The great oyster crash

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This OnEarth column was written by Eric Scigliano.

In the summer of 2007, something strange and troubling happened at the Whiskey Creek Shellfish Hatchery on Netarts Bay in Oregon, which raises oyster larvae for shellfish growers from Mexico to Canada. The hatchery's "seed," as the oyster larvae are called, began dying by the millions, for no apparent reason.

Disease isn't uncommon in a hatchery's tanks, but that same year, up the coast in Washington, wild oyster larvae also failed in Willapa Bay, which has been the heart of the Pacific Northwest's oyster industry since the 1850s.

The Willapa Bay growers scrambled to replace their natural beds with farm-raised seed from Whiskey Creek and other hatcheries. But there was very little of it to buy. Washington state's Taylor Shellfish Farms, the Pacific Coast's largest grower, also lost most of its larvae that year.

The situation was dire. Whiskey Creek and Taylor are key links in the nation's seafood supply chain. They and another Washington hatchery provide nearly all the seed for the West Coast's growers, who in turn produce more than a quarter of the 700 million or so farmed oysters that Americans slurp down every year.

Suddenly, it seemed, seafood lovers might have to do without their slippery delicacies, or at least pay a lot more for them. Growers on the Gulf and Atlantic coasts wondered if whatever was striking the Pacific hatcheries might soon hit them. And when the culprit was finally revealed, it provided the first example of how a worldwide crisis in ocean chemistry could devastate coastal economies and change restaurant menus across the country.

Whiskey Creek is owned by the husband-and-wife team of Sue Cudd and Mark Wiegardt. Wiegardt grew up tending oysters on Willapa Bay, where his family has been farming them since the late 1800s. Cudd, a fisheries biologist, got a job at the Wiegardt operation in 1984 and married Mark in 1989. She began managing the 33-year-old Whiskey Creek Hatchery in the mid-90s, and the couple took over the business together in 2002.

At the sprawling, barn-like warren about two hours west of Portland, where cylindrical plastic tanks serve as incubators for shellfish larvae and algae, a big part of their job is to keep vigilant watch for infections. When the 2007 crisis hit, Cudd and Wiegardt set about solving it according to standard industry practice: by looking for whatever pathogen might be making their "babies" sick.

They eventually found a larvae-eating bacterium called Vibrio tubiashii raging through their tanks. Attacking it with maximum force, they hired an engineer-turned-hatchery manager from Oregon State University named Alan Barton to build a $200,000 state-of-the-art system to filter and sterilize the water they drew from the bay. It squelched the Vibrio but failed to stop the carnage; the infestation, it seemed, was a symptom of some underlying problem, rather than the cause. The larvae were still dying, and Cudd and Wiegardt were facing ruin. So were many of the Pacific oyster farmers who relied on them.
Wiegardt has a farmer's weatherbeaten face and stoic manner. Like all farmers, he's used to boom-and-bust cycles. But even he started to despair. "The frustrating thing is people in the industry saying, 'It's got to be something you're doing wrong.'" His colleagues and competitors stopped their scoffing as news of other die-offs began to trickle in. In 2008, in an unprecedented cooperative effort for the industry, the Pacific Coast Shellfish Growers Association declared a "seed supply crisis." It persuaded its members to donate $40,000 so that Wiegardt and Cudd could keep Barton on the payroll and on the hunt for the culprit, in hopes of helping eradicate it elsewhere.

"We'd done everything we could to eliminate bacteria," Barton says in his native Georgia drawl. He began to wonder if something more fundamental might be amiss -- something in the makeup of the sea itself. "Shellfish hatcheries never worried about chemistry, just infections. I was back to being a 14-year-old kid with an aquarium, worrying about water chemistry."

Uncovering a killer

In July 2008, all of the remaining larvae at Whiskey Creek died suddenly. At the same time, the water in Netarts Bay (and hence in the hatchery's tanks) became noticeably more acidic -- an indication that it had welled up from lower depths offshore.

This wasn't entirely unexpected: Each summer, the north wind periodically pushes back the water along the Oregon coast, allowing deep, cold offshore water to surge in toward land. Barton checked federal CoastWatch reports and confirmed that a strong upwelling had been underway at the time the larvae died.

It was the breakthrough Whiskey Creek's operators had been waiting for. The culprit behind their die-offs, it turned out, was part of a much bigger change in oceans around the world. Called "ocean acidification," it results from too much carbon dioxide in the atmosphere. The sea is the world's great carbon sink, holding about 50 times as much of the element as the air. Phytoplankton at the ocean's surface absorb carbon dioxide for photosynthesis, and when the tiny plants die, they sink and decompose, releasing CO2 into the water column. Dissolved CO2 forms carbonic acid, the same weak acid that gives soda water its tang. Cold water can hold more CO2, so the frigid waters at the ocean bottom are more carbon-saturated, and more acidic, than the warmer surface water above.

Some people think that's a good thing; scientists and engineers have even proposed pumping CO2 into the deep ocean for storage, as a possible strategy to slow global warming. Trouble is, that acidified water doesn't stay down in the deep: It rolls back to the surface along the West Coast and other upwelling zones.

These nutrient-rich upwellings, full of sunken organic matter and minerals, support a famously rich marine food chain, from microscopic plankton to eight-ton killer whales. But if the waters become too acidic, they're lethal to many shell-building creatures -- including young clams and oysters, whose formative coverings are uniquely vulnerable in their first week or two of life.

