BLACKBIRD AND STARLING STRIKES TO CIVIL AIRCRAFT IN THE UNITED STATES, 1990-2001

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Abstract: Bird-aircraft collisions (bird strikes) pose hazards to aircraft and cost civil aviation hundreds of millions of dollars in repairs and logistical expenses annually in the United States. Blackbirds and starlings (*Sturnus vulgaris*) in particular have caused some of the most devastating aircraft accidents related to bird strikes in the United States and Europe. To determine the impacts of blackbirds and starlings to aviation in the United States, we searched the Federal Aviation Administration's (FAA) National Wildlife Strike Database for all reported strikes involving these species. During 1990-2001, 1,704 strikes involving blackbirds and starlings were reported to the FAA from 46 States and the District of Columbia. The annual number of strikes increased, 1990-2001. Most strikes occurred during daylight from late spring to early fall. Damage was reported for only 5.9% of the strikes involving blackbirds and starlings, but reported costs totaled $1,607,317. Recommended management strategies for reducing strikes with blackbirds and starlings in the airport environment include removal and pruning of woody vegetation to reduce or remove suitable roosting areas, exclusion of perches, and exclusion of small grain agriculture.

Key words: aircraft, airport, bird strike, blackbirds, European starling, Icteridae.

Bird-aircraft collisions (bird strikes) represent a serious hazard to aircraft and human safety in the United States (Cleary et al. 2000). Cleary et al. (2000) reported that 79% of bird strikes occurred below 305 m altitude (above ground level, AGL), and 90% occurred below 763 m AGL. These findings emphasized the importance of wildlife habitats and the management of wildlife with local movement patterns that may intersect airspace used during takeoffs, landings, and ground movements. Different species pose different hazards to aircraft (Dolbeer et al. 2000). Blackbirds (Icteridae) and starlings (*Sturnus vulgaris*) are species of concern because they are the most abundant groups of birds in North America, and several of the species gather in large feeding and roosting flocks (Dolbeer 1984, 1990).

Dolbeer et al. (2000) ranked blackbirds, starlings, and their allies as a relatively low hazard for damaging strikes, compared to other species of wildlife. Although these birds were involved in only 5% of the bird strikes where species was identified and reported to the Federal Aviation Administration (FAA), 1990-2000 (Cleary et al. 2002), blackbirds and starlings have caused some of the most damaging and fatal bird strikes in the United States (Cleary and Dolbeer 1999) and elsewhere (Thorpe 1996, 1998). These birds are small (40-200 g, Dunning 1993), but the higher density of their bodies relative to other birds (Seamans et al. 1995), their large populations, and their flocking behavior (Dolbeer 1984) enhances the severity of the hazard for damaging strikes (Thorpe 1998).

We searched the FAA National Wildlife Strike database for all records of reported strikes involving blackbirds and starlings. We extracted those records and summarized the data to describe the impacts of strikes involving blackbirds and starlings and to illustrate trends in bird strikes that involved these species.

METHODS

Strikes involving blackbirds and starlings were reported sometimes by group, such as "blackbird," and sometimes by the exact species involved. We extracted all records of strikes involving these groups and by individual species listed in Table 1. We assimilated information on date, location, species, cost of repairs, damage, number struck, and time of day for each reported strike. We calculated descriptive statistics using Microsoft Excel and SAS statistical software (SAS 1990) to illustrate patterns of bird strikes involving blackbirds and starlings. We used linear regression to determine if the number of strikes increased over time and if the number of facilities reporting strikes increased over time. We used simple correlation analysis to determine relationships between the number of strikes reported and the number of facilities reporting strikes (Zar 1984).

Table 1. Number of strikes to blackbirds and starlings reported to the FAA National Wildlife Strike Database, 1990-2001.

Species (group)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	Total
Blackbirds	57	70	72	77	61	71	55	63	81	43	57	52	759
Boat-tailed grackle (*Quiscalus major*)	0	0	1	0	0	0	1	0	0	0	0	2	4
Bobolink (*Dolichonyx oryzivorus*)	0	0	0	0	0	0	0	1	0	0	0	0	1
Brewer's blackbird (*Euphagus cyanocephalus*)	0	0	0	0	0	0	0	0	1	0	0	0	1
Brown-headed cowbird (*Molothrus ater*)	1	0	0	0	0	0	1	0	1	1	4	4	12
Common grackle (*Quiscalus quiscula*)	1	0	0	2	0	0	1	2	2	0	2	1	11
European starlings (*Sturnus vulgaris*)	44	49	57	57	60	48	64	76	77	95	133	92	852
Grackles	0	0	1	1	1	0	4	10	7	3	4	2	33
Great-tailed grackle (*Quiscalus mexicanus*)	0	0	0	0	0	0	0	0	0	0	2	2	4
Red-winged blackbird (*Agelaius phoeniceus*)	0	3	3	2	1	2	1	2	1	0	3	5	23
Yellow-headed blackbird (*Xanthocephalus xanthocephalus*)	0	0	0	0	0	0	0	1	0	3	0	0	4
Total	103	122	134	139	123	121	127	155	170	145	205	160	1704

