Was Underwater "Shot" Harmful to the Whales?

Some say Walter Munk's attempt to measure global warming disturbed many species of endangered marine mammals

LAST WEEK, 100 OCEANOGRAPHERS GATHered at the National Academy of Sciences to hear and discuss the preliminary results of Walter Munk's ambitious attempt to measure global warming by firing a sonic "shot" around the world under water. The experiment, the initial phase of which was carried out in January, stirred excitement among this group because it promises—for the first time—to measure precisely temperature changes over entire ocean basins. But the experiment has also stirred controversy. Some mammalogists say the sound waves fired by Munk, a renowned physical oceanographer from the Scripps Institution of Oceanography, may have damaged a variety of large marine mammals, including whales and seals.

Perhaps the most painful irony is that the debate over the underwater "shot heard 'round the world" isn't between heroes and villains—it's between two groups who are both on the side of the environment. Munk's project, after all, is aimed at measuring global warming, clearly a key environmental project. Says Munk: "We thought originally we were the good guys in global warming." In fact, he says, "without ocean data" researchers cannot tell whether global warming is actually occurring.

Then again, those who wanted to save the whales from Munk's sonic blaster are also attempting to defend the environment—but in this case against the predations of science itself. "I'm more worried about this experiment than any human activity other than toxic wastes," said one marine mammalogist speaking on condition of anonymity. Hyperbolic as that statement may be, it reflects the remarkable passions that have been aroused among some oceanographers over this issue.

And that researcher is not alone in his concern, *Science* has found, nor in his desire for anonymity. Even though Munk has no direct say over precious grant funding, he is perceived as having considerable influence, leading one researcher to call him "the most powerful oceanographer in the United States." The critics charge that his clout was in evidence when what they describe as a hastily drawn up and flawed application for a marine mammal permit to conduct the Heard Island Feasibility Test (HIFT) moved through the National Oceanic and Atmospheric Administration (NOAA) with unusual speed.

Munk denies that his reputation won him special favors at NOAA: "It's utter nonsense and insulting to the people at NOAA." He adds, "I think they were very tough on me—unduly tough. . . .In fact, I thought they treated me very badly." And top NOAA officials deny Munk got a personal red carpet there. Furthermore, although Munk and his colleagues concede the initial permit application was flawed, they contend that the flaws were corrected in the final application.

And, surprisingly, given how far apart they are, both sides agree on one key point: There is, as yet, little hard evidence that Munk's work harmed the big sea mammals. Says Munk: "I'm a little bitter, because the results show no observable negative effects."

Yet critics contend the matter isn't settled, and that future data could hold some nasty surprises. One mammalogist argues that "even if the risk is low, it has exposed a large number of endangered species to something that could affect their fertility and growth rates. I'm not saying that 50% of the whales were trying to leave the area, but I'm pretty sure they were undergoing stress."

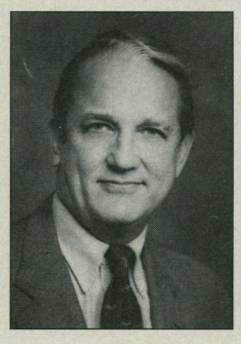
One reason that those concerned about big marine mammals are so worked up about HIFT is that they weren't told directly about it by Munk or his five collaborators; they learned about the globe-girdling plans only in the press. Last spring, *Science* ran an article about HIFT ("What's the Sound of One Ocean Warming?" 6 April 1990, p. 33) that startled John Twiss Jr., executive director of the Marine Mammal Commission, an independent federal agency that reviews all applications to NOAA involving marine mammals.

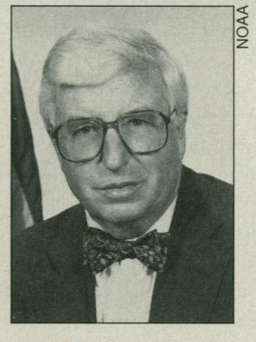
The story explained how Munk planned to drop loudspeakers from a ship in the Indian Ocean 50 kilometers from Heard Island, a glaciated volcano between Australia and Antarctica. The sound source would be so loud Munk hoped it would travel through five ocean basins to hydrophones at 16 receiving stations around the world, some as far as 18,000 kilometers away. The first "shot" was meant to be the forerunner of an ongoing ocean-based program to measure global warming—but later tests would involve several sound sources, none as loud as HIFT's big bang.

What raised Twiss' eyebrows was Munk's proposal to fire pulses through five loudspeakers at 209 decibels. Though the sound—comparable to standing under a jet engine at full throttle—would weaken as it traveled, Twiss felt that it could have a significant effect on nearby fish, birds, and marine mammals. "I don't think it takes a PhD to read '209 decibels' and say, 'Gee, this is worth thinking about,' " Twiss recalls, particularly in light of research showing that several species of marine mammals change their behavior at a sound level of about 120 decibels.

