

EcoAcoustic AI: Cloud-native Automated Pipeline for EcoAcoustic Monitoring

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Advanced AI-powered monitoring of Union Bay's diverse ecological sites: bats, birds, frogs, and more!

Background

The Union Bay Natural Area (UBNA) is an ecologically significant urban wildlife habitat in Seattle that has a rich and complex soundscape comprising sounds from birds, bats, and other species, as well as anthropogenic sounds from highways, waterways, traffic, and recreational activity. Passive acoustic monitoring (PAM) allows researchers to track biodiversity in such environments, providing insights into animal behaviors and ecological shifts. The EcoAcoustic AI project aims to leverage PAM data collected since 2021, including ~ 68.25 TB of high-resolution audio, to develop an automated, scalable detection pipeline. This initiative builds on previous research efforts to enhance the capability for continuous, efficient monitoring, supporting data-driven soundscape research and community science in urban ecological areas.

SIGNAL PROCESSING

Example frequency range of animals

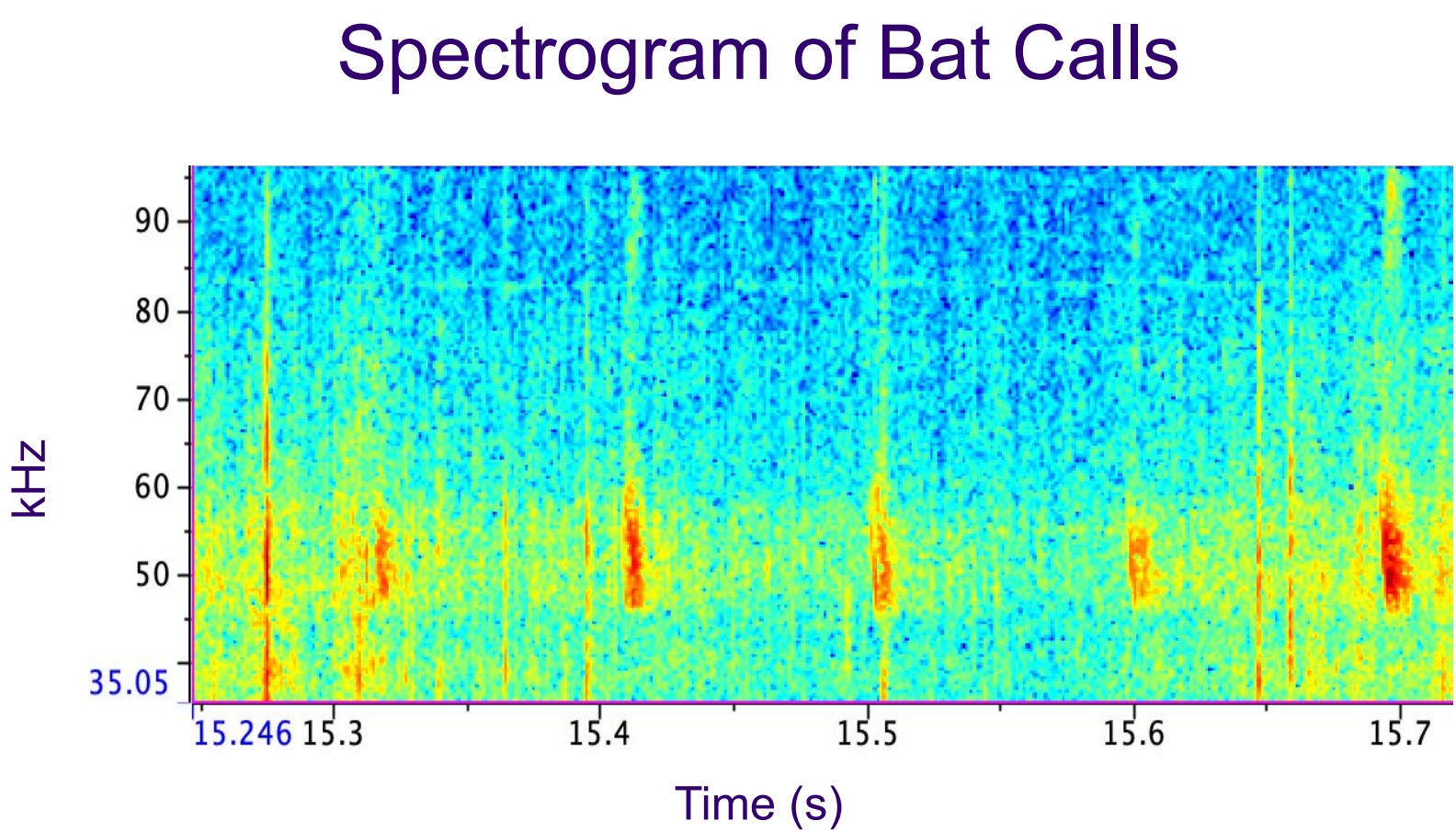
BATS
Big Brown Bats (20–40 kHz)
Little Brown Bats (35–80 kHz)