RESULTS

During 1990 - 2001, 1,704 strikes involving blackbirds and starlings were reported to the FAA National Wildlife Strike Database. Strikes involving these species were reported from 46 states and the District of Columbia (Table 2). The number of reported blackbird and starling strikes increased, 1990-2001 (t = 4.01; df = 1, 11; P = 0.003), nearly doubling during the 11 years (Fig. 1). Meanwhile, there was no statistical increase in the number of airports reporting blackbird and starling strikes, 1990-2001 (t = 1.59; df = 1, 11; P = 0.143). However, the number of strikes reported and number of facilities reporting strikes over time were positively correlated (r = 0.77, P = 0.003).

Table 2. Number of strikes involving blackbirds and starlings (1704 total), reported to the FAA National Wildlife Strike Database by state, 1990-2001.

State	Total	State	Total	State	Total
AK	1	LA	39	NY	122
AL	30	MA	27	OH	55
AR	20	MD	18	OK	21
AZ	14	ME	3	OR	30
CA	67	MI	56	PA	125
CO	10	MN	5	RI	11
CT	25	MO	56	SC	7
DC	58	MS	13	SD	2
FL	111	MT	1	TN	90
GA	69	NC	77	TX	121
IA	19	ND	5	UT	1
ID	3	NE	28	VA	30
IL	76	NH	12	WA	23
IN	38	NJ	49	WI	16
KS	10	NM	1	WV	7
KY	99	NV	3		

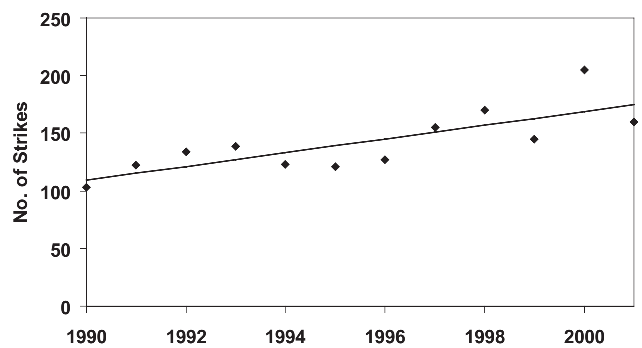

Fig. 1. Number of strikes per year involving blackbirds and starlings reported to the FAA National Wildlife Strike Database, 1990-2001.

Most strikes occurred from late spring through early fall, though strikes were reported for each month (Fig. 2). Mean monthly strike rate was essentially constant from November to April, but beginning in May, increased more than 5-fold and peaked in August (Table 3). Most (72% of total reported strikes, 84.4% of strikes where time was reported) reported strikes occurred during the day (Fig. 3), although strikes were reported for dawn, dusk, and night categories as well.

Strikes were reported to involve 9 species of blackbirds, cowbirds, and starlings (Table 1). Half (50%)

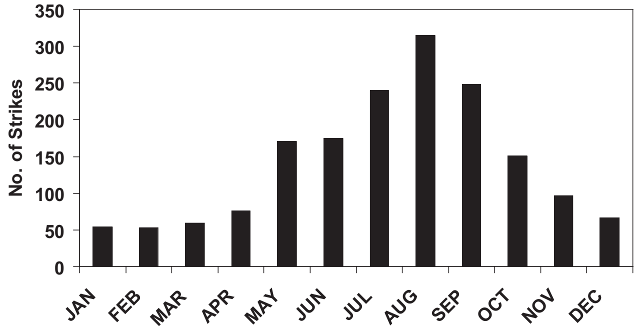

Fig. 2. Number of strikes involving blackbirds and starlings reported to the FAA National Wildlife Strike Database by month, 1990-2001.

of the strikes involved European starlings. Unfortunately, few blackbirds involved in strikes were identified to species; 44.5% were simply identified as blackbirds. This category likely included starlings and various blackbird species such as red-winged blackbirds (*Agelaius phoeniceus*), common grackles (*Quiscalus quiscula*), and brown-headed cowbirds (*Molothrus ater*). Most reported strikes involved single birds (62.9% of strikes where data were submitted on bird number), 31.5% involved 2-10 birds, 4.9% involved 11-100 birds, and few (< 1%) involved >100 individuals (Fig. 4).

