Of Whales and Ocean Warming

A plan to sound out the sea's temperature may be back on course

By JOCELYN KAISER

In a dozen universities and institutes from Massachusetts to Hawaii, oceanographer Walter Munk and his colleagues wait expectantly. If they get the permits they seek, the scientists will set sail this summer from Hawaii and California. Not far off the coast, they will lower two loudspeakers, each the size of a water heater, deep into the ocean.

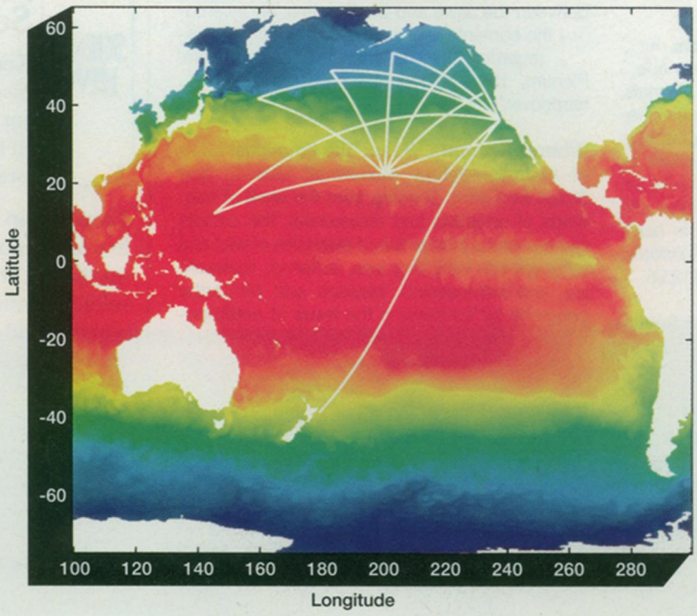
The researchers hope the long, low hum from these devices will help answer an important scientific question: Are greenhouse gases causing the world's oceans to heat up?

The first broadcast would mark the end of a long, bitter struggle. Munk's project, a 2-year feasibility study called Acoustic Thermometry of Ocean Climate (ATOC), was set to begin in the spring of 1994. But so far, instead of data, Munk's team has collected only angry letters and testimony from protesters who fear the project will harm whales, seals, and other animals.

While some ATOC scientists view the uproar as an unfortunate, wasteful public relations debacle, others say it has promoted greater understanding among physical and biological marine scientists. It has certainly drawn public attention to a long-ignored source of pollution: human-generated ocean noise.

Munk, of the Scripps Institution of Oceanography in La Jolla, Calif., and other oceanographers pioneered the acoustics behind ATOC in the 1970s. Because sound travels more slowly in warm water than in cold water, the travel time of underwater sounds can be used to gauge the ocean's temperature.

Thus sound, Munk reasoned, could be used to take the first accurate measurements of temperature changes across entire ocean basins. Because atmospheric temperatures fluctuate widely, scientists look to the more stable seas to tell them whether the globe is truly warming. Lowering thermometers from ships, however, has proved difficult and unreliable. If scientists could measure temperatures in the deep ocean, Munk says, they would know in a few years whether their climate models predicting global warming are correct. "It makes an awful lot of difference whether we're going to warm by 3° or 6° [Celsius]," Monk says.



A view of sea surface temperature from the highest-resolution computer model currently available. The variability of surface temperature (from 30°C, shown in red, to -2°C, in purple) makes it difficult to study long-term temperature changes in the ocean with point measurements. ATOC's long paths (shown in white) are intended to provide averages.

Munk planned to send the noise through what is known as the sound channel, a specific layer of water in the temperate ocean. In this channel, sound waves can travel great distances because they refract off warmer water above and denser water below. If the waves slowed by 1.5 seconds per decade over a 10,000 kilometer path, that would correspond to an increase in water temperature of 0.05° C, roughly the amount predicted in the sound channel by climate models.

The group successfully tested this idea from Heard Island off Antarctica in 1991 (SN: 1/26/91, p. 53). The scientists set off 215-decibel, 57-hertz pulses received as far away as California and Bermuda. But many marine biologists feared the test had disturbed sea mammals, even though biologists observing whales at the time noticed no adverse effects.

For ATOC, Munk and others

planned to use a softer sound—195 decibels at 75 hertz. That's about as loud as an ambulance siren, at a pitch comparable to the lowest notes on a cello. The sound would play for 20 minutes every 4 hours from loudspeakers 850 meters underwater off Point Sur, Calif., and Kauai, Hawaii, and would travel to 13 receivers scattered around the Pacific. A Defense Department swords-to-plowshares conversion program sponsors the $35 million project.

This time, the scientists set aside 10 percent of their funding and recruited leading bioacousticians and marine mammalogists to monitor how whales and other creatures reacted to the sound. If ATOC worked and didn't harm animals, the experiment could eventually be extended to the Indian and Atlantic Oceans over a decade or more.

The trouble began in February 1994, a few weeks before ATOC expected to receive a research permit from the National Marine Fisheries Service (NMFS) to begin the tests. Two sperm whale specialists, Lindy S. Weilgart and Hal Whitehead of Dalhousie University in Halifax, Nova Scotia, posted a message on the Internet, claiming that the project's transmissions could deafen whales.

