SOUND SCIENCE: BASICS OF BIOACOUSTICS – PRE READ ARTICLE

Bioacoustics: What Nature's Sounds Can Tell Us About the Health of Our World From Canadian Geographic

By Alanna Mitchell

The song of a male red-winged blackbird takes on a visible form as it stakes out its territory on a cold spring morning. (Photo: Stanley Bysshe)

Our planet has a soundtrack. There are the birds, of course — the chirps, warbles, tweedles, whistles and clicks of the dawn chorus. But mammals play in Earth's orchestra, too. Lions roar. Moose bellow. The panther has its deadly purr.

Insects are famously chatty; just ask the cicadas. Crocodiles snap. And where would Earth's concert be without the languorous basso of the bullfrog? Fish burble. Whales sing in linguistically discrete dialects. Coral reefs are underwater symphonies with shrimp snapping out the beat.

Plants emit sound waves. Pea seedlings listen for the flow of water. Bacteria converse, albeit at ranges higher than we can hear. Even a fungus may be able to talk; scientists say the thready networks of root fungi that link forests may be as gabby as a schoolyard at recess.

It’s not just the living that sing. Winds rustle. Water falls. Thunder booms. Glaciers splinter and the planet’s crust cracks into rifts.

Together, these sounds tell a story that scientists are just learning to decode.

“Sound is a really marvelous thing that’s around us that we’ve just ignored as a global society, but also as a scientific community,” says Bryan Pijanowski, an avian ecologist at Purdue University in Indiana who established the research discipline of soundscape ecology in 2011 along with a few colleagues.

The idea that sound is a clue to the health of our world began to be examined about 60 years ago when the American naturalist Rachel Carson published her book Silent Spring, an elegy to the vast numbers of birds killed by pesticides.

In the decades since, new generations of scientists have begun piecing together just how critical the acoustic assemblage of the planet is for creatures that communicate by sound.

From the purr of the cougar to the distinct mating calls of the moose and bullfrog, our planet has a soundtrack. (Photo: Delaney Frame)

“Sound has become the last frontier,” says Pijanowski, who is director of the Center for Global Soundscapes at Purdue. “We’re such a visual species, and we put such a high priority on it that we’ve discounted sound as a means to assess change and measure change.”

And the truth is, Earth is singing a strange and troubling song. The planet’s biophony — the sounds living creatures make — is being silenced. Humans are cutting down forests, ploughing fields, emptying the seas, killing wildlife, introducing invasive species.

In some places, the original soundscape has vanished, according to Bernie Krause, the California-based musician and naturalist who has amassed the world’s oldest collection of ecosystem sounds. Beginning in the late 1960s in the equatorial forests of Africa, Latin America and Asia, Krause started tenderly recording everything a particular soundscape had to offer, a shift from the usual practice of chasing the voices of individual creatures. He wanted to know what the animals heard in the world around them. Did a specific patch of the planet have a soundscape in a particular key? What happened at night? The result was 4,500 hours of tapes.

“For me, listening with open ears enhanced a sense of extraordinary humility and imparted a sacred gift: a souvenir of living sound from a distinct place at a moment in time,” he wrote in his 2012 book *The Great Animal Orchestra*.

Today, nearly half of those soundscapes exist only in his library. They are acoustic fossils.

And the depleted soundscapes that remain are competing with human-made noises, known as the anthrophony. Not just our voices — ever more numerous — but our doings, too. Factories, cars, ships, jets, bombs, bulldozers, air conditioners.

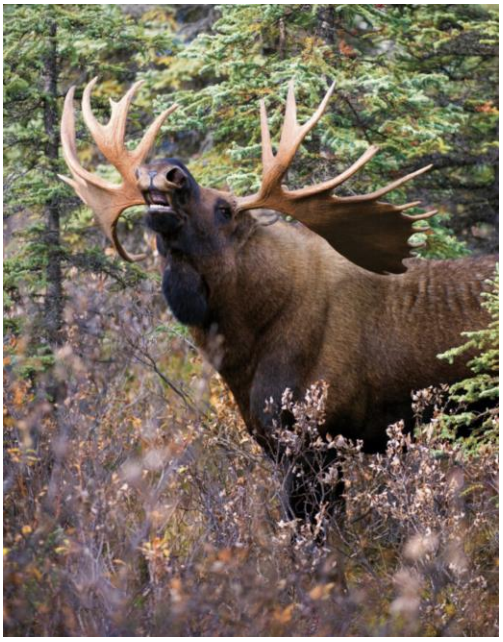

Photo: Mark Raycroft

More sinister, we're changing the fundamental media through which sound waves move. The carbon load in the atmosphere is making air hotter and wetter or sometimes hotter and drier, throwing the planet's instruments out of tune. It is causing the ocean to be warmer and less saline, and so sound waves move more quickly. Cyclones, wildfires, storms and floods are becoming more prevalent, altering the planet's geological voice.

Earth is talking. Are we listening?

Avian ecologist Bryan Pijanowski uses sound to assess and measure change in ecosystems. (Photo: Purdue Forestry and Natural Resources)

“Oh, absolutely not,” Pijanowski says.

Sound is intimate. Its waves pound against our bodies, penetrate the inner ear, pulse through our skin, flesh and bones. Sound tells us where we are, but it also evokes the memory of where we used to be. It carries with it a sense of time and place. We humans use the sounds we make to delight, woo, warn and even worship.

