Original Research

Birdstrike Risk Management at a Military Airfield Using Falconer Activity

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Abstract

Collisions between birds and aircraft have resulted in loss of human lives and aircraft. We evaluate the efficacy of a falconer's activity at deterring birds from Dęblin Military Airfield in Eastern Poland. The activity of a falconer using trained raptors (goshawk *Accipiter gentilis*, saker *Falco cherrug*, and peregrine *Falco peregrinus*) resulted in a reduction in the total number of birds in the airfield, in comparison with the control period. The greatest reduction in the number of birds in the airfield under influence of the trained raptors' action was recorded for: European starlings, black-headed gulls, and rooks. We found a significant negative correlation of total bird numbers with the number of days after the beginning of the falconer's activity. The significant trends in reduction of the number of birds observed at the airfield was indicated for many studied species, including: domestic pigeons, lapwings, and jackdaws. The effectiveness of the falconer in deterring birds was greater in the spring-summer period, in comparison with the autumn-winter period. Drawbacks of the falconry programs are discussed.

Keywords: birdstrike, risk management, air traffic safety, falconry, Poland

Introduction

Birds are a serious threat to air traffic, as their presence at airfields poses a risk of collision with aircraft. Birds are attracted to airfields primarily by their food sources, open landscape, and the possibilities of nesting and the presence of resting places [1-3]. Collisions between birds and aircraft can have catastrophic consequences and have resulted in loss of human lives and aircraft. Military losses are difficult to estimate, because in many cases they are kept secret, but there have been 283 military aircraft lost and 141 deaths recorded in a limited number of Western countries from which data were available for the period 1959-99 [4]. Fortunately, most birdstrikes are far less severe and the majority result in no damage whatsoever to the aircraft. Yet even they have their economical consequences and result, for example, in precautionary delays, and must be considered in terms of economic losses estimated at US $1.2 billion a year [5]. In such a situation, a significant role is attributed to active and effective methods of management of the presence of birds at airfields.

More frequently, methods based on sound biological principles resulting from the knowledge of ecology and bird behavior are applied. One such method is the use of falconer activity [1, 6, 7]. Falconry, which provides positive publicity and other unique attributes, can have an important role in integrated bird management at airfields. Still, little is known about the overall effectiveness of raptors in bird deterrence when they are used independently [7, 8].

The aim of our work was the quantification of effectiveness of falconer activity in the Dęblin Military Airfield (DMA) in eastern Poland, which for years has been one of the most threatened by collisions among military airfields in Poland.

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Study Area and Methods

DMA (51º33'N, 21º53'E, eastern Poland) was chosen for study because for years it has been characterized by a high frequency of collisions of birds with aircraft, and several very serious collisions have occurred there [9]. The area of the airfield is a rectangle with a length of about 4.5 km and width of about 1.5 km. In the further vicinity are the forks of the Wieprz and Wisła rivers, which results in the area of the airfield being a considerably warm area, guaranteeing year-round exploitation of the runway. Through all of summer, the grassy part of DMA is mowed. The area is characterized by an ample infrastructure responsible for execution of air traffic procedure from the airfield in the form of beacons, photocells, lighting and navigational lamps, main runway curb signs, radar, critical area signs, flags, masts, and antennas. Several dozen training airplanes of the Iskra class and several helicopters used for training by the Air Force Academy are stationed at DMA.

In the first period of studies, from September 1, 2007 to August 31, 2008, 25 bird counts were conducted in a transectional method in the entire DMA area. The bird counts were conducted every two weeks, averaging 2.1 counts per month. During the counting, all birds present at the airfield were recorded in their position at the moment they were noticed, both those feeding in the area of the airfield and those flying by. The positions of the birds noted for the first time were drawn on maps of 1:10,000. The first period of studies will further be referred to as the control period.

During the second period of studies (September 1, 2008 – August 31, 2009), 26 bird counts were conducted using the method mentioned above, which gave 2.2 counts per month. However, at that time, in contrast with the control period, a licensed falconer was employed at the airfield. The falconer worked five days per week, from 8 a.m. to 8 p.m. In field work, he alternated used three individual diurnal raptors during the day: an adult goshawk, *Accipiter gentilis*, a saker *Falco cherrug*, and a peregrine *Falco peregrinus*. Of these, the goshawk was always used to deter birds in the morning, the saker at midday, and the peregrine in the afternoon and evening. The falconer used a vehicle to change position often.