Information on damage was reported for 83.1% of reported blackbird and starling strikes (Table 4). In most cases where damage status was reported (77.2%), no damage was observed. Only 5.9% of all reported blackbird and starling strikes cited at least some aircraft damage. Costs associated with strikes to blackbirds and starlings were reported for only 34 of 1704 reported strikes. Reported costs totaled $1,607,317 for 1990-2001, of which $1,145,727 was reported as repair costs and $461,590 in other costs. Total costs averaged $47,274.03 ($n$ = 34, SE = 19,174.94) per damaging strike when costs were reported.

Table 3. Mean (and 95% CI) annual number of strikes involving blackbirds and starlings per month reported to the FAA National Wildlife Strike Database, 1990-2001.

Month	Mean	n	95% CI
January	4.91	11	2.64 - 7.18
February	4.82	11	3.22 - 6.41
March	4.92	12	3.51 - 6.33
April	6.33	12	4.19 - 8.47
May	14.17	12	11.76 - 16.58
June	14.58	12	11.10 - 18.06
July	20.00	12	15.46 - 24.54
August	26.25	12	21.81 - 30.69
September	20.67	12	16.80 - 24.54
October	12.58	12	9.12 - 16.04
November	8.08	12	6.27 - 9.89
December	5.50	12	4.26 - 6.74

DISCUSSION

Our analyses demonstrated that the number of reported strikes to blackbirds and starlings increased, 1990-2001. This increase reflected general increases in total wildlife strikes (Cleary et al. 2002). Observed increases in reported strikes might be attributed to a combination of factors that are not mutually exclusive. First, bird strike reporting rates, usually 15-25%, might have increased because of increased awareness of the bird strike problem (Dolbeer 2000). Second, the increased number of blackbird and starling strikes might be due in part to increased use by aircraft of airspace also used by an extremely large population of birds (Dolbeer 2000). The number of aircraft operations during this period increased (Dolbeer 2000). Although populations of the most abundant species of blackbirds (red-winged blackbirds, common grackles, brown-headed cowbirds) and starlings remain large (Dolbeer 2003), they are not increasing (Sauer et al. 2002) simultaneous with increases in air traffic.

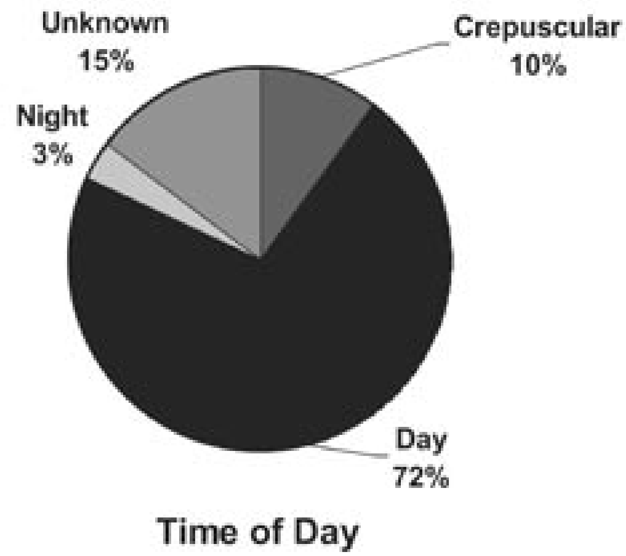

Fig. 3. Number of strikes and percentage of total strikes involving blackbirds, starlings, and their allies, reported to the FAA National Wildlife Strike Database by time-of-day category, 1990-2001.

The seasonal timing of peaks in bird strikes involving blackbirds and starlings coincided with the formation of post-breeding flocks that include many immature birds (Bent 1965). However, blackbirds and starlings remain in flocks during most of the year, even when strikes involving these species are relatively infrequent. Starlings, in particular, use many habitats and spend a great deal of time on the ground at airfields while foraging for insects (Thorpe 1998). The avail-

Table 4. Number of strikes involving blackbirds and starlings reported to the FAA Wildlife Strike Database that caused damage, by species, 1990-2001.

Species	Damage reported	No damage	Damage unknown	Total
Blackbirds	51	668	40	759
Boat-tailed grackle	1	2	1	4
Bobolink	0	0	1	1
Brewer's blackbird	0	0	1	1
Brown-headed cowbird	1	8	3	12
Common grackle	3	6	2	11
European starling	39	598	215	852
Grackles	3	18	12	33
Great-tailed grackle	0	1	3	4
Red-winged blackbird	1	12	10	23
Yellow-headed blackbird	1	3	0	4
Total	100	1316	288	1704

ability of insects and seeds, which are important foods to blackbirds during summer (Dolbeer 1994), may be greater in late summer and early fall in airport grasslands than other times when birds are flocked. Also, agricultural crops are often grown near airports (Cleary and Dolbeer 1999), and this period of increased strikes coincides with the ripening of cereal grains in some parts of the United States. The combination of naive immature individuals, formation of flocks, availability of food in airport grasslands, and attractive agricultural feeding habitats surrounding airports during late summer might explain increased strikes to blackbirds during this period.

