

Spatio-Temporal Patterns of Bird Communities Using Regional Passive Acoustic Monitoring



Pooja Panwar¹, Aaron S. Weed², Matthew P. Ayres¹, David A. Lutz³, Hannah ter Hofstede⁴, and Laurel B. Symes⁵



¹Department of Biology, Dartmouth College, USA ²U.S. Department of the Interior, National Park Service, Northeast Temperate Network, USA

³School of Arts & Sciences, Colby-Sawyer College, USA, ⁴Department of Integrative Biology, University of Windsor, Canada

Email: Pooja.Panwar.GR@dartmouth.edu

⁵K. Lisa Yang Center for Conservation Bioacoustics, Cornell Lab of Ornithology, Cornell University, USA

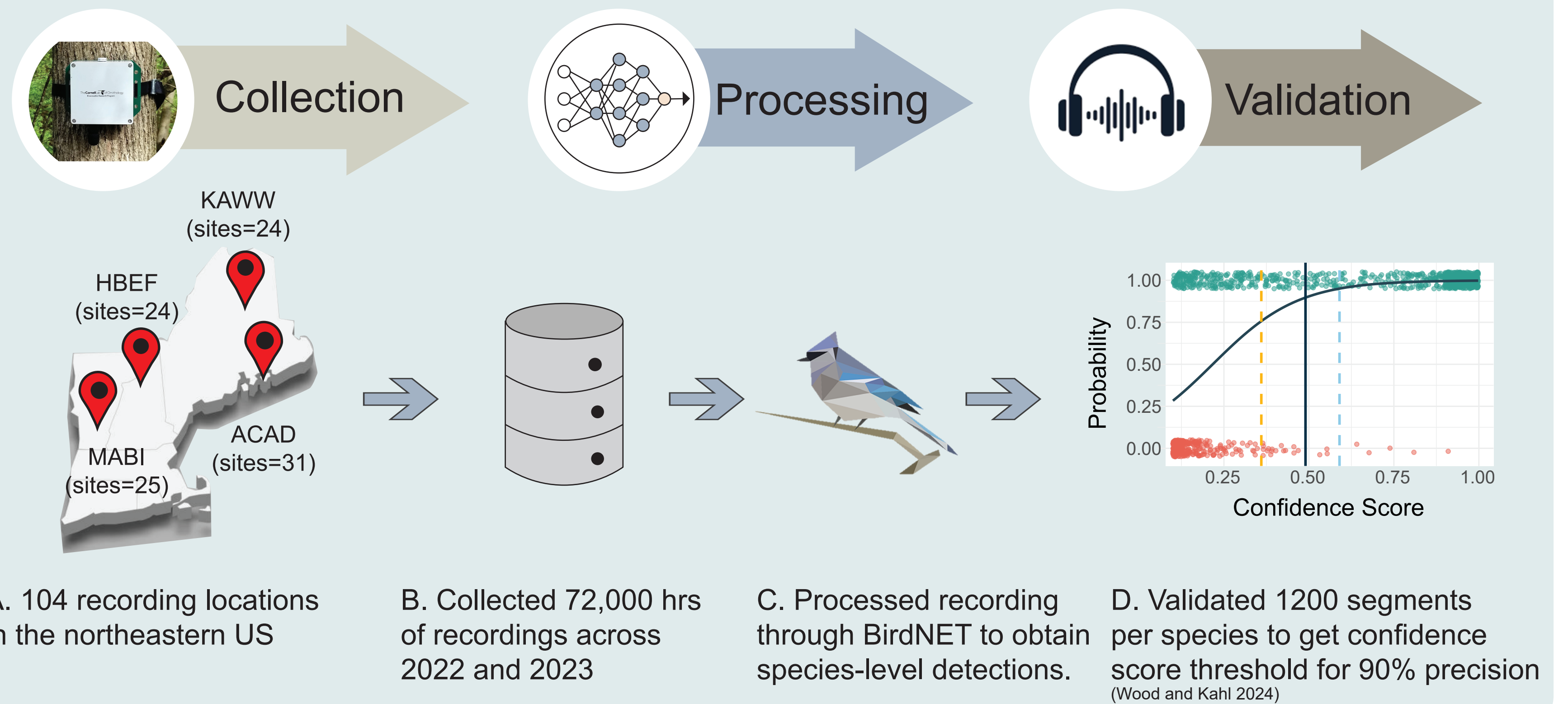
Introduction

- Passive Acoustic Monitoring (PAM) has emerged as a scalable solution for long-term Biodiversity Monitoring Program (Gibb et al. 2018, Sugai et al. 2019).
- Deep learning classifiers enable efficient processing of large acoustic datasets (Kahl et al. 2021).
- Evaluating the performance of these methods is critical for data-driven decision making.

