Close Your Eyes and Open Your Ears:
Educational Resources to For Your Sense of Sound



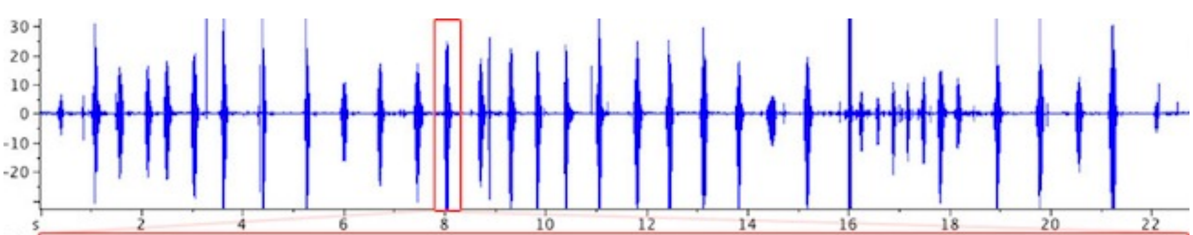

When it come to understanding animal adaptations, what you see is not all that you get. It turns out that sound production for all sorts of purposes, especially for communication, is critically important. We humans appreciate the value of sound for communicating and for adding beauty to the world. Some other species are even more acoustically oriented than we are. Each species of animal - whether it's an elephant, a human, a finch, or an insect - makes unique sounds. The sounds an animal makes can be just as identifying as its physical features, yet we humans are only capable of hearing sounds within a certain frequency range. Other animals can perceive and send sound signals across a way broader range than us, so we turn to technology to gather this acoustic data and interpret what it means.

How Animals Use Sound to Communicate

This interactive module from HHMI Biointeractive explores how different animals — elephants, birds, and bats — have evolved distinct ways of using sound to communicate. In addition to learning about the various reasons animals communicate, students will analyze three case studies to learn more about how animals use and sound to communicate and how this important, yet underrated sense has evolved over time. Students can also investigate the basic properties of sound and sound perception in the "Sound Tutorial" section.

Gorongosa Insect Spotlights

Half-Earth Chair and renowned entomologist, Piotr Naskrecki, studies insects in Gorongosa National Park. He shares stories of some of the insects he has come across in the park - including both physical descriptions as well as interesting information about the sounds they make in the Gorongosa Blog. Students can investigate different entries in the blog such as the high-frequency sounds of the glass katydid, the machine-like sounds of the pamphagid grasshopper, or the taunting sounds of the elusive Pardalota katydid. Additionally, you can have students learn about the Cataloipus cognatus grasshopper and compare the sound it makes to the oscillogram below that Piotr captured while listening to this species of grasshopper. Can you see the different sounds you hear appearing on the oscillogram? What questions does Piotr have about this species? How might he be able to answer these questions?



The Science of Soundscapes

For scientists, sound is data and this acoustic information can be observed and studied to get a better understanding of the biodiversity of an ecosystem. This introductory article discusses bioacoustics - the science of soundscapes and how it can be a valuable resource for scientists and conservation.

Compare and Share: Phenomenonal Sounds

In this article by National Geographic featuring Bernie Krause, a soundscape ecologist, there are two recordings of the same location in Lincoln Meadow, California. The first recording is before the forest was logged and the second recording is after logging. Follow this learning sequence to introduce students to the impact humans have on the acoustical diversity of an ecosystem.

- Without revealing this information to students, play the two recordings for students and have them write down any observations about what they hear in each recording and any differences or similarities they notice between recordings. (You may have to play the recordings more than once.)
- Have students share and discuss their observations with each other and develop some questions and inferences based on the similarities and differences they heard.
- Provide students an opportunity for more in-depth analysis by using the information in the Science of Soundscapes article linked above to identify the biophony, geophony, and anthrophony in the recording.
- Once students have had time to think, share, and formulate questions, share with them that these two recordings were taken from the exact same location. With this new piece of information, have students further discuss and develop hypotheses about what might be causing these differences. Discuss in small or whole group.
- Reveal to students that one recording is before a logging even and one was after a logging event. Ask students to determine which is which and use reasoning to defend their argument.
- BONUS: Have students make their own recordings of the ecosystems around them. Students can choose what they would like to compare. (i.e. two different locations at the same time of day, same location different time of day, same location same time different day, before or after rain, etc.) Students can present recordings and share their personal analyses of the acoustical diversity.

