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A Feasibility Study of Using Unmanned Aerial Vehicles to Survey Avian Abundance by Using Audio Recording

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A Feasibility Study of Using Unmanned Aerial Vehicles to Survey Avian Abundance by Using Audio Recording

Abstract

Roadside counts are commonly used to assess songbird abundance, but they result in oversampling habitat edges and underrepresenting core habitats, areas of steep terrain, and wetlands. Accessing off-road habitats can be logistical challenging and time-consuming, resulting in low survey efficiency. Aerial ecological surveys, using unmanned aerial vehicles (UAVs, or drones) have already proven to be valuable in wildlife monitoring. Previous studies have used photography or videography to provide permanent documentation of wildlife surveys through low altitude aerial imagery. A significant advantage of UAVs over manned aircraft is their greater safety and lower costs. We propose that UAVs can also be used to conduct audio surveys of vocal species. Here, we report on experiments to test the feasibility of using UAVs to conduct point counts of songbirds.

To establish the detection radius of bird songs recorded with a microphone attached to a UAV (DJI Phantom 2.0), recordings of the songs of five regionally abundant bird species (Wood Thrush, Eastern Towhee, Song Sparrow, Chipping Sparrow, and Eastern Meadowlark) were broadcast at distances of up to 140m from the UAV, which was flown at three altitudes (20m, 40m, and 60m). We found that detection rates and radial detection distances of the broadcasts did not differ with UAV altitude. Bird recordings were clearly audible at radial distances of 60m. We conclude that it is feasible to use UAVs to conduct aerial point counts that are comparable with traditional terrestrial bird point counts, and describe additional field experimentation needed to refine our survey protocols.

Keywords

bird populations, species monitoring, bird habitats, birdwatcher

Disciplines

Environmental Monitoring | Environmental Sciences | Poultry or Avian Science

Comments

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A feasibility study of using unmanned aerial vehicles to survey avian abundance by using audio recording

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Introduction

Songbird survey techniques often utilize road based counts to assess abundance, but this methodology results in oversampling of habitat edges and underrepresents core habitats, areas of step terrain, and wetlands (Harris and Haskett 2007). Accessing off-road habitats can be logistically challenging and time consuming, resulting in low survey efficiency. The implementation of unmanned aerial vehicles (UAVs, or drones) with audio recording capabilities could improve survey efficiency and safety.

In this study, we assess the feasibility of counting songbirds using audio recording from a microphone attached to a UAV. This promising technology has some important constraints, notably, FAA regulations and cost (Figure 1). We aim to demonstrate the feasibility of using a low cost (<$1,000) UAV to remotely record bird song. Important considerations are the noise of the drone, which must not interfere with the audibility of recordings, and flight duration (battery life), which must be long enough to access habitat interiors. Low cost drones have limited payloads, which restricts the specifications of recorders and microphones that can be used. Further, heavier payloads have costs in terms of increased motor noise and reduced flight duration. Hence, we aimed to devise a UAV system that allows for clearly audible bird song detection, while maintaining flight durations of >20 minutes.

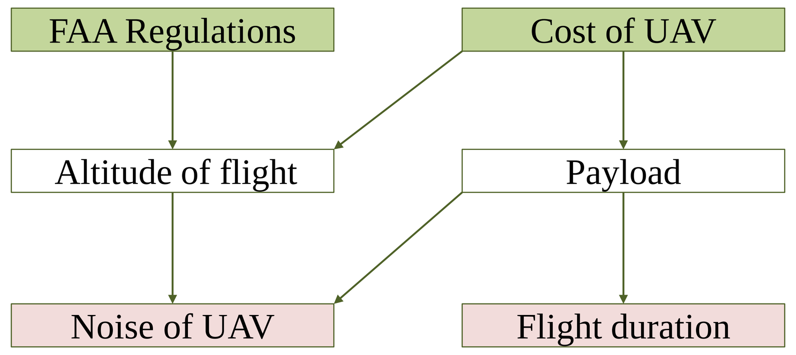

Figure 1. Constraint diagram for UAV use in surveying. Major constraints (green boxes) have indirect effects on feasibility (red boxes)

