



Development of Acoustic Classifiers for Boreal Chorus Frogs and American Bullfrogs Grant Report

Boulder County Parks and Open Space

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## 1.0 Introduction

### 1.1 Purpose

This report was compiled for Boulder County Parks and Open Space (BCPOS) with the main objective being to develop acoustic classifiers using cluster analysis in Kaleidoscope Pro software for local populations of Boreal Chorus Frog (*Pseudacris maculata*) and American Bullfrog (*Lithobates catesbeianus*) in Boulder County. American Bullfrogs are invasive in Colorado and have been implicated in the global decline of native amphibians (Ficetola et al., 2007). The presence of healthy Boreal Chorus Frog populations in Boulder County signifies the well-being of open spaces. The development of acoustic classifiers will enable BCPOS to efficiently and accurately detect Boreal Chorus Frog and American Bullfrog on open space.

While AES excels in deploying and analyzing song meters using software like Kaleidoscope Pro, there is currently no automated identification program for amphibians. Acoustic files must be manually examined and described. Therefore, the primary aim of this project is to create species specific classifiers, reducing the time required for analysis and potentially assisting land managers.

### 1.2 Objective

Develop acoustic classifiers using cluster analysis in Kaleidoscope Pro software for local populations of Boreal Chorus Frog (*Pseudacris maculata*) and American Bullfrog (*Lithobates catesbeianus*) in Boulder County, Colorado.

# 2.0 Methods

#### 2.1 Song Meter Deployment

AES deployed song meters through Wildlife Acoustics for a total of 4 weeks (April-May) at St. Vrain State Park. This timeframe reflects the breeding season window for the species of interest, when it is anticipated that males will be actively calling. Song meters were programmed to record for three minutes, every 30 minutes for 24 hours. This takes into consideration behavioral differences in frog species (e.g., diurnal vs. nocturnal). Additionally, from April to May of 2022, CPW deployed song meters in Boulder County. These audio files were shared with AES and used in the analysis.

#### 2.2 Acoustic Monitoring Analysis

After the song meters were collected from the field, AES used Kaleidoscope Pro's Cluster Analysis feature to analyze the recordings for American Bullfrog and Boreal Chorus frog detections. Kaleidoscope Pro's Cluster Analysis employs algorithms for pattern recognition, enabling it to automatically scan wildlife audio recordings and detect various animal vocalizations. These detected sounds are then organized into groups, or "clusters" based on their similarities. These clusters can be categorized and labeled to facilitate species inventory or annotated to create classifiers for subsequent recordings. Once grouped into clusters, AES viewed, edited, and labeled each cluster to analyze which recordings produced the most accurate frog calls. The subsequent results were saved in Kaleidoscope Pro. AES was successful in building a classifier for the Boreal Chorus frog from the generated cluster analysis using this software.



Song Meter Deployment St. Vrain State Park 2023 Date: November 20, 2023 Author: Kelly Triece Projected Coordinate System: NAD\_1983\_UTM\_Zone\_13N Projection: Transverse\_Mercador Coordinate System: GCS\_North\_American\_1983 Datum: D\_North\_American\_1983



Figure 1.Song Meter Deployment Locations St. Vrain State Park in April and May 2023

Song Meter	Date Deployed	Latitude/ Longitude
A	4/15/2023- 5/6/2023	40.1676559868, -104.98928775
В	4/15/2023- 5/6/2023	40.1628252851, -104.989022838
С	5/6/2023- 5/26/2023	40.1692069798, -104.982043262

Table 1. AES Song Meter Deployment Locations at St. Vrain State Park

#### Table 2. CPW Song Meter Locations

Song Meter	Dates	Location
1	04/04/2022- 09/14/2022	Boulder County
2	04/04/2022- 05/19/2022	Boulder County
3	04/05/2022- 09/15/2022	Boulder County
4	05/05/2022- 09/02/22	Boulder County
5	06/08/2022- 09/13/2022	Boulder County
6	04/07/2022- 06/21/2022	Boulder County
7	04/17/2022- 5/21/2022	Boulder County
8	04/04/2022- 09/19/2022	Boulder County

## 3.0 Results

**Boreal Chorus Frog:** Throughout this project, Kaleidoscope Pro was used to classify and detect frog calls from Boulder County, Colorado. The software grouped similar sounds into clusters and was particularly useful when identifying Boreal Chorus frog calls. Boreal Chorus frog calls were detected at all sites where song meters were deployed, providing plentiful, high-quality data to create a classifier.

It was frequently observed that the Boreal Chorus frog calls occurred during the early hours of the morning, generally from 1- 3 a.m. The duration of calls varied from 1 - 3 seconds intervals at a given time. This observed variation could be due to the number of Boreal Chorus frogs calling at a time. These vocalizations were of both individual and group calls.



