CONSERVATION

Sound Judgments

WILL A POWERFUL NEW NAVY SONAR HARM WHALES? **BY WENDY WILLIAMS**

BEACHED WHALE in the Bahamas is examined by David Ellifrit of the Center for Whale Research. The whale probably died as a result of sonar from naval antisubmarine exercises.

DIANE CLARIDGE *AP Photo*

The beaching of some 14 Cuvier's beaked whales in the Bahamas in March 2000 brought to critical mass a long-seething controversy. At least eight of the whales died, and the cause of death for many was cranial hemorrhaging, probably from exposure to intense sound waves. After investigating, the U.S. Navy took responsibility. "In fact, there was some cause and effect" between the deaths and the navy's sonar, said Admiral William J. Fallon, vice chief of naval operations, in a congressional hearing on May 9.

The incident couldn't have come at a worse time for the navy, which is struggling to gain public acceptance of its new low-frequency active (LFA) sonar. For decades, the navy has relied mainly on passive sonar, or simple listening with hydrophones, which could detect sound generated by a ship's boiler or even by pots and pans from the galley.

But by the 1980s the Soviet Union had built up a fleet of superquiet nuclear-powered submarines for which passive sonar proved inadequate. Midfrequency active sonar—the classic "pinging" of World War II submarine movies—wasn't an option, either, because it required targets to be close to the source: midfrequency sounds (between one and 10 kilohertz) attenuate quickly in water. But low-frequency sound (below about one kilohertz) travels more efficiently, enabling the LFA sonar, according to a navy official, to detect targets "an order of magnitude"—at least 10 times—farther away.

The current version of LFA sonar consists of sound projectors placed 300 to 500 feet deep. Lasting from six to 100 seconds and interspersed with somewhat longer periods of silence, the tones are emitted in the 100- to 500-hertz band. The navy wants to deploy LFA sonar arrays in both the Atlantic and Pacific oceans.

No one doubts that marine mammals will hear the system; sonar arrays can generate sound-pressure levels of up to 230 decibels in water near the source. The argument is over the severity of the animals' response, if any. Some environmentalists claim that LFA sonar will interfere with whales that use the same frequency bands. The Natural Resources Defense Council has circulated a petition among scientists, sponsored by board member and noted ecologist George M. Woodwell, calling for global efforts to control undersea noise in general—and for an end to LFA in particular. (Woodwell admits, though, that he knows little about the LFA system itself.)

Whale biologist Kenneth C. Balcomb of the Center for Whale Research in Friday Harbor, Wash., who tried to rescue a few of the Bahamian whales, says that the pressure of the low-frequency waves will cause the organs of certain animals to resonate. Commenting on the navy's environmental impact statement, Balcomb noted that there are several examples of "hemorrhagic injuries and death occurring in humans when they are inadvertently exposed to loud sound."

But extrapolating the human experience to undersea life is an unsubstantiated jump, many scientists argue. They add that the strandings in the Bahamas involved mid- rather than low-frequency sonar: the navy was conducting exercises in the area with sonar buoys and says that the only extant LFA was in Hawaii at the time and was not being used. And besides, low-frequency sound occurs quite regularly in the oceans because of landslides, earthquakes, lightning strikes and other events. Biologist Roger Payne of the Whale Conservation Institute, who discovered the "song" of the humpback in the early 1970s, believes the whales must have evolved a way to filter out unwanted sound, much as we can block out background conversations in a restaurant.

As for the beached beaked whales, their deaths may be more of an isolated incident than a portent of things to come. Harvard University biologist Darlene Ketten, who has

NEED TO KNOW: THE NOISY SEAS

Amid the cacophony over navy sonar lies a bigger problem: background noise in the ocean may have risen by as much as 10 decibels over the past 50 years, thanks largely to shipping and seismic exploration. "There are highways across the ocean that are just glowing with noise," says Cornell University biologist Christopher Clark. Little definitive science exists on how—or even whether—ambient noise bothers marine mammals. So far the results have been bewilderingly inconclusive; sometimes whales shifted their paths away from sound sources by a few hundred yards, and sometimes they did not. Part of the problem is that humans don't fully grasp the scale of the whale habitat: a herd of humpbacks might stretch for hundreds of miles.

studied the Bahamian incident, concludes that the animals appear to have been caught in a sound duct created by "physical parameters that were seasonal." Moreover, the whales were swimming in a canyon, which helped to create "an unusually intense sound field" during the naval exercises, Ketten says. "To say that a different sonar is going to impact other animals in the same way is going way off on a limb. Sonars have been around for decades."

