



ELECTRICAL & COMPUTER
ENGINEERING

UNIVERSITY *of* WASHINGTON



Investigation of Duty Cycles in Passive Acoustic Bat Monitoring

By Aditya Krishna, mentored by Dr. Wu-Jung Lee

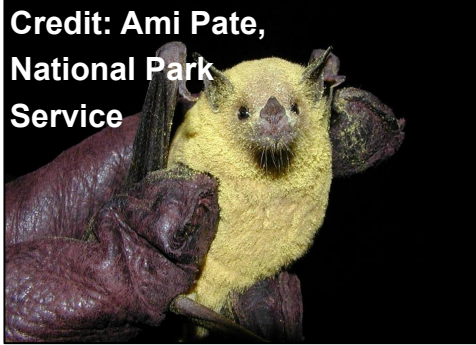
Introduction

- 1) Why monitor bats using Passive Acoustic Monitoring (PAM)?
- 2) Why investigate subsampling for bat-specific PAM?

Why are we monitoring bats with PAM?

- Bats have important environmental roles:
 - Pollinators
 - Natural Insecticides

**Credit: Ami Pate,
National Park
Service**



This lesser long-nosed bat is covered in pollen from feeding on nectar all night.

(Russo et al. 2021)

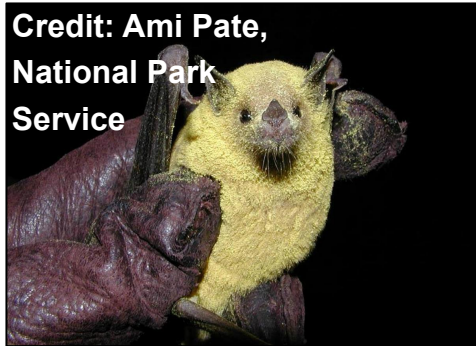
(Sugai et al. 2019)

Why are we monitoring bats with PAM?

(Surlykke et al. 2014)

- Bats have important environmental roles:
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- Bats echolocate for various activity!
- These calls can inform on behavior
- Thus, Passive Acoustic Monitoring!

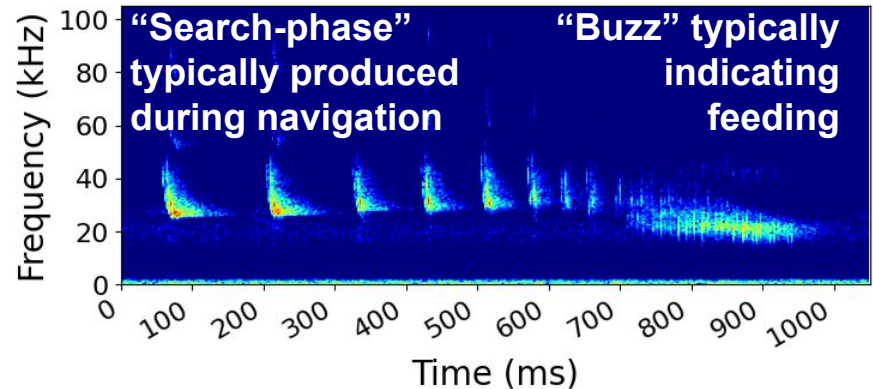
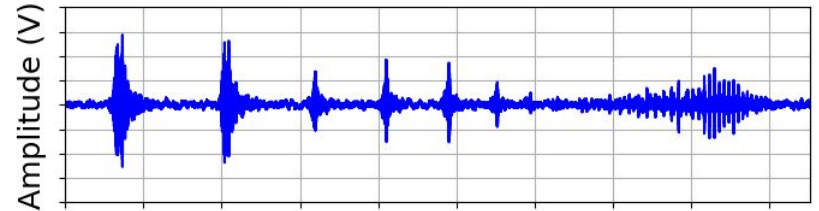


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*Humans can only hear sounds less than 20 kHz so all played bat calls are slowed down by 1.2x to be **audible**.



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- High sampling rate
 - Long-term application
- } Large data volume and logistics

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- Combination of cycle length and duty cycle
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Cycle Length: 12-min, Duty Cycle: 16.7% or 2/12



Cycle Length: 6-min, Duty Cycle: 33.3% or 2/6



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- Long-term application

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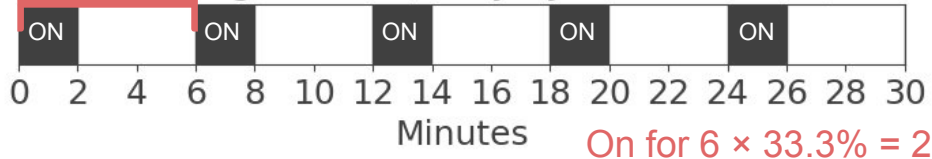
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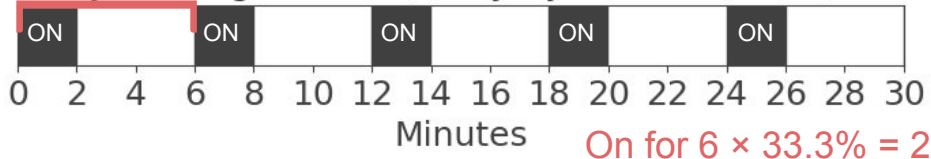
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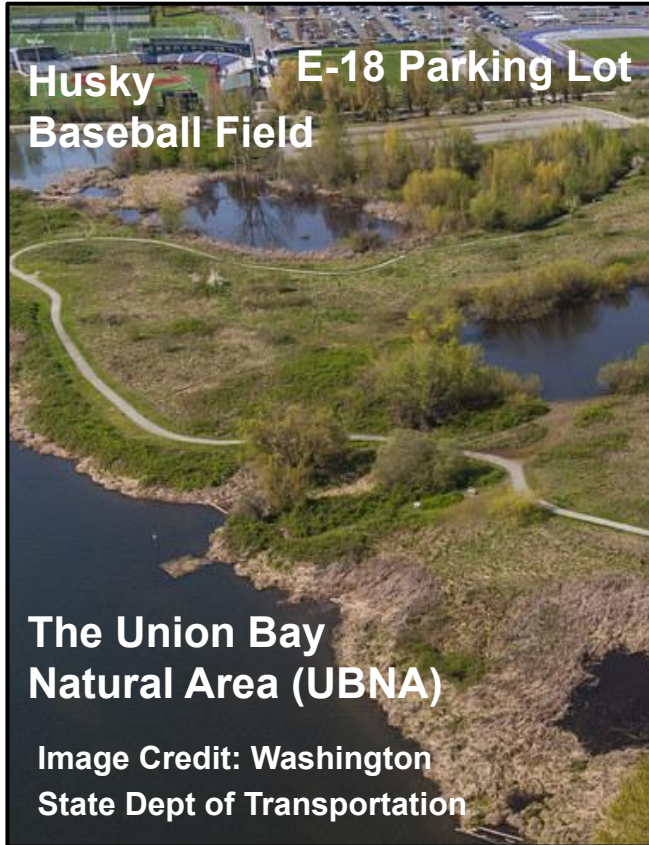
Research Question:

How does recording duty cycle and cycle length affect acoustic monitoring of bat activity?

