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Best Practices for Bioacoustic Analysis of Wood Frog (Rana sylvatica) Advertisement Calls Over a Suburbanization Gradient

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Best Practices for Bioacoustic Analysis of Wood Frogs (*Rana sylvatica*) Advertisement Calls over a Suburbanization Gradient

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ABSTRACT

- Identifying how species respond to anthropogenic changes in their environment is important for understanding human impact.
- I developed bioacoustics methods to analyze how wood frog (*Rana sylvatica*) advertisement calls vary in pitch, duration, and number across a suburbanization gradient (Figure 1).
- I examined call structure and different measures of frequency. Center and 95% frequency have more variability when compared to peak and 5% frequency.
- Wood frog calls are difficult to analyze for many reasons, but I have developed a method to quantify these calls and capture their variability.

INTRODUCTION

- Wood frogs' distribution makes them an excellent species to test the impacts of environmental change on their behavior and physiology[1].
- Wood frog (Figure 4) advertisement calls are hard to analyze as they are short, overlapping, and lack complex call structure[1].
- The hypothesis is that wood frogs found in more urban areas will have higher pitches (Figure 2), decreased durations, and a lower number of calls when compared to frogs from isolated areas[2].

Figure 1. Left to right: rural to suburban gradient of wood frog breeding ponds (light blue) surrounded by 2.5%, 25.4%, 40.4% and 74.7% suburban cover in a 200 m radius (circles). Used with permission from Holgerson et al, in prep.

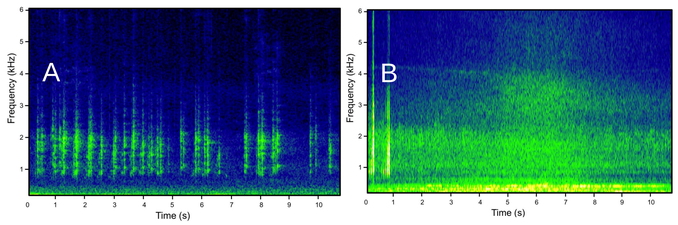

Figure 2. A) Spectrogram of wood frog (*Rana sylvatica*) calls and **B)** traffic noise recorded at a roadside vernal pool

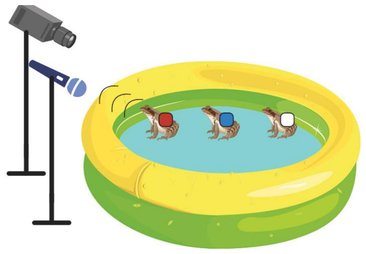

Figure 3. Diagram showing how audio data were collected. Three wood frogs were placed in a kiddie pool with a shotgun microphone and recording equipment and were allowed to perform mate-searching behavior. Made using Biorender.

Figure 4. Wood frogs (*Rana sylvatica*) in amplexus, male (top) and female (bottom). Photo by L. Swierk.

METHODS

- A total of 42 trials (Figure 3) from Madison, Connecticut were recorded with 2-3 male wood frogs each.
- Audio collected was analyzed with the program Raven Pro 1.6.4.
- Spectrograms have a y-axis that shows pitch (frequency, kHz), and an x-axis that shows time (Figure 5).
- The darker the color, the more intense the sound (greater “power”).

