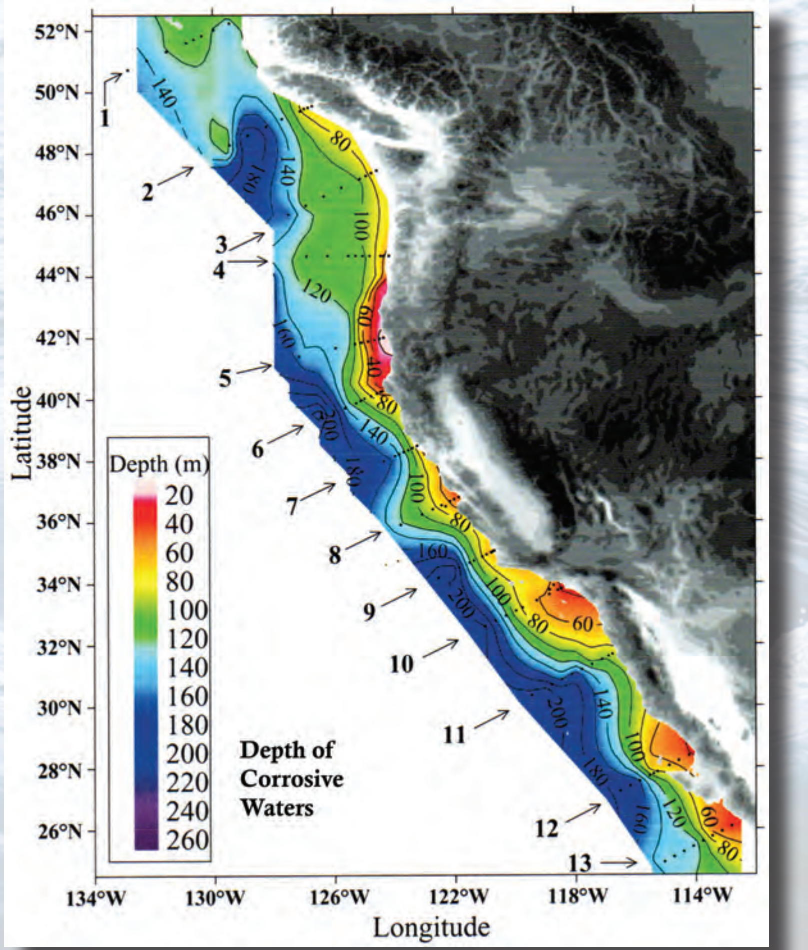
Ocean Acidification – The other CO_2 problem

Increasing levels of carbon dioxide (CO_2) emissions into the atmosphere, a consequence of fossil fuel use, are causing immediate, measurable impacts on ocean chemistry.

About one-third of the carbon dioxide produced every day around the world is absorbed by the oceans. As CO_2 reacts with seawater, it lowers seawater pH and reduces the concentration of carbonate ions, an essential component in the calcium carbonate that makes up the shells of shellfish and the skeletons of corals. Recently scientists have begun measuring changes in ocean chemistry and investigating the possible consequences to marine life, food webs and people. These studies find that ocean acidification is ongoing and may have significant biological impacts. The West Coast is vulnerable to the enhanced ocean acidification associated with seasonal upwelling, potentially causing serious impacts to ecosystems and some recreationally and commercially important shellfish.

Consider:

- Low pH seawater found in the deep ocean, low enough to be corrosive to the shells of some marine organisms, is expanding toward the ocean surface at the rate of 1-2 meters/year in the North Pacific.
- Some of the most vulnerable species may be tiny, shell-forming animals at the base of the food web, which provide food for many larger species.
- Also at risk are some shellfish commonly grown or harvested for human consumption, including oysters and sea urchins.
- Scientists are now conducting laboratory studies to "stress test" marine larvae (including oysters, abalone, sea urchins and other shellfish) at different CO_2 levels. Studies indicate significantly reduced shell growth for oysters and urchins in higher CO_2 environments.
- Options for an organism faced with environmental stress, such as ocean acidification, include migration, acclimatization (tolerance), adaptation (which may take generations if possible at all) and extinction.
- Demonstrated effects of ocean acidification on some species include reduced tolerance to temperature increase, impaired reproduction, inefficient cell function, impaired growth, larval shell dissolution, disease susceptibility and higher mortality rates at early life stages.
- Generally, there is a higher "cost of living" for many organisms subjected to a high CO_2 marine environment.