Methods & Analysis

- 1) Data collection & analysis
- 2) Applied subsampling on collected data

Data was collected from UW's natural laboratory!



**Husky
Baseball Field**

E-18 Parking Lot

**The Union Bay
Natural Area (UBNA)**

**Image Credit: Washington
State Dept of Transportation**

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Audiomoth

- Equipped w/ rechargeable batteries and an SD card



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Collection Period:

- Daily from July - October 2022, decrease in activity due to hibernation.

Internal Settings:

- No subsampling
- Sampling rate: 192000 samples/sec needed for ultrasonic calls

Data rate: ~30GB / day

Lasts only 3-4 days before needing replacements

Used an automated call detector on our collected data

'BatDetect2'

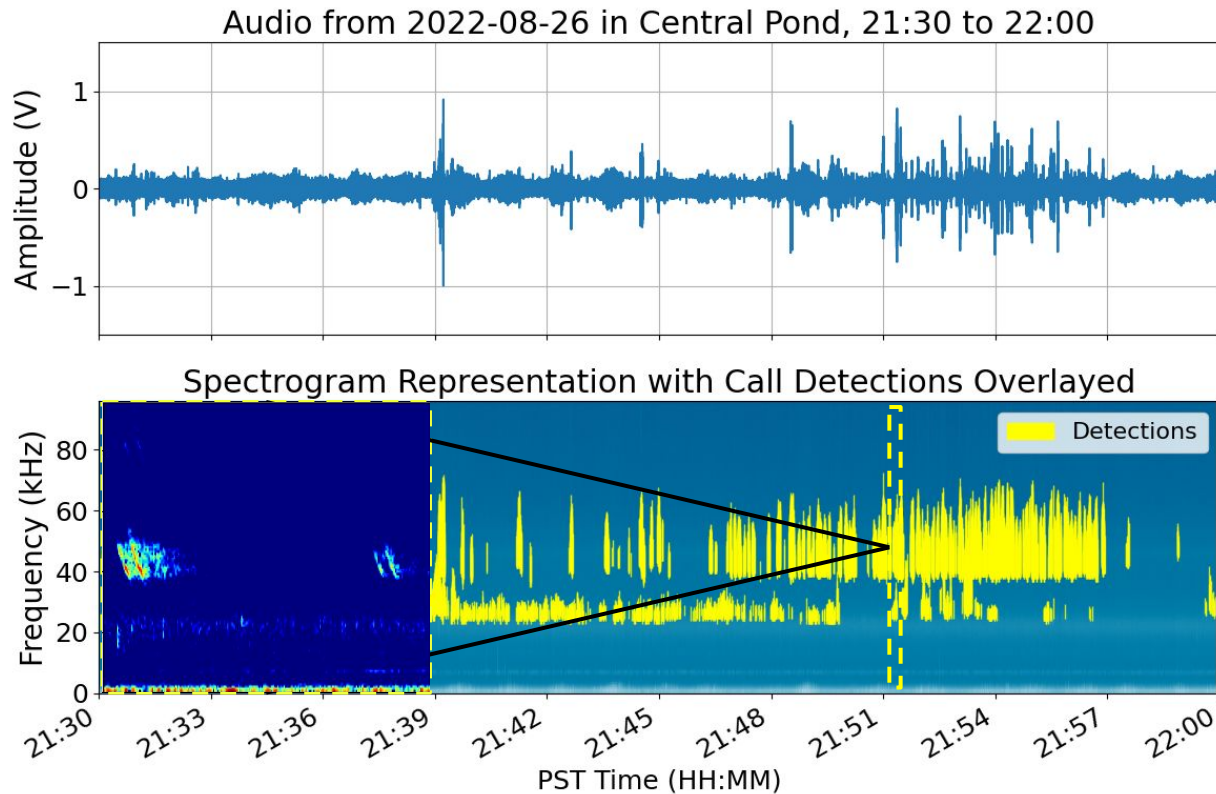
(Aodha et al. 2022)

- Detects 'search-phase' calls in recorded audio
- Uses a CNN model

Software Pipeline:

'bat-detector-msds'

- Developed by UW's Masters in Data Science students!



