SERIOUS BIRDSTRIKE ACCIDENTS TO U.K. MILITARY AIRCRAFT, 1923 TO 2004: NUMBERS AND CIRCUMSTANCES

W. John Richardson[1] & Tim West[2]
[1] LGL Ltd., environmental research associates
22 Fisher St., POB 280, King City, Ontario L7B 1A6, Canada
Tel: +1-905-833-1244, Fax: +1-905-833-1255, Email: wjr@LGL.com
[2] DeTect Inc.
3160 Airport Rd., Panama City, Florida 32405, U.S.A.
[2]Tel: +1-850-763-7200, Fax: +1-850-763-0920, Email: timbash@aol.com

Abstract

Available records of serious bird-related accidents to U.K. military aircraft are more complete than are military data from other countries. This paper provides an updated list and analysis of the U.K. military accidents, now for 82 years (1923-2004). Serious accidents are those where the aircraft was destroyed or damaged beyond repair, plus any others with a human fatality. Previously we documented 65 serious bird-related accidents to U.K. military aircraft, and 9 aircrew fatalities, during 1950–1999 [Richardson & West 2000: IBSC 25/WP SA1]. We now list 108 losses of U.K. military aircraft, 101 to birdstrikes and 7 to crashes during attempts to avoid birds. Of these accidents, 99 were Royal Air Force (RAF), 7 Royal Navy (RN), and 2 Army Air Corps (AAC). These totals are still underestimates as records for early years are incomplete, and losses for which birdstrike evidence is lacking or weak are omitted. Of 108 known serious bird-related accidents to U.K. military aircraft, 63 were in or near the U.K., 12 in continental Europe, 23 in south and SE Asia, 4 in the Mideast/SW Asia region, 4 in Africa, 1 in the Falklands, and 1 unknown. At least 25 aircrew were killed.

The many bird-related losses of U.K. military aircraft before 1950 (at least 39, all piston-engined and all RAF) are notable; the first confirmed U.K. loss of a turbine-engine aircraft to birds was in 1952. Although documented in RAF and aviation history records, most pre-1950 losses seem to have been previously unknown to bird-hazard specialists. The highest loss rates were in 1943-1945, when the U.K.'s annual losses to birds were at least 7-8 aircraft. Known pre-1950 losses included 18 single- and 21 multi-engine aircraft. Of these 39 pre-1950 losses, 21 were in southern Asia. Vultures were the predominant problem there, with gulls being more problematic in the U.K. There were more confirmed U.K. aircrew fatalities to birdstrikes before 1950 than since 1950 (at least 16 vs. 9), largely related to the use of ejection seats in most jet aircraft, which have predominated since 1950. Since 1955, 41 aircrew are known to have ejected successfully from U.K. military aircraft lost to birdstrikes.

This paper cross-tabulates the numbers of known accidents for various combinations of three eras (pre-1950, 1950–79, 1980–2004), region, type of aircraft, number of engines, month, phase of flight, near aerodrome vs. en route, altitude and speed, part(s) struck, and type of bird. An Appendix lists the circumstances of the 108 individual accidents. A separate list identifies 27 additional accidents to U.K. military aircraft that are discounted as "not bird related" or "not confirmed as bird related", and otherwise excluded from this paper.

Key Words: military aviation, mishap investigation, risk assessment, history, low-level, aerodrome, statistics, fatalities, ejection, location, aircraft type, bird type, gull, vulture, engine, windscreen, United Kingdom, Germany, India, Pakistan, Africa

Introduction

Considerable information about the numbers and circumstances of serious accidents to military aircraft has become openly available in recent years for various countries. For example, for the 1950-1999 period, we identified 286 serious bird-related accidents to military aircraft from 32 countries (Richardson & West 2000). By "serious", we mean cases where the aircraft was destroyed or damaged beyond repair, or where there were human fatalities. At least 63 of these 286 accidents were fatal, with at least 141 human deaths. That total included accident data of variable completeness from most countries in Europe and Russia plus Canada, U.S.A., Israel, Australia, and New Zealand. At least 67 additional serious bird-related accidents were known for a few other countries, mainly in 1978-1999. All of these totals were no doubt underestimates. Birdstrike accident records, and especially those openly available, are known or suspected to be incomplete for most if not all countries. Also, many countries still do not release much information about military aircraft accidents.

The value of data on numbers and circumstances of serious accidents to military aviation is noted in previous papers (Richardson 1994, 1996; Richardson & West 2000). Such data are important in understanding the scope of the problem and the most hazardous situations.

In our 2000 analysis, the United Kingdom (U.K.) was the country for which available data were most complete and extensive. The U.K. was unusual in that available records extended back to 1950. For 1950-1999, we found records of bird-related losses of 9 U.K. aircrew and 66 U.K. military aircraft (one now discounted—see 53-07-30 in Appendix 2). We now provide a further updated and expanded account for U.K. military aviation, including many additional serious bird-related accidents in 1923-1949 and four in 2000-2004, plus minor updates for the intervening period (Appendix 1). This provides by far the most extended (82 years) and comprehensive compilation of birdstrike accident data available for any country's military services.

It is notable that there were numerous bird-related aircraft and aircrew losses in the eras predominated by piston engines or early types of turbine engines. For most other countries, birdstrike accident data from those eras are not readily available. If the U.K. results summarised here are even loosely representative of military aviation in other countries, there must have been a large number of additional birdstrike losses elsewhere that are unknown to present-day birdstrike specialists. We hope that the newly-compiled information on early U.K. losses, based largely on official sources, will encourage others to investigate archived accident data from other countries.

Methods

2.1 Data Sources

Most of the information about the accidents in recent decades was obtained from official U.K. government sources described in our three earlier papers. Briefly, official data on Royal Air Force (RAF) losses from 1970 to 1999 were provided by the (then) RAF Inspectorate of Flight Safety (IFS). Similarly, the Royal Navy (RN)'s Flight Safety & Accident Investigation Centre (FSAIC) provided details for most RN birdstrike accidents in 1958-2000, and the Army Air Corps (AAC) provided information on their losses in 1964-1999. Accidents in 2000-2004 (4 RAF bird-related accidents) have been described in news reports summarising the results of the official accident investigations (2 accidents) and in unofficial accounts.

We compiled information about RAF (and some AAC) accidents in 1923-1973 from Aircraft Accident Record Cards (Air Ministry Form 1180) held at the Air Historical Branch (AHB), now

located at RAF Bentley Priory, Middlesex, and from microfilm copies at the RAF Museum, Hendon. Aircraft History Cards held at the same locations were also checked in cases of doubt as to whether a damaged aircraft had been repaired and re-flown. The accident cards provide information of varying detail (and legibility) concerning most RAF accidents from the early 1930s to 1973, and some in the mid-late 1920s (RAFM 2001). The format of the accident cards has varied over the years. Figure 1 shows an example involving loss of a 4-engine Lancaster bomber that encountered "plovers" during takeoff on 15 Dec. 1945.

To locate bird-related accidents among the vast number of RAF accident cards, TW scanned every available Accident Record Card and reviewed summarised individual histories of all RAF aircraft. The latter were compiled by J.J. Halley and published by Air Britain (Tonbridge, Kent, U.K.) in the "RAF register" series. The accident cards had been checked systematically during compilation of the Air Britain volumes. Other sources important in identifying or characterising bird-related accidents included the following: • published accident lists (Oliver 1990; Dunn 1996, pers. comm.; Gero 1999; Halley 1999); • histories of specific aircraft types (e.g., Mason 1986; Jackson 1989; Morgan & Stevens 2000); • various issues of *Flight International*, *Air Forces Monthly,* and *Aeromilitaria*; and • sources on the World Wide Web. When these unofficial sources attributed an accident to birds, we subsequently checked the official Accident Record Card, or consulted with IFS, to confirm and supplement the information. For known RAF birdstrike accidents in 1945-1953, we also checked the accounts by Cummings (2000, 2001, 2004), which he compiled from similar sources.

Various additional U.K. aviation historians who have investigated the original accident records were very helpful in identifying early birdstrike accidents. Data on early RN Fleet Air Arm accidents were provided by Sturtivant et al. (2004 and pers. comm.) from his investigation of the histories of all RN aircraft. Likewise, data on accidents during test flying of U.K. military aircraft were provided by Collier Webb (2002 and pers. comm.). E. Myall (pers. comm.) helped resolve questions about causes of some AAC and RN accidents.

Although unofficial sources were essential in identifying accidents reportedly caused by birds, some such reports are not supported by official records (Appendix 2). Therefore, we treated unofficial accounts with caution, and where possible used them only to identify accidents for which official data should be consulted. The few supposed bird-related U.K. accidents for which we were unable to obtain official data are marked with an asterisk (*) in Appendix 1. Also, it should be kept in mind that some bird-related accidents very likely were not recognised as such at the time, or were correctly characterised but the records have not come to our attention. A high proportion of U.K. military aircraft losses have been during wars, when causes of losses very often cannot be determined. Thus, our data undoubtedly are incomplete.

2.2 Accidents Included and Excluded

This paper includes cases in which aircraft were destroyed, damaged beyond repair (dbr), or damaged beyond (economical) repair as a result of collisions with birds. Any additional birdstrike accidents in which humans in the aircraft or on the ground were killed but the aircraft survived would also have been included; however, we are not aware of any such accidents to U.K. military aircraft. We include aircraft that crashed while attempting to avoid birds (6 U.K. cases) or simulated birds (1 case). We include 2 cases in which it is highly probable, but not certain, that there was a birdstrike. Aircraft with RAF serials but operated by U.K.-based Commonwealth (Australian and Canadian) squadrons during World War II were included (2 cases).

Excluded from the present compilation are unofficial accounts of birdstrikes that are discounted by official records, and several “possible birdstrike” cases where the evidence of a birdstrike was weak (Appendix 2). Also excluded are cases in which aircraft were initially treated as “dbr”, but much later were repaired and re-flown by a military or civil operator in the U.K. or elsewhere. Except in Figure 3, we also exclude foreign military aircraft lost to birdstrikes within the U.K.: we know of 4 U.S. Air Force F-111E aircraft that crashed in the U.K. due to birdstrikes (see Appendices to Richardson 1996; Richardson & West 2000).