The falconer was not informed about the course of the transect by which the observers moved during the counting, nor of the evaluation of his work. At the time of the studies, both during the control period and when the falconer worked in the airfield, there were practically no other methods used in deterring birds, except for a few short sessions of using one small gas cannon, whose location was unchanged for years (placed at the southwest end of the airfield). A strongly manifested process of habituation to the cannon was observed by the birds, mainly corvids *Corvidae* (sitting on the casing and feeding next to it).

With the purpose of evaluating the falconer's work, a more in-depth analysis of the information collected in the airfield was conducted with regard to 12 species of birds: European starlings *Sturnus vulgaris*, jackdaws *Corvus monedula*, rooks *Corvus frugilegus*, hooded crows *Corvus cornix*, lapwings *Vanellus vanellus*, domestic and feral pigeons *Columba livia*, wood pigeons *Columba palumbus*, fieldfares *Turdus pilaris*, white storks *Ciconia ciconia*, buzzards *Buteo buteo*, kestrels *Falco tinnunculus,* and black-headed gulls *Larus ridibundus*. Changes in numbers under the influence of the falconer were also subject to analysis within six systematic avian families to which the target species belonged. The first reason for such a choice of the considered species accounted for more than ¾ of the total number of birds observed in the airfield studied [10]. The second reason was that they pose a real threat in this airfield and others in Central Europe [11-13].

Trends in changes in the number of birds were ascertained by Pearson moment product correlations. The number of birds during the two study periods were compared with the Mann-Whitney U test or the Student's t test, depending on the data distribution [14].

Results

Total Number of Individual Birds and Total Number of Species of Birds Observed in the Airfield

In the period before introducing the falconer in the airfield, an average of 816.4±398.7 (n=25) birds were observed. During the period of the falconer's work, the number of birds decreased to 517.6±328.5 individuals (n=26). The differences proved to be highly significant statistically (Student's t=2.926, df=49, p=0.0052). Yet such statistical differences were not found when comparing the number of species of birds present in the airfield during the control period and during the study period when the falconer was present (Student's t=1.65, df=49, p=0.105), despite a noticeable change: 23.4±8.6 (n=25) vs. 19.9±6.3 (n=26).

When comparing the average number of birds (645.2±187.1 ind., n=10) recorded in the area of DMA for autumn and winter during the control period, with the average number for autumn and winter (during the out-of-breeding period of birds) in the period of the falconer's work in the airfield (624.9±353.6 ind., n=15), no statistically significant differences were found (Student's t = 0.166, df=23, p=0.879). Such differences were shown, however (Student's t=3.662, df=24, p=0.0012), when comparing the average numbers of birds for spring and summer (during the breeding period of birds), during the period when the falconer was not present in the airfield (930.5±463.0 ind., n=15), with the average number during the period when he did work there (371.2±232.0 ind., n=11).

The total number of species of birds recorded in the airfield during observations conducted in autumn and winter during the control period (15.6±5.3, n=10) was also compared with the data from the second period (8.0±6.4 species, n=15). Despite the decrease in the number of species in the airfield, significant differences were not found (Student's t test =-0.977, df=23, p=0.338). Significant differences were found, however, (Student's t test=2.658, df=24, p=0.014), when collectively analyzing the data from the time period relating to spring and summer.

Table 1. Bird numbers from target species on Dęblin Military Airfield (DMA) during two periods of study.