Insect Vocabulary

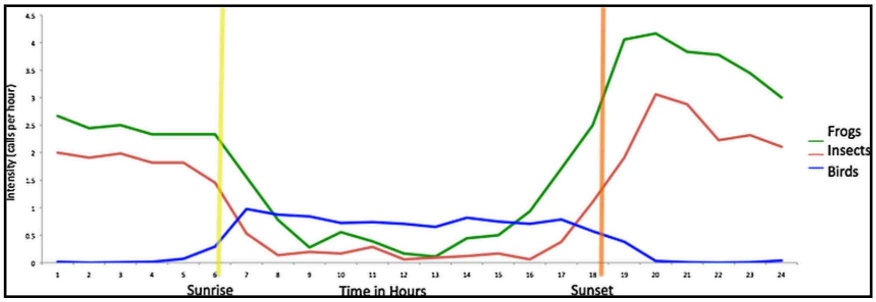
In this Beginners Guide to Song Identification, students can learn about the different syllables that insects use to create their various sounds and communicate. Just like we string words together into sentences, insects link these syllables together to create songs that mean different things - whether its a mating call or a warning call. Students can then dissect the sounds of a wide variety of crickets, katydids, and cicadas by listening to their calls and identifying which syllables they hear within the song. They can even record their own insect sounds and analyze the syllables present in the recording.

Data Play: Biophony in El Verde Puerto Rico

The two figures below have been excerpted from a review article in the journal *Behavior* titled "Sources of Background Noise and Their Influence on Vertebrate Acoustic Communication." The first figure shows the number of calls per hour of all frogs, insects, and birds in El Verde, Puerto Rico during a single 24 hours period. The second figure is a sonogram capturing all the sounds that were made during a 1-minute time period (6:55am) at El Verde, Puerto Rico

Initial Data Analysis:
Have students employ the I2 strategy for analyzing data from BSCS to both figures.

- **Identify**: What do you see? Students annotate what they see in the figure/data set. They can mark and describe at least three observations.
- **Interpret**: What does the data mean or what "could" the data mean? Students annotate the trends they see occurring or compare/contrast data points to explain similarities and differences.
- **Caption**: Students use all of their observations and interpretations to write their own caption for the figure.



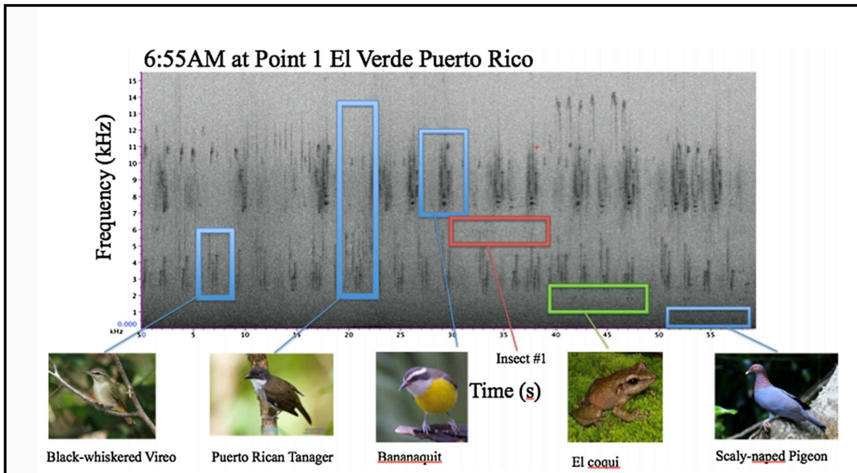


Figure 3. Sonogram of the acoustic community, all animals vocalizing at one point and during one minute during the dawn chorus at El Verde Puerto Rico. Insect vocalizations are not known from this location; thus, each distinct insect call is classified numerically. From unpublished data. This figure is published in colour in the online edition of this journal, which can be accessed via http://booksandjournals.brillonline.com/content/1568539x.

Acoustical Diversity Analysis
After initially analyzing both figures, students can answer the following questions independently or as discussion.

1. Compare the intensity of sounds from the frogs, insects, and birds. Which taxa of organisms would you say is diurnal vs. nocturnal species and why?
2. What is a possible explanation for the similarities among the frog and insect data curves in the first figure?
3. What is a possible explanation for the insect sounds diminishing as the bird sounds increase in intensity in the first figure?
4. Using the second figure, determine which organism made the most sounds based on the data provided during that 1-minute snapshot.
5. At approximately 6:55am (figure 2) what was happening to the frog, insect, and bird call intensities in figure 1? Does the data from each figure line up?