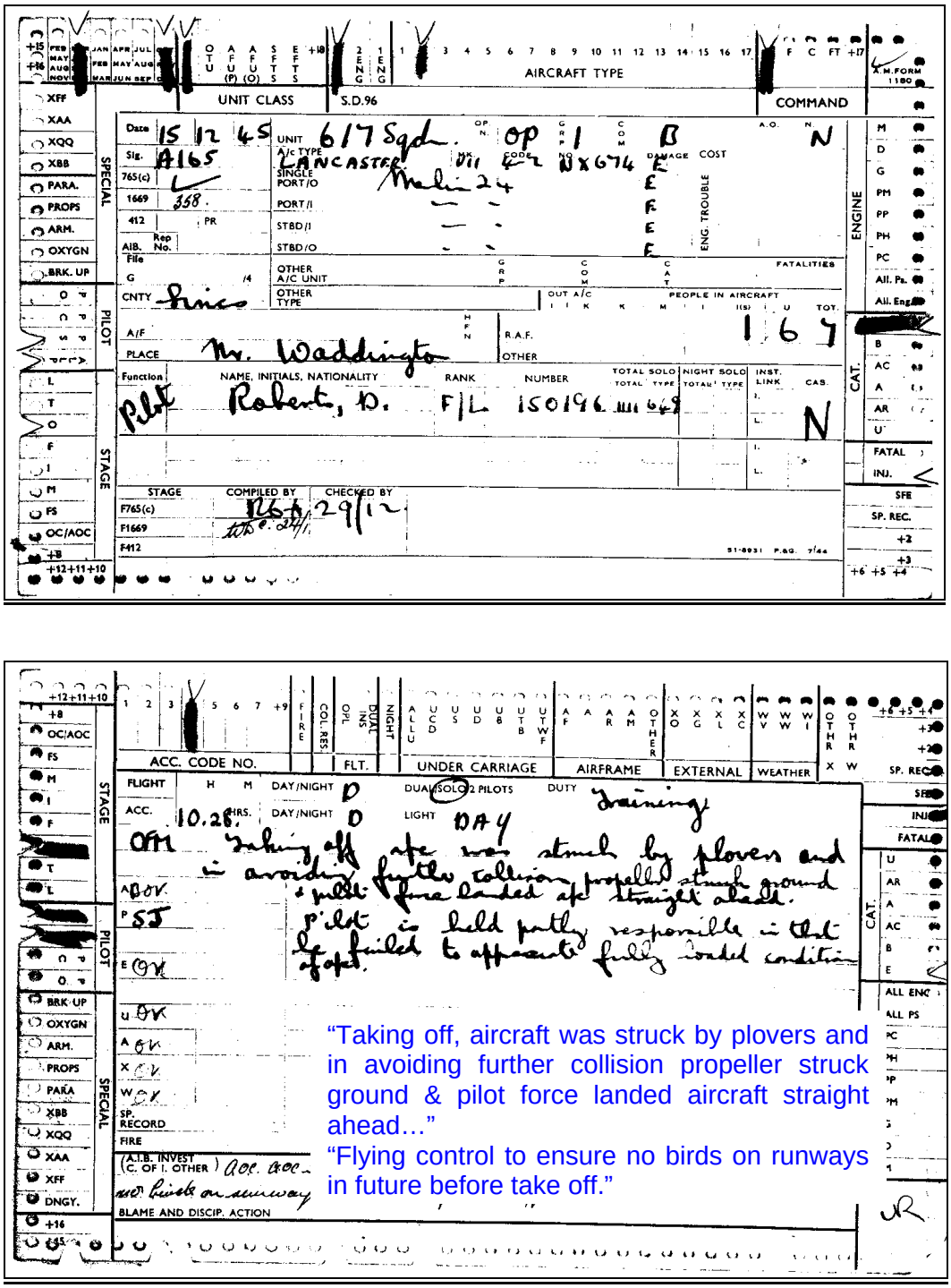

Figure 1. Sample Aircraft Accident Record Card (Air Ministry Form 1180), front and rear, showing loss of a Lancaster bomber struck by plovers, Waddington, England, 15 Dec. 1945.

Number of Serious Accidents and Fatalities

A total of 108 serious bird-related accidents to U.K. military aircraft are known (Appendix 1). These include losses of at least 99 RAF aircraft, 7 RN aircraft, and 2 AAC helicopters. Of these 108 serious accidents, 39 occurred before 1950, 44 in 1950-1979, and 25 in 1980-2004. More of the known bird-related aircraft losses (33) occurred in the 1940s than in any other decade (Figure 2; right side), i.e., an average of 3.3 per year. Most (28) of those occurred during World War II, despite the difficulty in determining causes of many accidents during wartime. The highest annual numbers of known losses to birds were 7 or 8 aircraft per year in each of 1943-1945 (Appendix 1). The known-loss rate decreased rapidly after mid-1945 with demobilisation. The average known-loss rates for 1950-1979 and 1980-2004 were 1.3 and 0.8 aircraft per year, respectively.

Of the 108 serious accidents, we categorised 69 as destroyed and 39 as damaged beyond repair (dbr)—see Appendix 1. Those listed as "dbr" included 13 of 39 losses before 1950 and 23 of 44 in 1950-1979, but only 3 of 25 in 1980-2004. There is some subjectivity in categorising aircraft as destroyed vs. dbr, and records of dbr accidents are perhaps less likely to have been found than those of destroyed aircraft. However, the large reduction in the percentage of dbr accidents in recent years is probably real. It may be related in part to the higher value and longer service lives of modern aircraft, which provide incentive to repair aircraft with damage that might (in the distant past) have been considered too severe to justify repairs. Also, a higher proportion of recent accidents have been at high speed (see Figure 6B, later), increasing the damage and reducing the likelihood of a successful landing.

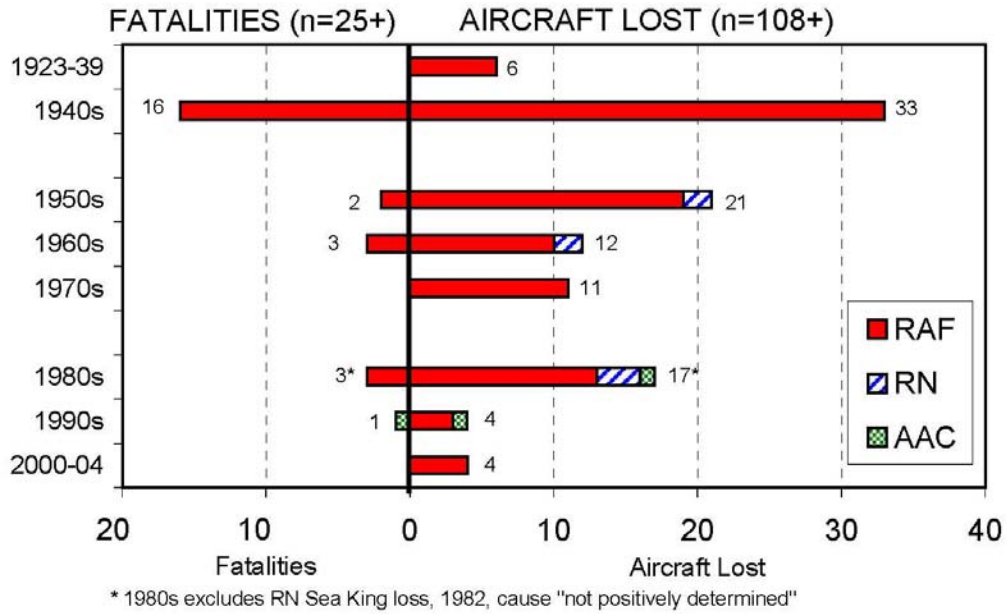

Figure 2. Number of known serious bird-related accidents (right) and associated human fatalities (left) in U.K. military aviation, by service (RAF, RN, AAC) and decade.

At least 25 U.K. military aircrew have been killed in bird-related accidents. Of these personnel, 24 were RAF and 1 was AAC (Figure 2, left side). These losses involved 14 different accidents, with 1-3 fatalities per accident. The majority of the known bird-related fatalities (16) were during the 1940s, all during World War II. The ratio of fatalities to aircraft losses was much higher in the pre-1950 era (16/39 = 0.41) as
compared with later years (9/69 = 0.13). This was at least partly related to the inclusion of ejection seats in most jet aircraft. Since 1955, 41 aircrew have ejected successfully from U.K. military aircraft that were lost to birdstrikes (Appendix 1). [Note that we do not include an RN Sea King helicopter lost with 21 fatalities near the Falkland Islands (19 May 1982; Appendix 2). There are unofficial reports that this crash was caused by collision with a large seabird, but RN FSAIC records show the cause as "not positively determined".]

Locations

Of the 108 aircraft losses considered, 63 accidents occurred in or near the U.K. (Table 1): 41 in England, 15 in Scotland, 5 in Wales, and 2 in or near Northern Ireland. Figure 3 shows the approximate locations where 50 of these aircraft encountered birds. In the other 13 cases, not mapped, uncertainty in location exceeded ~25 km. Also shown are locations of birdstrike accidents to 4 USAF F-111E aircraft.

The remaining 45 known U.K. losses were widely distributed. • South and SE Asia was the region with the second-largest number of losses (23). Most of these 23 accidents were before (4), during (15) or just after (2) World War II in what is now India (10), Pakistan (6), Bangladesh (4), or Burma (1). Birdstrike losses were a recognised concern to the RAF's Air Command South East Asia during World War II (Pavitt 1945; Innes 1985:109). There were two post-war RAF losses to birdstrikes in Hong Kong. • Northwest Europe was the region with the third-largest number of losses (12): 11 in West Germany; 1 in the Netherlands. • There have been 4 known losses in Africa, 4 in the Mideast/SW Asia region, and 2 others (1 in the Falklands Isl.; 1 location unknown). Recent losses (since 1980) have been mainly in the U.K. itself (Table 1), consistent with the reduced number of U.K. military aircraft based overseas in recent years.

Table 1. Regions where known losses of U.K. military aircraft occurred, by era.

