

© TOM BRANKFIELD, GETTY IMAGES



## Sounds of the 'silent world'

Remote acoustics is an effective way to study baleen whales, such as this humpback whale, living in inclement (for humans) environments such as the Southern Ocean. The technique will help scientists understand more about the populations and life histories of these animals.

Jacques Cousteau once described the ocean as the 'silent world'. But in fact, the ocean is filled with a cacophony of noise from creatures, machines, wind, rain, earthquakes, explosions, and anything else that can produce an underwater sound. Water is so efficient at carrying sound energy that some of these sounds even travel around the globe.

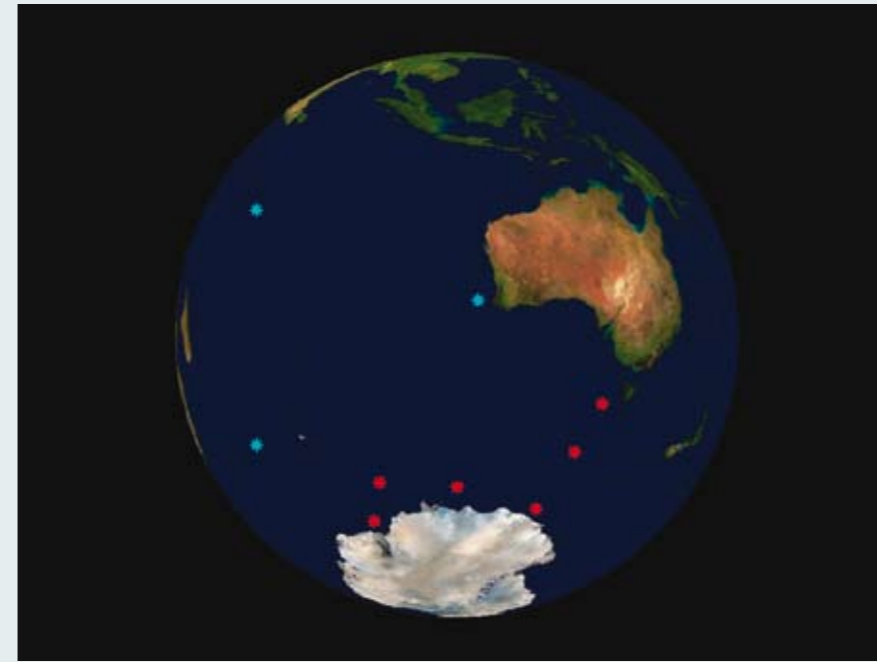
Over millions of years, cetaceans (dolphins, porpoises and whales) have evolved to use the acoustic properties of their ocean environment. Toothed cetaceans produce sounds to essentially 'see' their environment through echolocation (listening to the characteristics of echoes), much like bats in the terrestrial environment. Many species of baleen whales sing, producing stereotypic sounds in regular patterns for hours on end. These songs can travel for hundreds of kilometres, allowing the whales to communicate with distant individuals. Humans can also take advantage of water's incredible ability to conduct sound, learning more about whale populations by eavesdropping on their species-specific songs from great distances away.

Remote acoustic study is a remarkably effective tool for studying baleen whales and has been used to track blue, fin,

humpback, and bowhead whales in the Atlantic, Pacific, Arctic and Southern oceans. The technique allows researchers to be remote from their instruments (and the weather), and to record sound for a year or more. The simple presence or absence, and relative abundance of particular whale species' sounds, can be used to determine whale presence, seasonality and relative population density between locations and times of year.

The need to learn more about these animals was highlighted by recent manoeuvring within the International Whaling Commission to reintroduce commercial whaling. Even without commercial whaling, Southern Ocean baleen whales are facing increased pressure from so-called scientific whaling. In the face of these increasing pressures, it is important to understand as much as possible about the populations and life histories of these animals. There are still enormous gaps in our knowledge, but remote acoustic monitoring provides an excellent opportunity to fill some of these holes.