Questions

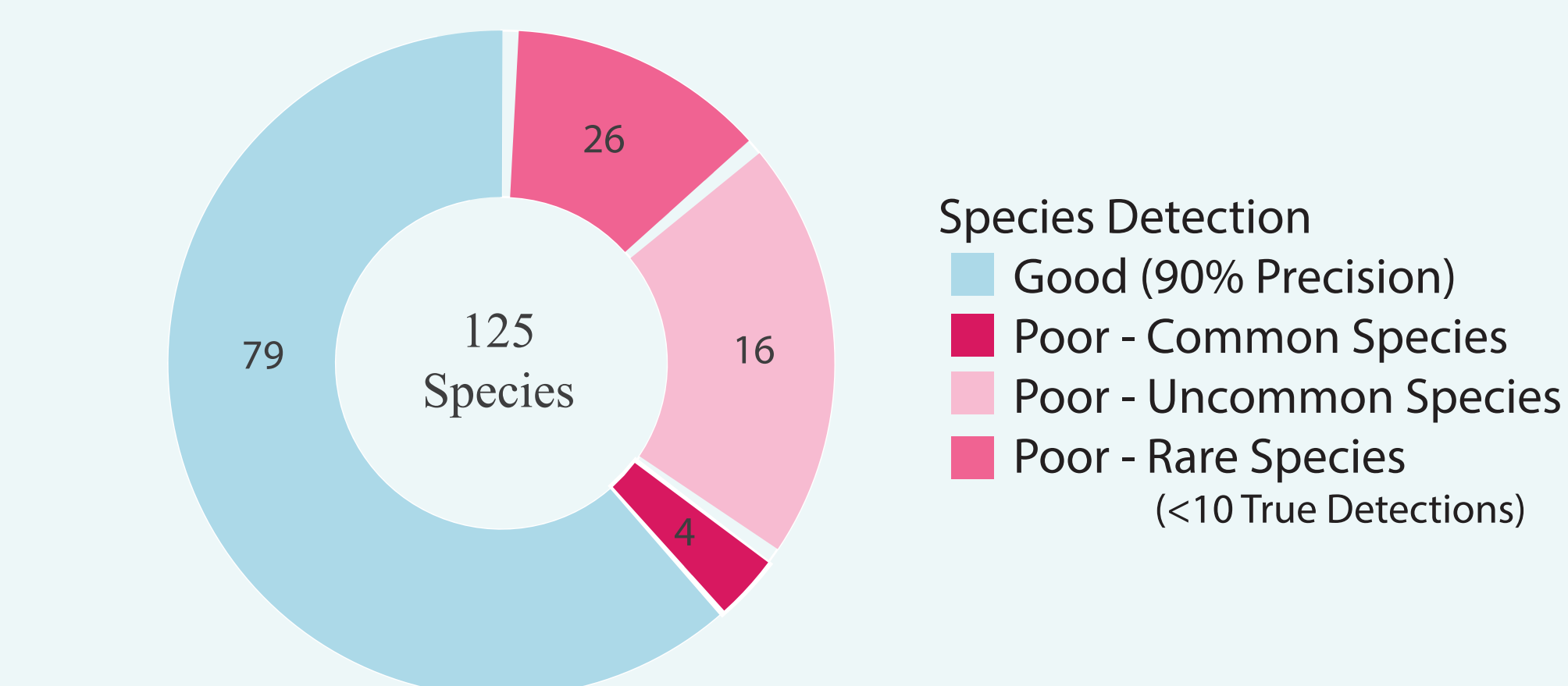
- How well does birdNET perform to detect species at a regional spatial scale?
- How robust are precision-based thresholds across different spatial extents and validation methods?
- Can we detect spatial and temporal occupancy patterns of birds using this approach?

Methods



Results

How many species detected with high precision?



How many segments should you validate?

