Microsoft

AI for Earth Grantee Profile

Cornell Bioacoustics Research Program

Monitoring insect sounds

Summary

Led by Holger Klinck and Laurel Symes of Cornell University's Bioacoustics Research Program, a team of researchers is looking to AI-powered acoustic monitoring of insects as a way of better understanding the dynamics of rainforest habitats. The team is focusing first on neotropical rainforest katydids, a diverse group that occupies a central position in tropical food webs. How the wide variety of katydids interacts with the rest of the forest species, both plants and animals, can provide lots of information about the overall ecosystem. Klinck aims to scale beyond insects to other species, including birds, monkeys, and other vocal animals, to help advance conservation of tropical rainforests.

Monitoring insect sounds in tropical rainforests

Much of Earth's biodiversity is found in tropical rainforests, which also provide carbon storage and oxygen production. But the very features that make them so special, even vital, to our planet also pose challenges for wildlife researchers—high canopies and dense vegetation within rainforests can make it hard to observe and census wildlife.

> While the benefits of rainforests are well known, a detailed understanding of species and ecosystems contained within is still largely out of reach.

Holger Klinck and Laurel Symes of the Bioacoustics Research Program at Cornell University's Lab of Ornithology are leading a team to meet this challenge. Klinck has been developing hardware and software tools for using passive acoustics to monitor animals in their environments. One of his long-term goals is to help assess the health of an ecosystem and its changes. Now, Klinck, Symes, and their team are zeroing in on insect monitoring as a way of better understanding the dynamics of rainforest habitats and the behavior of animals that live within them.

Insects typically produce a single, stereotyped mating call that varies relatively little within a species, which simplifies identification and classification. They also rarely travel far from where they're born, making them a

good indicator of the health of their local environment. Recent studies have shown a serious decline in insect populations, which also makes it critical to establish a baseline understanding of what's present.

Thanks to a grant from National Geographic and the Microsoft AI for Earth program, Klinck's team is developing an AI-powered monitoring scheme for studying the sounds that insects produce for attracting mates, focusing specifically on neotropical rainforest katydids, a relative of crickets and grasshoppers. Katydids

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are diverse—one small study area, the six-square-mile island of Barro Colorado in the Panama Canal, has over 100 species—and occupy a central position in tropical food webs. How the wide variety of katydids interact with the rest of the forest species, both plants and animals, can provide lots of information about the overall ecosystem.

Bringing field researchers, AI researchers and students together for science

Each member of the project team brings different skills and capabilities together to make this work. Symes, who has climbed many a tree to place field recorders, was preceded by Dr. Hannah ter Hofstede in conducting katydid field recordings and identification—work that ter Hofstede still does for this project. Dr. Rachel Page provides research insights on predator-prey relationships between the katydids and bats, while Dr. Sharon Martinson also works with the team on a contract basis for katydid recording and identification. Klinck works on the AI development with Dr. Shyam Madhusudhana, who has done much of the hands-on coding. And Dr. Jen Hamel brings this work together in the classroom, involving her students at Elon University in evaluating the software tools developed for this project.

Hamel's students will be examining recordings from the tropical forest, attempting to identify the calls in the recordings, and then comparing their efforts with what Madhusudhana's code can do. By doing so, the students will learn about animal behavior and communication, the challenges of sampling tropical ecosystems, and about recently reported declines in insect abundance. Importantly, the students will learn key concepts about research, including that most work is collaborative, that research is creative and often interdisciplinary, and that because research addresses questions for which the answers are not yet known, science knowledge changes over time. They will also be contributing to a professional research collaboration, which is valuable experience for students and an opportunity to put academic theory into practice.

Symes remarks, "One of the things that I love about that particular project is how integral all of the different pieces are. None of us alone has the skill set to pull off the combined output, and yet we already have a computer model that is better than any one of us at recognizing focal katydid calls."

> The team aims to scale beyond insects to other species, including birds, monkeys and other vocal animals, to help advance rainforest conservation.

Klinck and Symes see acoustics analysis as a great tool to study a lot of environmental issues. Their ultimate goal is to develop generalized models not just for insects but other species with more complex calls, such as birds and monkeys, as a resource to help advance conservation of tropical rainforests.

About the Cornell Bioacoustics Research Program

The Bioacoustics Research Program is a part of the Cornell Lab of Ornithology at Cornell University in Ithaca, NY. The Program's mission is to collect and interpret sounds in nature by developing and applying innovative conservation technologies across multiple ecological scales to inspire and inform conservation of wildlife and habitats. Its highly interdisciplinary team of scientists, educators, engineers, students, and research support personnel is working with many national and international collaborators on a wide variety of terrestrial, aquatic, and marine bioacoustics research projects tackling conservation issues worldwide.

