PikaID: Voice Identification for the American Pika

Niwot Ridge LTER
UNIVERSITY OF COLORADO BOULDER

RECCS

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INTRODUCTION

Bioacoustics is the **study of sound production, transmission, and reception by animals and plants**[1]. Animal sounds can reveal an animal's age, gender, social status, mood, and more.

- Bioacoustics **enables large-scale automated data collection** and supports less invasive study of animals, helping reduce **human impacts on animals and their habitats, the human capital required for these studies, and stress on animals**[2,3].
- Vocal animals like the **American pika are attracting bioacoustic studies. Pika populations have been declining** as they lose access to the cooler climates that have enabled their survival[4,5].

Project Statement

How can we automate pika call detection in wildlife recordings?

Previous Bioacoustics Work

Site selection
- Rocky 'talus' patches, each occupied by several pikas[5]
- This project uses pika calls recorded in Montana

Equipment selection and preparation
- AudioMoths, Solar BARs, and handheld microphones
- Deployment parameters:
  - Deployment length
  - Recording schedule
  - Microphone directionality

Post Processing
- Data retrieval
- Annotation: verifying pika calls in the recording
- Model training, using annotated data
- Listen to pikas with the QR code

We developed an R program using packages WarbleR & Ohun to facilitate pika call detection.

After data collection, the audio is primarily processed through analyzing the frequency composition of signals of interest; in this project, using a spectrogram[6,7].

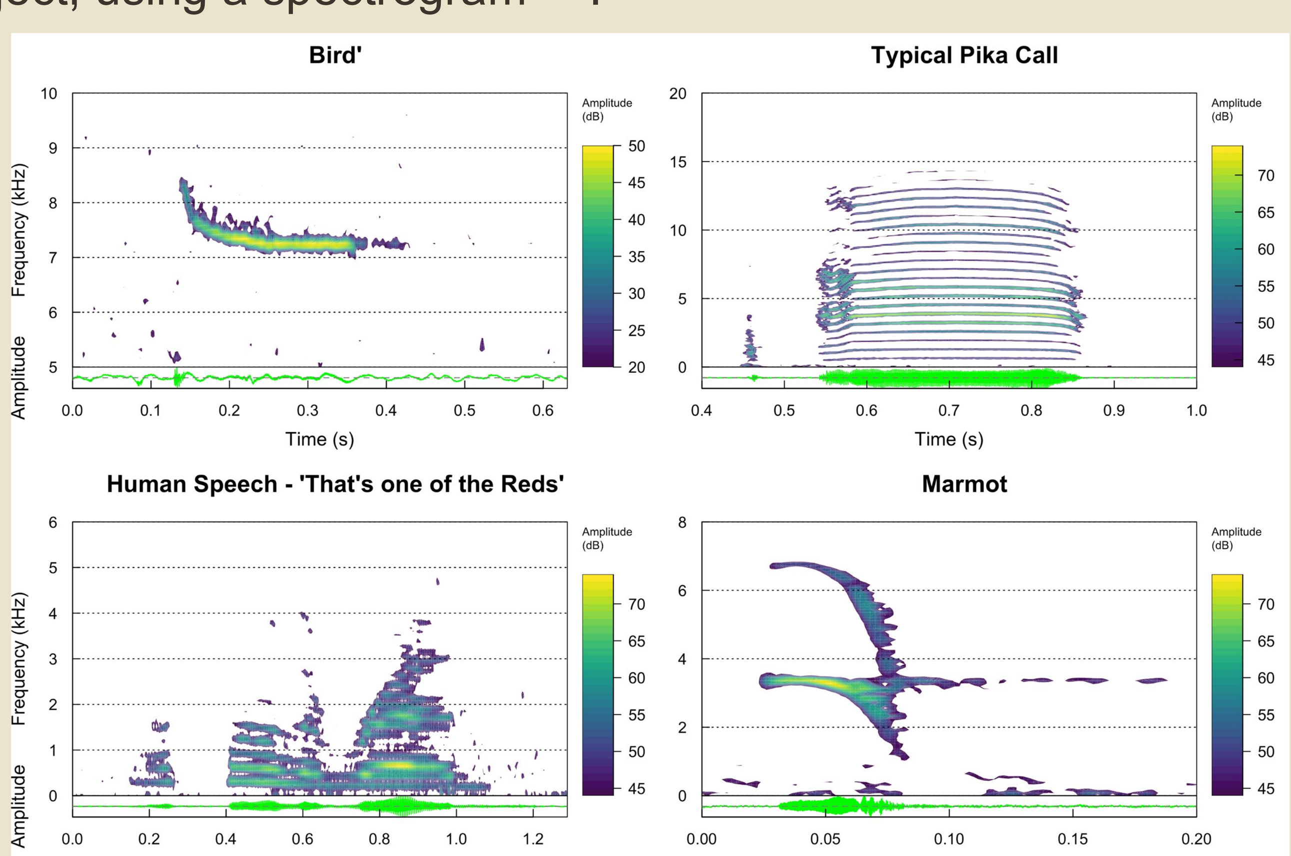

Figure 1: Human, Bird, and Pika speech visualized as spectrograms.

