versity of British Columbia, who has done studies of the sea lion declines sponsored by the fishing industry, says he's scrutinized the timing of the declines and the fisheries buildup and "I don't see a connection." Dayton tends to agree that overfishing "is too simplistic. ... The cause of the killer whale shift is probably very complicated."

Estes, however, believes overfishing is the most likely suspect—and he warns that the lesson applies far beyond Alaska. Fisheries are collapsing around the world, he notes, and as with the otters, if scientists looked more closely they might find the effects "very widely manifested in coastal ecosystems. We were lucky just to have been sitting on this and seen it when it happened. But very likely, they're the sorts of things we should be worrying about elsewhere." **–JOCELYN KAISER**

ATMOSPHERIC CHEMISTRY

Deep Chill Triggers Record Ozone Hole

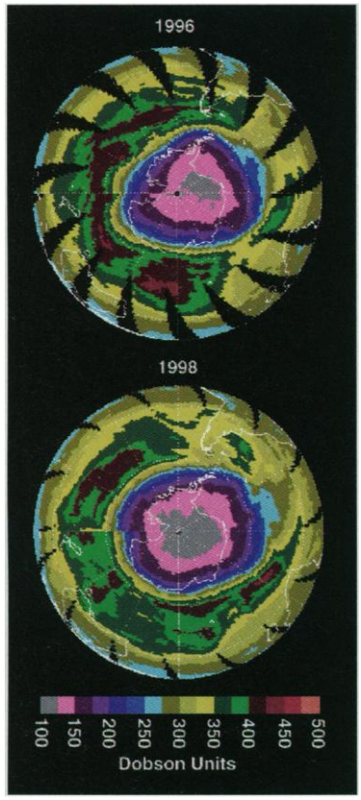
In theory, the ozone hole that reopens each year over Antarctica should gradually heal as international regulations choke off the flow of ozone-destroying chlorine compounds into the stratosphere. But little about atmospheric chemistry is that simple, as this year's Antarctic ozone hole testifies. It is almost as severe as any seen before, and it stretches over an area larger than North America, a new record. Unprecedented stratospheric cold is driving the extreme ozone destruction, say researchers. Some of the high-altitude chill, they add, may be a counterintuitive effect of the accumulating greenhouse gases that seem to be warming the lower atmosphere.

This year's Antarctic ozone hole is a whopper in every sense. Seen from a National Oceanic and Atmospheric Administration (NOAA) satellite, the area of depleted ozone extends over about 26 million square kilometers, the largest observed since annual holes first appeared in the late 1970s. Measured by balloon-borne instruments ascending from the South Pole, the layer of total ozone destruction extends from an altitude of 15 kilometers to 21 kilometers. That's higher than ever seen before, says ozone researcher David Hofmann of NOAA in Boulder, Colorado. And by 5 October, the total amount of ozone over the South Pole had dropped to 92 Dobson units, Hofmann says; only in 1993 was the ozone hole deeper, when the catalytic effect of debris from the 1991 eruption of Mount Pinatubo in the Philippines helped drive ozone down to 88 Dobson units. (Normally there are about 280 Dobson units of ozone over the pole.)

The deep chill that gripped the Antarctic stratosphere this past austral winter is to blame, say Hofmann and other scientists. Every winter, it gets cold enough there—below –78°C—to form the icy stratospheric clouds that catalytically accelerate the destruction of ozone by the chlorine from chlorofluorocarbons (CFCs). This year, the area cold enough to form polar stratospheric clouds "is larger than anything we've seen to date" for the same time of year, says meteorologist Melvyn Gelman of NOAA's Climate Prediction Center in Camp Springs, Maryland. "There's much less heat being pumped up into the stratosphere than usual," he says.

No one knows just why, but an underlying cooling trend in the stratosphere—induced by, of all things, greenhouse gases—is probably aggravating the situation, researchers say. Although greenhouse gases warm the lower atmosphere, they cool the stratosphere by radiating heat to space, creating an "icehouse effect." Recent computer modeling has suggested that greenhouse cooling might greatly worsen the nascent ozone hole over the Arctic (*Science*, 10 April, p. 202). And a new modeling study, published in the 1 October *Geophysical Research Letters* by M. Dameris of the German space agency DLR in Oberpfaffenhofen and colleagues, points to effects on Antarctic ozone, too. By 2015, their model says, ozone at lower latitudes will begin recovering as CFC controls take effect, but the chilling effect of greenhouse gases will have kept the Antarctic ozone hole as severe as ever.

–RICHARD A. KERR



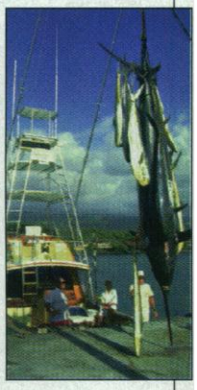
One of the worst. The 1998 Antarctic ozone hole (bottom, inside the blue) is the biggest ever and is deeper than most, as shown by a comparison of the gray area with 1996 (top).

CREDIT: (TOP) GREG VAUGHN/ALLSTOCK/PNI; (BOTTOM) NASA/GSFC

ScienceScope

BILLFISH PLAN NOT SHARP ENOUGH?

A new plan to protect Atlantic billfish such as marlin and sailfish doesn't go far enough to protect dwindling stocks from accidental catches, fisheries experts say. The guidelines, released last week by the National Oceanic and Atmospheric Administration (NOAA), are the first of 39 new conservation plans covering key fish species required by a 1996 law designed to prevent overfishing.



It has been illegal for commercial fishers to sell Atlantic billfish since 1988, but the fish are still legally caught in tournaments and accidentally snared by longlines intended for swordfish and other species. Russell Nelson of the Florida Marine Fisheries Commission says localized bans on longline fishing would reduce the accidental "bycatch" by more than 25%, while causing only a 5% loss in swordfish catches. He hopes such statistics convince NOAA to impose such a ban. The plan is open to public comment until early next January.

WHITE HOUSE ORDERS STUDY OF INTERNATIONAL ENERGY R&D

President Clinton is seeking expert input on global energy research. To get the most from U.S. spending on international collaborations aimed at understanding global warming and other issues, he has asked the President's Committee of Advisers on Science and Technology (PCAST) to review U.S. involvement in international energy R&D projects.

The request follows a PCAST study of domestic energy R&D issued a year ago. Led by Harvard environmental policy professor John Holdren, it helped boost the president's 1999 budget request for energy research. Now, Holdren will produce a sequel with an international flavor. The report, due in April, will tally what various U.S. and international agencies already do and offer advice for the coming decades. White House official Sam Baldwin says the panel will focus on applied research, but could comment on anything from fusion research to clean coal technology in China.

Contributors: David Malakoff, Gretchen Vogel, Jocelyn Kaiser