



**U. S. DEPARTMENT
OF TRANSPORTATION
FEDERAL AVIATION
ADMINISTRATION**

WILDLIFE STRIKES TO CIVIL AIRCRAFT IN THE UNITED STATES 1990-2000



**FEDERAL AVIATION ADMINISTRATION
NATIONAL WILDLIFE STRIKE DATABASE
SERIAL REPORT NUMBER 7**

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**REPORT OF THE ASSOCIATE ADMINISTRATOR OF AIRPORTS
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COVER

Part of engine that fell off a Boeing 747 after ingesting a gull on departure for Europe from a west coast airport in USA, August 2000. The aircraft, with 449 people aboard, returned to the airport safely after the crew dumped 83 tons of fuel. (Photo courtesy C. Collins)

Future reports will feature photographs of aircraft damage resulting from wildlife strikes. Anyone with quality photographs of wildlife-aircraft strike damage is encouraged to submit them to one of the authors for consideration. Credit will be given for all photographs used.

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PREFACE

It is widely recognized throughout the civil and military aviation communities 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 400 people and destroyed over 420 aircraft (Richardson 1994, 1996, Richardson and West 2000, Thorpe 1996, 1998, Dolbeer unpublished data). Other than controlled flight into terrain, wildlife strikes have caused more aviation fatalities than any other single source (Eschenfelder 2000). Several factors are contributing to this increasing threat:

1. Most airlines are replacing their older 3- or 4-engined aircraft fleets with more efficient and quieter, 2-engined aircraft. In 1969, 75% of the 2,100 USA passenger aircraft had three or four engines. In 1998, the USA passenger fleet had grown to about 5,400 aircraft, only 30% had 3 or 4 engines. It is estimated that by 2008 the fleet will contain about 7,000 aircraft, only 10% of which will have 3 or 4 engines (Cleary and Dolbeer 1999). This reduction in engine redundancy increases the probability of life-threatening situations resulting from aircraft collisions with wildlife, especially with flocks of birds.
2. Many populations of wildlife species commonly involved in strikes have increased markedly in the last few decades. For example, in the USA, from 1980 to 2000, the resident (non-migratory) Canada goose population increased at a mean rate of 10% per year; the ring-billed gull population increased at an annual rate of about 4%; the red-tailed hawk population increased at an annual rate of 3%; and the turkey vulture population increased at an annual rate of 2% (Sauer et al. 2001). 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 3 decades (Dolbeer and Eschenfelder 2002). The white-tailed deer population increased from a low of about 350,000 in 1900 to about 24 million in 1994 (Jacobson and Kroll 1994).
3. In the USA, air traffic has increased substantially since 1980. Passenger enplanements increased from about 310 million in 1980 to 700 million in 2000, and USA commercial air traffic increased from about 18 million aircraft movements in 1980 to 30 million in 2000 (3% per year, FAA 2002).

As a result of these factors, experts within the Federal Aviation Administration (FAA), U.S. Department of Agriculture, and U.S. Air Force expect the risk, frequency, and potential severity of wildlife-aircraft collisions to escalate 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, other than 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 U. S. Department of Agriculture, Wildlife Services, National Wildlife Research Center, initiated a project to obtain more objective estimates of the magnitude and nature of the wildlife strike problem nationwide for civil aviation. This project includes 1) editing all strike reports (FAA Form 5200-7) sent to the FAA since 1990 to ensure consistent, error-free data; 2) entering all edited strike reports since 1990 in a Wildlife Strike Database; 3) supplementing FAA-reported strikes with additional, non-duplicated strike reports from other sources; 4) providing FAA with an updated computer file each quarter containing all edited strike reports; and 5) assisting the FAA with the production of annual reports summarizing the results of the analyses. Such analyses are critical to determine the economic cost of wildlife strikes, the magnitude of safety issues, and most importantly, the nature of the problems (e.g., bird species, aircraft and engine types, airports, and seasonal patterns) so that corrective actions can be taken.

The first annual report on wildlife strikes to civil aircraft in the USA, covering 1994, was completed in November 1995 (Dolbeer et al. 1995). Subsequent reports covering the years 1993-1995, 1992-1996, 1991-1997, 1990-1998, and 1990-1999 were issued in 1996, 1997, 1998, 1999 and 2000, respectively (Cleary et al. 1996, 1997, 1998, 1999, 2000). This is the seventh report in the series, and covers the 11-year period 1990-2000.

WILDLIFE STRIKES TO CIVIL AIRCRAFT IN THE UNITED STATES, 1990-2000

This report presents a summary analysis of data from the Federal Aviation Administration's National Wildlife Strike Database for the 11-year period, 1990-2000. A more detailed publication covering the 10-year period, 1990-1999, was published in September 2000 (Cleary et al. 2000). Subsequent detailed reports will be produced at 5-year intervals. In interim years such as this, annual reports summarizing data in tabular form for all available years will be produced. Unless noted, all totals are for the 11-year period, and percentages are of the total known.

Between 1990 and 2000, 34,370 ($\bar{x} = 3,125/\text{year}$) strikes were reported to the FAA. There was a 16% increase in the number of wildlife strikes reported in 2000 over 1999, and a 3.4-fold increase in the number of strikes reported in 2000 compared to 1990 (Table 1). We suggest that the increase in reports is the result of several factors: an increased awareness of the wildlife strike issue; an increase in aircraft operations; an increase in populations of certain hazardous wildlife species; and an increase in the number of strikes (Dolbeer 2000).