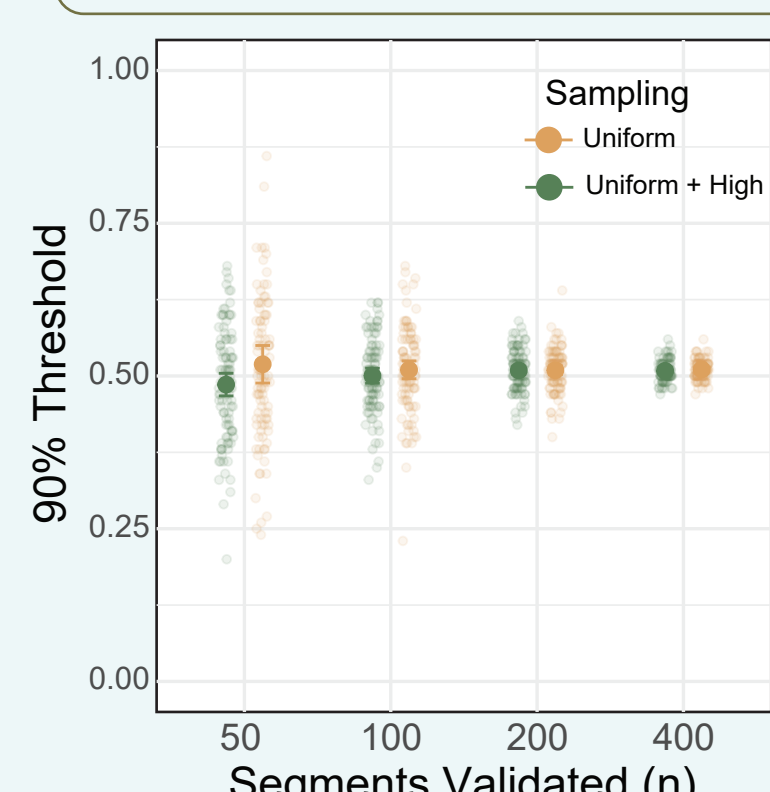
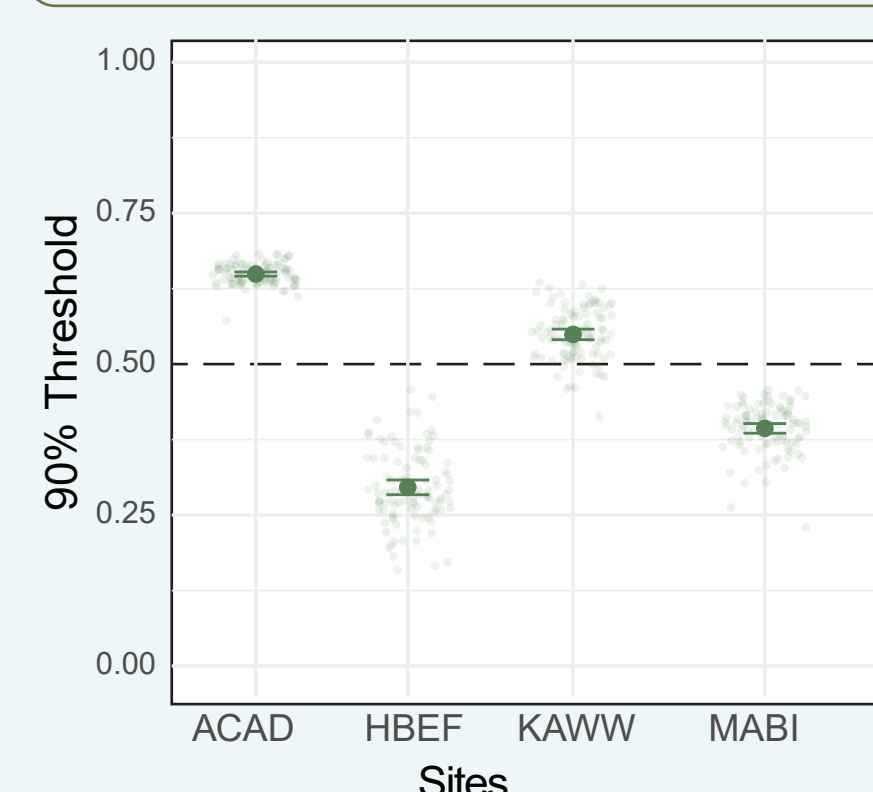


Figure. Left panel represents variation in confidence score threshold for 90% precision for Black-throated Blue Warbler for different number of segments validated when segments are drawn uniformly across confidence score range (0 - 1; yellow) and drawn uniformly with 20% extra segments in high confidence interval (0.8-1; green). Right panel shows variation in confidence score threshold for 90% precision across four sites.