Last year we worked with the Scripps Institute of Oceanography to use a relatively new technology -



The locations of past, present, and future Australian Antarctic Division acoustic instruments are represented by the red stars, while the blue stars show the locations of the nuclear monitoring project acoustic listening stations in the Indian Ocean. JASON GEDAMKE

autonomous acoustic recording packages - in Antarctica. These instruments are anchored to the ocean floor during the summer season, and left in place for a year to record all low frequency (i.e. most baleen whale) sounds. Once they're recovered, the hard drives can be replaced and the instrument immediately re-deployed, while the previous year's data can be analysed in the lab.

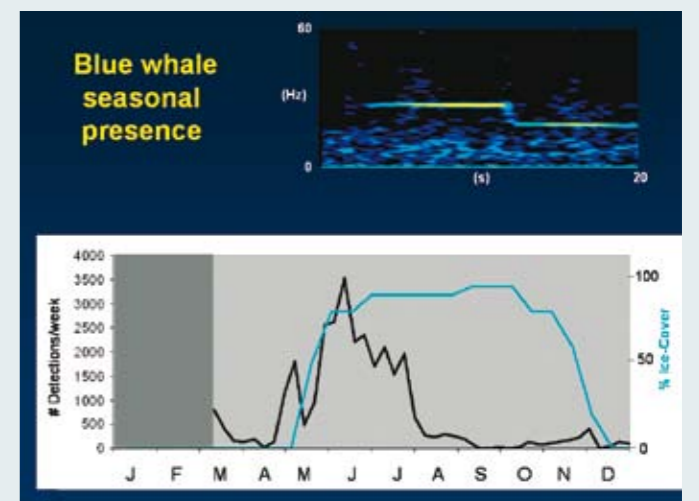
While this program is in its early stages, its promise is demonstrated by the data recorded on an acoustic recording package that we recovered from the ocean floor off Casey station. It was deployed from February 2004 to April 2005 at a depth of 3000 m and obtained clear recordings of blue, fin, and humpback whales. Blue whales demonstrated a distinct seasonality in their presence off Casey in 2004. Somewhat surprisingly, there appear to be large numbers even when the area is covered by sea ice, though their numbers drop quite quickly once the ice consolidates. Fin whales had a very low level presence throughout the year, with their sounds relatively rare. The lower frequencies of humpback whale song could be heard in April and May, prior to their migration to winter breeding grounds off the west coast of Australia.

Interestingly, there were at least three other repetitive, stereotypic sounds whose source remains a mystery. We suspect they are produced by baleen whales. During the 2005-06 BROKE-West cruise (*Australian Antarctic Magazine* 8: 12), we hope to ground-truth our recordings by determining which species produce them.

We also picked up the sound of the magnitude 8.1 earthquake that struck off Macquarie Island last year, and the magnitude 9.0 Indonesian earthquake - over 7500 km away - that caused the disastrous Boxing Day tsunami.

In the future, we will continue to deploy Scripps's acoustic recording packages in various locations off the Antarctic.

The autonomous acoustic recording package consists of a hydrophone (underwater microphone) and two round floats that hold it off the sea floor. The main unit contains underwater pressure cases that house the acoustic recording electronics and batteries.



The graph shows the number of blue whale vocalisations recorded at Casey station using an autonomous acoustic recording package. Whale numbers peaked at the start of winter and then declined as the sea ice thickened and winter set in. The spectrogram shows a typical Antarctic blue whale call, with two sequential 'tones' that are inaudible to the human ear. JASON GEDAMKE

We are also developing new acoustic recording devices with Curtin University in Western Australia. These will be attached to oceanographic moorings running south from Tasmania to the Antarctic. Ideally, if we can detect differences in the timing of the peak acoustic presence of whales, we will be able to assess north-south migratory patterns of various species.

Finally, we are planning to use an array of hydrophones established throughout the Indian Ocean by the nuclear monitoring project. The systems record the same low frequency sounds that blue and fin whales use, and will help determine their presence over very large scales.

Despite Cousteau's early assessment of the ocean as the silent world, sound's ability to travel great distances underwater provides a window that can be used to observe whale populations across entire ocean basins.

—JASON GEDAMKE  
*Southern Ocean Ecosystems Programme, AAD*