Region	1923-1949	1950-1979	1980-2004	Total
UK+N.Ireland	14	26	23	**63**
W Europe	-	11	1	**12**
SW Asia	-	4	-	**4**
S+SE Asia	21	2	-	**23**
Africa	3	1	-	**4**
Other/Unknown	1	-	1	**2**
Total Known	**39**	**44**	**25**	**108**

Types of Aircraft Involved

Prior to 1950, all 39 of the known birdstrike losses to U.K. military aircraft involved piston-engined aircraft (Figure 4), even though the first jets came into RAF service in 1944. These 39 early losses included 19 fighter and attack aircraft, 10 bombers, and 10 training or utility aircraft. Of the 39, 18 were single-engine, 19 were twin-engine, and 2 were four-engine. The losses of 4-engine aircraft included the aforementioned Lancaster (Figure 1) plus a Halifax that crash-landed after the pilot was injured by a bird penetrating the windscreen (Appendix 1). Although there were no known losses of U.K. jet aircraft to birds before 1950, a fatal crash of a German Me-262 jet fighter taking off from Achmer, Germany, on 28 Oct. 1944 has been attributed to a bird strike (O'Connell n.d.).

From 1950 onward, 66 of 69 known U.K. losses to birds involved turbine-engined aircraft (Figure 4). The first was a Meteor twin-engine fighter damaged beyond repair by an engine ingestion and fire in 1952. Jet fighter and attack aircraft were involved in 45 of the 69 accidents from 1950 to date, with 33 of these being single-engine and 12 twin-engine. Jet trainers were the next most common category (12; all single engine). Five jet bombers were lost; all of these were twin-engine Canberras. Of the remaining 4 losses, two involved four-engine jets lost when they struck gulls during takeoff: a Victor tanker and a Nimrod maritime patrol aircraft (for details, see Appendix 1 and Richardson & West 2000). The remaining two losses were AAC helicopters reported to have crashed while attempting to avoid birds.

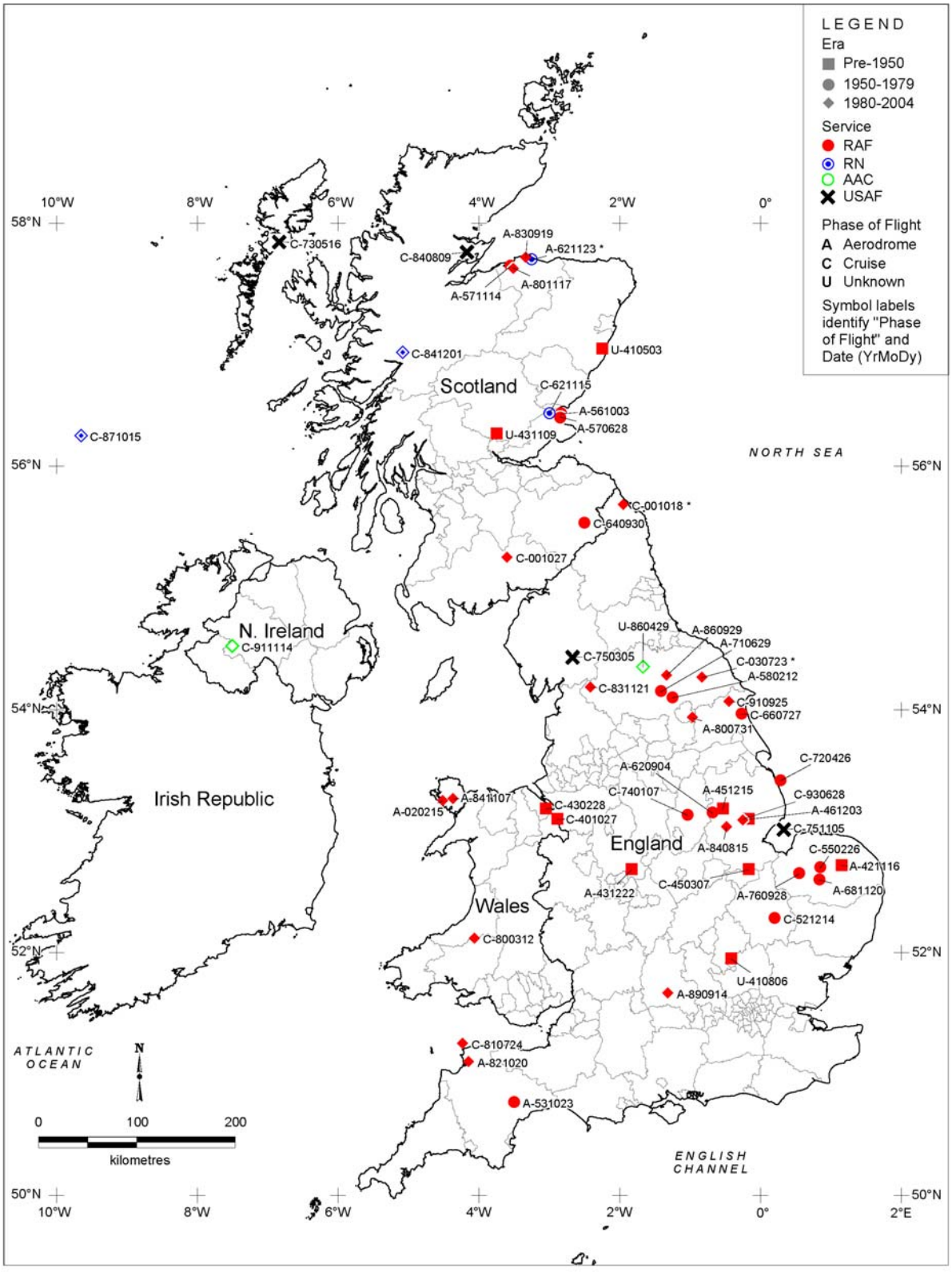

Figure 3. Locations of bird encounters in or near the U.K. that resulted in loss of a military aircraft. Excludes 13 additional cases with >25 km uncertainty in location of bird encounter.

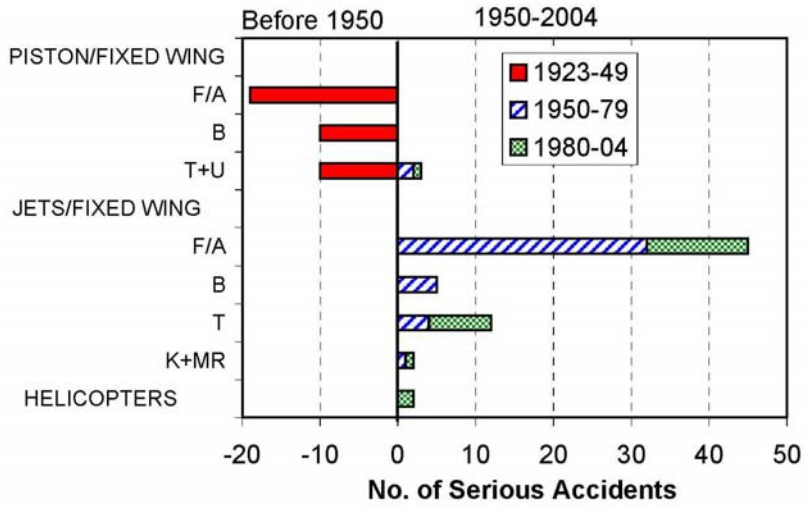

Figure 4. Types of aircraft involved in known bird-related losses of 108 U.K. military aircraft before (left) and since (right) 1950. F/A=fighter/attack; B=bomber; T=trainer; U=utility; K=tanker; MR=maritime.

The specific types of aircraft that were most commonly lost because of birds are listed below (with the number of aircraft lost). All aircraft types involved in 3 or more serious accidents in any one "era" are listed; * denotes multi-engine types:

- 1923-1949: Hurricane (8), Beaufighter (5)*, Mosquito (4)*, Blenheim (3)*, Oxford (3)*
- 1950-1979: Hunter (9[a]), Vampire (8), Harrier (5), Canberra (5)*, Jet Provost (4), Meteor (3)*
- 1980-2004: Harrier (7), Hawk (5), Jaguar (4[a])*, Jet Provost (3)

[a] There was an additional Hunter loss in 1982, and an additional Jaguar loss in 1979.

The Harrier vertical-takeoff and landing (VTOL) aircraft was the type most commonly involved in serious birdstrike accidents (10 RAF + 2 RN). This was related to its single engine, critical flight regime during VTOL operations, frequent operation at low-level, and engine problems in early Harriers. Several U.S. Harriers (AV-8A, -B) have also been lost to birdstrikes (Richardson 1994; Richardson & West 2000).

In terms of fatalities, the worst confirmed U.K. birdstrike accidents, each with 3 fatalities, involved twin-engine aircraft. This is perhaps to be expected given that twin-engine aircraft generally carry a larger crew. The aircraft involved were a Mitchell bomber in 1942 and a Beaufighter in 1944, both with piston engines, and a Canberra jet bomber during 1965.

Circumstances of Losses

6.1 Month

Serious birdstrike accidents occurred in the U.K. itself during all months, but especially in November (Figure 5). The U.K. losses in Western Europe (mainly Germany) were mostly (11 of 12) in February-July. However, when military aircraft from other countries are considered, losses in Western and Central Europe were more evenly spread across the year (Richardson 1996). Losses in South and SE Asia were most common in January-March (Figure 5).

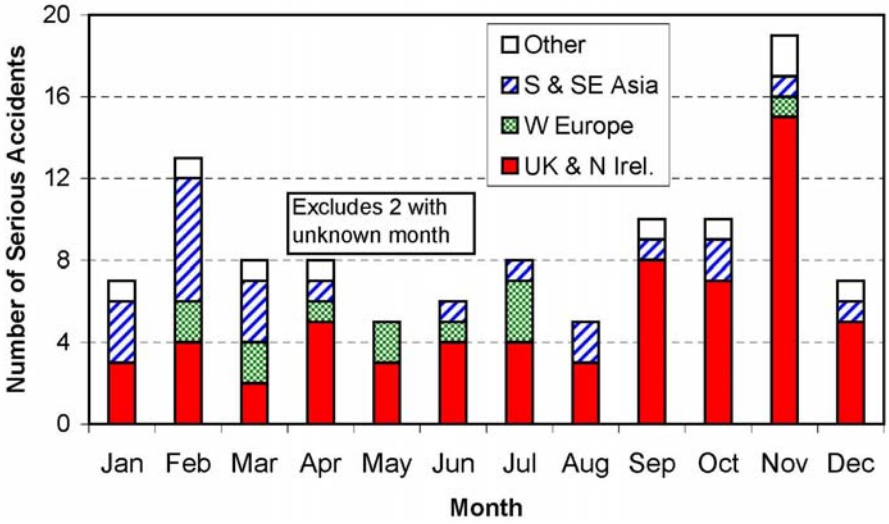

Figure 5. Month of occurrence for 106 known bird-related losses of U.K. military aircraft, subdivided by region.