Species	Number birds on DMA before falconer activity		Number birds on DMA during falconer activity		Mann-Whitney Statistics	
	N_1	Median	N_2	Median	Z	P
Ciconia ciconia	9	3.0	5	2.0	1.815	0.070
Buteo buteo	16	2.5	23	2.0	-0.087	0.9300
Falco tinnunculus	22	4.0	23	2.0	1.524	0.127
Vanellus vanellus	17	49.0	12	21.0	0.620	0.535
Larus ridibundus	**9**	**11.0**	**6**	**4.0**	**2.207**	**0.027**
Columba livia	22	26.0	22	30.0	-1.175	0.240
Columba palumbus	15	5.0	11	4.0	0.679	0.496
Turdus pilaris	16	4.5	17	4.0	-0.708	0.478
Sturnus vulgaris	**22**	**234.5**	**19**	**42.0**	**2.328**	**0.019**
Corvus monedula	25	126.0	26	75.0	0.914	0.361
Corvus frugilegus	**25**	**88.0**	**26**	**67.0**	**2.148**	**0.032**
Corvus cornix	15	2.0	15	2.0	0.446	0.655

Statistically significant data in bold.

At the time when the falconer was not employed to deter birds, during the spring and summer, on average, there were birds belonging to 28.5±6.0 species (n=15). Introducing the falconer reduced the number of species of birds observed there to (22. 5±5.4 species, n=11).

The Impact on Numbers of Selected Species and Families of Birds

For the twelve selected target species of birds posing a real and obvious threat to air traffic, a comparison of numbers was made between the period when the falconer did not work in the airfield, and the period when he deterred birds from the airfield (Table 1). When considering all of the individuals of the indicated bird species detected in the airfield, the median values from observation from the period when the falconer actively deterred the birds were lower, in comparison with the earlier, control period. The median value increased only for feral and domestic pigeons. In the case of species for which a decrease was recorded, only for rooks, European starlings, and black-headed gulls were these differences statistically significant. For white storks, the differences were close to significance (Table 1).

Trends

The evaluation of effectiveness of the falconer's work demands not only comparison of the face values referring to the number of birds present in the airfield, but also to the demands of analysis of temporary trends in the change in the number of birds with the passing of time of the falconer's work. With the passing of the control period, only in a few cases were the trends in change in the number of birds statistically significant (Table 2). This was observed for lapwings, and for all waders *Scolopacidae*, where the statistically significant number of birds increased with the passing of the control period. On the other hand, for rooks it was noted that with the passing of the control period, the number of individual birds decreased significantly. For the remaining cases analyzed, the observed changes were insignificant statistically (Table 2). The analysis of the trend in change in number of all birds observed in the airfield showed that with the passing of the control period, an insignificant increase in their number occurred (r=0.245, n=25, p=0.864).

The presence of the trained raptors brought a reversal in the trend in changes in the numbers of birds in the airfield. A significant negative correlation of the numbers of birds with the number of days after the beginning of the falconer's work in the airfield was noted for all birds (r=-0.567, n=26, p=0.003). Downward trends were also noted for the number of individual birds with the passing of time of the falconer's work, of 6 (50%) of the 12 analyzed species, as well as 4 (66.7%) of the 6 analyzed families (Table 2). This included such target species as lapwings, rooks, domestic and feral pigeons, jackdaws and kestrels. The trend in decrease in the number of all gulls was in the close of significance (Table 2). However, this trend was not ascertained for one target species: starlings. In the course of the studies, no processes of habituation to the falconer's birds used for work in the airfield were observed.

Discussion

The primary factors determining the success of using falconry as a method for managing the risk of bird-aircraft

Table 2. Trends in bird numbers on Dęblin Military Airfield (DMA).