Twiss' perplexity deepened when he talked to other members of his commission. "None of us had heard a word about this," says Twiss. And they should have, he adds, because HIFT was getting a total of $1.7 million from four federal agencies: the Office of Naval Research, the National Science

Animals, Animals





NOAA

Whale of a tale. *When John Twiss* (left) *found out about Walter Munk's plan to fire a blast through the world's oceans, his concern was for undersea mammals. John Knauss* (right), *head of NOAA, says Munk's project didn't get special handling—but some disagree.*

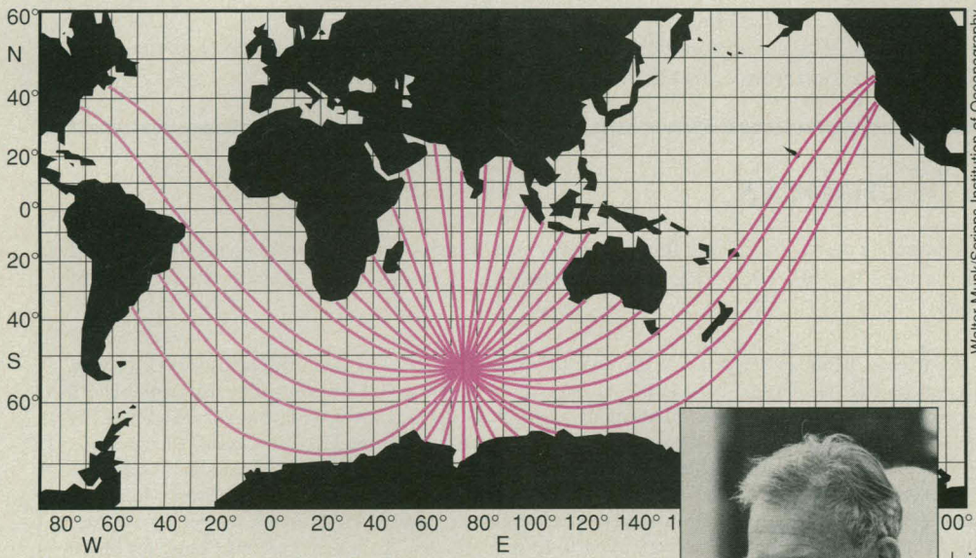
Foundation, the Department of Energy, and NOAA. "There appeared to be a profound attempt to ignore the permit process altogether," charges one oceanographer who has followed the project closely.

It wasn't that Munk and his colleagues had never considered the effect of their proposal—which called for 10 days of sound pulses, 1 hour on and 1 hour off—on mammals. *Science* obtained a "status report" by a Munk collaborator stating that in 1988 HIFT planning sessions "concern arose as to the effects of the proposal on marine mammals." Munk and his colleagues say, however, that they didn't think they needed a permit because their experiment wouldn't cause the animals injury. Yet both the Marine Mammal Protection Act and the Endangered Species Act stipulate that not only injury but also "harassment" of marine mammals requires a permit. "I was wrong," Munk now acknowledges. "I had thought that [injury] was the issue, and it wasn't."

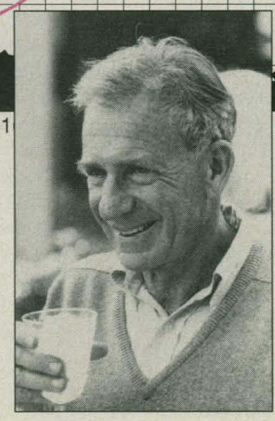
Prompted by Twiss' concerns, NOAA decided last August—only 5 months before the "shot" was scheduled to be fired—to get scientific feedback about HIFT's potential for harming marine life. They fielded opinions from a committee of marine mammalogists and got a wide range of opinions. One respondent, Frank Awbrey, a senior research associate at San Diego's Sea World Research Institute, wrote that there was only a "vague chance" the Heard Island work "might disturb some marine mammal somewhere."

A very different perspective came from two marine mammalogists at the Woods Hole Oceanographic Institution, William Watkins and Peter Tyack. "As planned," they maintained, "the Heard Island experiment is likely to disrupt feeding behavior and to mask communication over an area of many thousands of square kilometers of prime whale feeding and social habitat, during the peak of the season!" Many of the species involved are endangered, they noted.

One of the keys to this remarkable difference of opinion was the question of how far the underwater sound had to travel before it would drop below the crucial 120 decibel level. Australian Andrew Forbes, one of HIFT's principal investigators, estimated that only 50 kilometers from the source, sound near the surface would fade to 115 decibels. But Watkins and Tyack disagreed: They estimated the sound near the sea surface would still be close to the critical level a whopping 794 kilometers from Heard Island.