Pika calls are visually distinct from other sounds on a spectrogram (Fig 1); they regularly produce harmonics in the 10+ kHz range, therefore well-suited for bioacoustics analysis[3].

METHODS

[1] Data Sorting & Labeling

Annotated pika calls are manually extracted from wildlife recordings.

Table 1: Annotation table of selected pika calls

Selection	Begin Time (s)	End Time (s)	Low Freq (Hz)	High Freq (Hz)	File
1	0.61	1.04	886.84	13856.81	WIldlife.wav
2	3.07	3.55	1773.67	13413.40	WIldlife.wav
3	4.77	5.20	332.56	13468.82	WIldlife.wav
4	6.20	6.66	1607.39	13524.25	WIldlife.wav
...		Up to 70+ calls			

Annotation tables tell the program where to look to find the calls of interest.

[2] Template Creation

The program then calculates the variance in the audio features using Principal Component Analysis (PCA) to determine the most representative calls to use[8,9,10,11]. The templates are loud, clear pika calls, which makes it easy to pick out their dominant frequency, duration, and other features (Fig 2).

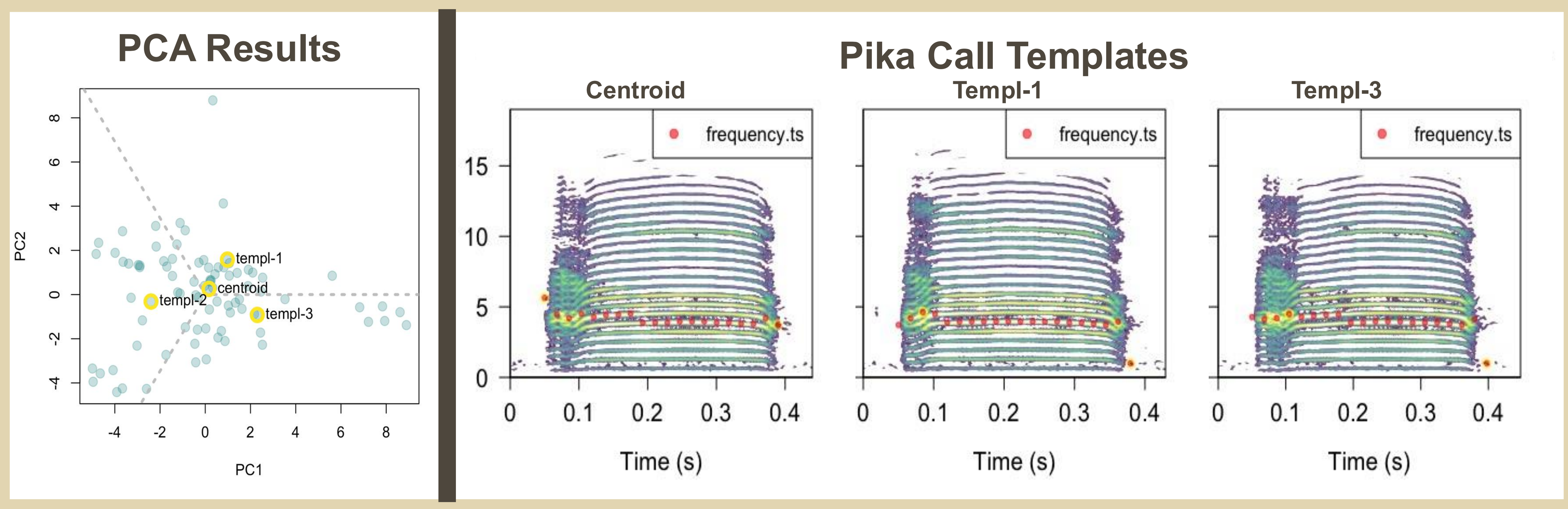

Figure 2: Spectrogram of template calls with dominant frequency highlighted.

[3] Template Correlation & Detection

The program searches for segments of a recording that have spectral content similar to the template. After searching, the program performs heuristic eliminations to clean up the data, such as ensuring that the call durations provided in a selection are possible for pikas.

