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Small differences in camera-trap mounting height can substantially affect bird recording rates

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Short Report

Keywords: camera trapping, birds, mounting height, recording rate, paired deployment

Posted Date: November 23rd, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11367513/v1

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Additional Declarations: No competing interests reported.

Abstract

Small differences in camera mounting height may alter records of birds using the ground-level focal area. We compared cameras mounted at 10 and 40 cm on the same tree at two woodland sites in northern Poland. Four fixed cameras operated simultaneously for 548 days each, yielding 903 camera events from 907 species records representing 18 species. Cameras mounted at 10 cm recorded 643 events and those mounted at 40 cm recorded 260, equivalent to 58.7 and 23.7 events per 100 camera-days, respectively. A Poisson mixed model accounting for site, height × site, annual seasonality, and temporal dependence estimated low/high recording-rate ratios of 2.59 (95% confidence interval: 2.04–3.30) at Site A and 2.30 (1.79–2.97) at Site B. Negative-binomial estimates were effectively identical, and moving-block bootstrap intervals for the unadjusted ratios remained above one. Refitted simulations identified opposing residual-variability discrepancies between the Site A cameras despite satisfactory overall model checks. These results indicate substantially higher detection rates near ground level at both sites. Limited spatial replication, fixed camera identities, and residual lack of fit constrain inference, but the observed contrast supports further replicated evaluation of near-ground camera placement for bird monitoring.

Introduction

Camera traps can document ground-associated birds that are difficult to observe directly (O'Brien and Kinnaird 2008). Mounting height affects the relationship between animal movements, the photographic field of view, and the passive infrared sensor's detection zone, which do not necessarily coincide (Welbourne et al. 2016). Camera model and settings can also influence recording performance (Palencia et al. 2022). The effect of mounting height is context dependent. Jacobs and Ausband (2018) reported similar detection rates at 0.6 and 3 m, but more blank images at the higher position. Across paired deployments in several biomes, the effect of mounting height varied with animal body size (Sereno-Cadierno et al. 2026). We examined a smaller difference in mounting height, comparing cameras positioned at 10 and 40 cm, in two woodland fragments. We expected cameras mounted closer to the ground to record more events involving birds using the ground-level focal area and estimated this contrast separately within each site. The response variable represented recording output rather than independently measured detection probability, abundance, or species richness.

Materials and methods

The study was conducted near Rogóźno, northern Poland (approximate midpoint: 53.552° N, 18.914° E). Each site comprised approximately 0.5 ha of open young woodland dominated by *Pinus sylvestris* and *Betula pendula*. Cameras were positioned along bird movement routes near ponds, 2–5 m from the water; vegetation within approximately 1.5 m in front of each camera was selectively cleared. At each site, we mounted two Denver WCT-5002 cameras on the same pine trunk. At Site A, Camera I was mounted at 10 cm and Camera III at 40 cm; at Site B, Camera II was mounted at 10 cm and Camera IV at 40 cm (Online Resource 1, Fig. S1). The devices remained in these positions throughout the study,

without swaps or replacements. Cameras operated in combined photo–video mode, with Normal infrared sensitivity and 12-MP image resolution. Each trigger produced three photographs and a 10-s video, with a 1-s trigger delay. No bait or lure was used. Daytime and night-time test recordings were used to guide camera alignment and tilt adjustment. Investigators confirmed continuous operation from 15 November 2023 to 15 May 2025 inclusive, corresponding to 548 camera-days per device and 2,192 camera-days in total.

Only confidently identified bird records were retained; empty recordings and false triggers were excluded. Each row in the workbook represented a species record. Records from the same camera with identical start and end timestamps were grouped into a single camera event, while separate species entries were retained. No additional temporal threshold was applied to distinguish successive events; consequently, camera events should not be interpreted as independent bird visits. Records from different cameras were not merged. Events were summed by camera-day, including operational days on which no events were recorded.

