Listening to mangroves: Using Autonomous Recording Units and Machine Learning tools to assess avian biodiversity in the mangroves of coastal Suriname

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Introduction.

This exploratory study investigates avian biodiversity in the mangroves and mudflats of coastal Suriname, as part of an interdisciplinary project on flood risk management and coastline mapping. These are critical ecosystems, providing coastal protection, habitats and farmland.

Above: Black Mangroves, with characteristic pneumatophore roots rising from the water. Below: Red mangroves

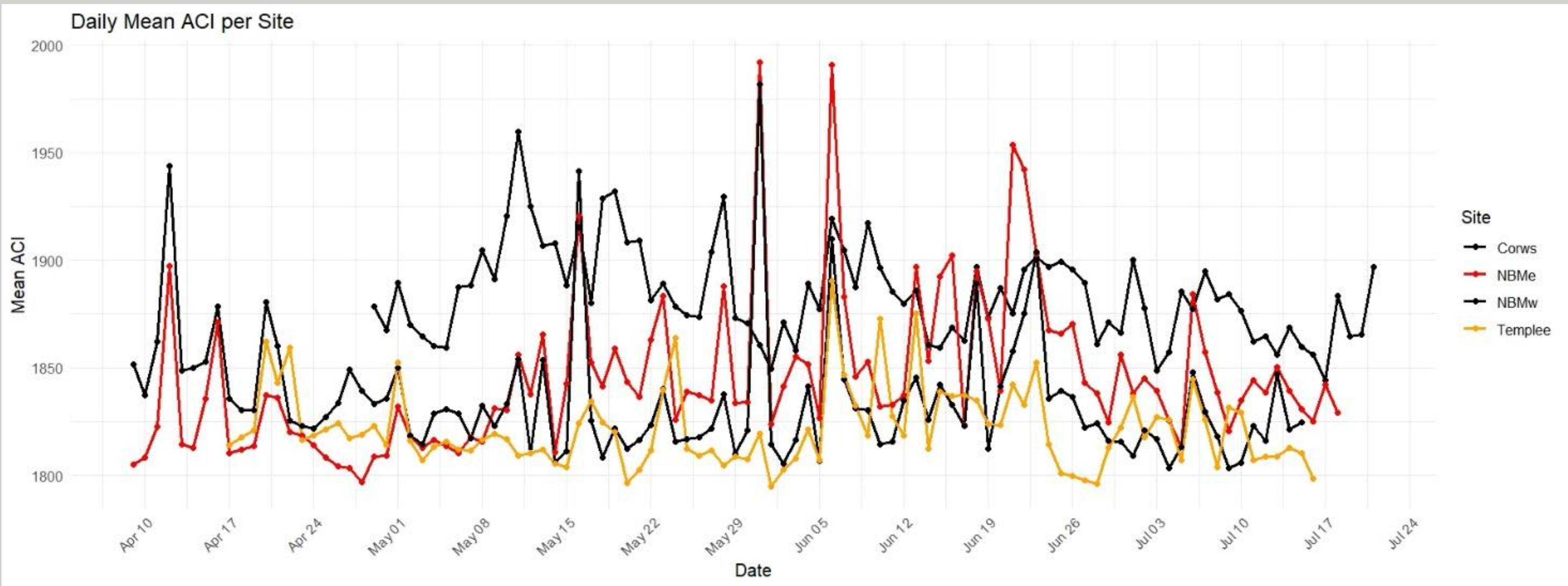
Data Collection

Automated Recording Units (ARUs) were deployed between December 2024–February 2025 and April–July 2025 across six focal sites in two areas, Weg Naar Zee and Totness (see below), representing the three species of mangroves found in the area: Avicennia germinans (Black), Laguncularia racemosa (White), and Rhizophora mangle (Red).

The two sites where ARU recorders were deployed, highlighted in red boxes.

Acoustic Indices

Acoustic Indices are numerical summaries of the amplitude and variation of ecosystem, and act as biodiversity and habitat quality indicators. The Acoustic Complexity Index (ACI) was used to assess correlations between mangrove composition and bird species richness.



The graph below shows the daily mean (ACI) in the four summer sites from April to July, colour-coded by the mangrove species present at the site (Black mangroves only – black, mixture of species, including Red mangroves – red, White mangroves only – yellow). High anomalies (animal noise near to the recorders) have been manually removed.

Statistically significant differences were found between each site, but definitive conclusions linking mangrove species to these differences are prevented by the small number of sites.

Classifying species using BirdNET

Passive acoustic monitoring has become a central tool for surveying avian communities, offering the ability to collect larger amounts of data than traditional methods. Recent advances in machine learning have accelerated the development of automated classifiers capable of detecting and identifying bird species from audio data. BirdNET is among the most widely used of these systems, and utilises the online bird audio dataset Xeno-Canto, and the online repository of in-field recordings and logs, eBird.

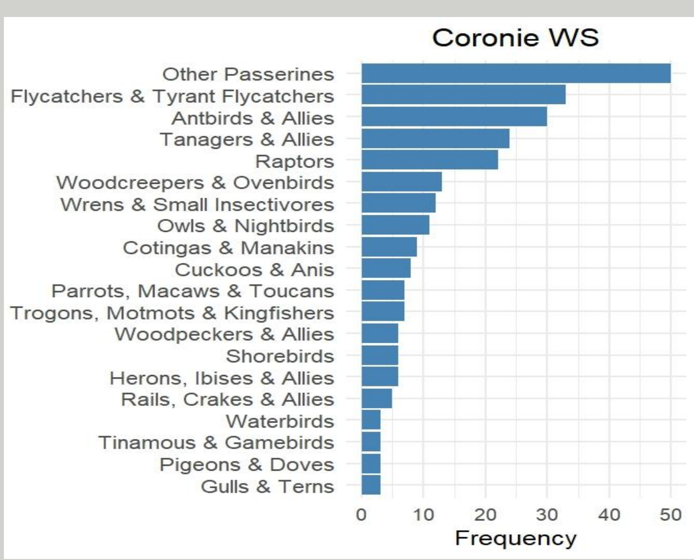
Metrics calculated

- Frequency Indexes (= Frequency/minutes of audio) account for varying amounts of audio data collected.
- Cue densities of Woodpeckers &Piculets provide a pathway to population modelling these important species

I recommend ways to interpret BirdNET confidence scores, providing practical guidance and cautions on the limitations of this methodology.
I extracted all the 3-second clips of audio where species where detected, and grouped them by species to facilitate manual verification

BirdNET Results

Using BirdNET, a total of 508 species were identified across all the sites, with 436 species identified across the 6 summer sites, and 404 across the 8 winter sites. The types of birds most frequently detected were flycatchers and other passerines, with frequent detections of antbirds & allies, tanagers & allies, raptors and owls & nightbirds also.
Right: species found at Coronie Weather station, an example site



Conclusion

Bird vocalisations were classified using the BirdNET algorithm, and Acoustic Indices were calculated to assess correlations between mangrove composition and bird species richness. The results provide new information on the ecology of these mangrove habitats. By integrating non-invasive remote monitoring with machine-learning tools such as BirdNET, this study demonstrates how these state-of-the-art tools can aid our understanding of ecosystems in a data-driven world.

Key references:

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Wood, C.M., Kahl, S. (2024) Guidelines for appropriate use of BirdNET scores and other detector outputs. J Ornithol 165, 777–782.

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