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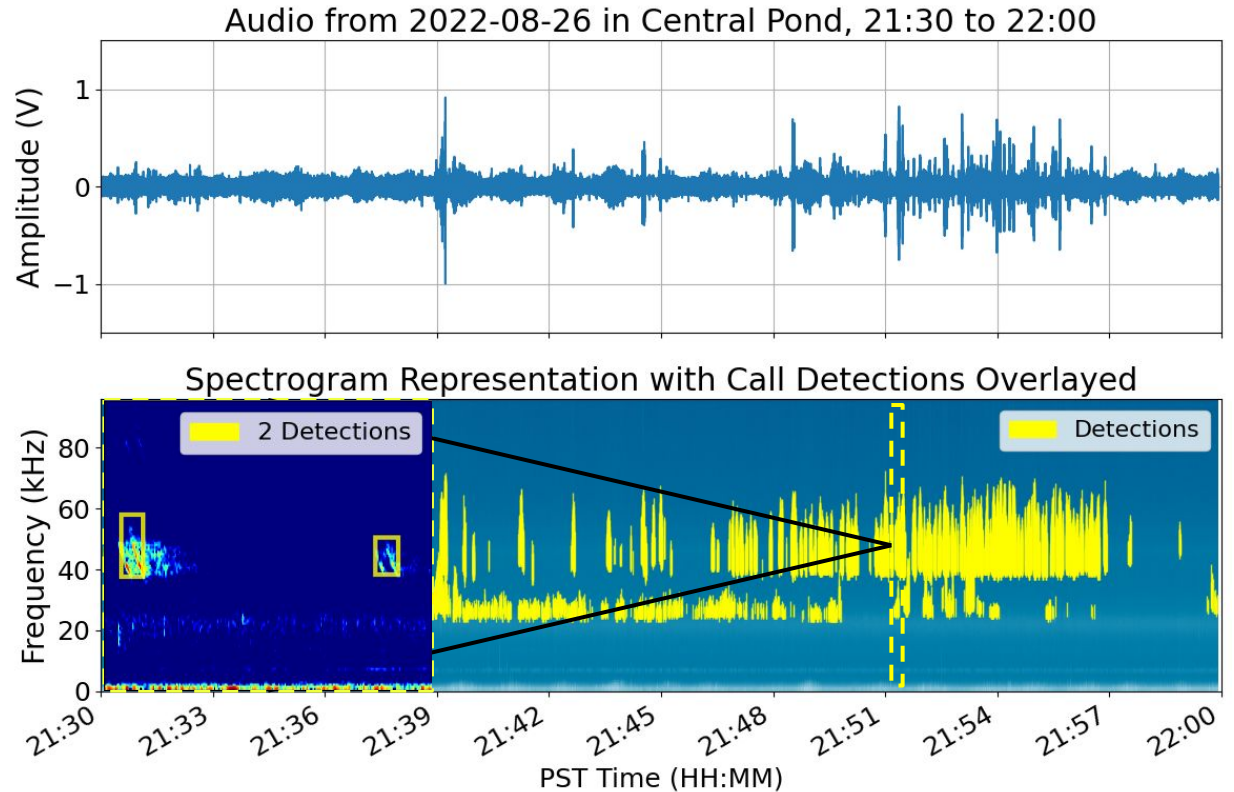
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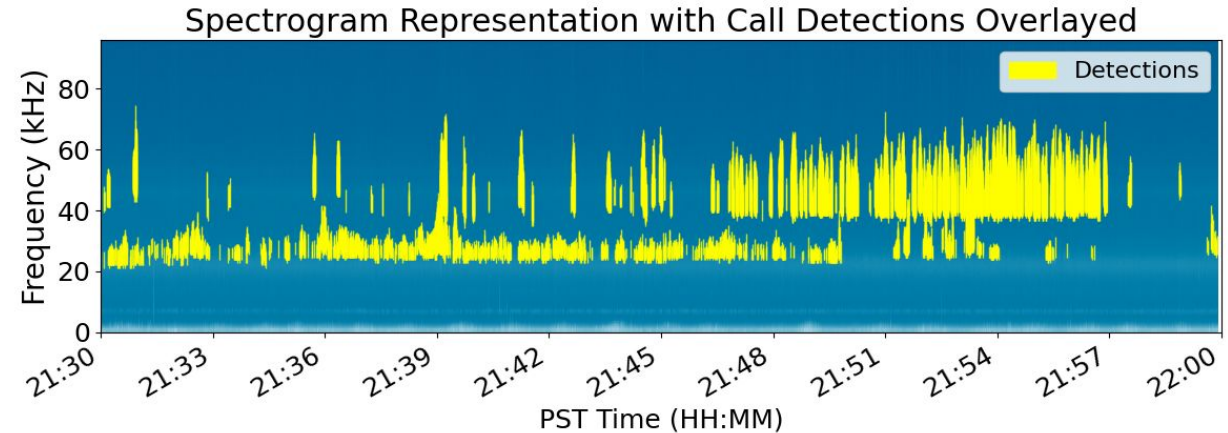
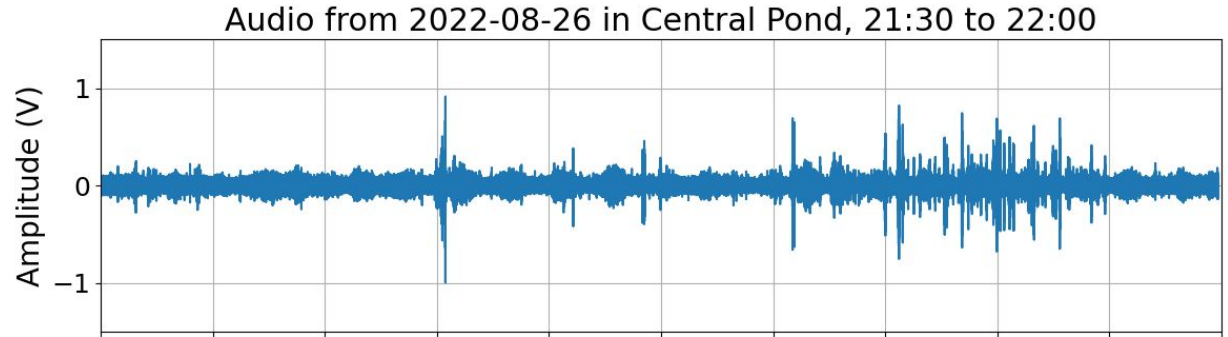
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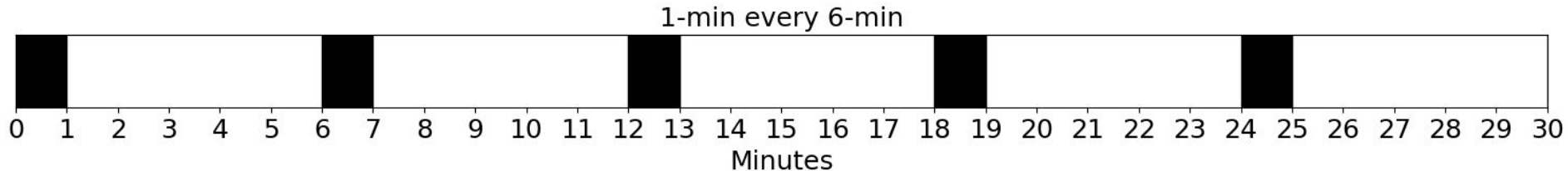
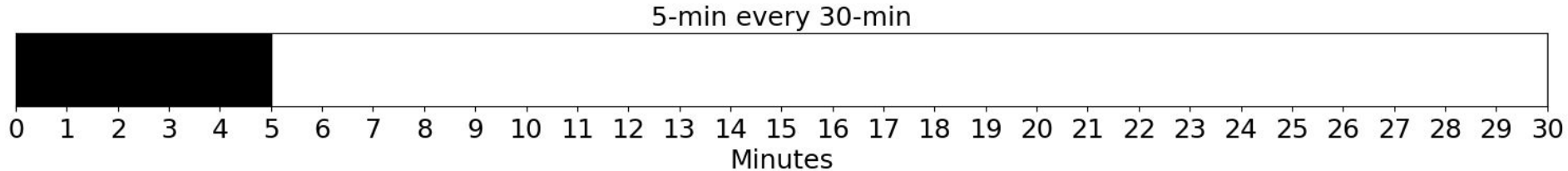
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2 subsampling schemes were applied on collected recordings

- Cycle Length: 30-min, Duty Cycle: 16.7%
 - ON for $30 \times 0.167 = 5$ -min every 30-min
- Cycle Length: 6-min, 16.7%
 - ON for $6 \times 0.167 = 1$ -min every 6-min

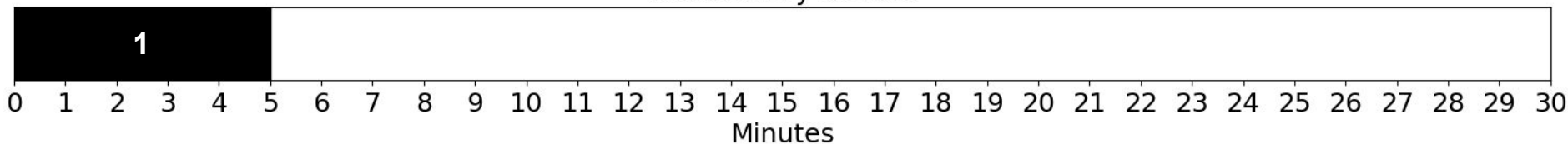


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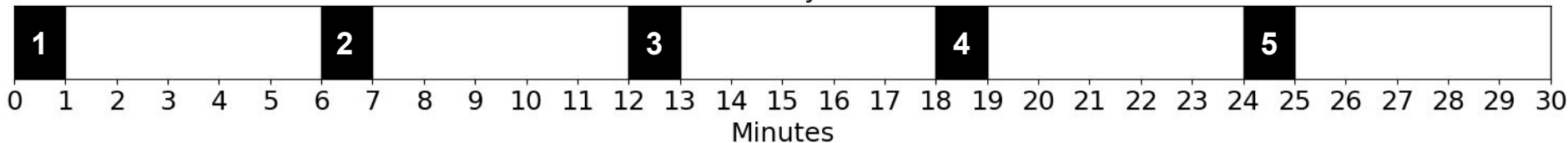
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Schemes have fixed sampling effort in observed time: 20:00 to 6:30 PST