Methods

Recordings of the songs (source: Cornell Ornithology Lab) for five species (Wood Thrush, Eastern Towhee, Chipping Sparrow, Song Sparrow and Eastern Meadowlark) played on homogenous speakers (SonaVERSE BXL, 12W peak) and sound pressure measured (Extech Instruments), as mp3 files manipulated in Audacity for consistency with known bird volumes (Anderson et al. 2008; Nelson 2000). Bird songs were then amplified by 3 dB, 3 dB, 0 dB, 3 dB, and 6 dB respectively using Audacity.

A cardioid microphone (H1 Handy Recorder) with robust front and minimal side-to-side pick up directionality was attached to the UAV using fishing line (Figure 2). Ambient UAV noise from rotors were then compared at various mic-to-UAV distances (4.5 to 9.1 m) to establish the 8 m optimal length of fishing line used.

Range trials were then performed using the aforementioned parameters. GPS technology embedded in the UAV communicated with an iPad Ground Station App for autonomous flight. The UAV hovered with ±2.5 m accuracy to allow the microphone to record randomized bird songs from three altitudes (20, 40, and 60 m) and random horizontal distances between 0 and 140 m in 20 m intervals.

Through blind analysis, over 220 minutes of individual bird songs were classified as: (3) Clear, (2) Audible, (1) Barely Audible, (0) Not Audible. Variations in detection radii were assessed using Program Distance (Buckland et al. 2001). Chi-square tests were used to see whether detectability varied with drone altitude, and among the species recordings.

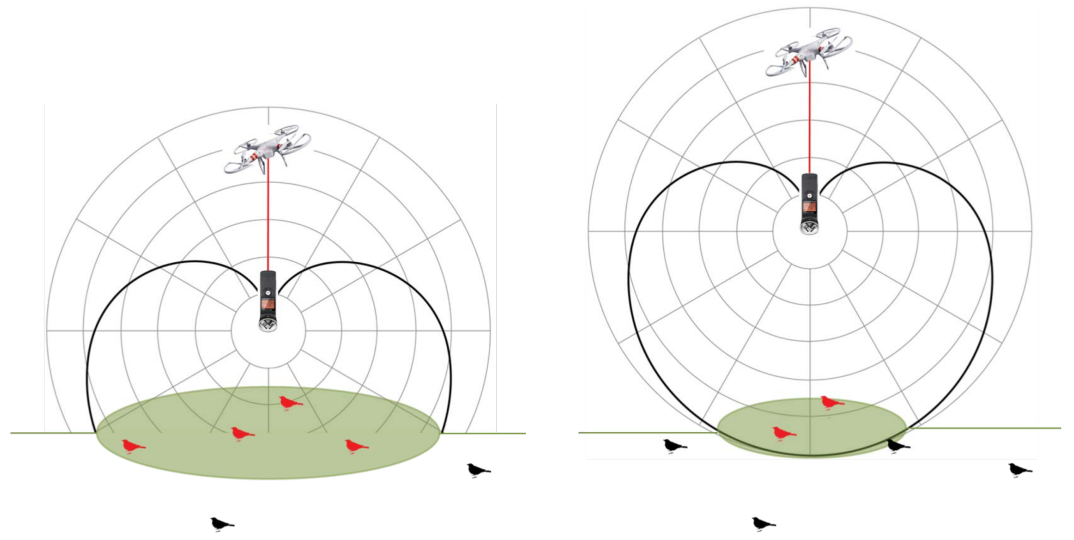

Figure 2. Demonstration of the potential impacts on radial detection distances due to the altitude of the cardioid microphone. Red birds are within the microphone pickup range, black birds are not detected.

