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Civil and Military Birdstrikes in Europe: An Ornithological Approach

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Abstract: Gulls and diurnal raptors posit the greatest danger for both military and civil air traffic in Europe. Less dangerous turn out to be Swallows, Swifts, Pigeons, European Starlings and Northern Lapwings. Storks, Herons and Vultures are dangerous locally. The most tragic accidents are caused by Gulls, European Starlings and Northern Lapwings. The most frequently used methods of bird deterrence are falconry, pyrotechnics and the broadcasting of distress calls. Bird deterrence methods with the use of lasers and radio controlled models are currently only being developed. A great future challenge for European air traffic will be connected with the rising populations of large wetland birds.

Key words: Bird strike, airfields, fatal casualties, risk management

INTRODUCTION

Europe plays an important integrating part in the global net of civil airlines connections (Graham, 1995; Steiner *et al.*, 2008). Currently in Europe there are ca. 280 airports serving international scheduled connections (Trzepacz, 2007). It is quite clear that in future the market of airline transportation will increase dynamically. Moreover, Europe is the base of several military powers possessing both numerous airports and a considerable number of military aircrafts (Dekker and van Gasteren, 2005). Just as the civil ones, they have to confront the danger posed by birds. Identifying the species endangering air traffic can help choose proper deterrence techniques employed at the airfields. The aim of this study is to present bird species posing danger to military and civil air traffic and to briefly characterise deterrence techniques used in Europe.

British Isles (UK and Ireland): Novel data analysing the top ten species most frequently causes collisions point to the Gulls *Laridae* as the most important danger at the UK airfields (Civil Aviation Authority, 2009). Out of 1154 collisions, in 635 (55%) cases the species of participating birds were recorded. Seagulls caused 196 (21%) of all accidents. Most of them (30%) were caused by Black-headed Gulls *Larus ridibundus*. The participation of common Gulls *Larus canus* and herring Gulls *Larus argentatus* was 25.1 and 18.5%, respectively. The remaining Gulls were not marked. Pigeons *Columba* sp., mostly Wood Pigeons *Columba palumbus*, were responsible for 13.2% of collisions. Common swifts *Apus apus* and Barn Swallows *Hirundo rustica* caused 13% of collisions. Skylarks *Alauda arvensis* and Eurasian

Kestrels *Falco tinnunculus*, typical of open fields, took part in 6.2 and 3.9% of all accidents, respectively.

The analysed list does not include Northern Lapwings *Vanellus vanellus*, although still in the years 1976-1995 they were responsible for the 17.4% of the 1704 collisions. This absence reflects the breakdown of the Lapwings population in the UK (Sheldon *et al.*, 2004). In 1973-1982 Gulls caused 42% of bird strikes in the UK (Horton *et al.*, 1983), including the 1981 catastrophe over the Bristol Channel where the collision of a Jaguar T2 with a Gull caused the life of one of the pilots (Richardson and West, 2000). Richardson and West (2005) cite data on 62 collisions of Royal Air Forces (RAF) aircrafts over the British Islands in the years 1923-2004, confirming the leading role of Gulls in causing dangers. In 23 (37.1%) cases the perpetrators were identified: 65.2% of them were Gulls, particularly Black-headed Gulls (5 accidents) and in isolated cases Common Gulls *Larus canus* and Herring Gulls *Larus argentatus*. Two collisions were caused by both Lapwings and unidentified Ducks. Single accidents were provoked by Wood Pigeons, Buzzards *Buteo buteo*, Rock Pigeons *Columba livia* and unmarked waders.

In two cases Gulls collided with planes particularly important for national security. In 1976 at the Merdam Air Base (E England) a strategic bomber aircraft Victor K-2 reported damages of the nose, fuselage and wings. In 1980 at Kinloss Air Base (N Scotland) a maritime patrol aircraft Nimrod MR2 crashed after the collision with a flock of Black-headed Gulls and common Gulls. Two members of the crew were killed (Richardson and West, 2005).

