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Heating up. The Antarctic toothfish is having a harder time finding cold water.

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Warming Spells Trouble for Fish

By Christopher Pala
*Science*NOW Daily News
10 July 2008

FORT LAUDERDALE, FLORIDA--Global warming of the oceans will likely cause the extinction by 2050 of dozens of fish species that cannot migrate to colder waters, according to a study presented here yesterday at the 11th International Coral Reef Symposium. "The loss of biodiversity will be considerable, and replacing them with new species would take millions of years," says co-author Daniel Pauly of the University of British Columbia (UBC) in Vancouver, Canada.

Fish can tolerate temperature fluctuations of a few degrees in a laboratory aquarium. But in the wild, a difference of even a degree or two can force them to move into a new ecosystem where they will face different foods and different predators. "Some will not be able to handle that and will disappear," says the study's lead author, ecosystem modeler William Cheung, also at UBC. Indeed, almost two-thirds of fish in the North Sea now live in different locations or depths because of rising sea temperatures (*Science*, 13 May 2005, p. 937).

No one had taken a broad look, however, at how climate change might affect a multitude of oceanic species. To do this, Cheung and his colleagues created a model that considered a range of habitat conditions--such as water temperature, depth, and distance from sea ice--that species prefer and can withstand. The model predicts where and how much those habitats will change in response to global warming and simulates how populations will respond. Cheung's team plugged in data on 1066 abundant commercial species of fish and invertebrates.

The results highlight major changes in the polar regions. For instance, the area with water cold enough for the Antarctic toothfish (*Dissostichus mawsoni*) to survive is going to shrink as waters get warmer, and its population will have to shrink as well, Pauly said. Within 30 years, it will probably go extinct.

All told, some 50 species of commercial fishes that live at or near the poles will likely die off. Species living farther from the poles will probably migrate toward the Arctic or Southern oceans, where these newcomers may disturb the existing ecosystems, Cheung says. In addition, Pauly notes, past fishing has already reduced genetic diversity and may limit the ability of populations to adapt to new conditions.

Other populations may be trapped. As the Sea of Cortez warms, the giant croaker (*Totoaba macdonaldi*), an endangered fish that can reach 2 meters in length, won't be able to escape northward. The same will happen in closed seas such as the Mediterranean Sea, where fish populations, such as the local hake (*Merluccius merluccius*), will be unable to migrate to colder waters. Vicky Lam, another author, adds that the results come out the same with several different simulation models of predicted temperatures. The model and some of these results were described in detail in January in one of UBC's *Fisheries Centre Research Reports*.

The model has several limitations, the authors note. It doesn't simulate the food availability in the new

habitats that the species will encounter as they move poleward, nor does it account for changes in oxygen distribution that may affect fish and that do not exactly parallel changes in temperature, Cheung notes.

"Pauly looks at the big picture," says Jeremy Jackson, a biological oceanographer at the Scripps Institution of Oceanography in San Diego, California. "There are lots of studies that clearly demonstrate that species have been galloping toward the poles for decades, but this study puts it all together in a genuinely oceanic scale. Wherever there are barriers to these mass migrations, it's obvious that there is no hope for the species involved."