Are blue whales finding new "microphone channel" to communicate in?

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A blue whale off the California coast. Credit: Oregon State University

For the past two decades, scientists have documented a gradual lowering of the frequency of blue whale calls and they haven't been sure why – or even whether the phenomenon is intentional.

Other baleen whales in the North Pacific have been recorded in recent years generating vocalizations that are missing the "overtone" portions of their calls. Again, scientists are unsure why.

A new study published this week in *Scientific Reports* may shed some light on these mysteries. A group of acoustic researchers at Oregon State University's Hatfield Marine Science Center recorded a blue whale call,

then created a model to replicate that sound based on a series of controlled air bursts from the animal's vocal cords.

In other words, they showed that whales can control the frequency of their calls by blowing air through their vocal cords at a faster or slower rate.

"Our study shows that blue whales in particular – and perhaps other baleen whales in general – may be making their harmonious sounds in a much different way than previously thought," said Robert Dziak, an acoustics scientist with the National Oceanic and Atmospheric Administration and lead author on the study. "It was long thought that they generated their calls mostly by resonating sound in large chambers or cavities in their upper respiratory system.

"But this implies that the frequency of the whale's calls are dictated by the size of the animal – the lower the frequency, the bigger the animal. We show that blue whales can make these low frequency sounds, and even change frequency in the middle of their call, by pulsing air through their vocal cords."

"That also suggests that the change in the frequency might be cognitive. They are choosing to make it higher or lower in response to some sort of environmental stimulus."

One theory is that as blue whale populations recover from commercial whaling, there are more of them and the lowering of frequency and other unusual characteristics of the calls are related to changes in population. It also is possible that an increase in ambient noise off the Pacific Coast plays a role, noted Joe Haxel, an Oregon State University acoustics specialist at Hatfield Marine Science Center.

"We conducted a year-long study of sound off the Oregon Coast and at

times it can be really noisy out there," Haxel said. "In addition to vibrant natural sounds – especially waves breaking on the beach – a few long-term studies have documented a substantial increase in ocean noise over several decades from expanding container shipping traffic.

"It may be possible the whales are modulating their vocalization frequency in response to an increase in human-generated noise. They are essentially trying to find a radio channel that has less static to communicate in."

Dziak and his colleagues have created similar acoustic models to replicate the sounds of icebergs scraping across the seafloor as well as the explosions from undersea volcanic eruptions. To recreate the sound of a blue whale, they began using a clear call from a blue whale off Yaquina Head near Newport that they recorded using an undersea hydrophone that was part of a study to monitor the environmental impacts of wave energy.

They then developed acoustical models of the whale sound and incorporated anatomical respiratory system models of blue whales, the largest animals to have ever lived on Earth.

"We tried to envision a mechanism whereby whales could gradually lower the frequency of their calls through time, or produce calls with unusual harmonic structure, by only resonating sound in their upper respiratory chamber – and it was physically impossible," said Dziak, who has a courtesy appointment in OSU's College of Earth, Ocean, and Atmospheric Sciences.

"Only when we pulsed air through the process of opening and closing the vocal cords did we get a way to produce sounds that can change frequencies in mid-call as well as remove overtones. And this method produced models that matched the natural Yaquina Head blue whale call

very, very closely.

"Lower-frequency sounds can be produced at lower intensity by the animal than high-frequency sounds and yet low-frequency sound still travels further," Dziak pointed out. "Those factors may also play a role in the vocalization changes over the past two decades."

More information: R. P. Dziak et al. A pulsed-air model of blue whale B call vocalizations, *Scientific Reports* (2017). DOI: 10.1038/s41598-017-09423-7

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