

## Sound Analysis Exercise

### Overview

This exercise was developed by Dr. Tim Wright and members of his lab in the Biology Department at New Mexico State University. It was originally designed in January, 2011 as an exercise for use with 7<sup>th</sup> grade students from the Sierra Middle School Science Magnet program in Las Cruces, NM. Its goal is to guide students in generating hypotheses for how sound parameters might vary with animal size, and give them a brief introduction to sound analysis so they can test these hypotheses with measurements from parrot calls. It relies on software and parrot calls that are available from the Cornell Lab of Ornithology. Users should feel free to adapt as necessary to suit their purposes and available equipment. If you have general suggestions for improvement please send them to Dr. Wright at [wright@nmsu.edu](mailto:wright@nmsu.edu).

### Instructor Notes

1. This is planned for a 45 minute session with middle school students with limited relevant computer experience. May need to be adjusted. 2 persons per laptop, all files put on computers and datasheets prepared beforehand.
2. Start the session by introducing self, and helpers, and main scientific interest (sounds animals make to communicate with each other)
3. What is sound? How does animal make sound? How do you make a sound? You move something back and forth, pushes air molecules together to make denser waves and less dense waves. Draw vibrating membrane on board, translate to pressure wave diagram.
4. An aside: Need molecules to transmit sound. Sound in water? Yes. Sound through ground? Yes. Sound in space? No- space is a vacuum, no molecules, no sound when the spaceship blows up.
5. Lets think about how sound may change with animals of different sizes. A big animal could have big vibrating membrane, a small animal a small one. Show how frequency of pressure wave will differ, with big having longer wavelength, lower frequency and small having smaller wavelength, higher frequency.
6. Our ear translates these pressure waves into the sounds we hear. Low frequency sounds low pitch, like this (deep voice). High frequency sounds like high pitch, like this (high voice).
7. So lets turn this into a hypothesis about how sounds might differ between big species and small species: Bigger species will have lower frequency sounds than smaller animals. Now we have first hypothesis. (Hint: barks of dogs of different sizes)
8. Lets also think about how the duration of a sound might change with the size of an animal. What determines how long a sound might be? How long the membrane

vibrates. What vibrates the membrane? In birds and mammals it is the air that passes from lungs past the membrane. Who has bigger lungs? Big animals

9. So lets turn this into hypothesis 2. How will the duration of the sound vary between big species and small species: Bigger species will have longer duration sounds than smaller animals.
10. Now we have our hypotheses, lets learn some tools to test them. Pair up, open laptops and hand out exercise. Work through exercise SLOWLY on projected computer.
11. At end of exercise, have students come up to the board and graph their points on two sets of axes: one with frequency (1-2 kHz) on body mass (0-1500 g), other duration (0-1 sec) on body mass (0-1500 g).

## Student Exercise: Parrot Call Measurement

Now that we have formulated our hypotheses for how the sounds that animal make may differ among species of different sizes, we can test our predictions on actual animal sounds. We will do this by making measurements of the acoustic properties of calls from different parrot species that vary in size. We will do this using a computer program called Raven Pro, which is produced by the Cornell Lab of Ornithology especially for the analysis of animal sounds. The calls we will be using are from a CD called "Voices of the New World Parrots" that is also produced by the Cornell Lab of Ornithology.

First we will try out some of the basic controls of the program, and then we will move right into measuring parrot calls. We will end by graphing the data from different groups to see if our hypothesis was supported by the data.

### I. Basics controls for Raven Pro:

12. Opening Raven: Double click on Raven icon (a big black bird) in the dock to start the application.
13. Opening files: Under the <File> menu go to <Open Sound Files> and select the 2000Hz.aif sound file in the Examples folder. Click OK on the next dialog window to open entire sound.
14. Sound views: You will now see two panels open with representations of the sound. The top view is the waveform; it represents the actual pressure wave of the sound. The bottom view is a spectrogram; it is a picture of how the frequency (pitch) of the sound changes with time. Does the frequency of this sound change with time?
15. Play the sound: You can play the sound by pressing the triangular Play button in the center of the console at the top of the window. How does this sound sound? Can you hear any change in its frequency over time?
16. Expand the sound waveform: The buttons on the bottom right corner of sound window allow you to expand or contract these pictures of the sound. Try clicking on the Plus button on the bottom of the window 12-15 times to really expand the sound. What do you see? You can return your sound to the original view by clicking the Minus button.
17. Measure the sound: On the lower left corner of the window is a button that says <Layout> with an arrow next to it. Click on the arrow twice until it says <Selection>. The pane above the arrow should switch to one showing the beginning, ending and delta (duration) Time measures and the high, low and delta Frequency measures for your selection. Now in the spectrogram window (the lower window) click on the beginning of the sound and then drag the cursor until the entire sound is highlighted. How long is your sound (what is the delta time in seconds)? Now click on the exact middle of the dark line representing the sound in the spectrogram. What is the frequency of the sound in Hertz? Hint: it should be around 1 sec and have a frequency of about 2000 Hz.

18. Play with an animal sound: Go back to <Open Sound Files> under the <File> menu and choose one of the animal sounds in the Examples folder. Play the sound a few times at regular speed and watch spectrogram below to see how the frequency changes with time. For fun you can change the color of the spectrogram by selecting <color scheme> under the <View>. You can also change the speed of the sound by clicking in the <Rate> box at the top of the window and typing in either 2.0 or 0.5. What happens to the sound?

## II. Measuring parrot calls to test your hypothesis

19. You are now ready to measure actual parrot calls recorded from wild parrots in the jungles of Central and South America. These measurements can be a little tricky, so don't be afraid to ask for help if you need it!
20. Under the <File> menu go to <Open Sound Files>. In the next window, click on <Examples> then <select Raven 1.3>. Finally, double-click on the <Parrot Calls>. You will now see a list of sound files from of different parrot species. Check your data sheet to see what species you have been assigned. Select a call from that species and open it.
21. Play the call a few times. What does it sound like? Many parrot calls sound horrible; a few are faintly tolerable.
22. Measure the duration as you did earlier by clicking on the beginning of the sound and then dragging the cursor until the entire sound is highlighted. Then write down the number in the Delta Time box on the left side of the window onto your data sheet.
23. Measure the frequency of the sound can be a little trickier with parrot calls. Many of them have calls that look ladder-like, with bars of sounds going up. Try to pick a point in the middle of the call and click your cursor on the lowest bar of the ladder (called the fundamental frequency). Then write down the number from either the Low or High Frequency box on the left onto your data sheet. These numbers should be the same, please ask if you need help.
24. Finally, look up your species in the Parrots of the World book and write down its mass on your data sheet next to your call data. While you are there make sure to take a look at the picture of your species.
25. If you have time, repeat these measures on another call from the same species. How do your measurements from the second call compare to those from the first?
26. We will end the exercise by graphing your results to see whether the data you have collected support your hypotheses.