Most (68%) of the 34,370 strike reports were filed using FAA Form 5200-7 (Table 2). Pilots and airline personnel filed 32% and 21% of these 34,370 reports, respectively (Table 3). About 83% of the reported strikes involved commercial aircraft; the remainder involved business, private, and miscellaneous 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). CA, FL, TX, NY, and IL reported the most bird strikes. NY, IL, PA, MI, and TX reported the most mammal strikes.

Most bird strikes (51%) occurred between July and October (Table 6); 64% occurred during the day (Table 7); 54% occurred when the aircraft was on approach or during the landing roll, and 39% occurred during take off and climb (Table 8). About 55% of the bird strikes occurred when the aircraft was at an altitude of less than 100 ft. above ground level (AGL), 78% occurred under 1,000 ft. AGL, and 86% occurred under 2,000 ft. AGL (Table 9).

Most mammal strikes (41%) occurred between September and November (Table 6); 63% occurred at night (Table 7); 52% occurred during the landing roll; 35% occurred during take off. About 10% of the reported mammal strikes occurred while the aircraft was still in the air, when the aircraft struck deer with the landing gear or encountered bats (Table 8).

The aircraft types most often involved in strikes that damaged one or more aircraft components were Boeing 737, McDonnell Douglas MD-80 and DC-9 series,

Boeing 757, and Boeing 727. The aircraft types most often involved in a strike that had a negative effect-on-flight were Boeing 737, McDonnell Douglas MD-80 and DC-9 series, Saab-340, Cessna-172 and British Aerospace 31 (Table 10).

The aircraft components most commonly reported as struck by birds were nose/radome, windshield, engine, wing/rotor, and fuselage. Aircraft engines were the component most frequently (35% of all damaged components) reported as being damaged by bird strikes. Of the 5,129 aircraft engines reported as being struck by birds, 39% (1,979) were damaged (Table 11). There were 255 incidents in which two or more engines on a single aircraft were struck by birds.

Of the 33,488 bird strikes reported, 28,755 provided some indication as to the nature and extent of any damage. Of the 28,755 reports, 23,881 (83%) indicated the strike did not damage the aircraft; 2,563 indicated the aircraft suffered minor damage; 1,495 indicated the aircraft suffered substantial damage; and 9 reports indicated the aircraft was destroyed as a result of the strike (Table 12). Reports were received detailing 76 bird strikes that resulted in 79 human injuries and 5 fatalities (Table 13).

Aircraft components most commonly reported as struck by mammals were landing gear, propeller, and wing/rotor. These same components ranked highest for the parts most often reported as damaged by mammals (Table 11).

Of the 844 mammal strikes reported, 653 provided some indications as to the nature and extent of any damage. Of the 653 reports, 207 (32%) indicated the strike did not damage the aircraft; 222 indicated the aircraft suffered minor damage; 187 indicated the aircraft suffered substantial damage; and 11 reports indicated the aircraft was destroyed as a result of the strike (Table 12). Not surprisingly, a much higher percentage of mammal strikes resulted in aircraft damage than did bird strikes, about 68% and 17% respectively. Reports were received of 17 mammal strikes that resulted in 21 human injuries and 1 fatality (Table 13).

Fifteen and 62% of the bird and mammal strike reports, respectively, indicated the strike had an adverse effect-on-flight (Table 14).

Birds were involved in 97.4% of the reported strikes, mammals in 2.5%, and 0.1% involved reptiles (Table 1). Table 15 shows the number of reported strikes, the number of strikes that damaged 1 or more aircraft components, and the number of strikes that had a negative effect-on-flight by identified wildlife species, 1990-2000.

Gulls (27%), doves (12%), raptors (12%), and waterfowl (11%) were the most commonly struck bird groups. Gulls were involved in 2.4 times as many strikes as waterfowl, but waterfowl were involved in more damaging strikes, 759 (32% of all damaging strikes in which the bird type was identified) than were gulls (713, 30%

of damaging strikes). The most commonly struck mammals were deer (57%) and coyotes (11%, Table 15).

For the 11-year period, reported losses from bird strikes totaled 158,886 hours of aircraft down time and \$102.9 million in monetary losses. Reported losses from mammal strikes totaled 106,846 hours of aircraft down time and \$11.7 million in monetary losses (Table 16).

Of the 6,996 reports that indicated the strike had an adverse effect on the aircraft and/or flight, 1,587 provided an estimate of the aircraft down time ($\Sigma = 265,723$ hours, $\bar{x} = 167$ hours down time/incident), and 1,174 provided an estimate of the direct and/or other cost ($\Sigma = \$114.6$ million, $\bar{x} = \$97,615$ damage/incident). Of the 1,174 reports providing a damage cost estimate, 1,048 gave an estimate of direct aircraft damage ($\Sigma = \$96.0$ million, $\bar{x} = \$91,590$ damage/incident), and 414 gave an estimate of other monetary losses ($\Sigma = \$18.6$ million $\bar{x} = \$44,915$ lost/incident) (Table 17).

Analysis of strike reports from three major USA airports showed that less than 20% of all strikes occurring at these airports were reported to the FAA (Cleary et al. 1996, 1997, 1998; Dolbeer et al. 1995). Additionally, many reports received by the FAA were filed before aircraft damage had been fully assessed. For these reasons, the information on the number of strikes and their associated costs compiled from the voluntary reporting program is believed to severely underestimate the magnitude of the problem.