5-min every 30-min



1-min every 6-min



Results & Discussion

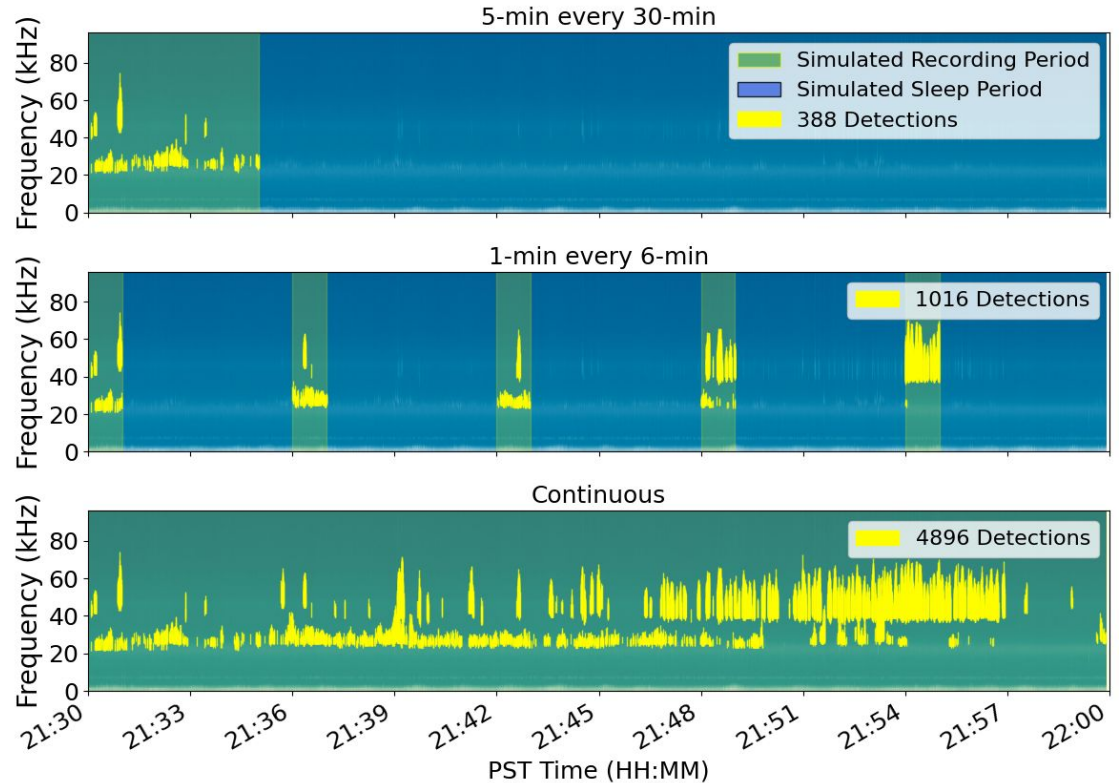
- 1) Recorded bat call features
- 2) Subsampling effects

Collected recordings had multiple bat species

Data consisted of:

- Low-Frequency Bat Calls (~20-45 kHz)
- High-Frequency Bat Calls (~35-75 kHz)

