

WHALE SONG

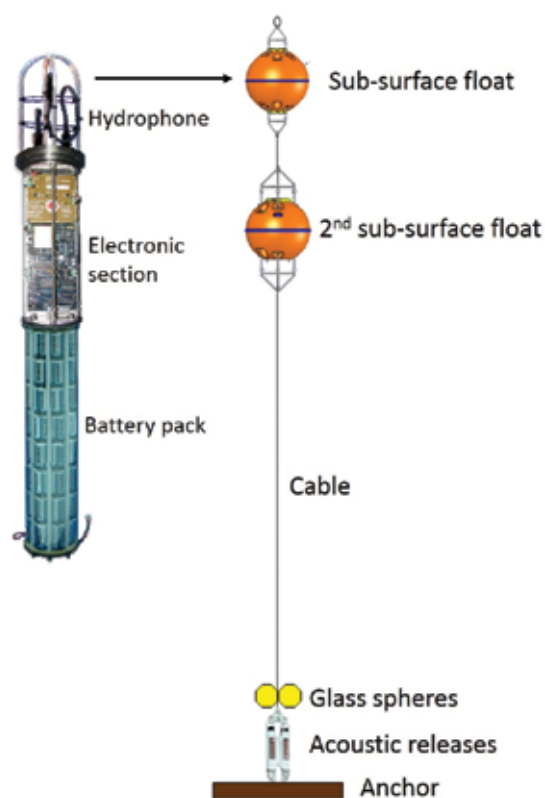
NOAA

Fannie Shabangu tells us about the underwater melodies of ocean giants

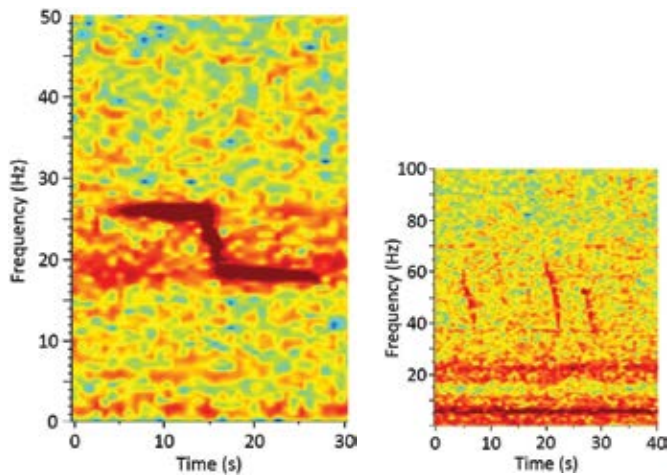
Reaching a maximum recorded length of 30 m, weighing as much as 148 000 kg, with a heart roughly the weight of a small car, and living more than 90 years, Antarctic blue whales are the largest animals on Earth. Fin whales come a close second, growing up to 27 m long. The two species are classified by the International Union for the Conservation of Nature (IUCN) as critically endangered and endangered, respectively.

Both used to be commonly encountered on the west and east coasts of South Africa, but many were killed during the whaling era, which began in the 1790s and ended in the 1970s. Whale blubber and baleen were used for products such as lamp oil, margarine, cooking oil, candles, soaps, cosmetics, corsets, umbrellas and tennis racquets, while whale meat was sold for human consumption, animal feed and fertilizer. As a result, these two whale species were reduced to precariously low population sizes, and it is now rare to see them along the South African coast.

These and other baleen whales, or mysticetes, which filter food through baleen plates, produce some of the loudest sounds ever recorded. The sounds, which are species- and region-specific, can be produced as individual, often repeated, calls or merged into sequences as songs that last from minutes to hours, days and sometimes weeks. For example, humpback whales are known for singing rhythmic songs throughout their distribution range. Most baleen whale sounds have a frequency below 100 Hz (100 sound wave cycles per second), and can be detected by underwater



Not-to-scale diagram of a hydrophone attached to the top sub-surface float of an oceanographic mooring. The hydrophone is equipped with a battery pack allowing autonomous recording of acoustic data for more than a year.