Assuming all 6,996 reported wildlife strikes that had an adverse effect on the aircraft and/or flight had similar amounts of down time and/or monetary losses, and that these reports are all of the damaging strikes that occurred, then at a minimum, wildlife strikes cost the USA civil aviation industry 106,490 hours/year of aircraft down time, \$58.2 million/year in direct monetary losses, and \$28.6 million/year in associated costs.

Further, assuming a 20% reporting rate, the cost of wildlife strikes to the USA civil aviation industry is estimated to be in excess of 532,451 hours/year of aircraft down time, \$291.3 million/year in direct monetary losses and \$142.8 million/year in associated costs (Table 17).

CONCLUSIONS

With the analysis of 11 years of strike data, the magnitude and severity of the wildlife-aircraft strike problem is becoming more obvious. Two important points need to be made. First, airport managers need to be aware of the wildlife hazards on their airports (Dolbeer et al 2000) and take appropriate actions, under the guidance of professional biologists trained in wildlife damage management, to minimize the problems. Second, the focus of airport wildlife management needs to be widened to consider habitats and land-uses in proximity to the airport, such as

wetlands, waste-disposal facilities, and wildlife refuges, all of which can attract wildlife hazardous to aviation. Such land uses and activities are often incompatible with aviation safety and should be prohibited near airports or designed and operated in a manner that minimizes the attraction of hazardous wildlife.

A recently published manual, *Wildlife Hazard Management at Airports* (Cleary and Dolbeer 1999), has been prepared to assist airport personnel in developing and implementing wildlife hazard management plans. Copies of this manual (stock number 050-007-012837) can be ordered from the Superintendent of Documents, P. O. Box 321954, Pittsburgh, PA 15720-7954 or is 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 analysis indicated <20% of all wildlife strikes involving USA civil aircraft are reported. Furthermore, over 50% of all reported bird strikes, 1990-2000, provided no information on the species struck and only about 17% of strike reports indicating an adverse effect provided an estimate of cost.

Pilots, airport operations and aircraft maintenance personnel, or anyone else having knowledge of a strike should report the incident. 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 than would be possible if just one report were filed.

The identification of the species of wildlife struck is particularly important. Bird strike remains that cannot be identified by airport personnel can often be identified by a local biologist or by sending feather remains in a sealed plastic bag (with FAA Form 5200-7) to:

Smithsonian Institution
Natural History Building, E607
10th and Constitution NW
Washington, DC 20560
Attn: Carla Dove

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. Do not send entire bird carcasses through the mail.

Strikes can also be reported via the Internet (<http://wildlife-mitigation.tc.faa.gov>), in addition to the traditional means of filling out and mailing FAA Form 5200-7. FAA Form 5200-7 can be accessed and printed from the above internet site.

SELECTED SIGNIFICANT STRIKES TO CIVIL AIRCRAFT IN THE UNITED STATES, 1990-2000

The following examples, two from each year, 1990-1999 and 6 from 2000, have been selected from the FAA National Wildlife Strike Database to show the serious impact that strikes by wildlife can have on aircraft. A more complete listing of significant strikes to civil aircraft is available at the FAA's Wildlife Hazard website: <http://wildlife-mitigation.tc.faa.gov>. 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. Some of the strike examples reported here occurred off airport property during approach or departure.



This engine on a Boeing 727-200 incurred major damage when a Canada goose was ingested at 500 feet AGL after take off from a mid-western USA Airport in April 2000 (Photo, R. Johnson).

Date: 11 January 1990

Aircraft: Hawker Siddeley

Airport: John Tune (TN)

Phase of Flight: Take off

Effect on Flight: Aborted take off

Damage: Engine

Wildlife Species: White-tailed deer

Comments from Report: Several deer were struck during take off. One was completely ingested in the left engine. The impact tore the engine loose from the aircraft. The aircraft was replaced at a cost of \$1.4 million dollars.

Date: 9 October 1990

Aircraft: Cessna 550

Airport: DeKalb Peachtree (GA)

Phase of Flight: Take off

Effect on Flight: Precautionary landing, engine shut down

Damage: Engine

Wildlife Species: Unknown bird

Comments from Report: Ingested a bird in #1 engine during take off. Vibration increased and the engine was shut down. Fan and inlet guide vanes were destroyed. Time out of service was 65 hours. Cost of repairs estimated at \$105,000.

Date: 28 August 1991

Aircraft: Cessna 550

Airport: Person County (NC)

Phase of Flight: Take off

Effect on Flight: Aborted take off

Damage: Engine

Wildlife Species: Doves

Comments from Report: Right engine inlet was damaged due to the temperature probe being tossed back and forth prior to going through the fan. All 28 fan blades were bent, torn and chipped. Stator behind fan was damaged. Time out of service was 70 hours. Cost of repairs was \$160,000.

Date: 30 December 1991

Aircraft: Cessna 550
Airport: Angelina County (TX)
Phase of Flight: Take off
Effect on Flight: Aborted take off
Damage: Engine
Wildlife Species: Turkey vulture

Comments from Report: Ingested 1-2 vultures in #1 engine during take off. Engine had an uncontained failure, fire and vibration with 100% thrust loss. Wing and fuselage received damage from engine shrapnel. Time out of service was 2 weeks. Cost of repairs was \$552,500.

