THE PEW ENVIRONMENT GROUP

SEA AROUND US PROJECT

OCEAN SCIENCE SERIES

Climate change could reduce catch in developing countries.

OCTOBER 2009

Redistribution of Fish Catch by Climate Change

A Summary of a New Scientific Analysis:

Cheung, W.W.L., Lam, V.W.Y., Sarmiento, J. L., Kearney, K., Watson, R., Zeller, D. and Pauly, D. 2009. Large-scale redistribution of maximum fisheries catch potential in the global ocean under climate change. *Global Change Biology.*

Global climate change is expected to affect marine fisheries productivity because of changes in water temperature, ocean currents and other ocean conditions. Marine fisheries are an important food source, and changes in the total amount or geographic distribution of fish available for catch could affect food security. Changes in marine food supply due to climate change, however, were previously unknown.

William Cheung and his coauthors used models that linked ocean conditions with the geographic range of species to predict changes in potential catch under low and high greenhouse gas emissions scenarios. They found that globally, the maximum total catch potential in the year 2055 remained essentially unchanged from current levels under both scenarios. But catch potential changed within regions, and the magnitude

of that change was greater under the high emissions scenario. In general, maximum possible catch increased at higher latitudes and decreased in the tropics, which tend to be the most socioeconomically vulnerable areas. The authors conclude that this change may have large implications for global food security. This *Pew Ocean Science Series* report is a summary of the scientists' analysis.

Climate Change and Fisheries

Marine fisheries productivity may be affected by changes in ocean conditions resulting from climate change, including changes in food web structure and species distribution. Studies show that marine fish and invertebrates tend to shift their distributions toward higher latitudes and deeper waters in response to climate change. Relative abundance of species may also change as some habitats become less appropriate for them.

Study Methods

The authors used several models incorporating a wide range of environmental and biological factors that affect fisheries to predict future changes in maximum fisheries catch potential around the world under two climate change scenarios. The factors considered included a number of ocean conditions such as temperature, salinity and primary productivity (the amount of chemical energy in plants, especially algae), as well as species' environmental preferences and their relative abundance and distribution. The scientists set a low greenhouse gas scenario for carbon dioxide at 2000 levels and a high emissions scenario of doubled carbon dioxide by 2100. The authors defined "maximum catch potential" as the maximum possible catch of a species given a certain habitat size and food availability. Climate projections were generated by a U.S. National Oceanic and Atmospheric Administration laboratory. Although using modeling to predict fisheries response to climate change does not necessarily provide the probabilities of different scenarios happening, it can help policy makers and stakeholders consider the potential scale of the impacts and develop response scenarios.

The scientists predicted maximum catch potential in the year 2055 for 1,066 species of major commercially exploited fish and invertebrates. These species represent 70 percent of global fisheries landings as reported by the U.N. Food and Agriculture Organization for 2000 to 2004. To reduce the effect of year-to-year variability, the authors applied a 10-year running average to the estimated catch potential. Their estimates include global projections as well as estimates broken down by latitudinal regions, within continental shelf and offshore regions, and at the country level.

Climate change may lead to large-scale redistribution of catch potential across the globe.

FIGURE 1. CHANGE IN MAXIMUM CATCH POTENTIAL FROM 2005 TO 2055 under the climate change scenario where greenhouse gas concentration is doubled by the year 2100.