2022-08-26 from 21:30 to 22:00 PST

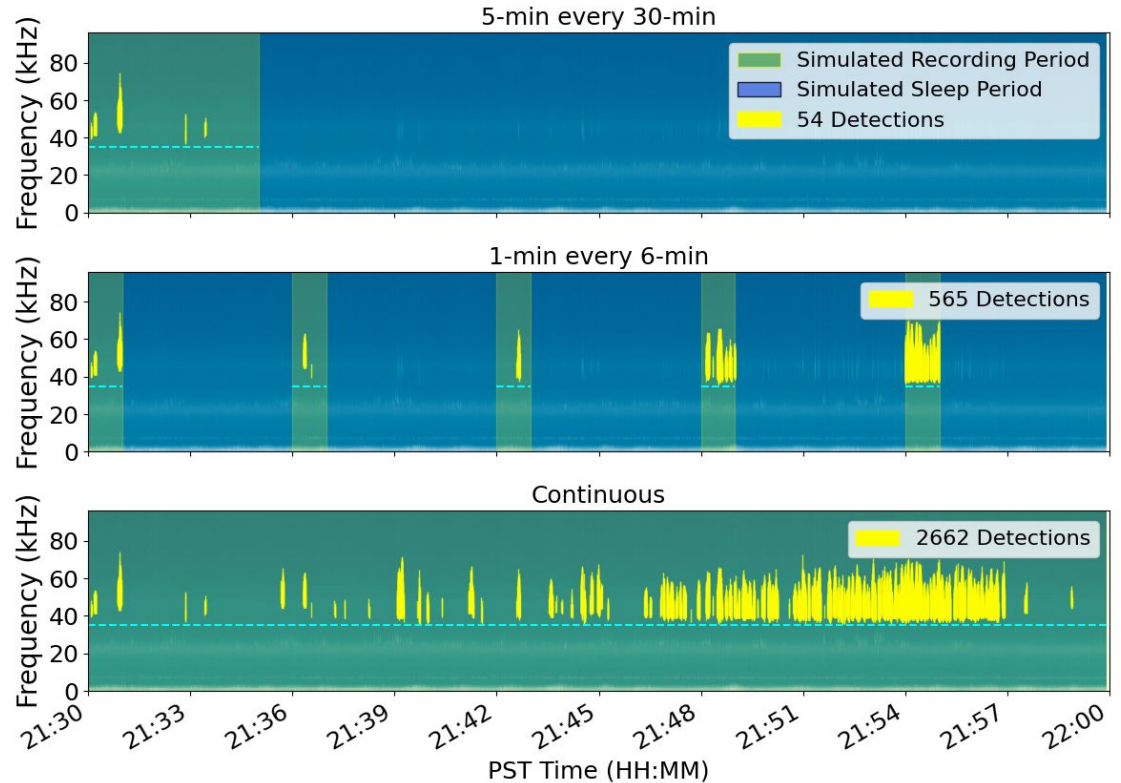


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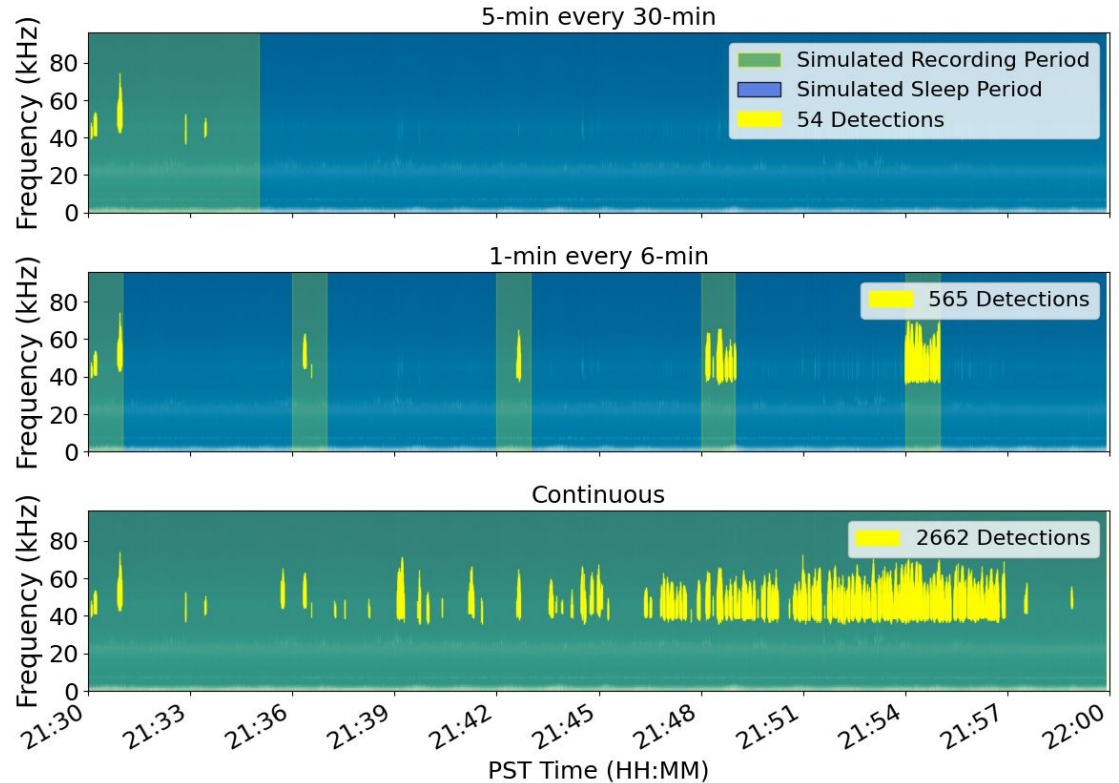
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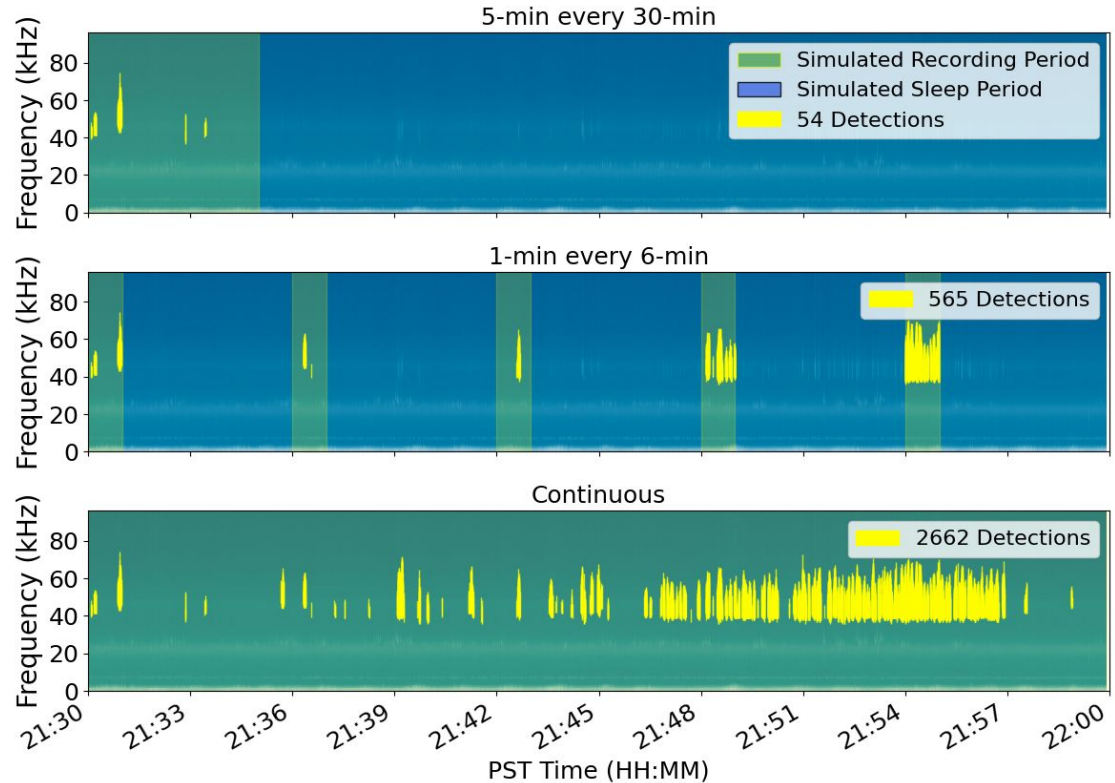