Species and Families	Trends in bird numbers on airfield before falconer activity			Trends in bird numbers on airfield during falconer activity		
	r	n	P	*r*	n	P
Ciconia ciconia	0.100	9	0.804	0.267	5	0.664
Vanellus vanellus	**0.571**	**17**	**0.017**	**-0.591**	**26**	**0.001**
all *Scolopacidae*	**0.555**	**17**	**0.021**	**-0.761**	**15**	**0.001**
Larus ridibundus	-0.312	9	0.414	0.225	6	0.668
all *Lariadae*	-0.348	14	0.222	-0.841	9	0.078
Corvus frugilegus	**-0.483**	**25**	**0.014**	**-0.451**	**26**	**0.021**
Corvus monedula	-0.211	25	0.310	**-0.443**	**26**	**0.024**
Corvus cornix	-0.008	15	0.979	0.319	15	0.119
all *Corvidae*	-0.372	25	0.067	**-0.496**	**26**	**0.010**
Columba livia	-0.237	22	0.287	**-0.710**	**22**	**0.001**
Columba palumbus	-0.012	15	0.964	**-0.611**	**11**	**0.046**
all *Columbidae*	-0.061	23	0.782	**-0.520**	**24**	**0.009**
Turdus pilaris	-0.492	16	0.057	-0.365	17	0.150
all *Turdidae*	-0.307	21	0.175	-0.369	19	0.120
Sturnus vulgaris	0.172	22	0.442	-0.362	19	0.128
Falco tinnunculus	0.156	22	0.486	**-0.549**	**23**	**0.007**
Buteo buteo	-0.347	16	0.187	-0. 210	18	0.424
all *Falconiformes*	-0.035	25	0.864	**-0.534**	**26**	**0.005**

Statistically significant data in bold.

collision is the use of individual birds of prey that are natural enemies of the birds appearing in the airfield [15, 16], as well as the adaptation of the birds used to the landscape surrounding the airfield. The diurnal raptors used for work in the area of DMA have in their diet species occurring in the airfield, including 12 target species that posed the largest threat there. Analysis from Hungary stated that for sakers, the basic avian prey are: European starlings, pigeons *Columba* spp., doves *Streptopelia* sp., and corvids of the genus *Corvus* spp. [17, 18]. Analyses from England of food, based on almost 5,500 captured prey, indicate that the goshawk eats pigeons *Columbidae*, corvids *Corvidae,* and raptors, including kestrels. Birds of these prey groups accounted for as much as 78.1% of the total prey biomass [19]. Research on the food of the peregrine indicated that pigeons *Columba* spp., European starlings, and thrushes *Turdidae* are important components of their diet [20, 21].

The composition of the typical diet of the raptors working in the airfield, and because of this, the threat which they posed to the birds occurring there, can be explained with a higher productivity of the falconer's work in the spring-summer period in the DMA area in comparison with the autumn-winter period. The birds, especially those breeding in the areas surrounding DMA, recognize the specimens used by the falconer as their natural enemies and abandon the airfield for alternative feeding areas. However, in the case considered, another factor must also be noted: DMA is situated in the valley of the Wisła River, which is one of the most important pathways of bird migration in Poland and Europe, and one of the significant locations for the wintering of many species of birds [22, 23]. For this reason, even a very active falconer is not able to locally degrade these large-scale processes that occur during the out-of-breeding period. It is also important to note that the autumn migration of birds is extended in time, in contrast with the brief spring migration to breeding grounds [22-24].

In the context of threats that the bird-control raptors should pose, it should be noted that red-tailed hawks *Buteo jamaicensis*, and harris hawks *Parabuteo unicinctus* are used in deterring birds in airfields of many countries, including Poland [25, 26]. Research shows, however, that they are much less effective in deterring birds in comparison with falcons from places where they are burdensome to people [8]. The cause of this is that their natural diet is based on lagomorphs and small mammals [27], so that they are not interested in the pursuit of birds such as gulls and corvids. Such a situation can quickly bring the possibility of habitation processes [28].

In evaluating the falconer's work in the DMA area, an important factor aiding in the activity of the falconer in affecting the target species which feed in the airfield during the breeding period is the fact that two of the species used by the falconer, the goshawk and peregrine, certainly occur in the vicinity of the airfield. Of these, the first is certainly during breeding [29, 30] (Kitowski I., Grzywaczewski G. – unpublished data).

During our research, we were able to quantify and express in specific values the effects of the falconer's work. Other data showing the effectiveness of deterring birds in airfields and other places burdensome to people with the use of raptors are scarce. Soldatini et al. [7] state that under the influence of the falconer (with two hybrid falcons *Falco peregrinus* × *Falco cherrug*, the number of yellow-legged gulls *Larus michahellis* at a refuse dump was reduced during the week in which the two hybrids were used by 5.6, 1.5, and 2.3 times in relation to the numbers indicated during three control weeks, when the falcons were not used to deter the birds. In the case of the black-headed gull, the falconer was less effective, as the number recorded during the week when the falconer deterred birds from the refuse dump was reduced only by 1.8, 1.0, and 2.0 times in relation to the numbers of three control weeks.