6.2 Phase of Flight

During all eras, more than half of the U.K.'s known bird-related losses have been during the en route (cruise) phase of flight (Figure 6A). The proportion of the in-cruise losses to birds that have occurred at low altitude (≤1000 ft above ground level, AGL) has increased over the years. Of the bird-related losses near aerodromes, the proportion and number involving birds encountered during the takeoff run has decreased over the years (Figure 6B), perhaps because of improved airfield bird control methods. In contrast, the proportion occurring during climb has increased.

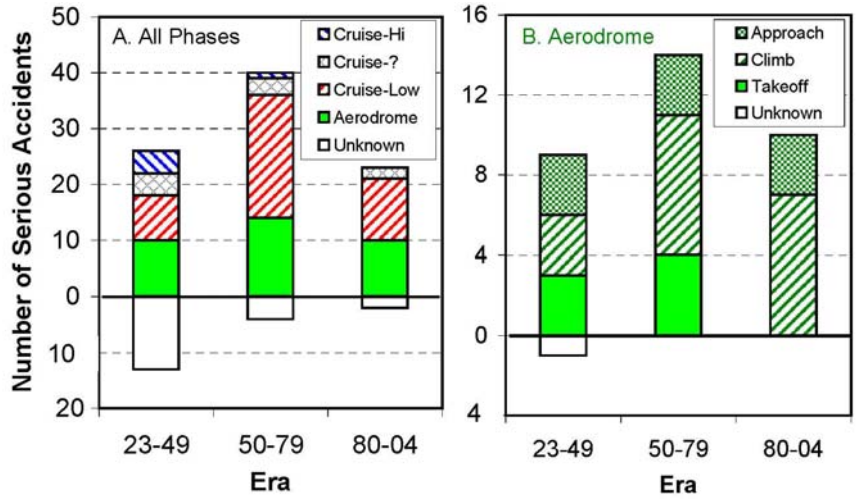

Figure 6. Phase of flight for known bird-related losses of U.K. military aircraft, by era. A: all 108 losses. B: 34 losses near aerodromes.

6.3 Altitude and Speed

Bird-related accidents occurring near aerodromes have been mainly below 500 ft AGL during all eras, as expected (Figure 7A). Similarly, speeds at the times of those near-aerodrome accidents have been low in all eras (Figure 7B).

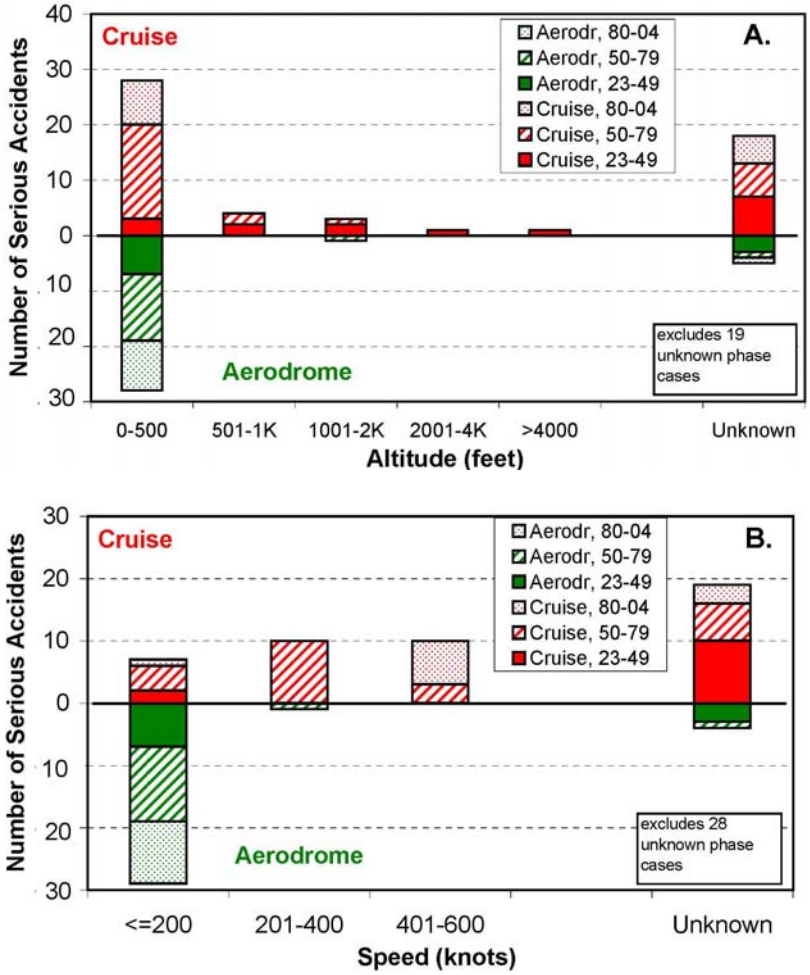

Figure 7. Aircraft altitudes ***(A)*** and speeds ***(B)*** for known bird-related losses of U.K. military aircraft, subdivided by era and by cruise vs. aerodrome. Most accidents with unknown flight phase were at unknown altitudes and speeds.

Altitudes of U.K. military aircraft lost to birds during cruise were mostly ≤500 ft AGL during the encounter (Figure 7A). However, altitudes have ranged up to 4000 ft and 8000 ft (AGL?), in both cases in South Asia in 1944 (bird species unknown; see Appendix 1). Bird-related accidents during cruise flight were more widely distributed in altitude prior to than after 1950. Since 1980, all 8 in-cruise losses for which altitude is known involved birds encountered at ≤500 ft AGL, consistent with the increased proportion of low flying in recent decades.

Aircraft speeds for the in-cruise accidents have tended to increase from era to era, although speeds for early accidents often are undocumented (Figure 7B). Since 1980, most in-cruise losses have involved aircraft travelling at >400 knots.

6.4 Parts Struck

For all years combined, engine damage was the most common cause of bird-related accidents both near aerodromes and in cruise (Figure 8). However, before 1950, when all losses involved piston engine aircraft, engine strikes were not the predominant cause of losses. Accidents before 1950 resulted from strikes to a wide variety of locations on the airframe: most often the wing or ailerons, but sometimes the propeller, radiator, oil or fuel lines, engine, windscreen, air intake/carburettor, etc. (Appendix 1). From 1950 onward, losses were most often caused by ingestion of birds into turbine engines, although during cruise (when speed tends to be high), several losses were due to windscreen penetrations.

The first U.K. jet aircraft had centrifugal-flow compressors in their engines, and these were more ruggedly constructed than the axial-flow compressors adopted later. Of the 29 U.K. jets lost to birdstrikes up to 1965, 13 had centrifugal-flow engines (Meteor, Vampire, Venom, and Sea Hawk aircraft). Of those aircraft, 11 were categorised as dbr and only 2 as destroyed. In contrast, of the 16 cases (up to 1965) with axial-flow jets, 7 were dbr and 9 destroyed (Appendix 1). Up to 1965, engine ingestions were noted for 4 of 12 accidents to aircraft with centrifugal-flow engines, but for 12 of 15 aircraft with axial-flow engines. These data are consistent with the idea that early jet aircraft were more susceptible to serious birdstrike accidents if powered by axial-flow jet engines.

Seven U.K. military losses have been ascribed to crashes during manoeuvres to avoid actual or (in 1 case) simulated birds. These 7 accidents included 2 cases near aerodromes, 4 in cruise, and 1 during an unknown phase of flight (Appendix 1). Given the lack of physical evidence of a birdstrike, there is doubt about the stated reason for some of these accidents.

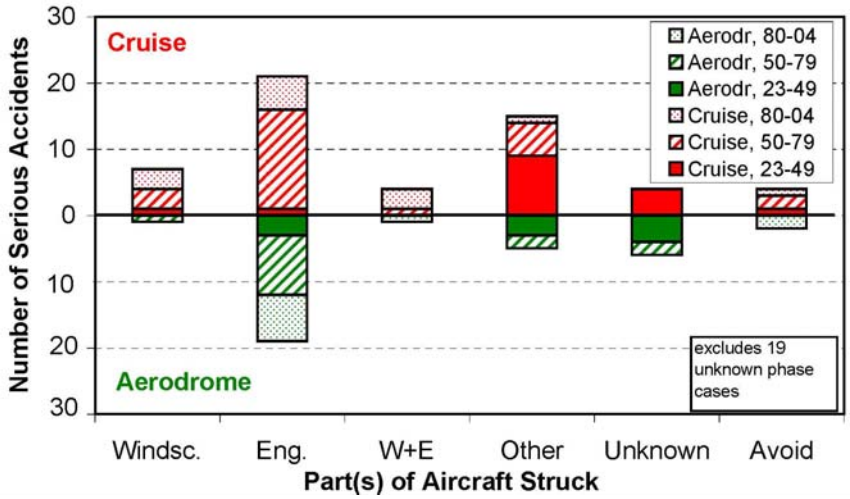

Figure 8. Part(s) of aircraft struck during known bird-related losses of U.K. military aircraft, subdivided by era and by cruise vs. aerodrome. The 19 accidents with unknown flight phase were mainly before 1950, and of those, the part struck was most often “Other”.

6.5 Type of Bird

Of the 44 U.K. accidents attributable to birds of known types, 19 (43%) involved gulls and 10 (23%) involved vultures. Those two groups were problematic both around aerodromes and for cruising aircraft (Figure 9A). Other groups that were each responsible for at least 2 aircraft losses were ducks, waders, kites, hawks, and doves. However, for 59% of the bird-related losses (64 of 108), the type of bird responsible is unknown. It may have been easier to identify the type of bird in the cases of gulls and vultures than for some other groups, so the 43% gulls and 23% vultures figures may overestimate the actual percentages.