We fitted daily event counts in R using glmmTMB (Brooks et al. 2017). The Poisson model used a log link and included height as a categorical predictor, site as a fixed effect, a height × site interaction, and annual sine and cosine terms. A shared-date Gaussian random intercept represented daily variation common to all cameras. Independent stationary first-order autoregressive processes were fitted within cameras, with a shared variance and lag-one correlation. Log camera-day effort was included as an offset. This structure accounts for temporal dependence but cannot separate the effect of camera height from permanent differences among devices. An otherwise identical negative-binomial model (NB2) approached the Poisson limit; we therefore compared the two distributions and assessed agreement between two Poisson optimisers. We estimated within-site low/high recording-rate ratios and the height × site interaction from fixed-effect contrasts, with approximate 95% Wald confidence intervals. Holm adjustment was applied to the two within-site tests. Model fit was assessed using 499 parametric simulations followed by model refitting, including both overall and camera-specific discrepancy measures. We assessed the sensitivity of the unadjusted ratios using a paired moving-block bootstrap with block lengths of 7, 14, and 28 days and 2,000 replicates for each block length. Full model specifications and diagnostic results are provided in Online Resource 1. We executed analyses in R.

Results

The four cameras recorded 903 events comprising 907 species records representing 18 species (Online Resource 1, Table S4). Cameras mounted at 10 cm recorded 643 events (71.2%), whereas those mounted at 40 cm recorded 260 events, with equal sampling effort of 1,096 camera-days per height. Pooled recording rates were 58.7 and 23.7 events per 100 camera-days, respectively. Median daily event counts were zero for all cameras; interquartile ranges were 0–1 for cameras mounted at 10 cm and 0–0 for those mounted at 40 cm (Table 1). Monthly recording rates varied throughout the monitoring period (Fig. 1). Model-estimated low/high recording-rate ratios were 2.59 (95% Wald confidence interval: 2.04–3.30) at Site A and 2.30 (1.79–2.97) at Site B; both Holm-adjusted p-values were < 0.001. The interaction

ratio, expressed as Site B relative to Site A, was 0.89 (0.63–1.26; p = 0.512). Poisson and NB2 log-likelihoods were effectively identical (− 1738.686), as were the estimated contrasts. The corresponding AIC values were 3495.373 and 3497.373, respectively (Online Resource 1, Table S1 and Fig. S2). Of the 499 simulated datasets, 498 yielded usable refits. Overall Pearson discrepancy, fitted–residual rank correlation, zero frequency, and adjusted lag-one checks showed no evidence of model misfit. However, the high camera at Site A showed less residual variability than expected (Holm-adjusted p = 0.016), whereas the low camera showed greater residual variability than expected (p = 0.048; Table S2). The unadjusted low/high ratios were 2.64 at Site A and 2.29 at Site B. All within-site moving-block bootstrap intervals excluded one; the 28-day block intervals were 2.21–3.05 and 2.07–2.52, respectively. All interaction intervals included one (Table S3).

Table 1

Camera-specific recording summaries. Each camera operated for 548 days. Rates are events per 100 camera-days; Q1–Q3 are daily event-count quartiles. Events are recording units, not independent visits.

Site	Camera	Height (cm)	Events	Days with events	Rate	Median (Q1–Q3)
A	I	10	364	213	66.4	0 (0–1)
A	III	40	138	120	25.2	0 (0–0)
B	II	10	279	214	50.9	0 (0–1)
B	IV	40	122	111	22.3	0 (0–0)

Monthly bird-event recording rates at Sites A and B. Blue circles denote 10 cm and orange triangles 40 cm. Rates use actual camera-days in each month, including partial first and last months. Lines connect descriptive summaries, not fitted trends.

Discussion

Both paired deployments produced substantially more bird events at 10 cm than at 40 cm. Similar estimates from the Poisson and NB2 models, together with the moving-block bootstrap sensitivity analyses, support the direction and magnitude of this local recording-rate contrast. Near-ground placement may improve the overlap between bird movements and the sensor's detection zone, although we did not directly measure this mechanism. Event counts reflect a combination of triggering, framing, and potentially repeated recording during individual visits; therefore, they cannot isolate detection probability or bird abundance. Our findings complement previous evidence that the effects of camera height depend on the animals being monitored and the deployment conditions (Jacobs and Ausband 2018; Sereno-Cadierno et al. 2026). They apply specifically to birds using open, ground-level areas near ponds rather than to the entire woodland avifauna. They do not demonstrate equivalent effects across species, increased species richness, improved image quality, or an optimal mounting height across camera systems.

