The**Cornell**Lab of Ornithology

Exercise: Band Limited Energy Detector

Summary:

The purpose of this exercise is to practice using the Band Limited Energy Detector to find sounds in acoustic recordings. The Band Limited Energy Detector is particularly-well suited to finding sounds with high amplitude in a specific frequency band.

Learning objectives:

- Use the Band Limited Energy Detector to find target sounds
- Understand how to refine the detector to improve performance

Prerequisite knowledge:

- Assumes knowledge of acoustic concepts such as frequency and bandwidth
- Assumes knowledge basic Raven familiarity for opening files and making selections

Exercise:

1. Open Raven.

2. To open the sound, select **File** -> **Open Sound File** from the Raven menu bar. Navigate to the sound file that contains the sounds that you wish to detect.

   For this demonstration, we will use a recording of a Red-eyed Vireo (a species of North American bird). This sound is located in the folder: Sounds/Detector Demos/Single species/RedeyedVireo-ML176120.wav).

3. Open the entire sound (not paged).
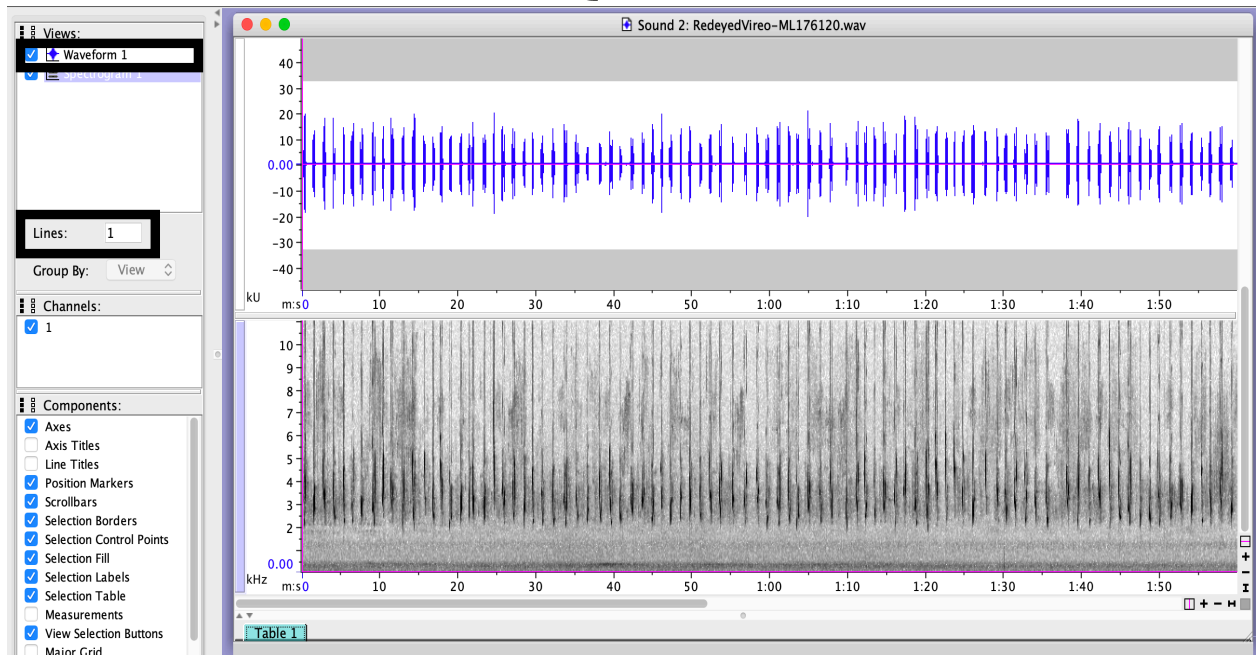
4. Go to "Lines" box (see black box above) and enter "4" to get four lines. Turn off the Waveform view (see black box above). You might also choose to change the contrast or brightness to increase the visualization of the samples. Now, your view should look similar to the view below.
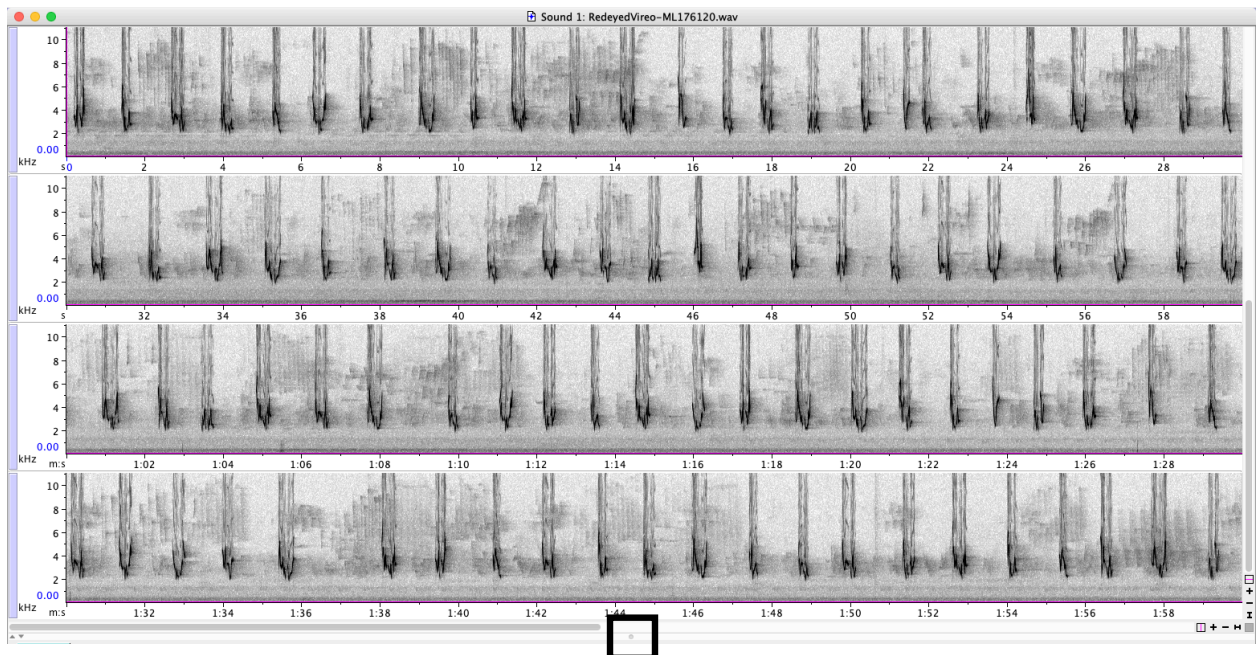
5. For this example, let's practice using a Band Limited Energy Detector to find and draw a box around each individual call of the Red-Eyed Vireo.