Spectrograms showing a Z-call (left) and D-calls (right) by Antarctic blue whales recorded off the west coast of South Africa. Spectrograms are visual representations of the spectrum of a sound changing through time.

instruments called hydrophones from tens to thousands of kilometres away. Distances travelled by these sounds depend on water temperature, ocean noise and sea bottom type, among other things.

The study of listening to and recording sounds produced by animals is called bioacoustics, and the method of conducting such listening and recording is called passive acoustic monitoring (PAM). The main advantage of using PAM to study these animals' occurrence is that it is a non-invasive and non-lethal method that can be conducted at low cost, independent of weather and daylight conditions. Furthermore, sound is an important component of these ocean giants' life as they use it for short- and long-range communication, navigation and avoidance of sounds associated with danger. They produce sounds underwater using specialised vocal cords, other body parts or unknown mechanisms.

Since these whales are rarely seen during traditional sighting surveys aboard research vessels, their recovery post-whaling remains uncertain, but their sounds are useful for telling us about the behaviour and seasonality of these animals in their important and preferred habitats. My colleagues and I monitored these ocean giants in Antarctic and South African waters using hydrophones deployed

on moorings. Antarctic blue whales produce two types of calls: D- and Z-calls. D-calls are produced by both sexes for short-distance communication during feeding and for antagonistic interaction during mating. Z-calls (so-called due to their resemblance to the letter Z on a spectrogram – a visual representation of a sound signal) are characteristic of Antarctic blue whales and produced only by males for long-distance communication as individual units or in song form to attract females. Fin whales also produce two types of calls: the 20 Hz pulse used by males for communication (it can also be produced in song form), and the 40 Hz pulse probably used during feeding.

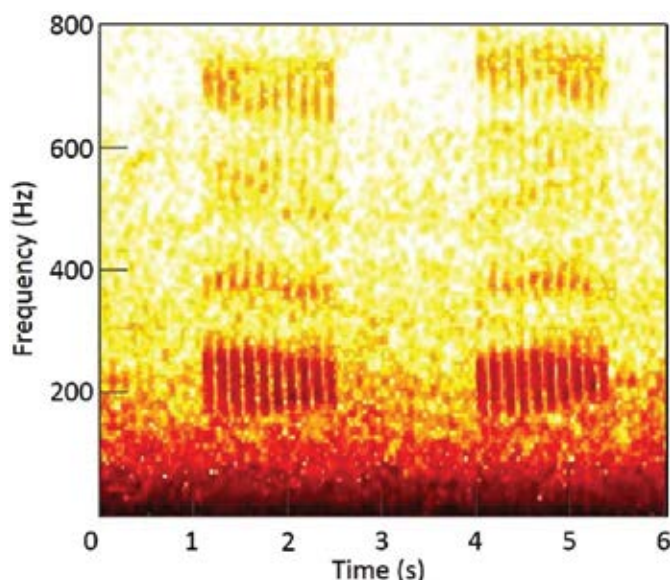
Our research indicated that these whales are in South African waters from May to November. This finding is very important in informing local and international management and conservation efforts of a useful habitat of these species. Results of our studies also suggest that these whales might be feeding off the west coast, which enables them to remain in our waters for extended periods, up to the entire year. Some of the whales migrate between Antarctica to feed during summer and the low latitudes of southern Africa, Australasia and Patagonia to overwinter, breed or calve. Most whales move out of Antarctica when the sea surface is frozen in winter, although some animals remain there in winter, most likely by staying on the edge of the sea ice or using open waters surrounded by sea ice, called polynyas. Warmer waters of the low latitudes, such as South Africa's west coast, provide nursery areas for these whales as they promote fast growth of calves.

