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Line of sight: simulated aerial avian predators can reduce problematic bird flyovers of airfields

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Abstract: Collisions between birds and aircraft (bird strikes) are a serious threat to air safety and represent a substantial economic cost to the global aviation industry. In recent years, the frequency of wood pigeons (*Columba palumbus*) flying over active runways has increased at airports in Ireland. Here, we examine the effectiveness of imitation hawk-kites as a means of excluding wood pigeons from sensitive airfield locations. Over 2 years, during August and September, we conducted control (no kites deployed) and treatment trials (kites deployed) at Casement Aerodrome, an active airfield of approximately 320 ha in County Dublin, Ireland and on agricultural farmland in County Waterford, Ireland, where the movement of large numbers of wood pigeons had previously been identified (≥50 birds per hour). Overall, we recorded a significant reduction in the mean (±SE) number of wood pigeons observed to successfully cross sites during deployment of the hawk-kites (70.69 ± 11.01 per hour), compared to control trials (178.37 ± 29.98 per hour). Although preliminary, our data suggest that hawk-kites can be used to provide an additional means of bird control to reduce instances of airfield flyovers by a problematic species. Nevertheless, further research is required to determine the reliability of hawk-kites under a range of context-dependencies, such as airfield location, size surrounding land-use, seasonality, and weather conditions.

Key words: airfield, bird strikes, *Columba palumbus*, hawk-kites, human–wildlife conflicts, Ireland, non-lethal, wildlife management, wood pigeon

Globally, collisions between birds and aircraft (bird strikes) are a considerable threat to air safety, and a substantial economic burden to the aviation industry (Kelly and Allan 2006, Dolbeer 2011). The majority of damaging bird strikes occur at the level of the airfield, with ~61% of bird strikes occurring at or below a height of 30 m (Cleary and Dolbeer 2005), primarily during critical phases of flight (i.e., take-off and landing; Dolbeer 2011). A wide range of synergistic techniques such as grassland management, scare-technologies, lethal shooting, and live-capture and relocation are used to deter hazardous bird species from entering, foraging, or loafing on airfields (Cleary and Dolbeer 2005, Pullins et al. 2018). However, birds flying over airfields are often commuting between roosts and foraging sites well beyond airfield boundaries (Kelly et al. 2001, Fennessy et al. 2005). Accordingly, management actions within the airfield boundary may not necessarily influence such movements, which are related to the wider spatial use of landscapes by bird species. Therefore, as aviation continues to increase, there is an urgent need for the development of management measures that can facilitate a reduction in the frequency of airfield over-flight by birds (Cleary and Dolbeer 2005, Lambertucci et al. 2015).

The wood pigeon (*Columba palumbus*; Figure 1) is a widespread and highly abundant crop-pest species in many European countries (O'hUallachain and Dunne 2013). Weighing ≥500 g, wood pigeons often travel in large numbers between feeding and roosting sites (Cramp and Brooks 1988) and have caused bird strikes at many European airfields (Lensink et al. 2000, European Union Aviation Safety Agency 2009). As these strikes can potentially cause substantial and costly metal deformation or induce

Figure 1. Wood pigeons (*Columba palumbus*) are a common crop pest species in Ireland (*photo courtesy of M. Mackey; Copyright DAA collection*).

Figure 2. Imitation hawk-kites flown to reduce flyovers by wood pigeons (*Columba palumbus*) at selected airfield and agricultural sites located in Ireland during 2012 and 2013 (Table 1; *photos courtesy of J. Nicholson*).

mechanical failure of an aircraft engine (Kelly et al. 2016, 2017), the frequency of airfield overflight by wood pigeons is a concern for airfield managers. In Ireland, this species has experienced a significant population increase since 1998 (>34%; Balmer et al. 2013), and flocks are regularly reported crossing airfield boundaries.

