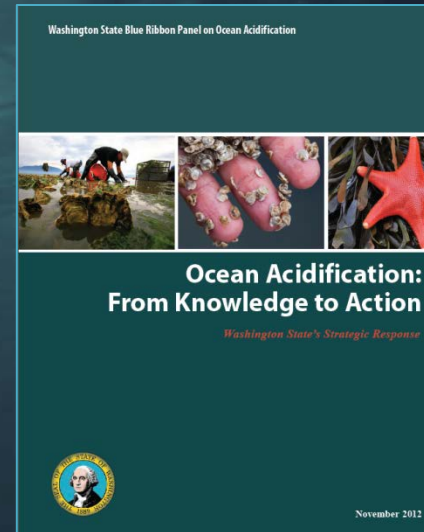
- May 2009: EPA was sued for failing to address ocean acidification under the CWA
- Nov 2010: EPA issued a memorandum on how states should address OA under the CWA
  - States should list waters not meeting pH water quality standards on their 2012 303(d) lists
- Hard to consider listings because we don't have the data to define reference condition

An underwater photograph showing sunlight rays filtering through the water, creating a dramatic and serene atmosphere. The water is dark blue, and the light rays are bright and distinct, creating a sense of depth and tranquility.

**What Efforts Are Underway To  
Address The Issue?**

# Washington State's Blue Ribbon Panel on Ocean Acidification

- Convened by Governor Gregoire in February 2012 to help set Washington's course for protecting shellfish and marine resources
- 27 high profile members representing a cross-section of disciplines
- Panel produced two reports
  - State of the science report
  - Panel's management recommendations report
- Both reports were released in November
  - Accompanied by an Executive Order to begin implementing the recommendations



# The Panel's Report Included Six Themes (Accompanied by 42 Recommended Actions)

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- Reduce global and local CO<sub>2</sub> emissions
- **Reduce local nutrient and dissolved carbon contributions to acidification**
- Adapt and remediate the impacts of ocean acidification
- Study and monitor our marine waters and species
- Educate the public about ocean acidification
- Support and facilitate implementation of the Panel's recommendations

# Ocean Protection Council Expert Panel

- OPC has formed an expert panel to provide them technical guidance for policy development
- Panel just formed last month
  - First meeting scheduled for March 26
- Charge questions still evolving, but are likely to include:
  - What are “natural” variations in acidification parameters in space and time?
  - To what extent have, or are, we going to deviate from “natural?”
  - How much do land-based sources of nutrient inputs, such as runoff and wastewater discharge, contribute to local patterns of ocean acidification and hypoxia?
  - What biological responses have, or are likely to, occur in response to the present trends in acidification and hypoxia?
  - What research should be conducted to increase confidence in the answers to these questions?

# California Current Acidification Network (C-CAN)

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- An informal collaboration to increase understanding about coastal acidification and its effects on biological resources
  - A partnership between science and industry
- Begun in 2010, coincident with observations that acidification was affecting the shellfish industry
  - Acidified seawater measured close to shore
  - Shellfish larvae dying at commercial hatcheries
  - Reduced recruitment to oyster beds
- C-CAN's goal: Develop a coordinated OA measurement system for the West Coast
  - Facilitate its use for addressing questions of management relevance

# Integrating Monitoring Data to Address Management Questions

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- Causal modeling
  - Investigating the relative contribution of local and global processes
- Short-term predictive models (weather predictions)
  - Required by hatcheries so they can modify how they mitigate effects of OA
- Long-term predictive models (climate predictions)
  - Temporal to identify ecosystem vulnerability
  - Spatial to identify sensitive habitat and help with spatial planning on where to place hatcheries and MPAs
- Economic Modeling
  - What is the cost of non-action?

An underwater photograph showing sunlight rays filtering through the water, creating a dramatic, ethereal effect. The water is dark blue, and the light rays are bright and distinct, creating a sense of depth and mystery.

**What Is SCCWRP Doing To  
Address The Issue?**

# C-CAN

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- SCCWRP is now chairing and staffing the Steering Committee
- Leading preparation of three document types:
  - A vision document
  - A C-CAN network principles document
  - Several how-to manuals

# West Coast Governor's Alliance

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- WCGA has elevated OA to one of their focal issues
- Has asked SCCWRP to help develop their strategic plan
  - Inventory existing and potential assets for developing a West Coast-wide OA monitoring network
  - Define the science and policy questions most relevant to stakeholder needs
  - Develop a prioritized research agenda based on these policy questions

# Enhance Member Agency Monitoring

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- Explore ways to upgrade existing OA measurements to better address Ocean Plan requirements
- The Bight program is an opportunity to determine feasibility of upgraded monitoring
  - C-CAN experts will help provide protocols
  - Bight can serve as the noncommittal test ground
- Extend mission of the Ocean Plan Water Quality Compliance Committee to develop pH assessment framework

# Modeling Facilitation

- Host a modeling workshop
  - Help define the critical management questions the models need to address
  - Define relevant temporal and spatial scales for models
  - Identify data required for model calibration and validation
- Provide key model inputs
  - Nutrient inputs: stormwater, wastewater and atmospheric deposition
  - Rates and processes: productivity, respiration, nutrient uptake, nutrient transformations
  - Validation data sets: Bight program
- SCCWRP will partner with modelers to develop management tools
  - Connect data inputs with data products

# SCCWRP Activities To Address The Issue

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- Leadership role in C-CAN
- Assist West Coast Governors Alliance for Ocean Health (WCGA) in developing a coast-wide strategy
- Help member agencies determine the feasibility of upgrading existing OA measurements
- Facilitate causal modeling efforts