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OF TRANSPORTATION
FEDERAL AVIATION
ADMINISTRATION**

WILDLIFE STRIKES TO CIVIL AIRCRAFT IN THE UNITED STATES 1990–2007



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COVER

A mixed flock of blackbirds (red-winged blackbirds, common grackles, brown-headed cowbirds) and European starlings descend into a wooded roosting area at dusk, less than 2 miles from a southern USA airport, 11 January 2007. Over 500 million blackbirds and starlings from Canada and the northern USA migrate to the southern USA each winter where they gather nightly in numerous roosts in marshes and woodlots. Flight lines of birds entering to and departing from these roost sites at dusk and dawn can pose a serious risk to aircraft at nearby airports. Airports should work with nearby communities to prevent large bird roosts from developing near airports. Photo, S. Stopak, USDA.

The most deadly civil (62 human fatalities, Massachusetts 1960) and military (34 fatalities, Netherlands 1996) bird strikes were caused by flocks of starlings.

Anyone with quality photographs of aircraft damage resulting from wildlife strikes or of wildlife at airports is encouraged to submit them to one of the authors for consideration in future wildlife strike publications.

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The database files and support programs used to enter and organize strike data initially were established by **E. LeBoeuf** and **J. Rapol**, Federal Aviation Administration (FAA), Office of Airport Safety and Standards, Washington, DC, and were subsequently updated by **A. M. Dickey** and **A. Newman**, Embry-Riddle Aeronautical University, Prescott, Arizona. **E. C. Cleary**, who retired from FAA in 2007, was instrumental in developing and co-authoring the previous reports in this series. We acknowledge his long-standing contributions to the database. We greatly appreciate the assistance provided by these above-acknowledged professionals. **S. Agrawal** and **R. King**, FAA William J. Hughes Technical Center, Atlantic City, NJ, also provided critical support and advice. Finally, we acknowledge and thank all of the people who took the time and effort to report wildlife strikes – pilots, mechanics, control tower personnel, airport operations personnel, airline flight safety officers, U.S. Department of Agriculture Wildlife Services biologists, and many others. Sponsorship and funds for the ongoing maintenance and analysis of the FAA Wildlife Strike Database are provided by the FAA, Office of Airport Safety and Standards, Washington, DC, and Airports Division, Airport Technology Branch, FAA William J. Hughes Technical Center, Atlantic City, NJ.

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PREFACE



A Boeing 767 departing a Midwestern USA airport at night for Brazil struck a flock of canvasback ducks at 800 feet AGL, 15 March 2007. Witnesses on the ground reported flames shooting out of engine #1. The pilot returned aircraft to airport using 1 engine. Subsequent inspection revealed that ducks were ingested in both engines. Engine #1 had substantial damage to fan blades and compressor blades; the brakes were also damaged due to a “heavy” landing. The following morning, the remains of 9 canvasbacks were recovered near the departure end of the runway. Feathers removed from the engines and sent to Smithsonian Institution Feather Lab also were identified as canvasback.

The civil and military aviation communities widely recognize that the threat to human health and safety from aircraft collisions with wildlife (wildlife strikes) is increasing (Dolbeer 2000, MacKinnon et al. 2001). Globally, wildlife strikes have killed more than 219 people and destroyed over 200 aircraft since 1988 (Richardson and West 2000; Thorpe 2003; 2005; Dolbeer, unpublished data). Three factors that contribute to this increasing threat are:

1. Many populations of wildlife species commonly involved in strikes have increased markedly in the last few decades and adapted to living in urban environments, including airports. For example, from 1980 to 2006, the resident (non-migratory)



A Cessna 525 en-route at 5,000 feet AGL hit a flock of white-winged scoters, 21 May 2007. An emergency landing was made at a northeastern USA airport. Both engines, the windshield and fuselage were damaged.

Canada goose population in the USA and Canada increased at a mean rate of 7.3 percent per year. Other species showing significant mean annual rates of increase included bald eagles (5.0 percent); wild turkeys (13.0 percent); turkey vultures (2.3 percent), American white pelicans (4.3 percent) double-crested cormorants (4.9 percent), and sandhill cranes (4.7 percent) (Sauer et al. 2007). Thirteen of the 14 bird species in North America with mean body masses greater than 8 lbs have shown significant population increases over the past three decades (Dolbeer and Eschenfelder 2003). The white-tailed deer population increased from a low of about 350,000 in 1900 to over 17 million in the past decade (McCabe and McCabe 1997, Hubbard et al. 2000).

2. Concurrent with population increases of many large bird species, air traffic has increased substantially since 1980. Passenger enplanements in the USA increased from about 310 million in 1980 to a record 749 million in 2007 (3.3 percent per year), and commercial air traffic increased from about 18 million aircraft movements in 1980 to over 28 million in 2007 (1.8 percent per year, Federal Aviation Administration 2008). USA commercial air traffic is predicted to continue growing at a rate of about 2 percent per year to over 36 million movements by 2020.
3. Commercial air carriers are replacing their older three- or four-engine aircraft fleets with more efficient and quieter, two-engine aircraft. In 1969, 75 percent of the 2,100 USA passenger aircraft had three or four engines. In 2005, the USA passenger fleet had grown to about 8,200 aircraft (Department of Transportation 2007), and only about 10 percent have three or four engines (Cleary and Dolbeer 2005). This reduction in engine redundancy increases the probability of life-threatening situations resulting from aircraft collisions with wildlife, especially with flocks of birds. In addition, previous research has indicated that birds are less able to detect and avoid modern jet aircraft with quieter engines (Chapter 3, International Civil Aviation Organization 1993) than older aircraft with noisier (Chapter 2) engines (Burger 1983, Kelly et al. 1999).

As a result of these factors, experts within the Federal Aviation Administration (FAA), U.S. Department of Agriculture (USDA), and U.S. Air Force expect the risk, frequency, and potential severity of wildlife-aircraft collisions to grow over the next decade.

The FAA has initiated several programs to address this important safety issue. Among the various programs is the collection and analysis of data from wildlife strikes. The

FAA began collecting wildlife strike data in 1965. However, except for cursory examinations of the strike reports to determine general trends, the data were never submitted to rigorous analysis. In 1995, the FAA, through an interagency agreement with the USDA, Wildlife Services, (USDA/WS), initiated a project to obtain more objective estimates of the magnitude and nature of the national wildlife strike problem for civil aviation. This project involves having specialists from the USDA/WS: (1) edit all strike reports (FAA Form 5200-7, *Birds/Other Wildlife Strike Report*) received by the FAA since 1990 to ensure consistent, error-free data; (2) enter all edited strike reports in the FAA National Wildlife Strike Database; (3) supplement FAA-reported strikes with additional, non-duplicated strike reports from other sources; (4) provide the FAA with an updated computer file each month containing all edited strike reports; and (5) assist the FAA with the production of annual and special reports summarizing the results of analyses of the data from the National Wildlife Strike Database. Such analyses are critical to determining the economic cost of wildlife strikes, the magnitude of safety issues, and most important, the nature of the problems (e.g., wildlife species involved, types of damage, height and phase of flight during which strikes occur, and seasonal patterns). The information obtained from these analyses provides the foundation for refinements in the development, implementation, and justification of integrated research and management efforts to reduce wildlife strikes.

The first annual report on wildlife strikes to civil aircraft in the USA, covering 1994, was completed in November 1995 (Dolbeer et al. 1995). Since then we have published subsequent reports covering the years 1993–1995, 1992–1996, 1991–1997, 1990–1998, 1990–1999, 1990–2000, 1990–2001, 1990-2002, 1990-2003, 1990-2004, 1990-2005, and 1990-2006 (Cleary et al. 1996, 1997, 1998, 1999, 2000, 2002a, 2002b, 2003, 2004, 2005, 2006, 2007). This is the 14th report in the series and covers the 18-year period, 1990-2007.



A bald eagle shattered the windshield of a Schweizer 300 helicopter at 2,000 feet AGL in Minnesota, 3 June 2007. The passenger was knocked unconscious and suffered cuts and bruises. Pilot landed the aircraft safely with the dead eagle at his feet. Photo, Chris Cooper, Hummingbird Helicopters.

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WILDLIFE STRIKES TO CIVIL AIRCRAFT IN THE UNITED STATES, 1990–2007



The leading edge of left wing of a B-737 hit a great blue heron on approach to an east coast USA airport, 7 November 2007. The pilot landed the aircraft uneventfully where it was taken out of service for repairs.

INTRODUCTION

This report presents a summary analysis of data from the FAA's National Wildlife Strike Database for the 18-year period 1990 through 2007. Unless noted, all totals are for the 17-year period, and percentages are of the total known. Because of the large amount of data, Tables 2 through 17 present 18-year totals only and do not display data for individual years, 1990 through 2007.

A sample of significant wildlife strikes to civil aircraft in the USA during 2007 is presented in Appendix A. These recent strike examples demonstrate the widespread and diverse nature of the problem.

RESULTS

NUMBER OF REPORTED STRIKES

For the 18-year period (1990-2007), 82,057 strikes were reported to the FAA. Birds were involved in 97.5 percent of the reported strikes, terrestrial mammals in 2.1 percent, bats in 0.3 percent and reptiles in 0.1 percent (Table 1).

The number of strikes annually reported more than quadrupled from 1,759 in 1990 to a record 7,666 in 2007 (Table 1, Figure 1). We suggest that the increase in reports from 1990 to 2007 was the result of several factors: an increased awareness of the wildlife strike issue, an increase in aircraft operations, an increase in populations of hazardous wildlife species, and an increase in the number of strikes (Dolbeer 2000, Dolbeer and Eschenfelder 2003). The temporary plateau in reported strikes from 2000-2003 may be related to a slight (<6 percent) decline in air traffic after the events of September 2001.



These wild turkeys were in the Air Operations Area at a southeast USA airport, June 2007. From 1990-2007, 38 turkey strikes with civil aircraft were reported at USA airports. Photo, J. Weller, USDA.

METHODS OF REPORTING STRIKES

Most (65 percent) of the 82,057 strike reports were filed using the paper (46 percent) or electronic (19 percent) version of FAA Form 5200-7, *Bird/Other Wildlife Strike Report*. Since the online version of this form became available in April 2001, use of the electronic reporting system has climbed dramatically. In 2007, 62 percent of the strike reports were submitted electronically (Table 2).

SOURCE OF REPORTS

Airline personnel and pilots filed 31 percent and 24 percent of the strike reports, respectively (Table 3). About 85 percent of the reported strikes involved commercial aircraft; the remainder involved business, private, and government aircraft (Table 4). Reports were received from all 50 states, from some USA territories, and from foreign countries when USA-registered aircraft were involved (Table

5). California, Texas, Florida, and New York had the most (6,920, 5,317, 5,178, and 4,333, respectively) bird strike reports. Twenty-one other states each had more than 1,000 bird strikes reported. New York, California, Illinois, New Jersey, Texas, Colorado, and Michigan each had 80 or more terrestrial mammal strikes. In all, strikes were reported at 1,625 airports (1,418 airports in the USA and 207 foreign airports where USA-based aircraft were involved).

TIMING OF OCCURRENCE OF STRIKES

Most bird strikes (51 percent) occurred between July and October (Table 6); 62 percent occurred during the day (Table 7); 60 percent occurred during the landing (descent, approach, or landing roll) phase of flight; and 37 percent occurred during takeoff and climb (Table 8).



A Learjet 36 ingested a mallard into an engine during the takeoff run at a northern USA airport, 4 June 2007. Pilot aborted takeoff. Cost of repairs was >\$250,000.

Most terrestrial mammal strikes (58 percent) occurred between July and November with 33 percent of deer strikes concentrated in October-November (Table 6). Most terrestrial mammal strikes (64 percent) occurred at night (Table 7), 55 percent occurred during the landing roll, and 34 percent occurred during the takeoff run.

HEIGHT ABOVE GROUND LEVEL (AGL) OF STRIKES

About 60 percent of the bird strikes occurred when the aircraft was at a height of 100 feet or less AGL, 73 percent occurred at 500 feet or less AGL, and 92 percent occurred at or below 3,000 feet AGL (Table 9). Less than 2 percent of bird strikes occurred above 10,000 feet AGL. The record height for a reported bird strike involving civil aircraft in USA was 32,500 feet AGL. Terrestrial mammal strikes predominately occurred at 0 feet AGL; however, 9 percent of the reported strikes occurred while the aircraft was in the air, e.g., when the aircraft struck deer with the landing gear (Table 8).