Date: 2 January 1992

Aircraft: Piper 28
Airport: Sandstone (MN)
Phase of Flight: Approach
Effect on Flight: Impacted trees and ground
Damage: Aircraft destroyed
Wildlife Species: Deer

Comments from Report: Just prior to touchdown, a deer ran toward and collided with the aircraft. The pilot added power and aborted the landing. Loss of engine power was experienced during the climb and the aircraft crashed into trees then the ground ¼ mile south of airport. Pilot was seriously injured and the aircraft was destroyed. The NTSB found that the deer had damaged the gascolator and fuel starvation resulted.

Date: 10 August 1992

Aircraft: Cessna 441
Airport: Lee Gilmer Memorial (GA)
Phase of Flight: Climb
Effect on Flight: Impacted ground
Damage: Aircraft destroyed
Wildlife Species: Unknown birds

Comments from Report: Immediately after take off, aircraft hit birds. Right engine lost power and aircraft would not maintain altitude. Pilot was forced to land in a residential area ¼ mile from Gainesville Airport. Both pilot and passenger were seriously injured. NTSB reported that pilot shut down wrong engine and did not follow emergency checklist. Aircraft worth \$690,000-\$1.7 million.

Date: 24 March 1993

Aircraft: Bell BHT-47
Airport: En route
Phase of Flight: En route
Effect on Flight: Impacted water
Damage: Aircraft destroyed
Wildlife Species: Unknown bird

Comments from Report: During cruise, pilot heard a loud bang and felt vibration in rudder pedals then lost all yaw control. Pilot thought the tail rotor struck a large sea bird as many were in the area. He maintained directional control and tried to lower the helicopter so that the passenger (a ship's captain) could reach small boats being lowered by his ship nearby. The passenger jumped before the pilot gave the okay and was killed. The pilot subsequently made a running landing on the water and was hoisted on board the ship.

Date: 3 December 1993

Aircraft: Cessna 550
Airport: DuPage (IL)
Phase of Flight: Climb
Effect on Flight: Diverted, emergency landing
Damage: Engine
Wildlife Species: Geese

Comments from Report: Struck a flock of geese. Loud bang, followed by unstable flight. Lost power to #2 engine and had a substantial fuel leak on left side. Emergency was declared and aircraft landed safely at Midway. Both engines had to be replaced. Time out of service was 90 days. Cost of repairs was \$800,000.

Date: 16 May 1994

Aircraft: Bell BHT-47
Airport: En route (OK)
Phase of Flight: En route
Effect on Flight: Impacted ground
Damage: Aircraft destroyed
Wildlife Species: Unknown bird

Comments from Report: Witnesses heard a loud noise and saw an object separate from the second of two helicopters. The helicopter then impacted inverted in the back yard of a residence. The pilot of the first helicopter said he had warned the second pilot of a flock of birds and that he had to bank sharply to avoid them. NTSB said probable cause was loss of control due to pilot's improper use of the cyclic and collective controls when he maneuvered abruptly to avoid colliding with a flock of birds. Two fatalities.

Date: 15 July 1994
Aircraft: Cessna 172
Airport: En route (FL)
Phase of Flight: En route
Effect on Flight: Impacted water
Damage: Aircraft destroyed
Wildlife Species: Pelicans
Comments from Report: Aircraft was seen flying about 200 ft above the water along the beach. A large bird collided with the windshield. The aircraft rolled inverted and hit the water. The pilot was killed.

Date: 3 June 1995
Aircraft: Concorde
Airport: John F. Kennedy (NY)
Phase of Flight: At touchdown
Effect on Flight: Aircraft was towed to gate
Damage: Engines
Wildlife Species: Canada geese
Comments from Report: Aircraft ingested a Canada goose into the #3 engine which had an uncontained failure causing parts to go into the #4 engine. Both engines were destroyed. Flames and smoke were seen coming from both engines. Cost was over \$9 million. Aircraft was out of service for 5 days. The NY Port Authority paid \$5.3 million in compensation for losses.

Date: 10 December 1995
Aircraft: Boeing 747
Airport: John F. Kennedy (NY)
Phase of Flight: Approach
Effect on Flight: Not reported
Damage: Engines, cowling, wing, fuselage
Wildlife Species: Snow geese
Comments from Report: As the aircraft broke through a cloud bank at 7500 feet, it was struck by a flock of snow geese, which sounded like sandbags hitting. The impact destroyed one engine, damaged several fan blades on another and extensively damaged the airframe. Repairs cost approximately \$6 million.

Date: 2 June 1996
Aircraft: Boeing 737
Airport: Chicago Midway (IL)
Phase of Flight: Climb
Effect on Flight: Precautionary landing
Damage: Engine
Wildlife Species: Gull
Comments from Report: Ingested a gull during climb out. Tower observed flames from #2 engine and advised pilot who declared an emergency and returned to land without incident. Emergency equipment was on the runway. Aircraft landed using single engine landing procedures. Core and all fan blades were damaged. Engine was rebuilt.

Date: 13 December 1996
Aircraft: Beechcraft 1900
Airport: Arnold Palmer Regional Airport (PA)
Phase of Flight: Landing roll
Effect on Flight: Skidded to stop on runway
Damage: Left main landing gear
Wildlife Species: White-tailed deer
Comments from Report: Struck deer on landing causing left main gear to collapse, underside of fuselage, wing tip and aileron flaps damaged, prop blades broken. No injuries.

