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What a Healthy Jungle Sounds Like

Species may have evolved their wide array of sounds to fill unused parts of the frequency spectrum. This could also reveal the degree of biodiversity in an ecosystem

By Erica Gies on September 8, 2016



New Guinea, the second largest island in the world, is home to one of the last great expanses of tropical rainforest as well as some of the world's most traditional forest dwellers. Despite covering less than 0.5 percent of Earth's surface, New Guinea is estimated to contain 5-10 percent of global biodiversity. *Credit: MANGIWAU Getty Images*



The rugged, diverse landscape of Papua New Guinea, just north of Australia, is a global hotspot of biodiversity, including fantastic creatures such as birds of paradise, echidnas and cuscuses. It is also home to more than 800 human languages. Because infrastructure is limited, more than 80 percent of PNG's people still lead subsistence lifestyles, but population pressure and the opportunity to plant cash crops like cocoa or timber are threatening the balance that tribal people had maintained for centuries.

In the remote Adelbert Mountains on the island's northern coast, The Nature Conservancy is working with local communities to help them create zoning plans for land management, with areas for villages, subsistence agriculture, hunting and conservation. Here, each family had planted their own little garden in the forest, which, when done widely, seemed to be causing deforestation.

To maintain biodiversity, The Conservancy encouraged communities to instead build a larger village garden at a single site, leaving more of the forest unaltered. But was that working, and how could it be measured? Physically counting species is time-consuming and expensive. Plus many types of animals alter their behavior in the presence of humans, which can skew results.

To find out, Conservancy biologist Eddie Game is using techniques from a new branch of science called soundscape ecology. He set up 20 passive acoustic and ultrasonic recorders and captured the voice of entire sections of the forest ecosystem over a 24-hour period. He then moved the recorders to a new location. The sound could serve as a proxy for biodiversity: The more complete and complex the soundscape, the healthier and more intact the ecosystem. A degraded forest might have a lot of noise but a lesser variety of frequencies.

One example recording, from the Musiamunat area, follows:

This audio file was recorded on July 4, 2015, in the Musiamunat community conservation area, a rugged rainforest and the largest of three conservation areas sampled. Researchers are not looking to identify

individual species in these recordings but rather are comparing the relative fullness of the sound among different sites. *Credit: Audio © The Nature Conservancy*

Soundscape ecology (aka eco-acoustics) is a new field, perhaps less than a decade old. It measures both natural and anthropogenic sounds over both time and space, including underwater. It can also be used to monitor the impact of climate change, pollution or noise pollution on biodiversity.

Bioacoustics for Conservation in Papua New Guinea



Nature Conservancy lead scientist Eddie Game explains how acoustic sampling can help support conservation planning in Papua New Guinea's Adelbert Mountains. *Credit: Video © The Nature Conservancy and Justine E. Hausheer*

Bryan Pijanowski, a professor of landscape ecology at Purdue University who is a pioneer in the field, is using sound to monitor changes in amphibian and bird populations over time in Costa Rica. He's also recording sounds in the Sonoran Desert to study how it is recovering from wildfire, and has found differences in the recovery of nocturnal and diurnal animals.

Because the field is so young, researchers are just beginning to discuss theories, methods and tools, both for data acquisition and processing as well as to figure out how to collaborate with other disciplines. One theory being tested is the niche hypothesis, which argues that species have evolved their sounds to find open space in the audio ecosystem,

