DAWN STOVER

Not So Silent Spring

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A MALE EUROPEAN BLACKBIRD was terrorizing the neighborhood. For several months, he started singing at around 5 A.M. each day, but this was no ordinary song. The bird imitated the sounds of ambulance sirens and car alarms at a jarringly lifelike volume. It even produced cell-phone ring tones that went unanswered for hours.

The tale of the annoying blackbird in Somerset, United Kingdom, was not unique. Hans Slabbekoorn, an assistant professor of behavioral biology at Leiden University in the Netherlands, had heard similar stories—but he was skeptical that such bizarre reports could be true. So he started asking people to send him recordings of the off-kilter blackbirds. Sure enough, what he got back was pitch-perfect imitations of urban noises, including not just sirens and car alarms but even the distinctive sound of a golf cart backing up—mimicked by blackbirds living near a golf course.

While the sounds seemed artificial, the reason birds were making them was surprisingly natural. Living amid a growing cacophony of man-made noises, the blackbirds started incorporating human sounds into their repertoire. And Slabbekoorn says the unusual strategy might actually help the birds: song variety indicates maturity in male blackbirds, and female blackbirds prefer older guys.

Blackbirds aren't the only animals changing their tunes. As human noise intrudes on nature—from freeway traffic noise to jets screaming over the rainforest—scientists are starting to believe that the acoustic environment is far more intricate and fragile than

they ever imagined. Long regarded as a random collection of bird songs and animal cries, the natural soundscape might actually be a coordinated symphony, with animal calls spread carefully across the acoustic spectrum. Now researchers are getting the first glimpses of what happens when humanity's choir drowns out whole sections of that spectrum. Animals ranging from blackbirds to beluga whales are changing their calls or switching them to new frequencies. Others are adapting in ways so powerful that they may be triggering the first steps in an evolutionary shakeup. And some animals are disappearing altogether.

Scientists have traditionally studied animal sounds by focusing on individual species and their vocalizations. Bernie Krause, a bioacoustician who has spent forty years recording the calls of the wild, has hatched a radically different approach and, in turn, a revolutionary vision of the relationship between animals, their environment, and the sounds they emit.

It all started in 1968 when Krause, then a musician, was having lunch with Van Dyke Parks of the Beach Boys. Parks suggested that Krause "do an album on ecology." Krause and his musical partner had introduced the Moog synthesizer to pop music and had contributed to hundreds of albums and movie soundtracks, but Krause knew little about ecology beyond his recent reading of Rachel Carson's *Silent Spring*. Intrigued by Parks's suggestion, Krause went alone with his equipment to Muir Woods, north of San Francisco. "I was so intrigued by what I heard that I made a decision that this was what I wanted to do for the rest of my life," he recalls.

Overtaken by his newfound passion for ecology, Krause eventually sold his music company, enrolled in graduate school, and got his doctorate in bioacoustics. But his musical training never left him. In fact, it helped spawn a startling notion that came to him early one morning while camping in Kenya's Masai Mara reserve. Krause had been up for thirty hours, recording the sounds of insects, owls, hyenas, bats, and elephants. Exhausted and "completely out of it," Krause was suddenly struck by the idea that the animal sounds around him were . . . orchestral. "These critters are vocalizing in relationship to one another," he thought to himself.

Back in his studio, Krause examined sonograms of the recording session. It was clear to him that what he had heard was a sequence

of sounds so carefully partitioned that they read like a musical score. Different species vocalize at specific frequencies or times so they can be heard above the other animals—in the same way you can make out the individual sounds of the trumpets, violins, and clarinets as Beethoven's Fifth builds to a crescendo. Krause dubbed the spectrum of animal sounds "biophony" and distinguishes them from human sounds, which he calls "anthrophony."

Krause wasn't alone in his conclusions. More than a decade later, in a laboratory far away from Krause's California headquarters, Hans Slabbekoorn picked up on the same distinction. And, taking Krause's work a step further, he started piecing together its startling implications.

Before studying blackbirds, Slabbekoorn worked in the tropics of Cameroon, testing a theory that habitat constraints can drive birds to sing at different frequencies. Sounds that mask birdcalls may cause difficulty or ambiguity in communication, and Slabbekoorn thought he could get to the bottom of this by comparing the songs of birds living in dense rainforest with those in more open habitats.

His test subject was a bird called the little greenbul. He discovered that little greenbuls in the dense forest sang more often at lower frequencies than their relatives living in open areas, probably because lower frequencies transmit more effectively through thick vegetation—and also because the dense forest is filled with the sounds of high-pitched insects. "It was often so noisy in these habitats that I could hardly make good recordings," Slabbekoorn recalls.

After returning to the Netherlands, Slabbekoorn suspected a similar dynamic was taking place in the city. Most urban noise comes from cars, trucks, buses, and trains, whose sounds are concentrated at low frequencies. If the rainforest's high-frequency noise drives birds to use lower frequencies, Slabbekoorn reasoned, then the low-frequency sounds of the city should pressure birds to use higher frequencies. As his research progressed, Slabbekoorn found that great tits and European blackbirds are indeed switching to higher frequencies to be heard.