The two-site design represents the principal limitation to generalisation. Repeated daily observations improve temporal resolution but do not substitute for independent deployments (Hurlbert 1984). Fixed camera identities also confound mounting height with persistent differences among devices and their orientations. The uncertain height × site interaction does not demonstrate that the effect of mounting height is independent of site. Furthermore, the opposing residual discrepancies observed for the Site A cameras indicate incomplete model fit despite stable numerical estimates. Model-based intervals therefore remain approximate, while moving-block bootstrap intervals provide complementary evidence of robustness but likewise depend on assumptions about temporal resampling. Near-ground camera placement therefore warrants explicit testing when surveys target birds using the ground-level focal area. Additional paired stations, randomised or exchanged device identities, and independent observations of birds entering the focal area would help determine how widely this recording advantage applies and which detection processes generate it.

Declarations

Funding:

This research received no specific grant from public, commercial, or not-for-profit funding agencies.

Competing interests: The authors declare no competing interests.

Author Contribution

Wojciech Lipa conceived the study and conducted fieldwork. Wojciech Lipa and Andrzej Oleksa managed the data, performed analyses, and contributed to manuscript drafting and revision. Both authors read and approved the manuscript.

Acknowledgement

We thank the landowners for access and the field assistants for deployment and maintenance support.

Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request

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Figures

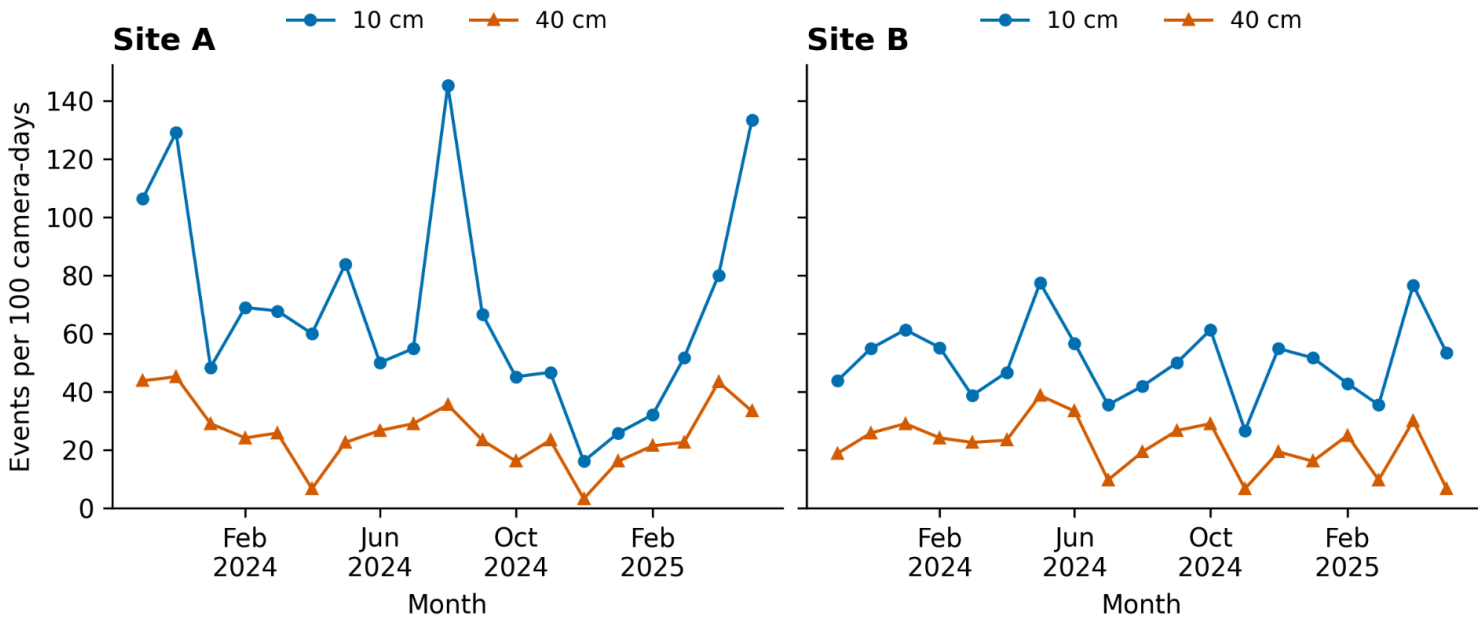

Figure 1

Monthly bird-event recording rates at Sites A and B. Blue circles denote 10 cm and orange triangles 40 cm. Rates use actual camera-days in each month, including partial first and last months. Lines connect

descriptive summaries, not fitted trends.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- CameratrapsOROnlineResource20261016.docx