The work of the falcons brought noticeable good results in the airfield of the Talavera base in Spain. During the counting from March 1984, a total of 1,461 birds were recorded there of species such as white storks, little bustards *Tetrax tetrax*, common cranes *Grus grus*, red-legged partridges *Alectoris rufa*, magpies, and pigeons, and in April and May, when only four falcons were intensively used there, the number of observed birds was reduced respectively to 422 and 364 individuals. Among the species mentioned above, only white storks, little bustards, magpies, and pigeons were observed in the airfield [31]. Other Spanish data come from the airfield of the Air Force Academy in San Javier. During numerous counts done in April 1994, 1,088 birds were sighted. Among them, the most numerous were: red-capped larks *Calandrella cinerea*, gulls, little bustards, and hoopoes *Upupa epos*. These species accounted for 89.5% of all instances of counted birds. Already after a month of activity of eight falcons, the number of counted birds was reduced to 464. Of these, 391 instances concerned the mentioned species; yet hoopoes already in the airfield were not noted. The number of gulls, posing the greatest threat in this airfield situated near the Mediterranean Sea, was also significantly reduced [31]. On a French airfield, a group of falcons deterred a population of 6-8 thousand lapwings wintering there. Observations indicate that one falcon during one hour was able to effectively deter birds from about 400 ha. The use of falcons brought a marked reduction in the number of lapwings in the airfield. A 75% reduction in the number of birdstrikes was also recorded there [32]. Researchers have shown that the most effective raptors have proven to be trained peregrines. Because individuals of these falcons are fast and accustomed to open areas ([15, 31, 33-35], they also state that peregrines are a much more effective tool for deterring gulls in one of the airfield bases of the Royal Navy in Scotland, in comparison with firing pyrotechnic charges, emission of alarm calls, and shooting birds. The effect of activity of the group of raptors working there was a reduction in the number of birds in the airfield and the number of collisions with them, which lasted for two years after falconer activity ended.

Studies conducted in DMA showed that gulls *Larus* sp. responded with a reduction in number close to significance with the passing of time of the falconer's work in the airfield. Furthermore, the number of black-headed gulls, expressed in the median of individuals sighted in the airfield, was significantly less during the period of the falconer's work, in comparison with the control period. Some sources indicate the high effectiveness of using peregrines in deterring gulls *Larus* sp. [3, 15], which may have a great significance in DMA, but also in other airfields connected with aquatic and marshy areas, as well as airfields in the vicinity of large dump sites and large urban areas of Europe, in which gulls are a serious hazard.

Our studies showed that the effects of a falconer's work can be seen with reference to many birds, including gulls, from a long-term perspective. It corresponds with the study of the Soldatini team [7], where it was revealed that trained raptors can elicit a clear response in the beginning, resulting in a high reduction of the number of birds in places from which they are deterred, yet this response becomes less evident over time. However, it seems that habituation processes observed by the Soldatini team [7] were possibly due to the small area (refuse dump) in which the falconer worked. In our case, the falconer worked in an area of approximately 7.5 km^2 and was constantly on the move. We also presume that a significant factor was the fact that the local birds were confronted year-round by two mentioned species of raptors (goshawk and peregrine), and recognized the threat they posed [29, 30]. Corvids from Eastern Europe [36] wintering at the airfield also recognized them as a threat (Kitowski I., Grzywaczewski I. – unpublished data). Probably for these reasons we did not observe processes of habituation with reference to the trained raptors.

Other researchers state that in order to effectively deter gulls from the airfield, the daytime work of the falcons should be supplemented with nighttime patrols equipped with pyrotechnic charges. The role of patrols should consist in firing pyrotechnic charges near the communal roosts of gulls located in airfields or in critical zones surrounding them [6, 31].