The categories of birds responsible for aircraft losses in the U.K. differed from those in southern Asia (Figure 9B). Losses to gulls, as well as ducks, waders and doves, were mainly or entirely in the U.K. and Western Europe. Gulls have remained the dominant cause of aircraft losses in the U.K. up to the present day (Appendix 1). In contrast, losses of U.K. aircraft to vultures, kites, and eagles were mainly in southern Asia (Figure 9B), and predominantly before 1950. U.K. operations there were much reduced after World War II.

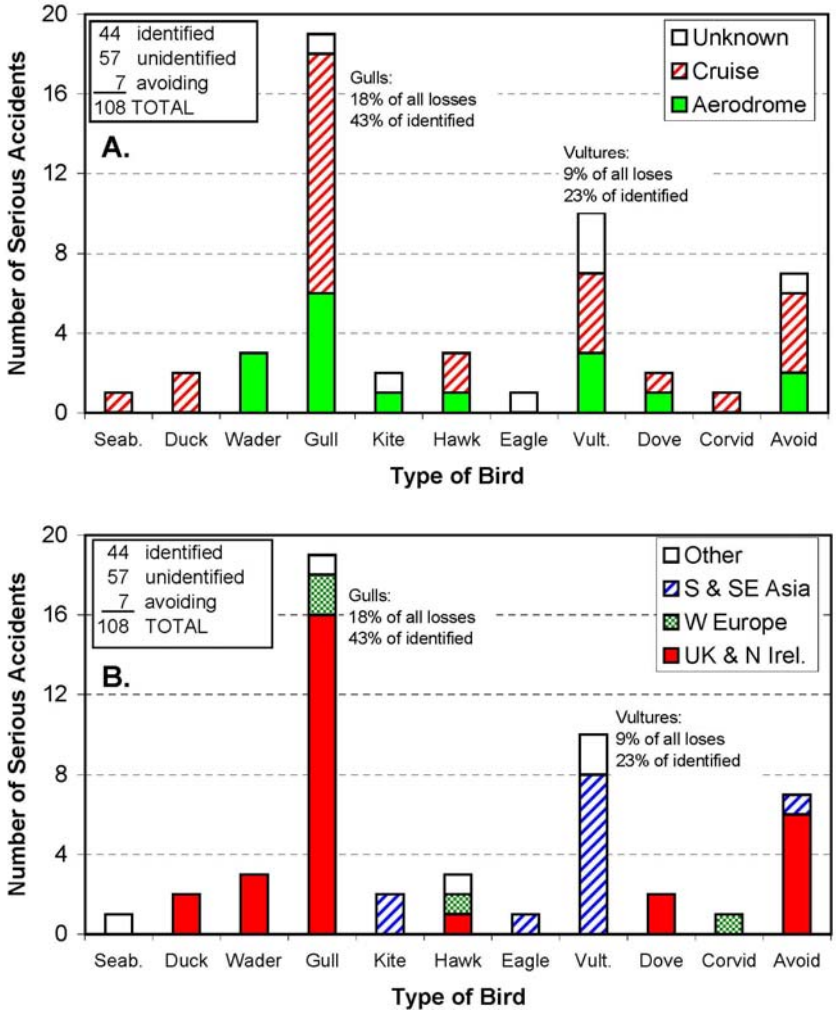

Figure 9. Types of birds responsible for losses of U.K. military aircraft, subdivided by ***(A)*** cruise vs. aerodrome, and ***(B)*** geographic region.

6.6 Special Cases

Avoidance of Birds: At least 7 of the U.K. military aircraft crashes (included above) have been said to involve avoidance of birds or simulated birds: 1 case in India in 1944; 2 cases in the U.K in 1952-1953; and 4 cases in the U.K. or Northern Ireland in 1984-1991 (Figure 9; Appendix 1). Two of the "avoiding" aircraft struck cables. Five of them struck the ground or trees. Whether birds were actually involved in all 7 accidents is unknown. Elsewhere, three similar USAF cases have been reported (Richardson & West 2000), and a Cessna 172 of the Irish Air Corps was lost in Sept. 1978 while avoiding birds (Thorpe 1979; ASI n.d.).

Fatality but Aircraft Not Destroyed: We are not aware of any cases of this type in U.K. military aviation. At least 3 such accidents have occurred in the U.S.A., and one in Brazil (Richardson & West 2000; L.C. Magalhães Bastos, CENIPA, pers. comm., 2000).

Ejection but Aircraft Not Destroyed: We have previously listed two such cases in the U.K.—involving an RN Buccaneer and a USAF F-15E. In those cases, a goose or duck penetrated the windscreen or canopy, 1 of the 2 aircrew ejected, and the other landed the aircraft successfully (Richardson 1996). Those 2 cases are not included elsewhere in this paper. Several similar accidents to non-U.K. aircraft have occurred elsewhere (Richardson & West 2000). A related accident in 1934 that *is* included in our tabulations involved an RAF Fairey Gordon whose undercarriage was struck by a vulture. Two of 3 aircrew baled out. The pilot landed safely but the aircraft was destroyed (RAF 1934).

7. Discussion and Conclusions

This paper summarises 108 serious accidents to U.K. military aircraft ascribed to birds during 1923-2004: 101 with actual birdstrikes, and 7 attributed to avoidance of birds. That is an average rate of about 1.3 known aircraft losses per year over 82 years. However, the known-loss rate has varied greatly from year to year, with the highest rate during the last 3 years of World War II.

Loss numbers and rates quoted here are minima, with the possible exception of those attributed to bird avoidance. • Causes of some accidents cannot be determined, especially in wartime. • We (and those who compiled broader catalogues of accident causes) probably failed to find records for some early accidents originally determined to be bird-related. • Aircraft accident cards are missing from AHB and RAF Museum files for some RAF accidents, especially in the 1920s (RAFM 2001). • It is possible that the involvement of birds was not noted on some of those cards even if that was known at the time. • We made little effort to find any bird-related RN accidents before 1950. • Additional data on bird-related accidents to U.K. aircraft probably could be found in accident files held in the Public Records Office and other archives (Fowler et al. 1994; Spencer 2000).

Despite the limitations, this compilation of U.K. birdstrike accident data is more complete for 1950-1970 than is the publicly available information for military air arms of most other countries. Also, few pre-1950 data are available for any other country. The U.K. data reveal numerous accidents to early jet aircraft (1950-1970). The data also show that the number of serious birdstrike accidents prior to 1950 was surprisingly large, given the presumed lesser susceptibility of slower aircraft with piston rather than jet engines. In retrospect, the many pre-1950 bird-related accidents are to some extent understandable given the far larger numbers of aircraft operated by the U.K. during World War II than in later years. The RAF alone held ~20,000 aircraft in 1945 (Cummings 2004). It would be instructive to calculate the known-loss rates in different eras in relation to flying hours or number of aircraft movements, if “hours” or “movements” could be estimated.

The U.K. data confirm that, before 1950, birdstrike accidents usually involved damage to the wing or other parts of the airframe, and most often did not involve the engine (in contrast to later accidents to turbine-engine aircraft). Before 1950, when engine failure did occur as a result of a birdstrike, the effect was usually peripheral or indirect, e.g., damage to fuel or oil lines, radiator, or carburettor, which subsequently resulted in engine failure. Wing and aileron damage sometimes included damage to fabric-covered or wooden structures, which would not be present on many military aircraft after 1950. In addition, the adoption of swept-back leading edges on many jet aircraft may have reduced the frequency of wing damage, other factors being equal. Thus, it would appear that the wings became less vulnerable to serious birdstrike damage while at about the same time engines became more vulnerable because of the gradual transition from piston engines to centrifugal- and then axial-flow jets.

Considering the accidents for which the type of bird was identified, vultures were the predominant problem before 1950 (9 of 15 accidents) and gulls thereafter (18 of 29 accidents). This was related to the extensive pre-1950 RAF operations in southern Asia, where vultures were abundant. Thereafter, U.K. operations in southern Asia were much reduced, and there has been only one known U.K. loss to a vulture since 1950 (in Nigeria; see Collier Webb 2002:145). However, the Indian and Pakistani Air Forces subsequently lost numerous aircraft in collisions with vultures (Satheesan 1994; Khan 1998). The recent drastic decline in vulture populations in India (Green et al. 2004), though problematic for other reasons, has presumably reduced the risk of aircraft losses there.

The U.K. data suggest that many now-unknown birdstrike accidents must have occurred in other countries where extensive military flying occurred prior to the periods for which accident data are readily available. For example, we are aware of only 9 birdstrike losses of U.S. military aircraft before 1950, 2 for Germany, and 1 for the U.S.S.R. (vs. 39 for the U.K.). Also, we are aware of only 2 losses in those 3 countries in the 1950s (vs. 21 for the U.K.). During years before 1960, those 3 countries (and others) probably incurred many more birdstrike accidents than are currently known, including many before 1950. Further review of early accident reports for those countries would very likely reveal additional birdstrike accidents.

Data on the numbers and circumstances of serious bird-related accidents are useful in documenting the extent of the problem, its persistence to the present day, and the circumstances associated with

the most serious birdstrike accidents. The long series of U.K. data (82 years) is especially instructive in showing how those circumstances have changed as aircraft characteristics and flight practices have evolved. Similar data from other countries would also be instructive. We are continuing to compile data on serious birdstrike accidents to military aircraft of many countries, in anticipation of further analyses for other countries. *We ask that readers who can provide additional or corrected data on such accidents please contact us.*

8. Acknowledgements

We thank the various personnel at the (former) RAF Inspectorate of Flight Safety, RN Flight Safety & Accident Investigation Centre, and AAC Aviation Standards Branch who provided accident information for our previous related papers. We also thank M. Hatch of the Air Historical Branch and D. Cowd of the RAF Museum, Hendon, for providing direct access to the Aircraft Accident Record Cards for the RAF. Aviation historians D. Collier Webb, R.J. Dunn, E. Myall, and R. Sturtivant provided much assistance, and the compilations of J.J. Halley were essential in identifying bird-related accidents. Others who helped in substantial ways over the years included H. Blokpoel, W.R.P. Bourne, and J. Thorpe.