Date: 7 January 1997
Aircraft: MD-80
Airport: Dallas-Fort Worth (TX)
Phase of Flight: Climb
Effect on Flight: Precautionary landing
Damage: Engine, wing & radome
Wildlife Species: Blackbirds (437)
Comments from Report: Aircraft struck over 400 birds just after take-off. Almost every part of the plane was hit. Pilot declared an emergency and returned to land without event. Substantial damage was found on various parts of the aircraft. #1 engine had to be replaced. Runway was closed for an hour. Personnel were sent to disperse another large flock on the airfield. Cost estimated at \$1 million.

Date: 15 November 1997

Aircraft: Airbus 320
Airport: John Wayne (CA)
Phase of Flight: Take off
Effect on Flight: Precautionary landing
Damage: Engine
Wildlife Species: Large bird

Comments from Report: A large bird was ingested into one of the two engines causing a fire. Passengers heard a loud boom, then the aircraft dropped momentarily before recovering altitude. The aircraft circled for 30 minutes before making an emergency landing. There were no injuries. Bird hit blades on starboard fan that broke or bent all blades causing damage to cowling and to system behind the fan. Engine changed. Time out of service 30+ hrs. Cost of repairs \$300,000 and other cost \$800,000

Date: 9 January 1998

Aircraft: Boeing 727
Airport: George Bush Intercontinental (TX)
Phase of Flight: Climb
Effect on Flight: Precautionary landing
Damage: Engine, radome, right wing
Wildlife Species: Snow geese

Comments from Report: Aircraft was climbing through 6,000' when a flock of snow geese was encountered. Three to five birds were ingested. Engine lost all power and was destroyed, radome was torn from the aircraft and leading edges of both wings were damaged, pitot tube for first officer was torn off. Intense vibration in airframe and noise level in cockpit increased to the point that communication between crew members became difficult. Emergency was declared. Flight returned safely to Houston. Time out of service was 216 hours and cost was \$468,000.

Date: 7 May 1998

Aircraft: Boeing 727
Airport: Colorado Springs Muni (CO)
Phase of Flight: Climb
Effect on Flight: Engine shut down, precautionary landing
Damage: Radome, wing, fuselage and engine
Wildlife Species: Canada geese (6 or more)

Comments from Report: Aircraft had severe damage to #3 engine, all inlet guide vanes, all 1st and 2nd stage compressor blades, 1st stage stator vanes, hole in anti-ice bleed air duct, wire harness, blade exited engine case, oil cooler broke due to vibration. Radome cracked, wing-tip had minor damage. Time out of service was 98 hrs. NTSB investigated. Cost was \$1.4 million.

Date: 4 March 1999
Aircraft: McDonnell Douglas DC-9
Airport: Kansas City Intl. (MO)
Phase of Flight: Approach
Effect on Flight: Engine shut down
Damage: Both engines
Wildlife Species: Snow geese
Comments from Report: Aircraft struck a flock of snow geese. Geese were ingested in both engines. One engine shut down and the other was severely damaged but continued working. Aircraft landed without incident. NTSB investigated.

Date: 12 June 1999
Aircraft: Beechcraft 90
Airport: Westchester County (NY)
Phase of Flight: Take off
Effect on Flight: Aborted take off
Damage: Landing gear, nose, engines, props, wings, fuselage, lights
Wildlife Species: Coyote
Comments from Report: Nose gear was torn from aircraft causing other parts of plane to be damaged. Time out of service 5 months, lost revenue \$55,000 and cost of repairs \$550,000.

Date: 7 February 2000
Aircraft: McDonnell Douglas DC-10-30
Airport: Subic Bay (Philippines)
Phase of Flight: Climb (250' AGL)
Effect on Flight: Precautionary landing
Damage: Engine
Wildlife Species: Fruit bats
Comments from Report: USA air freight carrier. Engine ingested at least 1 bat. Vibration was felt. Five damaged fan blades had to be replaced. Time out of service was 3 days. Cost of repairs was \$61,000. Other related costs totaled \$3,008,400.

Date: 14 July 2000
Aircraft: Fokker 100
Airport: Chicago O'Hare Intl. (IL)
Phase of Flight: Take off
Effect on Flight: Precautionary landing
Damage: Engine
Wildlife Species: American crow
Comments from Report: Pilot heard thump and felt aircraft yaw slightly to the right. Foul odor in cabin, caution light for engine came on. Pulled back power on engine and returned to land. Emergency equipment was standing by. Engine was destroyed.

Date: 23 August 2000
Aircraft: Boeing 747
Airport: Philadelphia Intl. (PA)
Phase of Flight: Take off
Effect on Flight: Aborted take off
Damage: Engine, wing,
Wildlife Species: Canada geese
Comments from Report: The aircraft flew through a flock of about 30 Canada geese and ingested 1 or 2 in the #1 engine. The high-speed aborted take off resulted in 9 flat tires. The aircraft was towed to the ramp. Time out of service was 72 hours. Engine was a total loss. Cost was \$3 million.

