SOUND LOCALIZATION FOR ACOUSTIC MONITORING OF BIRD POPULATIONS

IN RESPONSE TO FIRE AND ENERGY SECTOR ACTIVITY

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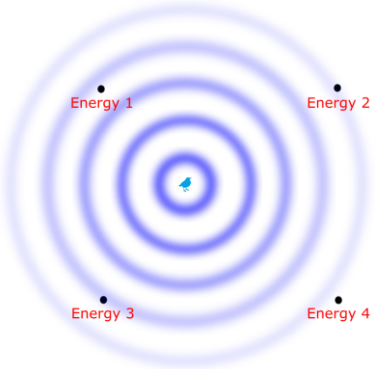
Background

Assessing the impact of natural and anthropogenic habitat alteration on bird populations requires approaches at various spatial scales. Sound localization is a promising technology for assessing these impacts at small spatial scales. Localization uses an array of multiple microphones to triangulate the precise location of a singing bird. In doing so, it allows birds to be tracked throughout the day without the presence of a human observer. Localization technology remains an emerging technology, and various methodological questions remain before it can be widely adopted. My project seeks to resolve some of the methodological issues and use sound localization to assess the responses of birds to habitat disturbances.

Goal 1: explore localization methods and recording hardware
Goal 2: streamline sound localization analysis by refining the software involved
Goal 3: Use sound localization to examine behavioral responses of Yellow Rail and Rusty Blackbird to disturbances.

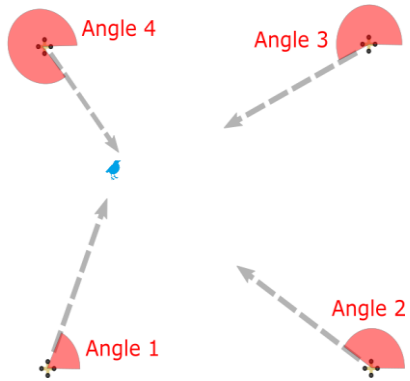
Localization Methods

Energy-based Localization



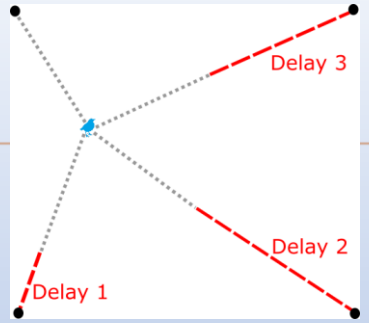
Sounds are louder closer to the source. Estimate location from relative sound level.
Pros: No time synchronization required, lightweight equipment.
Cons: Lower accuracy.

Direction of Arrival



Recording devices are constructed from multiple microphones to estimate the angle to a sound source.
Pros: Good accuracy, no synchronization between nodes.
Cons: Time synchronization within each node.

Time Differences of Arrival



Sounds propagate outward from the source at the speed of sound. Estimate location from relative time delays.
Pros: High accuracy.
Cons: Time synchronization via GPS, bulky equipment.

Hardware

Wildlife Acoustics Songmeter SM4
Pros: Small, lightweight
Cons: No time-synchronization, energy-based localization only.

Wildlife Acoustics Songmeter SM3
Pros: Time synchronization enables time differences of arrival localization.
Cons: Big, heavy.

Far-field Microphone Array
Pros: Direction-of-arrival localization, inexpensive (<$200), small.
Cons: Engineering required to ensure field readiness.

Field Deployments

How do Yellow Rails and Rusty Blackbirds respond to well pads and other habitat disturbances?

To answer this question, I will identify breeding sites of these two species, and set up localization arrays on territories that have been disturbed by human activity.
Data analysis will include 5 steps:

1) Identify sounds of interest
2) Localize sounds
3) Calculate time budgets in disturbed vs undisturbed habitat
4) Analyze whether birds avoid or prefer disturbed parts of the territory.
5) Additional variables can be analyzed:
    a) Which habitat features are most preferred.
    b) Is the nest a center of activity?
    c) Do behaviours change throughout the day?

Conclusion

Sound localization holds great potential as a method for monitoring birds. Most importantly, it doesn't require humans to be present, and allows round-the-clock monitoring with unprecedented precision.