by Jennifer Hawks

A sampling bottle emerges from the Bering Sea during research to explain what your eyes are telling you: Specifically, the water is green. The change in color was caused by a bloom of coccolithophore algae – surprisingly, an indicator of nutrient-poor water. Until recent environmental changes, the Bering was considered to be rich in nutrients. The other photos show researchers and crewmen aboard the F/V Sea Storm *as they capture and examine salmon, pollock, and other species. Photos by Lisa Eisner, a biological oceanographer at NOAA.*

The Pacific is becoming more acidic, and that kills fish

The oceans are becoming more acidic, and the acid is killing fish you hope to catch.

Consider these findings, drawn primarily from a survey of scientific research on ocean acidification compiled by consultant and *Pacific Fishing* columnist Brad Warren:

• Acidified water dissolves shells of living animals that should be eaten by salmon, halibut, mackerel, cod, and other fish. Without their shells, those small creatures may not survive long enough to feed the fish you now catch. They die, and your fish starve before you can catch them.

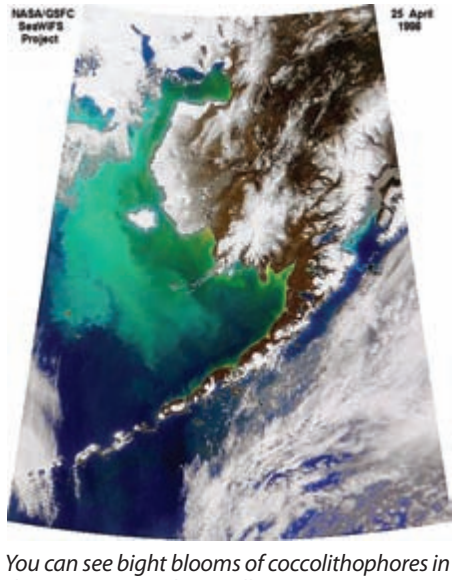
• Acidified water is bad news for king crab. Early experiments have shown that acidified water can kill most juvenile and larval king crab, according to experiments led by Mike Litzow, a NOAA scientist. And those that survive show retarded growth.

• In 2001, researchers from the Monterey Bay Aquarium Research Institute and Stanford University used a remotely operated vehicle to inject CO_2 into plastic pools at a depth of 12,000 feet in Monterey Bay. Sea urchins and sea cucumbers placed near the carbon dioxide pools died.

• Oceanographers and biologists have learned other disturbing facts too. For instance, it takes very little acidification to destroy certain kinds of fish larvae and eggs. Even mature fish are affected. Halibut and amberjack die from heart failure. Squid asphyxiate in acidic water because they can't breathe.

• Early symptoms of ocean acidification are already appearing in northern waters. If acidity levels continue to climb as expected, Dutch Harbor may become a ghost town.

• Ocean acidification affects the entire marine food chain, from tiny creatures in the ocean we can hardly see, to you at the top of that food chain. ■



You can see bight blooms of coccolithophores in the Bering Sea in this satellite image. Green water means nutrient-poor conditions.

Tiny organism may herald a huge change

This is a story about a very tiny thing: a type of plankton called coccolithophore. Yet, what we learn from it could outline the end of your business, your job, the way you live.

Whenever you hit the light switch at home, turn up the thermostat, or pump diesel into your boat, you're changing the ocean that gives you a living.

And the coccolithophores are merely a milepost on the way.

But we have to start at the beginning — with your light switch.

Humans burn stuff — coal, petroleum — to harvest energy. In the process, there's a lot of carbon left over.

Most scientists agree that carbon has caused our climate to change. You can see signs everywhere, from backyard thermometers to glaciers.

But the carbon causing the atmosphere to warm also changes the chemistry of the ocean — a phenomenon not understood until recent months.

Oceans absorb 30-50 percent of the world's carbon dioxide, according to the Alaska Fisheries Science Center Web site. The CO_2 converts into carbonate ions, and that, in turn, increases the water's acid content.

It's like the fizzy stuff in Coca-Cola.

"The reason it's so acidic and fizzy is that they just pump tons and tons of CO_2 in it, and the acid you get in Coca-Cola is carbonic acid," says Dr. Phillippe Tortell, an oceanographer based at the University of British Columbia.

Carbonic acid isn't necessarily a bad thing, unless you have too much of it. When you do, it hurts plankton first.

Like the coccolithophores (coco-lith-oh-fores).

They're plants — phytoplankton — too small to see. It would take 250 of them to equal a grain of sand. But coccolithophores can grow with such abandon that they literally change the color of the sea across areas as large as Oregon.

Coccolithophores have an advantage over their fellow phytoplankton: They thrive where other types struggle.

They can also migrate to an area and overwhelm competing phytoplankton. When coccolithophores bloom, they turn the ocean color turquoise, and the massive bands of color are visible from space.

Phytoplankton (fi-tow-plank-ton) — including coccolithophores — are everywhere but, because they are plants, they must live near the surface to absorb light. They grow on nutrients upwelling from deep water, like off the Northwest Coast.

