Photos courtesy of Stony Brook University School of Marine and Atmospheric Sciences

Ocean acidification is affecting the shells of clams, scallops and other species.

Lethal waters

Pacific oyster growers find themselves 'canaries in a coal mine'

By Lisa Duchene

EDITOR'S NOTE: *This is the first of two features on ocean acidification. Look for the follow-up piece in January.*

Sue Cudd, owner of Whiskey Creek Shellfish Hatchery on Netarts Bay in Tillamook, Ore., recalls 2005 as the last normal year for spawning oysters. To produce oyster, mussel and clam larvae by the millions, Whiskey Creek typically draws 200 gallons of seawater per minute into its hatchery — but can no longer count on natural seawater.

In late 2007, oyster larvae started dying in huge numbers. Die-offs continued throughout 2008; Whiskey Creek lost about 75 percent of its production that year. The oysters that survived, says Cudd, were sub-par.

"Batch after batch after batch with almost no survival," recalls Cudd. "We'd lose millions and millions and millions of larvae. Maybe they'd look like they would make it, but then they wouldn't. Or, they couldn't develop. Even if they survived, they'd swim and swim and swim and never grow past 120 microns."

In the same period, Taylor Shellfish Farms' hatchery on Washington's Dabob Bay also lost oyster larvae. In 2008, Taylor's production was 60 percent below average and in 2009 it was down 80 percent. All told, the seed shortage translated to a 22 percent decrease in farmed Pacific oyster production between 2005 and 2009, according to the Pacific Coast Shellfish Growers Association.

While the two hatcheries, accounting for much of the region's farmed oyster seed production, are located in places with different coastal dynamics — Whiskey Creek's facility is right on the Pacific Coast while Taylor's is nearly 80 miles from the open ocean, tucked within the Hood Canal estuary, sort of a fjord within a fjord — they are likely suffering from the same problem: acidifying sea water.

Simply put: Excess CO_2 in the atmosphere drives climate change while excess CO_2 in the oceans drives ocean acidification.

Over the past 250 years or so, burning fossil fuels has increased atmospheric CO_2 levels by nearly 40 percent from 280 ppmv (part per million by volume) to 391 ppmv, and the level is rising by about 2 ppmv per year, according to the European Project on Ocean Acidification (EPOCA).

During this time, the oceans have been absorbing carbon dioxide. Otherwise, atmospheric CO_2 would be 460 ppmv, according to EPOCA.

The oceans have absorbed an estimated 525 billion tons, or about half the fossil fuel carbon emissions, over the last 200 years, according to Richard Feely, senior scientist at the National Oceanic and Atmospheric Administration's Pacific Marine Environmental Laboratory in Seattle.

"The ocean's daily uptake of 22 million tons of carbon dioxide is starting to take its toll on the chemistry of seawater," writes Feely and colleagues in a briefing paper. Carbon dioxide absorption lowers ocean pH, which decreases availability of the calcium carbonate essential to shellfish.

Scientists have been working to make sense of the implications for wild and farmed shellfish. Stephanie Talmage and Christopher Gobler, at Stony Brook University in Southampton, N.Y., studied the growth and survival of the larvae of hard clams (*Mercenaria mercenaria*) and Atlantic bay scallops (*Argopecten irradians*) under past, present and projected future seawater conditions.

Larvae grown in pre-industrial CO_2 concentrations grew faster and had higher survival rates and thicker, more robust shells compared with larvae grown under modern CO_2 levels. "Bivalves exposed to CO_2 levels expected later this century had shells that were malformed and eroded," according to the abstract of Talmage and Gobler's paper, published Oct. 5 in the *Proceedings of the National Academy of Sciences*.

The Pacific Northwest oyster industry is likely seeing the first acute effects of ocean acidification. Along the Pacific Coast, CO_2 levels in seawater traditionally spike due to upwelling, which varies depending on weather conditions, explains George Waldbusser, a biological oceanographer at Oregon State University's College of Oceanic and Atmospheric Science. North winds affect currents and push surface waters offshore, allowing deep water to move in.