Though the two biologists had overestimated the potential for damage from the sound, says Munk, the Los Angeles Times and other newspapers quoted the predictions. Other people misinterpreted an important term in the permit applications. The permits would have allowed ATOC to "take" a certain number of animals. The term describes a range of results, from killing an animal to causing a very slight change in its behavior, such as swimming in a new direction. ATOC scientists didn't expect animals to die. But some critics assumed that "take" meant "kill."

The resulting public outcry led to thousands of letters to Congress and the NMFS. Late last spring, after holding several public hearings, the NMFS put the permits on hold until ATOC completed federal environmental impact statements.

Darlene Ketten of Harvard Medical School in Boston, a marine biologist who studies hearing in both humans and whales (but not as an ATOC participant), says that the hum, though loud, seems unlikely to cause permanent damage to marine mammals. For one thing, she says, the sound begins softly, then grows, rather than erupting in a loud blast. Also, the frequency is too low to be heard well by most ocean echolocators—the dolphins and toothed whales that use sound to navigate and find food. What's more, most ocean animals don't dive as deeply as the sound channel used by ATOC. Those that do—elephant seals, for example—would have to stay very close to the loudspeaker for a long time to damage their hearing, Ketten says.

Project supporters also point out that the ocean is by no means a silent place. Besides the natural low-frequency sounds made by waves, earthquakes, and whales, noises from human activities such as oil drilling platforms, geologic blasting, and ships fill the seas. ATOC scientists argue that their sound rises no louder than the din made by a container ship.

But nobody knows much about how these sounds affect marine mammals, a point made by the National Research Council last year in its report "Low-frequency Sound and Marine Mammals: Current Knowledge and Research Needs." ATOC opponents argued, however, that the lack of information provides sufficient reason in itself not to add to the noise.

Munk and his colleagues have listened to their critics, both in meetings last summer and at a second round of public hearings following the release of the draft environmental impact statements this winter.

Along the way, they agreed to changes. They plan to broadcast less frequently — every fourth day instead of daily. Instead of beginning oceanography and biology tests together, biologists will control the sound sources for the first 6 to 10 months of the experiment. "They can turn it off and on when they like and use whatever sound level they like," says Scripps oceanographer Andrew Forbes, AOTC project manager. This will allow them to gather baseline data on the sound's possible effects.

ATOC will place the loudspeaker planned for Point Sur, within the Monterey Bay National Marine Sanctuary, outside that area. The new site lies twice as far from shore (88 km) and in rougher seas. The drawback, says bioacoustician Christopher Clark of Cornell University, who heads the marine mammal program, is that distance and sea conditions will force the cancellation of studies from small boats. The biologists had also hoped to use an old Navy array of hydrophones to listen to animals at the Point Sur site.

The scientists will turn up the sound for 20 minutes, just as it will be used to measure ocean temperatures. But they'll begin tests at 10 to 100 times below 195 decibels and raise the level over several months. And while those observing animals will know when a test takes place, they won't know how loud the sound is.

The biologists will listen to and track the movements of whales, seals, dolphins, and sea turtles from planes and, when possible, from boats and the shore. If the sound appears to harm some animals or consistently change their behavior—if more turtles seem to get hit by boats, for example, or if whales leave the area when the sound comes on—researchers will turn off the loudspeaker, at least temporarily.

Scientists have already gathered some data—they counted humpbacks in 1993 and 1994 in Hawaii, for example—so they'll have a reference point when they survey the whales during ATOC. In addition, they've begun testing two toothed whale species to find out what frequencies they hear.

ATOC leaders submitted their federal and state environmental impact statements for California in early May and Hawaii's last week. They expect NMFS to decide within several weeks whether to grant the permits.

Despite modifications to ATOC, the Natural Resources Defense Council wants to stop the project, arguing in part that the environmental impact statement should encompass the 10 years of tests that may follow ATOC. Joel Reynolds, an attorney for the group, says it remains concerned about "long-term unknown and unknowable impacts on [marine mammal] feeding and breeding."

Clearly, the public battle of the past year has frustrated the researchers. "You have a complex scientific project, and to communicate that to the public without exaggeration or alarm isn't straightforward," Forbes says. He says ATOC scientists have been setting aside some of the Defense Department grant, which ran out this May, so they can carry out their experiments. But the running conflict has stalled the project so long that oceanographers may wind up with only a few months of data unless they find new funding.

But Clark also points to a silver lining of sorts. For one thing, since Heard Island, oceanographers have begun accepting marine biologists' concerns about their acoustic experiments. "Historically, there's been no oversight of oceanographers' impact on the biological environment," Clark says. "Hopefully, in the future, the interactions between the biologists and the physical scientists will be much better."

What's more, he adds, the ATOC uproar has made the public aware of a little-noticed source of ocean pollution—the racket made by humans. That includes not only the air guns of oceanographers and the blasts of geologists, but also the rumble of ocean liners, the sonic boom of jetliners, the sonar of yachts, and the blare of motorboats. Most of these sources remain unregulated, but time (and the kind of data ATOC is expected to produce) could change that, Clark says.

"Awakening people to these things is good," he says. "If there's actually an improvement in the marine environment 5 years after all this hocus-pocus with ATOC, hey, then it's all worth it." □