Wendy Williams writes on ecology and conservation from Mashpee, Mass.

ASTRONOMY

Catching Some Sun

THE GENESIS SPACECRAFT WILL RETURN WITH A PIECE OF SOL BY STEVEN ASHLEY

Sometime late this month a robotic deep-space probe will begin gathering up bits of the sun—specifically, the solar wind. Twenty-nine months afterward NASA's Genesis spacecraft will begin the long trip back home bearing a precious hoard of pristine solar-wind samples weighing no more than a few grains of salt. On arrival in Earth's atmosphere in April 2004, the spacecraft's 210-kilogram return capsule and its fragile cargo will ride the winds on a special high-lift parachute to a dramatic midair capture by helicopter over the Utah desert. The specimens will be the first extraterrestrial material collected from beyond the orbit of the moon.

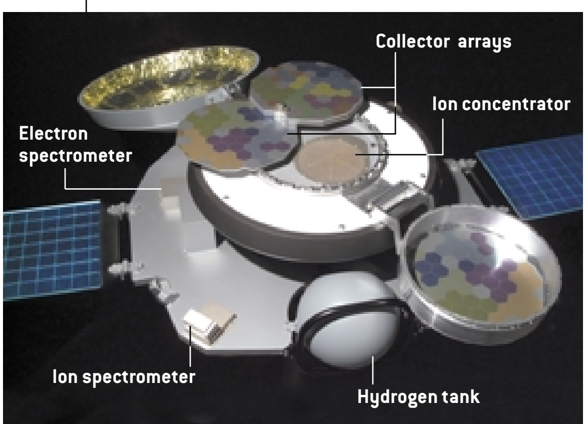
Solar wind consists of invisible charged particles ejected from the sun's surface at high velocities. Whereas the sun's interior has been modified by nuclear reactions, the outer layers are thought to be composed of the same material as the original solar nebula, the cloud of interstellar gas and dust that gave rise to the solar system some 4.6 billion years ago. Prospecting the sun's surface is impossible, so the next best thing is to collect material flung out from its hot, turbulent exterior.

The ideal place to accomplish this task is way out beyond Earth's magnetic field, which deflects the solar wind away from its environs. The most stable location for collection is one million miles away, where the sun's and Earth's gravities are balanced—the so-called Lagrangian sun-Earth libration (L1) point. Once in position, Genesis will uncover its collectors. Of greatest interest to researchers are the elemental and isotopic oxygen, nitrogen, carbon and noble-gas components of the solar wind. When they are brought to Earth, the samples—about 10 to 20 micrograms' worth—will be analyzed, stored and catalogued in ultraclean rooms.

In addition to determining the makeup of the solar nebula, the $209-million Genesis mission is expected to reveal how the terrestrial planets came to be, notes Donald Burnett, the mission's principal investigator and a professor of geochemistry at the California Institute of Technology. "There are unexplained variations in the isotopic composition of oxygen within the inner solar system from which we have specimens—Earth, the moon, Martian meteorites and meteoritic samples of the asteroid belt," he says. Hence, scientists are unsure whether the terrestrial planets formed primarily from the dust of the primordial solar nebula or whether they evolved from a mixture of its gas and dust.

Genesis should help answer that fundamental question and others. Says Chester Sasaki, Genesis project manager at the Jet Propulsion Laboratory in Pasadena, Calif.: "This mission will be the Rosetta stone of planetary science data."

THE SOLAR PROSPECTING KIT



NASA/JPL

The Genesis probe (*shown at right in model form*) has several main scientific instruments:

Solar-wind collector arrays, which are the size of bicycle tires and reside on an apparatus that resembles a compact-disc changer. Each array is a stable grid supporting hexagonal wafers of superpure silicon, germanium, industrial diamond and sapphire coated variously with gold, silicon and aluminum.

Ion and electron spectrometers, which characterize the various solar-wind "regimes" by recording the speed, density, temperature and approximate composition of the charged elemental particles and the electrons that accompany them.

Ion concentrator, an "electrostatic mirror" that uses high voltages to separate out and focus charged ionic elements such as oxygen onto a special collector tile of high-purity diamond and silicon carbide ceramic.