Thorpe (1978) analysed 400 bird strikes from the UK in the years 1968-1977 involving planes of the mass lower

than 5.7 ton. The perpetrators were Gulls (54%), Northern Lapwings (18%), Pigeons (9%) and Swallows (3%). There have also been reported collisions with greylag geese *Anser anser* and Northern Gannets *Sula bassana*. Gulls *Laridae* were the perpetrators of the 68.5% of all the 734 RAF aircrafts collisions whose offenders were found. Among them, 65.4% of events resulted in noticeable damages (Dekker and Van Garsteren, 2005). Other families provoked fewer collisions: Columbidae (4.9%), Passeriformes and Hirudidae (4%), Charadriidae (4%), Sturnidae (3.8%), Accipitriidae (3.5%), Corvidae (3.5%), Apodidae (3.2%), Anatidae (1.9%), Falconidae (1.6%) and Turdidae (0.5%). The remaining birds were responsible for 0.5% of collisions. Several interesting birdstrikes recorded from the Heathrow Airport (London) are worth presenting. From 1991-98 we know of at least 6 collisions involving Grey Herons *Ardea cinerea* and at least 2 collisions with Ducks (AAIB Bulletin 1999, 2001). An important collision in September 1998 involved a Boeing 767-322 ER colliding with a flock of Canadian Geese *Branta canadensis* (AAIB Bulletin, 2001).

In the autumn-winter seasons of the years 1990-2000 at the Dublin airport (Ireland) Gulls constituted 24% of the 273 individuals involved in birdstrikes (Kelly *et al.*, 2001). Fennessy *et al.* (2005) observe that at the same airport in the years 1995-2002 frequently observed Rooks *Corvus frugilegus* elicited only 1 0% of collisions. Black-headed Gulls caused 15% of collisions there, although they were rarely recorded.

Countries of Western Europe (Belgium, Netherlands and Germany): From Belgium and Netherlands Gulls, Feral Pigeons, wading birds, Corvids *Corvidae* and European Starlings *Sturnus vulgaris* are recorded as the most frequent danger for planes and the species involved in birdstrikes (Richardson and West, 2000; Dekker, 2003). Louette (1972) points to Domestic Pigeons *Columba livia domestica* and Black-headed Gulls as the basic threat for Belgian airfields. He describes the frequent presence of dead Black-headed Gulls on the runway of the Zaventem-Brussels Airfield. In April 1978 at the airport at Gosselies a serious collision of a B-373 with a Wood Pigeon was recorded (Russell, 2002).

In the years 1977-1983 226 birdstrikes of fighters F-104, NF-5 and F-16 from Royal Netherlands Air Forces were recorded (Buurma *et al.*, 1984). Most frequently they were caused by Swallows and often by Common Swifts (38.9%) and Gulls (31.0%). Occasionally the offenders were Magpies *Pica pica* (14.6%) and pigeons Columbidae (8.4%). Eurasian Buzzards and definitely Common Swifts, took part in only 3.5% of such accidents. For the remaining collisions the perpetrators were not identified.

In the years 1987-2008 at 3 main military airbases of Netherlands 27 collisions with Eurasian Buzzards and 116 with Eurasian Kestrels were recorded (Dekker, 2009). In July 1996 at the airport in Eindhoven (S Netherlands) a Belgian Hercules C-130 crashed after the collision with a big flock of European Starlings and Lapwings; 34 people were killed. A month earlier a Belgian SF 260 collided with a flock of Lapwings at the airport of Morsele (Richardson and West 2000). In 2001 near Vlieland Island a combat jet Tornado class flew into a flock of Black Guillemots *Cepphus grylle*. Pilots ejected successfully (Wiede, 2003).

In the years 2002-2004, 2008 birdstrikes were recorded at 12 main airfields of Germany, for the 40% of which the perpetrators were identified (Breuer, 2005). Most numerous among them were the diurnal raptors *Falconiformes* which caused 215 (26.5%) accidents. Buzzards were the dominating species here, responsible for the 61.1% of the 144 cases. Eurasian Kestrels caused 37.5% of collisions. In contrast, Red Kites *Milvus milvus* took part in only 2 (1.4%) events.