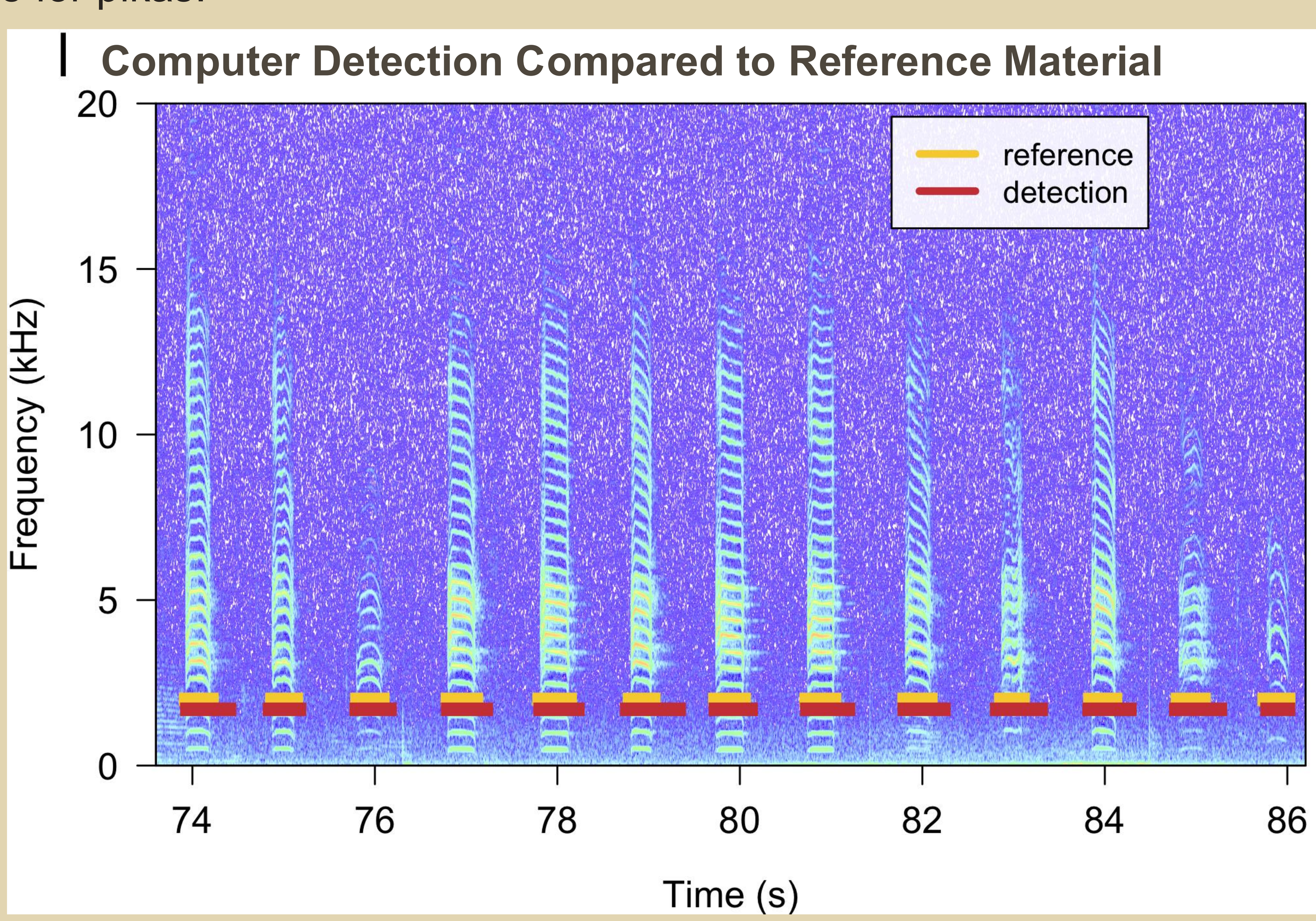

Figure 3: Spectrogram of computer-annotated calls vs the template given

At the end, the program produces an annotation table of calls that can be tested against a reference for further optimization and analysis (Fig 3).

RESULTS & DISCUSSION

The program was applied to a test file containing 76 pika calls from various individuals and recording situations. It made 71 detections, including 70 true positives.

Table 2: Computer-generated annotation diagnoses

Automated Detection Test Results							
Detections	True Positives	False Positives	False Negatives	Splits	Merges	Overlap	Grade
71.00	66.00	1.00	6.00	0.00	4.00	0.59	0.95

Grade: Measure of accuracy accounting for both how many correct detections it made, missed, or incorrectly identified[10].

The algorithm's grade of 95 indicates the **high potential for use as the basis for an individual pika call-identification pipeline**.

This project **successfully built an adaptable engine for pika call detection**. The underlying methodologies guiding the proposed algorithm can be **easily improved upon** and adapted for tracking other animals such as farm animals

FUTURE WORKS

Major improvements to be made:
- Larger-scale testing with audio containing other animals
- Optimizing the detection algorithm's parameters for faster processing
- Take advantage of distributed on-site computing: have the processing done on the microphones
- Inclusion of human annotation for enhanced tagging capability
- Adding more sophisticated spectral features for better individual identification.

