I BET YOU DIDN'T KNOW...

Whale song is changing

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Have you ever wondered what sounds there might be deep in the oceans?

Nature films are often soundtracked with meditative music so you may not have thought about this. Scientists have been monitoring the oceanic acoustic environment for many years and have shown that abiotic processes (earthquakes and volcanic activities), human activities (shipping, seismic exploration of subsurface deposits of crude oil, natural gas and minerals) and biotic sources (animal sounds) all contribute to this. Whales dominate the low-frequency range (low pitch) of many recordings.

Scientists know that whales use a variety of sounds to communicate verbally: clicks, whistles and pulses (which sound like squeaks to the human ear). Whales also use their tails and fins to make loud slapping noises on the surface of the water to communicate nonverbally. Discussing types of whale communication with children could be an interesting way to explore and learn about sound and environmental change.

Figure 1. An adult blue whale (Balaenoptera musculus), up to 29.9 m in length and a maximum recorded weight of 173 tonnes, it is the largest animal known to have ever existed.

Figure 2: A pygmy blue whale. Calls from Antarctic and pygmy blue whales, and fin whales were analysed at sites across the Indian Ocean

Questions children might like to consider:

How do whales communicate?

How is this different from how humans communicate?

Consider both verbal and body languages.

What about other animals?

What is happening when we make sound?

Children could explore many types of sound to develop an understanding that sound originates with a vibration.

Do you know what is meant by high and low pitch (the frequency of sound)?

Children could be asked to demonstrate their understanding by making appropriate sounds!

A 'sound' background

Sound is a pressure wave vibration of molecules. Whenever molecules vibrate, they will lose some energy to heat. Because of this, sound is lost to heating of the molecules in the medium it is propagating through. Consequently, a sound wave can only propagate through a limited distance. The attenuation of sound waves is frequency dependent in most materials. In general, low frequency waves travel further than high frequency waves because there is less energy transferred to the medium.

Sound research

Scientists have known for some years that whales emit low frequency calls (<100 Hz) which travel up to several hundreds of kilometres. They have also known that the frequency (pitch) of blue whale calls is decreasing worldwide but the reasons are unknown.

Recently, researchers have analysed acoustic data from six sites in the Indian Ocean over 7 years. They have shown a long-term frequency decrease (reduced pitch) for the call of the Antarctic blue whale, pygmy blue whales and the fin whale. To help children understand what this means, they could investigate how the pitch of a sound can be changed by tapping or blowing over bottles containing different amounts of water, or twanging rulers (details of investigations can be found in the Teacher Guide).

The researchers suggest that the long-term decrease in call frequency must have a long-term cause and describe two possibilities. The population density of the whales may have increased since the International Whaling Commission (IWC) banned commercial whaling because of the extreme depletion of most of the whale stocks. If whale numbers have increased, the interindividual distance is reduced and the need for whales to raise their call intensity (loudness) is reduced. Scientists believe that the intensity of the whale's call and its frequency are linked: low-level (quieter) calls have lower peak frequencies (lower pitch) than high-level (louder) calls. Thus, the lower frequencies of calls observed might be a result of an increase in the whale population. Alternatively, the acidification of the oceans since the industrial age has resulted in decreased sound absorption and therefore an increase in the distance the sound can travel. This means that for a given distance, the whales could lower their intensity of call and this might facilitate the lower-frequency calls.

In addition, the researchers have shown short-term cyclical call-frequency changes in Antarctic blue whales, fin whales and the Madagascan pygmy blue whales which follow the seasonal changes in ambient noise levels at similar frequencies. For example, the Antarctic blue whale low-frequency noise level increased during the austral summer (January to February) which is when most iceberg cracking noises are heard and decreased in the autumn (April to May) and winter. Because ship traffic (another potential source of noise) is limited in the southern Indian Ocean, the scientists suggest that the seasonal changes in whale calls could be due to the whales adapting to the seasonal changes in the ambient noise level. This adaptation to maintain the signal-to-noise ratio of vocalizations is known as the Lombard effect and has been demonstrated for birds, primates and for other species of whales.

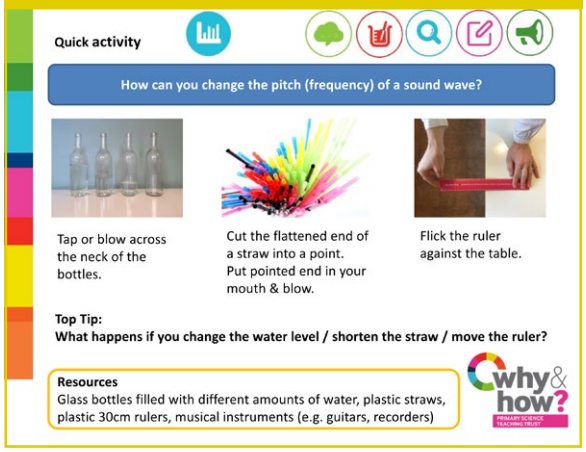
Although noise levels are rising in other parts of the world ocean, there seems to be no effect on the worldwide frequency decline in whale calls. This presents a paradox: changes in environmental noise correlate with a short-term seasonal effect on the frequency of whale calls, but not a long-term effect. Scientists will need to investigate acoustic behaviour of other whale species in other parts of the world, along with monitoring the pH and acoustic properties of the ocean to find answers to this.

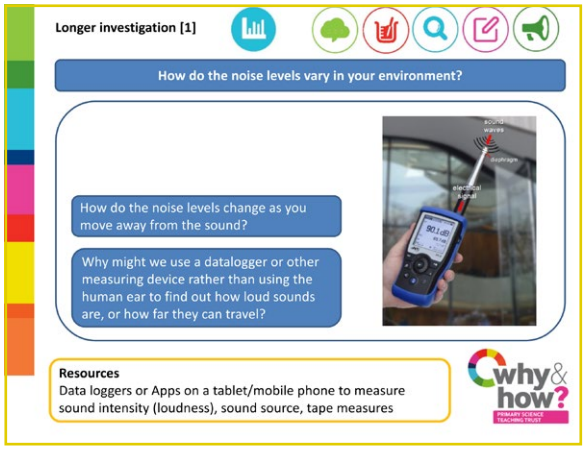
How can children investigate sound in their local environment in a similar way to the scientists who carried out this research?

Using data loggers or sound apps, children could investigate ambient noise levels in different locations, at different times of the day, in different weather conditions, or how sound intensity (loudness) varies with distance from the noise source. They may also consider how different materials might reduce the distance sound travels.

Apps for measuring sound frequency (pitch) are also available. Using an electronic sound source (a keyboard or computer) with fixed volume, children could investigate how far different frequencies of sound can travel and what effect different background noises have on this. Details of these investigations are included in the Teacher Guide (see figure 3).

Figure 3: Example pages from the accompanying Teacher Guide PowerPoint presentation.





GLOSSARY

Sound intensity
relates to the loudness of the sound (measured in decibels) which depends on the energy or power of the sound wave and how far the sound wave travels from its source.

Sound frequency
the number of vibrations per second (measured in Hertz) which determines the pitch ('higher' and 'lower' sounds associated with music)

The research paper that generated this work was:

Long-Term and Seasonal Changes of Large Whale Call Frequency in the Southern Indian Ocean
By Emmanuelle C. Leroy[1], Jean-Yves Royer[1], Julien Bonnel[2], and Flore Samaran[3].
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