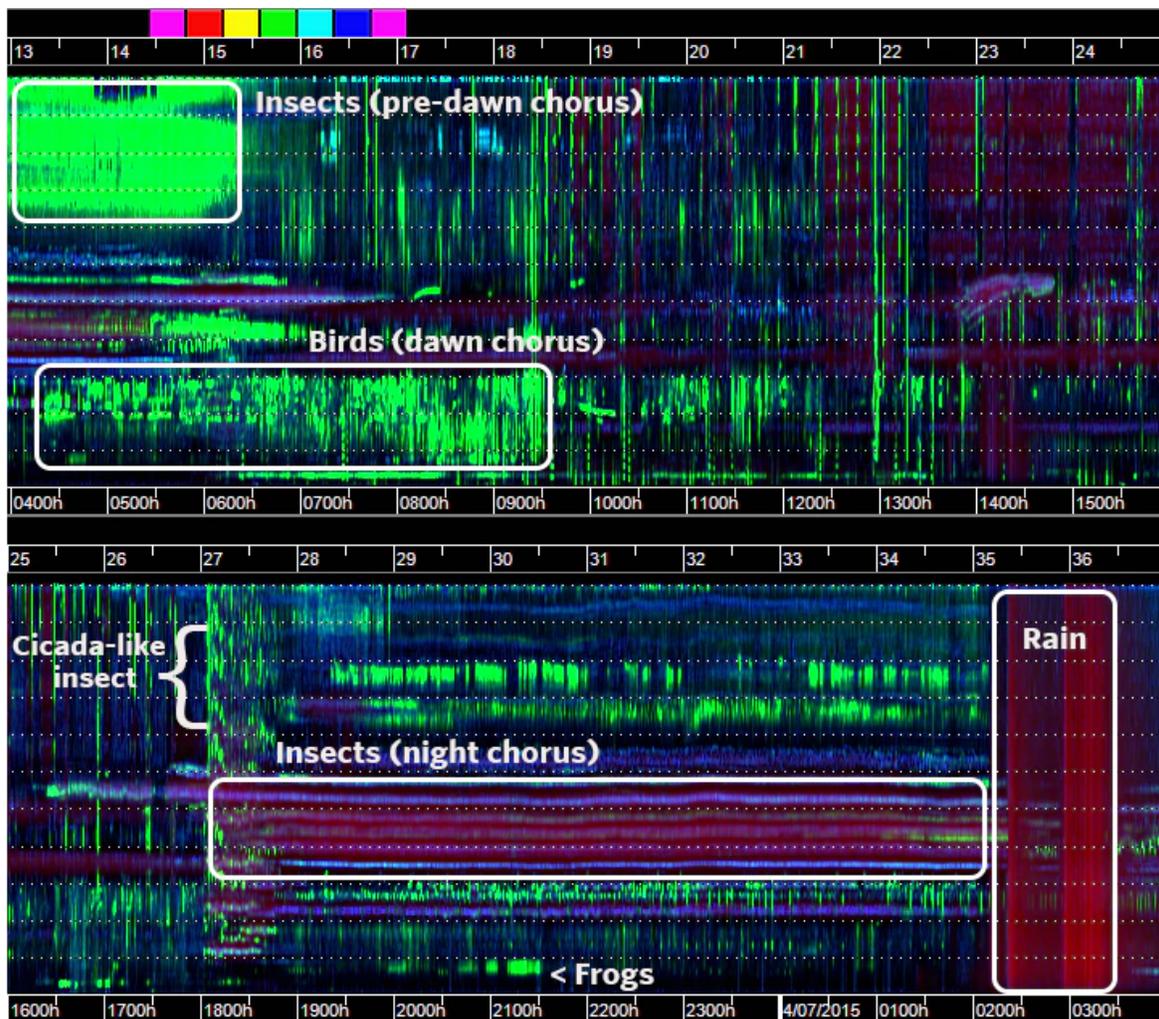
which is why so many frequencies are occupied. Even the basic premise that sound saturation can serve as a proxy for biodiversity is being tested.

The scope of Game's project—multiple recordings covering about 50 square kilometers—is unprecedented, Pijanowski says. Previous acoustic studies recorded an individual species, or just took a few recordings of the soundscape, typically for much shorter periods.

Getting the recorders into place for the PNG study required strenuous hikes. In July 2015 Game's team placed five recorders a day, returning the second day to collect and reposition them at new sites. In total they sampled 34 sites.

The scale of this study was made possible, thanks to a dramatic price decline over the last few years for passive audio recorders—from \$3,000 to about \$300, Game notes. "It's allowed us to do a soundscape study at a landscape scale in a way that hasn't been done before," he adds.

Dramatic strides in data processing have also been critical. Game is working with computer scientists at Queensland University of Technology in Australia. The researchers converted decibels, frequency, pitch and other sound data into numbers called acoustic indices. They then convert the data into a colored graph, a spectrogram, which shows the sound saturation at various frequencies over the course of a day, says Zuzana Burivalova, a Princeton University postdoc who worked with Game. Before, using conventional statistics tools, turning a minute of audio into numerical data took 10 minutes, Game says. But the Queensland team took one terabyte of data, about 800 hours of recordings, and turned it into numbers in four hours.