Hawk-kites are a mobile predator model (Figure 2), which are used as bird deterrents on the principle that prey species will flee an area in response to a perceived predatory threat (Harris and Davis 1998). Although previous studies have reported mixed results while investigating the effectiveness of hawk-kites as a means of inhibiting crop damage by bird species (Conover 1983, 1984; Cook et al. 2008), quantitative data concerning the effectiveness of hawk-kites as a deterrent for bird flyovers are scarce. Herein, we examine the preliminary efficacy of hawk-kites as a management tool for bird control at airports. Our primary objective was to determine if the presence of hawk-kites along pre-identified wood pigeon flight paths can lead to a reduction in flyovers.

Study area

This study was conducted in 2012 and 2013 across 5 sites (Table 1), chosen in response to reports of high wood pigeon activity. Three sites bordered an airfield (Casement Airbase, County Dublin, Ireland), which is situated within an area of arable land. Casement Airbase is an active military airfield consisting of 2 runways and approximately 320 ha. It is situated in southeastern County Dublin in the east of Ireland and has an elevation of 97 m above sea level (Figure 3). The additional 2 sites were located on arable farmland approximately 200 km from the airfield in Cappoquinn, County Waterford in southern Ireland, approximately 60 m above sea level (Figure 3; Table 1). The dominant crops in both study areas were winter barley (*Hordeum vulgare*) and winter wheat (*Triticum aestivum*). All sites were relatively flat and open with hawk-kites clearly visible from a distance. Ireland has a moderate oceanic climate lacking extreme temperatures in both summer and winter, with relatively high levels of precipitation throughout the year.

Methods

To establish the directional position of wood pigeon flight lines, we monitored each site for 60 minutes, twice daily for approximately 3 weeks prior to the trials commencing. We used a threshold of ≥50 wood pigeon flights per hour to select appropriate sites. We examined 3 sites in 2012. One of these sites was assessed again in 2013 due to logistical difficulties of identifying new wood pigeon flight paths, along with the addition of 2 new sites that were not previously examined. We indicated details concerning site designations, locations in Ireland, and visitation and trial orders (Table 1).

Sites were examined for 2- or 4-day periods (Table 1) depending on observer availability, with kite treatment trials occurring after

Table 1. Experimental site designations, locations in Ireland during 2012 and 2013, visitation, and trial orders for the assessment of imitation hawk-kites to reduce flyovers by wood pigeons (*Columba palumbus*). All trials were carried out on separate days. C is control trials, T is treatment.

Site no.	Site type	Location	Date	Number of days	Time of day	Trial order
Site 1	Runway approach	53°18′ N, 6°26′ W	Sep. 2012	4	0900–1300	C1-C2-T1-T2
Site 2	Airfield boundary	53°18′ N, 6°26′ W	Sep. 2012	4	1400–1700	C1-C2-T1-T2
Site 3	Farmland	52°07′ N, 7°58′ W	Sep. 2012	2	1300–1600	C1 -T1
Site 4	Airfield boundary	53°18′ N, 6°26′ W	Aug. 2013	4	0900–1300	C1-C2-T1-T2
Site 2	Airfield boundary	53°18′ N, 6°26′ W	Aug. 2013	4	1400–1700	C1-C2-T1-T2
Site 5	Farmland	52°07′ N, 7°46′ W	Sep. 2013	2	1400–1700	C1-T1

