Species Concepts in Birds

All four of the bird species pictured below are currently recognized as being separate species. However, one of these pairs of species hybridizes and the other does not. Your group will analyze the sounds of one of these species pairs for evidence of possible behavioral reproduction isolation.

Eastern Meadowlark by W.A. Paff

Western Meadowlark by D. Robert Franz

Blue-winged Warbler by Betty Cottrille

Golden-winged Warbler by Isidor Jeklin

Photos courtesy of Macaulay Library, Cornell Lab of Ornithology

1. Which species pair are you analyzing?

2. What differences in their appearance, if any, do you notice? (Refer to the photos above and videos of these species from the Macaulay Library)

3. Do you hypothesize that your species pair hybridizes or does not hybridize in nature? Explain.

4. Go to the Macaulay Library website (http://macaulaylibrary.org) and search for your pair of species.

   You can limit your search to Audio files only by unchecking "Video" above the search box. Be sure to spell the name correctly (Blue-winged Warbler, Golden-winged Warbler, Eastern Meadowlark, or Western Meadowlark).

5. Listen to several audio recordings from your pair of species to get an idea of whether and how their songs differ.

   Click on the visualize button (shown at right) to open a RavenViewer window which graphs the song in several ways. (If you want, you can open new windows for each recording and arrange them on your desktop in order to compare them more easily.)

   

6. At this point, make sure you understand what the x- and y-axes of the sound graphs are telling you, along with any differences in color you see. Refer to the RavenViewer at-a-glance guide and the basic information on sound analysis at the end of this handout.

   Some adjustments that you might want to make to RavenViewer include zooming in, changing the spectrogram colors to "Red on Black" or "Purple on Black" (unless you can't see color, in which case you likely want to use "White or Black" or vice versa), adjusting the contrast and brightness, and slowing down the playback speed.

7. Quantify differences in the songs of your species pair by using RavenViewer to analyze at least 3 different recordings per species. (Why?) Record your observations in Table 1, and be sure to note your units of measurement.

Table 1

Species	Catalog number	Song duration	Highest frequency in song	Lowest frequency in song	Other trait 1	Other trait 2

9. Describe the two other traits you measured below, in enough detail that someone could replicate your methods.

Discussion Questions

10. Based on the song analysis you did, do you think these two species are likely to hybridize? Why or why not?

11. Based on songs and plumage, would you classify these groups as separate species? Why or why not?

12. If one species was endangered and the other was not, do you think the differences between them (if any) would warrant conservation for the endangered one?

The Basics of Sound Analysis

A spectrogram is constructed by Fourier transformation, a process that decomposes complex sounds and allows us to visualize them. Because of the physics of sound and the nature of the Fourier transformation, there is a trade-off between time resolution and frequency resolution in sound analysis, but you don't need to worry about that for this exercise.

The spectrogram shows time on the x-axis and sound frequency on the y-axis. The loudness of the sound is represented by the intensity of the color.

Many bird songs can be described as a series of notes, where a note is defined as a continuous trace on the spectrogram. If a note or a set of notes (i.e., a syllable) is repeated over and over within a song, then that can be considered a trill.

The power spectrum takes a short time slice of a spectrogram and turns it on its side, so that sound frequency is on the x-axis. The y-axis is now the amplitude of the sound, so peaks on the line correspond to intense colors (i.e., loud sounds) in the spectrogram.

The waveform is the raw information used to generate sound spectra and spectrograms. It shows the pressure of the sound wave (y-axis) over time. For more information, see: http://macaulaylibrary.org/help/ravenViewer/details.do

Helpful Hints for This Investigation

You can start with duration (in seconds) and frequency range (in kilohertz, kHz). One hertz = 1 cycle/second, a kilohertz is a thousand hertz. Then, measure other traits you noticed that differ between the species, and be sure to describe how you measured them.

Slowing down the playback speed can help you have better control with finding the songs in the recordings (but it will make things sound very different!).

You can make better time measurements if you zoom in on the songs using the timeline zoom slider. If you click on the spectrogram while the sound is stopped (i.e., not playing), the program will re-align the spectrogram with that point as the center.

You can make better frequency measurements by changing the Frequency Limit or the Y-axis scale and Y-axis offset sliders to zoom in. Frequency measurements should appear just above where it says "Spectrogram Tab"—just move your mouse to the point you want to measure.

To help determine where the sound starts and stops in frequency, it may help to look at the power spectrum (click on the power spectrum tab at the bottom of the page; you may need to click "Hide" then "Show" to make it pop up). This only shows the frequency profile of a very short slice of time, so you'll want to look at multiple slices through the song to see where the frequencies are. Look for abrupt changes in the slope of the line, and compare with the spectrogram to see if you think it's the bird singing or just background noise.