AIRCRAFT COMPONENTS DAMAGED

The aircraft components most commonly reported as struck by birds were the nose/radome, windshield, engine, wing/rotor, and fuselage (Table 10). Aircraft engines were the component most frequently reported as being damaged by bird strikes (32 percent of all damaged components). There were 10,916 strike events in which a total of 12,028 engines were reported as struck (9,877 events with one engine struck, 986 with two engines struck, 33 with three engines struck, and 20 with four engines struck). In 3,419 damaging bird-strike events involving engines, a total of 3,627 engines were damaged (3,214 events with one engine damaged, 202 with two engines damaged, and 3 with three engines damaged).

Aircraft components most commonly reported as struck by terrestrial mammals were the landing gear, propeller, and wing/rotor. These same components ranked highest for the parts most often reported as damaged by mammals (Table 10).

REPORTED DAMAGE AND EFFECT-ON-FLIGHT

Of the 79,972 bird strikes reported, 63,973 provided some indication as to the nature and extent of any damage. Of these 63,973 reports, 54,886 (86 percent) indicated the strike did not damage the aircraft; 4,856 (8 percent) indicated the aircraft suffered minor damage; 2,375 (4 percent) indicated the aircraft suffered substantial damage; 1,836 (3 percent) reported an uncertain level of damage; and 20 reports (less than 1 percent) indicated the aircraft was destroyed as a result of the strike (Table 11).

Of the 1,737 terrestrial mammal strikes reported, 1,176 reports provided some indication as to the nature and extent of any damage. Of these 1,176 reports, 457 (39 percent) indicated the strike did not damage the aircraft; 318 (27 percent) indicated the aircraft suffered minor damage; 321 (27 percent) indicated the aircraft suffered substantial damage; 58 (5 percent) reported an uncertain level of damage; and 22 (2 percent) indicated the aircraft was destroyed as a result of the strike (Table 11). Not surprisingly, a much higher percentage of terrestrial mammal strikes (61 percent) resulted in aircraft damage than did bird strikes (14 percent). Deer (760 strikes, Table 6) were involved in 44 percent of the 1,737 terrestrial mammal strikes.

In 13 percent and 54 percent of the bird and terrestrial mammal strike reports, respectively, an adverse effect-on-flight was reported (Table 12). Three percent of bird strikes resulted in an aborted takeoff compared to 17 percent of terrestrial mammal strikes.

WILDLIFE SPECIES INVOLVED IN STRIKES



A CRJ 200 descending into a southern USA airport hit a flock of snow geese, 27 November 2007. Aircraft landed safely, but inspection revealed major damage to multiple components including 1 engine, nose, wing root and horizontal stabilizer.

Table 13 shows the number of reported strikes, strikes causing damage, strikes having a negative effect-on-flight, strikes involving >1 animal, the reported aircraft down time, and the reported costs by identified wildlife species for the 18-year period, 1990 through 2007.

Only 34,304 (43 percent) of the 79,972 bird strike reports provided information on the type of bird (e.g., gull or hawk). Furthermore, only 20,974 (61 percent) of these 34,304 reports provided identification to species level (e.g., ring-billed gull or red-tailed hawk; Table 13). Thus, birds were identified to species level in only 26 percent of the 79,972 reported bird strikes. In all, 369 identified species of birds were

struck; 166 identified species were reported as causing damage.

Gulls (20 percent), doves/pigeons (14 percent), raptors (13 percent), and waterfowl (9 percent) were the most frequently struck bird groups (Table 14). Gulls were involved in 2.4 times more strikes than waterfowl (7,021 and 2,956, respectively). Waterfowl, however, were involved in more damaging strikes (1,326 or 31 percent of all damaging strikes in which the bird type was identified) than were gulls (1,119 or 26 percent of all damaging strikes in which the bird type was identified). Gulls were responsible for the greatest number of bird strikes (895 or 27 percent) that had a negative effect-on-flight.

The most frequently struck terrestrial mammals were Artiodactyls – primarily deer (46 percent) – and Carnivores – primarily coyotes (32 percent) (Tables 13, 14). Artiodactyls were responsible for 92 percent of the mammal strikes that resulted in damage and 80 percent of the mammal strikes that had a negative effect-on-flight. In all, 36 identified species of terrestrial mammals and 8 identified species of bats were reported struck; 19 identified species of terrestrial mammals and 2 identified species of bat caused damage (Table 13).

HUMAN FATALITIES AND INJURIES DUE TO WILDLIFE STRIKES

For the 18-year period, reports were received of 8 wildlife strikes that resulted in 11 human fatalities (Table 15). Five of these strikes resulting in 7 fatalities involved unidentified species of birds. Canada geese, white-tailed deer and brown-pelicans were responsible for the other 4 fatalities. Reports were received of 158 strikes that resulted in 197 human injuries. Waterfowl (38 strikes, 42 humans injured), vultures (22 strikes, 24 injuries), and deer (18 strikes, 26 injuries) caused 78 (62 percent) of the 125 strikes resulting in injuries in which the species or species group was identified (Table 15).

AIRCRAFT DESTROYED DUE TO WILDLIFE STRIKES



This Cessna 150 crash landed in a tomato field and was damaged beyond repair after a hawk shattered the windshield during approach to a California airport, 20 July 2007. Photo, Matthew Henderson.

For the 18-year period, reports were received of 43 aircraft destroyed or damaged beyond repair due to wildlife strikes (Tables 11, 16). The majority (63 percent) were small ($\leq 2,250$ kg maximum takeoff mass) general aviation (GA) aircraft. Terrestrial mammals (primarily white-tailed deer) were responsible for 23 (53 percent) of the incidents. Canada geese and vultures were each responsible for 3 (27 percent) of the 11 incidents involving birds in which the species or species group was identified.

Thirty-one (72 percent) of the 43 wildlife strikes resulting in a destroyed aircraft occurred at GA airports, 7 occurred away from an airport, and 5 occurred at airports certificated for passenger service under 14 CFR Part 139. GA airports, often located in rural areas with inadequate fencing to exclude large mammals, face unique challenges in mitigating wildlife risks to aviation (DeVault et al. 2008, Dolbeer et al. 2008).

ECONOMIC LOSSES DUE TO WILDLIFE STRIKES



Snowy owls invade the northern USA in winters when rodent populations are low in Canada. These large owls are attracted to airports for hunting. Snowy owls are 1 of 369 identified species of birds that have been struck by civil aircraft in USA, 1990-2007 (Table 13). Photo, G. Wright.

For the 18-year period, reported losses from bird strikes totaled 362,073 hours of aircraft downtime and \$291.1 million in monetary losses. Reported losses from terrestrial mammal strikes totaled 227,996 hours of aircraft downtime and \$38.2 million in monetary losses. Bat strikes resulted in 100 hours of aircraft downtime and \$3.2 million in losses. Reptile strikes resulted in 3 hours of aircraft downtime (Table 13).

Of the 14,275 reports that indicated the strike had an adverse effect on the aircraft and/or flight, 3,943 provided an estimate of the aircraft down time ($\Sigma = 590,172$ hours,

avg. = 149.7 hours down time/incident, Table 17). Of the reports providing a damage cost estimate for the incident; 2,453 gave an estimate of the direct aircraft damage cost ($\Sigma = \$292.6$ million, avg. = \$119,270 damage/incident), and 1,023 gave an estimate of other monetary losses ($\Sigma = \$39.9$ million, avg. = \$39,000 lost/incident). Other monetary losses include such expenses as lost revenue, the cost of putting passengers in hotels, re-scheduling aircraft, and flight cancellations.

Analysis of strike reports from USA airports and airlines indicated that less than 20 percent of all strikes were reported to the FAA (Cleary et al. 2005, Wright and Dolbeer 2005). Additionally, only 17 percent of the 14,275 reports indicating an adverse effect provided estimates of direct costs and only 7 percent provided estimates of other (indirect) costs. Furthermore, many reports providing cost estimates were filed before aircraft damage and downtime had been fully assessed. As a result, the information on the number of strikes and associated costs compiled from the voluntary reporting program (summarized by species of wildlife struck in Table 13) is believed to severely underestimate the magnitude of the problem.

Assuming (1) all 14,275 reported wildlife strikes that had an adverse effect on the aircraft and/or flight engendered similar amounts of downtime and/or monetary losses and (2) that these reports are all of the damaging strikes that occurred, then at a minimum, wildlife strikes cost the USA civil aviation industry 118,712 hours per year of aircraft downtime and \$126 million in monetary losses (\$95 million per year in direct costs and \$31 million per year in associated costs, Table 17).



Earthworms, which sometimes accumulate in large numbers on airport pavements after heavy rains, can be a major food attraction for gulls and other birds. Photo, J. Smith, USDA.

Further, assuming a 20 percent reporting rate, the annual cost of wildlife strikes to the USA civil aviation industry is estimated to be in excess of 593,000 hours of aircraft downtime and \$628 million in monetary losses (\$473 million per year in direct costs and \$155 million per year in associated costs, Table 17).

CONCLUSIONS

An analysis of 18 years of strike data reveals the magnitude and severity of the wildlife-aircraft strike problem for civil aviation in the USA. Wildlife strikes continue to pose a significant economic and safety risk for civil aviation in the

USA. Management actions to reduce wildlife strikes are being implemented at many airports (e.g., Wenning et al. 2004, DeFusco et al. 2005, Dolbeer 2006a), but much work remains to be done to reduce wildlife strikes.

To address the problem, airport managers first need to assess the wildlife hazards on their airports (Cleary and Dolbeer 2005). They then must take appropriate actions, under the guidance of professional biologists trained in wildlife damage management, to minimize the risks posed by wildlife. The aviation community must also widen its view of wildlife management to consider habitats and land uses in proximity to the airport. Wetlands, dredge spoil containment areas, waste-disposal facilities, and wildlife refuges can attract hazardous wildlife. Such land uses are often incompatible with aviation safety and should either be prohibited near airports or designed and operated in a manner that minimizes the attraction of hazardous wildlife.

The manual *Wildlife Hazard Management at Airports* (Cleary and Dolbeer 2005) provides guidance to airport personnel in developing and implementing wildlife hazard management plans. Adobe Acrobat© PDF versions of the manual are available online in English, Spanish, and French at <http://wildlife-mitigation.tc.faa.gov>.

Finally, there is a need for increased and more detailed reporting of wildlife strikes. For example, our previous analyses (Cleary et al. 2005, Wright and Dolbeer 2005) indicated less than 20 percent of all wildlife strikes involving USA civil aircraft are reported. Further, only about 43 percent of all reported bird strikes for 1990-2007, provided information on the type of bird struck, and only about 26 percent of the reports identified the birds struck to species level. In addition, only 17 percent of strike reports indicating an adverse effect on the aircraft or flight provided at least a partial estimate of economic losses resulting from the strike.

REPORTING A STRIKE AND IDENTIFYING SPECIES OF WILDLIFE STRUCK

Pilots, airport operations, aircraft maintenance personnel, and anyone else having knowledge of a strike should report the incident to the FAA using FAA Form 5200-7. Strikes can be reported electronically via the internet (<http://wildlife-mitigation.tc.faa.gov>) or Form 5200-7 can be accessed and printed for mailing in reports.

It is important to include as much information as possible on FAA Form 5200-7. All reports are carefully screened to identify duplicate reports prior to being entered into the database. Reports of the same incident filed by different people are combined and often provide a more complete record of the strike event than would be possible if just one report were filed.

The identification of the exact species of wildlife struck (e.g., ring-billed gull, Canada goose, mallard, mourning dove, or red-tailed hawk as opposed to gull, goose, duck, dove, or hawk) is particularly important. This species information is critical for biologists developing and implementing wildlife risk management programs at airports because a problem that cannot be measured or defined cannot be solved. Bird strike remains that cannot be identified by airport personnel can often be identified by a local biologist trained in ornithology or by sending feather and other remains in a sealed plastic bag (with FAA Form 5200-7) to:

Material sent via Express Mail Service:	Material sent via U.S. Postal Service:
Feather Identification Laboratory	Feather Identification Laboratory
Smithsonian Institution	Smithsonian Institution, Division of Birds
NHB, E610, MRC 116	PO Box 37012
10 th & Constitution Ave. NW	NHB, E610, MRC 116
Washington, D.C. 20560-0116	Washington, D.C. 20013-7012
(Identify as “safety investigation material”)	(Not recommended for priority cases.)
Phone# 202-633-0787 or 202-633-0791	

Please send whole feathers whenever possible as diagnostic characteristics are often found in the downy barbules at the feather base. Wings, as well as breast and tail feathers should be sent whenever possible. Beaks, feet, bones, and talons are also

useful diagnostic materials. Even blood smears can provide material for DNA analysis. Do not send entire bird carcasses through the mail. However, photographs of the carcasses can be very useful supplemental documentation.