Data from 1978-1997 suggest that in birdstrikes of German Air Forces 415 of marked diurnal raptors took part. Most numerous of them (66.3%) were Eurasian Buzzards, Red Kites and Black Kites *Milvus migrans*. Falcons, mostly Eurasian Kestrels, constituted 118 (28.4%) of all collision victims. The remaining 22 birds included Harriers *Circus* sp., Sparrowhawks *Accipiter nisus* and Goshawks *Accipiter gentilis*. Small songbirds analysed by Breuer (2005) caused 22.6% of collisions. Among them, the most numerous were Swallows, taking part in 123 (15.2%) accidents. Big songbirds (e.g., European Starlings, Black Birds *Turdus merula* and other Thrushes *Turdus* sp. were the cause of 4.7% of collisions, while Common Swifts provoked only 5.9%. Pigeons were responsible for ca. 11% of collisions and among the Gulls, Black-headed Gulls dominated (82.0%). Northern Lapwings were responsible for 78% of the 41 birdstrikes involving waders. Worth noticing are also 2 collisions with both Curlews *Numenius arquata* and Oystercatchers *Haematopus ostralegus*.

Thirteen collisions with Grey Herons and one with a white stork *Ciconia ciconia* were reported. Sixteen other collisions with unknown Geese and Ducks took place, too. The picture of the danger posed by wetland birds at German airfields is completed by isolated accidents involving Common Cranes *Grus grus* and Great crested Grebes *Podiceps cristatus*. Breur cites data on 38 collisions with Corvids and Galliform birds *Galliformes*. Out of the 13 owls, only 7 individuals of Long-eared Owl *Asio otus* were marked.

For the years 1952-1998 only 5 perpetrators of the collisions with the RAF aircrafts located in the Western part of Germany were recorded. Two first accidents were caused by Gulls, including Black-headed Gulls. The remaining accidents involved unidentified Passerines, Rooks and Buzzards (Richardson and West, 2005). From East Germany comes the data from the years 1970-81 and 1987-1992 on birdstrikes involving the aircrafts of Soviet Air Forces located there (Jacoby, 1998). The offenders were identified for 63 out of 426 events. Most numerous among them were diurnal raptors (13%). The following 11% of accidents involved Pigeons and Gulls. Ducks, Swallows and European Starlings caused 8% of collisions each. Geese, Skylarks and Sparrows (*Passer* sp.) provoked birdstrikes in 6% of times each.

Dekker and van Garsteren (2005) claim that Gulls *Laridae* stand behind 29.2% of the collisions of German Air Forces (out of the 685 collisions in the years 1991-2000 whose offenders were identified). Almost 72.4% of these accidents resulted in damages of aircrafts. Other groups of birds caused far fewer collisions: Passeriformes and Hirudidae (26.8%), Accipitriidae (10.5%), Apodidae (9.2%), Columbidae (4.9%), Charadriidae (4.3%), Corvidae (2.5%), Anatidae (3.4%), Falconidae (3.4%), Turdidae (3.4%) and Sturnidae (1.2%). The remaining birds were responsible for only 0.9% of all collisions. Richardson and West (2000) described the collision of a German AF Alpha Jet with Herring Gulls over the North Sea in March 1990, in which the pilot was killed.