Yet, coccolithophores — like crabgrass — are less particular than most. In fact, coccolithophores thrive in water that has so few nutrients that other species of phytoplankton struggle merely to live.

In short, where you find coccolithophores, you have sterile water.

In normal times, coccolithophores have existed in waters in the North

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Researchers aboard the F/V Sea Storm *examine samples to chart growth. Lisa Eisner photo*

Atlantic, off Iceland, and northern Australia. Lately, however, they've covered massive areas of the Bering Sea. Why?

Scientists are puzzled, because the Bering Sea is normally rich in nutrients, something coccolithophores aren't supposed to like.

The sudden proliferation coincides with increased carbon in the atmosphere in the ocean. But the cause has yet to be determined. Irrefutable is this: Most scientists agree that significant biogeochemical changes in the ocean have begun.

Though it's too soon to say for certain, what may be happening is that the nutrient level in northern waters is declining. If so, every living creature in the region will be hurt — as will human creatures who make a living catching them.

And what may be good times for coccolithophores because of increased acidification, may eventually doom the coccolithophores themselves, because they have a calcium shell that could fizz away in an acid ocean. ■

The fish you hope to catch will starve first

Every fish you harvest from the Pacific rests atop a food chain of creatures almost too small to see with the naked eye.

Yet, if subtle changes in ocean chemistry affect these tiny creatures, your business and your job are vulnerable.

Today, scientists are seeing such changes happening. People pump carbon into the atmosphere. Burning of fossil fuels like oil, gas, and coal for energy generates 82 percent of all human-created carbon dioxide. The carbon interacts with ocean water. The water becomes more acidic. Plankton die. You go broke.

> ***You could have food chains collapse, and fisheries ultimately with them, because most of the fish we get from the ocean are at the end of long food chains. You probably will see shifts in favor of invertebrates, or the reign of jellyfish.***
>
> ***— Thomas Lovejoy, president of the Heinz Center for Science, Economics, and the Environment, quoted in*** **The New Yorker**

If a member of the food chain goes missing or overwhelms its competition, the whole marine life cycle can be affected.

Dr. Phillippe Tortell is an oceanographer based at the University of British Columbia who has spent many years studying phytoplankton and ocean productivity. Field studies have even taken him aboard icebreakers.

"We tend to think that phytoplankton are phytoplankton are phytoplankton, because they're all invisible to us, and are just single cells, but there are important differences that affect the way that herbivores are going to use that resource. In terms of fisheries, it certainly does matter what kind of organisms you've got."

In a report released last July, a number of scientists predicted that increased levels of CO_2 may have adverse effects on certain marine life and disrupt or significantly alter marine food webs. *Impacts of Ocean Acidification on Coral Reefs and Other Marine Calcifiers* evolved from a workshop that the National Science Foundation, the National Oceanic and Atmospheric Administration, and the U.S. Geological Survey sponsored.

The report warns that acid levels in seawater are higher now than they've been since pre-Industrial times.

Even if those levels don't further increase, prolonged exposure to seawater will have adverse effects on ocean life.

Many marine plants and animals have protective shells made from calcium carbonate, which are vulnerable to acid — sea urchins, corals, and pteropods among them. Studies have shown that in 50-100 years, those shells will dissolve from the acid concentrations.

Conceivably, without their protective shells, these animals will die or significantly decline in number.

In the best-case scenario, they'll migrate to healthier waters, which can also disturb the balance.

Kate Myers, faculty researcher in the School of Aquatic & Fishery Sciences at the University of Washington, specializes in high-seas salmon. How long will it be before we see fisheries affected from ocean acidification?

"It's a new hot topic. I think a lot of people are talking about it, but there's not been a lot of detailed work done yet to be able to make a prediction."

One thing is certain. The problem of ocean acidification isn't going away, and it's likely to get worse. For now, it's a game of wait and see. ■

Canadians build acidification model

The Canadian Department of Fisheries and Oceans collaborates with Environment Canada and the University of Victoria to build ocean climate-carbon models at the Canadian Centre for Climate Modelling and Analysis.

About five years ago, the Centre began studying the land-ocean carbon cycle. The model they're building helps us to understand how carbon dioxide in the atmosphere can affect Earth.

Climate models are not a crystal ball, however. Two scientific researchers on the team, Jim Christian and Ken Denman, prefer to use the word "projection" rather than "prediction" when it comes to possible future scenarios involving CO2 and ocean acidification.

Christian says, "There are certain things that are relatively well known, and there are some things that are highly uncertain. We can't really state with a lot of confidence what the impacts of (ocean acidification) are going to be. But there will be impacts. There are certain kinds of plankton that will find it increasingly difficult to grow in a more acidic ocean."

Denman believes that for now, there are more questions than answers.

"We don't know how or whether the fish will be affected. In the short term, we don't think it will affect the salmon, but in a few decades it could start to affect their food chain." ■

– Jennifer Hawks