Are BirdNET threshold same across space?



79 species detected with 90% precision.

High resolution data on space use & phenology

Spatial Occupancy Across Season

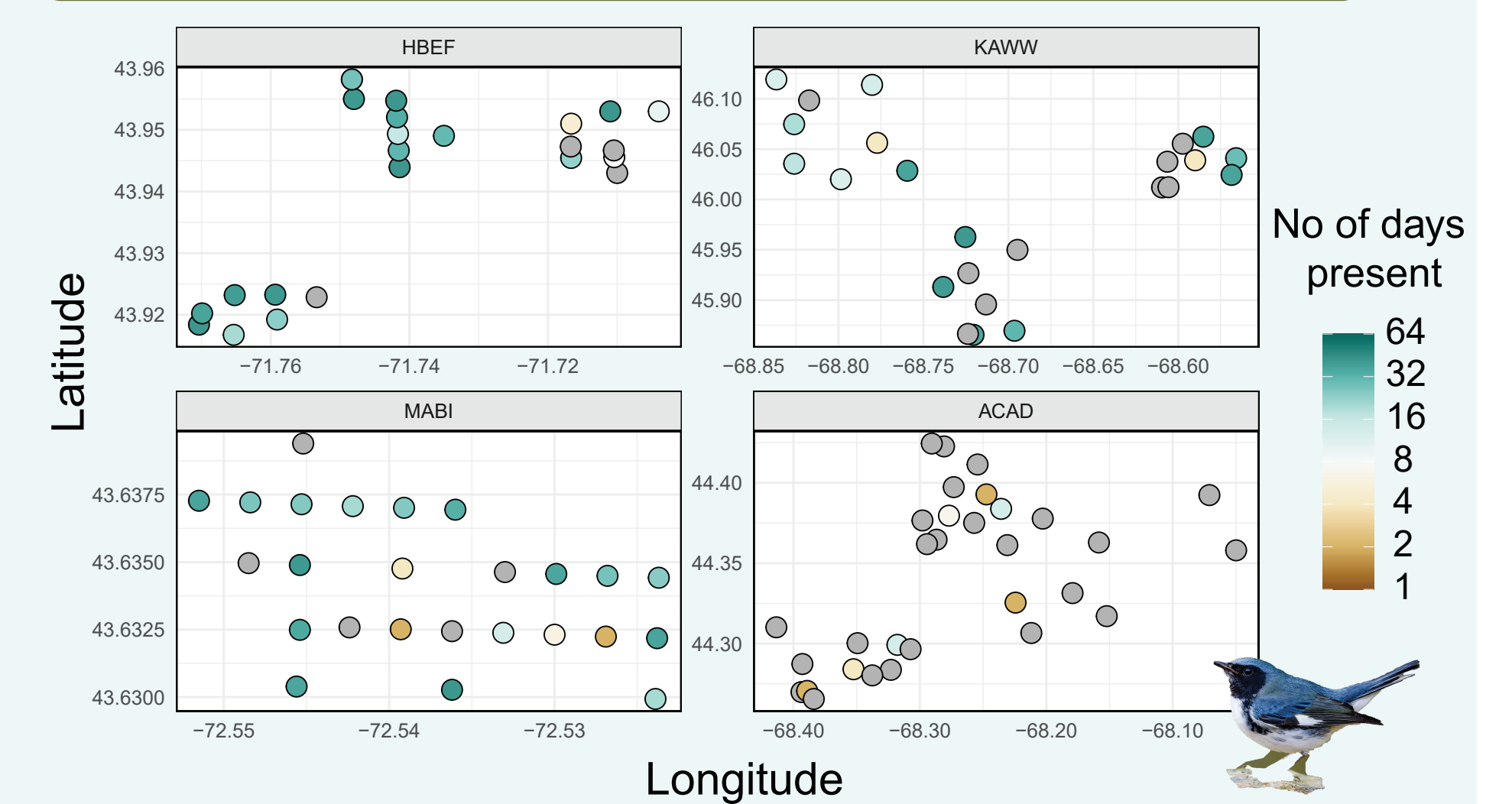
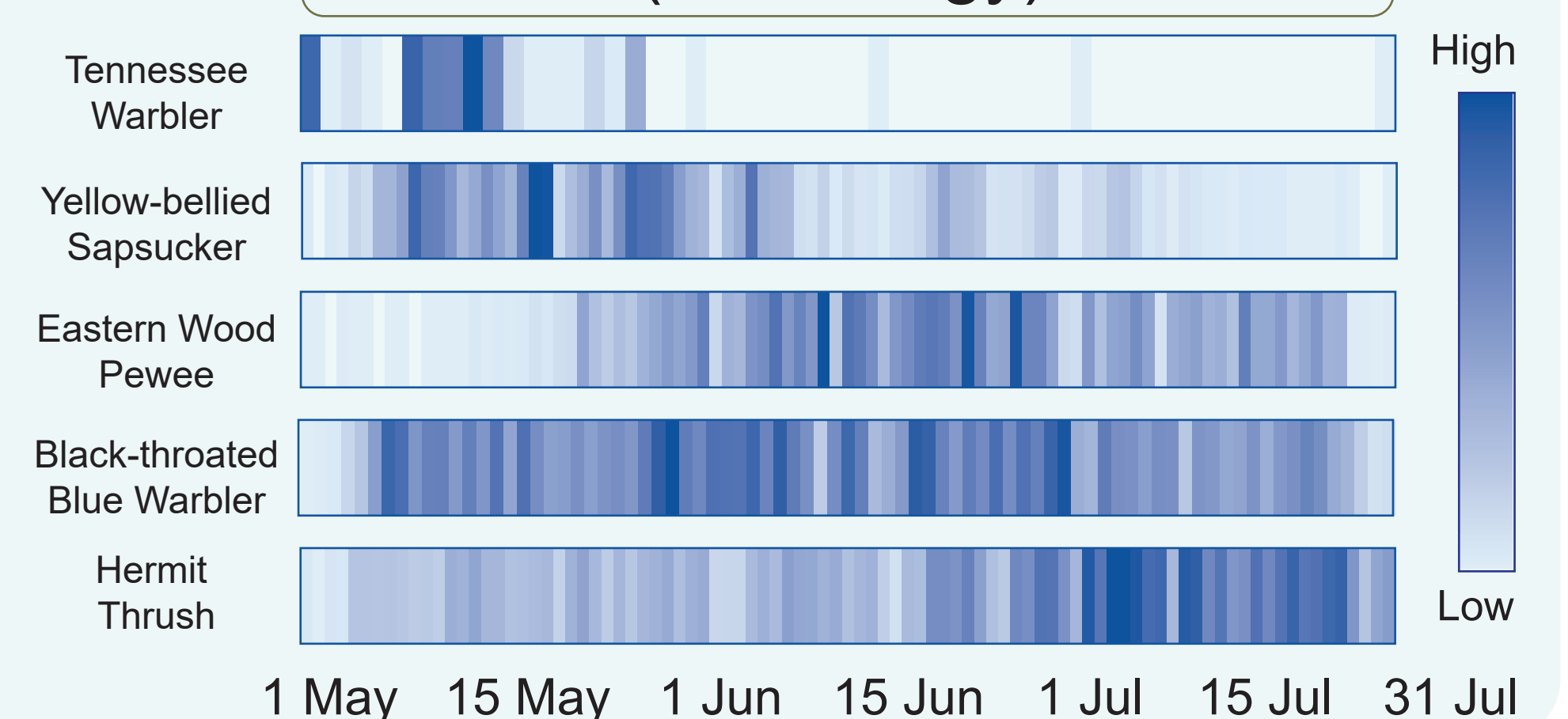


Figure. Number of days Black-throated Blue Warbler was observed at each recording location (circles). Grey circles represent unoccupied site.

Vocal Activity across Season (Phenology)



Discussion

Confidence score thresholds for 90% precision vary across species. Using a blanket threshold may overestimate presence of many species.

Some species are poorly detected due to similar-sounding species or background noise (e.g., wind). Improving model accuracy with **strongly annotated training data** would be beneficial.

Validating at least **200 segments per species** and including some high-confidence detections helps reduce uncertainty in threshold estimation.

The 90% precision threshold vary spatially. In areas where a species is relatively uncommon, false positives can inflate presence estimates. Adding conditions such as high precision detections on at least two separate days can make occupancy data more robust.

Conclusions

Deep Learning Classifier (BirdNET) can detect most species with high precision within the eastern temperate forest bird community in North America.

However, careful filtering of true detections from false detections is critical to maintain integrity of longterm monitoring data.

Passive Acoustic Monitoring offers high-resolution spatial and temporal data on presence of soniferous species, to assess changing species distribution, vocal activity behavior, and phenology.

References

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