Scandinavia (Norway, Sweden and Finland): Data on birdstrikes in Scandinavia come chiefly from Norway. In the years 1985-1995 345 military birdstrikes were recorded there (Aas, 1996, 1997). The greatest number of collisions-90 (26.1%)-was caused by Gulls *Lariade*. Among them, the most common perpetrators were Herring Gulls and Common Gulls. Waders took part in 13.0% of accidents, mostly Golden Plovers *Pluvialis apricaria*. The collisions with Curlews were noted as well. Diurnal raptors and Corvids were involved in a small percentage of collisions: 1.4 and 0.9%, respectively. Swallows and Common Swift *Apus apus*, grouped together in analyses of collision risks, provoked only 4.1% of accidents. Aas (1996) informs also about 2 collisions with Fulmars *Fulmarus glacialis* (mass ~6 kg). Reported, too, were the collisions with Snow Buntings *Plectrophenax nivalis* (3.5%) at the airport on the island Andoya (N Norway), caused by the inadequate snow management near the runway (Bentz, 1984).

In December 2004 at the military base Orland (S Norway) a C-130 Hercules, while taking off, collided with four Whooper Swans *Cygnus cygnus* (mass ~13.5 kg) reporting damages (NBSAG, 2008). Yet,

these were large Sea Gulls that caused greatest losses to the military aviation in Norway (Aas, 1996, 1997). In May 1995 a F-16 B jet crashed in Rygge airbase (SE Norway) when at the altitude of 335 m it collided with a Great Black-backed Gull *Larus marinus*. Pilots were ejected successfully and saved life (Aas, 1996). In 1971 the collision with a Lesser Black-backed Gull *Larus fuscus* resulted in the death of the pilot and the crash of a F-5 jet (Aas, 1996).

Information from Sweden about 917 birdstrikes recorded in the years 1998-2005 does not mention the bird species involved in them (Andersson, 2006). It just points out that 65% of accidents were caused by small bird species the size of the European Starling, 29% were provoked by birds the size of Gulls and in 6% of cases the perpetrators were the size of geese. Widely commented was the catastrophe of a Finnish school jet Hawk Mk51 at Kruunupyy base on 28 September 2006, when during the night landing the plane flew into a flock of Eurasian Wigeons *Anas penelope*. The pilot ejected successfully.

East Central Europe (former Czechoslovakia, Poland and Hungary): Murar (1994a, b) records that in the years 1987-1992 the military aircrafts of Czechoslovakia (now The Czech Republic and The Slovakia Republic) took part in 217 birdstrikes. In 82 cases the offenders were identified. Most numerous of them (20.7%) were Gulls *Larus* sp. (17 events). Fewer accidents were caused by Barn Swallows (14 events) and Feral Pigeons (10 events), Eurasian Buzzards (9 events), Common Swifts (6 events), Eurasian Kestrels (5 events), Skylarks 4 (events) and Ducks (3 events). Ten species were the cause of 14 (17.1%) of collisions; these were Rook, Long-eared Owl, Grey Partridge, European Starling, European Blackbird *Turdus merula*, House Sparrow *Passer domesticus*, Goldfinch *Carduelis carduelis*, Common House Martin *Delichon urbicum*, Quail *Coturnix coturnix* and Meadow Pipit *Anthus pratensis*.

In the years 1993-1999 Air Forces of The Czech Republic recorded 98 collisions whose perpetrators were identified (Krupka, 2000). Among them, Black-headed Gulls, Barn Swallows and Common House Martins dominated, causing 12 (12.2%) events. The following eleven birdstrikes were provoked by Pigeons *Columba* sp. Eurasian Kestrels, Hoopoes and European Starlings were responsible for 8 collisions each, while Skylarks, Eurasian Buzzards, Rooks and Long-eared Owls were involved in 5 accidents each. The remaining 19 birdstrikes involved 1-3 collisions with Mallards, Greylag Geese, White Storks, Northern Lapwings, Partridges, Greenfinches *Carduelis chloris*, Great Spotted Woodpeckers *Dendrocopos major*, Chaffinches *Fringilla*

coelebes, Linnets *Carduelis cannabina*, Wagtails Motacillidae, Doves *Streptopelia* sp. and unknown owls (Krupka, 2000). In Czechoslovakia two collisions were reported: an Aero L-29R with a Grey Partridge in 1967 and a jet Mig 21 MF with Black-headed Gulls in 1985 (Richardson and West, 2000).