Even as the hatchery folks were struggling with acidifying water inshore, scientists from Mexico, Canada, and the United States were documenting similar changes in the waters further out. They found that the upwellings operated on a time lag: The water rising from the depths today holds CO2 absorbed about 30 to 50 years ago, when expansions in transportation, industry, and other human activities began pushing increased amounts of carbon into the atmosphere.

Because carbon emissions have continued rising since, future upwellings are sure to be even more acidic. "We've mailed a package to ourselves," says Oregon State oceanographer Burke Hales, one of the scientists who conducted the offshore research, "and it's hard to call off delivery."

Adaptation in action

Sue Cudd and Mark Wiegardt didn't have time to worry about future deliveries; they had to protect their oysters now. That meant rethinking their operation from the sea bottom up.
"We used to think cleaner water was better," Cudd says, and so they purified and filtered relentlessly. But seawater chemistry is devilishly complex and hard to manipulate. Cudd and Wiegardt decided they had to learn to make better use of the water the ocean was giving them, but to do that they needed to know precisely what was in it. Unfortunately, their monitoring gear, like that of most in the industry, was minimal and crude. "We were driving down the road blind," sighs Wiegardt.

Hales turned on the lights. In 2010, he lent Whiskey Creek a gizmo that looks like a hospital heart monitor, but is actually a seawater monitor that he built in his lab at Oregon State. The colored squiggles snaking across its twin screens measure the vital signs of the incoming water: temperature, salinity, and dissolved carbon dioxide.

Cudd and Wiegardt call their monitor "the Burkalator" and watch it like day-traders tracking their stocks. Once, Hales tried to borrow it back for a research cruise. "No, you can't!" Cudd exclaimed. "If you take it, I'll go out of business!"

The Burkalator revealed a striking pattern: Carbon dioxide and acidity levels tended to peak in early morning. They fell off through the day as the algae in the bay did what green plants everywhere do when the sun shines: take up CO2 for photosynthesis. When night fell, the photosynthesis ceased and the pattern reversed itself. The readings often varied dramatically in a single day, Wiegardt said, from the aquatic equivalent of as many as 800 parts per million of CO2 to as few as 200 parts, and from a lethal pH of 7.5 to a luxurious pH 8.5. (Because pH is measured on a logarithmic rather than an arithmetic scale, 7.5 is 10 times as acidic as 8.5.)

Thus informed, Cudd and Wiegardt could time their draws to take only sweet, low-CO2 water, avoiding the sour morning blend. This entailed compromises; to draw less often they had to reduce production and recycle used water. But as Cudd says, "It's worse to put in bad water than to reuse mucky water."

Hales and his colleagues installed another Burkalator at the Taylor hatchery in Washington. They found that pH and CO2 levels varied just as widely there, but by depth rather than time of day. Taylor's hatchery sits on a deep bay whose waters are stratified like a layer cake. Cold, sour upwelled water tends to slide under the warmer, sweeter surface water. Again, the solution was simple: Taylor now draws from a shallow pipe rather than from deep water.

A temporary reprieve

The results are bracing. After a dire 2008 and 2009, Taylor has had its best years ever in 2010 and in the first half of 2011. Whiskey Creek isn't out of the woods -- Cudd and Wiegardt had to resume buffering their water this spring, and the upwellings this August have again made it difficult for them to find times when the water is suitable for incubating baby oysters -- but they are shipping seed again.

"Here's 2 million oyster larvae," Cudd says, showing me a swatch of white muslin wrapped around a gob of what looks like black sand. "I just shipped 40 million this morning." She has even volunteered to send 10 million larvae to help replenish a Japanese hatchery ravaged by the March tsunami. That same hatchery helped supply the West Coast oyster industry's original seed decades ago.

The hatcheries crisis offers both a foretaste of how the seas are changing due to acidification and a model for how industry and science can work together to mitigate it, says Lisa Suatoni, a National Resources Defense Council staff scientist working on the issue. "It's our first good example of the potential economic impacts of ocean acidification," she says. "And it's a perfect example of people adapting to the crisis."

But even the scientists and hatchery operators who have collaborated in this success admit that it's a stopgap. In the long run, only reducing carbon emissions into the atmosphere will keep ocean acidification from getting worse and threatening more shellfish.
Alan Barton, who diagnosed Whiskey Creek's chemistry problem, isn't waiting around for that to happen. He wanted to get as far away from souring seas as he could, so in late 2009 he left Oregon to start an oyster hatchery on North Carolina's Intracoastal Waterway. "I looked at a map of the world and tried to figure out where ocean acidification was least likely to be a problem," he says. "I picked here -- and I was wrong."

Already, Barton sees the problems that nearly shut down the West Coast's hatcheries settling in on the East, thanks both to local conditions and, he believes, to bigger changes in the sea itself. That's good for his business, at least in the short term; natural oyster beds have failed in many East Coast estuaries, just as they did on Willapa Bay, and Eastern oystermen are turning to hatcheries like his for seed.

But his current success will be cold comfort if carbon emissions don't abate and the sea undergoes catastrophic change.

"I'm afraid the ocean will be dead long before we have to worry about the other implications of global warming," Barton says quietly. "I didn't believe any of this stuff three years ago. I was always skeptical about our global models ... But ocean acidification is pretty cut and dried for me now. You see it every day. You can't escape it."

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