9. Literature Cited

Note: *URL references show websites where various documents were accessible as of 27 Aug. 2005.*

ASI. n.d. Irish Air Corps aircraft 1922-1997. Aviation Society of Ireland. Available at www.iol.ie/~asire/aircorps.html

Collier Webb, D. 2002. UK flight testing accidents 1940-71. Air Britain, Tunbridge Wells, Kent, U.K. 224 p.

Cummings, C. 1997. Lost to service/Summary of accidents to RAF aircraft and losses of personnel, 1959-96. Nimbus Publ., Yelvertoft, Northamp., U.K. 281 p.

Cummings, C. 1999. To fly no more/RAF aircraft accidents and write-offs, 1954-58. Nimbus Publ., Yelvertoft, Northamp., U.K. 332 p.

Cummings, C. 2000. Last take-off/A record of RAF aircraft losses 1950 to 1953. Nimbus Publ., Yelvertoft, Northamp., U.K. 479 p.

Cummings, C. 2001. Final landings/A summary of RAF aircraft accidents and combat losses 1946 to 1949. Nimbus Publ., Yelvertoft, Northamp., U.K. 616 p.

Cummings, C. 2004. The price of peace/A catalogue of RAF aircraft losses between VE-Day and end of 1945. Nimbus Publ., Yelvertoft, Northamp., U.K. 688 p.

Dunn, R.J. 1996. Some of our aircraft are missing/British military aircraft losses 1956 to 1996, Feb. 1996 ed. Privately printed., 58 Penmanor, Finstall, Bromsgrove, Worcs. B60 3BZ, U.K. 238 p.

Fowler, S., P. Elliott, R.C. Nesbit and C. Goulter. 1994. RAF records in the PRO. PRO Readers' Guide 8. Public Records Office, Kew, U.K. 138 p.

Gero, D. 1999. Military aviation disasters/Significant losses since 1908. Patrick Stephens (Haynes Publ.), Sparkford, nr. Yeovil, U.K. 176 p.

Green, R.E., I. Newton, S. Shultz, A.A. Cunningham, M. Gilbert, D.J. Pain and V. Prakash. 2004. Diclofenac poisoning as a cause of vulture population decline across the Indian subcontinent. *J. Appl. Ecol.* 41(5):793-800.

Halley, J.J. 1999. Broken wings/Postwar Royal Air Force accidents. Air Britain, Tunbridge Wells, Kent, U.K. 274 p.

Innes, D.J. 1985. Beaufighters over Burma/No. 27 Squadron, RAF, 1942-45. Blandford Press, Poole, Dorset, U.K. 128 p.

Khan, A.A. 1998. Air accidents in spite of high efficiency. *Def. J. (Pakis.),* Aug. 1998 issue. Available at www.defencejournal.com/aug98/airaccidents.htm

Jackson, R. 1989. Canberra/The operational record. Smithsonian Press, Washington, DC. 168 p.

Mason, F.K. 1986. Harrier, 3rd ed. Patrick Stephens, Wellingborough, U.K. 240 p.

Morgan, E. and J. Stevens. 2000. The Scimitar file. Air Britain, Tunbridge Wells, Kent, U.K. 232 p.

O'Connell, D. n.d. Me 262 Werk Nummer & losses list. Available at www.stormbirds.com/werknummer/

Oliver, D. 1990. British military aircraft accidents/The last 25 years. Ian Allan, London, U.K. 144 p.

Pavitt, H.J. 1945. Collisions between aircraft and birds/ACSEA--Jan, 1944 to April, 1945. Roy. Air Force/P.A. 3. 2 p. + Appendix.

RAF. 1934. Report on flying accidents July - December 1934. Royal Air Force, Rep. on file at Air Historical Branch, RAF Bentley Priory, Middlesex, U.K.

RAFM. 2001. Royal Air Force aircraft: service histories. Info. Sheet 5. Dep. Res. & Info. Serv., RAF Museum, Hendon, U.K. 2 p. Available at www.rafmuseum.org.uk/london/research/enquiries.cfm.

Richardson, W.J. 1994. Serious birdstrike-related accidents to military aircraft of ten countries: preliminary analysis of circumstances. Proc. Bird Strike Commit. Europe 22 (Vienna): 129-152. WP 21.

Richardson, W.J. 1996. Serious birdstrike-related accidents to military aircraft of Europe and Israel: list and analysis of circumstances. Int. Bird Strike Commit. Proc. Pap. 23 (London): 33-56. WP 2.

Richardson, W.J. and T. West. 2000. Serious birdstrike accidents to military aircraft: updated list and summary. Int. Bird Strike Commit. Proc. Pap. 25 (Amsterdam, vol. I): 67-97. WP SA1. Available at www.int-birdstrike.com/authors.html

Satheesan, S.M. 1994. The more serious vulture hits to military aircraft in India between 1980 and 1994. Proc. Bird Strike Commit. Europe 22 (Vienna): 163-168. WP 23.

Spencer, W. 2000. Air Force records for family historians. PRO Readers' Guide 21. Public Records Office, Kew, U.K. 114 p.

Sturtivant, R., M. Burrow and L. Howard. 2004. Fleet Air Arm fixed-wing aircraft since 1946. Air-Britain, Tonbridge, Kent, U.K. 639 p.

Thorpe, J. 1979. Bird strikes during 1977 to European registered civil aircraft (Appendix 3). Proc. theBird Strike Commit. Europe 14 (The Hague). WP 11. 44 p.

Appendix 1. Known serious accidents caused by birds to U.K. military aircraft, 1923-2004. * denotes accidents for which key details, including the role of birds, are based on unofficial data only. Blanks denote "unknown". See footnotes (last page of this Appendix) for explanation of codes. Narratives for most post-World War II accidents are given by Cummings (1997-2004), Halley (1999), and other sources cited in “2. Methods”.

Date			Aircraft		Acc.	# Persons			Flight			Altitude		Parts Hit			Aircraft
Y M D	Location Where Struck	Ser-vice	Type	Cate-gory	Cate gory	A b.	E j.	Kil-led	Phase/ Time		Type of Bird(s) Struck	AGL (feet)	Speed (knots)	W s	E n	Other	Serial Number
230316	Pakistan**	Dardoni	AF	Br.Fighter F2b	pFA 1	wo		na			vulture		low	-	-	W	J6779
31____ *	Pakistan**	Lahore	AF	Hart	pB 1	dbr?		na			kite		low				J9947
310110	Pakistan**	Risalpur	AF	Wapiti IIa	pO 1	wo		na			eagle		low				J9380
34 [Jul-Dec]			AF	Gordon	pO 1	wo	3	2j	0		vulture		low	-	-	L	
360207	Pakistan**	Kohat?	AF	Wapiti IIa	pO 1	wo		na	0	Cl	unkn.	low	low				J9750
380218	Uganda	Lira	AF	Gordon	pO 1	wo	1	na	0	Cl	large, 2	75	low				K2750
401027	UK/Eng.	Holt, Cheshire	AF	Master I	pT 1	wo	2	na	0	CrL?	D	>1	250	low	-	-	P	N7900
410503	UK/Scot.	Stonehaven	AF	Master I	pT 1	wo	1	na	1			gull		low	-	-	W	T8878
410806	UK/Eng.	Barton-in-the-Clay	AF	Magister I	pT 1	wo	1	na	0		D	unkn.		low	-	-	W	N3833
411115	UK/Eng.	Radcot, Oxfordsh.	AF	Oxford I	pT 2	wo	2?	na	2	CrL	D	duck	low	low	-	-	W	L4638
420424	Zimbab.**	Westacre Jct.	AF	Oxford II	pT 2	dbr		na	0			large		low	-	F?	W	R5997
420824	India	Alipore	AF	Hurricane II	pFA 1	wo	1	na	0	Cir	D	vulture	low	low	-	-	W	BN495
421116	UK/Eng.	Attlebridge, Norf.	AF	Mitchell II	pB 2	wo		na	3	Ap?	D	unkn.			-	F'		FL179
430212	Pakistan**	Risalpur	AF	Hurricane I	pFA 1	wo	1	na	1	Ap	D	vulture	low	low				AG128
430216	India	Calcutta	AF	Hurricane IIC	pFA 1	wo	1	na	0		D	unkn.			-	-	W	HV794
430228	UK/Wal.	Hawarden	AF	Mustang I	pFA 1	wo	1	na	1	Cr_	D	>1						AG585
430328	India	Jodphur (SE of)	AF	Blenheim V	pB 2	wo	3	na	0			large	700					BA931
431011	'India'	Poonawalee	AF	Hurricane IIC	pFA 1	wo	1	na	0		D	unkn.			-	F'	C	HW780
431109	UK/Scot.	Gleneagles	AF	Hurricane I	pFA 1	dbr	1	na	0		D	unkn.			-	F'	-	W9128
431222	UK/Eng.	Lichfield, Staffs.	AF	Wellington X	pB 2	wo		na	0	TO	T	>1	low	low	-	F	-	HE653
440214	India	Vandavapura, Mys.	AF	Blenheim IV	pB 2	dbr	4	na	0	CrH	D	Avoiding Birds	4000		-	-	-	V5956
440225	UK/Eng.	Croft, Yorksh.	cAF	Halifax V	pB 4	wo	8	na	0	Cr_	D	unkn.			P	-		LK907
440424?*	UK/Eng.	Thorney Isl. (near)	aAF	Mosquito FB.6	pFA 2	dbr		na				unkn.						HP924
440623	Pakist.?**	Bahun [Banun?]	AF	Hurricane I	pFA 1	dbr	1	na	0	CrL	D	unkn.	500		-	-	W	Z4692
440905	India	Lucknow	AF	Blenheim V	pB 2	dbr	1	na	0	CrH	D	vulture	~1500					EH379
441010	'India'	Piadoba (NW of)	AF	Mosquito VI	pFA 2	wo	2	na	2	CrH?	D	unkn.	8000		-	-	W	HX821
441105	Banglad.**	Chittagong (near)	AF	Beaufight. X	pFA 2	wo	3	na	3	CrL	D	unkn.	600		-	F?		NV322
441215	Egypt	Gianachlis (NE of)	AF	Baltimore IIIA	pB 2	dbr	4	na	0	CrH	D	unkn.	1800		-	-	W	FA262
450121	Banglad.**	Chiringa	AF	Beaufight. X	pFA 2	dbr	1	na	0	Cl	D	large	500		-	-	W	LZ399
450130	India	Hansi (near)	AF	Hurricane IID	pFA 1	wo	1	na	0	CrL	D	vulture	1000		-	F'	W	HW654
450221	Burma	Sadaung (S of)	AF	Hurricane IIC	pFA 1	wo	1	1j	1		D	vulture			-	-	W	LB668

Appendix 1 (continued).

