Greenhouse ocean may downsize fish

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The last fish you ate probably came from the Bering Sea. But during this century, the sea’s rich food web—stretching from Alaska to Russia—could fray as algae adapt to greenhouse conditions.

“All the fish that ends up in McDonald’s, fish sandwiches—that’s all Bering Sea fish,” said USC marine ecologist Dave Hutchins, whose former student at the University of Delaware, Clinton Hare, led research published Dec. 20 in *Marine Ecology Progress Series*, a leading journal in the field.

At present, the Bering Sea provides roughly half the fish caught in U.S. waters each year and nearly a third caught worldwide.

“The experiments we did up there definitely suggest that the changing ecosystem may support less of what we’re harvesting—things like pollock and hake,” Hutchins said.

While the study must be interpreted cautiously, its implications are harrowing, Hutchins said, especially since the Bering Sea is already warming.

“It's kind of a canary in a coal mine because it appears to be showing climate change effects before the rest of the ocean,” he noted.

“It’s warmer, marine mammals and birds are having massive die-offs, there are invasive species—in general, it’s changing to a more temperate ecosystem that’s not going to be as productive.”

Carbon dioxide's direct effects on the ocean are often overlooked by the public.

"It's all a good start that people get worried about melting ice and rising sea levels," he said. "But we're now driving a comprehensive change in the way Earth's ecosystem works—and some of these changes don't bode well for its future."

The study examined how climate change affects algal communities of phytoplankton, the heart of marine food webs.

Phytoplankton use sunlight to convert carbon dioxide into carbon-based food. As small fish eat the plankton and bigger fish eat the smaller fish, an entire ecosystem develops.

The Bering Sea is highly productive thanks mainly to diatoms, a large type of phytoplankton.

"Because they're large, diatoms are eaten by large zooplankton, which are then eaten by large fish," Hutchins explained.

The scientists found that greenhouse conditions favored smaller types of phytoplankton over diatoms. Such a shift would ripple up the food chain: as diatoms become scarce, animals that eat diatoms would become scarce, and so forth.

"The food chain seems to be changing in a way that is not supporting these top predators, of which, of course, we're the biggest," Hutchins said.

A shift away from diatoms towards smaller phytoplankton could also undermine a key climate regulator called the "biological pump."

When diatoms die, their heavier carbon-based remains sink to the seafloor. This creates a "pump" whereby diatoms transport carbon from the atmosphere into deep-sea storage, where it remains for at least 1,000 years.

"While smaller species often fix more carbon, they end up re-releasing CO_2 in the surface ocean rather than storing it for long periods as the diatom-based community can do," Hutchins explained.

This scenario could make the ocean less able to soak up atmospheric carbon dioxide.

"Right now, the ocean biology is sort of on our side," Hutchins said. "About 50 percent of fossil fuel emissions since the industrial revolution is in the ocean, so if we didn't have the ocean, atmospheric CO_2 would be roughly twice what it is now."

Hutchins and colleagues are doing related experiments in the north Atlantic Ocean and the Ross Sea, near Antarctica. The basic dynamics of a greenhouse ocean are not well understood, he noted.

"We're trying to make a contribution by doing predictive experimental research that will help us understand where we're headed," he said. "It's unprecedented the rate at which things are shifting around."

The researchers collected the algae samples from the Bering Sea's central basin and the southeastern continental shelf. They incubated the phytoplankton onboard, simulating sea surface temperatures and carbon dioxide concentrations predicted for 2100.

Each of these variables was tested together and independently. Ratios of diatom to nanophytoplankton in manipulated samples were then compared with those in plankton grown under present conditions.

The scientists found that photosynthesis in greenhouse samples sped up two to three times current rates. However, community composition shifted from diatoms to the smaller nanophytoplankton.

Temperature was the key driver of the shift with secondary impacts from the increased carbon dioxide concentrations, according to the study.

Source: University of Southern California

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