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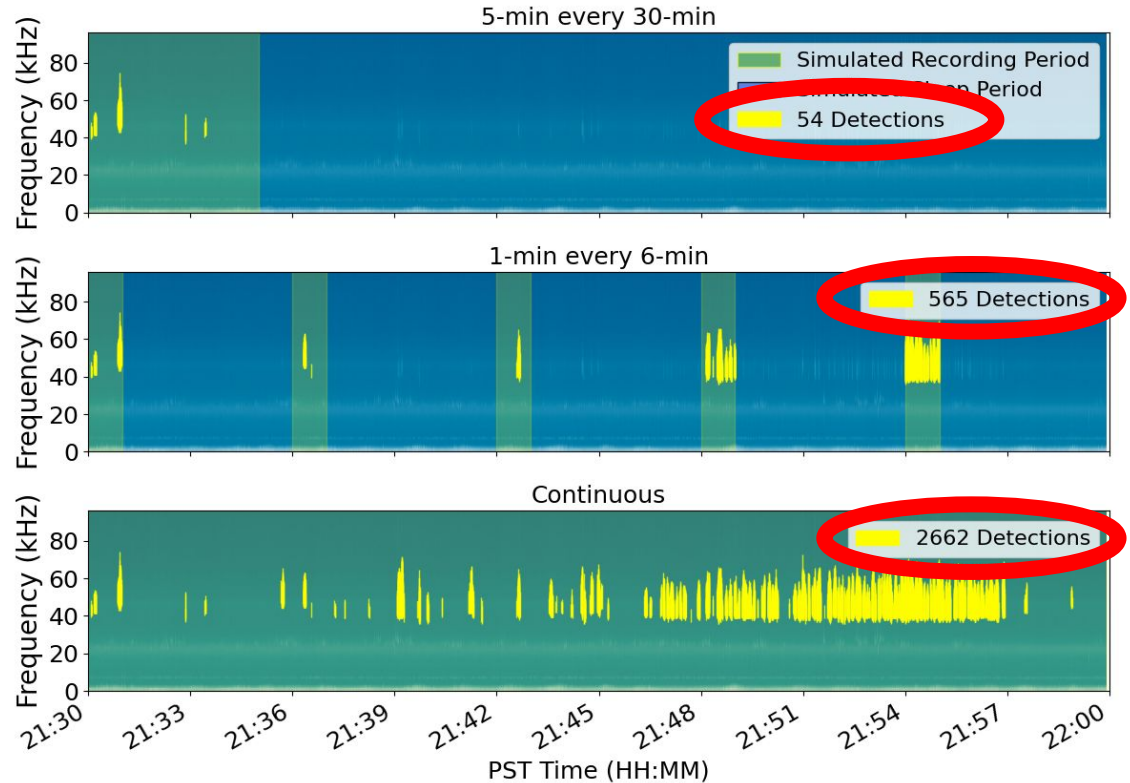
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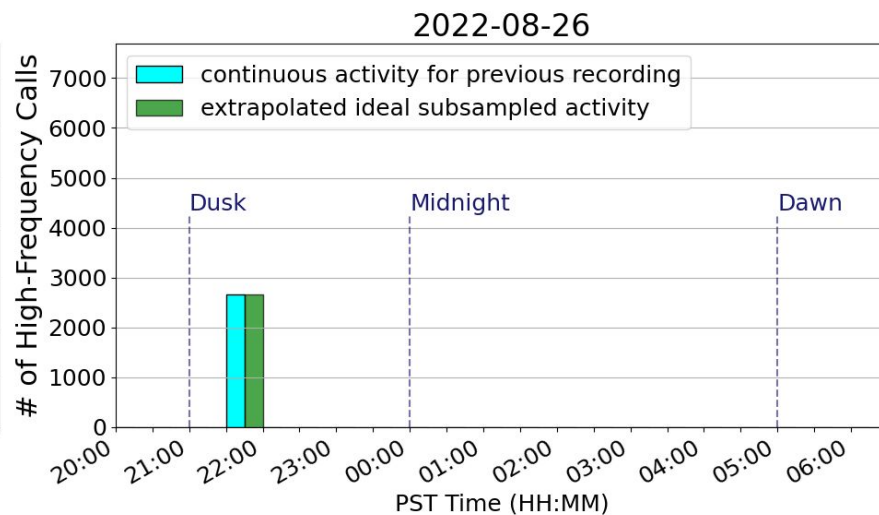
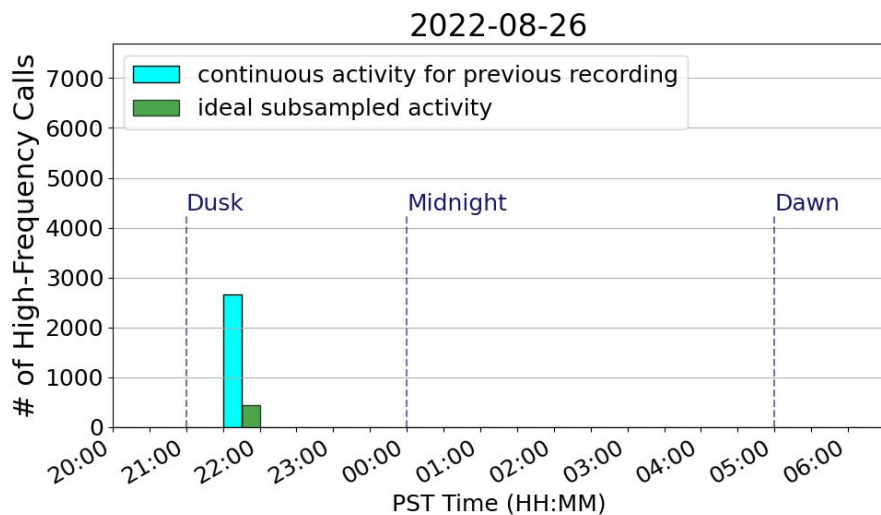
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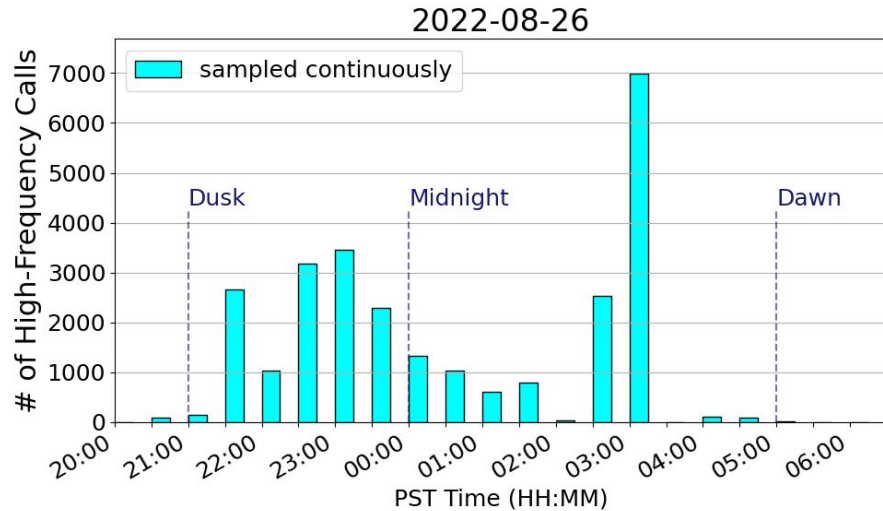


