fact sheet

A whale of a time

Echolocation

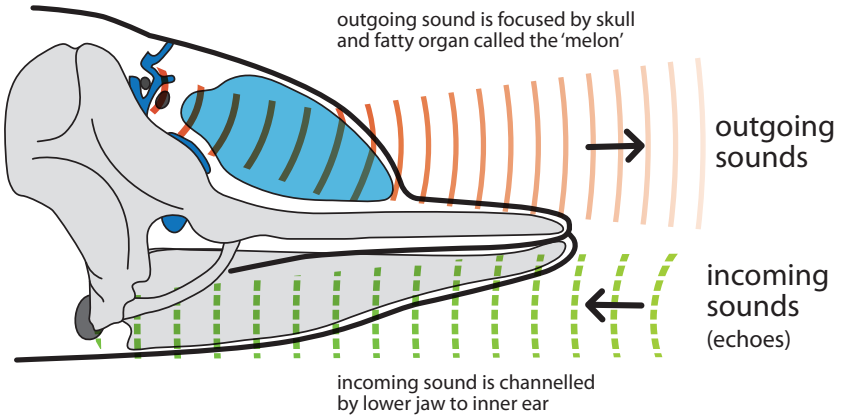
Many animals that move in darkness or live in environments where vision is difficult have evolved a method of 'seeing with their ears' known as *echolocation*. The technique is common amongst mammals such as bats, dolphins and whales, and two cave-dwelling bird species have developed echolocation to navigate through their dark environments.

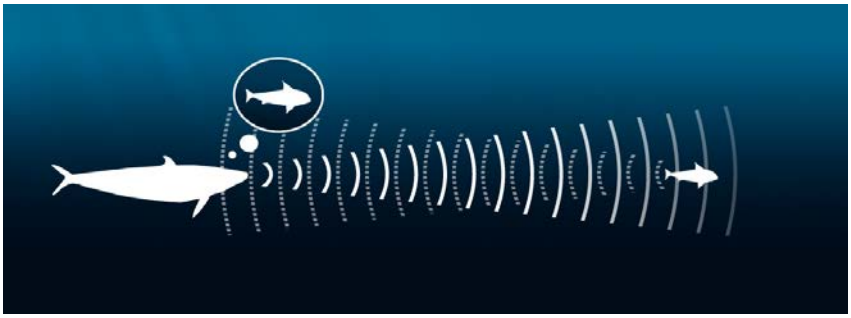
Echolocation in whales and dolphins works in the same way as sonar in boats. Both create a strong pulse of sound and listen for returning echoes. The animal can learn a lot about the surrounding environment from the loudness of the echoes and the time it takes them to reach each ear. Echolocation normally gives an incredibly accurate picture of the distance, position, size and movement of an object.

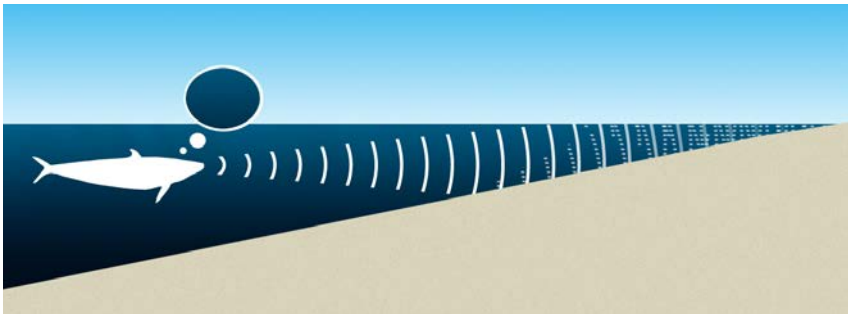
Because echolocation uses acoustic (sound) waves, physicists have figured out how these signals work. Echolocation pulses are subject to the same physical laws as all waves: they reflect off surfaces, they create interference with other waves, and they can lose energy and weaken (or 'attenuate') as they travel.

Physicists have also discovered that echolocation can sometimes let an animal down. Since whales and dolphins rely strongly on these signals to feed and navigate around the ocean, if they get the wrong signal (or no signal at all) due to interference with the sound waves, it can get them into some serious trouble.

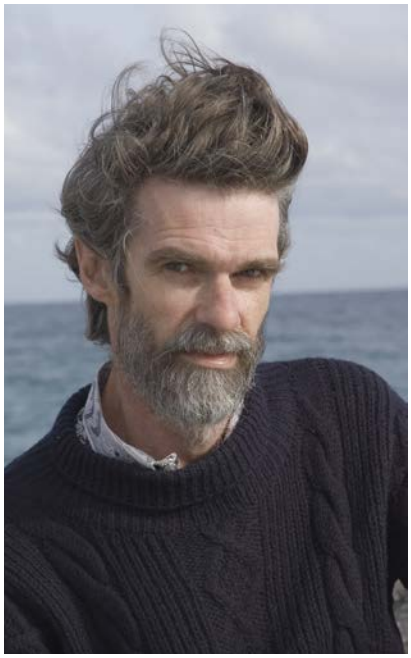
- **All toothed whales, including dolphins, river dolphins, porpoises, orcas and sperm whales, use echolocation by creating a focused beam of high-frequency clicks. Each burst of sound may have more than 600 clicks per second.**
- **Dolphins can detect golfball-sized objects from 100 m away using echolocation.**
- **Dolphins can use echolocation to 'see' through materials. They can easily identify objects behind brick walls and can even see what a fellow dolphin has just eaten for dinner by 'seeing' into their stomach!**
- **Sound waves travel through water at 1.5 km s^{-1}. That's 4.5 times faster than sound travelling through air.**







Why is this physicist interested in whales?



Dr Ralph James gave up a life as a musician to begin working at the School of Physics at The University of Western Australia. His early research involved finding ways to stop microwaves from bouncing around inside the equipment of communication systems. For this he used a 'terminator', a tube with a ramp of carbon at one end. Any microwaves sent into the terminator reflected along the ramp and decreased in intensity (or 'attenuated') to the point where no echo would return.

One night, Ralph James was called away by friends to help a group of beached whales in Augusta. He noticed that the slope of the beach was similar to that of the ramp in the terminator. Knowing whales and dolphins use echolocation to navigate underwater, he wondered if their echolocation sound signals were being weakened ('attenuated') just like microwaves in his research. In that case the whales would not hear any echo and would not 'see' the beach ahead of them. They would think they were swimming into open water.

Dr James and his team are now conducting research to see if his theory can explain why so many healthy whales beach themselves and die along the Western Australian coast. Perhaps, one day, his work will lead to ways in which we can prevent these deaths.

Stranding facts

- Between 1960 and 2000, 943 whales and dolphins were stranded on WA beaches. Only half of these whales escaped or were saved.
- Whales or dolphins common in strandings are usually open ocean species that are not used to coastal conditions.
- Beachings commonly occur after storms, whilst earthquakes, navy sonar tests and underwater explosions may also be a factor in beachings.
- Whales that beach first are usually the youngest in a pod (a 'pod' is a group of whales). Once the young animals are stranded their distress calls attract other whales to support and care for them. These animals also become stranded and send more distress calls. Eventually the entire pod may become stranded.

Image: 'Stranded whales at Quindalup Beach, 2 June 2005' by Paul Smoker. Used with permission.