Additional information on sending bird remains to the Smithsonian is available at: <http://wildlife-mitigation.tc.faa.gov>.

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TABLES

Table 1. Number of reported wildlife strikes to civil aircraft by wildlife group, USA, 1990–2007 (see Figure 1).

Year	Number of reported strikes-all aircraft					Commercial aircraft only ¹		
	Birds	Bats	Terrestrial mammals	Reptiles	Total	Total	Movements (x 1 million) ²	Strikes/10,000 movements
1990	1,738	4	17	0	1,759	1,322	25.10	0.527
1991	2,252	3	36	0	2,291	1,769	24.82	0.713
1992	2,351	2	56	1	2,410	1,800	25.22	0.714
1993	2,395	6	53	0	2,454	1,779	25.60	0.695
1994	2,459	2	73	1	2,535	1,905	26.63	0.715
1995	2,643	5	69	8	2,725	2,019	27.13	0.744
1996	2,840	1	91	3	2,935	2,087	27.62	0.756
1997	3,351	1	92	14	3,458	2,457	27.80	0.884
1998	3,658	3	105	7	3,773	2,522	28.05	0.899
1999	5,002	7	89	1	5,099	3,850	28.81	1.336
2000	5,872	16	120	3	6,011	4,483	29.56	1.516
2001 ³	5,644	8	138	8	5,798	4,163	29.22	1.425
2002	6,044	19	117	15	6,195	4,403	27.65	1.592
2003	5,854	20	125	5	6,004	4,284	27.93	1.534
2004	6,398	27	118	6	6,549	4,687	28.92	1.621
2005	7,036	27	130	7	7,200	5,171	29.27	1.767
2006	6,996	49	141	9	7,195	4,914	28.34	1.734
2007	7,439	53	167	7	7,666	4,970	28.38	1.751
Total	79,972	253	1,737	95	82,057	58,585	496.04	1.181

¹ See Table 4.

² Departures and arrivals by air carrier, commuter, and air taxi service (FAA 2008).

³ The decline in reported strikes in 2001 was likely related to the decrease in air travel after 11 September. There was a 9 percent increase in the number of reported strikes for January–August 2001 compared to the same months in 2000; there was a 24 percent decline in reported strikes for September–December 2001 compared to the same months in 2000.

Table 2. Source of information for reported wildlife strikes to civil aircraft, USA, 1990–2007.

Source	18-year total	% of total known
FAA Form 5200-7 ¹ (Paper)	38,006	46
FAA Form 5200-7E ² (Electronic)	15,817	19
Airline report	12,632	15
Multiple ³	7,124	9
Airport report	4,073	5
Other ⁴	1,590	2
Preliminary Aircraft Incident Report	888	1
Engine manufacturer	830	1
Aircraft Incident Report	774	1
Aviation Safety Reporting System	179	<1
National Transportation Safety Board	77	<1
Aircraft Incident Preliminary Notice	67	<1
Total	82,057	100

¹ Bird/Other Wildlife Strike Report

² Electronic filing of reports (<http://wildlife-mitigation.tc.faa.gov>) began in April 2001. In 2001, 0.4 percent of reports were filed electronically compared to 20, 28, 32, 38, 46, and 62 percent in 2002-2007, respectively.

³ More than one type of report was filed for the same strike.

⁴ Various sources, such as news media and Commercial Incident Reports.

Table 3. Person filing report of wildlife strike to civil aircraft, USA, 1990–2007.

Person filing report	18-year total	% of total known
Airline Operations	20,030	31
Pilot	15,811	24
Carcass Found ¹	11,804	18
Tower	8,522	13
Airport Operations	7,418	11
Other	1,884	3
Total known	65,469	100
Unknown	16,588	
Total	82,057	

¹ Airport personnel found wildlife remains within 200 feet of a runway centerline that appeared to have been struck by aircraft and no strike was reported by pilot, tower, or airline.

Table 4. Number of reported wildlife strikes to civil aircraft by type of operator, USA, 1990–2007.

Type of operator	18-year total	% of total known
Commercial	58,585	85
Business	7,789	11
Private	1,926	3
Government/Police ¹	416	1
Total known	68,716	100
Unknown	13,341	
Total	82,057	

¹ U.S. Coast Guard aircraft were involved in 126 of these strikes.

Table 5. Number of reported bird, bat, terrestrial mammal, and reptile strikes to civil aircraft by USA state, including the District of Columbia (DC), Puerto Rico (PR), USA-possessed Pacific Islands (PI), and the U.S. Virgin Islands (VI), 1990–2007.

State	Reported strikes (18-year total)					State	Reported strikes (18-year total)				
	Birds	Bats	T. mam- mals	Rep- tiles	Total		Birds	Bats	T. mam- mals	Rep- tiles	Total
AK	560	1	26	0	587	NC	1,322	2	30	0	1,354
AL	653	2	11	0	666	ND	252	0	12	0	264
AR	302	1	15	0	318	NE	826	6	16	0	848
AZ	1,268	27	56	0	1,351	NH	446	7	7	0	460
CA	6,920	2	97	0	7,019	NJ	2,148	2	88	10	2,248
CO	2,474	5	85	0	2,564	NM	194	0	22	0	216
CT	824	1	18	0	843	NV	404	0	7	0	411
DC	1,871	4	39	0	1,914	NY	4,333	6	130	23	4,492
DE	65	0	1	0	66	OH	2,572	7	79	0	2,658
FL	5,178	6	61	46	5,291	OK	734	0	27	4	765
GA	1,241	2	30	0	1,273	OR	1,329	1	8	0	1,338
HI	1,738	0	6	0	1,744	PA	2,588	4	72	0	2,664
IA	568	1	19	0	588	PI	146	0	0	0	146
ID	210	0	7	0	217	PR	143	2	0	5	150
IL	3,681	5	95	1	3,782	RI	334	1	12	0	347
IN	1,012	2	23	0	1,037	SC	368	0	17	0	385
KS	230	1	6	0	237	SD	154	0	12	1	167
KY	2,071	4	17	0	2,092	TN	2,302	1	19	0	2,322
LA	1,237	3	19	2	1,261	TX	5,317	83	91	1	5,492
MA	1,045	1	20	0	1,066	UT	1,022	3	16	0	1,041
MD	890	6	58	0	954	VA	1,019	1	57	0	1,077
ME	239	0	12	0	251	VI	95	0	0	0	95
MI	1,951	10	81	1	2,043	VT	87	0	3	0	90
MN	765	5	21	0	791	WA	1,202	2	13	0	1,217
MO	1,738	8	35	0	1,781	WI	680	1	51	0	732
MS	251	0	8	0	259	WV	177	0	49	0	226
MT	114	0	8	0	122	WY	68	0	6	0	74
						Total known¹	69,358	226	1,718	94	71,396
						Foreign²	1,640	8	8	0	1,656
						Unknown	8,974	19	11	1	9,005
						Total	79,972	253	1,737	95	82,057

¹ Strikes were reported at 1,418 airports in the USA.

² Strikes to USA air carriers were reported at 207 foreign airports.

Table 6. Number of reported bird and terrestrial mammal strikes to civil aircraft by month, USA, 1990–2007¹.

Month	All birds		All terrestrial mammals		Deer only ²	
	18-year total	% of total known	18-year total	% of total known	18-year total	% of total known
Jan	3,019	4	94	5	36	5
Feb	2,699	3	83	5	32	4
Mar	4,272	5	109	6	39	5
Apr	5,654	7	107	6	45	6
May	7,616	10	94	5	33	4
Jun	6,052	8	145	8	52	7
Jul	9,079	11	174	10	69	9
Aug	10,722	13	206	12	75	10
Sep	10,821	14	179	10	76	10
Oct	10,245	13	224	13	101	13
Nov	6,117	8	225	13	149	20
Dec	3,676	5	97	6	53	7
Total	79,972	100	1,737	100	760	100

¹ In addition, 253 strikes with bats were reported of which 53 percent occurred in July - September; 95 strikes with reptiles were reported of which 61 percent occurred in May - August.

² Deer strikes were comprised of 712 white-tailed deer, 36 mule deer, and 12 deer not identified to species. Other wild artiodactyls struck (but not included in this column of table) were 9 wapiti (elk), 7 pronghorns, 4 moose, 2 caribou, 1 swine (feral hog) and 2 collared peccaries (Table 13).

Table 7. Reported time of occurrence of wildlife strikes to civil aircraft, USA, 1990–2007¹.

Time of day	Birds		Terrestrial mammals	
	18-year total	% of total known	18-year total	% of total known
Dawn	2,309	4	37	3
Day	32,722	62	255	23
Dusk	2,860	5	107	10
Night	14,877	28	709	64
Total known	52,768	100	1,108	100
Unknown	23,782		629	
Total¹	71,670		1,737	

¹ In addition, 253 strikes with bats were reported: time not reported (186), night (50), dusk (6), day (9), and dawn (2). Also, 95 strikes with reptiles were reported: time not reported (80), day (8), night (4), dusk (2), and dawn (1).

Table 8. Reported phase of flight at time of wildlife strikes to civil aircraft, USA, 1990–2007¹.

Phase of flight	Birds		Terrestrial mammals	
	18-year total	% of total known	18-year total	% of total known
Parked	31	<1	1	<1
Taxi	230	<1	29	2
Takeoff run	11,455	19	423	34
Climb	10,742	18	27	2
En route	1,465	2	0	0
Descent	2,191	4	0	0
Approach	23,042	39	81	7
Landing roll	9,749	17	680	55
Total known	58,905	100	1,241	100
Unknown	21,067		496	
Total¹	79,972		1,737	

¹ In addition, 253 strikes with bats were reported: phase of flight not reported (189), approach (41), climb (7), descent (5), landing roll (6), en route (2), and takeoff run (3). Also, 95 strikes with reptiles were reported: phase of flight not reported (72), taxi (5), takeoff run (9), approach (4), and landing roll (5).

Table 9. Number of reported bird strikes to civil aircraft by height (feet) above ground level (AGL), USA, 1990–2007¹.

Height of strike (feet AGL)	All reported strikes			Strikes with damage		
	18-year total	% of total known	% cumulative total	18-year total	% of total known	% cumulative total
0	21,503	42	42	1,817	27	27
1-100	9,505	18	60	1,122	17	44
101-200	2,507	5	65	319	5	49
201-300	1,624	3	68	209	3	52
301-400	996	2	70	150	2	54
401-500	1,794	3	73	262	4	58
501-600	513	1	74	96	1	59
601-700	405	1	75	76	1	60
701-800	817	2	77	165	2	62
801-900	259	0	77	67	1	63
901-1,000	1,553	3	80	311	5	68
1,001-2,000	3,767	7	87	874	13	81
2,001-3,000	2,378	5	92	517	8	89
3,001-4,000	1,262	2	94	218	3	92
4,001-5,000	904	2	96	165	2	94
5,001-10,000	1,678	3	99	319	5	99
10,001-15,000	291	1	100	82	1	100
15,001-20,000	30	<1	100	19	<1	100
20,001-30,000	14	<1	100	9	<1	100
>30,000	1	<1	100	1	<1	100
Total known	51,801	100		6,798	100	
Unknown height	28,171			2,315		
Total	79,972			9,113		

¹ A more detailed analysis of bird strikes by height AGL is provided by Dolbeer (2006b).

Table 10. Civil aircraft components reported as being struck and damaged by wildlife, USA, 1990–2007.