Walter Munk/Scripps Institution of Oceanography



Booming business. *Walter Munk's grand experiment was centered at Heard Island, near Antarctica, where a sonic blast was generated that traveled throughout the world's oceans.*

NOAA head John Knauss told *Science* that when he learned Walter Munk had "a whale problem," he put the odds of the project's going forward at no more than 50/50. That's when things started to happen that critics say reflect Walter Munk's long reach in the oceanographic community. And insiders in oceanography agree that Munk, who's been described as a "founding father" of U.S. physical oceanography and who's chaired the National Academy of Science's Ocean Sciences Board and advised the Navy on research, has more than ordinary pull in his field.

Munk's project needed an "incidental-take" permit, which authorizes the limited harassment of the mammals. Such a permit typically requires a minimum of 1 year to issue—far more time than was available. But there was another option. A permit to conduct scientific research that would benefit the animals usually requires only 4 months to process. Munk added a biological experiment to HIFT in which researchers would assess the effects of sound on marine mammals; that study would be of benefit to the animals, his team said.

On 15 October, Munk filed an application with NOAA for the biological experiment that estimated HIFT would harass no more than 10 cetaceans (whales, porpoises, dolphins) and 100 pinnipeds (seals, sea lions, walruses). NOAA officials involved in the permit process, who requested anonymity, say the application fell short of the usual scientific standards. "The permit application wasn't scientific research that could pass scrutiny," says one official. "The sample was too small, there was no control—just one thing after another." Yet NOAA went ahead with the next step in the permit process, publishing the application in the *Federal Register*.

On condition that Munk modify the application in some respects, the permit was granted on 7 December—less than two months after the initial application. Munk's modifications, which came in 3 days later, upped the "take"—the number of mammals that could be harassed—from 10 cetaceans and 100 pinnipeds to *234,200 cetaceans and 115,000 pinnipeds* and added five new species.

Several NOAA officials who requested anonymity say Munk got special treatment at the agency from Knauss, who, as it happens, is a 1959 graduate of Scripps whose PhD thesis was approved by (among others) Walter Munk. Knauss acknowledges that Munk is "a very old friend" but insists there was no conflict of interest and no special treatment. "I pushed very hard to see what could be done," says Knauss, "but in some sense I kept out of it. I applied no pressure on our biologists to accept or not to accept anything. I only said: 'Look, this is scheduled to go and has cost a lot of time, money, sweat, and tears. If possible, let's help pull it off.'"

Indeed, the experiment was revised in several key ways at NOAA's behest. The frequency of the "shots" was decreased, and another ship was brought along to monitor effects on marine mammals before and during the experiment. With those (and other) changes in place, Munk, Forbes, and nine biological observers set sail. But even after all the human obstacles had been surmounted, Nature interceded. Thirty-five-foot seas damaged equipment and forced the experiment to be called off at the halfway

point. Nonetheless, Munk says "our data were extremely interesting. We don't know all the answers but we certainly got some good results."

The jury is still out on how much the experiment affected marine mammals. Those who took part in HIFT acknowledge that there may have been some effect. A preliminary report by Ann Bowles, leader of the biological survey team, says that although observers did not detect physical damage, there may have been an "avoidance response" by beaked and pilot whales. Says marine mammalogist Bob Pitman, who made the journey on the observation ship that NOAA required: "The worst-case scenario didn't happen, but it's possible that deep-diving mammals were affected."

Although much remains uncertain regarding HIFT's impact on marine life, one thing is clear: The sound took much longer to weaken than Munk and his colleagues had anticipated. According to preliminary data from HIFT, 124-decibel levels were detected *1000* kilometers from the source at a depth of 50 meters. For now, however, that's one of the few hard facts about the project's possible biological effects.

More concrete indications regarding sea life could come next fall, when Aleta Hohn, a permitting officer in NOAA's National Marine Fisheries Service branch, will hold a closed meeting to evaluate the effects of the experiment on marine mammals and decide what should be done if the experiment is repeated. "This was a tough project for all of us," says Hohn, "but I feel fine about it. We're going to get a lot of information about how acoustics affect marine mammals—or at least how to get that information."