Number of calls will always be underestimated by subsampling

- Question: **How representative is our sample of the recorded calling activity?**
 - In other words, given features from 5-min samples, could a simple 6× extrapolation recover the features from 30-min of calling activity?

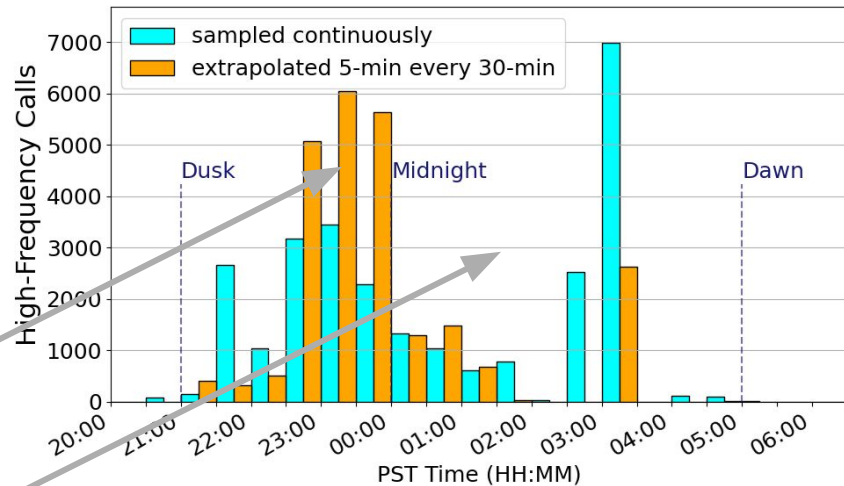
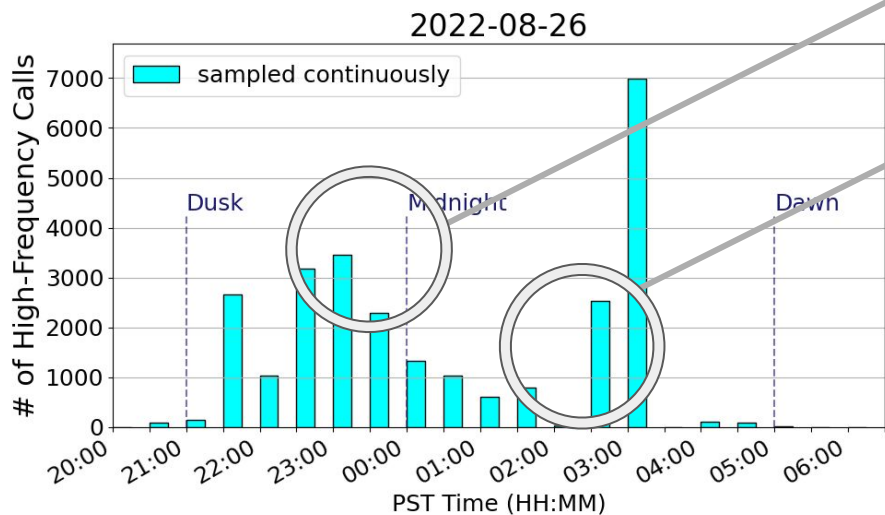


Bat activity over the Summer was generally overestimated by subsampling



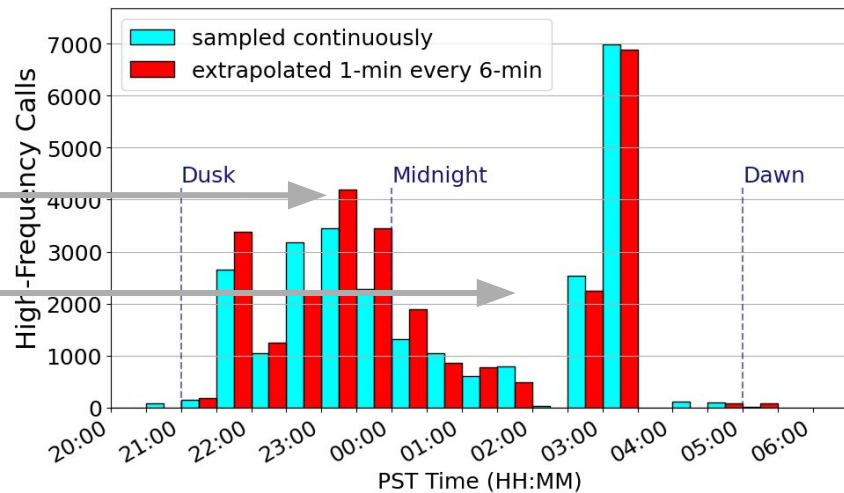
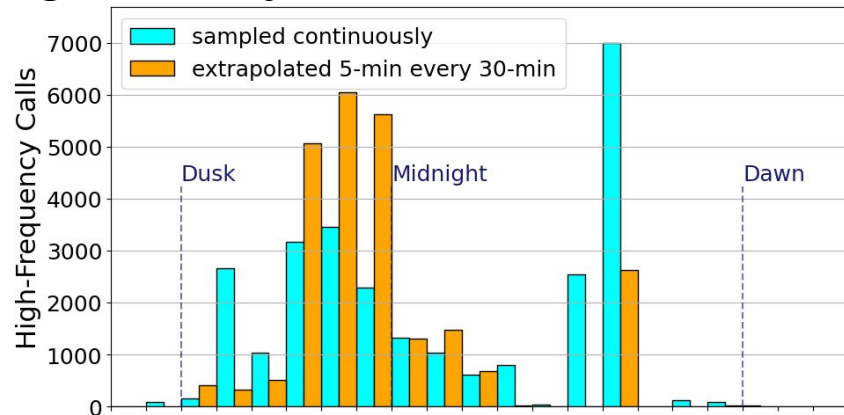
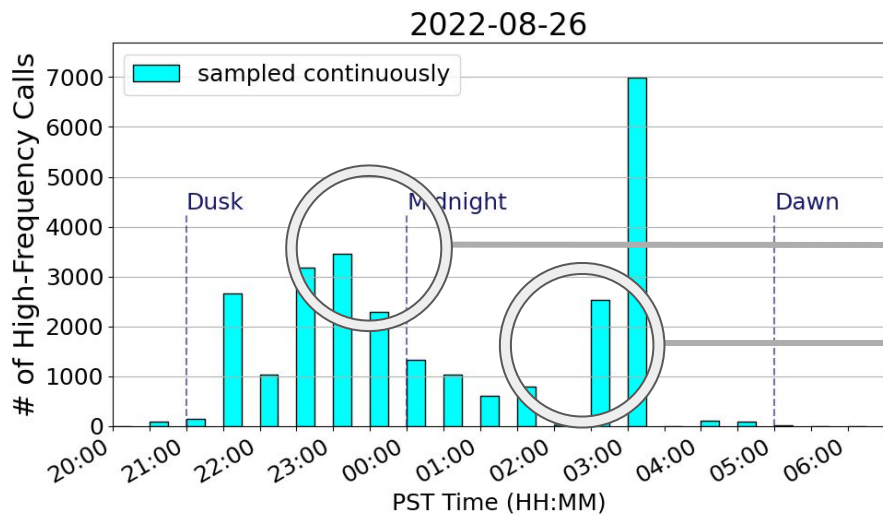
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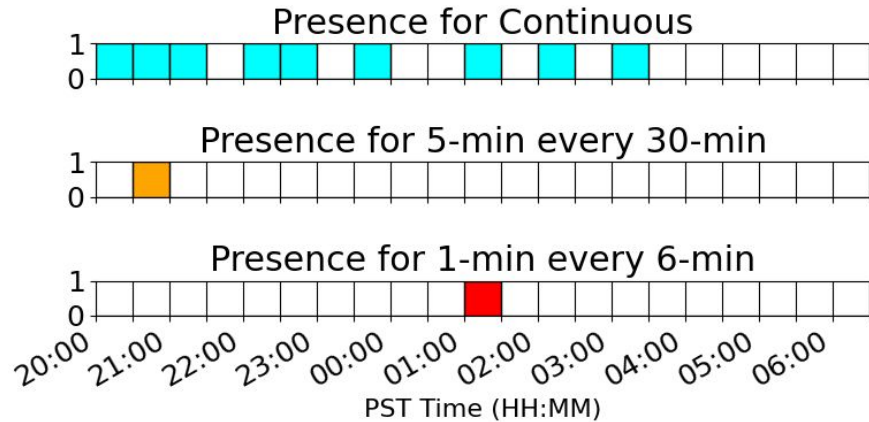
- **5-min every 30-min** results drastically overestimated and missed activity
- **1-min every 6-min** results slightly overestimated and captured activity