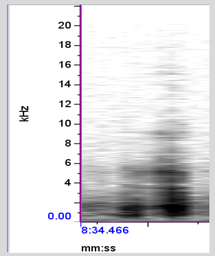

Figure 5. Wood frog advertisement call in spectrogram form, made using Raven Pro

PRELIMINARY RESULTS

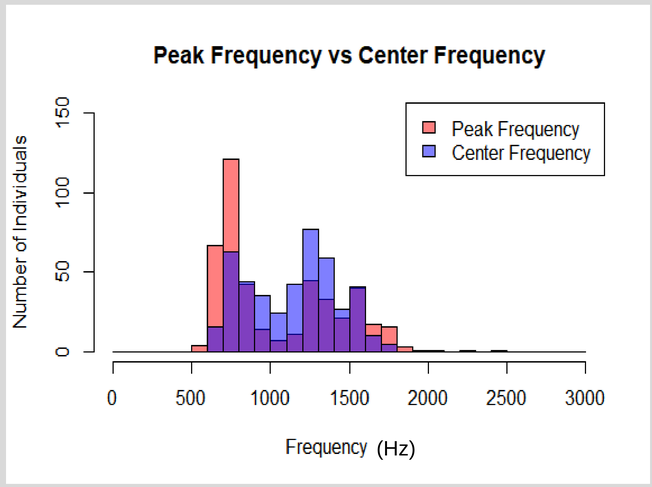

Figure 6. A comparison of peak frequencies and center frequencies from individual advertisement calls. Peak frequency is the frequency at which max power occurs in a selection, and the center frequency is the frequency that splits a selection into two parts of equal energy.

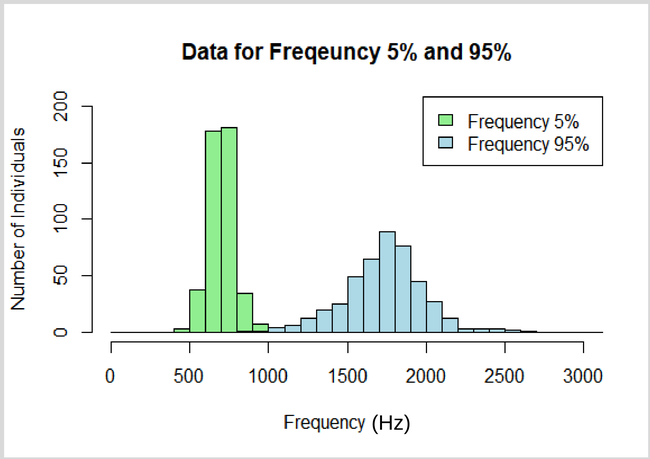

Figure 7. A comparison of frequencies 5% and 95% from individual advertisement calls. Frequency 5% is the frequency at which 5% of the energy in a spectrogram selection has been reached. Frequency 95% is the frequency at which 95% of the energy in a spectrogram selection has been reached.

PRELIMINARY RESULTS (CONT.)

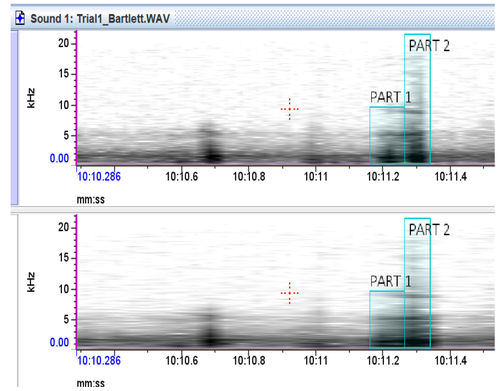

Figure 8. Example of how a single advertisement call was split into two parts to be analyzed. The first spectrogram has a Hann window of 2048 (frequency resolution) and the second spectrogram has a Hann window of 4096 (time resolution).

- Boxes to analyze calls were hand-drawn around both parts of each wood frog call. Splitting the calls into two parts made analysis more accurate.
- Center frequency has more variability than peak frequency; individuals vary more when it comes to center frequency in calls (Figure 6).
- Frequency 95% has more variability than frequency 5%; individuals vary more when it comes 95% frequency in calls (Figure 7).
- The Hann window of 2048 has better frequency resolution, and the Hann window of 4096 has better time resolution (Figure 8).
- 90% duration (time measurement based on the dominant sound energy) was used to account for any subjectivity in hand-drawn boxes.

DISCUSSION

- Some aspects of wood frog advertisement calls have more variability than others.
- This variability is important when it comes to changes in advertisement calls since it suggests which call components are more plastic.
- Some aspects of calls appear to be more consistent or less affected by the environment.
- These methods can be used to analyze calls in other frog species.
- In the future, the reason for differing variability in aspects of wood frog calls can be examined.

REFERENCES

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