# Lab puts sea life to an acid test

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The baby crabs look like lint specs swirling in glass jars. The 3-day-old geoducks are too small to even see.

But the shellfish being reared in this cramped government laboratory will play a central role in predicting the future of sea life in Puget Sound.

Biologists at the Northwest Fisheries Science Center are doing some of the most sophisticated work anywhere to see how the marine world responds to a major side effect of fossil-fuel emissions: increasingly corrosive seas.

As oceans absorb evermore carbon dioxide, pH levels of the world's seas have been dropping. And recent experiments in laboratories around the globe show such shifts in ocean chemistry can spark bizarre and serious changes in plants and animals.

Sea-grass populations can increase while oysters, brittle stars and barnacles die young. Shells of marine snails called frilled dogwinkles get thinner, while sea bass ear bones tend to get bigger. The changes can even interfere with the ability of clown fish to smell predators.

But the Pacific Northwest and Puget Sound aren't like the open sea. Because they're fed by currents that well up from the cold, dark ocean bottom, waters in this region already are more corrosive. Carbon-dioxide emissions have exaggerated the effect.

Scientists last summer determined Puget Sound holds some of the most corrosive seawater found on Earth.

So researchers here have been designing experiments to solve some significant riddles.

Because Puget Sound sea life is used to a more corrosive environment, are its creatures more likely to adapt?

Or do those creatures already live so close to survival's edge that the consequences of ocean acidification will strike here first-and hardest?

"The ocean-chemistry changes we're seeing are happening faster than we've ever seen in history," said Paul McElhany, a research ecologist with the National Marine Fisheries Service in Seattle. "They can really alter the ecology of the ocean and lead to fundamental shifts in the structure of the marine food web."

The question is, said Kristy Kroeker, a Stanford University biologist, "How will it play out across an entire ecosystem?"

The pH of oceans measures a slightly alkaline 8.1 on the scale between acid and base, but scientists for years have predicted the emissions that fuel climate change would make waters more acidic as $CO_2$ is absorbed by the ocean. In 2008, oceanographers discovered that was happening decades faster than expected, with waters off the West Coast and Puget Sound registering as low as 7.7. Some waters in Washington's Hood Canal hit 7.4.

Scientists always feared increasingly acidic waters would be hard on creatures with calcium-carbonate shells - such as oysters. And wild Pacific oysters on the coast in Willapa Bay have not reproduced successfully in recent years.

But it's never been precisely clear if acidification is a root cause, or one factor. And it's not clear what other creatures may be affected-now or later.

So, to unravel the mysterious ways our marine world may be changing, McElhany and other researchers are raising sea critters thought to be particularly sensitive to corrosive waters. Every day at the lab on Seattle's Montlake Cut, they duck around mazes of pumps, tubes and hoses. They inject baby marine creatures into highly controlled waters designed to mimic our preindustrial past, our present and a predicted carbon-dioxide-rich future.

By monitoring how much CO2 is in each batch, they hope to tease out differences in how well and how fast species develop and reproduce. They are working with everything from krill and copepods-the planktonic creatures that make up the base of Puget Sound's food web-to Dungeness crabs, pinto abalone and rockfish.

The first experiments are with geoducks, because the absurd-shaped clams make up the largest biomass in Puget Sound and support its most economically significant commercial fishery. Researchers hope to have results early next fall.

But it's what happens next that really sets this work apart.

The scientists will be working with University of Washington experts who specialize in studying genetic changes, and with a San Juan Islands laboratory that will attempt to build a microcosm of the marine environment.

Together, these researchers hope to see what happens to the entire food web when multiple changes hit the marine world at once.

Several things complicate efforts to understand those changes. First, ocean life is constantly shifting anyway, and all the creatures in it rely on each other for food. Plus, ocean acidification isn't happening in a vacuum.

For example, shellfish tend to struggle in corrosive waters, while some crustaceans appear to actually get bigger.

But is that true when you combine corrosive waters and rising temperatures? Are crustaceans really thriving, or are they using up energy in ways that will only be understood later.

"What we know is that there will be winners and losers-both directly and indirectly," said Shallin Busch, an ecologist with Seattle's Northwest Fisheries Science Center.

While Montlake's acidification research is still in its infancy, Busch and other scientists have been examining the complex interactions of the Puget Sound's marine food web-and what happens when some species decline. They have found that changes can reverberate in surprising ways.

For example, computer models suggest that, if acidification reduces one type of plankton eaten by herring, herring populations may go down. But if acidification hits a different plankton species, the number of the fish could in fact increase. In another hypothetical scenario, potential declines in invertebrates such as urchins and sea cucumbers might be less than first expected because their predators-sea stars-decline, too.

"We're not saying that any of these things are happening or will happen, just that there are a lot of indirect impacts we don't yet understand," Busch said.

But researchers in the next several years hope to become expert in the very indirect impacts that ultimately will dictate Puget Sound's future health.