That's not the only way birds cope with human noise. In 2007 Richard Fuller and two other scientists at the University of Sheffield in the United Kingdom discovered that European robins living in noisy urban areas have radically departed from their normal behavior of singing during the day. Now they sing almost exclusively at night, presumably to evade interference from the human din. If you hear a bird singing on your way home from a night at the pub, it's probably a robin, Fuller says.

In Berlin, nightingales have taken a different approach, raising their singing volume in response to traffic noise, according to a study by Henrik Brumm of that city's Free University, published in the *Journal of Animal Ecology*. In what is known as the Lombard effect, where a singer or speaker raises his voice to be heard, the nightingales try to counteract rush-hour clamor by singing louder on weekday mornings than on weekend mornings.

Most research on the impact of human sounds has focused on birds, but there is growing evidence that what's happening in the avian world is playing out across the animal kingdom, even in remote places that might seem impervious to human sounds—places like the deep ocean.

Cities are getting louder, but underwater noise is increasing even faster. There are about twice as many ships plying the world's oceans now as in the 1960s, and these ships are faster, more powerful, and collectively far noisier than their predecessors. When scientists at the Scripps Institution of Oceanography and the Colorado-based company Whale Acoustics compared sound levels west of California's San Nicolas Island in 2003 and 2004 with measurements made during the 1960s at the same site, they found that ambient noise levels had increased about tenfold. And this area may be representative of the entire northeast Pacific, the scientists say in a report published in the *Journal of the Acoustical Society of America*.

Instead of containing this noise within shipping lanes or coastal areas, the ocean's unique dynamics actually help the sounds travel hundreds or even thousands of kilometers. The so-called "deep sound channel" is a layer of water where sound travels slowly but encounters little resistance or interference. Some scientists suspect that humpback whales dive down to this channel and then sing into it, communicating with other humpbacks hundreds of kilometers away. And when noises from commercial shipping, offshore drilling, and other human activities get caught in the channel, they too are carried far from the original source.

Researchers have only just begun investigating these sounds' exact impacts, but a few studies suggest man-made noise is forcing marine mammals to respond in much the same way as birds do. Scientists at the Institute of Ocean Sciences in Sidney, Canada, have shown that beluga whales change their vocal patterns in response to the presence of icebreakers, whose systems interfere with the belugas' preferred frequencies. Belugas also switch the frequencies of their echolocation clicks when background noise increases. Elsewhere, orcas in the Pacific Northwest have changed their calls, perhaps in response to increased traffic by commercial ships and whale-watching boats.

In more extreme cases, human sounds have forced whales to abandon their preferred habitat. For instance, gray whales have long used Baja California's Guerrero Negro lagoon as a calving ground. But when construction at a nearby salt factory spurred increases in ship traffic and dredging activities, the whales stayed away from the lagoon for several years, returning only after construction ebbed.

Some researchers interpret these adaptations as a heartening sign, pointing out that some animals will simply change along with the soundscape. But Slabbekoorn cautions that some species could be wiped out by the human din.

Because low-frequency traffic noise accounts for most of humans' clamor, animals that use low-frequency calls and can't switch to higher frequencies are threatened most. Slabbekoorn says birds such as orioles, great reed warblers, and house sparrows fit this category. Populations of house sparrows are declining throughout Europe; researchers haven't pinpointed the cause, but Slabbekoorn suspects human noise is a factor.

Bernie Krause has witnessed a similar phenomenon among spadefoot toads in the Mono Lake basin east of Yosemite National Park. Using its big front claws, the toad buries itself one meter below the desert floor and can survive there for up to six years. When rain finally comes, the toad emerges and joins others to sing in chorus, which makes it harder for predators such as owls and coyotes to get a bead on where the sound is coming from.

The problem is that during nighttime periods when the toads do their singing, military jet planes often use the basin for training.

Flying only one hundred meters above the ground, the planes are so loud that the toads can't hear each other. Even after the planes leave, it takes twenty to forty-five minutes for the toads to resume their synchronized chorus, and in the meantime they're vulnerable to predators. Krause believes the noise is partly responsible for a precipitous decline in spadefoot populations, which he has studied since 1984.

Even adaptable species may be altered in fundamental ways. For instance, if changing calls or switching frequencies helps male birds be heard, they could earn an advantage when it comes to attracting female mates. Over time, this dynamic could force evolutionary changes, splitting populations of birds into localized species with specialized reactions to the sounds in their vicinity.

Slabbekoorn and his colleague Erwin Ripmeester think these noise-driven evolutionary forces may already be separating European blackbirds into urban and rural subspecies. The two researchers have even begun testing whether rural birds can recognize their urban brethren's hip new calls. If Slabbekoorn and Ripmeester's hunch is correct, it could mean that humans, already powerful conductors of the material world, may be extending their fierce control to the audible one.