Before detecting calls, you will need to measure a few calls by hand so that you can tell the computer what to look for. To measure calls, add a selection table that includes the measurement "Delta Time (s)."

Note: If you do not see the selection table, you will need to drag up the bar at the bottom of the spectrogram. This bar has one large dot in the middle (see black box above). The default selection table includes a few measurements, but you can add measurements by placing your mouse in the selection table window and right clicking or control clicking (on computer without a right click button) to show the selections menu. You will need to select the measurement and add it to the column of active measurements.

6. Now zoom in a bit and draw boxes around several of the individual calls. You will use these measurements to tell the computer what to look for, so you will want to include calls with a variety of durations and frequencies. Draw the box around the dark part of the call so that your measurement captures the part of the call that contains the majority of the energy (shown by selections 1-3).

    We will also need to tell the computer approximately how far apart the calls are so that it knows whether to create one long box or two short boxes with a gap in between. To do this, make a selection around the gap between two calls (see below, highlighted box with selection label 4).
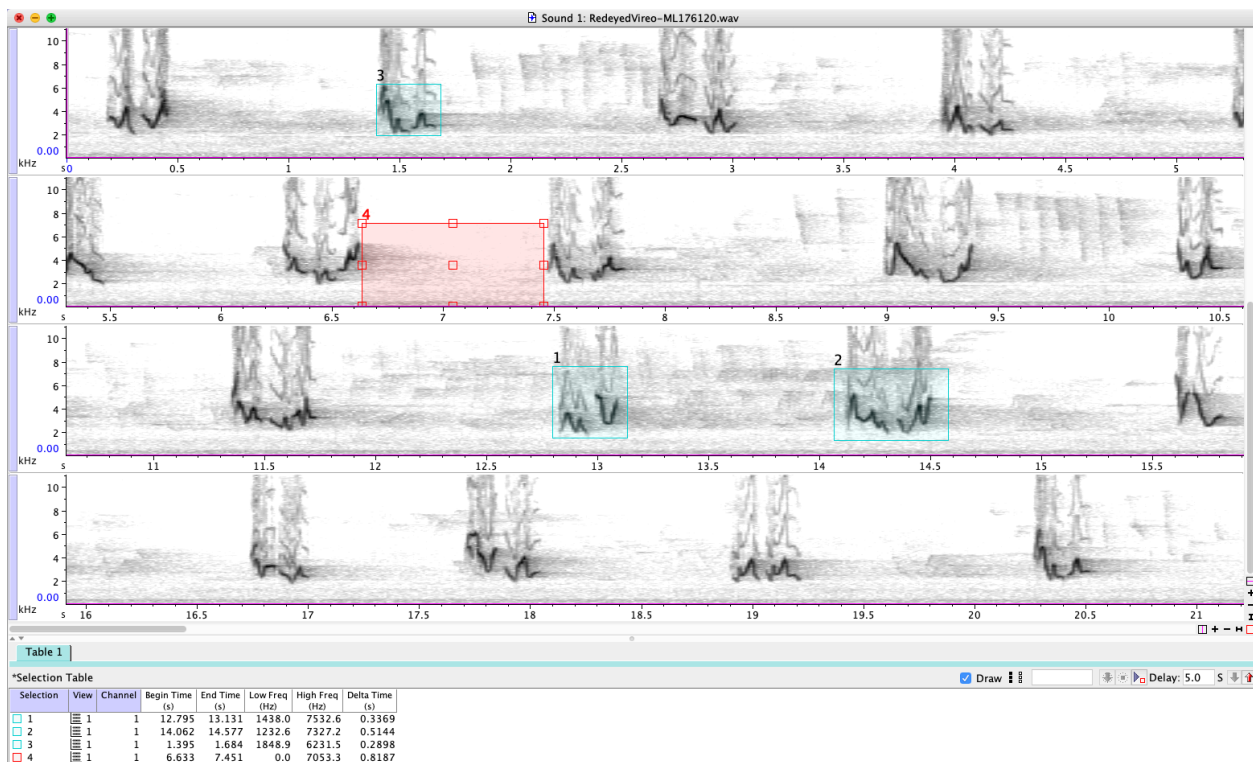
7. Now you have the information that you need to configure the detector. To initiate the detector, right click (PC) or control click (Mac) on the spectrogram window. Select the bottom option **Interactive Detector** and then **Band Limited Energy Detector.**
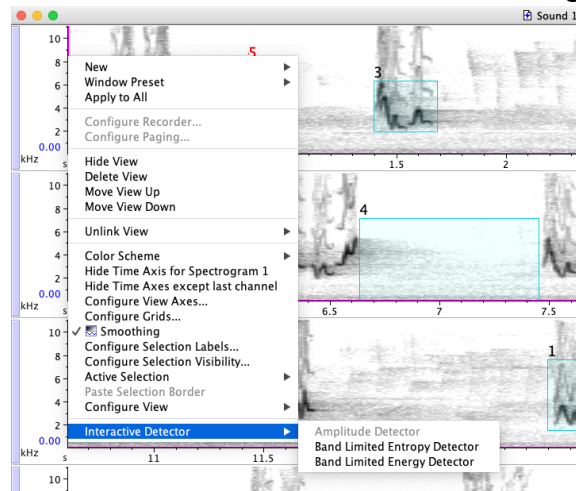