Date: 27 August 2000
Aircraft: Boeing 747
Airport: Los Angeles Intl. (CA)
Phase of Flight: Climb (500' AGL)
Effect on Flight: Emergency landing
Damage: Engine
Wildlife Species: Western gull
Comments from Report: At least one western gull was ingested just after take off. Bystanders on a beach heard a giant backfire and saw the jet spewing 8 to 10-ft flames. Three pieces of the engine fell to the ground, one 5-ft piece landed on a beach where people were having a cookout. No one was injured. The pilot dumped 83 tons of fuel over the ocean for over an hour and then made an emergency landing. The flight had 449 people who were not able to get another flight to Amsterdam until the next day. The costs reported do not include room and board. Time out of service was 72 hours and cost of repairs was \$400,000.

Date: 8 November 2000

Aircraft: Saab 340
Airport: Aberdeen Regional (SD)
Phase of Flight: Approach (400' AGL)
Effect on Flight: Aircraft was grounded
Damage: Fuselage, wiper, propeller
Wildlife Species: Snow geese

Comments from Report: A flock snow geese was struck. The windshield wiper broke off, hit the prop which broke the blade into several pieces and threw them through the fuselage. One piece of wiper blade lodged in a passenger's thigh, requiring an emergency trip to the hospital.

Date: 6 December 2000

Aircraft: Embraer 120
Airport: Yeager Airport (WV)
Phase of Flight: Landing roll
Effect on Flight: None
Damage: Prop and fuselage
Wildlife Species: White-tailed deer

Comments from Report: Aircraft collided with 2 deer just after landing. The tip of a propeller blade (4" x 3") separated and punctured the fuselage, injuring a passenger, who later died.

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TABLES

Table 1. Number of reported wildlife strikes to civil aircraft by wildlife group, USA, 1990-2000.

Year	Birds	Mammals	Reptiles	Total
1990	1,719	19	0	1,738
1991	2,119	39	0	2,158
1992	2,251	56	1	2,308
1993	2,259	59	0	2,318
1994	2,309	74	1	2,384
1995	2,479	73	8	2,560
1996	2,677	92	3	2,772
1997	3,316	91	15	3,422
1998	3,626	109	7	3,742
1999	4,972	97	1	5,070
2000	5,761	135	2	5,898
Total	33,488	844	38	34,370

Table 2. Source of information for reported wildlife strikes to civil aircraft, USA, 1990-2000.

Source	11-year total	% of total known
FAA Form 5200-7	23,298	68
Multiple ¹	2,971	9
Airline report	3,358	10
Airport report	1,916	6
Other ²	716	2
Engine manufacturer	721	2
Aircraft Incident Report	658	2
Preliminary Aircraft Incident Report	458	1
Aviation Safety Reporting System	144	<1
Aircraft Incident Preliminary Notice	58	<1
National Transportation Safety Board	54	<1
Daily Alert Bulletin	18	<1
Total	34,370	100

¹. More than one report is filed for the same strike.

². Various sources such as news media and Commercial Incident Reports.

Table 3. Person filing report of wildlife strike to civil aircraft, USA, 1990-2000.

Person filing report	11-year total	% of total known
Pilot	8,089	32
Airline operations	5,295	21
Tower	4,981	20
Carcass found ¹	3,006	12
Airport operations	2,287	9
Other	1,287	5
Total known	24,945	100
Unknown	9,419	
Total	34,370	

¹ Airport operations 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, 1990-2000.

Type of Operator	11-year total	% of total known
Commercial	25,162	83
Business	3,829	13
Private	1,158	4
Government/Police	216	<1
Total known	30,365	100
Unknown	4,005	
Total	34,370	

Table 5. Number of reported bird and mammal strikes to civil aircraft by USA state, including Puerto Rico (PR) and the U.S. Virgin Islands (VI), 1990-2000.

State	Reported strikes			State	Reported strikes		
	Birds	Mammals	Total		Birds	Mammals	Total
AK	297	7	304	NC	744	17	761
AL	373	6	379	ND	79	1	80
AR	155	11	166	NE	310	8	318
AZ	351	29	380	NH	139	5	144
CA	3,000	32	3,032	NJ	953	40	993
CO	628	31	659	NM	62	1	63
CT	419	15	434	NV	171	2	173
DC	880	21	901	NY	2,035	62	2,097
DE	17	1	18	OH	1,085	28	1,113
FL	2,677	35	2,712	OK	374	18	392
GA	641	13	654	OR	510	6	516
HI	608	1	609	PA	1,432	50	1,482
IA	249	6	255	PR	57	0	57
ID	76	5	81	RI	112	3	115
IL	1,752	55	1,807	SC	172	6	178
IN	354	4	358	SD	58	6	64
KS	104	3	107	TN	835	12	847
KY	874	9	883	TX	2,390	47	2,437
LA	694	10	704	UT	326	4	330
MA	471	8	479	VA	552	26	578
MD	357	22	379	VI	36	0	36
ME	122	6	128	VT	28	0	28
MI	733	49	782	WA	519	8	527
MN	301	8	309	WI	331	27	358
MO	562	22	584	WV	84	37	121
MS	128	3	131	WY	21	5	26
MT	46	2	48				
				Total USA known	30,284	833	31,117
				Foreign ¹	713	5	718
				Unknown	2,491	6	2,488
				Total ²	33,488	844	34,332

¹ Reported strikes to USA air carriers at foreign airports.

² In addition, 38 strikes with reptiles were reported in the USA.

Table 6. Number of reported wildlife strikes to civil aircraft by month, USA, 1990-2000.

