Climate changes, Cod collapse have altered North Atlantic ecosystems

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Ecosystems along the continental shelf waters of the Northwest Atlantic Ocean, from the Labrador Sea south of Greenland all the way to North Carolina, are experiencing large, rapid changes, reports a Cornell oceanographer in the Feb. 23 issue of *Science*.

While some scientists have pointed to the decline of cod from overfishing as the main reason for the shifting ecosystems, the article emphasizes that climate changes are also playing a big role.

"It is becoming increasingly clear that Northwest Atlantic shelf ecosystems are being tested by climate forcing from the bottom up and overfishing from the top down," said Charles Greene, director of the Ocean Resources and Ecosystems Program in Cornell's Department of Earth and Atmospheric Sciences. "Predicting the fate of these ecosystems will be one of oceanography's grand challenges for the 21st century."

Most scientists believe the planet is being warmed by greenhouse gases emitted in the burning of fossil fuels, and by changing land surfaces. Early signs of this warming have appeared in the Arctic: Since the late 1980s, scientists have noticed that pulses of fresh water from increased precipitation and melting of ice on land and sea in the Arctic have flowed into the North Atlantic Ocean and made the water less salty.

At the same time, climate-driven shifts in Arctic wind patterns have redirected ocean currents. The combination of these processes has led to

a freshening of seawater along most of the Northwest Atlantic shelf.

In the past, during summer months, a wind-mixed layer of warmer, less salty water (which is less dense and lighter) floated on the ocean surface. When the air temperature cooled during autumn, temperature and density differences lessened between the surface mixed layer and the cooler, saltier waters below. Similar to the flow of heating and cooling wax in a lava lamp, as the density differences became smaller, mixing between the layers typically increased and the surface mixed layer deepened.

But, Greene cites recent scientific studies that reveal the influx of fresh water from Arctic climate change is keeping the surface mixed layer relatively shallow, curbing its rapid deepening during autumn. A gradual rather than rapid deepening of the surface mixed layer has led to changes in the seasonal cycles of phytoplankton (tiny free-floating plants like algae), zooplankton (tiny free-floating animals like copepods) and fish populations that live near the surface, according to the report.

Without the fall deepening of the surface mixed layer, phytoplankton populations have continued access to daylight needed for growth, and their numbers have stayed abundant throughout the fall. In turn, zooplankton, which feed on the phytoplankton, have increased in number during the fall through the early winter. Herring populations also rose during the 1990s, which some scientists suspect may be because of the abundance of zooplankton to feed on.

At the same time, Greene's article cites how the collapse of the cod populations in the early 1990s has led to increases in bottom-living species such as snow crab and shrimp that cod feed on. Without cod preying on them, other animals that live in the water column and feed on zooplankton, including herring, may have increased in numbers. But, while the story with herring is still unclear, the authors contend that the

crash of cod populations does not fully explain why phytoplankton and zooplankton populations at the base of the food chain have risen during autumn.

"We suggest that, with or without the collapse of cod, a bottom-up, climate driven regime shift would have taken place in the Northwest Atlantic during the 1990s," Greene said.

Source: Cornell University