




Navy Leads the Way in
MARINE MAMMAL
SCIENCE

Continuing Investments Will Aid
Decision Making, Protect Ocean Life

A Digital Acoustic Recording Tag (D-TAG) attached to the back of a female dense-beaked whale, (*Mesoplodon densirostris*), AUTEC range, Bahamas.
Photo by Ari Friedlaender



The Navy continues to be one of the world's leaders in marine mammal research. And ongoing efforts on the east and west coast of the United States, Hawaii and the Bahamas demonstrate the breadth and depth of the Navy's commitment to this area of research.

Based in San Diego, the Navy's Marine Mammal Program employs dozens of bottlenosed dolphins and sea lions. The dolphins' ability to echolocate, or use sound to detect objects, can be used to find mines. Trained California sea lions can mark and retrieve objects from the ocean depths. These are working animals, and they earn their fish.

The skills of these marine mammals protect the Navy. In turn, the Navy's scientific work protects them. In 2005, the Marine Mammal Program began a five-year strategy to fund clinical research on the detection, diagnoses and treatment of diseases that can affect

marine mammals. Animal health care officials have collaborated with research institutions to study viruses, kidney stone and liver diseases and diet.

Three years into the effort, eleven marine mammal viruses have been identified, including nine that are new.

A therapy traditionally used on humans was used to treat iron overload in several dolphins. Researchers came up with new, easy blood tests that may help the program and the wider research community, such as during a response to a stranding event.

"The Navy is committed to providing the highest quality care for its marine mammals, and the furtherance of science that benefits all marine mammals," said Mike Rothe, head of the Space and Naval Warfare Systems Center Pacific's Bioscience Division, which manages the Marine Mammal Program.

Some of that science benefits humans, too. Navy-funded research has led to an increased understanding of similarities between dolphins and people that may lead to new ways to treat debilitating human illnesses such as diabetes.

This work is only a portion of the \$100 million the Navy spent on marine mammal research over the past five years, including \$26 million this year. No organization in the world does more to fund marine mammal research.

Navy elements such as the Office of Naval Research (ONR) and the Chief of Naval Operations Environmental Readiness Division have invested in the study of marine mammal health, hearing and the effects of man-made sound, particularly on dolphins and whales. Through Navy funding, scientists have done groundbreaking work in studying echolocation in whales, the effects of deep diving on some animals and furthered the inventory and accessibility of recorded whale sound libraries, a key to identifying marine mammals that are heard with passive, or listening, sonar. Researchers are even studying the potential to use unmanned, underwater gliders rigged with hydrophones to listen for whales during future exercises that use active sonar.

FOR MORE **insights**

For more information about the Navy's efforts to train dolphins to find mines, see our article entitled, "Enemy Mines No Match for Marine Mammals: Biosonar & Other Capabilities Are Assets for Navy Missions" in the spring 2004 issue of *Currents*. You can browse the *Currents* archives on the Naval Air Systems Command's environmental web site at www.enviro-navair.navy.mil. *Currents* is also available on the Defense Environmental Network & Information eXchange (at www.denix.osd.mil) via "Publications/Source/Navy/Currents" and "Publications/Frequency/Quarterly/Currents."



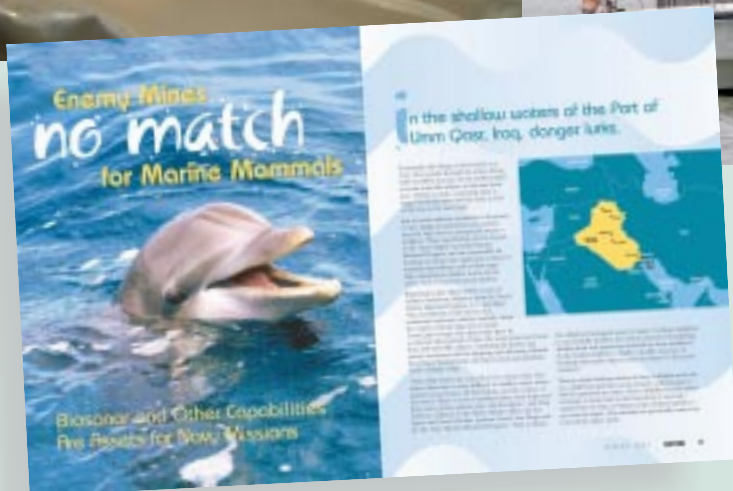
LEFT: A bottlenose dolphin on a beaching mat before being sent out of a training mission.