Month	Birds		Mammals	
	11-year total	% of total known	11-year total	% of total known
Jan	1,288	4	37	5
Feb	1,247	4	29	4
Mar	1,825	5	52	7
Apr	2,196	7	43	6
May	2,966	9	44	5
Jun	2,311	7	62	7
Jul	3,511	10	76	9
Aug	4,469	13	88	10
Sep	4,696	14	106	12
Oct	4,524	14	120	14
Nov	2,794	8	130	15
Dec	1,661	5	57	7
Total	33,488	100	844	100

Table 7. Reported time of occurrence of wildlife strikes to civil aircraft, USA, 1990-2000.

Time of day	Birds		Mammals	
	11-year total	% of total known	11-year total	% of total known
Dawn	1,047	4	16	3
Day	16,318	64	142	24
Dusk	1,280	5	59	10
Night	6,783	27	376	63
Total known	25,428	100	593	100
Unknown	8,060		251	
Total	33,488		844	

Table 8. Reported phase of flight at time of wildlife strikes to civil aircraft, USA, 1990-2000.

Phase of flight	Birds		Mammals	
	11-year total	% of total known	11-year total	% of total known
Parked	16	<1	0	0
Taxi	119	<1	18	3
Take off run	5,346	20	237	35
Climb	5,144	19	16	2
En route	919	3	1	<1
Descent/approach	11,270	41	56	8
Landing roll	4,430	16	351	52
Total known	27,244	100	679	100
Unknown	6,244		165	
Total	33,488		844	

Table 9. Number of reported bird strikes to civil aircraft by altitude (feet) above ground level (AGL), USA, 1990-2000.

Altitude of strike (Feet AGL)	Reported strikes		
	11-year total	% of total known	% cumulative total
0	9,939	41	40.7
1 - 99	3,586	15	55.4
100 - 199	1,613	7	62.0
200 - 299	1,040	4	66.2
300 - 399	756	3	69.3
400 - 499	451	2	71.2
500 - 599	835	3	74.6
600 - 699	245	1	75.6
700 - 799	180	1	76.3
800 - 899	364	1	77.8
900 - 999	143	1	78.4
1,000 - 1,499	1,178	5	83.2
1,500 - 1,999	791	3	86.5
2,000 - 2,499	930	4	90.3
2,500 - 2,999	117	<1	90.7
3,000 - 3,999	746	3	93.8
4,000 - 4,999	422	2	95.5
5,000 - 9,999	878	4	99.1
10,000 - 19,999	210	1	99.9
20,000 - 29,999	5	<1	100.0
≥30,000	3	<1	100.0
Total known	24,432	100	
Unknown	9,056		
Total	33,488		

Table 10. Number of reported strikes that damaged aircraft component(s), or had a negative effect-on-flight of the aircraft, for the 25 most frequently reported aircraft types, USA, 1990-2000.

Damaged aircraft component(s)			Negative effect on flight		
Aircraft type	10-year total	% of total known	Aircraft type	10-year total	% of total known
B-737	1,026	20.3	B-737	580	18.0
B-757	241	4.8	MD-80	140	4.3
MD-80	232	4.6	Saab 340	135	4.2
B-727	231	4.6	C-172	126	3.9
DC-9	158	3.1	BAe 31 Jetstream	123	3.8
B-747	154	3.0	B-757	106	3.3
BAe 31 Jetstream	146	2.9	DC-9	94	2.9
C-172	140	2.8	B-727	91	2.8
BE-1900	138	2.7	PA-28	88	2.7
PA-28	123	2.4	B-747	77	2.4
B-767	115	2.3	BE-1900	76	2.4
Saab 340	69	1.4	DHC8 Dash 8	58	1.8
Citation II	67	1.3	C-152	57	1.8
A-320	66	1.3	B-767	49	1.5
DC-10	65	1.3	CL-RJ	49	1.5
C-152	57	1.1	EMB-120	47	1.5
FK-100	57	1.1	Citation II	40	1.2
EMB-120	51	1.0	Helicopter	36	1.1
PA-31	51	1.0	ATR 42	33	1.0
A-300	46	0.9	C-150	33	1.0
DC-8	44	0.9	Learjet 35	31	1.0
Learjet 35	43	0.8	Bell 206	29	0.9
BE-200 King	41	0.8	PA-31	29	0.9
C-182	39	0.8	C-402	28	0.9
C-310	39	0.8	A-320	26	0.8
Total top 25	3,439	67.9	Total top 25	2,181	67.5
Total other known	1,626	32.1	Total other known	1,049	32.5
Total known	5,065		Total known	3,230	
Unknown aircraft	69	100.0	Unknown aircraft	72	100.0
Total	5,134		Total	3,302	

Table 11. Civil aircraft components reported as being struck and damaged by wildlife, USA, 1990-2000.

Aircraft component	Birds 11-year total		Mammals 11-year total	
	Components struck (% of total)	Components damaged (% of total)	Components struck (% of total)	Components damaged (% of total)
Radome/nose	7,491 (25)	825 (14)	49 (6)	40 (7)
Windshield	5,286 (18)	381 (7)	9 (1)	5 (1)
Engine	5,129 (17)	1,979 (35)	65 (8)	64 (11)
Wing/rotor	4,010 (14)	1,230 (21)	97 (12)	101 (17)
Fuselage	3,504 (12)	192 (3)	59 (7)	61 (10)
Landing gear	1,502 (5)	201 (4)	297 (37)	183 (30)
Propeller	1,013 (3)	118 (2)	125 (16)	113 (19)
Tail	444 (2)	202 (4)	29 (40)	33 (5)
Light	269 (1)	216 (4)	9 (1)	10 (16)
Other	755 (3)	389 (7)	62 (8)	62 (10)
Total	29,403	5,733	801	607

Table 12. Number of civil aircraft with reported damage resulting from wildlife strikes, USA, 1990-2000.

