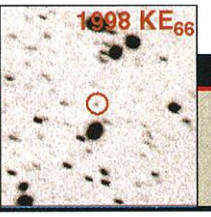
PAGE 685
Putting the heat on salmon



689
Finding an edge

MARINE ECOLOGY

Warmer Waters More Deadly To Coral Reefs Than Pollution

NUSA DUA, INDONESIA—Contrary to conventional wisdom, warmer ocean waters are a greater threat to coral reefs than local environmental insults. That assessment comes from a new scientific report* released this week that documents a sudden and steep jump in damage stemming from the 1997–98 El Niño–La Niña event.

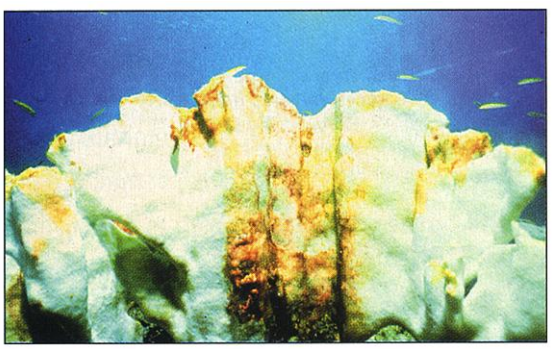
"Coming up to 1998, we thought direct human impacts were the biggest threat to reefs," says Clive Wilkinson, editor of the report and a marine biologist at the Australian Institute of Marine Science in Cape Ferguson, referring to such events as pollution and destructive fishing practices. "Now, we've got to reset our agenda to focus on climate change as well." He admits that climate change was first mentioned as a possible cause in the 1980s, but the incidence of bleaching then was isolated and at a low level. "In the latest event, we had bleaching all the way from Brazil to the Indian Ocean," Wilkinson says.

The new analysis comes from the Global Coral Reef Monitoring Network, an affiliation of marine scientists and government agencies that 2 years ago produced its first snapshot of the health of reefs. Presented here at the 9th International Coral Reef Symposium in Bali, the current report is the first that contains a complete description of the physical damage caused by warmer than usual sea temperatures during 1997 and 1998. Prior to 1998, an estimated 11% of the world's known reefs had been destroyed by human activities, according to the report. Barely 1 year later, another 16% had been "severely damaged" by the El Niño event, with little chance of short-term recovery (see table). Although some of these reefs will recover over time, others have already slipped into the destroyed category. "It was a wake-up call for reef scientists," says Wilkinson, noting that climate change models predict not only a steady rise in baseline sea temperatures but possibly more frequent and ferocious El Niños that would cause more bleaching.

THE EL NIÑO EFFECT

Region	Pre-1998 destruction	Occurred in 1998
Arabia	2%	33%
Indian Ocean, overall	13%	46%
Australia, Papua New Guinea	1%	3%
South, East Asia	16%	18%
Pacific Ocean, overall	4%	5%
Caribbean	21%	1%
GLOBAL TOTAL	**11%**	**16%**

Often called the "rainforests of the sea," coral reefs host a disproportionate share of marine life. What's more, "their sensitivity to rising temperatures" also makes them "silent sentinels" of global warming, says Alan Strong, an oceanographer who studies global climate change at the U.S. National Oceanic and Atmospheric Administration in Camp Springs, Maryland. "We don't have many systems that give us such a characteristic climate change signal as coral reef bleaching," Strong says.



Whiteout. Bleaching, from rising water temperatures spawned by El Niño, is a growing hazard to coral reef populations.

Even small temperature changes can have dramatic effects on reefs. Exceeding a threshold of around 30°C triggers bleaching, in which coral expel zooxanthellae, the symbiotic algae that give the coral its color. Coral appear able to survive short-term bleaching if there are no other stresses, such as pollution or destructive fishing. They can die, however, if subjected to high temperatures for long periods of time or if already stressed. Previous bouts of bleaching have been limited to particular areas, such as the Caribbean. But the 1997–98 El Niño event, which lasted for over a year, produced record-high sea surface temperatures throughout the Indian and western Pacific oceans; this in turn led to the most extensive coral bleaching ever seen. "Some of those reefs will come back, but others won't," Wilkinson says.