U.S. Navy photo by Photographer's Mate 1st Class Brien Aho



ABOVE: Sailors enjoy a lighter moment with a dolphin that is part of the swimmer defense team, protecting ports and ships from enemy swimmers.

U.S. Navy photo by Photographer's Mate 2nd Class Veronica Birmingham



Research funding, and the science it produces, represents the Navy's devotion to its role as a steward of natural resources.

"It's a hundred-percent commitment," said Dr. V. Frank Stone, marine resources project manager for the Chief of Naval Operations, Environmental Readiness Division. "The Navy is in the marine environment. We have to understand the effects of our actions in that marine environment."

Much of the research has focused on the detection, behavior, hearing and response to sound of marine mammals—facets of the ongoing debate over the Navy's use of active sonar, in which sound is introduced into the water to detect underwater objects. Science informs steps taken by commanders to avoid harming marine mammals during training events that involve sonar. The data also are used in environmental compliance documents the Navy develops for areas in which it trains.

"Certainly, the Navy recognizes that it has an environmental stewardship issue that it needs to address in a



Ari Friedlaender, a Duke University Marine Laboratory researcher collaborating with scientists at Woods Hole to study the effects of sound on marine mammals, attaches a D-TAG to an adult male pilot whale off the Kona Coast, Hawaii.
Photo by Brandon Southall

responsible fashion," said Dr. James Eckman, head of ONR's Marine Mammal Program, which invests about \$14 million per year in marine mammal research. "The Navy needs to base its decisions on how to train and mitigate marine mammal issues based on the best available scientific research."

NAVY-FUNDED RESEARCH

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The head of a male dense-beaked whale.
Photo by Ari Friedlaender



The head and back of a male dense-beaked whale.
Photo by Ari Friedlaender

“The most important thing we as a Navy have to do is determine the effects of our sound sources on living marine resources,” Stone said. “We know this will be a long-term program because, fundamentally, very little is known about marine mammals.”

Steadily, that’s changing. Studying the effects of sound involves several elements, but a big part of gathering information is tagging. Dr. Peter Tyack, senior scientist at Woods Hole Oceanographic Institute in Woods Hole, MA, joined Woods Hole years ago to develop a telemetry device that stuck to a dolphin with a suction cup and lit up when the animal made a sound. Such “primitive” tags were predecessors of the Digital Acoustic Recording Tag (D-TAG) developed with engineer Mark Johnson, also of Woods Hole. The D-TAG helps record behavior, movement and vocalizations in the wild. Navy funds helped pay for its development, and the tag is helping unlock mysteries about the behavior of whales.

In 1996, after a stranding in Greece was linked to a sonar exercise, Tyack began on the path toward studying elusive beaked whales. Woods Hole, with the Navy’s support, studied deep-diving sperm whales and, later, Cuvier’s beaked whales, using a newer generation of the D-TAG. They collected the first known evidence that toothed whales use echolocation while they dive by

recording data from dives by two Cuvier’s beaked whales and two Blainville’s beaked whales.

“That was what enabled this large Behavioral Research Study (BRS),” Tyack said.

In 2007, researchers began studying beaked and pilot whales in the Bahamas’ Tongue of the Ocean at the Atlantic Undersea Test and Evaluation Center (AUTEK), an instrumented Navy range stocked with hydrophones—underwater microphones.



Three dense-beaked whales surfacing in front of the AUTEK range vessel Ranger, AUTEK range, Bahamas.
Photo by Ari Friedlaender

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echolocation in whales, the effects of deep diving
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A D-TAG attached to the back of a male dense-beaked whale.
Photo by Ari Friedlaender

They gathered information what is believed to be a behavioral response to simulated sonar and other control sounds, though they were careful not to draw conclusions from a

relatively small sample size of animals. The program, Tyack believes, will influence future approaches to experiment-based research involving the whales.

“The basic goal of the study is not pose any risk to the animals but to be very conservative in exposing tagged beaked whales in a known location,” Tyack said. “We have to

THE BASICS ABOUT THE SLMRROG

The Navy has established an advisory body to help determine how it uses available funds for marine mammal research.