Bat presence over the Fall was underestimated by subsampling

For Oct-17:

- Bat presence was detected in continuous data for 9 separate instances
- Each scheme detected only 1 instance

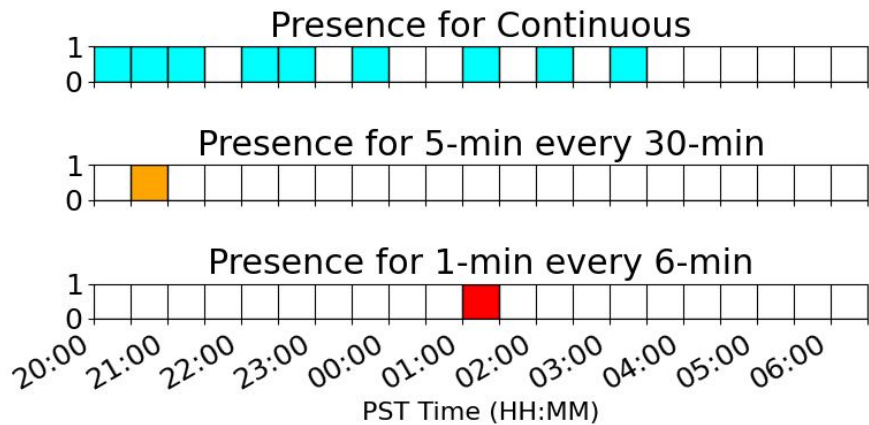


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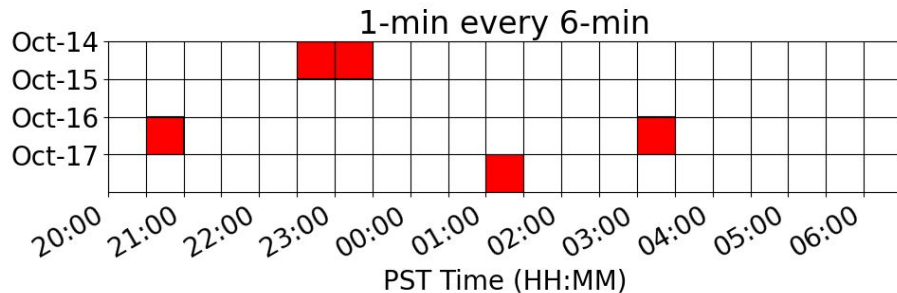
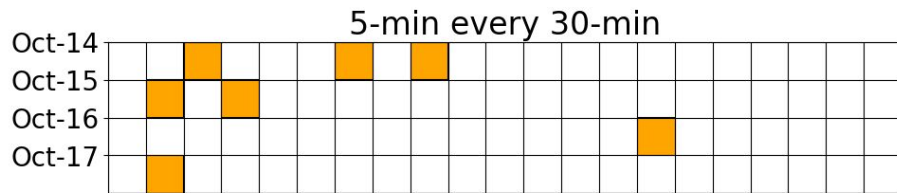
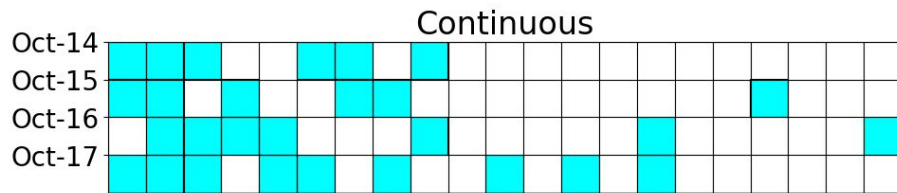
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High-Frequency Bat Presence Comparisons



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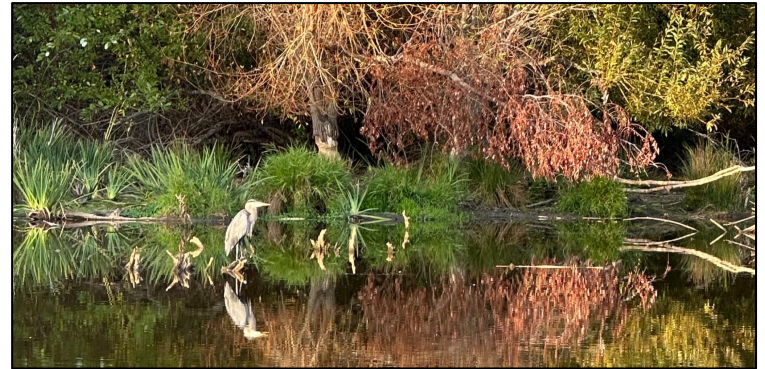
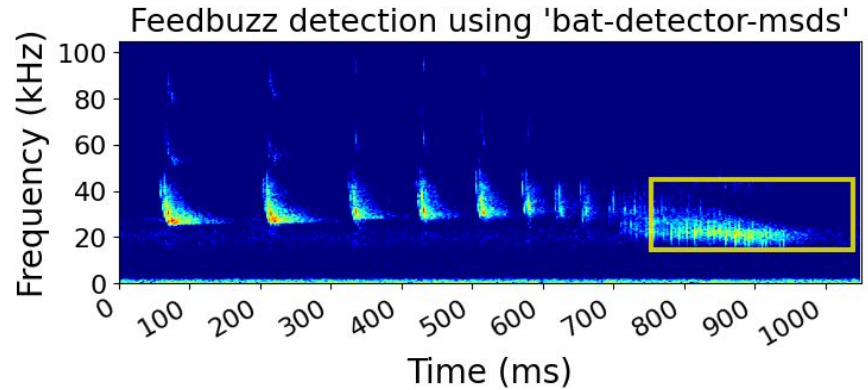
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- 3) PAM still requires subsampling so further investigation is required to identify schemes to capture desired activity features.

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- 3) PAM still requires subsampling so further investigation is required to identify schemes to capture desired activity features.
- 4) Fortunately, the UBNA bat population remains feeding and healthy so we can continue to noninvasively study these effects!

Future steps

- Simulating more schemes and looking at seasonal variations!
- Developing tools for detecting specific bat acoustic behaviors:
 - Feeding buzzes
- Continuing our PAM program at the Union Bay Natural Area this Summer!



Resident Great Blue Heron at the UBNA

Acknowledgements

Contributors:



Wu-Jung
Lee



Josie
Sachen



YeonJoon
Cheong



Authors of 'bat-detector-msds':

- Corbin Charpentier
- Kirsteen Ng
- Ernesto Cediell

References:



Echospace @ UW

uw-echospace.github.io



Applied Physics Laboratory
UNIVERSITY of WASHINGTON

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