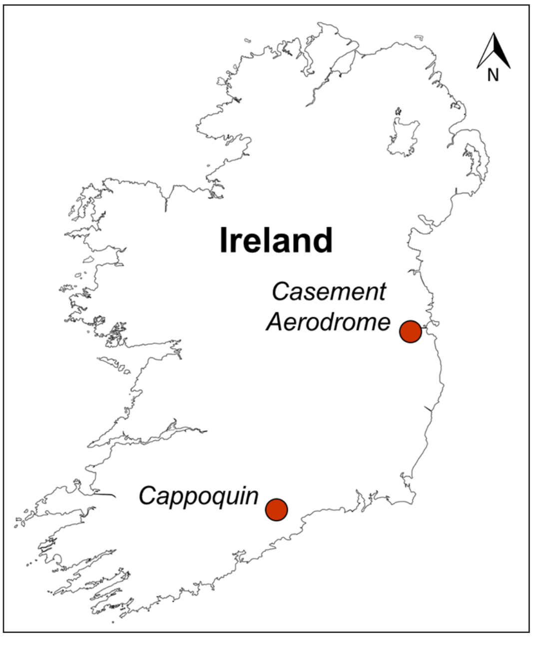

Figure 3. Imitation hawk-kites were flown to reduce flyovers by wood pigeons (*Columba palumbus*) at Casement Aerodrome, County Dublin, Ireland, and at agricultural sites at Cappoquin, County Waterford, Ireland, during 2012 and 2013 (Table 1).

control trials. Trials lasted between 3–4 hours beginning in the morning or afternoon and were completed at least 3 hours after dawn and 2.5 hours before dark. Within sites, control and treatment trials occurred at the same time of day (Table 1).

During treatment trials, we flew 6 imitation hawk-kites (Hawk Kite, Bird Control Ireland Ltd., County Waterford, Ireland; see Figure 2) attached to a telescopic pole (10 m in length) secured to a wooden stake embedded within the ground, with an 8-m tether allowing for a maximum flight height of 18 m and a minimum height of 2 m. The telescopic poles were erected at 18–24 hours prior to the commencement of trials to minimize disturbance (Table 1). Hawk-kites can be flown in winds 6–49 km/hour. We positioned 6 hawk-kites at intervals of 50 m in a line across each site. At 1 site, a single interval within the line of kites was increased to 100 m due to the presence of overhead powerlines. Hawk-kites were positioned to cross the previously observed wood pigeon flight paths at each site. The kites mostly resemble the hen harrier (*Circus cyaneus*), a predator of wood pigeons (Picozzi 1978) in size, shape, and "flight actions" (gliding and diving). Hen harriers are not known to inhabit the study sites. Other deliberate bird scaring efforts were not employed during our data collection times.

We conducted the trials using a single observer sitting approximately 100 m from the experimental area, with clear line of sight 500 m ahead and of the surrounding area. Observations were conducted from the same location during control and kite trials, with trials beginning at least 30 minutes after kites were erected. Using binoculars, we observed and subsequently counted the number of wood pigeons flying along the flight path over the experimental area during each trial in both directions. Wood pigeons were clearly observable by their distinctive flight pattern and plumage. Wood pigeons comprised the majority of birds flying over the study area.

We estimated flight heights for each bird (>30 m or ≤30 m), relative to stationary objects of known height as reference points positioned close to the flight line (e.g., tree line, communications antenna, overhead powerlines; objects varied between 10–20 m). We recorded wood pigeon evasion behaviors only on kite deployment days, as they did not occur during con-