A new advisory group is reviewing the way the Navy invests in marine mammal research and will make recommendations to several areas of the sea service that, in total, has spent more than \$100 million on scientific study over the past five years.

The Sonar and Living Marine Resources Research Oversight Group (SLMRROG) was chartered in August 2008 and is developing a list of priorities that will be shared with research institutions outside the Navy, as well as with organizations within the Navy.

The group includes representatives from the Navy’s senior-most ranks, the Office of Naval Research, the fleets and commands involved in research.

“Marine mammals have been at the forefront of our environmental issues for several years now,” said Frank Stone.

“We think it’s time to bring folks in who represent the Fleet and the systems commands and go eyeball to eyeball, face to face and come up with issues that need to

be addressed by research,” he said. “It’s going to ensure that the amount of money that is available is invested properly to meet the Navy’s requirements.”

The group will prioritize Navy research requirements that deal with the effects of sonar on marine mammals, while considering the preparation of environmental compliance documents, Fleet needs and litigation. By reviewing projects being run within separate areas of the Navy, officials said they hope to avoid redundant research.

“The goal is to identify specific areas or questions we need to have answered, and then prioritize,” said Jene Nissen, “Now there’s an overview of all the stakeholders to look at what’s being proposed and say I think this will answer my questions or this won’t answer my questions.”

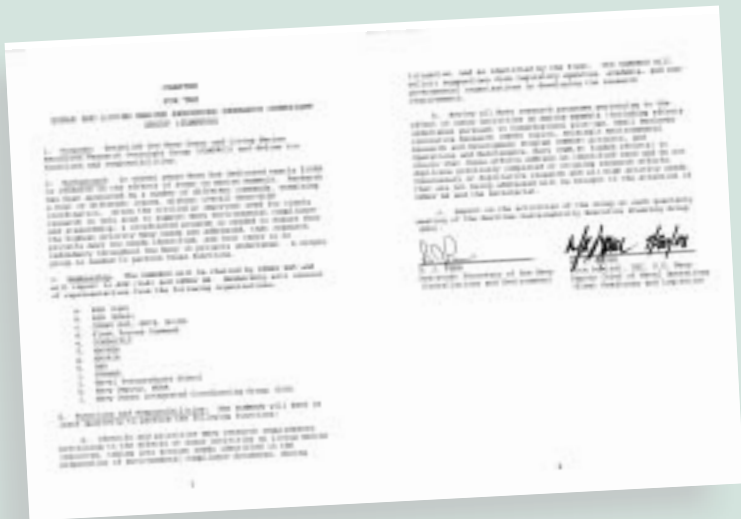
The advisory nature of the group may also influence processes through which future systems are brought into use by the Navy.

“We have new systems coming down the pike, and science is evolving, especially in the sonar world,” said Hank Eacho, the environmental operational support section head at U.S. Fleet Forces Command. “We’ll have to have a process set up where we can constantly look ahead and set priorities, pulling the stakeholders together and getting feedback on the studies we’re going to be investing in.”

“Getting those decision makers involved on the front-end will help avoid an environmental show-stopper when a system is ready to be deployed to the Fleet,” Stone said.

“What we’re hoping this group will be able to do is be able to reach out to the warfare capability czars to see what they’re thinking for the future,” he said.

“The more informed we are,” Eacho said, “the better decisions we can make.”



track them in real time, that's why we're at AUTEC."

One whale in the study stopped a foraging dive when exposed to sonar, and moved away.

"It was very systematic," Tyack said. "It wasn't like panicked flight. So we're not worried about the safety of the animal. It's just giving us an idea of how the animals respond. We can link that to a parallel study that Dave Moretti has been doing by listening to the whales at the AUTEC range."

Moretti is an electrical engineer with the Naval Undersea Warfare Center in Newport, R.I. His background is in signal processing, and he has used the infrastructure at AUTEC to study vocalizations of marine mammals. Developed as part of the Marine Mammal Monitoring on Navy Ranges (M3R) program, Moretti said the Navy's capabilities for finding marine mammals were used to guide BRS researchers to whales during the study at AUTEC.