*Figure 2. Result of several Boreal Chorus Frog calls identified with Kaleidoscope Pro, observed at St. Vrain State Park* 

**American Bullfrog**: Through our partnership, CPW shared their American Bullfrog classifier (attached in this report) with AES. The classifier is built from Bullfrog calls collected in 2022 in Boulder County. This fall, AES also scoured through our previous song meter data to build upon the CPW classifier, but the additional data did not change the outcome of the classifier. Therefore, the data we present is the CPW Bullfrog classifier and AES will not invoice \$1520 (50% of task 2&3).

#### 3.1 Song Meter Observations

The recordings from song meters at St. Vrain State Park and in Boulder County provided Boreal Chorus Frog vocalizations. Below are tables with frog recordings, showing date, time, and duration examples throughout the time the song meters were deployed. These samples give some insight into temporal patterns and duration for calls.

Date	Time	Duration
05/04/2023	0131	1.33 s
05/05/2023	0142	1.22 s
05/06/2023	0139	1.44 s

Table 3. Sample of Boreal Chorus frog recordings observed in St. Vrain State Park

05/06/2023	0253	1.17 s

#### Table 4.Sample of Boreal Chorus frog recordings observed in Boulder County

Date	Time	Duration
04/09/2022	0159	3.35 s
05/01/2022	0225	1.01 s
05/05/2022	0211	2.91 s
05/09/2022	0243	1.76 s

#### 3.2 Photos

#### St. Vrain State Park- Song Meter A



Name: SMA\_04152023

Description: West near County Rd 21 1/2

Location: 40.167686, -104.989286



Name: SMA\_04152023 Description: West near Blue Heron

Reservoir

Location: 40.167708, -104.989192

#### St. Vrain State Park- Song Meter B



Name: SMB\_05062023 Description: Checking song meter on tree Location: 40.162769, -104.988992



Name: SMB\_05062023 Description: Song meter on tree Location: 40.162767, -104.989000



Name: SMB\_04152023

**Description:** Song meter facing southeast **Location:** 40.162889, -104.989014



Name: SMB\_04152023

Description: facing Coot Pond Location: 40.162894, -104.989014

#### St. Vrain State Park- Song Meter C



Name: SMC\_05062023 Description: Song Meter attached to tree Location: 40.169236, -104.982011



Name: SMC\_05062023 Description: East near County Rd 21 <sup>1</sup>/<sub>2</sub> Location: 40.167708, -104.989192

### 4.0 Discussion

Simple classifiers of Boreal Chorus Frogs and American Bullfrogs are attached to this report. The classifiers will allow Boulder County Parks and Open Space to efficiently monitor and track the distribution and population dynamics of Boreal Chorus Frogs and American Bullfrogs, which can be difficult to observe directly. This can be done in the future by using song meters, and the obtained audio files can be played against the built classifier. This passive method of surveying will reduce the time in the field when audio and visual detection of frogs can be difficult. The classifiers will help accurately identify Boreal Chorus Frog and American Bullfrog based on their unique call patterns, especially in cases where visual identification might be challenging, such as in dense wetlands or during nighttime.

Classifiers can aid in distinguishing between vocalizations of various frog species, reducing the effort needed to analyze data from thousands of recordings. Classifiers can also give some temporal insight into their calling activity, as well as other characteristics, such as breeding season duration. It was commonly observed that Boreal Chorus Frogs are active in the early hours of the morning (between 1am -3am), with calls varying from less than one second up to several seconds in length.

The classifiers can provide valuable insights into the overall ecosystem health. Changes in the frequency or absence of specific calls can indicate critical ecosystem alterations or imbalances. Such alterations may include habitat degradation due to land use change, climate change related impacts, or invasive species establishment. For example, the Boreal Chorus Frog is considered an indicator species. The loss or reduction of their populations could indicate pollution or toxic substances in the environment. Additionally, since the American Bullfrog is an invasive species, the classifier can also be used to detect presence or movement of this species over the landscape (e.g., wetlands). These observations can provide important implications for management (Graeter et al., 2013).

Moving forward, Boulder County Parks and Open Space can continue to add more vocalizations to the classifiers, which may improve classification accuracy. This could involve further analysis of temporal patterns, frequency components, or specific characteristics unique to different species of animals. Furthermore, the more data processed through Kaleidoscope Pro over time, the more accurate and useful the classifier will be.

## Literature Cited

- Graeter, G.J., K.A. Buhlmann, L.R. Wilkinson, and J.W. Gibbons (Eds.). 2013. Inventory and Monitoring: Recommended Techniques for Reptiles and Amphibians. Partners in Amphibian and Reptile Conservation Technical Publication IM-1, Birmingham, Alabama.
- Ficetola, G.F., Thuiller, W. and Miaud, C. (2007), Prediction and validation of the potential global distribution of a problematic alien invasive species the American bullfrog. Diversity and Distributions.