About the team

Dr. Holger Klinck *(co-leader: AI and project management)* is the director of the Bioacoustics Research Program (BRP) at the Cornell Lab of Ornithology in Ithaca, NY, USA. He is also a Faculty Fellow with the Atkinson Center for a Sustainable Future at Cornell University and holds a courtesy assistant professor position at Oregon State University (OSU). Before moving to the United States in early 2008 for a postdoctoral position at OSU, Holger was a graduate student at the Alfred Wegener Institute for Polar and Marine Research in Germany. His graduate research was centered around the development and operation of the Perennial Acoustic Observatory in the Antarctic Ocean (PALAOA). Holger's current research focuses on the development and application of hardware and software tools for passive acoustic monitoring of terrestrial and aquatic ecosystems and biodiversity. One of his goals is to enable researchers around the globe to acoustically monitor habitats and wildlife at large spatial scales. He advises several undergraduate and graduate students at Cornell and OSU and teaches national and international classes on animal bioacoustics.

Dr. Laurel Symes *(co-leader: katydid recording and identification)* joined the Cornell Lab of Ornithology as a Rose Post-doctoral Fellow in 2018 and will soon start as the Assistant Director of the Bioacoustics Research Program. Previously, she held post-doctoral positions at Dartmouth College (Neukom Fellowship), the University of Wisconsin, and the Smithsonian Institute for Tropical Research. Laurel completed a PhD at Dartmouth College and a BS in Biology at Denison University. Her research focuses on the community ecology of communication: the way that interactions within and between species affect the production and perception of signals. To address these questions, she studies a variety of taxa including crickets, katydids, frogs, bats, and birds.

Dr. Hannah ter Hofstede *(co-leader: katydid recording and identification, neurobiology, long-term research on BCI)* is an assistant professor in the Department of Biological Sciences at Dartmouth College. She studies the sensory ecology of acoustic interactions between bats and insects. She first started investigating trade-offs between attracting mates and avoiding predators in neotropical katydids during her PhD at the University of Toronto, and she continues to conduct research in this area at Dartmouth College. After her PhD, Hannah had postdoctoral research appointments in the UK at the University of Bristol, investigating moth hearing as a defense against echolocating bats, and the University of Cambridge, investigating communication in crickets.

Dr. Shyam Madhusudhana *(co-leader: AI)* is a Postdoctoral Research Associate within the BRP at the Cornell Lab of Ornithology. Prior to joining Cornell, Shyam had worked at the Centre for Marine Science and Technology, Australia (as a Research Associate), National Institute of Oceanography, India (as a Research Associate), and Indian Institute of Science Education and Research, Tirupati, India (as a postdoctoral research fellow). In the past, he had also worked as a Speech Scientist for a leading Automatic Speech Recognition (ASR) solutions provider, before steering his career into bioacoustics and allied disciplines. His research interests have been largely multidisciplinary, with applications in autonomous monitoring and conservation of fauna in both terrestrial and marine environments. His current research involves developing solutions for automatic source separation in continuous ambient audio streams and the development of deep-learning techniques for classification of acoustic events in the big-data realm, with focus on efficient utilization of modern computing capabilities.

Dr. Jen Hamel *(co-leader: field research with students, class integration of AI)* is an Assistant Professor of Biology at Elon University, where she teaches courses in biodiversity, population biology, animal behavior, invertebrate zoology, and tropical field biology. Previously, she held a post-doctoral position at the University of Florida. Jen completed a PhD at the University of Missouri and an undergraduate degree at Carnegie Mellon University. At Elon, Jen mentors small teams of undergraduate researchers. Her research is about how interactions among species contribute to the evolution of behavior. She focuses on mating behavior and vibrational signaling with insects including katydids, treehoppers, and leaf-footed bugs.

Dr. Rachel Page *(co-leader)* is a staff scientist at the Smithsonian Tropical Research Institute and conducts research on predator-prey dynamics and foraging strategies of bats (http://www.noseleaf.org).

Dr. Sharon Martinson *(collaborator: katydid collection and recording)* is a research ecologist who specializes in population dynamics. At other times of year, she is a professional touring musician. (http://www.littlestbirds.net).

Resources

Websites

Cornell Lab of Ornithology at Cornell University
Cornell Bioacoustics Research Program
Microsoft AI for Earth
Microsoft environmental sustainability

Press

Microsoft and National Geographic Society announce AI for Earth Innovation grantees