8. You will now configure the Band Limited Energy Detector. To find the lowest frequency of your calls, look at the "Low Freq (Hz)" column of your selection table and find the lowest value. If needed, you can sort this column by clicking on the column name to make it easy to find the lowest value. This is the lowest value of the calls that you selected, but it is generally advisable to round this value down a little in case some of the other calls are lower. If the signals are all similar in frequency, you can round by 10-50 Hz. If they're more variable, you might round down by 500 Hz or more. Enter this value in the "Minimum Frequency" box. Now do the same for the "Maximum Frequency" but this time, round your highest value up a bit in case there are calls in the dataset that are higher than the calls that you measured. For Minimum Duration, look for the call with the shortest length by finding the selection with the shortest Delta Time and round down a little bit in case other calls are shorter. Do the same for Maximum Duration, this time looking for the longest selection and rounding up a bit. The Minimum Separation specifies far apart events have to be before the program will make a new selection. The gap that you measured (Selection 4) gives you a sense of how long the gaps are, but you will want to make your Minimum Separation parameter shorter than the gap that you measured in case the gap is shorter for other calls.
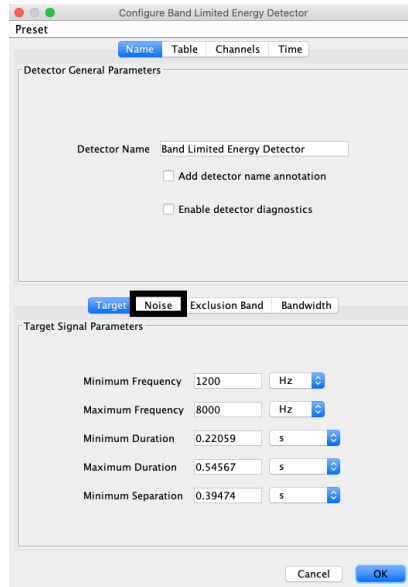
9. Now, navigate to the Noise tab (see black box above). In this tab, you will set the Minimum Occupancy (%). This is what proportion of the detection needs to be above the detection threshold. If the target signal is a long, continuous sound, you might set this at a high percentage (since the signal will not drop below the threshold). If the target signal has pulses and gaps, you will want to set this percentage lower so that your detection is not excluded based on the moments when the signal drops below the threshold.