> ***"We thought originally we were the good guys in global warming."***
>
> —WALTER MUNK

Although Munk does plan to continue his experiments, he argues that in the future the marine mammal issue will not be nearly as critical, because he plans to rely on lower sound levels and work on measuring temperature in individual ocean basins. In addition, he says, he learned from HIFT that sound can be transmitted less frequently and at a greater depth (affecting fewer marine mammals) and still get good results. Why, then, did Munk begin by shooting a loud bang around the world? "We wanted to bracket the problem," he says, "and we have done so." ■ JON COHEN

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IOM Elects New Members

The Institute of Medicine has elected 45 new active members, raising the total active membership to 471. Five persons were elected directly to senior membership, bringing the total to 430. The foreign associates membership now totals 28 with the election of five this year. The new active members are:

Bernard W. Agranoff, University of Michigan; **Myron Allukian Jr.**, Department of Health and Hospitals, City of Boston; **K. Frank Austen**, Harvard Medical School and Brigham and Women's Hospital; **John R. Ball**, American College of Physicians, Philadelphia; **C. Wayne Bardin**, The Population Council and Center for Biomedical Research, New York City; **Elizabeth Barrett-Connor**, School of Medicine, University of California, San Diego; **J. Michael Bishop**, University of California, San Francisco; **Richard J. Bonnie**, University of Virginia School of Law; **Dorothy Brooten**, School of Nursing, University of Pennsylvania; **Larry R. Churchill**, University of North Carolina; **Francis S. Collins**, School of Medicine, University of Michigan Medical Center; **Edward J. Connors**, Mercy Health Services, Farmington Hills, Michigan; **Patricia M. Danzon**, The Wharton School, University of Pennsylvania; **Ezra C. Davidson Jr.**, American College of Obstetricians and Gynecologists, Los Angeles; **Carolyne K. Davis**, Ernst and Young, Washington, D.C.

Don E. Detmer, Health Sciences Center, University of Virginia; **Patricia K. Donahoe**, Harvard Medical School, Massachusetts General Hospital; **Philip J. Fialkow**, School of Medicine, University of Washington; **Bernard D. Goldstein**, Robert Wood Johnson Medical School, University of Medicine and Dentistry of New Jersey; **G. Anthony Gorry**, Baylor College of Medicine; **Antonio M. Gotto Jr.**, Baylor College of Medicine; **Larry A. Green**, University of Colorado Health Sciences Center; **William R. Hazzard**, Bowman Gray School of Medicine of Wake Forest University; **Edgar B. Jackson Jr.**, School of Medicine, Case Western Reserve University; **Jerome P. Kassirer**, Tufts University School of Medicine and New England Medical Center; **John A. Kirkpatrick Jr.**, Harvard Medical School and Children's Hospital, Boston; **Barbara J. Lowery**, University of Pennsylvania School of Nursing; **Myron S. Magen**, College of Osteopathic Medicine, Michigan State University; **Jonathan M. Mann**, Harvard School of Public Health and Harvard AIDS Institute; **Guy M. McKhann**, Johns Hopkins University.

Louis H. Miller, National Institute of Allergy and Infectious Diseases; **Elizabeth F. Neufeld**, School of Medicine, University of California at Los Angeles; **Peter C. Nowell**, University of Pennsylvania School of Medicine; **Charles P. O'Brien**, University of Pennsylvania School of Medicine and Veterans Administration Medical Center, Philadelphia; **Suzanne Oparil**, School of Medicine, University of Alabama at Birmingham; **Charles E. Phelps**, School of Medicine and Dentistry, University of Rochester Medical Center; **Samuel H. Preston**, University of Pennsylvania; **Fred S. Rosen**, Harvard Medical School and Center for Blood Research, Boston; **Allan Rosenfield**, School of Public Health, Columbia University; **Gerold L. Schiebler**, University of Florida Health Science Center; **Lucille Shapiro**, Stanford University School of Medicine; **Phillip A. Sharp**, Massachusetts Institute of Technology; **Thoralf M. Sundt Jr.**, Mayo Clinic and Mayo School of Medicine; **Harold E. Varmus**, University of California, San Francisco; **Savio Lau-Yuen Woo**, School of Medicine, University of Pittsburgh.

Elected directly to senior membership are:

Harold Amos, Harvard Medical School; **John A. Benson Jr.**, American Board of Internal Medicine, Portland, Oregon; **Gertrude B. Elion**, Wellcome Research Laboratories, Burroughs Wellcome Company, Research Triangle Park, North Carolina; **Yuan-Cheng B. Fung**, University of California at San Diego; **Mildred T. Stahlman**, Vanderbilt University School of Medicine.

Newly elected foreign associates are:

John A. Downey, Columbia University College of Physicians and Surgeons; **Jens Jorgen Pindborg**, Royal Dental College, Copenhagen, Denmark; **Guillermo A. Soberón**, Fundación Mexicana para la Salud, San Jeronimo Lidice, Mexico; **Jan Hendrik van Bemmel**, Erasmus University, Rotterdam, The Netherlands; **Sir David J. Weatherall**, University of Oxford, England. ■