That water is generally rich in carbon dioxide, accumulated from sinking, decomposing organic matter. The difference now, says Waldbusser, is that upwelling is delivering water that hasn't surfaced in 50 to 75 years and is also enriched with carbon dioxide from the burning of fossil fuels.

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>
> *— George Waldbusser, biological oceanographer, Oregon State University's College of Oceanic and Atmospheric Science*

"What's happening," says Waldbusser, "is all of these things are occurring on daily and seasonal time scales, but in the background of that you have a general increase in the CO_2 that's there. That's what we're concerned about is the shifting baseline. Essentially, what we're seeing now is the beginning of the increase in atmospheric CO_2. If we project forward, it's a whole lot worse."

By 2009, the Pacific Northwest shellfish industry, scientists and legislators were working together on the oyster die-off problem. This year's federal budget included $500,000 to help hatcheries purchase monitoring equipment. In July, growers, scientists and managers gathered for a workshop on ocean acidification impacts on shellfish. They concluded that existing datasets varied too much to explain the impacts of ocean acidification on shellfish productivity, and that data collection should be coordinated among all groups.

Taylor's real-time monitoring equipment was installed this year. Sometimes multiple times a day, the equipment measures the water's dissolved carbon dioxide, pH, salinity, temperature and dissolved oxygen. The data picture tells the hatchery when to spawn the oysters and when not to spawn.

"It's like putting headlights on a car," says Bill Dewey, director of public policy and communications for Taylor Shellfish Farms. "All of a sudden, we could see. Before, we were blindly pumping in seawater and not understanding the chemistry and not knowing what's going on every time we failed. Now, with monitoring equipment, we can see the correlations."

Says Cudd of Whiskey Creek: "For us, the only thing that is correlated with mortality is the CO_2 level."

Whiskey Creek stops pumping if CO_2 levels are too high and it's working on treating the water to adjust the pH, which helps but doesn't entirely solve the problem. It is also experimenting with algae to cleanse the seawater of CO_2.

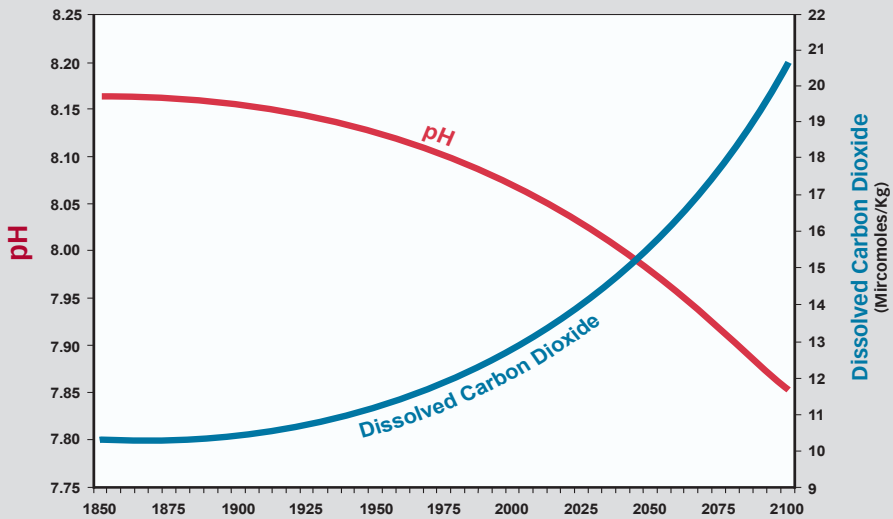
Taylor's hatchery is also closely monitoring the water and looking to improvements in genetics to adapt. While native oysters seem to be better adapted to more acidic water, non-native Pacific oysters are commercially preferred. Among the Pacifics, some strains are emerging that appear to be more resilient to the acidity.

Meanwhile, Taylor's 2010 hatchery production was double — its best year ever. The winds generally blew into Hood Canal from the south, keeping the surface waters in place and protecting the hatchery — for now — from water rich in CO_2.

Contributing Editor Lisa Duchene lives in Bellefonte, Pa.

Balancing act

As the ocean concentration of carbon dioxide increases, so does acidity (causing pH to decline)



Source: NOAA