Acoustics: Sounding the Deep

If a tree falls in a forest, does it make a sound? It depends on whether the tree is falling in air or in a vacuum. Sound travels through materials in waves and, depending on the material, sound travels at different speeds. That's why a tree falling in air makes a sound; the air molecules around the tree move, pushing other air molecules until the rippling air reaches your ears. In a vacuum, there are no air molecules so the ripple effect is eliminated and the sound waves cannot be created. From the basic understanding of the physics of sound, many applications have been developed to "see" with our ears, or with our instruments.

The following examples are projects which take this idea one step further. Through advances in Naval Science & Technology, we are able to explore the ocean in ways previously unimaginable – "sounding" the deep in order to learn more about endangered species, the environment, and seismic activity.

Much about the migration patterns of endangered whale species is unknown, thus contributing to their extinction.

- Using existing technology developed through Naval S&T, scientists are able to learn more about these large, intelligent mammals while avoiding collisions in critical whale habitats.

In order to study the greenhouse effect, researchers turned to the science of ocean acoustics since oceans act as a heat receptacle for the atmosphere.

- Naval scientists and researchers demonstrated that an acoustic signal can be used to track the changes in temperature in the ocean--and thus monitor possible increases in global warming. The basic principle is that sound travels faster in warmer water.

TRACKING ENDANGERED WHALES

One of the greatest barriers to to repopulating endangered whale species is the lack of information on these mammoth, intelligent mammals.

In a project called Whales '93, a team of scientists set out to track and monitor several endangered species in the Western Atlantic Ocean. Navy analysts who normally listen to ocean noise to detect submarines used Navy undersea resources and expertise to detect whale traffic. As a result, more whale-tracking data was generated in the span of a few months than existed in 20 years of scientific databases.

Building on the information from Whales '93, scientists used the Navy's acoustic and optical remote-sensing capabilities for real-time tracking of the Northern Right Whale in its winter calving ground and nursery area, habitat it shares with commercial and Navy shipping lanes near Mayport, Florida.

Since the right whales are very slow (travelling at 1-3 knots) and spend much of their time at or near the surface, the greatest threat they face is colliding with ships and injury from propellers.

Using fixed and towed underwater listening cables and infrared detection devices mounted on ships, scientists were able to detect and track whales better than with visual aerial surveillance, which is limited by adverse weather, heavy seas, and cover of darkness.

Scientists installed a fixed, passive acoustic array composed of almost nine miles of armored cable and 20 hydrophones along the ocean bottom southeast of Naval Station Mayport, Florida. When a right whale was detected, its location was forwarded to the Navy's Fleet Area Control and Surveillance Facility, who in turn sent the report to the civilian Early Warning System (EWS). The EWS then warned ships in the area of the right whale sighting so they could avoid the animal.

Similar to a bottom-mounted array, a towed array is a passive acoustic device 100 meters long which was towed behind a 113-foot research vessel called the R/V Sea Diver. The towed array allowed project personnel to go to the whales rather than waiting for the whales to come to them.

Lastly, an infrared sonar similar to night-vision goggles was used to sense the warm water and air ejected from a whale's blowhole. With this equipment, not only could detections be made during daylight hours, but also at night; a crucial feature when ships needed to transit the habitat after sunset.

Being able to detect right whales greatly decreased the probability of injury to the animals, while still allowing commercial and military ships to share this critical habitat .

in water, scientists speculated that if they could document a decrease in sound travel times over several years, they could substantiate the occurence of global warming.

Naval scientists and researchers from nine nations conducted experiments near Heard Island (located in the Indian Ocean between Antarctica and Australia). The experiment was conducted by lowering several acoustic transmitters into the ocean and transmitting sound patterns which were then received at stations around the globe.

Signal transmissions continued for four days, during which 34 transmissions were made, each lasting one hour. The sound used had about the same intensity as a foghorn; nearly all of the 19 reception stations heard the signals, which took approximately three and one half hours to travel from Heard Island to the farthest station in Coos Bay, Oregon. After demonstrating that the signal was of sufficient intensity to be heard, investigations continue to resolve the precision with which the signal can be used to determine arrival times and ocean temperatures. But without a doubt, the Heard Island experiment was truly a sound heard around the world!

ANALYZING THE GREENHOUSE EFFECT

One cause of global warming is the greenhouse effect: the process where carbon dioxide is trapped in the earth's atmosphere and may increase the earth's base temperature from year to year. Although small, this increase in temperature has serious long-term ramifications, such as the melting of polar ice caps and the changing of global weather patterns.

In order to study the greenhouse effect, researchers turned to the science of acoustics.

Since oceans act as a heat receptacle for the atmosphere, and since warmer temperatures increase the speed of sound