The intensive studies of this bleaching event, many being reported for the first time at the symposium, are likely to shed light on which reefs are at risk from bleaching, the mechanism of bleaching, and the possibilities of recovery. Reefs in areas with weak ocean currents or those already damaged by human impact fared the worst. But even populations thought to be in ideal health, like those around the Maldive Islands in the Indian Ocean, succumbed to the bleaching. Alternately, reefs washed by strong currents, which typically bring cooler water up from the depths, were often spared.

The news is not entirely bleak. Some reefs have recovered from the 1997–98 event more quickly than researchers expected, says Terry Done, a senior research scientist at the Australian Institute of Marine Science and the current president of the International Society for Reef Studies. In some cases, coral apparently survived deep within reef structures; in others, new coral was recruited from nearby deeper, cooler water. Several groups are also reporting that certain species of coral can apparently adapt to higher temperatures. But Done warns that these findings should not lead to complacency. "It's a question of the quality of the reefs in the short term," he says. Even those reefs showing early recovery face a decades-long process to regain their previous state. "And while there is some adaptive capability, it is unlikely to be at rates fast enough to cope with global warming," he says.

One bright spot, say Wilkinson and others, is the growing interest of tropical nations, where the majority of the world's reefs are located. Indonesia has started to address the local human impact on the reefs through a coral

CREDITS: (LEFT TO RIGHT) SOURCE: GLOBAL CORAL REEF MONITORING NETWORK, 2000; OAR/NATIONAL UNDERSEA RESEARCH PROGRAM

* "Status of Coral Reefs of the World: 2000."

reef recovery program that combines education with more careful management. But "climate change is a tragedy not of our making," says Sarwono Kusmaatmadsa, Indonesia's Minister of Maritime Affairs and Fisheries, calling on the industrialized world to shoulder more responsibility for the causes of global warming. Although potentially costly to industrialized nations, such efforts would be good for local economies, conferees noted. Indeed, coral reefs provide the basis for an estimated $400 billion fishing and tourism industry around the world. That figure provides another—and for some more compelling—reason to protect coral ecosystems.

–DENNIS NORMILE

2001 BUDGET

NSF and NASA Score Last-Minute Victories

Moved to generosity by the impending elections and a big budget surplus, Congress last week gave both NASA and the National Science Foundation (NSF) significant hikes for 2001. After traveling a rocky road to reach this point, legislators gave NSF $4.42 billion, a $522 million boost over this year that nearly matched NSF's 17% request. NASA received $14.3 billion, nearly twice the White House's request for a 3% boost—but with hundreds of millions of dollars in earmarks added on.

When the House and Senate differ on funding, they usually produce a final budget by splitting the difference. But this year leaders "compromised" on a total for both NSF and NASA that exceeded the earlier levels set by either body. "I really like Congress's math this year," quipped NSF director Rita Colwell. "I'm thrilled with the outcome." Leaders greased the legislative process by adding in numerous last-minute increases requested by such key members of the Appropriations Committee as Senators Barbara Mikulski (D–MD), Robert Byrd (D–WV), and Ted Stevens (R–AK).

The Senate had been considering a NASA bill nearly $200 million below the Administration's request, which would have required the space agency to scale back many programs (*Science*, 22 September, p. 2018). The House version was lower, at a whopping $377 million less than the request and just slightly above the 2000 level. The final bill, however, leaves space science with a $2.5 billion budget—$100 million more than requested and well above the $2.2 billion spent in 2000.