BIRDS
Northern Flickers (1–2 kHz)
American Robins (2–5 kHz)

FROGS
American Bullfrogs (100–400 Hz)
Pacific Tree Frogs (3–5 kHz)

Audio Preprocessing

- Resampling: Adjusts the captured audio to match the target analysis sampling rate.
- Segmenting: Audio segmented for analysis.



Example bat echolocation calls used to detect prey.

Models Integrated



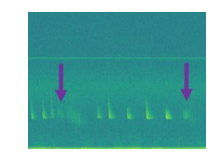
BirdNET-Analyzer: Uses ResNet to identify 6,000+ species including: birds, frogs, bugs... [1]



Batty-BirdNET-Analyzer: Utilizes transfer learning via BirdNET, resampling input audio to 256 kHz to classify bat echolocation calls. [2]



BatDetect2: Applies a deep neural network to detect and classify bat echolocation calls [3]



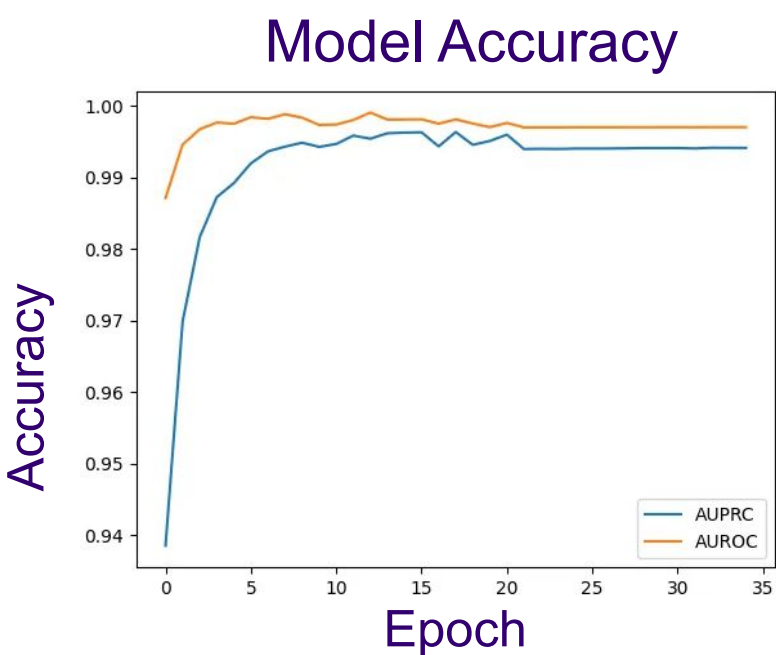
Buzzfindr: Identifies rapid sequences in bat echolocation indicative of feeding behavior. [4]



Custom FrogNET: Adapts BirdNET-Analyzer to detect and classify frog vocalizations. [1]