Aircraft component	Birds (18-year total)				Terrestrial mammals (18-year total)			
	Number struck	% of total	Number damaged	% of total	Number struck	% of total	Number damaged	% of total
Windshield	12,564	17	636	6	6	<1	13	1
Engine(s) ¹	10,916	15	3,419	32	124	8	136	10
Nose	10,390	14	618	6	78	5	78	6
Wing/rotor	9,709	13	2,446	23	188	11	199	15
Fuselage	9,227	13	397	4	102	6	113	8
Radome	9,124	12	1,062	10	13	1	14	1
Other	4,888	7	808	8	194	12	182	14
Landing gear	3,344	5	330	3	657	40	309	23
Propeller	1,947	3	197	2	217	13	208	15
Tail	1,003	1	426	4	46	3	60	4
Light	557	1	434	4	25	2	32	2
Total²	73,669	100	10,773	100	1,650	100	1,344	100

¹ For birds, 12,028 engines were reported as struck in 10,916 strike events involving engines (9,877 events with one engine struck, 986 with two engines struck, 33 with three engines struck, and 20 with four engines struck). In 3,419 bird-strike events with engine damage, a total of 3,627 engines were damaged (3,214 events with one engine damaged, 202 with two engines damaged, and 3 with three engines damaged). For terrestrial mammals, 140 engines were reported as struck in 124 strike events (108 events with one engine struck and 16 with two engines struck). In 136 terrestrial mammal strike events with engine damage, a total of 168 engines were reported as damaged (104 events with one engine damaged and 32 with two engines damaged). Some engines were damaged without being struck when the landing gear collapsed.

² In addition, bat strikes had 79 and 7 components reported as struck and damaged, respectively: radome/nose (21, 0), windshield (18, 0), engine (10, 3), propeller (1, 0), wing/rotor (10, 3), fuselage (7, 0), tail (2, 0), other (6, 0), landing gear (3, 0), light (1, 1). For reptile strikes, there were 18 and 5 components reported struck and damaged, respectively: windshield (1, 1), wing/rotor (1, 1), fuselage (1, 1), landing gear (13, 0); tail (1, 1), other (1, 1).

Table 11. Number of civil aircraft with reported damage resulting from wildlife strikes, USA, 1990–2007.

Damage category ²	Reported strikes					
	Birds		Terrestrial mammals		Total ¹	
	18-year total	% of total known	18-year total	% of total known	18-year total	% of total known
None	54,886	86	457	39	55,430	85
Damage	9,087	14	719	61	9,814	15
Minor	4,856	8	318	27	5,177	8
Uncertain	1,836	3	58	5	1,895	3
Substantial	2,375	4	320	27	2,699	4
Destroyed	20	<1	23	2	43	<1
Total known	63,973	100	1,176	100	65,244	100
Unknown	15,999		561		16,813	
Total	79,972		1,737		82,057	

¹ Included in totals are 253 and 95 strikes involving bats and reptiles, respectively. For bats, 74 reports indicated no damage, 172 failed to report if damage occurred, 3 reported minor damage, 1 reported uncertain level of damage, and 3 reported substantial damage. For reptiles, 13 reports indicated no damage, 81 failed to report if damage occurred, and 1 reported substantial damage.

² The damage codes and descriptions follow the *International Civil Aviation Organization Bird Strike Information System (1989)*: Minor = the aircraft can be rendered airworthy by simple repairs or replacements and an extensive inspection is not necessary; Uncertain = the aircraft was damaged, but details as to the extent of the damage are lacking; Substantial = the aircraft incurs damage or structural failure that adversely affects the structure strength, performance, or flight characteristics of the aircraft and that would normally require major repair or replacement of the affected component (specifically excluded are bent fairings or cowlings; small dents or puncture holes in the skin; damage to wing tips, antenna, tires, or brakes; and engine blade damage not requiring blade replacement); Destroyed = the damage sustained makes it inadvisable to restore the aircraft to an airworthy condition.

Table 12. Reported effect-on-flight (EOF) of wildlife strikes to civil aircraft, USA, 1990–2007.

Effect-on-flight ²	Reported strikes					
	Birds		Terrestrial mammals		Total ¹	
	18-year total	% of total known	18-year total	% of total known	18-year total	% of total known
None	41,368	87	432	46	41,877	87
Negative effect	6,010	13	506	54	6,525	13
Precautionary landing	3,094	7	76	8	3,173	7
Aborted takeoff	1,442	3	164	17	1,606	3
Engine shutdown	312	1	26	3	338	1
Other	1,162	2	240	26	1,408	3
Total known	47,378	100	938	100	48,402	100
Unknown	32,594		799		33,655	
Total	79,972		1,737		82,057	

¹ Included in totals are 253 and 95 strikes involving bats and reptiles, respectively. For bats, 60 reports indicated no effect-on-flight, 191 failed to report if an effect-on-flight occurred, and 2 reported a precautionary landing. For reptiles, 17 reports indicated no effect-on-flight, 71 failed to report if an effect-on-flight occurred, 1 reported a precautionary landing, and 6 reported “other”.

² Effect-on-flight: None = flight continued as scheduled, although delays and other cost caused by inspections or repairs may have been incurred after landing; Aborted takeoff = pilot aborted the takeoff; Precautionary landing = pilot landed at other-than-destination airport after strike; Engine shut down = pilot shut down the engine or the engine stopped running because of strike; Other = miscellaneous effects, such as reduced speed because of shattered windshield, emergency landing at destination airport, or crash landing; Unknown = report did not give sufficient information to determine an effect-on-flight (Dolbeer et al. 2000).

Table 13. Total reported strikes, strikes causing damage, strikes having a negative effect-on-flight (EOF), strikes involving >1 animal, aircraft downtime, and costs by identified wildlife species for civil aircraft, USA, 1990–2007 (page 1 of 16).

Wildlife group or species	18-year totals					
	Number of reported strikes				Reported economic losses ¹	
	Total	With damage	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
Birds						
Loons	15	10	6		2,819	1,754,200
Loons	3	3	2		557	251,200
Common loon	12	7	4		2,262	1,503,000
Grebes	43	8	5	7	250	1,209,470
Grebes	8	1		1		
Eared grebe	6	1		1	10	100,000
Western grebe	13	4	3	5	168	1,000,000
Pied-billed grebe	8		1			
Horned grebe	5	2	1		72	109,470
Red-necked grebe	2					
Clark's grebe	1					
Albatrosses/shearwaters	42	6	6		147	62,500
Laysan albatross	28	6	5		147	62,500
Black-footed albatross	3					
Bonin petrel	1					
Wedge-tailed shearwater	7		1			
Townsend's shearwater	2					
Fork-tailed storm-petrel	1					
Tropicbirds	10	7	6		124	60,300
Tropicbirds	5	5	4		124	40,200
White-tailed tropicbird	2	1	1			14,500
Red-tailed tropicbird	3	1	1			5,600
Pelicans	49	24	18	5	422	351,123
Pelicans	4	2			80	
Australian pelican	1	1	1			
Brown pelican	41	19	16	5	318	251,123
American white pelican	3	2	1		24	100,000
Red-footed booby	1					
Cormorants	56	22	15	10	239	2,204,370
Cormorants	2					
Great cormorant	2	1		2		
D.-crested cormorant	51	21	15	8	239	2,204,370
Pelagic cormorant	1					
Anhinga	14	4	5	2	117	7,800

Table 13. Continued (page 2 of 16).

Wildlife group or species	18-year totals					
	Number of reported strikes				Reported economic losses ¹	
	Total	With damage	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
Frigatebirds	11	4	2		21	18,400
Frigatebirds	2	1	1		18	13,500
Great frigatebird	7	2	1		3	4,900
Magnificent frigatebird	2	1				
Herons/bitterns	323	61	44	12	3,384	4,843,701
Herons	44	13	9	4	99	3,200
Great blue heron	193	43	33	4	2,623	4,765,115
Blk.-crowned night-heron	25	2		2	16	31,200
Little blue heron	4					
Green heron	6					
Yel.-crowned night heron	3					
American bittern	5	3	2		646	44,186
Yellow bittern	43			2		
Egrets	466	56	67	124	3,717	5,318,690
Egrets	264	30	38	76	3,455	3,465,140
Cattle egret	150	17	23	41	141	12,750
Great egret	36	7	6	6	97	1,840,800
Snowy egret	16	2		1	24	
Storks/ibises	30	6	4	4	1	
White stork	1	1				
Wood stork	7	1				
Ibises	11	1	2	1		
Glossy ibis	1			1		
White ibis	4	1	1			
White-faced ibis	5	2		2		
Roseate spoonbill	1		1		1	
Waterfowl	2,956	1,326	651	1,092	96,842	95,799,452
Ducks, geese, swans	132	63	30	53	715	758,775
Ducks	643	222	101	214	4,880	4,007,871
American wigeon	21	12	5	7	327	888,089
Northern pintail	41	27	16	21	1,289	1,139,044
Green-winged teal	20	7	6	6	696	673,142
Blue-winged teal	13	7	3	7	105	601,440
European wigeon	1			1		
Mallard	424	109	55	95	8,406	5,128,261
Common eider	3	2	1	1		
Ring-necked duck	6	3	2	2	72	9,568
Greater scaup	4	1	1	1		

Table 13. Continued (page 3 of 16).

Wildlife group or species	18-year totals					
	Number of reported strikes				Reported economic losses ¹	
	Total	With damage	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
Wood duck	17	9	4	4	294	85,704
Muscovy duck	1	1			120	443,332
Common goldeneye	1	1	1			2,000
Red-breasted merganser	3	1		1	2	
Hooded merganser	3	1		1		
Common merganser	1	1	1		72	2,500
Northern shoveler	19	10	2	10	624	1,049,370
Gadwall	16	3	2	4	336	600,000
Canvasback	11	4	1	4	335	2,154,077
American black duck	21	3	1	7	36	1,500
Mottled duck	9	3	3	2	24	
Lesser scaup	13	8	5	5	984	101,000
Ruddy duck	12	4	1		24	8,446
Redhead	3	1		1		
Bufflehead	3					
Long-tailed duck	1	1				
Philippine duck	1	1	1	1	96	9,456,000
B.-bellied whistling duck	1					
Cinnamon teal	1					
White-winged scoter	1	1	1	1	1,400	430,000
Geese	297	180	80	107	16,884	1,934,004
Snow goose	68	53	26	37	3,749	16,821,986
Canada goose	1,109	568	294	482	54,704	47,406,735
Brant	15	6	3	6	40	1,271
Gr. white-fronted goose	8	7	2	6	292	1,500,547
Emperor goose	1					
Swans	2	1				
Mute swan	4			1		
Tundra swan	5	4	2	3	336	144,790
Trumpeter swan	1	1	1	1		450,000
Raptors	4,545	779	523	167	78,035	34,782,970
Hawks, eagles, vultures	29	16	7	1	2,559	17,550
Vultures	245	143	69	25	21,116	9,263,289
Black vulture	37	19	17	5	5,029	1,315,987
Turkey vulture	289	151	98	12	19,842	2,743,290
Osprey	135	30	19	3	2,174	219,803
White-tailed kite	11	3	1		40	5,000,000
Black kite	2	1	1			

Table 13. Continued (page 4 of 16).

Wildlife group or species	18-year totals					
	Number of reported strikes				Reported economic losses ¹	
	Total	With damage	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
Swallow-tailed kite	1					
Eagles	6	3	2	1		
Bald eagle	101	45	28	9	5,623	331,240
Wh.-breasted sea eagle	1	1	1			
Golden eagle	7	2	3		3,696	801,000
Hawks	928	183	123	25	8,842	3,836,534
Red-tailed hawk	851	146	107	14	8,118	5,518,767
Rough-legged hawk	20	1	1			167
Red-shouldered hawk	14	1	2		41	900
Swainson's hawk	39	3	3	1	4	
Sharp-shinned hawk	9					
Cooper's hawk	20	1				
Ferruginous hawk	5					
Broad-winged hawk	5					
Harris's hawk	1					
Common buzzard	1				24	
Northern harrier	59	1	1	1		200,000
Lappet-faced vulture	1	1	1		240	4,000,000
Falcons	36	3	3	1	81	30,000
Peregrine falcon	116	7	2	5	30	235,500
Gyrfalcon	1					
Merlin	30		2		3	130
Crested caracara	4	2	1		2	
Prairie falcon	7					
American kestrel	1,533	16	31	64	571	1,268,813
Eurasian kestrel	1					
Gallinaceous birds	135	37	30	27	980	530,287
Grouse	7	2		3	2	
Greater sage grouse	5	3	4	1	337	256,077
Sharp-tailed grouse	1	1	1		24	500
Ptarmigans	6	4	1	2	57	57,500
Black francolin	2					
Quails	8		2	2		
Northern bobwhite	6	2	3	1	73	800
Scaled quail	3					
Ring-necked pheasant	50	10	8	5	15	2,000
Gray partridge	5	2	1	3	24	120
Chukar	2		1	1		

Table 13. Continued (page 5 of 16).