In Poland, too, birds pose danger for airtraffic. Data from the years 1965-1966 report at least 2 dangerous air accidents caused by birds. The first of them involved a jet TS 11 Iskra class which collided with a flock of Pigeons *Columba* sp. Several birds got into the engine stopping its work, the pilot had to perform a crash landing. The other situation involved the collision of the plane Lim 5 with a flock of several thousand Jackdaws *Corvus monedula* and Hooded Crows *Corvus cornix*. While colliding, approximately 400 Corvids were killed, of which 30-50 individuals were sucked into the engine (Milkiewicz, 1967). In August 1965 near the airfield in Radom (C Poland) a TS-11 Iskra flew into a flock of domestic pigeons which stopped the work of the engine. During the crash landing the pilot was killed and the plane crashed (Klich, 2008). In April 1972, during the collision of the plane Lim-1A”T” with a Buzzard or Goshawk, the pilot lost his eye and suffered head damages (Klich, 2008). At present, some of the Polish airfields, e.g., Babie Doly or Babice, report collisions of planes with Eurasian Kestrels. These are the birds which feed on prey on runways (personal information: Oraczewski J., Kaminska M.). Well-known are also the collisions with Gulls, particularly at the airfields located in the vicinity of big river valleys (e.g., Deblin or Modlin) and the regions of northern and western Poland abundant in wetlands (Cwiklak *et al.*, 2009; Kitowski *et al.*, 2010). Troublesome, too, is White Stork as Poland is the nesting place of its world-largest population estimated to consist of 34-41 thousands breeding pairs (Tomialojc and Stawarczyk, 2003). Collisions of planes with White storks have been noted in Poland during the last 40 years (Milkiewicz, 1967; Dzik and Kiernicki, 2005). In 1993 a TS Iskra jet collided with a White Stork, the plane was severely damaged. Another TS Iskra hit a White Stork in 1999 over the Deblin airport, also reporting damages. Also, other big mass birds included; Cranes *Grus grus*, Bean Goose *Anser fabalis*, Mute Swans *Cygnus olor*, generated possibilities of collisions (Kitowski *et al.*, 2009) This airport records collisions with Black-headed Gulls as well (Kitowski *et al.*, 2010).

Papp (1996) observes that in the years 1960-1996 birds caused 67 collisions with the aircrafts of Hungarian Air Forces. In 6 cases the offenders were identified; these were Mallards, European Starlings, Wood Pigeons and Collared Doves *Streptopelia decaocto*. At the airfield in

Taszar (S Hungary) in 1960 a Mig 15 S jet collided with Imperial Eagles *Aquila heliaca*. In 1984 at the same airfield a Mig 21 fighter collided with a Bean Goose, causing the death of one of the two pilots.

Eastern Baltic States (Lithuania and Estonia): The offenders were identified in the case of 33 collisions of civil aircrafts with birds which took place in the years 1958-78 Lithuania (Zalakevicius, 1994). 27.3% of them involved Ravens *Corvus corax*, Jackdaws, Rooks and Hooded Crows. The following 21.2% were attributed to Domestic Pigeons. Herring Gulls and Black-headed Gulls caused 18.2% of accidents. Only 2 (6.1%) events involved unidentified raptors Kite *Milvus* sp. and Buzzard *Buteo* sp. Similarly, two civil aircrafts each were in danger of striking Barn Swallows, Partridges, Common Starlings and Swifts and one plane did hit an unidentified duck (Zalakevicius, 1994).

Shergalin (1990, 1992) sums the data on over 350 strike events in Estonia in the years 1951-1991. The collisions were mostly caused by Black-headed Gulls, Herring Gulls and Common Gulls which were responsible for 57% of accidents. Skylarks and Swallows took part in only ca. 20% of collisions. Geese and Ducks (including Ducks of the genus *Anas* sp.) stood behind 4% of events. Birds like diurnal and nocturnal raptors, Ravens, Grey Partridges, Northern Lapwings, Common Swifts and Pigeons *Columba* sp. or Doves *Streptopelia* sp. were involved in fewer than 5 % of analysed accidents. Worth noticing as well are the collisions with Black Grouse *Tetrao tetrix*. The collision of a Soviet supersonic jet Mig 17 class with a Common Crane near Tallin in April 1966 was also widely commented, as it resulted in the death of the pilot (Russell, 2002).