Date			Ser-	Aircraft	Cate-	Acc.	# Persons A	E	Kil-	Flight Phase/		Type of	Altitude AGL	Speed	Parts Hit W	E		Aircraft Serial
Y M D	Location Where Struck		vice	Type	gory	Cate	b.	j.	led		Time	Bird(s) Struck	(feet)	(knots)	s	n	Other	Number
450307	UK/Eng.	Crowland, Lincs	AF	Oxford I	pT 2	wo	2	na	0	Cr_	D	>1		low	-	-	P	PH413
450322	Banglad.**	Chiringa (near)	AF	Beaufight. X	pFA 2	wo	2	na	0	CrL	D	unkn.	low		-	-	W	LZ534
450410	Banglad.**	Chiringa (SE of)	AF	Beaufight. X	pFA 2	wo	3	1j	2	Ap	D	vulture			-	F'	W	RD270
450730	India	Yelahanka	AF	Mosquito VI	pFA 2	dbr	2	na	0	CrL	D	vulture	400		-	F'	C	RF650
451215	UK/Eng.	Waddington, Lincs.	AF	Lancaster VII	pB 4	wo	7	na	0	TO	D	plovers	v.low	low				NX674
461203	UK/Eng.	Coningsby, Lincs.	AF	Mosquito XVI	pFA 2	dbr	2	na	0	TO	T	>1	v.low	low	-	-	W,P,C	PF572
461215	India	Poona	AF	Beaufight. X	pFA 2	dbr	2	na	0	Cr_	D	unkn.						RD829
491110	UK/Eng.	Finningley, Yorks.	AF	Wellington X	pB 2	dbr	2	na	0	CrL	D	ducks	low					PF993
520424	Germ.,W	Wahn (near)	AF	Meteor NF.11	FA 2	dbr	2	0	0	Cr_	D	unkn.			-	F	-	WD712
521214	UK/Eng.	Cambridge (near)	AF	Chipm. T.10	pT 1	wo	2	na	0	CrL	D	Avoiding Flock	40	low	-	-	-	WG325
530904	UK/Eng.	Moreton-in-Marsh	AF	Harvard T.2B	pT 1	dbr	2	na	0	CrL	D	Avoiding Flock	low	low	-	-	-	KF221
530925	Iraq	Habbaniya (near)	AF	Vampire FB.9	FA 1	dbr	1	0	0	Cr_	T	large, >1		390	S		U	WL549
531023	UK/Eng.	Souden, Exeter	AF	Canberra B.2	B 2	wo	2	0	2	Cl	D	>1	v.low	low		F	U	WF892
540224	Germ.,W?	Gütersloh (near)	AF	Meteor FR.9	FA 2	dbr	1	0	0	CrL	D	>1	100		-	F		VZ600
550121	Jordan	Amman (near)	AF	Vampire FB.9	FA 1	dbr	1	0	0	CrL	D	>1	50	240	-	-	W,N	WR155
550226	UK/Eng.	Wendling, Norf.	AF	Meteor F.8	FA 2	wo	1	1	0	CrL?	D	>1	low		-	F		WE884
560127	UK/Scot.	Kinloss (nr), Moray.	AF	Vampire FB.5	FA 1	dbr	1	0	0	CrL?	D	unkn.	1000		-		W	VZ286
560202	Hong Kong	Sek Kong	AF	Vampire FB.9	FA 1	dbr	1	0	0	Ap	D	unkn.			-	-	W	WG850
561003	UK/Scot.	Leuchars, Fife	AF	Hunter F.4	FA 1	wo	1	0	0	Cl	D	unkn.	v.low	low	-	F		XE705
561101	UK/Eng.	Norfolk?	AF	Hunter F.1	FA 1	dbr	1	0	0	CrL	D	unkn.	low		-	-	I	WW600
570410	UK/Wal.	Anglesey area	AF	Vampire T.11	FA 1	dbr	2	0	0	CrL	D	gulls	500	350	-	-	W,I	XH319
570521	UK/Eng.	Devon area	AF	Hunter F.1	FA 1	dbr	1	0	0		D	>1			-	-	I	WT681
570628	UK/Scot.	Leuchars, Fife	AF	Hunter F.4	FA 1	wo	1	0	0	Ap	D	>1	low	low	-	F		XF997
571114	UK/Scot.	Kinloss	AF	Hunter F.4	FA 1	dbr	1	0	0	Cl	D	unkn.	1800	300	-	I	I	WT719
580212	UK/Eng.	Linton on Ouse	AF	Vampire FB.5	FA 1	dbr	1	0	0	TO	D	unkn.	0	90	S	-		WA257
580428	UK/Scot.	Moray Firth?	RN	Sea Hawk FB.3	FA 1	dbr	1	0	0	Cr_		unkn.			-	I	I	WM981
581028	Nigeria	Kano, ENE of	RN	Sea Vix. FAW.1	FA 2	wo	2	2	0	CrL	D	vulture	100	450	-	I		XJ479
591104	Aden	Khormaksar area	AF	Venom FB.4	FA 1	dbr	1	0	0	CrL	D	hawk?	1000	350	-	-	W,A	WR531
591110	UK/Eng.	Lincolnshire?	AF	Hunter F.4	FA 1	dbr	1	0	0	CrL	D	gulls	300	360	-	I	I	XF953
600329	UAE	Sharjah	AF	Hunter FGA.9	FA 1	dbr	1	0	0	CrL	D	gull	250	400	-	I	I	XF424
600507	UK/Eng.	Somerset/Devon?	AF	Vampire FB.5	FA 1	dbr	1	0	0		D	unkn.			-	-	I	WA445
601109	Germ.,W	near Jever?	AF	Hunter F.6	FA 1	dbr	1	0	0	CrL	D	unkn.	250	390	-	I	I	XE590
610316	Germ.,W	near Jever?	AF	Swift FR.5	FA 1	dbr	1	0	0		D	unkn.			-	-	I	WK295
620904	UK/Eng.	Swinderby, Lincs.	AF	Vampire T.11	FA 1	wo	2	0	0	TO	D	gulls+plovers	0	95				XD448
621115	UK/Scot.	Firth of Tay?	RN	Scimitar F.1	FA 2	wo	1	1	0	CrL		gull?	400	420	-	I		XD265
621123 *	UK/Scot.	Milltown	RN	Scimitar F.1	FA 2	wo	1	1	0	Ap		unkn.	low	low				XD282

Appendix 1 (continued).

Date			Ser-	Aircraft	Cate-	Acc.	# Persons			Flight			Altitude		Parts Hit			Aircraft
Y M D	Location Where Struck		vice	Type	gory	Cate gory	A b.	E j.	Kil- led	Phase/	Time	Type of Bird(s) Struck	AGL (feet)	Speed (knots)	W s	E n	Other	Serial Number
640817	Hong Kong	Kai Tak	AF	Canberra B.15	B 2	wo	4	0	0	Cl	D	Kites, Black-ear.	15	120	-	F	U	WH958
640930	UK/Scot.	Jedburgh (near)	AF	Jet Prov. T.4	T 1	wo	2	2	0	CrL	D	large	300	190	-	F		XR664
650714	Netherl.	Roermond (near)	AF	Canberra B(I)6	B 2	wo	3	0	3	CrL	D	unkn.	low		-	F		WT324
660727	UK/Eng.	N. Frodingham	AF	Jet Prov. T.4	T 1	wo	1	1	0	CrL	D	unkn.	250	180	-	F		XP625
681120	UK/Eng.	Watton, Norf.	AF	Canberra T.17	B 2	dbr	1+	0	0	TO	D	gulls	0	105	-	I		WJ988
710225	Germ.,W	Nordholz (E of)	AF	Canberra PR.7	B 2	dbr	2	0	0	CrL	D	gulls	500	300	S	-	N,F,W	WT523
710629	UK/Eng.	Dishforth, N.Yorks.	AF	Jet Prov. T.3	T 1	wo	2	2	0	Cl	D	large	300	110	-	F	F	XN558
720426	UK/Eng.	The Wash	AF	Harrier GR.1	FA 1	wo	1	1	0	CrL	D	gulls	500			F		XV749
720504	Germ.,W	Flensburg (near)	AF	Harrier GR.1	FA 1	wo	1	1	0	CrL	D	large	400	360	-	I		XV794
720627	Germ.,W	Wesel	AF	Harrier GR.1A	FA 1	wo	1	1	0	CrH	D	Gull, Bl.-head.?	1200	420	-	F	N	XV780
730709	Germ.,W	Wildenrath	AF	Harrier GR.3	FA 1	wo	1	1	0	Cl	D	>1	20	135		F		XV791
740107	UK/Eng.	Mansfield, E of	AF	Jet Prov. T.4	T 1	dbr	2	0	0	CrL	D	Pigeon, Wood	300	230	S	-	N	XP548
740516	Germ.,W	Wildenrath	AF	Harrier GR.3	FA 1	wo	1	1	0	Cl		small	20	20	-	F		XV800
760928	UK/Eng.	Marham, Norf.	AF	Victor K.2	Oth. 4	wo		0	0	TO	D	gulls	0	145	-	-	W,N,F	XL513
781116	UK/Eng.	Brize Norton (nr)	AF	Hunter FGA.9	FA 1	dbr	1	0	0			unkn.						XJ695
790326	Germ.,W	Südlohn (near)	AF	Jaguar T.2	FA 2	wo	2	2	0	CrL	D	Rook	250	240	P	F		XX147
800312	UK/Wal.	Lampeter	AF	Harrier GR.3	FA 1	wo	1	1	0	CrL	D	buzzard	200	420	S	F		XW765
800731	UK/Eng.	Elvington, N.Yorks.	AF	Jet Prov. T.3A	T 1	wo	1	1	0	Cl	D	Pigeons, feral	400	140		F	M	XN590
801117	UK/Scot.	Kinloss	AF	Nimrod MR.2	Oth. 4	wo	20	na	2	Cl	T	Gulls,Bl.-h.+Com.	20	138	S	F	NWTF	XV256
810601	UK/Scot.	Forfar, Tayside	AF	Jaguar T.2	FA 2	wo	2	2	0	CrL	D	Gull, Bl.-head.	300	450	P	F		XX828
810724	UK/Eng.	Bristol Channel	(AF)	Jaguar T.2	FA 2	wo	2	2	1	CrL	D	gull	500	450	P	F		XX916
820819 *	UK/Eng.	Yeovilton (near)?	RN	Hunter GA.11	FA 1	dbr	1	0	0			unkn.						XE682
821020	UK/Eng.	Chivenor, Devon	AF	Hawk T.1	T 1	wo	1	1	0	Ap	N	unkn.	350	130	-	F		XX300
830919	UK/Scot.	Lossiemouth	AF	Jaguar GR.1	FA 2	wo	1	1	0	Ap	D	Lapwings	100	low		F	U	XX114
831121	UK/Eng.	Settle (N of)	AF	Jet Prov. T.3A	T 1	wo	2	2	0	CrL	D	>1; unid.	low			F	U	XM453
840815	UK/Eng.	Cranwell, Lincs.	AF	Jet Prov. T.3A	T 1	dbr	2	0	0	Cl		Avoiding Birds	25	low	-	-	-	XN473
841107	UK/Wal.	Mona, Anglesey I.	AF	Hawk T.1	T 1	wo	2	2	0	Cl	D	Lapwings	100	140	-	F	F	XX180
841129	S. Atlantic	Stanley, Falkl. Isl.	AF	Harrier GR.3	FA 1	wo	1	1	0	CrL	D	seabird, large	250	480	S	-	N	XZ992
841201	UK/Scot.	Ft. William, NE of	RN	Sea Har.FRS.1	FA 1	wo	1	1	0	CrL	D	gull?	500	420	-	F		XZ458
860429	UK/Eng.	Catterick, N.Yorks.	AAC	Gazelle AH.1	H 1	dbr	4	na	0		D	Avoiding Birds	125	low	-	-	-	XZ336
860929	UK/Eng.	Thirsk, N.Yorks.	AF	Bulldog T.1	pT 1	wo	2	na	0	Cl	D	Avoid Sim.Birds	~250	low	-	-	-	XX514
871015	N.Ireland	off NW Ireland	RN	Sea Har.FRS.1	FA 1	wo	1	1	0	CrL	D	large	250	480	-	F		ZA190
890914	UK/Eng.	Abingdon	AF	Tornado GR.1	FA 2	wo	2	2	0	Cl	T	gulls	150	170		F		ZD710
910925	UK/Eng.	Great Driffield	AF	Harrier T.4A	FA 1	wo	2	2	0	CrL	D	Gulls, Bl.-head.	250		P	-	U	XZ147
911114	N.Ireland	Gortin Gap, Tyr.	AAC	Lynx AH.7	H 2	wo	11	na	1	CrL	D	Avoiding Birds	low	low	-	-	-	XZ186
930628	UK/Eng.	Coningsby (W of)	AF	Harrier GR.7	FA 1	wo	1	1	0	CrL	D	unkn.(prob.birdstr)	250	420	-	-	W	ZD430