Results

Effective detection radii (EDR) were established based on the horizontal distance at which each species' probability of detection was 50%. Our estimated EDRs were: Wood Thrush at 62m, Eastern Towhee at 43m, Chipping Sparrow at 30m, Song Sparrow at 39m, and Eastern Meadowlark at 50m (Figure 3).

The altitude of the UAV did not significantly impact the detection radius of each bird species, except for the Wood Thrush (X^2(6, N = 24) = 17.67, p = 0.0071; Figure 4). However, an altitude of 40m for the quietest and loudest recordings in this study suggests confidence in successful song bird identification can be maintained at higher UAV altitudes (Figure 5).

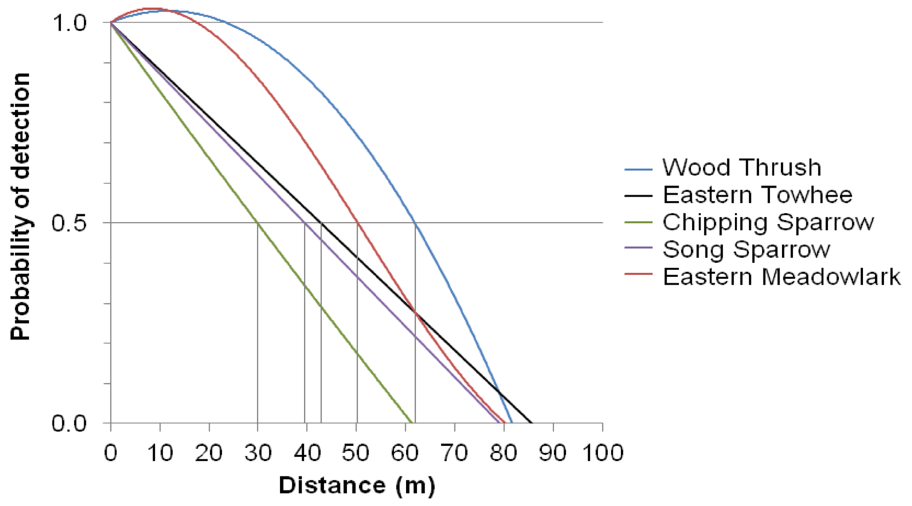

Figure 3. Detection probability of the five regionally abundant song birds with respect to horizontal distance.