Audio files are converted to numerical measures of sound that can be used to create visual tools, such as this false-color spectrogram, which is a plot of sound in various frequencies across a 24-hour period.
 Credit: Spectrogram © Michael Towsey & Anthony Truskingier, Queensland University of Technology

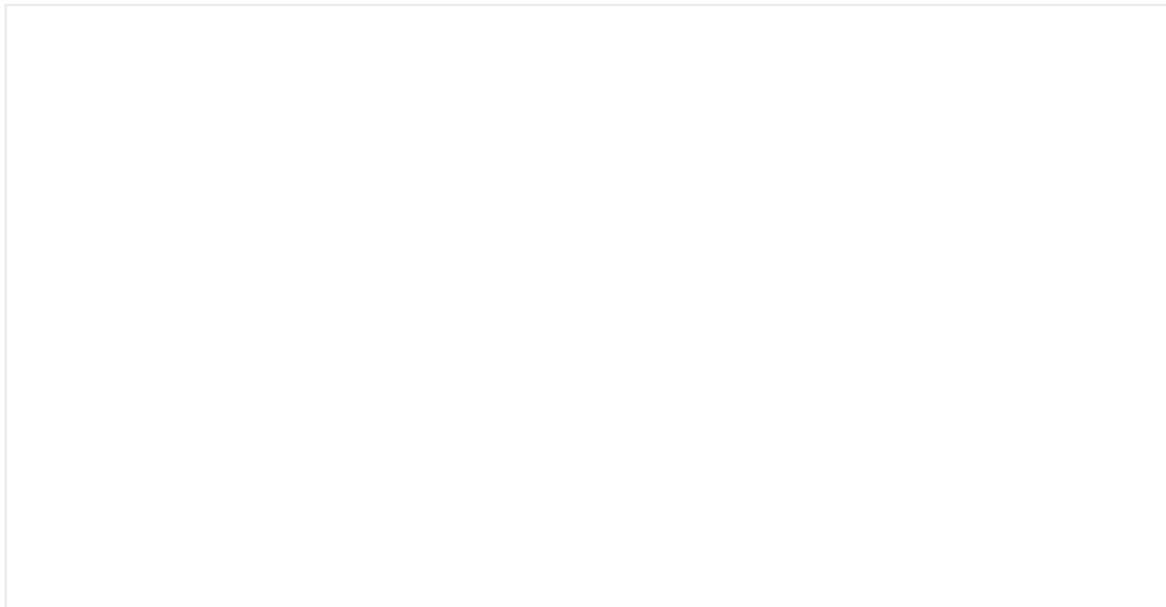
“The big finding for us is that you can really pick up the impact of that gardening,” Game says. “These are not huge areas of open land. These are little gardens tucked among the forest. But it’s made a big impact.” The dawn chorus, a particularly rich period of sound, he says, is “being deadened by any kind of human use.”

On the plus side, the team found rich biodiversity in the conservation zones, even in smaller zones belonging to a single clan. If, on the other hand, they had found a strong effect of the size of zones, “that would suggest maybe this can’t be done community by community but needs to be done at larger scale,” Game says. The accountability could also be a boon for nonprofit organizations, Game says; in the past, philanthropists were sometimes reluctant to donate to conservation efforts because it was so difficult to measure impact.

Soundscape ecology is in its infancy but looks set to boom, says Pijanowski, based on enthusiasm he sees in young ecologists who “have a handle on technology and aren’t afraid of big data.” The field is also attracting unusual suspects such as musicians. “They understand signal processing as well as engineers and can influence how scientists think, analyze and even perceive the environment,” Pijanowski says. Game also sees roles for people in other fields such as computer programmers, sound engineers and gamers. “Those interests are completely compatible with making a big contribution to conservation,” he says.

Game is working in Borneo now, comparing low-impact logging areas with protected areas. Even if clear-cutting is not done, and “you cut some logs everywhere, you’re probably also losing species from everywhere,” Game says. Essentially, “it’s a question of balancing loss to get the best outcome.”

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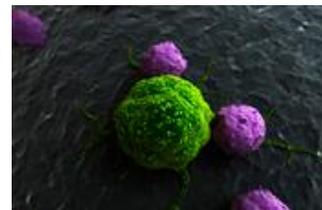
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