

EAR TO THE WATER

A MARINE MAMMAL SONAR DETECTION SYSTEM BENEFITS THE NAVY



Marine-environment researchers have been listening to the ocean.

Specifically, they've been homing in on marine mammals' responses to Navy sonar.

In March of 2000, there was a marine mammal-stranding event in the Bahamas. According to a 2001 joint interium report by the National Oceanic and Atmospheric Administration (NOAA) and the US Navy, it was concluded that Navy sonar was the cause of this stranding, and that the Navy should "put into place mitigation measures that will protect animals to the maximum extent practical."

During "war game" exercises, the Navy uses active sonar to detect submarines and underwater hazards. Unfortunately, cetaceans, an order that includes some 70 species of whales, dolphins, and porpoises, are far

more sensitive to active sonar than was previously believed. And because marine mammals rely on echo-location, or innate bio-sonar, as their primary means of communicating, migrating, breeding, and finding food, any disruption to their ability is of primary concern.

When exercises take place in waters native to cetacean pods, research has revealed a correlation between anti-submarine acoustic pulses and marine mammal stranding or "beaching," eardrum ruptures, and premature ascension (which can cause decompression illness). Among the *Cetacea*, whales are particularly vulnerable to the sonar used in anti-submarine warfare exercises.

Under a US Federal Court ruling to prioritize marine mammal health and safety, and in compliance with environmental requests, the Navy has become increasingly proactive in monitoring for whale activity and presence

in “shared” waters. After initial modifications to their training exercises, naval anti-submarine operations sought alternative technology that would allow for conducting underwater tactical training without disturbing marine mammals.

When this specialized need emerged, Jacksonville, Florida-based Analysis, Design & Diagnostics, Inc. (AD&D) saw a prime opportunity to diversify their sonar business.

“Those assessments required the Navy to do more to protect whales and dolphins in the training grounds,” said Gary Donoher, AD&D president. “We have responded to several SBIRs [and STTRs] regarding marine mammal mitigation, but the first phase was in 2001.”

AD&D has been in the sound analysis business for twenty years. “One of AD&D’s core competencies is understanding sounds in the world’s oceans,” Donoher said. “We’ve supported the United States Navy in detecting and classifying submarines and surface ships.”

Today, the company provides the Navy passive technology that captures and analyzes marine mammal activity via sonobuoys and technology fitted onboard naval vessels. Sonobuoys use a passive receiver and a radio transmitter to record and transmit underwater sounds. Together, the data received provides a location on marine mammals (or any objects in the water).

But AD&D wasn’t always interested in listening for marine mammals. According to Donoher, before federal court cases ruling that the Navy should continue “monitoring and mitigation measures” to prevent harm to marine mammals, “AD&D considered marine mammals’ sounds to be unwanted clutter. At that time, our detection and classification algorithms were tuned to ignore these sounds.” But that perspective quickly changed.

“Once we realized that the Navy wanted to know if marine mammals were



in the vicinity, we decided to exploit the marine mammal vocalizations and began optimizing our algorithms to automatically detect and classify these sounds,” Donoher explained. But because their sensor product line was previously geared toward non-mammal frequencies, AD&D reached out to cetacean experts for direction.

“The first step in developing our Marine Mammal Detection and Mitigation (MMD&M) technology was to ensure that we fully understood the types of sounds marine mammals make,” said Donoher. AD&D

teamed up with Dr. William Watkins at Woods Hole Oceanographic Institution (WHOI) for his world-renowned expertise in marine mammal vocalizations.

Working with Dr. Watkins, AD&D learned that *Cetacea* produced a variety of sounds. Quoted in an article for *OceanUs* Magazine, Watkins classified them as “Whistles, clicks, click trains, and burst pulse transmissions.” The ability to distinguish these sound frequencies

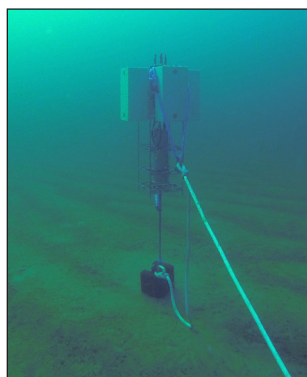
helped tune AD&D’s development efforts to create a mitigation system alerting Navy vessels to avoid potentially harmful activities.

According to Donoher, Whistles are vocalizations that have characteristics of a continuous wave (CW), Linear Frequency Modulation (LFM), Non-Linear FM or Hyperbolic transmission modes. This marine

mammal vocalization category consists of low-frequency calls from blue whales and the North Atlantic right whale; as well as higher frequencies observed from melon-headed whales and the common dolphin. When these sounds fall in the lower-frequency spectrum, Donoher called them “moans and groans.”

“Clicks, click trains, and burst-pulse transmissions are temporally short, broadband sounds produced by sperm whales, Cuvier’s beaked whale, and bottlenose dolphins,” said Donoher, “We use our click

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An underwater Marine Mammal Detection and Mitigation sensor



Gary Donoher,
President, AD&D

detector for these sounds.” Regardless of where sound frequencies fall in the spectrum, he said, “They all have similar characteristics, and we use our whistle and click detectors to locate them.”

To ensure accuracy, Donoher and his team tested their detection and classification algorithms against the direction Dr. Watkins provided. “We also obtained acoustic data that was recorded from Navy surface ship sensors and from sonobuoys deployed by Navy aircraft,” Donoher said. All of the data enabled AD&D to place their buoys in the water, and relay mammal vocalizations and locations to MMD&M components aboard the ships.

“We were onboard the Navy ships’ Improved Performance Sonar (IPS) platforms,” said Donoher, “and we are currently working to back fit this technology onto all Navy Surface ships and submarines.” The automated system uses passive acoustics to detect mammal vocalizations, then alerts ships to move out of shared waters. The technology has been developed to use onboard sensors and operates on commercial-off-the-shelf hardware that has been approved for shipboard use.

Regardless of weather or operational conditions, the MMD&M system provides the Navy nonstop, reliable marine mammal

detection support. The detection system also allows commercial industry an effective and low-cost method to monitor marine mammal activity when conducting offshore activities that may be harmful to marine life.

“In the years after we were awarded our first STTR contract, we have continued to improve our technology,” Donoher said. “We have developed high frequency sensors that can detect the highest frequency vocalizations produced by marine mammals.” AD&D has continued to improve the detection and classification technology, so much so that they are able to classify some species to a taxon level.

In the near future, AD&D predicts that all DDG 1000 (newest destroyer class ships) and CG (Ticonderoga class) warships will employ MMD&M technology to protect marine mammals from the adverse effects of active sonar, while still allowing the Navy to maintain anti-submarine warfare readiness.

Teamed with Dr. Watkins at Woods Hole Oceanographic Institution (WHOI), Duke University Marine Laboratory, and Advanced Acoustic Concepts, Inc., and thanks in no small part to the DoD’s SBIR/STTR program, AD&D has successfully addressed the Navy’s marine mammal detection need. 🌊



Analysis, Design & Diagnostics, Inc.

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