In areas of airfields penetrated by birds of greater size, the activity of the peregrine should be supplemented with that of other falcons such as gyrfalcons *Falco rusticolus*, whose use proved to be effective in airfields in Canada. There, the species of gulls that posed a threat to air traffic were the glaucous-winged gull *Larus glaucescens*, the California gull *Larus californicus*, common gull *Larus canus*, herring gull *Larus argentatus*, and the great black-backed gull *Larus marinus*. However, deterring birds took place only when the raptors were in the air. During a longer period of the falcons' stay in aviaries, the gulls returned to the airfield [15].

In details the effectiveness of falconry and shooting for bird control was evaluated at JFK International Airport near New York and the study indicated that shooting reduced bird-strikes but falconry didn't [37]. The authors of the work presented do not recommend shooting as a management technique for birds at the airport, as it simply proves to be laborious (as in the case of starlings) or won't be effective, as the areas of the dead birds will be occupied by individuals of the same species, as is shown in the case of Kestrels [38].

Besides this, many birds are protected by national and international environmental law, which also involves low social acceptance. In the case of rooks, the number of birds at the airport can be limited by trimming branches on which nests are placed, in colonies adjacent to the airport [39]. However, this can be done during the autumn-winter period. Finally, we must nonetheless present the drawbacks of using falcons at airfields, which was the cause of discontinuation of many falconry projects in many parts of the world [15, 28].

The presence of strong wind (above 20-25 km/s), fog, darkness, temperatures above 36ºC, and the time of molting are periods when falcons cannot be used effectively [6, 31, 34]. And falcons, as well as hawks, appear to be helpless in the case of large birds that are hazardous to air traffic such as swans and herons [40].

Falcons are not effective in deterring other raptors that are larger and capable of forming flocks, such as black vultures *Coragyps stratus* [41]. It is evident that the use of a particular species of raptors can also bring certain limitations; for example, peregrines do not attack sitting birds [15]. Merlins *Falco columbarius* in turn can only be effective in deterring small passerines.

At present, the prevalence of telemetry facilitates the recovery of lost birds. However, we must remember that falconers should particularly take care not to allow the unauthorized introduction of birds from breeding during their work at airfields. This particularly pertains to hybrids.

There must be a zone of about 0.5 km on both sides of the runway where the falcons can operate. The presence of forests and bodies of water near the airfield substantially reduce the effects of falcon activity, as birds deterred from the airfield find refuge in those places. In the airfield where the falcons work, aircraft should take off/land no more frequently than every three minutes [31].

Another drawback of the falconry programs is the consequence and time consumption. Activity of trained raptors in an airfield should not be incidental; it requires a well-planned, long-term project of risk management of collision with birds [15, 31, 41, 42] and notes that if the activity of the raptors in the area of the airfield is discontinued for a minimum of 15 days, then it is very likely that there will be a return of the birds of the to pre-falcon population levels. Moreover, some sources [15, 42, 43] point to the exceptionally high costs of training falcons for such work.

The employment of a falconer cannot be the only bird-strike management tool for birds in airfields. Undoubtedly, in the conditions of Dęblin Military Airfield, as well as other airfields in Central Europe, the application of three procedures seems to be important: foreign object debris (FOD), the long grass policy (LPG), and zero tolerance for water bodies) (ZTWB). It is important to remove foreign object debris from runways because the carrion of small vertebrate mammals and other organisms appearing there is an attractant to birds. In the case of the airfield studied, this pertains to carrion of small mammals (*Micromammalia*), which attract gulls and corvids [10]. Occasionally, bits of carrion can bring tragic results.

The management of small water bodies helps avoid the appearance of birds associated with these habitats in airfields, especially gulls and waders [1, 6]. The long grass policy, implemented by the omission of mowing the grassy areas on both sides of the main runway, can signify a deprivation of food supplies and a decrease in the comfort of feeding for many species of birds [44, 45]. Technological advancement also generated a considerable alternative to falconry in the form of radio-controlled models. The application of models in deterring birds from airfields was preceded by earlier testing of them with great success in deterring fish-eating birds (mostly herons and cormorants) from aquacultural operations [46]. This manner of deterring birds facilitates the removal of the main shortcomings of the falconers' work, namely the high cost and low effectiveness in deterring individual birds of large sizes, and very large flocks of gulls and other birds [40].

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