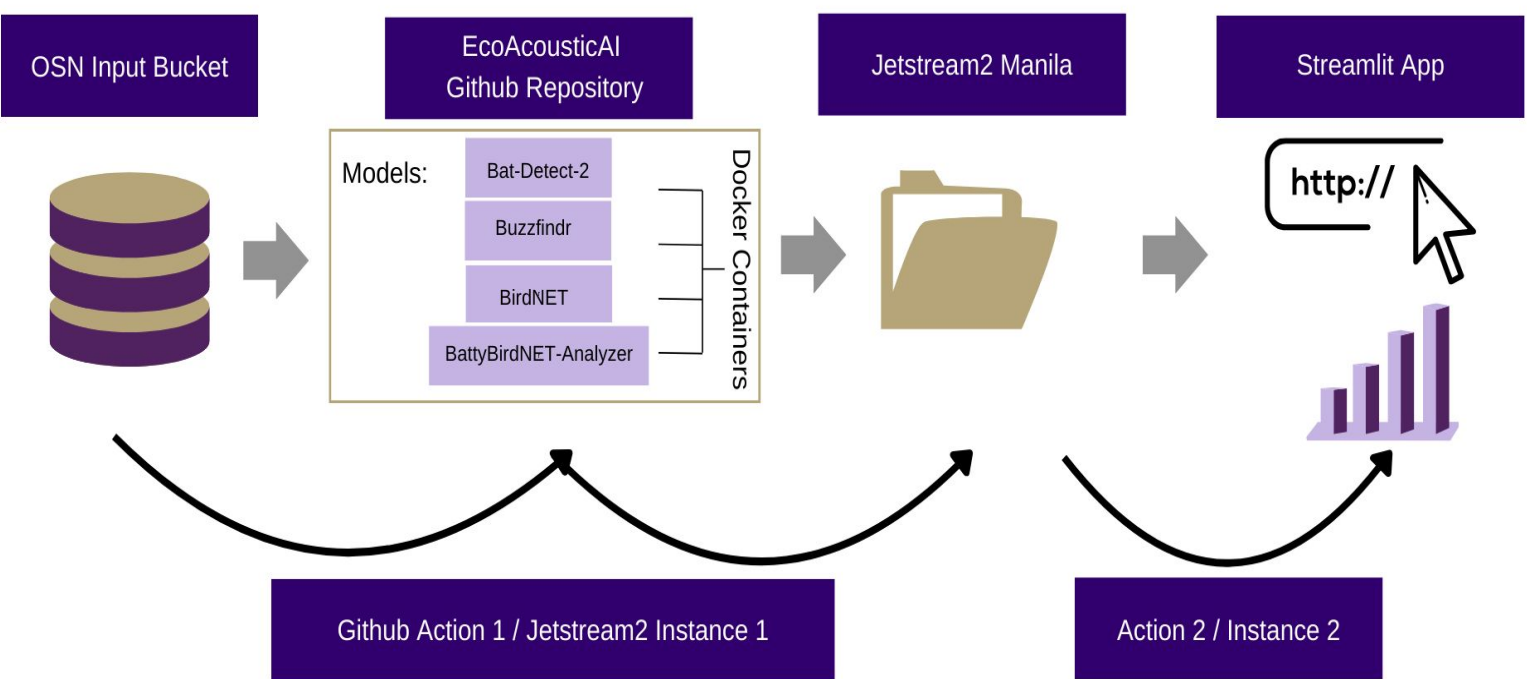
Training FrogNET:

Trials: 30
Execution per Trial: 1
Bandpass Frequency: 300-15000
Audio Speed Modification: 1
Crop Mode: center



Cloud-native Pipeline

1. Link OSN data bucket to GitHub workflow
2. Trigger pipeline by activating Jetstream instance
3. Run model inference in Docker containers across four integrated models with one workflow handling scheduled and conditional start/stop of the instance.
4. Mount model output directory to Manila storage on the Jetstream instance
5. Streamlit instance (with mounted Manila) runs app