A 2007 NOAA research cruise measured evidence of acidified seawater in surface waters off the Pacific Coast. Observed levels of "corrosive" seawater had not been predicted to occur for another 100 years.
diagram: courtesy of Richard A. Feely and Dana Greeley, NOAA/PMEL

Shellfish Industry Challenges

Shellfish recruitment problems challenging West Coast growers and harvesters may be associated with ocean acidification, *Vibrio tubiashii* infections, low-oxygen "dead zones," or all three in combination. More research is clearly needed. Research and observations include:

- A 20-year study in California found significant differences in annual larval settlement of red and purple sea urchins, crabs and clams between northern and southern sites.
- In Northern California, where high upwelling is common in spring and summer, sea urchin larval settlement declined during upwelling periods.
- Oyster larval rearing problems were first observed at Hatfield Marine Science Center at Oregon State University in 2005.
- Whiskey Creek Hatchery in Oregon, and Taylor Shellfish Hatchery in Washington, subsequently experienced massive larval mortalities leading to steep declines in production over the past four years.

Common scrub brushes have proved to be efficient and cost-effective collectors to study larval settlement in marine field studies.
photo: courtesy of Dr. Steve Schroeter

Shellfish Industry Response

Shellfish growers launched an initiative to research and develop adaptive solutions. Some hatcheries, including Whiskey Creek, now employ continuous seawater monitoring systems. Potential hatchery remedies to avoid the effects of acidified seawater:

- Install water monitoring and treatment systems for seawater intakes
- Pump seawater into hatcheries only during low CO_2 periods
- Culture larvae during periods with no upwelling
- Engineer treatment systems to modify seawater chemistry for rearing shellfish larvae
- Investigate evidence of local adaptation and vulnerability to changes in water chemistry and develop resistant oyster larval strains

Canary in the coal mine? *Pacific oysters in Willapa Bay, Washington, have experienced six years of recruitment failure. Similar periods of low recruitment have been recorded in the past but the cause is unknown.*
photo: courtesy of Richard Wilson

Whiskey Creek and other hatcheries have installed continuous water monitoring and treatment systems.
photo: courtesy of Jesse Vance

For additional information: www.sccwrp.org/Meetings/Workshops/OceanAcidificationWorkshop.aspx

West Coast in the National Ocean Acidification Context

Mounting evidence suggests that ocean acidification may change the structure, function and biodiversity of marine ecosystems. In 2009, Congress passed the Federal Ocean Acidification Research and Monitoring (FOARAM) Act, authorizing federal ocean acidification research funding through NOAA, NASA and the National Science Foundation. The Act also established an interagency committee to develop a national ocean acidification strategic research and monitoring plan, expected to be completed in spring 2011. The national strategic plan process is now seeking recommendations, and this workshop is an important step toward developing a regional plan for the West Coast.

Future Collaboration

Addressing questions about ocean acidification requires integration of:

- ocean observing measurements
- laboratory exposure studies
- shellfish recruitment and production data
- field studies of organism performance in relation to ocean conditions

These data are collected by different sectors that to date have had limited interaction.

The West Coast Ocean Acidification-Shellfish Workshop stimulated discussion among a balanced group representing academia, government and industry and laid the groundwork for future collaboration.

Significant workshop findings:

Existing water quality and biological data sets are physically and spatially disassociated.

There is a need to:

- coordinate chemical data collection at the best biological monitoring sites, leveraging long-term data sets and employing standardized methods.
- supplement correlative data with an understanding of biological processes.
- develop predictive models at smaller scales.

Different communities must work collaboratively to resolve these issues.

The momentum generated at this workshop needs to be maintained.