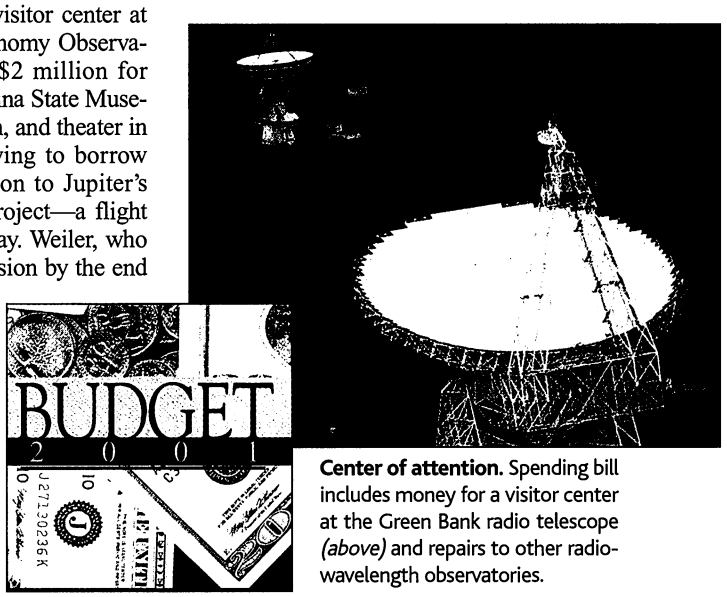
Ed Weiler, NASA's space science chief, cautions that the boost won't give him much wiggle room to cope with inflation in planetary missions, several of which are likely to cost more than promised. The flexibility disappeared because much of the new money will go to pork-barrel projects, such as $10.5 million for education centers on Mauna Kea in Hawaii, $4 million for a visitor center at the Green Bank Radio Astronomy Observatory in West Virginia, and $2 million for equipment at the South Carolina State Museum's observatory, planetarium, and theater in Columbia. But Weiler is trying to borrow funds from a planned mission to Jupiter's moon Europa to keep one project—a flight to Pluto—from a lengthy delay. Weiler, who aims to rule on the Pluto mission by the end of November, acknowledges its scientific merit but notes that "Europa is clearly the priority of the White House."

In contrast to the small increase NASA requested, NSF asked for a record $675 million boost in 2001, or 17%. In June the House voted for a rise of just 4%, and last month the Senate approved a 10% hike, so the final 13.3% boost made NSF officials very happy. Even so, Congress failed to fully support several key initiatives. The bill provides $215 million of a $327 million request for information technology research, $150 million of the $217 million sought for nanotechnology, and $75 million of the $136 million planned for biocomplexity.

But Congress responded with enthusiasm to projects that promised tangible benefits for local institutions and had strong backing from influential sectors of the scientific community. Although legislators avoided earmarks to individual institutions, they shelled out more than the Administration had requested for programs that support smaller states, graduate fellowships, and informal science education. They also rejected NSF's request for $29 million to begin two ground-based research networks, substituting $12.5 million to continue work on a high-altitude research plane that had fallen off NSF's list of priorities for 2001. And they added $15 million for badly needed upgrades and repairs to radio telescopes in West Virginia, New Mexico, and Puerto Rico.

One big winner is the agency's 20-year-old program to bolster the 20 states that traditionally receive the fewest federal research dollars. Long a congressional favorite, the Experimental Program to Stimulate Competitive Research (EPSCoR) this year received a 56% boost, to $75 million.

"Everybody's delighted," says Joe Danek, head of the nonprofit EPSCoR Foundation that represents the eligible states. The money will help NSF fund a competition now under way that will award up to $3 million a year to build research capacity in EPSCoR states and assist researchers applying for funding through regular channels.



Center of attention. Spending bill includes money for a visitor center at the Green Bank radio telescope *(above)* and repairs to other radio-wavelength observatories.

CREDIT: M. BAILEY/NRAO

President Bill Clinton is expected shortly to sign the bill, which was bundled with a $24 billion measure to fund the Department of Energy and various water and conservation projects.

–ANDREW LAWLER AND JEFFREY MERVIS

ACADEMIC COMMUNITY

Institute Goes to Court To Remove Researcher

The Institute for Advanced Study (IAS) in Princeton, New Jersey, has served for 70 years as a peaceful haven for scholars, including Albert Einstein. But this fall it is embroiled in an uncharacteristically tense—and public—fight to remove one of its tenured professors.

The persona non grata is Piet Hut, a 47-year-old astrophysicist who was hired at the