Date			Ser-	Aircraft	Cate-	Acc.	# Persons			Flight			Altitude		Parts Hit			Aircraft
Y M D	Location Where Struck		vice	Type	gory	Cate gory	A b.	E j.	Kil- led	Phase/	Time	Type of Bird(s) Struck	AGL (feet)	Speed (knots)	W s	E n	Other	Serial Number
980707	Germany	Laarbruch	AF	Harrier GR.7	FA 1	wo	1	1	0	Ap	D	buzzard	200	159	-	F		ZG533
001018 *	UK/Eng.	Lowick, Northumb.	AF	Hawk T.1A	T 1	wo	2	2	0	Cr_	D	large			S			XX282
001027	UK/Scot.	Dumfries (NE of)	AF	Jaguar GR.3A	FA 2	wo	1	1	0	CrL	D	unkn.	low			F		XZ111
020215	UK/Wal.	Anglesey area	AF	Hawk T.1A	T 1	wo	1	1	0	Cl	D	Gull, Herring	low	low	-	F		XX352
030723 *	UK/Eng.	Sinnington (nr)	AF	Hawk T.1	T 1	wo	1	1	0	Cr_	D	Gull, Common			-	F		XX183

* Unofficial report of uncertain accuracy.
** Modern-day name of country.
Service: AF = Royal Air Force; AAC = Army Air Corps; RN = Royal Navy. a=Australian. c=Canadian.
Aircraft Category: B = Bomber; FA = Fighter/Attack; H = Helicopter; T = Trainer; Oth = Other. Prefix "p" means piston-engined.
Following digit shows number of engines.
Accident Category: wo = aircraft written off (destroyed); dbr = damaged beyond (economical) repair.
Persons: Ab. = Number of aircrew aboard; Ej = # who ejected; Killed = # aircrew killed (no known ground fatalities).
Flight Phase: TO = takeoff; Cl = Climb; CrL = cruise at low-level (up to 1000 ft AGL); CrH = cruise at high altitude (above 1000 ft AGL); Ap = approach; La = land;
T&G = touch and go landing; Cir. = in circuit
Time: D = Day; N = Night; T = Twilight.
Parts Hit. Ws = windscreen or canopy: - = not struck; S = struck, not reported as penetrated; P = penetrated.
En = Engine(s): - = no ingestion; I = ingestion, damage limited or uncertain; F = engine failure after ingestion.
Other parts reported struck: A = antenna or probe; C = radiator; F = fuselage; I = intake; L = landing gear; M = multiple parts; N = nose or radome; P = propeller; T = tail;
U = unknown other parts; W = wing(s).

Appendix 2. Accidents excluded from this analysis because role of birds has been discounted or is speculative.

360922	UK/Eng.	Thornaby	AF	Audax	K5251	wo (1F); cause unknown but possibly BS [AARC]
430303	UK/Eng.	Foulsham (near)	AF	Mitchell II	FL174	BS but repaired & reflown; wo for other reasons 29 Mar. '43 [AARC]
440516	'India'	?	AF	Spitfire	?	wo (1F); no AARC found but AARCs for many fatal Spitfire accidents are known to be missing from AHB & RAFM files [Cummings 2004]
441020	India	Kumbhirgram	AF	Mosquito VI	HP921	wo (2F); structural failure--possible BS but no specific evidence [AARC]
450730	India	Yelahanka	AF	Mosquito VI	RF714	dmg in collision with RF650 whilst checking BS dmg to latter [AARC]
450823	Norway	Trondheim (near)	nAF	Spitfire IX	NH372	substantial dmg from BS; unclear if dbr [AARC]
491125	UK/Eng.	Horsham St. Faith	AF	Meteor F.4	RA427	dmg by BS with gull flock [AARC]; repaired & reflown [Halley 1999]
501012	Malay.	Butterworth (near)	AF	Tempest II	PR782	dmg by BS; repaired [AARC]
530730	France	Reims	AF	Vampire FB.5	WA383	subst. dmg from multiple BS [AARC]; retired by RAF but later repaired for RNZAF [AHC] & flown as NZ5762
560913	Germ.,W	Keitum, Sylt	AF	Hunter F.4	WV412	wo; feather in engine but BS doubtful [AARC]
640705	Aden	Thumier	AAC	Auster AOP 9	XP245	BS & major injury but not wo [AARC; Dunn 1996]
641005	Singapore	Tengah	AF	Canberra PR.7	WJ820	wo but not by BS [AARC; Halley 1999]
661206	Aden	Habilayan (W of)	AAC	Bell 47G-3	XT125	wo (3F); no evidence of BS [AARC]
701109	UK/Scot.	L. Strathbeg	RN	Buccan. S.2	XV358	goose penetr. canopy; navigator ejected; pilot landed aircraft [AARC]
730728	UK	Lee-on-Solent	AF	Gnat T.1	XR993	subst. BS dmg [IFS]; reflown by RAF [T. West] & in U.S. as N3XR [NTSB]
730730	Germ.,W	Coesfeld	AF	Harrier GR.1A	XV805	wo due to FOD damage from a bolt, not BS [AARC, IFS]
731012	UK/Eng.	Leeming, Yorks.	AF	Gnat T.1	XR537	subst. dmg from BS [AARC, IFS] but repaired & reflown by RAF [AHC]
751201	Belize	?	AF	Harrier GR.3	XV788	wo but no evidence of BS [IFS]
791004	Germ.,W	Ravensberg	AF	Harrier GR.3	XW766	wo due to metal FOD, not BS [IFS]
801028	Germ.,W	Bitburg (near)		Harrier GR.3	XV761	wo due to engine surge; BS unlikely [IFS]
820519	S. Atlantic	Falkl. Isl. (E of)	RN	Sea King HC4	ZA294	wo (21F); cause "not positively determined" [RN FSAIC]
851129	UK/Eng.	Portland, S of	RN	Hunter GA.11	WV267	subst. dmg from BS; to U.S.A. as civil aircraft [Sturtivant 2004]; reflown?
880513	UK/Wales	Brawdy	AF	Hawk T.1A	XX197	wo due to engine technical failure, not BS [IFS]
940720	UK/Scot.	Moray Firth	AF	Tornado GR.1	ZA368	wo due to technical failure, not BS [IFS]
970603	UK/Scot.	Palnackie, Dumfr.	AF	Harrier GR.7	ZG861	wo due to engine failure, not BS [IFS; Halley 1999]
981116	UK/Scot.	Otterburn Range	AF	Jaguar GR.1B	XZ103	subst. dmg from multiple BS but repaired [IFS]

Notes: **AARC**=Aircraft Accident Record Card; **AHB** = Air Historical Branch; **AHC**=Aircraft History Card; **BS**=birdstrike; **dbr**=damaged beyond (economical) repair; **dmg**=damage; **F**=fatality; **FOD**=foreign object damage; **FSAIC**=RN Flight Safety & Accident Investigation Centre; **IFS**=RAF Inspectorate of Flight Safety; **NTSB**=U.S. Nat. Transportation Safety Board; **wo**=written off (destroyed).