Diurnal strike patterns observed in these analyses reflected the diurnal habits of these species (Bent 1965). However, we expected more strikes during crepuscular periods, given the roosting habits of blackbirds and starlings and daily movements of flocks between roosts and feeding areas (Bent 1965, Lyon and Caccamise 1981, Dolbeer 1984).

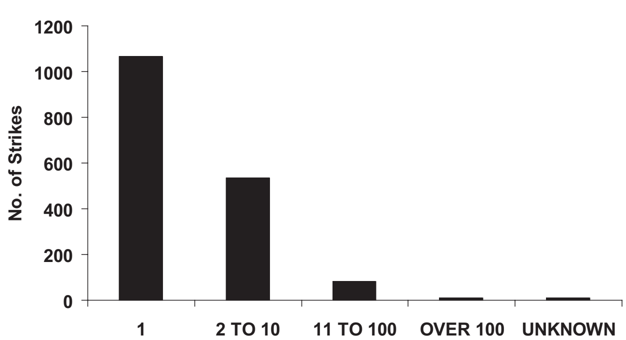

Fig. 4. Number of strikes involving blackbirds, starlings, and their allies, reported to the FAA National Wildlife Strike Database by flock size, 1990-2001.

Inferences about the strike patterns of individual species are difficult to develop, and may not be reliable. Many of the species are quite similar in appearance, and the voluntary nature of strike reporting subjects the data to species-specific reporting bias (Barras and Dolbeer 2000). Most of the strikes were reported by non-biologists (Cleary et al. 2002), such as mechanics and pilots, who did not recover and examine the bird carcasses or might have mis-identified them. Blackbirds, as a general category, almost certainly included some starling strikes. Thus, sound inferences may be limited to the use of the broad category "blackbirds and starlings." Interestingly, most of the strikes that involved these flocking birds were reported as strikes to single birds. This result might indicate that their carcasses are difficult to find because of their small size (40-120 g), or that reports might have been completed incorrectly and incidents involving multiple birds were reported as a single strike. In cases of reports from maintenance crews, organic matter remaining following a jet engine ingestion of these birds would have left few clues to the number of birds involved. Typically, only a small sample of tissue is submitted to the FAA for species identification purposes.

As predicted by Dolbeer et al. (2000), the frequency and cost of damaging strikes that involved blackbirds and starlings were relatively low compared to overall wildlife strike means (Cleary et al. 2002). However, strikes involving blackbirds and starlings have resulted in some of the most catastrophic bird strike incidents worldwide (Thorpe 1996, 1998; Cleary and Dolbeer 1999). Many of these catastrophic incidents were not included in this analysis because they happened prior to the development of the national FAA database or they happened overseas, outside of the jurisdiction of the FAA. The occasional damaging effect that these small birds have on aircraft might be due to the high density of their bodies relative to other birds (Seamans et al. 1995) and their flocking behavior (Dolbeer 1984). These factors, combined with their large population sizes (Dolbeer 1990, Dolbeer 2003), may enhance the severity of the hazard for damaging strikes.

MANAGEMENT IMPLICATIONS

Management of blackbirds and starlings often involves exclosure netting for area protection (Feare and Swannack 1978, Feare and Wadsworth 1981, Dolbeer 1994, Johnson and Glahn 1994), which might have application for airport buildings. Airfield vegetation management, especially removal and pruning of woody vegetation to reduce or remove suitable roosting areas (Wright 1967, Good and Johnson 1978, Lyon and Caccamise 1981, Dolbeer 1984), is generally recommended. Perch exclusion also has been recommended on airport structures such as signs, fences, buildings, and antennae through placement of wire strands and specialized barbed products (Lefebvre and Mott 1987, Johnson and Glahn 1994). Management of food resources also might reduce blackbird and starling use of airports. On-site options include application of insecticides to reduce invertebrate populations on airport grasslands. Off-site, land use practices such as cereal grain agriculture should be prohibited within established regulatory distances (Cleary and Dolbeer 1999).

FUTURE RESEARCH

We recommend research to determine if insecticide application might reduce bird use of airport grasslands. We also recommend studies to determine the reliance of blackbirds and starlings on perches such as fences, signs, light fixtures, and building ledges, and studies of the efficacy of exclusion devices for reducing use of airfield structures by different species.

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