User-facing Web Portal

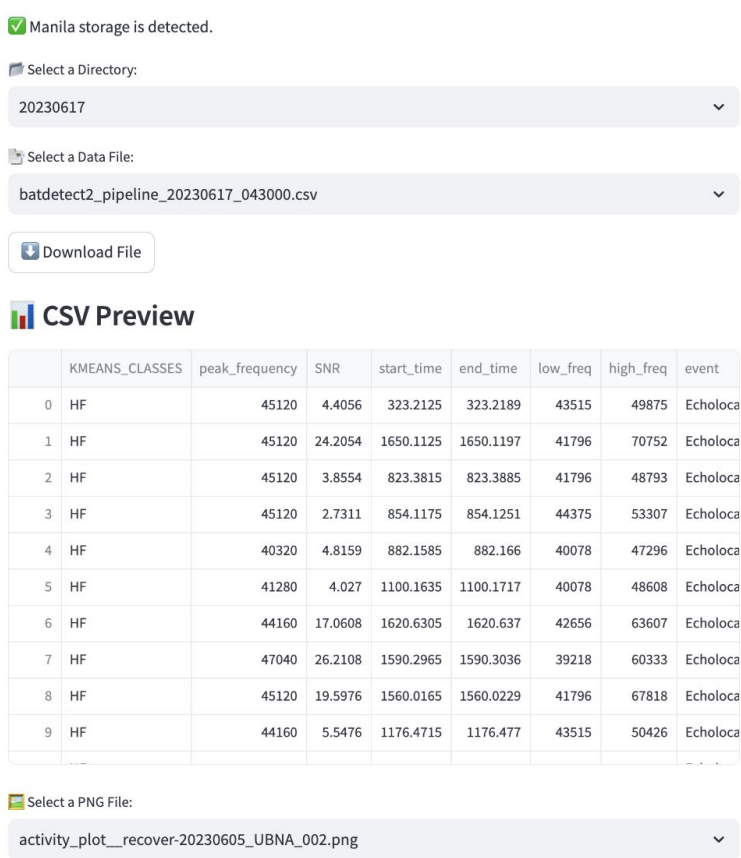
1. Automated Wildlife Monitoring

The web portal enables continuous, automated detection of vocalizations from bats, birds, frogs, and other species; providing researchers with insights into biodiversity trends. By leveraging passive acoustic monitoring, it eliminates the need for manual species identification, making large-scale PAM studies more efficient and accurate.

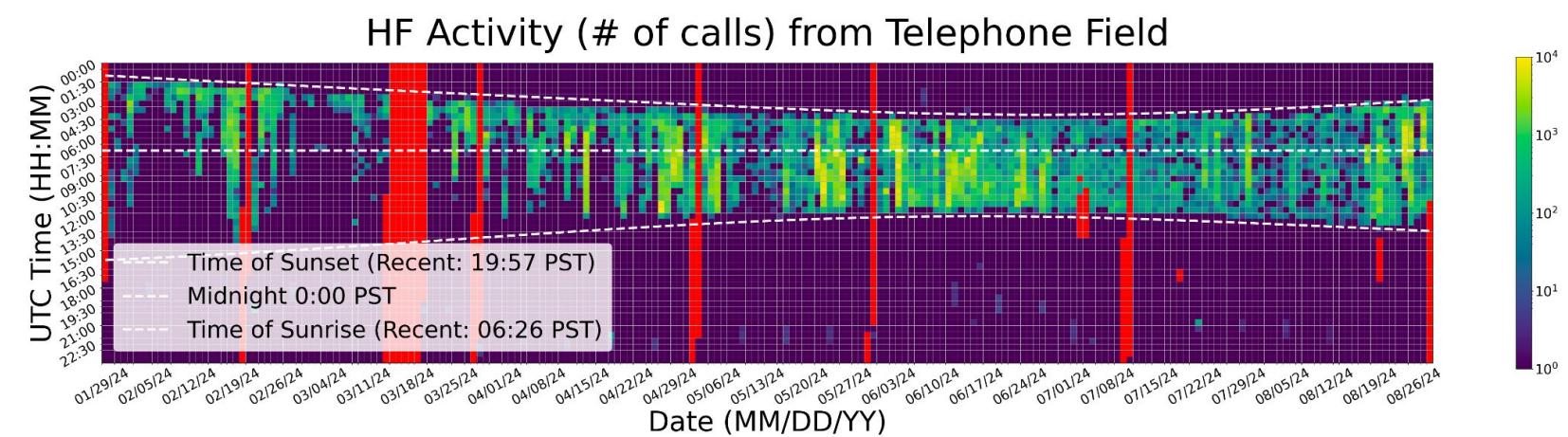
2. Ecological Research & Conservation

Designed for conservationists and researchers, the platform processes long-term PAM data to track species presence and to analyze model detection outputs. Interactive summary tables, downloadable files, and plots allow users to explore model results in a one stop shop application.

Manila Storage Browser



- The **Manila Storage Browser** provides access to output tables and visuals in addition to download of output files from each model.
- The **UBNA Activity Chart** offers an intuitive time of day visualization of bat acoustic activity across 5 to 7 sites. [5]



Future Work

Further developments include enhancing model adaptability, pipeline scalability, and geolocation of calls in UBNA. We are working on adapting the Batty-BirdNET-Analyzer model to output species identification formats comparable to BatDetect2. Other visual display options could include higher complexity dashboards such as Bokeh or Tableau.

Acknowledgements

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[1] Kahl, S., et al. *BirdNET-Analyzer*. GitHub. <https://github.com/kahst/BirdNET-Analyzer>.
[2] Zinke, R., et al. *Batty-BirdNET-Analyzer*. GitHub. <https://github.com/rdz-oss/BattyBirdNET-Analyzer>.
[3] Mac Aodha, O., et al. *BatDetect2*. GitHub. <https://github.com/macodha/batdetect2>.
[4] Jameson, J. (n.d.). *Buzzfindr*. GitHub. <https://github.com/joelwjameson/buzzfindr>.
[5] Code Author: Aditya Krishna, UW Echospace