Wildlife group or species	18-year totals					
	Number of reported strikes				Reported economic losses ¹	
	Total	With damage	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
Grey francolin	1					
Guineafowl	1	1		1		
Wild turkey	38	12	9	8	448	213,290
Cranes	84	32	24	27	2,364	433,060
Cranes	12	3	5	2	31	250,000
Sandhill crane	71	28	19	25	2,285	132,760
Whooping crane	1	1			48	50,300
Rails/gallinules	71	16	8	6	903	907,926
Rails	3	1	1	1		
Sora	1					
Common moorhen	2	1	1		24	990
American coot	57	13	5	5	807	881,486
Purple gallinule	3	1	1		72	25,450
Virginia rail	2					
Clapper rail	3					
Shorebirds	2,119	65	87	388	1,285	2,999,921
Shorebirds	16			8		
American oystercatcher	17			2		
Plovers	37	3	3	8	24	
European golden-plover	3					
American golden-plover	38	1	3	11	16	2,000
Black-bellied plover	32	2	2	5	12	38,622
Snowy plover	1			1		
Killdeer	1,107	29	34	132	278	2,362,453
Pacific golden-plover	401	3	6	69	15	1,200
Semipalmated plover	22			10		
Wilson's plover	1					
Northern lapwing	1	1	1	1	25	
Southern lapwing	1	1	1			8,000
Sandpipers	158	9	19	62	168	106,560
Upland sandpiper	77	4	5	8	12	1,000
Spotted sandpiper	5			2		
Willet	4			2		
Common snipe	24	2	1	2		12,615
American woodcock	20	1	2	2		
Dunlin	14	3	2	5	504	205,300
Baird's sandpiper	8			1		
Western sandpiper	27	1	1	16	60	94,311

Table 13. Continued (page 6 of 16).

Wildlife group or species	18-year totals					
	Number of reported strikes				Reported economic losses ¹	
	Total	With damage	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
Pectoral sandpiper	4	1		2		300
Sanderling	9		1	7		
Buff-breasted sandpiper	11			3		
Ruddy turnstone	4					
Least sandpiper	29		3	13	3	
Semipalmated sandpiper	19			7		
Lesser yellowlegs	2			1		
Short-billed dowitcher	4	1		1		
Hudsonian godwit	1	1	1	1	96	23,495
Solitary sandpiper	2			1		
Greater yellowlegs	1					
Long-billed dowitcher	2					
Red knot	1					
White-rumped sandpiper	1					
Black turnstone	1					
Marbled godwit	1	1	1	1	48	144,065
Whimbrel	6	1	1	1	24	
Long-billed curlew	3					
American avocet	3			2		
Black-necked stilt	1			1		
Gulls	7,021	1,119	895	1,710	46,545	35,471,453
Gulls	5,182	913	715	1,391	34,775	18,943,469
Herring gull	623	72	69	76	1,595	1,659,351
Mew gull	31	5	4	4	5	15,717
Ring-billed gull	716	73	62	153	3,708	2,714,380
Glaucous-winged gull	48	12	6	9	290	346,545
Great black-backed gull	61	7	5	4	27	250,000
Franklin's gull	30	3	3	14	18	139,000
Laughing gull	214	15	16	37	720	529,136
Bonaparte's gull	18	2	2	5		65,000
Lesser black-backed gull	1					
Western gull	55	7	4	7	92	540,857
California gull	35	7	6	6	4,859	361,948
Heermann's gull	1			1		
Thayer's gull	3					
Yellow-legged gull	3	3	3	3	456	9,906,050

Table 13. Continued (page 7 of 16).

Wildlife group or species	18-year totals					
	Number of reported strikes				Reported economic losses ¹	
	Total	With damage	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
Terns	98	4	3	24	4	
Terns	38	2		12		
Caspian tern	15			1		
Common tern	10			1		
Gull-billed tern	1					
Fairy tern	1					
White tern	1		1	1		
Arctic tern	3	1		2		
Roseate tern	1					
Forster's tern	5		1	1	4	
Least tern	6			2		
Black noddy	3			2		
Brown noddy	5		1	1		
Royal tern	2					
Sooty tern	1					
Black-legged kittiwake	1					
Black skimmer	5	1		1		
Pigeons/doves	4,936	323	376	1,333	21,507	11,034,436
Pigeons, doves	12	1	1	8	24	400
Pigeons	26	4	4	12	32	46,050
Doves	760	41	70	227	287	282,560
Rock pigeon	1,459	170	155	525	13,793	4,941,299
Racing pigeon	17	4	2	7	144	16,000
Mourning dove	2,483	98	139	539	7,093	5,473,722
Spotted dove	52	3	3	4	132	274,405
Zebra dove	88	2	2	11	2	
Inca dove	14					
Philippine turtle dove	4					
White-winged dove	15					
Common ground-dove	6					
Parrots	11			1		
Parrots	6			1		
Budgerigar	4					
Black-hooded parakeet	1					
Cuckoos	9	1		2		
Cuckoos	1			1		
Yellow-billed cuckoo	7	1		1		
Common cuckoo	1					

Table 13. Continued (page 8 of 16).

Wildlife group or species	18-year totals					
	Number of reported strikes				Reported economic losses ¹	
	Total	With damage	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
Owls	1,007	76	47	8	1,450	4,003,288
Owls	240	29	14	4	959	296,875
Barn owl	459	22	17	3	246	1,900,310
Snowy owl	43	4	4		46	27,500
Short-eared owl	117	4	4		17	1,045
Long-eared owl	7	2	1			
Northern saw-whet owl	3					
Burrowing owl	59	1			1	
Barred owl	6	1	1			
Northern pygmy-owl	1					
Eastern screech owl	2	1			24	7,558
Western screech owl	2					
Great horned owl	68	12	6	1	157	1,770,000
Nightjars	132	2		9		
Nightjars	3	1				
Whip-poor-will	2					
Common poorwill	4					
Lesser nighthawk	4					
Chuck-wills-widow	1					
Common nighthawk	118	1		9		
Swifts	93	2	1	7		
Swifts	7	1		2		
Chimney swift	69	1	1	5		
Vaux's swift	10					
White-throated swift	7					
Hummingbirds	3					
Hummingbirds	1					
Ruby-thrted hummingbird	1					
Anna's hummingbird	1					
Belted kingfisher	7					
Woodpeckers	44	2	4	1	1	15,000
Woodpeckers	9		1			
Northern flicker	25	2				
Yellow-bellied sapsucker	5		1	1		
Hairy woodpecker	3					
Red-naped sapsucker	1		1			15,000
Downy woodpecker	1		1		1	

Table 13. Continued (page 9 of 16).

Wildlife group or species	18-year totals					
	Number of reported strikes				Reported economic losses ¹	
	Total	With damage	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
Flycatchers	98	1	4	9	1	9,800
Tyrant flycatchers	6			1	1	
Eastern wood-pewee	3					
Great crested flycatcher	1					
Eastern kingbird	7	1	1			9,800
Scissor-tailed flycatcher	38		2	4		
Acadian flycatcher	1					
Say's phoebe	2					
Western kingbird	35		1	3		
Ash-throated flycatcher	1					
Western wood-pewee	1					
Sulphur-bellied flycatcher	1					
Eastern phoebe	1					
Yellow-bellied flycatcher	1			1		
Larks	674	10	13	183	30	504,625
Larks	5			1		
Eurasian skylark	10			1		
Horned lark	659	10	13	181	30	504,625
Swallows	1,597	16	33	407	155	40,597
Swallows	442	4	23	142	25	
Purple martin	67	2	1	17	3	
Bank swallow	71	2	1	36	5	
Barn swallow	649	5	3	123	109	27,282
Cliff swallow	204	3	2	35	9	13,250
Tree swallow	145		3	54	4	65
Violet-green swallow	8					
N. rough-winged swallow	11					
Starlings/mynas	1,907	82	113	758	1,404	4,258,299
European starling	1,868	81	112	747	1,402	4,258,299
Mynas	4			2		
Common myna	35	1	1	9	2	
Crows/jays/magpies	484	53	47	72	6,609	1,478,158
Crows	211	22	20	33	905	144,000
American crow	221	21	19	32	5,562	1,265,113
Carrion crow	1					
Hooded crow	1	1	1			
Northwestern crow	1			1		
Blue jay	9					

Table 13. Continued (page 10 of 16).

Wildlife group or species	18-year totals					
	Number of reported strikes				Reported economic losses ¹	
	Total	With damage	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
Common raven	24	7	5	2	141	68,490
Yellow-billed magpie	8			2		
Black-billed magpie	8	2	2	2	1	555
Chickadees	19	1		7		
Chickadees	4	1		2		
Black-capped chickadee	12			2		
Mountain chickadee	2			2		
Gray-headed chickadee	1			1		
Wrens	41	1	2	8		
Wrens	36	1	1	8		
Marsh wren	2		1			
Carolina wren	1					
Rock wren	1					
Cactus wren	1					
Mimics	68	1	2	2		120
Brown thrasher	7					120
Northern mockingbird	42	1	2			
Gray catbird	19			2		
Thrushes	306	24	19	26	1,589	2,331,615
Thrushes	15	3	1	2	7	25,500
Western bluebird	2				3	
Swainson's thrush	12	2	1	1		2,000,000
American robin	251	17	14	22	1,555	297,630
Hermit thrush	8	1			22	3,800
Eastern bluebird	3					
Gray-cheeked thrush	1					
Varied thrush	10	1	2		2	4,405
Wood thrush	4		1	1		280
Kinglets	4					
Golden-crowned kinglet	2					
Ruby-crowned kinglet	2					
Vireos	9			1		
Vireos	2					
Yellow-throated vireo	1					
Warbling vireo	2			1		
Red-eyed vireo	3					
Cassin's vireo	1					

Table 13. Continued (page 11 of 16).

Wildlife group or species	18-year totals					
	Number of reported strikes				Reported economic losses ¹	
	Total	With damage	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
Warblers	73	2	1	3	3	43
Wood warblers	19			1		
Canada warbler	2					
Yellow-breasted chat	3					
Pine warbler	2					
Black and white warbler	3					
Northern parula warbler	2					
Ovenbird	5	1	1			
Wilson's warbler	3					
Common yellowthroat	4					
Yellow-rumped warbler	11			1		43
Blackpoll warbler	1			1		
American redstart	2				3	
Yellow warbler	1	1				
Northern waterthrush	2					
Nashville warbler	4					
Townsend's warbler	1					
Palm warbler	3					
Magnolia warbler	3					
Blk-throated blue warbler	1					
Prothonotary warbler	1					
Meadowlarks	701	9	17	86	221	216,452
Meadowlarks	132	2	5	9	10	
Eastern meadowlark	342	3	5	31	4	
Western meadowlark	227	4	7	46	207	216,452
Blackbirds/orioles	1,334	88	96	383	1,459	1,046,630
Blackbirds	1,022	72	76	312	584	862,725
Red-winged blackbird	80	2	6	13	6	750
Yellow-headed blackbird	6	1	1	1		
Brewer's blackbird	24			2		
Brown-headed cowbird	65	1	2	23	5	5,155
Bobolink	5		1			
Orioles	5					
Baltimore oriole	4			1		
Orchard oriole	1					
Grackles	61	6	3	17	720	133,000
Common grackle	46	4	5	12	123	45,000
Boat-tailed grackle	5	1	1		20	

Table 13. Continued (page 12 of 16).

Wildlife group or species	18-year totals					
	Number of reported strikes				Reported economic losses ¹	
	Total	With damage	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
Great-tailed grackle	7			2		
Scarlet tanager	2	1				
Western tanager	1		1		1	
Finches/buntings	243	4	21	98	73	5,000
Finches	48		5	15	4	
Lapland longspur	6			3		
Chest.-collared longspur	1					
Dark-eyed junco	10	1	2	2	48	5,000
Rose-breasted grosbeak	1					
Pine siskin	1					
Purple finch	1					
Evening grosbeak	1					
American goldfinch	20		1			
House finch	23			3		
Smith's longspur	1					
Dickcissel	1					
White-winged crossbill	1					
Red avadavat	2			1		
Red-crested cardinal	2			1		
Northern cardinal	2					
Snow bunting	99	2	13	69	19	
Indigo bunting	1					
Lazuli bunting	1					
Lark bunting	21	1		4	2	
Sparrows	2,186	43	85	558	582	13,840
Sparrows	2,027	40	84	543	579	8,340
Swamp sparrow	3					
Savannah sparrow	68	1		5		1,000
Fox sparrow	8	1				4,100
White-throated sparrow	14	1	1	2		
Golden-crowned sparrow	1					
Field sparrow	1					
Lark sparrow	5					
White-crowned sparrow	6					
Grasshopper sparrow	11					
Java sparrow	1					
Vesper sparrow	3			1		
Chipping sparrow	4			1		

Table 13. Continued (page 13 of 16).