Countries of Southern Europe: Bulgaria, Greece, Croatia, Italy and Spain: Out of the 70 birdstrikes of Bulgarian aircrafts in the years 1974-1981, in 18 cases the offending species were identified (Nankinov, 1982). In 6 (33.3%) cases these were White Storks, in 4-Herring Gulls and in 2-Jackdaws. One collision each was attributed to such taxons as Rock Pigeon *Columba livia*, Wood Pigeon, Ring-necked Pheasant, Partridge, Duck of the genus *Anas* sp. and Sparrow *Passer* sp. There is no recent data from Bulgaria, e.g., on the well-known collision in January 1997 when in the Air Base Dobritch (NE Bulgaria) a jet Mig 21 class crashed after flying into a flock of Wood Pigeons.

Croatia reported 36 birdstrikes in 2007. In 10 cases only the cause of the collision has been identified. Seven of them involved Herring Gulls and Yellow-legged Gulls *Larus michahellis*, the remaining three were caused by

European Starlings, Barn Swallows and Goshawks (BSCC 2008). In 2008, the offending species were identified in 35 cases. Herring Gulls, Yellow-legged Gulls and Black-headed Gulls were responsible for 37.1% of accidents. Fewer collisions were provoked by Owls *Strigiformes* and Falcons *Falco* sp.: 17.1 and 14.3%, respectively. In 4 cases (11.4%) the machines hit Swallows and 2 times each they collided with Buzzards *Buteo* sp. and Corvids. Moreover, isolated collisions involved Starlings, Grey Herons and unmarked Ducks (BSCC., 2009).

Nikolaidis (2003) presents data on 55 birdstrikes that took place in Greece in the years 1999-2000. The highest percentage of events (25-45.5%) was provoked by Gulls, in one case definitely involving Black-headed Gulls. In 25.5% of accidents the perpetrators turned out to be Swallows Hirundinidae and in one case it was possible to identify Barn Swallows. Five (9.1%) of collisions were caused by family finches Fringillidae and by diurnal raptors, including Vultures. Three (5.4%) birdstrikes involved Pigeons. In single cases the collisions were provoked by unidentified Herons, Owls and an unmarked Partridge (Nikolaidis, 2003). A dangerous collision took place in July 1996 at the airport of Aktion (W Greece). A Boeing E-3 Sentry (AWACS) taking off flew into a flock of Starlings and into an unmarked diurnal raptor. The crew survived but the aircraft crashed (Richardson and West, 2000).

Italian data for the year 2007 gathered at 27 civil airfields record 275 birdstrikes whose offenders were determined (ENAC and BSCI, 2007). Among them, the most numerous were Gulls (28.7%). In the majority of cases (58%) they were unmarked; the remaining events involved Yellow-legged Gulls and Black-headed Gulls. 24% of accidents were provoked by diurnal raptors, chiefly by Eurasian Kestrels (86.4%). A small percentage of collisions was caused by Buzzards, Marsh Harriers *Circus aeruginosus* and Montagu's Harriers *Circus pygargus*. Passerines were responsible for 61 (22.2%) birdstrikes, most of which (30) involved Swallows Hirundinidae. The participation of Starlings and Sparrows *Passer* sp. was 3 times smaller than that of Swallows. Other passerines, smaller in size, took part in 1-2 collisions. Corvids were represented by 6 individuals of Hooded Crows. Among the remaining species, worth noticing are Pigeons (9.8%). Owls took part in 20 accidents, locally posing considerable danger, e.g., at the Trapani Airfield in Sicily. At this particular airport Little Owls *Athene noctua* caused half of all the birdstrikes. In Italy, the participation of Common Swifts in the collisions was small (ca. 3%), just as was the case of Herons Ardeide (2.2%). Waders, represented by