   The SNR Threshold indicates how strong the signal needs to be relative to the background noise. If you have clear signals on a quiet background, this value can be relatively high. If the signal is quiet and the background is loud, this threshold will need to be relatively low.

   There is quite a bit of trial and error to finding detector parameters. It often makes sense to begin with the defaults on the Noise tab and adjust them if needed.

10. Now hit okay to run the detector. If you are fortunate, you will have detections immediately, but often you will need to refine your detector a bit. The **Enable Diagnostics** tool is a useful way of refining the detector. To activate this tool, select the box in the upper left corner of the screen (see black box below). When this tool is activated, a column at the right of the selection table shows candidate detections and the reason that they were excluded in Stage 2 (too short, too long, too sparse, etc). In addition to using the diagnostic tool, ask yourself what is similar about the detections that were missed. If they tend to be low amplitude, long duration, etc, you will want to consider this information when considering what detector modifications to try.
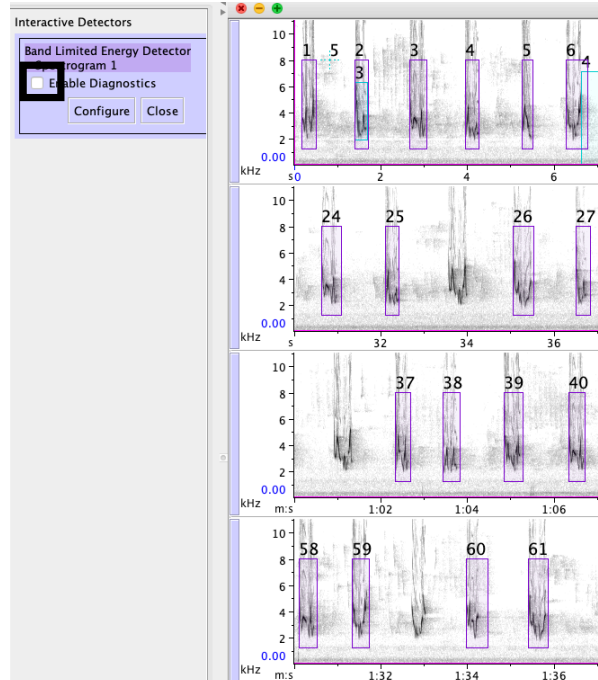
11. Once you have a template detector that you like, you can save this detector to use on future recordings. Hit the configure button and then go to the **Preset** menu in the detector box. Select **Save As** and name your detector.

12. You can also find options under the file menu for saving your selection table and the individual sound selections.
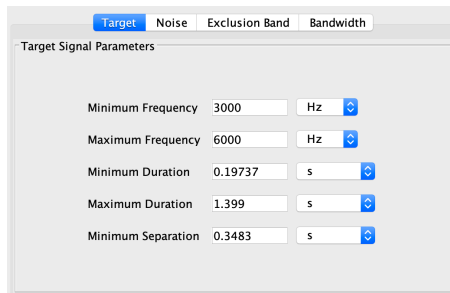
Note that there are many other options and parameters in the Band Limited Energy Detector. You might want to look through the different tabs to see if there are additional options that are useful in your project.

Synthesis
1. To practice, try detecting the katydid sounds in the file *Katydid-20121002.wav*.
2. If you are failing to detect a series of rapid pulses with silence in between, what parameter might you change to increase the detection success?
3. Imagine that your detector is finding the target signal, but also loud broadband sounds such as falling trees. Explore the "Exclusion Band" tab to see if there are ways that you might be able to reduce the number of false detections.
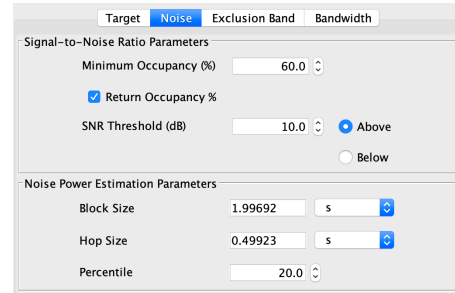
Answers

1. There are many different parameters that work well. Below are configurations of the Target and Noise tabs that enabled effective detection.

2. One approach is to lower the Minimum Occupancy (%) value. This decreases the proportion of time that the signal amplitude has to be above the detection threshold.

3. The Exclusion Band allows you to exclude detections where there is high energy at many different frequencies. This parameter is especially useful for excluding broadband sounds. In some cases, the Exclusion Band can also be used to exclude other species that overlap with the target species but have acoustic energy at other frequencies.