

Cranking up the volume

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It is common knowledge that the world's oceans and atmosphere are warming as humans release more and more carbon dioxide into the Earth's atmosphere. However, fewer people realize that the chemistry of the oceans is also changing—seawater is becoming more acidic as carbon dioxide from the atmosphere dissolves in the oceans. According to a paper to be published this week by marine chemists at the Monterey Bay Aquarium Research Institute, these changes in ocean temperature and chemistry will have an unexpected side effect—sounds will travel farther underwater.

Conservative projections by the Intergovernmental Panel on Climate Change (IPCC) suggest that the chemistry of seawater could change by 0.3 pH units by 2050 (see below for background information on pH and ocean acidification). In the October 1, 2008 issue of *Geophysical Research Letters*, Keith Hester and his coauthors calculate that this change in ocean acidity would allow sounds to travel up to 70 percent farther underwater. This will increase the amount of background noise in the oceans and could affect the behavior of marine mammals.

Ocean chemists have known for decades that the absorption of sound in seawater changes with the chemistry of the water itself. As sound moves through seawater, it causes groups of atoms to vibrate, absorbing sounds at specific frequencies. This involves a variety of chemical interactions that are not completely understood. However the overall effect is strongly controlled by the acidity of the seawater. The bottom line is the more acidic the seawater, the less low- and mid-frequency sound it absorbs.

Thus, as the oceans become more acidic, sounds will travel farther underwater. According to Hester's calculations, such a change in chemistry will have the greatest effect on sounds below about 3,000 cycles per second (two and one half octaves above "middle C" on a piano).

This range of sounds includes most of the "low frequency" sounds used by marine mammals in finding food and mates. It also includes many of the underwater sounds generated by industrial and military activity, as well as by boats and ships. Such human-generated underwater noise has increased dramatically over the last 50 years, as human activities in the ocean have increased.

The MBARI researchers say that sound already may be traveling 10 percent farther in the oceans than it did a few hundred years ago. However, they predict that by 2050, under conservative projections of ocean acidification, sounds could travel as much as 70 percent farther in some ocean areas (particularly in the Atlantic Ocean). This could dramatically improve the ability of marine mammals to communicate over long distances. It could also increase the amount of background noise that they have to live with.

There are no long-term records of sound absorption over large ocean areas. However, the researchers cite a study off the coast of California showed an increase in ocean noise between 1960 and 2000 that was not directly attributable to known factors such as ocean winds or ships.

Hester's research shows once again how human activities are affecting the Earth in far-reaching and unexpected ways. As the researchers put it in their paper, "The waters in the upper ocean are now undergoing an extraordinary transition in their fundamental chemical state at a rate not seen on Earth for millions of years, and the effects are being felt not only in biological impacts but also on basic geophysical properties,

including ocean acoustics."

Source: Monterey Bay Aquarium Research Institute

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