Lapwings and Eurasian Stone Curlews *Burhinus oedicnemus*, caused a very small percentage of accidents (1.5%) in Italy. Ring-necked Pheasants close the list of collisions, being responsible for only 2 (<1%) birdstrikes with planes. Recent data from 2009 mention two feral pigeons which damaged an aircraft at the Bologna airfield. Other data point to Yellow-legged Gulls as the cause of several serious collisions at the airfields of Florence and Naples.

Spain plays the leading role as the chief European habitat of Eurasian Griffon Vulture *Gyps fulvus*, Bearded Vulture, *Gypaetus barbatus*, Egyptian Vulture *Neophron percnopterus* and Cinereous Vulture *Aegypius monachus* (Heath *et al.*, 2000). Hence, the most serious birdstrikes there involve vultures. In 1964 the aircrafts AISA II 15 and F-86 Sabre class collided with them. In 1976 a Dornier Do 27 hit a vulture, just as in 1994, when a fighter aircraft F-18A hit another vulture over the military airfield Bardenas (W Spain) (Chamorro and Clavero, 1994). Manueco (1992) reported that in the years 1987-1991 fourteen collisions of military jets with vultures took place. In the years 1992-1994 two jets were damaged by Eurasian Griffon Vultures (Chamorro and Clavero, 1994). In July 1996 at the airport of Pamplona, a Robin DR380 crashed after colliding with a Griffon Vulture, killing 3 people (Thorpe, 2003; 2005). We have also data on 7 further birdstrikes with Little Bustards *Otis tetrax* in 1968 (Chamorro and Clavero, 1994). The record from 1984 describes the collision of a jet Northrop F-5 A class with unidentified Ducks over the wetland National Park Tablas de Daimiel (C Spain) (Richardson and West, 2000). At the airport of Ibiza (Balearic Islands) in 1980 a DC-9 with 120 passengers on board hit a flock of Gulls. In 1990 the same airport witnessed the collision of a CON-AIR Airbus-300 with 220 passengers on board with two Gulls. The latter cases were the result of an unprecedented increase in the local population of Audouin's Gulls *Larus audouinii*, Black-headed Gulls and Herring Gulls (Chamorro and Clavero, 1994).

Geographical trends in birdstrikes: Summing up, it is easily noticed that Gulls play the most important role as a source of danger for aircrafts in British Islands and in the coastal parts of the continent. In northern parts of Europe the danger is posed by Common Gulls, Herring Gulls and in the south by Yellow-legged Gulls and Vultures. In western and central Europe, apart from Gulls (Herring Gulls and Black-headed Gulls) the danger of birdstrikes is connected with diurnal raptors (Kestrels, Buzzards), Corvids and Storks. On the one hand, such species as Northern Lapwings, European Starlings, Pigeons, Swallows, Swifts, Black-headed Gulls, Eurasian Kestrels

and European Starlings seem to create a real danger for planes all over the continent. Due to the abundance of wetlands, the airtraffic in the north of Europe is jeopardized by the increase in the number and range of big flocky wildflows such as Geese or Swans. Fortunately, the all-year-round presence of Corvids at airfields, on the other hand, does not seem to influence the participation of these birds in birdstrikes.

Deterrence of birds: Europe employs a number of methods to keep birds off the airfields. One of the most common is falconry. Spain and the UK have been particularly good at it, successfully chasing off the airfields such species as Eurasian Stone-curlews, Red-legged Partridges *Alectoris rufa*, Lapwings, Gulls, Pigeons, Corvids and European Starlings (Ericson *et al.*, 1990; Chamorro and Clavero, 1994). In Poland, falconry brings good results in the deterrence of Corvids, European Starlings, Lapwings and Gulls (Kitowski *et al.*, 2010). Other European airports, too, use trained raptors to chase away unwanted birds (Kuzir and Muzinic, 1999). Most commonly employed for that purpose are trained Peregrines *Falco peregrinus*, Sakers *Falco cherrug* and Goshawks (Ericson *et al.* 1990; Chamorro and Clavero, 1994; Kitowski *et al.*, 2010).