Wildlife group or species	18-year totals					
	Number of reported strikes				Reported economic losses ¹	
	Total	With damage	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
Lincoln's sparrow	3					
Song sparrow	26			6	3	400
Sage sparrow	2					
American tree sparrow	3					
Towhees	4					
Rufous-sided towhee	3					
Green-tailed towhee	1					
Mannikins	81		1	43	3	2,000
Mannikins	23			11		
Nutmeg mannikin	25			15	1	
Chestnut mannikin	33		1	17	2	2,000
Misc perching birds	144	8	3	20	53	87,100
Perching birds	62	7	2	7	49	87,100
Red-vented bulbul	1			1		
Wrentit	1					
American pipit	9			1		
Cedar waxwing	16		1	2	4	
Loggerhead shrike	3					
Japanese white-eye	1					
Common waxbill	2					
Warbling silverbill	1			1		
House sparrow	48	1		8		
Total known birds	34,304	4,335	3,284	7,630	273,339	211,802,626
Total unknown birds	45,668	4,752	2,726	4,980	88,734	79,310,069
Unknown birds - ? size	21,902	2,457	1,183	1,376	25,944	28,531,411
Unknown birds - large	1,741	749	358	201	25,297	28,409,975
Unknown birds - medium	5,978	964	518	848	28,796	10,692,890
Unknown birds - small	16,047	582	667	2,555	8,697	11,675,793
Total birds	79,972	9,087	6,010	12,610	362,073	291,126,695
Flying mammals (bats)						
Old world fruit bats	5	1	2	1	72	3,069,400
Red bat	10	1		1	1	
Hoary bat	2					
East. small-footed myotis	1					
Little brown bat	12					
Big brown bat	1					
Free-tailed bats	12			1		

Table 13. Continued (page 14 of 16).

Wildlife group or species	18-year totals					
	Number of reported strikes				Reported economic losses ¹	
	Total	With damage	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
Brazilian free-tailed bat	13					
Pocketed free-tailed bat	1					
Total known bats	57	2	2	3	73	3,069,400
Unknown bats	196	5		19	27	106,440
Total bats	253	7	2	22	100	3,175,840
Terrestrial mammals						
Marsupials (Opossum)	59					
Xenarthyras (Armadillo)	16	1			8	700
Lagomorphs	182	5	8	2	20	104,384
Black-tailed jackrabbit	73	2	1			24,384
White-tailed jackrabbit	9			1	1	
Rabbits	59	1	3	1	13	2,000
Eastern cottontail	41	2	4		6	78,000
Rodents	120	2	2	4	3	
Pocket gophers	2					
Prairie dog	18		1	4		
Woodchuck	77	2	1		3	
Woodrats	2					
Muskrat	9					
Black rat	2					
N. American porcupine	10					
Carnivores	551	43	84	4	13,949	3,111,576
Canids	3		1			
Coyote	252	27	55	1	11,679	2,774,640
Domestic dog	27	8	15		96	301,000
Foxes	57	4	4		10	750
Red fox	46		4			
Common gray fox	4	1	1		2	186
Raccoon	47	2	3	2	2,160	35,000
White-nosed coati	1					
Ringtail	1					
Skunks	40		1		2	
Striped skunk	52			1		
River otter	2	1				
Badger	2					
Mink	1					

Table 13. Continued (page 15 of 16).

Wildlife group or species	18-year totals					
	Number of reported strikes				Reported economic losses ¹	
	Total	With damage	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
Domestic cat	14					
Small Indian mongoose	2					
Artiodactyls	793	658	401	76	213,008	34,951,055
Deer	12	12	7		696	197,000
White-tailed deer	712	586	351	66	180,887	28,175,056
Mule deer	36	31	20	3	8,520	739,695
Wapiti (elk)	9	9	6	2	11,560	5,496,204
Moose	4	3	4			
Caribou	2	2	1			
Cattle	8	8	6	2	6,215	187,000
Pronghorn	7	6	5	2	5,130	156,100
Swine (wild pig)	1					
Collared peccary	2	1	1	1		
Perissodactyls	4	4	3		1,008	23,849
Horse	3	3	3		1,008	23,849
Burro	1	1				
Total known t. mammals	1,725	713	500	86	227,996	38,191,564
Unk. terrestrial mammals	12	6	6	1		
Total t. mammals	1,737	719	506	87	227,996	38,191,564
Reptiles						
Turtles	74		2	1		
Turtles	43		2	1		
Florida soft shell turtle	4					
Eastern box turtle	4					
Common snapping turtle	3					
Diamondback terrapin	18					
Painted turtle	2					
American alligator	14	1	2		3	
Green iguana	7		3			
Total reptiles	95	1	7	1	3	

Table 13. Continued (page 16 of 16).

Wildlife group or species	18-year totals					
	Number of reported strikes				Reported economic losses ¹	
	Total	With damage	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
Total known (all species)	36,181	5,051	3,793	7,720	501,411	253,063,590
Total (unknown species)	45,876	4,763	2,732	5,000	88,761	79,416,509
Grand total	82,057	9,814	6,525	12,720	590,172	332,480,099

¹ These reported economic losses by species and species groups should be considered as relative indices of losses and not as actual estimated losses. Only about 20 percent of strikes involving civil aircraft are reported and only about 44 percent of reported strikes identify the wildlife species or species group responsible. Furthermore, less than 25 percent of reported strikes indicating damage also provided an estimate of the cost of damage or the downtime (see Table 17). Finally, even when cost estimates were provided, many reports were filed before aircraft damage had been fully assessed. See Table 17 for a more detailed projection of actual economic losses.

² More than 1 animal was struck by the aircraft.

Table 14. Number of reported strikes, strikes with damage, and strikes having a negative effect-on-flight (EOF) for the four most commonly struck bird groups and three most commonly struck terrestrial mammal groups, civil aircraft, USA, 1990–2007.

Species group ¹	Reported strikes		Strikes with damage		Strikes with EOF	
	18-year total	% of total known	18-year total	% of total known	18-year total	% of total known
<u>Birds</u>						
Gulls	7,021	20	1,119	26	895	27
Pigeons/ doves	4,936	14	323	7	376	11
Raptors	4,545	13	779	18	523	16
Waterfowl	2,956	9	1,326	31	651	20
All other known	14,846	43	788	18	839	26
Total known birds	34,304	100	4,335	100	3,284	100
Unknown birds	45,668		4,752		2,726	
Total birds	79,972		9,087		6,010	
<u>Terrestrial mammals</u>						
Artiodactyls	793	46	658	92	401	80
Carnivores	551	32	43	6	84	17
Lagomorphs	182	11	5	1	8	2
All other known	199	12	7	1	7	1
Total known terr. mam.	1,725	100	713	100	500	100
Unknown terr. mam.	12		6		6	
Total mammals	1,737		719		506	

¹ See Table 13 for listing of species within each species group.

Table 15. Number of strikes to civil aircraft causing human fatality or injury and number of injuries and fatalities by wildlife species, USA, 1990–2007.

Species of wildlife	No. of strikes	No. of humans	Species of wildlife	No. of strikes	No. of humans
<u>Strikes causing fatalities</u>			<u>Strikes causing injuries (continued)</u>		
Unknown bird	5	7	Eastern cottontail	1	1
White-tailed deer	1	1	Domestic dog	1	2
Brown pelican	1	1	Mule deer	1	2
Canada goose	1	2	Horse	1	1
Total (fatalities)	8	11	Western grebe	1	1
			Horned grebe	1	1
<u>Strikes causing injuries</u>			Tropicbirds	1	1
Unknown bird	33	38	Red-tailed tropicbird	1	1
White-tailed deer	17	24	D.-crested cormorant	1	1
Ducks	13	15	Anhinga	1	1
Canada goose	13	15	Great frigatebird	1	1
Turkey vulture	10	12	Egrets	1	1
Vultures	9	9	Lesser scaup	1	1
Gulls	8	9	Long-tailed duck	1	1
Geese	7	7	Snow goose	1	1
Red-tailed hawk	4	5	Golden eagle	1	1
Black vulture	3	3	American kestrel	1	5
Hawks	3	5	Sharp-tailed grouse	1	2
Cattle	2	3	Sandhill crane	1	1
Mallard	2	2	Doves	1	1
Osprey	2	2	Mourning dove	1	1
American coot	2	2	Spotted dove	1	4
Herring gull	2	2	Owls	1	1
Ring-billed gull	2	8	Sparrows	1	1
Rock pigeon	2	2	Total (injuries)	158	197

Table 16. Number of civil aircraft lost (destroyed or damaged beyond repair) after striking wildlife by wildlife species and aircraft mass category, USA, 1990-2007.

Wildlife species or species group	Aircraft ¹ mass category (Maximum takeoff mass)			Total aircraft lost
	≤2,250 kg	2,251-5,700 kg	5,701-27,000 kg	
White-tailed deer	11	5	1	17
Unknown bird	7	1	1	9
Canada goose		3		3
Vultures ²	3			3
Cattle	1	1		2
Bald eagle	1			1
Brown pelican	1			1
Coyote			1	1
Domestic dog	1			1
Eastern cottontail	1			1
Hawk	1			1
Mourning dove			1	1
Ring-billed gull		1		1
Wapiti (elk)			1	1
Total	27	11	5	43

¹ Engine types on the 43 destroyed aircraft were piston (32), turboprop (3), and turboshaft (1). Aircraft operator was business (22), private (19), and commercial transport (2).

² Two turkey vultures and 1 unknown (either turkey or black vulture).

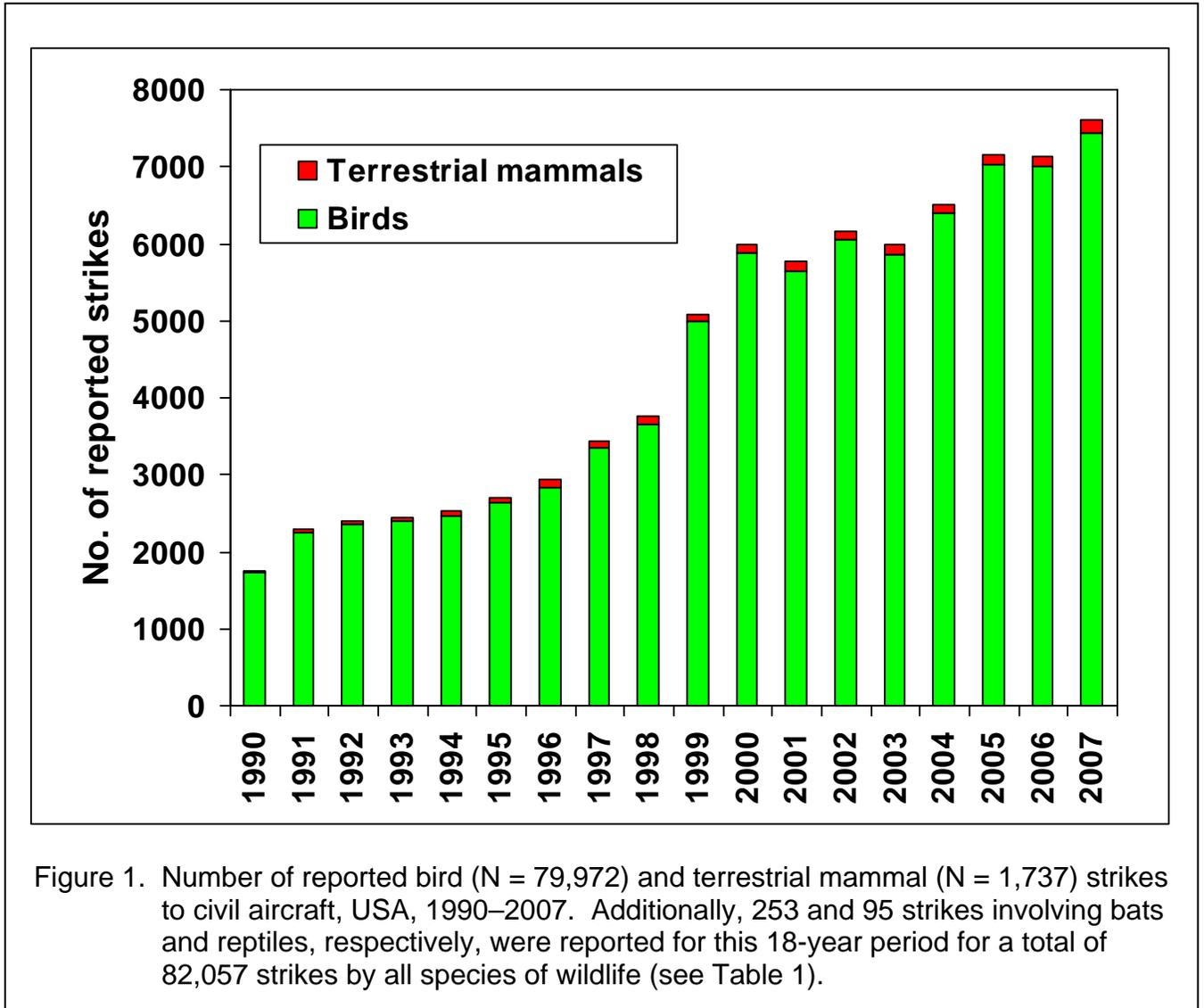
Table 17. Number of reported wildlife strikes indicating damage or a negative effect-on-flight (EOF) and reported losses in hours of downtime and U.S. dollars, for civil aircraft, USA, 1990–2007.

