[for funding]. But it would be hard to convince an agency like NSF to put in the millions of dollars into a vehicle that can routinely go to a place like the trenches.

Q: What's the future of exploration and research in this area?

I know India and China are building deep submergence vehicles—they may take up some of the activity that the U.S. has led on. It just won't be done exclusively or primarily by the U.S. We'll still run *Alvin* and *Nereus*, so work won't dry up in the U.S.

FINDINGS

Panel: Conserve Forage Fish To Protect Ecosystems

Fishing of small species near the base of the food web—forage fish such as herring—should be more conservative, because these species are prone to collapse and are an important source of food for seabirds and

Legacy. Seabirds have not recovered from overfishing of anchovetas.

other predators, according to a blue-ribbon panel of scientists.

In 2009, the Pew Charitable Trust's Lenfest Ocean Program commissioned 13 scientists to study how fishing impacts forage fish and their predators. Under conven-

tional management, forage fisheries have a 42% chance of collapsing, they found. If fishing rates are cut in half, the likelihood of collapse falls to 6%, and predators are less likely to go extinct.

Fishing less could also have an economic payoff: Forage fish are worth more when left in the ocean, because the predatory fish that eat them can be sold for more money. Based on computer models of 72 ecosystems, the researchers found that the global value of forage fish caught is $5.6 billion a year, but those left in the ocean contribute twice that amount to other fisheries. "They have an important value in the ecosystem, and that value can translate into big dollars," says Ellen Pikitch of Stony Brook University in New York, who led the study.
http://scim.ag/foragefish

Case Closed: CO_2 Helped End Last Ice Age

Any doubts about carbon dioxide's power to warm the world can be put to rest. A new record of global temperatures as Earth came out of the last ice age demolishes the contrarian contention that carbon dioxide merely followed global warming.

The problem had been that ice core records from Antarctica showed carbon dioxide rising only *after* warming was in full swing. But climate scientists knew that no one place is representative of trends in global climate. So Jeremy Shakun of Harvard University and his colleagues carefully combined 80 paleo-temperature records from around the globe—from pollen in Alaskan lake muds to microfossils in Indian Ocean sediments.

In this week's issue of *Nature*, Shakun and his colleagues report that about 18,000 years ago, global warming did in fact lag the rise of carbon dioxide by a few centuries, as it should if the greenhouse gas were helping drive the world out of the ice age. "All in all, a solid study," says climate scientist Michael Mann of Pennsylvania State University, University Park; carbon dioxide is indeed a potent climate changer. **http://scim.ag/CO2ice**

Random Sample

Turing's Ideas Blossom

A sunflower is more than just a pretty face: It's a floral expression of the so-called Fibonacci sequence—1, 1, 2, 3, 5, 8, and so on, where each number is the sum of its two preceding numbers. And now, a U.K.-based project is enlisting the help of gardeners around the world to help test a theory that originated with one of history's greatest mathematicians, Alan Turing.

In the 1950s, toward the end of his life, Turing investigated why features in nature, such as the number of spirals in which seeds grow on a sunflower, often relate to the Fibonacci

sequence. Turing tried to show that simple geometry constrains new growth so that, over time, an organism's features take on higher Fibonacci numbers. Later theoretical models supported Turing's ideas, but they also predicted that other numbers, such as those from a more complex "Lucas" sequence, should sometimes be present instead.

"If you look at cases where sunflowers don't have Fibonacci numbers—that's actually where you start getting information about whether these models are true or not," says Jonathan Swinton, a consultant systems biologist in the United Kingdom. Working with the Manchester Science Festival, Swinton is asking people to test the models by growing sunflowers and counting the number of seed spirals (http://www.manchestersciencefestival.com/connect/getinvolved/sunflowers). If these numbers don't match the models' predictions, scientists will know to improve the models, he says.

Project manager Erinma Ochu at the University of Manchester in the United Kingdom, says she already has participants around the world, from the United States to Palestine. "Using the public is the best way to get a big data set," she says.

Science LIVE

Join us Thursday, 12 April, at 3:00 p.m. EDT for a live chat with experts on the **science of decision-making** and how human and animal groups come to consensus. **http://scim.ag/science-live**