Radiocontrolled models are an interesting alternative to falconry. Presently, the Italian radiocontrolled model FALCO ROBOT GBRS®, particularly efficient in the dispersal of large flocks of birds, seems to be the most advanced project (Battistoni, 2003, 2007; Battistoni *et al.*, 2008). The use of lasers is also being developed; they are used to deter Gulls, Ducks, Waders, Pigeons and Corvids from airfields and communal roosts located near them in the UK, France, Netherlands and Italy (Briot and Bataille, 2003; Mens, 2006; DGAC., 2008).

Starting from the 1950s British airfields (Brough and Bridgman, 1980) and recently German ones (Schmid and Matthaus, 2005; Morgenroth and Pfeleging, 2006), began to implement the so-called Long Grass Policy (LPG) project. It aims to control the height of plants overgrowing the airfields in order to effectively curb the presence of birds (Deacon and Rochard, 2000). The long grass policy assumes that tall plants (i.e., taller than 15-25 cm) can seriously limit the birds' possibilities of finding food, their social contacts and the detection of predators (Deacon and Rochard, 2000). The LPG has been particularly effective at reducing the numbers of Northern Lapwings, Eurasian Kestrels, Black-headed Gulls, European Starlings, Golden Plovers and Herons (Brough and Bridgman, 1980; Schmid and Matthaus, 2005; Morgenroth and Pfeleging, 2006).

One of the major problems of European airfields is the presence of invertebrates (earthworms Lubricidae,

beetles *Coleoptera*, etc.) attracting especially Gulls. A range of chemical and biological products is used to repel them by infecting them with their natural enemies (Aas *et al.*, 2008; Stenman *et al.*, 2007). Special drainpipes installed near the runways are one of the alternatives to the abovementioned method. In contrast to Israel or the USA, Europe does not seem to use dogs of the *Border collie* breed, or to implement translocation projects (Carter, 2000a, b; Cummings *et al.*, 2002; Anderson and Osmek, 2005). Exceptional in this respect are Dutch air bases, where a successful project of translocating raptors has been carried out (Dekker, 2009). European airfields use more invasive methods, too. Shooting seems to reduce the number of Gulls and Corvids (Dahl, 1984; Kuzir and Muzinic, 1999; Von Ramin, 2008), but it fails completely in the case of Eurasian Kestrels (Stenman *et al.*, 2007). Apart from shooting, some European airfields have resorted to the destroying of nesting places and breeding habitats of birds (Heighway, 1969; Dahl, 1984; Stenman *et al.*, 2007; Weitz 2003). Distress calls and pyrotechnics have also been employed to disperse larger groups of birds (Dahl, 1984; Briot, 1987; Mens, 2006; Stenman *et al.*, 2007).

Future challenges: Just as other species, large wetland birds such as Geese, Swans and Herons tend to increase their population and range. This increase may in future generate problems similar to those posited presently by Canadian Geese in the USA and Canada. Interestingly, the latter species has been considerably increasing its numbers in Europe, too (Burfield and van Bommel, 2004). The safety of many airfields is further complicated by the attitude of local governments which arbitrarily locate large waste dumps in their vicinity. It is a common problem for the airports in both East-European undeveloped countries and in other more developed countries, too (Krupka, 2000; Dzik and Kiernicki, 2005; Stenman *et al.*, 2007). Another danger is produced by breeders of domestic pigeons living near the airports (Krupka, 2000; Kitowski *et al.*, 2010). Finally, the operation of airports near important wildfowl refuges protected by the law in accordance with the NATURA 2000 programme, is a still ongoing problem far from being solved.

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