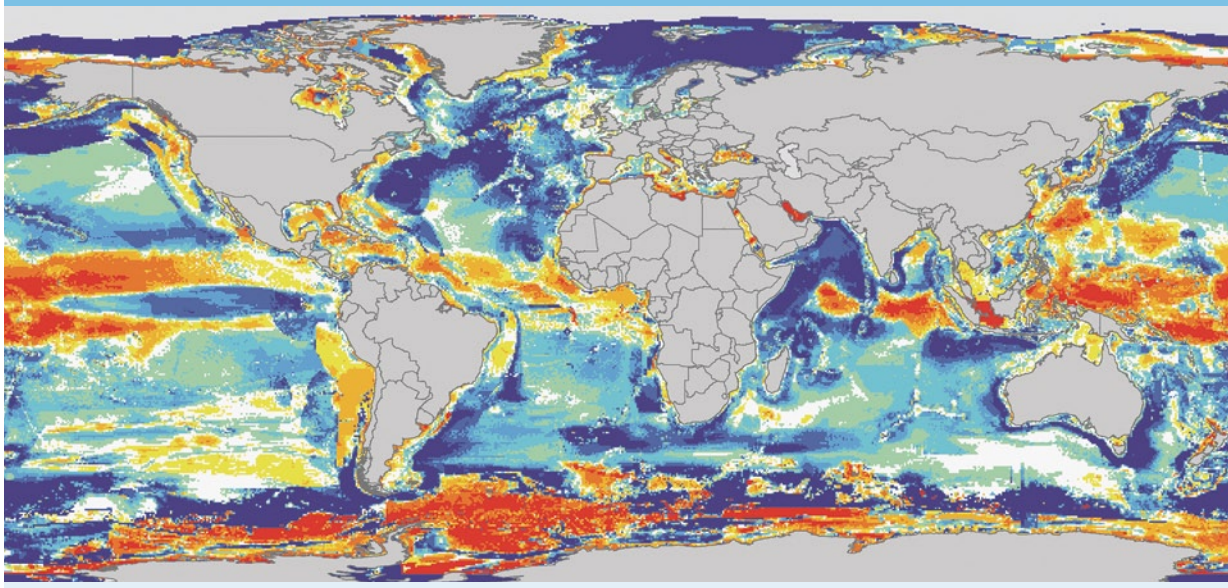
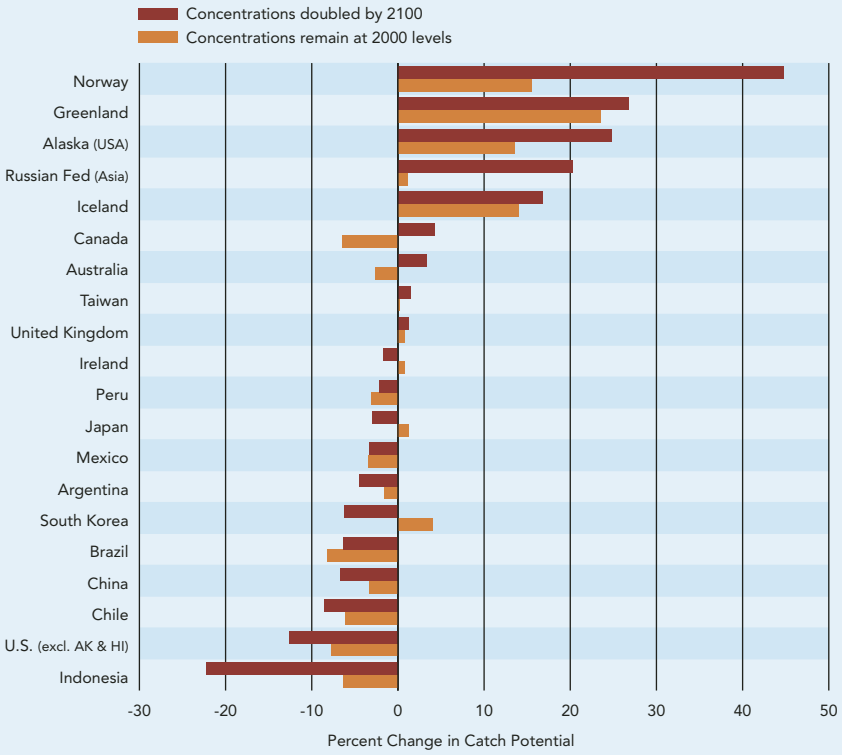


FIGURE 2. CLIMATE CHANGE IMPACTS ON CATCH POTENTIAL.



The two scenarios represent possible greenhouse gas emissions. In the first scenario, emissions continue to grow in their current trajectory and will double by 2100. The second scenario assumes that greenhouse gas concentrations remain constant at 2000 levels.

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Findings and Implications

The authors projected very little change in overall fisheries productivity globally. However, they found large regional changes in potential catch regardless of a high or low emissions scenario, and these changes could be even greater under the high emissions scenario (see Figure 1).

- Climate change may lead to large-scale redistribution of global catch potential, ranging from a 30–70 percent increase in high latitude regions to a drop of up to 40 percent in the tropics.
- Catch potential may decrease in semi-enclosed seas such as the Mediterranean and in coastal areas.
- Catch potential may increase in the North Atlantic, North Pacific and the poleward tips of continental margins, such as around South Africa, Argentina and Australia.
- Catch potential in offshore areas of high latitude regions, such as the North Atlantic and North Pacific, the Arctic and the northern edge of the Southern Ocean, may increase by more than 50 percent under a high greenhouse gas scenario.
- Analyses of 20 fishing Exclusive Economic Zones (EEZ) with the highest catch in the 2000's showed gains for high latitude EEZ regions and losses for most others (see Figure 2). The authors note that these country-specific estimates are more uncertain than projections for larger regions.

The authors concluded that regional changes in maximum catch potential have large implications for global food security. In particular, climate change may reduce access to food in tropical communities that depend on fisheries for food and income. These findings support similar projections for a reduction in land-based food production in tropical developing countries due to climate change, and suggest that shifts in fisheries productivity may exacerbate future food security problems.

This study results from a research partnership between the Sea Around Us Project and investigators at Princeton University. The Sea Around Us Project is a scientific collaboration between the Pew Environment Group and the University of British Columbia.

Regional changes in maximum catch potential may have large implications for global food security.

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