Varied thrush. Photo credit: Adam Hadley (PhD student, FES).

Bioacoustics in Birdland

How computer scientists and wildlife ecologists are changing the way we listen to the environment

By Bryan Bernart

It's 3:00 AM. While many of us are fast asleep, for a field researcher taking a bird census, the day has already begun. For the next several hours, he or she will hike many miles, stopping for 10 minutes at each site to listen for, and then identify, bird calls. The next day, and for every day following it, the process is the same.

"Honestly, it takes a lot of effort," says Matt Betts, an associate professor of forest wildlife landscape ecology. "It's a highly skilled occupation; there aren't many people who can do this kind of job."

Even some who are trained for it will not end up working in the forest. "There are a lot more interesting things to do in ecology than stand around and count birds," Betts notes. "With that in mind, we came up with the question, 'Can we automate this process?'"

The answer arrived in 2008 following the formation of the OSU Bioacoustics Group. The group comprises a number of scientists, including students, faculty, and outside collaborators, hailing from such disparate fields as ecology, electrical engineering, computer science, and marine resources. Its aim has been to solve ecological problems using tools from mathematics, as well as to discover new problems in mathematics due to the necessity of solving environmental issues.

With such a broad scope, why study birds, specifically? "Birds are often excellent indicator species—the canaries in the coal mine, so to speak," Betts explains. As is the case with frogs and amphibians, the health of a bird population can say much about the rest of an ecosystem. Thus, it would be useful to have an effective

means for studying bird populations, especially if it doesn't involve time-consuming and arduous fieldwork.

This is where Forrest Briggs, a PhD student in Computer Science at OSU, and other members of the group come in. A 2006 graduate of Harvey Mudd College, Briggs has been working to develop software capable of identifying species of birds using recordings of their songs collected in the field and uploaded to a laboratory computer many miles away. Birds can be classified using algorithms. Briggs explains that an algorithm "is a step-by-step, unambiguous sequence of instructions for how to accomplish a particular task. A cooking recipe, for example, is an algorithm."

By using machine learning, a sub-field of artificial intelligence, algorithms can, through exposure to many different instances of bird song, be made more effective in classifying the birds present in those recordings. An algorithm does this by analyzing the spectrogram that is generated when a recording is represented visually, allowing properties such as frequency, length, and amplitude of the sound to be observed. The algorithm compares results with other human-expert-labeled examples to make a prediction based on similarity.

Researcher Sarah Hadley (PhD student, FES) is using this instrument to monitor bird sounds in the forest. This technology is far more effective than any available before. Photo credit: Forrest Briggs.

Clark's nutcracker pulling seeds from a whitebark pine cone. Photo credit: Rebecca Brenton ('11, NR; post-bacc, FM). Brenton is currently working on the fish bio crew for the USDA Forest Service, Tiller Ranger District, Umpqua National Forest.

It is simpler to classify other animals than it is to classify birds, says Betts. For example, it's easy for an algorithm to identify a single species of cricket because a cricket will chirp at a certain frequency. "With birds, it's more difficult. Their songs are intricate, and when multiple species are audible, they will even sing over each other," he says. "Because of the many variables involved in this study, the algorithms we employ are complex."

At present, the Bioacoustics Group is using 16 microphones in the H.J. Andrews Experimental Forest in order to capture birdsong recordings, and would like to expand the study over a larger area. Betts envisions 24-hour surveillance of bird populations, which would enable researchers to know precisely when birds enter and exit a site, and, when analyzed alongside other data, including environmental and climatological changes, why they do so.

In a few years, a form of this technology may even become available to citizen scientists who are interested in bird ecology. "People have a lot of affinity for birds," says Betts. "We'd like to have an iPhone app that would use our technology to allow citizen scientists to classify birds in their own backyards, or in locations around the world. That's a really exciting possibility."