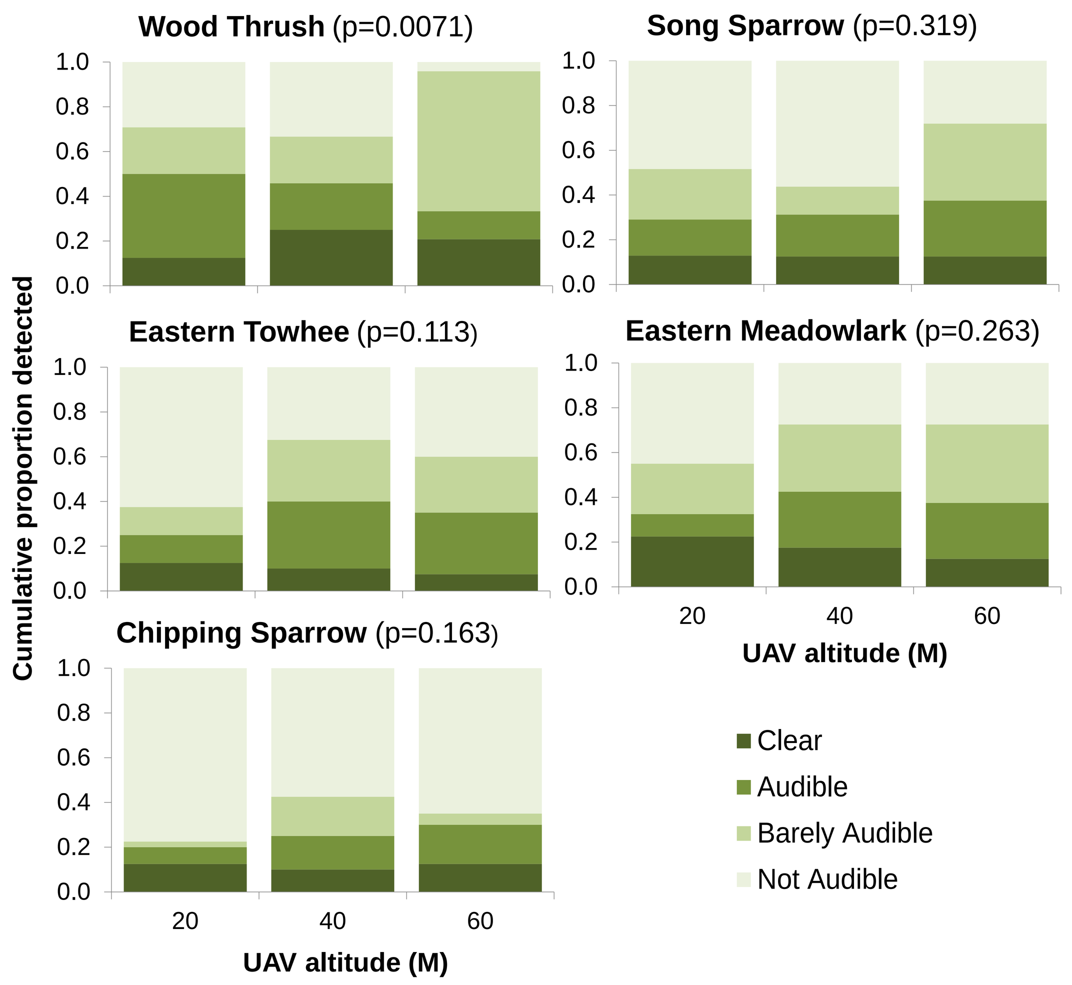

Figure 4. Comparison of species detection based on altitude of UAV. P values from chi-square test for independence to assess differences in detection with UAV altitude.