The vocal structure of American pika calls is **audibly discernible by individual and call function.** Two pikas conversing can easily be **distinguished from each other on a spectrogram simply through the tone** (Fig 4).

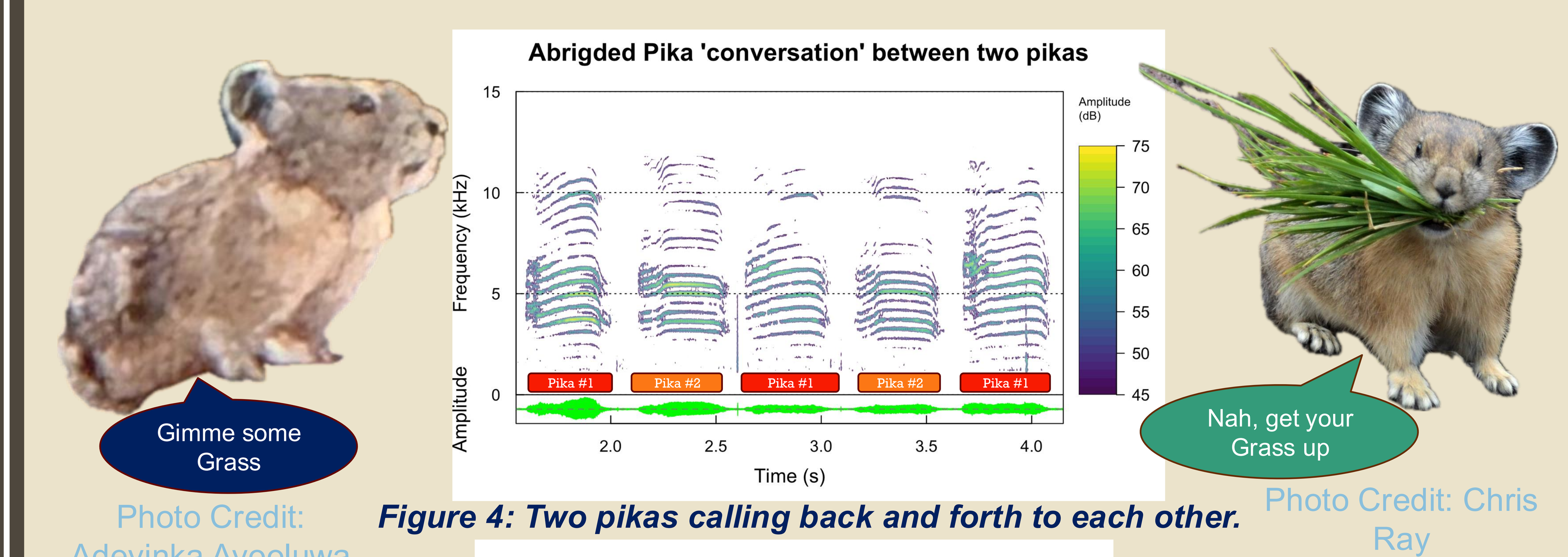

Figure 4: Two pikas calling back and forth to each other.

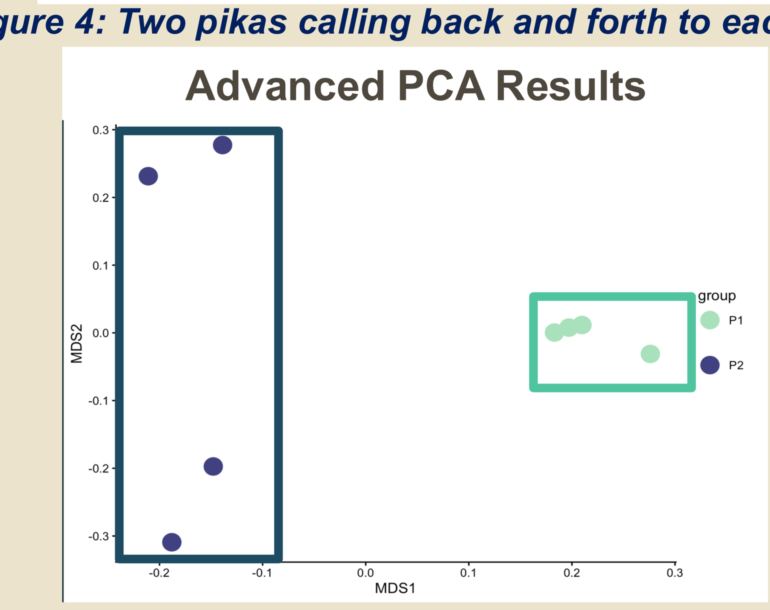

Figure 5: Average feature deviation of calls from two pikas

As seen in Figure 5, simply plotting the variations of the audio features of a group of calls shows potential for individual identification.

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