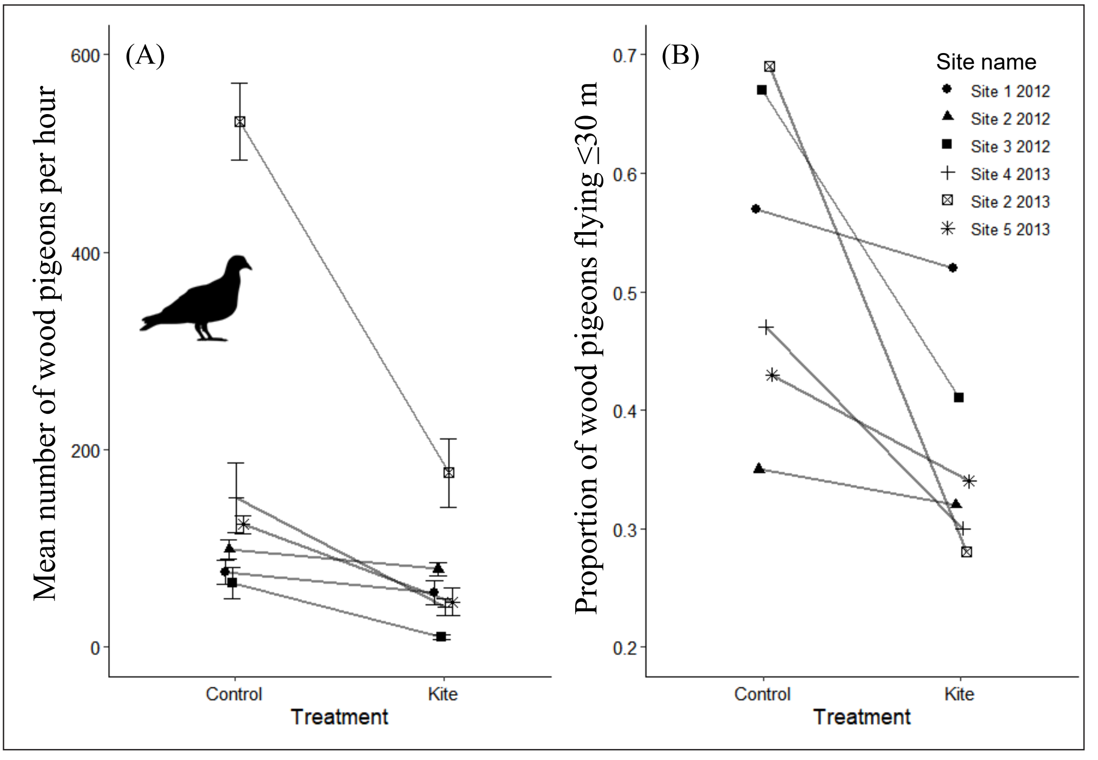

Figure 4. Assessment of imitation hawk-kites to reduce flyovers by wood pigeons (*Columba palumbus*) at selected sites located in Casement Airfield, County Dublin and Cappoquinn, County Waterford, Ireland during 2012 and 2013 (Table 1). (A) Mean (±SE) count per hour of wood pigeons observed flying over experimental sites, and (B) the total proportion of wood pigeons flying over experimental sites at a height ≤30 m.

trol trials. These behaviors were categorized as per Fennessy et al. (2005): (1) U-shaped flight response, (2) protean flight, (3) S-shaped flight, (4) increased elevation, and (5) decreased elevation. U-shaped flights were defined as when a wood pigeon, upon arriving at the line of kites, turned and vacated the area by the direction from which it initially arrived. Protean flights consisted of instances of flights through the line of kites while displaying anti-aerial predator movements. These were defined as sudden, random movements across all axes of flight (Kelly et al. 2001, Fennessy et al. 2005). We documented an S-shaped flight when a wood pigeon arrived at the kites, altered direction to fly along the line of kites until it had passed them, and then returned to its normal flight direction.

Data analysis

We performed all data analysis using the lme4 package within the R environment (R v.3.22; R Core Development Team 2016). Due to the non-normal distribution of the data, the number of wood pigeons flying over per hour was square-root transformed and analyzed using linear mixed effects models. We included treatment type (control = 0 or kites = 1) as a fixed factor as well as trial date and year. Site was included as a random effect. We calculated *P*-values using the likelihood-ratio test (α = 0.05). Visualization of the data indicated a particularly large reduction in the number of wood pigeons observed during trials conducted in site 2 in 2013 (Figure 4). An analysis of Cook's distance confirmed that high flyover numbers recorded during control trials at site 2 in 2013 were outliers. Our reanalysis of data collected from site 2 in 2013 resulted in the site being excluded; similar results were obtained in terms of the statistical significance of fixed effects. We analyzed the effect of treatment on the proportion of wood pigeons flying below 30 m using a binomial mixed effects model with treatment type (control = 0 or kites = 1), year, and date as fixed effects. Site was fitted as a random effect. The proportion of wood pigeons that performed evasive behaviors, with respect to flight height, was analyzed using a binomial generalized linear mixed model (GLMM). Flight height (≤30 = 0, >30 = 1), date, and year were fitted as fixed factors; site was included as a random effect.