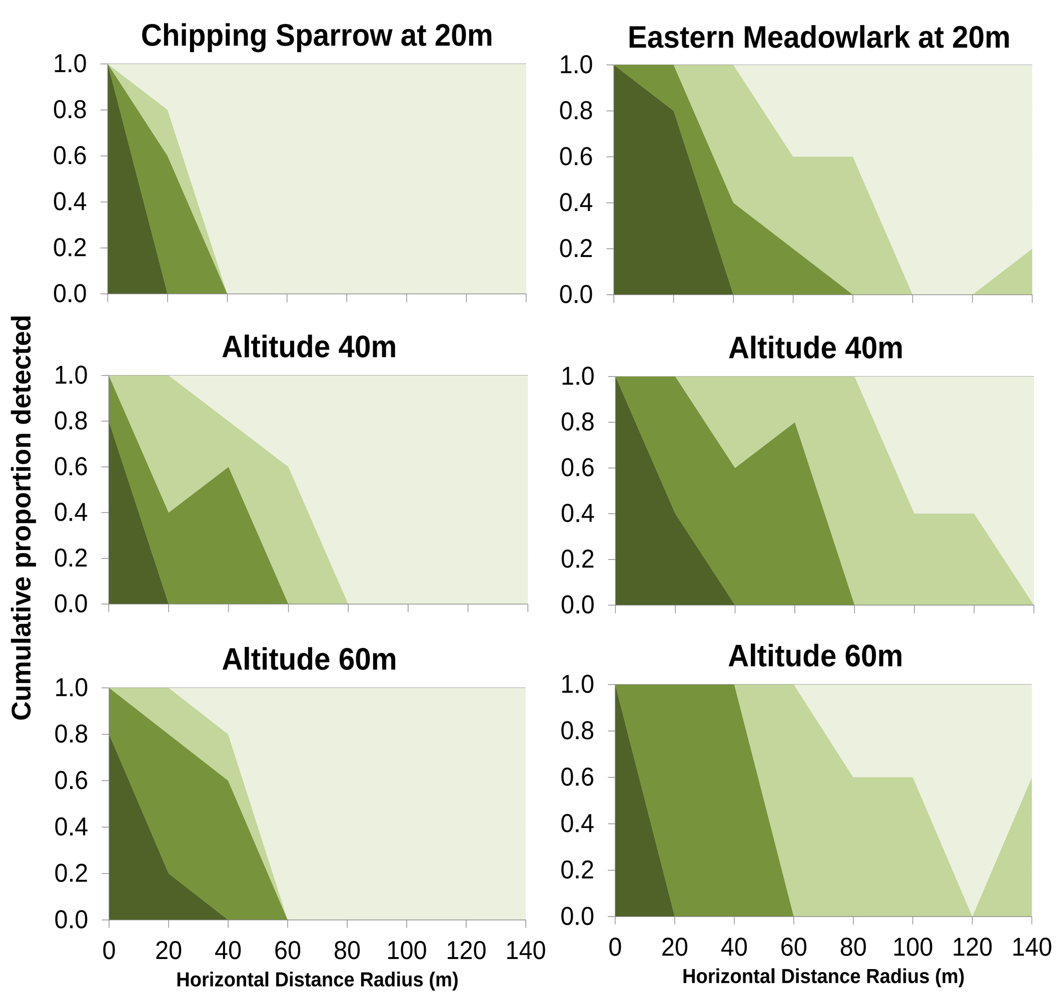

Figure 5. Detection rates with radial distance from the UAV.

Conclusions

The experimentally determined detection radii support the use of UAVs as a versatile alternative to traditional point counts for surveys. Radii of 50-60m are comparable to those used in several well–established point count protocols. Our system protocol has the potential to efficiently gather high resolution population data in underrepresented ecosystems. Acoustic recordings have the capability to reduce misidentification and improper documentation of birds to generate unbiased datasets as bird detections vary based on species, observer, and singing rate (Celis-Murillo et al. 2009; Alldredge et al. 2007). With over 15% of UAV models devoted to the civil and commercial sector, the adaptability and affordability of this technology is expected to increase with time (Chabot and Bird 2012). A recent study has showed that various wetland bird species were unresponsive to UAV presence within 4 m (Vas et al. 2015)

In future studies, we will:
(1) validate our protocol against traditional bird surveys
(2) determine the response of song bird behavior to the presence of UAVs.

Literature Cited

Anderson, R.C., Searcy, W.A., Peters, S., and Nowicki, S. 2008. Soft song in Song sparrows: acoustic structure and implications for signal function. *Ethology* 114: 662-676.

Alldredge, M.W., Simons, T.R., and Pollock K.H. 2007. Factors affecting aural detections of songbirds. *Ecological Applications* 17(3): 948-955.

Buckland, S.T., Anderson, D.R., Burnham, K.P., Laake, J.L., Borchers, D.L. and Thomas, L. 2001. *Introduction to Distance Sampling: Estimating Abundance of Biological Populations*. Oxford University Press, Oxford, UK.

Celis-Murillo, A., Deppe, J.L., and Allen, M.F. 2009. Using soundscape recordings to estimate bird species abundance, richness and composition. *Journal of Field Ornithology* 80(1): 64-78.

Chabot, D., and Bird, D.M. 2012. Evaluation of an off-the-shelf unmanned aircraft system for surveying flocks of geese. *Waterbirds* 35(1): 170-174.

Harris, J.B.C., and Haskell, D.G. 2007. Land cover sampling biases associated with roadside bird surveys. *Avian Conservation and Ecology* 2(2): 12.

Nelson, B.S. 2000. Avian dependence on sound pressure level as an auditory distance cue. *Animal Behavior* 59(1): 57-67.

Vas, E., Lescroel, A., Duriez, O., Boguszewski, G., and Gremillet, D. 2015. Approaching birds with drones: first experiments and ethical guidelines. *Biology Letters* 11. DOI: 10.1098/rsbl.2014.0754

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