“When you’re dealing with vision, there are light waves. But sound is something that is actually physical. You’re being hit by it. You can hear it, and you’re feeling it,” says Valeria Vergara, a research scientist who is co-director of the Raincoast Conservation Foundation’s cetacean research program based in British Columbia. She studies the calls that baby belugas and their mothers make, among other acoustic topics.

Vergara remembers sitting in a tent on the edge of the Arctic Ocean where belugas bring their newborn calves for a few weeks each year. It was piercingly cold and so foggy that she couldn't see anything, but she could hear the occasional beluga blow above the surface of the sea. When she hooked up her underwater microphone, she was all of a sudden plunged into the complex, loquacious world of beluga chatter. "In my core, I felt, wow, this is what it must be like to be an acoustic species where sound is everything," she says.

For whales and other marine creatures, sound is far more important than vision. For one thing, water carries sound nearly five times more quickly than air does, making it an efficient medium for sonar communication. As well, part of a marine creature's life is spent in water too deep for light to reach, further sidelining the use of sight. And in the Arctic and Southern oceans, marine mammals live without any sunlight for half the year, fully dependent on what they can hear.

"They live in a world of sound. Every sound they hear tells them something," Vergara says. "Every sound they hear tells them where they are located in relation to their peers, tells them how far away from them their little calf might be, tells them where to navigate, where there might be an ice hole or an ice lead where there might be prey."

Photo: Katie Heykoop/Can Geo Photo Club

Getting a full picture of how most creatures use sound is still elusive. Biologists have found that frogs and toads use their voices to attract mates, for example. Birds sing to sound alarms, defend their territory and let other birds know that they're there. Bats use echolocation to find prey. Fish use it to migrate and synchronize spawning.

Creatures also seem to communicate across species, using their voices to establish their own niche in a soundscape, like the harmonies in a choir. That means scientists can figure out what Pijanowski calls an ecosystem's "acoustic heritage" by assessing the range of pitches in an area, understanding how and when creatures showed up in an ecosystem. It's like hearing evolution.

But there's no full catalogue yet of what sounds specific creatures make, apart from most birds, Pijanowski notes. When it comes to listening to a whole ecosystem rather than the individuals within it, even the most basic information is often lacking.

That's why Pijanowski is on a mission to record the most pristine examples of Earth's roughly 30 unique biomes. So far, he's got 27, recorded in some of the most remote parts of the planet, like the eastern steppes of Mongolia. Still to come: the spiny forest of Madagascar, the boreal forest and the temperate rainforest. It's a pioneering baseline of information that he hopes to assess and then compare with research on climate disruption and the loss of species. He's also keen to understand how humans are reacting to those sonic changes.

"My great worry is that we would potentially become disconnected from nature," he says. "Sound is a way to reconnect us because it's an emotional trigger. It's an emotional bridge to place."

He's aware that time is of the essence. He and the oceanographer Craig Brown of Dalhousie University in Halifax made a plea earlier this year to colleagues in the pages of the journal *Frontiers of Remote Sensing* to get a wiggle on.

The time is ripe. Technologies to collect soundscapes have advanced dramatically in recent years. All of a sudden, a discipline that was clumsy, slow, labor-intensive and fraught with technical failure (think computers hooked to microphones in suitcases) has become as easy as putting up a passive digital recorder or listening to a satellite feed. And advances in artificial intelligence mean that parsing meaning from the recordings is getting easier, too.

"We've gone from low-tech to a technology that records 48,000 times a second. So we have one of the most detailed means of collecting data available to us," Pijanowski says. "And we can probe these files, ask the questions."

Who or what, exactly, is making the sounds? What happens to a soundscape when one species vanishes? Does another enter in its acoustic space or does that space remain empty? How does that soundscape compare to what was here a year ago? Data mining tools are so powerful now that they can begin to answer some of these questions by seeking patterns in the sounds. For example, Pijanowski is working with NASA using remote sensing from the International Space Station to

develop a global model of how climate heating is changing ecosystems, pairing his biome soundscapes with maps of habitats.

It's not just technological progress that is driving the interest, though. Passion for the field has exploded. Published research papers have gone from just a handful a year in the early 1990s to hundreds today. Researchers span most continents and many countries. "When we first started talking about this, small community that we were, we were struggling just trying to get our main concepts out there," Pijanowski says. "Now there's lots of questions, lots of intrigue."

While the answers to those questions are still in the works, it's a big leap from 1977, when the Canadian musician R. Murray Schafer popularized the term "soundscape" in his influential work *The Tuning of the World*, which was as much a dissertation on sound as a lyrical invocation to future scholars and musicians to bear "earwitness" to the planet. "The world is a huge musical composition that's going on all the time, without a beginning and presumably without an ending," Schafer once said.

The Global Library of Underwater Biological Sounds, a.k.a. GLUBS, is making the case for listening, too. A collaboration among 17 scientists in nine countries, GLUBS announced earlier this year its goal of gathering vast collections of marine sounds onto a single global web-based platform. The impetus? The mounting realization that humans have not just warmed the planet and altered its landscapes, not just pushed a million species to the brink of extinction, not just fiddled with the patterns of rainfall and wind and seasons, but that we've also meddled with the ancient, secret way wildlife communicate in order to survive.

"It's not necessarily loss," Pijanowski says, referring to the emotion he feels as he races to capture the voice of the planet. "It's concern about what we're doing in ways we don't fully understand or don't even think about."

We hope you enjoyed this lesson!
Learn more about Conservation Nation at
www.conservationnation.org