"Navy ranges are places where active sonar is used but they're also highly-instrumented areas with fields of bottom-mounted hydrophones," Moretti said. "Because of our processing expertise, we thought we could make use of both our infrastructure and our knowledge of signal processing and apply those to the study of marine mammals."



Pilot whales surfacing off the Kona coast, Hawaii, with NOAA ship Oscar Elton Sette.
Photo by Ari Friedlaender

Using recordings of whale vocalizations captured by Tyack and Johnson's D-TAG, Moretti's team programmed signal processors to effectively listen for deep-diving beaked whales.

"As soon as we looked—literally within 30 seconds of turning on the instrumentation at AUTEC with the reprogrammed signal processor—we actually detected vocalizations from beaked whales," Moretti said. "It turns out that AUTEC is almost like a laboratory for Blainville's beaked whales."

INITIAL RESULTS

indicate that beaked whales appear to have an avoidance response to simulated sonar sounds that may distinguish them from other marine mammals.

The head of a male dense-beaked whale.
Photo by Ari Friedlaender





A D-TAG attached to the back of an adult male pilot whale off the Kona coast, Hawaii.
Photo by Ari Friedlaender

That's counterintuitive because it's an area where active sonar is used and—given the public perception of sonar, especially with this species—you wouldn't anticipate finding Blainville's beaked whales at AUTEK."

Moretti said in study on the West Coast at the Southern California Offshore Range (SCORE), the Navy has found a significant population of Cuvier's beaked whales.

In 2007, the initial year of the BRS, 10 whales were tagged and "play back" data were collected on individual whales, including a Blainville's beaked whale.

This past year, researchers placed acoustic listening tags on six whales from four species and played simulated mid-frequency sonar sounds and natural sounds.

"We're trying to study what's going on with animal responses to these signals and what we can do to try and minimize the impact of active sonar on marine mammals, generally, and beaked whales, specifically," said Dr. Brandon Southall, director of the U.S. National Oceanic and Atmospheric Administration's (NOAA) Ocean Acoustics Program.

Southall said initial results from two seasons of BRS, as well as related observations at AUTEK, indicate that beaked whales appear to have an avoidance response to simulated sonar sounds that may distinguish them from other marine mammals.

"If you put the pattern together with our tag data," Tyack said, "what it suggests is, at least at AUTEK, where these animals are experienced with sonar, when they hear sonar sounds they will stop what they're doing and they will move away to a safe distance, maybe ten or twenty kilometers. They'll stay away during the exercise and start coming back within a day or two after the exercise. It's

very helpful to get that detailed a view of what the response is."

"They're living seemingly in concert with sonar," Moretti said. "Why is that? And what does that mean long-term for the health of the population?"

This summer, researchers tagged and tracked several whales during the 2008 Rim of the Pacific (RIMPAC) exercise that involved Navy sonar. RIMPAC gave researchers a unique chance to conduct aerial and ship-board monitoring surveys and NOAA's Pacific Islands Fisheries Service Center conducted a month long marine mammal survey.

Researchers used D-TAGs, which provide detailed data but stay on for a short period of time, and longer-term tags that track an animal's movement for weeks. In October 2008, researchers were still tracking a Cuvier's beaked whale and a fin whale tagged off the coast of California during an M3R test in August 2008, according to Moretti.

Jene Nissen, the environmental program acoustics manager at the Navy's U.S. Fleet Forces Command in Norfolk, VA, manages the development of environmental compliance documents for the Navy. He said other important research includes studies of "threshold shift measurements," which studies the reactions of dolphins to sound. Those studies are used to develop criteria for environmental documents.

"It adds to the scientific community's baseline data on what kind of sounds affect dolphins," Nissen said. "It helps

us to better understand how sound could affect marine mammals so we can write better compliance documents and better quantify what the effects of our training may be."

Ari Friedlaender attaches a D-TAG to a pilot whale.
Photo by Danielle Waples



Stone said there is another benefit to the Navy's commitment to environmental research—making room for others who would like to study marine mammals and contribute to future environmental research.

Because of the high quality research we're funding at Woods Hole and other institutions, graduate students are drawn into marine biology and acoustics," Stone said. "Over the years, the program has increased the number of scientists out there who can go into this field and contribute to the scientific knowledge base." 📌

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