Results

Overall, the presence of hawk-kites reduced the mean (±SE) number of flyovers made by wood pigeons on an hourly basis, from 178.37 per hour (± 29.98) to 70.69 per hour (±11.01; LMM: t = -4.042, P < 0.001; 95% CI [-5.44, -2.03]; Figure 4A). Our reanalysis excluding the outlier location of site 2, 2013 also yielded a reduction in wood pigeon flyovers, from 105.07 per hour (±11.88) to 48.79 (±5.76; LMM: t = -4.526, P < 0.001; 95% CI [-4.16, -1.68]). The proportion of wood pigeons flying at heights of ≤30 m decreased in the presence of hawk-kites (binomial GLMM: z = -3.848; P < 0.001; 95% CI [-2.91, -2.28]; Figure 4B). Further, during kite deployments, 52% of wood pigeons that crossed the site first performed an evasive behavior. Evasive behaviors were more frequent for wood pigeons flying at ≤30 m (69%) than those flying at heights >30 m (50%; binomial GLMM: z = -15.11; P < 0.001; 95% CI [-1.56, -1.20]). Overall, for wood pigeons that displayed evasive behaviors, 60% performed S-shaped flights, 20% performed a U-shaped flight, while 9% were observed to display protean flight.

Discussion

Although preliminary, our results indicated that imitation hawk-kites can be used to mitigate wood pigeon flyovers of sensitive airfield locations. In particular, flyovers were reduced at flight heights ≤30 m, where the majority of airfield bird strikes occur (Cleary and Dolbeer 2005). Overall, given the significant reduction of wood pigeon flyovers we recorded and the alteration of flight paths along with anti-predator displays, it would appear that these birds responded to a perceived predation risk (Harris and Davis 1998).

As a result of this study, hawk-kites have been routinely deployed at both Casement Airbase and Dublin International Airport, Ireland, from 2013 to the present (2020) to protect sensitive stretches of runway. Following deployment events, an immediate and sustained reduction in wood pigeon flyovers has been consistently reported by the wildlife management teams at these Irish airports (J. Nicholson and N. Mitham, Bird Control Ireland Ltd., and T. C. Kelly, University College Cork, personal observations). In these scenarios, hawk-kites are frequently flown for >20 consecutive days. Further, non-systematic observations indicate that wood pigeons can be diverted away from sensitive runway areas by the presence of the hawk-kites and will cross airfields at less sensitive locations where kites are not positioned. In the present study, for instance, some birds were observed to alter their flight path by ≥600 m to avoid crossing through the line of hawk-kites.

As a tool, imitation hawk-kites do not eliminate the risk of a bird strike. However, no tools or techniques currently available to airfield managers can accomplish the complete expulsion of a strike risk. At best, the application of multiple tools and techniques in a synergistic fashion can deter hazardous bird species and mitigate the risk of a strike (Cleary and Dolbeer 2005). Further, due to runway position, landscape topography, agricultural practices, and bird community assemblages, every airfield will experience an almost unique collection of wildlife management challenges (Soldatini et al. 2011). Therefore, the use of hawk-kites by airfields would need to be assessed on a case-by-case basis, as are almost all other tools or techniques currently used by airfield managers (Cleary and Dolbeer 2005). Importantly, in addition to the assessment of any long-term impacts, such as seasonal effects or potential habituation of wood pigeons, assessment of operational deployment of hawk-kite lines merits further examination. The detailed examination of factors such as weather conditions, spacing intervals between the deployed hawk-kites, the directional length of hawk-kite lines as well as increased flying heights (>30 m) is required.

Management implications

We provided the first empirical data for the use of imitation hawk-kites at an active airfield. Overall, this study confirms that a predator effigy can be used to significantly reduce problematic airfield flyovers by wood pigeons. Specifically, hawk-kites can be used to deter wood pigeons from crossing sensitive stretches of runway. We argue that hawk-kites are a useful bird deterrent tool and can support the pre-existing suite of wildlife control measures at airfields, but further research is required to realize their full potential.

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