Southern right whales calve mainly on the south-east coast of South Africa, and can be commonly seen during the famous Whale Festival in the coastal town of Hermanus in September. The adult whales can grow up to 17 m in length, weigh more than 80 000 kg and have an estimated lifespan of up to 80 years. These whales produce up to 13 call types depending on the behavioural state – resting, swimming, mating, feeding, etc. My colleagues and I recorded the 'gunshot' sound of southern right whales off the west coast of South Africa, mainly in October when most whales are expected to be in this area. These sounds, which sound like a rifle being fired, are broadband (30–34 000 Hz) sounds believed to function as an antagonistic signal between males, as communication between mother-calf pairs and also as an echolocation method. However, it is not known



Pavel Spindler, CC BY 3.0

Southern right whales can be seen in Walker Bay from the cliffs of Hermanus and De Kelders from July to November.



A spectrogram showing the new subcall type of Antarctic minke whale, bioduck B2, which the research team discovered in Antarctic and South African waters. Bioduck B2 calls consist of 10 pulses.

how this sound is produced. Our PAM results showed that years with low gunshot sounds corresponded well with low whale counts from aerial surveys conducted by the Marine Research Institute Whale Unit of the University of Pretoria, indicating that PAM can be successfully used to monitor species of concern in South African waters.

Our PAM research also showed that Antarctic minke whales in Antarctic and South African waters have similar call types. These calls range in frequency from 60 Hz to 311 Hz, and are called bioducks because the researchers who first heard them underwater thought they sounded like duck quacks. Additionally, our PAM results suggest that there could be two acoustic populations of Antarctic minke whales, the first one from the western Antarctic Peninsula and the second one from the eastern Weddell Sea. Such work shows that it might be possible to tell where Antarctic minke whales



MRI Whale Unit, University of Pretoria

originate based on recorded call type. Antarctic minke whales are one of the smallest baleen whale species, growing up to 10.7 m, weighing a maximum of 9 100 kg and living between 50 and 70 years.

A sperm whale shows its tail flukes before going for a long, deep dive.

Sperm whales are the largest of the odontocetes – the toothed whales – growing up to 19 m, weighing up to 57 000 kg and living to at least 70 years. They produce the second loudest sounds to those of blue whales, and their sounds are called clicks. These powerful, broadband (10–32 000 Hz) clicks were first thought to be used for stunning or disorienting prey, predominantly giant squid. However, recent research has revealed that clicks are used purely for echolocation. My own research shows

that sperm whale clicks are present throughout the year off the west coast of South Africa, probably because of the year-round availability of prey and suitable environmental conditions. Sperm whales can dive to an estimated depth of 3 200 m, spending two or more hours underwater without breathing. This deep-diving behaviour makes them difficult to study with other observation methods, but a suitable species for PAM as they are continuously clicking throughout their dives.

The ocean is a noisy environment, where noise is produced by multiple sources including marine organisms, weather conditions, earthquakes and human activities. Some of the noise is tolerated by the ocean giants and other marine organisms, whereas certain noise types are harmful to them, as they lead to physiological damages and behavioural changes. Some of my PAM research quantifies ocean noise levels in relation to whale acoustic occurrence and behaviour, with the aim of providing baseline information needed to advise management and conservation authorities on how to curb animals' disturbance by noise produced through human activities. Such activities include gas and oil exploration, ecotourism and shipping in our oceans.

Given that human activities are increasing, and oceans are becoming noisier, it is very important that PAM be conducted to gauge impacts of our actions on marine organisms. Since PAM research is still in its developing phase in South Africa, more expertise in this field is needed to help us fully understand the functioning of our marine system.

- Visit the 'Discovery of sounds in the sea' website to listen to recordings of various whale and dolphin species: <https://dosits.org/galleries/audio-gallery/>



Dr Fannie Shabangu ^{ORCID} has been employed at the Department of Environment, Forestry and Fisheries (DEFF) since 2009, the same year that he completed his master's degree at the University of Bergen in Norway, following honours and undergraduate degrees at the University of Limpopo. In 2018 he was awarded his PhD by the University of Pretoria for his thesis on acoustic assessment of the seasonal occurrence and behaviour of Antarctic blue whales in the south-eastern Atlantic and Southern Oceans.

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