	Number of reports				Reported time (hours) aircraft out of service (No. of reports)	Cost in millions of dollars (\$) (Number of reports)		
	Total reports	Reports indicating adverse effect	Reports indicating aircraft damage	Reports indicating negative EOF		Direct cost	Other cost	Total cost
18-yr total	82,057	14,275	9,814	6,525	590,172 (3,943)	292.591 (2,453)	39.889 (1,023)	332.480
18-yr avg.	4,559	793	545	363	32,787 (219)	16.211 (136)	2.216 (57)	18.471
Mean losses per incident reported					149.7	0.119	0.039	0.158
Estimated annual losses								
Minimum¹					118,712	94.588	30.927	125.515
Maximum²					593,560	472.940	154.635	627.575

¹ Minimum values are based on the assumption that all 14,275 reported strikes indicating an adverse effect (negative EOF and/or damage) to aircraft (mean of 793/year) incurred similar amounts of damage and/or downtime and that these reports are all of the adverse-effect strikes that occurred.

² Maximum values are based on the assumption that the 14,275 reported strikes indicating an adverse effect represent only 20 percent of the total strikes that occurred (Cleary et al. 2005, Wright and Dolbeer 2005).

Figures



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APPENDIX A.

SELECTED SIGNIFICANT STRIKES TO CIVIL AIRCRAFT IN THE UNITED STATES, 2007



A CRJ-700 struck a black vulture on final approach to an airport in Kentucky on 28 August 2007. The strike caused substantial damage to nose cone. The black vulture population in USA increased at a mean annual rate of 2.6%, 1980-2006.

The U.S. Department of Agriculture, through an interagency agreement with the Federal Aviation Administration, compiles a database of all reported wildlife strikes to U.S. civil aircraft and to foreign carriers experiencing strikes in the USA. We compiled 82,057 strike reports from 1,418 USA airports and 207 foreign airports for 1990 through 2007 (7,666 strikes in 2007), but estimate that this represents only about 20 percent of the strikes that have occurred (Wright and Dolbeer 2005). The following examples from the database in 2007 are presented to show the serious impact that strikes by birds or other wildlife can have on aircraft. These examples, from throughout the USA, demonstrate the widespread and diverse nature of the problem. The examples are not intended to highlight or criticize individual airports because strikes have occurred on almost every

airport in the USA. Some of the strike examples reported here occurred off airport property during approach or departure. For more information on wildlife strikes or to report a strike, visit www.birdstrike.org and <http://wildlife-mitigation.tc.faa.gov>.

Date:	27 January 2007
Aircraft:	Cessna 172
Airport:	Orlando Sanford Intl. Airport (FL)
Phase of Flight:	Climb (1,300' AGL)
Effect on Flight:	Precautionary landing
Damage:	Aircraft destroyed
Wildlife Species:	Turkey vulture
Comments from Report:	As pilot departed the airport with a new student, a vulture hit the right wing which caused the plane to turn right and severely limited his ability to control the plane. The plane went into a spiral. The pilot recovered from the spiral and made a forced landing in a field. The nose wheel dug into the ground and separated bringing the plane to a stop. NTSB investigated. The aircraft was destroyed. No injuries.

Date:	28 January 2007
Aircraft:	B-737-300
Airport:	San Jose Intl. Airport (CA)
Phase of Flight:	Climb (150' AGL)
Effect on Flight:	Precautionary landing
Damage:	Engine
Wildlife Species:	Gull
Comments from Report:	Encountered a flock of gulls just prior to entering the cloud deck. Several thumps were heard followed by a strong smell of roasted gull. The engine vibration level increased and the plane returned to land. Engine parts were found on the runway along with several gulls. Fan blades were bent and cracked along with damage to the heat shielding.

Date:	3 March 2007
Aircraft:	Hughes 369
Airport:	Gustavus, AK
Phase of Flight:	Hover
Effect on Flight:	Abrupt landing
Damage:	Tail rotor
Wildlife Species:	Moose
Comments from Report:	A moose, which had been tranquilized for tagging, charged the helicopter and damaged the tail rotor forcing it to the ground. The helicopter had to be lifted from the scene because it could not fly. The moose was euthanized due to serious injury.

Date:	5 March 2007
Aircraft:	B-737
Airport:	Portland Intl. (OR)
Phase of Flight:	Approach (~300' AGL)
Effect on Flight:	Flight cancelled
Damage:	Engine
Wildlife Species:	Greater white-fronted goose
Comments from Report:	The aircraft was 1 mile west of PDX when 2-10 geese were struck. At least 1 was ingested. There was no internal damage to the engine but there was major damage to the cowling. The following flight was cancelled. Cost of repairs was \$494,660 and cost due to customer impact was \$250,000. Time out of service was 24 hours.

Date:	15 March 2007
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Aircraft: B-767-300
 Airport: Chicago O'Hare Intl. (IL)
 Phase of Flight: Climb (700' AGL)
 Effect on Flight: Precautionary landing
 Damage: Engine, pitot, cowl, nose, AOA sensor, fuselage
 Wildlife Species: Canvasback duck
 Comments from Report: Just after the aircraft departed, flames were seen shooting out of the #1 engine. The aircraft returned to land overweight on one engine and was towed to the terminal. Remains of nine ducks were found near the departure end of runway 9R. ID by the Smithsonian, Division of Birds. Time out of service was 12 days. Estimated cost for repairs was \$1.8 million. Cost for aircraft time out of service was \$309,000. Cost not reported for housing 165 passengers overnight.

Date:	28 April 2007
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Aircraft: A-300
 Airport: Cleveland Hopkins Intl. (OH)
 Phase of Flight: Takeoff
 Effect on Flight: Aborted takeoff
 Damage: Engine
 Wildlife Species: Herring gull
 Comments from Report: A gull was ingested in the #2 engine damaging 5 fan blades and resulting in a high-speed rejected takeoff. Aircraft was out of service for 32 hours. Cost of repairs was \$144,750. Other costs were \$19,700. ID by Smithsonian, Division of Birds.

Date:	4 May 2007
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Aircraft: Cessna 180
 Airport: Lopez Island (WA)
 Phase of Flight: Takeoff
 Effect on Flight: Nosed over
 Damage: Empennage
 Wildlife Species: Canada goose
 Comments from Report: The pilot tried to avoid geese during taxi down the runway. He jammed on the brakes and a tailwind gust flipped the aircraft over. There was substantial damage to the empennage. NTSB investigated.

Date:	21 May 2007
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Aircraft: Cessna 525
 Airport: Beverly, MA
 Phase of Flight: En route (3,000' AGL)
 Effect on Flight: Emergency landing
 Damage: Engines, fuselage, windshield
 Wildlife Species: White-winged scoter
 Comments from Report: The aircraft hit a flock of scoters while en route to the Beverly Airport. They declared an emergency and requested equipment to stand by. The flight was diverted to Hanscom and landed without incident. Both of the engines and the fuselage were damaged. Birds were reported as geese; correct ID by Smithsonian, Division of Birds. Time out of service was 8 weeks. Cost of repairs was \$230,000 and other cost was \$200,000.

Date:	3 June 2007
Aircraft:	A-320
Airport:	Metro Oakland Intl. (CA)
Phase of Flight:	Takeoff
Effect on Flight:	Engine vibration
Damage:	Engine
Wildlife Species:	Rock pigeon
Comments from Report:	The aircraft hit a large flock of pigeons. There was a noticeable change in engine sound and a loud thump was heard. Because engine instruments were in the normal range, the flight continued. After landing, 3 bent fan blades were found. Time out of service was 8 hours.

Date:	3 June 2007
Aircraft:	Schweizer 300
Airport:	Eden Prairie, MN
Phase of Flight:	En route (800' AGL)
Effect on Flight:	Precautionary landing
Damage:	Windshield and instrument console
Wildlife Species:	Bald eagle
Comments from Report:	Three miles from the airport, an eagle crashed through the helicopter's windshield and slammed into the chest of a passenger. She was temporarily knocked out and suffered a fractured shoulder. Pilot landed safely and passenger was taken to the hospital with several injuries. Aircraft damage estimated at \$10,000. Aircraft was out of service for 3 weeks.

Date:	4 June 2007
Aircraft:	Learjet 36
Airport:	Bismarck Municipal (ND)
Phase of Flight:	Takeoff run
Effect on Flight:	Aborted takeoff
Damage:	Engine
Wildlife Species:	Mallard
Comments from Report:	A mallard was ingested into the #2 engine. The engine was totally destroyed. Fan blades perforated the cowling. ID by Smithsonian, Division of Birds. Cost totaled \$250,000.

Date:	24 June 2007
Aircraft:	Embraer 145
Airport:	Memphis Intl. (TN)
Phase of Flight:	Climb (300' AGL)
Effect on Flight:	Precautionary landing
Damage:	Engine
Wildlife Species:	Red-tailed hawk
Comments from Report:	A hawk was ingested into the #1 engine causing erratic pressure readings and oil loss. The flight was diverted to Shreveport and later cancelled. The engine had bent compressor fan blades and broken stator vanes. ID by Smithsonian, Division of Birds.

Date: 7 July 2007

Aircraft: B-767-400
Airport: Fiumicino Airport (Rome)
Phase of Flight: Climb (20' AGL)
Effect on Flight: Precautionary landing
Damage: Both engines, landing gear
Wildlife Species: Yellow-legged gull
Comments from Report: The engine ingested gulls during takeoff and dumped fuel before returning to land. Birds hit the cockpit window, right engine nose cowl, wing, and right main undercarriage. The main gear struts were deflated. Some of the fan blades had large chunks taken out. The left engine had many fan blades damaged midway along the blade leading edge. Both engines were replaced. ID by an ornithologist, who is a member of Bird Strike Committee Italy, and verified by the Smithsonian, Division of Birds. Time out of service was 1 week. Cost for repairs was approximately \$785,000. No cost reported for landing fees, passengers and crew hotel, and rebooking on other airlines. (United States carrier at a foreign airport)

Date: 8 July 2007

Aircraft: Cessna 182
Airport: Matinicus Island (ME)
Phase of Flight: Approach (50'AGL)
Effect on Flight: Crash landing
Damage: Aircraft destroyed
Wildlife Species: Bald eagle
Comments from Report: On final approach, the pilot swerved to avoid an eagle, hit the tree tops near the runway, and crashed. The aircraft was destroyed and two people were injured. NTSB investigated.

Date: 9 July 2007

Aircraft: B-737-300
Airport: Birmingham Intl. (AL)
Phase of Flight: Takeoff run
Effect on Flight: None
Damage: Engine
Wildlife Species: Mourning dove
Comments from Report: The engine ingested doves during takeoff with no apparent effect on the flight. Maintenance found 6 fan blades damaged. All 38 fan blades were replaced. Cost was estimated at \$900,000. ID by Smithsonian, Division of Birds.

Date: 19 July 2007

Aircraft: MD-10-10
Airport: El Paso Intl. (TX)
Phase of Flight: Takeoff run
Effect on Flight: Aborted takeoff
Damage: Engine
Wildlife Species: Unknown
Comments from Report: The aircraft returned to the gate after ingesting small birds during takeoff. One engine was replaced along with the fire bottle and nose cowl. Time of service was 3 days. Costs totaled \$516,712.

Date:	20 July 2007
Aircraft:	Cessna 150
Airport:	Watts-Woodland Airport (CA)
Phase of Flight:	Approach (1,000' AGL)
Effect on Flight:	Crashed in a field
Damage:	Aircraft destroyed
Wildlife Species:	Hawk
Comments from Report:	A hawk broke through the windshield during approach. The pilot tried to land at the airport but the aircraft was losing power, so he opted for a crash landing in a tomato field. The plane landed and flipped upside down. Both the pilot and his passenger sustained minor injuries. The aircraft was valued at \$25,000 and other costs totaled \$10,000.

Date:	20 July 2007
Aircraft:	Schweizer G-164B
Airport:	Walker Field (IA)
Phase of Flight:	Climb (50' AGL)
Effect on Flight:	Overran runway
Damage:	Aircraft destroyed
Wildlife Species:	Unknown bird
Comments from Report:	The aircraft was substantially damaged during an emergency landing following a loss of engine power after takeoff. When the engine lost power, the aircraft settled to the ground but the pilot was not able to stop the aircraft on the remaining runway. The plane hit a fence, then a ditch and nosed over. Bird remains were found near midfield on the centerline. NTSB investigated. Cost to replace the aircraft was \$210,000.

Date:	1 August 2007
Aircraft:	Cessna 180
Airport:	Sky Harbor (MN)
Phase of Flight:	Landing roll
Effect on Flight:	Aborted landing
Damage:	Wing, fuselage, other unknown parts
Wildlife Species:	Canada goose
Comments from Report:	The aircraft was substantially damaged when it impacted terrain during an aborted landing attempt. The pilot was lowering the tail wheel when he hit 2 geese. The plane started turning right and the pilot tried to correct using left brake and rudder and right aileron controls. He then added full power to get back in the air. The left wing hit the runway and the aircraft flipped over on its back. NTSB investigated.

Date:	17 August 2007
Aircraft:	CRJ 700
Airport:	Port Columbus Intl. (OH)
Phase of Flight:	Takeoff run
Effect on Flight:	Precautionary landing
Damage:	Engine
Wildlife Species:	European starling
Comments from Report:	A flock of over 300 starlings was hit during takeoff. Thirty-eight carcasses were removed from the runway which was closed for 40 minutes. An emergency landing was made when engine lost thrust. Engine damage consisted of bent fan blades and several damaged compressor blades. Time out of service was 3 days. Cost was \$35,000.

Date:	20 August 2007
Aircraft:	Citation 650
Airport:	Benton Harbor (MI)
Phase of Flight:	Takeoff run
Effect on Flight:	Aborted takeoff
Damage:	Radome, landing gear, fuselage, pitot tube
Wildlife Species:	White-tailed deer
Comments from Report:	The pilot saw 2 deer and hit 1. Damage consisted of a cracked radome, bent nose gear door and the pitot tube was pushed into the fuselage skin. Cost of repairs and lost revenue was \$97,186. Time out of service was 31 days.

Date:	25 August 2007
Aircraft:	B-737-300
Airport:	El Paso Intl. (TX)
Phase of Flight:	Climb (10,000' AGL)
Effect on Flight:	Precautionary landing
Damage:	Nose, tail
Wildlife Species:	Marbled godwit
Comments from Report:	A loud bang was heard in the cockpit during climb followed by rushing air as the cabin began to depressurize. The cabin alt horn sounded and oxygen masks were put on as they descended to 10,000 feet. After landing, two large holes were found; one under the captain's side by his foot and the other in the left horizontal stabilizer. The cockpit on the first officer's side was dented. Blood and feathers were found. No birds were seen in flight. Ground crew said "turkey buzzards" were in the area. ID by Smithsonian, Division of Birds. Cost of repairs was \$144,000. Time out of service was 2 days.

Date:	28 August 2007
Aircraft:	CRJ 700
Airport:	Louisville Intl. (KY)
Phase of Flight:	Approach (2,300' AGL)
Effect on Flight:	Emergency landing
Damage:	Nose, fuselage
Wildlife Species:	Black vulture
Comments from Report:	The pilot declared an emergency after a vulture smashed in the front fuselage between the radome and the windshield. The strike ripped the skin, broke the avionics door, broke a stringer in half and bent 2 bulkheads. Temporary repairs were made then the aircraft was ferried for permanent repairs. ID by Smithsonian, Division of Birds. Cost of repairs was \$200,000. Time out of service was 2 weeks.

Date:	6 September 2007
Aircraft:	Kitfox IV
Airport:	Cowen, WV
Phase of Flight:	En Route (1,000' AGL)
Effect on Flight:	Engine shut down, emergency landing off airport
Damage:	Propeller
Wildlife Species:	Unknown
Comments from Report:	A bird struck the wooden propeller causing it to disintegrate. An off airport emergency landing was made during which the aircraft hit a fence, traveled down an embankment and flipped over. There was substantial damage to the aircraft and minor injuries to the pilot. Cost was estimated at \$25,000.

Date:	17 September 2007
Aircraft:	DC-10
Airport:	Cherry Point MAS (NC) (found at)
Phase of Flight:	Unknown
Effect on Flight:	None
Damage:	Engine
Wildlife Species:	Great blue heron
Comments from Report:	A heron was ingested. The pilot was unaware of the strike. Damage was found by maintenance during an inspection after landing. The engine was damaged beyond repair. Cost was \$1.7 million. ID by Smithsonian, Division of Birds. Time out of service was 62 hours.

Date:	22 September 2007
Aircraft:	MD-80
Airport:	Jackson-Evers Intl. (MS)
Phase of Flight:	Landing roll
Effect on Flight:	Flight cancelled
Damage:	Wing, radome, landing gear
Wildlife Species:	Canada goose
Comments from Report:	Seven geese were found after the strike. Parts damaged include a wing, the radome and the landing gear. ID by Smithsonian, Division of Birds.

Date:	27 September 2007
Aircraft:	Eurocopter 130
Airport:	Near Meadview, AZ
Phase of Flight:	En Route (600' AGL)
Effect on Flight:	Precautionary landing
Damage:	Windshield
Wildlife Species:	Golden eagle
Comments from Report:	An eagle broke through the pilot's windshield hitting a passenger in the head. The pilot and two passengers were injured with cuts and scratches. Time out of service was three months. Cost was \$800,000. NTSB investigated. ID by Smithsonian, Division of Birds.

Date:	29 September 2007
Aircraft:	B-737-700
Airport:	Philadelphia Intl. (PA)
Phase of Flight:	Climb (3,000' AGL)
Effect on Flight:	Emergency landing
Damage:	Radome, radar dish, windshield, nose
Wildlife Species:	Canada goose
Comments from Report:	Several geese were struck. The windshield shattered, injuring the co/pilot. An emergency landing was made. One carcass was removed from the radome. The aircraft was taken out of service. Passengers were put on another aircraft and the flight continued about 5 hours later. Time out of service 48 hours. Cost totaled \$60,160. ID by USDA.

Date: 11 October 2007

Aircraft: CRJ 700
Airport: Denver Intl. (CO)
Phase of Flight: Climb (1,500' AGL)
Effect on Flight: Emergency landing, engine shut down
Damage: Engine, wing
Wildlife Species: Sandhill crane

Comments from Report: Several cranes were struck shortly after takeoff. The captain said several geese came at them and they heard 3-4 thuds. The right engine immediately began to run roughly and the VIB gauge was fluctuating rapidly from one extreme to the other. Captain declared an emergency and said he didn't think he was going to make it back to DEN. The aircraft landed safely. The engine fan was damaged and there were dents along the left wing leading edge slat. ID by Smithsonian, Division of Birds. NTSB investigated.

Date: 23 October 2007

Aircraft: PA-44
Airport: Near Browerville MN
Phase of Flight: En Route (3,400' AGL)
Effect on Flight: Impacted terrain
Damage: Aircraft destroyed
Wildlife Species: Canada goose

Comments from Report: The aircraft disappeared during a night training flight. Wreckage was found upside down in a bog 36 hours later. The instructor and student pilot did not report any difficulties or anomalies prior to the accident. The damage that crippled the aircraft was to the left horizontal stabilator. ID by Smithsonian, Division of Birds. NTSB investigated. Two fatalities.

Date: 29 October 2007

Aircraft: BK-117
Airport: Near Hamburg, PA
Phase of Flight: Enroute (1,400' AGL)
Effect on Flight: Emergency landing in parking lot
Damage: Windshield, and rear door window
Wildlife Species: Wood duck

Comments from Report: Helicopter was enroute to an accident scene when it hit a flock of ducks. Two penetrated the aircraft. One broke through the front windscreen and the second through the rear door window. The impact forced both throttles into the "idle" position which caused the aircraft to lose power. The pilot placed the aircraft into autorotation for an emergency landing and sent a "mayday" notice to the local airport. When he realized what caused the power failure he returned both throttles into the "fly" position and landed in a nearby parking lot, a mile from their intended pickup location. One injury. Crew was wearing helmets with visors. Time out of service was 8 days. Cost of repairs estimated at \$8,000.

Date:	29 October 2007
Aircraft:	MD-88
Airport:	Daytona Beach Intl. (FL)
Phase of Flight:	Takeoff run
Effect on Flight:	Precautionary landing
Damage:	Engine
Wildlife Species:	American golden plover
Comments from Report:	Multiple plovers were struck on takeoff, but the pilot was unaware of the strike. A flight attendant noticed a burning odor and an airline mechanic on the flight heard a pop from the engine. The right engine fan section was ruined. ID by Smithsonian, Division of Birds.

Date:	22 November 2007
Aircraft:	B-767-300
Airport:	Nice Cote d'Azur (France)
Phase of Flight:	Climb (250' AGL)
Effect on Flight:	Precautionary landing
Damage:	Engine, wing, tail
Wildlife Species:	Yellow-legged gull
Comments from Report:	A flock of gulls was seen during takeoff. As the aircraft rotated, the flock lifted off the runway. Multiple birds were hit. The crew felt vibrations and returned to land. The # 2 engine had fan blade damage. One piece of a fan blade broke off and exited out the front and the core nozzle fell off. The engine was replaced. ID by Smithsonian, Division of Birds. Time out of service was 12 days. Cost of repairs was \$8,925,000 and other cost was \$196,000. (United States carrier at a foreign airport)

Date:	27 November 2007
Aircraft:	CRJ 200
Airport:	Memphis Intl. (TN)
Phase of Flight:	Descent
Effect on Flight:	Unknown
Damage:	Engine, nose, wing, tail, fuselage, anti-ice cowling
Wildlife Species:	Snow goose (immature)
Comments from Report:	During descent the aircraft encountered a flock of birds, ingesting them into both engines. Maintenance made temporary repairs then the aircraft was ferried for permanent repairs.

Date:	29 November 2007
Aircraft:	B-757-200
Airport:	Los Angeles Intl. (CA)
Phase of Flight:	Climb (1,000' AGL)
Effect on Flight:	Precautionary landing
Damage:	Engine
Wildlife Species:	Western grebe
Comments from Report:	Grebes were ingested in the # 2 engine. An emergency was declared and the aircraft returned to land. Damage was found on 13 fan blades. The flight was cancelled. ID by the Smithsonian, Division of Birds. Time out of service 1 week. Cost was over \$1 million.

Date:	2 December 2007
Aircraft:	B-767-400
Airport:	Dakar-Yoff-Léopold Sédar Senghor Intl.
Phase of Flight:	Climb (200' AGL)
Effect on Flight:	Precautionary landing
Damage:	Engine
Wildlife Species:	Unknown bird
Comments from Report:	A bird was ingested in the # 1 engine just after takeoff. The pilot made a precautionary two-engine landing. All fan blades were replaced. Time out of service 4 days. Cost of repairs was \$1.2 million. (United States carrier at a foreign airport)

Date:	4 December 2007
Aircraft:	B-767
Airport:	John F. Kennedy Intl. (NY)
Phase of Flight:	Approach (3,000' AGL)
Effect on Flight:	Emergency landing
Damage:	Windshield, radome, radar & vertical stabilizer
Wildlife Species:	Snow goose
Comments from Report:	Geese penetrated the radome, damaged the radar and then penetrated the fuselage into the aircraft. The vertical stabilizer was dented. ID by Smithsonian, Division of Birds.