Damage category ²	Reported strikes					
	Birds		Mammals		Total ¹	
	11-year total	% of total known	11-year total	% of total known	11-year total	% of total known
None	23,881	83	207	32	24,125	82
Minor	2,563	9	222	34	2,785	9
Uncertain	807	3	26	4	833	3
Substantial	1,495	5	187	29	1,683	6
Destroyed	9	<1	11	2	20	<1
Total known	28,755	100	653	100	29,446	100
Unknown	4,733		191		4,924	
Total	33,488		844		34,370	

¹ Included in totals are 38 strikes involving reptiles in which 37 reported no damage and 1 reported substantial damage.

² The damage codes and descriptions follow the *Manual on the International Civil Aviation Organization Bird Strike Information System*: 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 which adversely affects the structure strength, performance or flight characteristics of the aircraft and which 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; engine blade damage not requiring blade replacement); Destroyed = The damage sustained makes it inadvisable to restore the aircraft to an airworthy condition.

Table 13. Number of reported wildlife strikes to civil aircraft resulting in human injuries or fatalities and number of injuries and fatalities resulting from these strikes, USA, 1990-2000.

Year	Birds			Mammals			Totals		
	Strikes	Injuries	Fatalities	Strikes	Injuries	Fatalities	Strikes	Injuries	Fatalities
1990	3	4	0	0	0	0	3	4	0
1991	7	7	0	2	3	0	9	10	0
1992	9	7	1	1	1	0	10	8	1
1993	3	3	0	1	1	0	4	4	0
1994	9	9	2	3	5	0	12	14	2
1995	5	6	0	0	0	0	5	6	0
1996	5	9	0	3	4	0	8	13	0
1997	11	11	0	2	3	0	13	14	0
1998	12	11	2	4	4	0	16	15	2
1999	3	3	0	0	0	0	3	3	0
2000	9	9	0	1	0	1	10	9	1
Total	76	79	5	17	21	1	93	100	6

Table 14. Reported effect-on-flight of wildlife strikes to civil aircraft, USA, 1990-2000.

Effect-on-flight ²	Reported strikes					
	Birds		Mammals		Total ¹	
	11-year total	% of total known	11-year total	% of total known	11-year total	% of total known
None	17,895	85	184	38	18,115	84
Precautionary landing	1,602	8	150	31	1,753	8
Aborted take off	768	4	92	18	860	4
Engine shut down	192	1	52	11	244	1
Other	512	2	12	2	525	2
Total known	20,969	100	490	100	21,497	100
Unknown	12,519		354		12,873	
Total	33,488		844		34,370	

¹ Included in totals are 38 strikes involving reptiles in which 36 reported no effect-on-flight, 1 reported precautionary landing and 1 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 take off = Pilot aborted the take off; Precautionary landing = Pilot landed at other-than-destination airport after strike; Engine shut down = Engine was shutdown by the pilot or stopped running because of the strike; Other = Miscellaneous effects such as reduced speed because of shattered windshield, emergency landing as destination airport, or crash landing; Unknown = Report did not give sufficient information to determine if effect-on-flight occurred (Dolbeer et al. 2000).

Table 15. Number of reported wildlife strikes, strikes causing damage, and strikes having a negative effect-on-flight (EOF) by identified wildlife species for civil aircraft, USA, 1990-2000. Page 1 of 4.

Species	11-year totals			Species	11-year totals		
	Struck	Dam- age	Neg. EOF		Struck	Dam- age	Neg. EOF
Birds							
Loons	3	1	0	Common eider	2	2	1
Loons	1	0	0	Ring-necked duck	2	1	1
Common loon	2	1	0	Wood duck	4	1	0
Grebes	10	2	2	Canvasback	1	1	0
Grebes	4	1	0	Hooded merganser	1	1	0
Eared grebe	4	0	0	Common merganser	1	1	1
Western grebe	1	1	1	Northern shoveler	1	1	1
Pied-billed grebe	1	0	1	Gadwall	2	0	0
Tropicbirds	1	1	0	American black duck	3	2	0
Albatrosses	1	1	0	Mottled duck	1	1	1
Pelicans	24	15	0	Lesser scaup	1	1	0
Pelicans	21	13	0	Ruddy duck	1	1	0
Australian pelican	1	1	0	Geese	346	194	77
Brown pelican	2	1	0	Snow goose	36	26	11
Cormorants	16	5	2	Canada goose	505	258	144
Cormorants	9	2	1	Brant	8	5	2
Dble-crested cormorant	7	3	1	Greater wh-frted goose	1	1	0
Anhingas	7	2	1	Swans	2	1	0
Frigatebirds	4	1	1	Mute swan	2	0	0
Hérons	160	24	17	Tundra swan	3	3	1
Hérons	31	9	5	Raptors	1,698	377	244
Great blue heron	80	13	11	Hawks, eagles, vultures	17	9	5
Blk-crowned night-heron	5	1	0	Vultures	142	83	43
American bittern	1	1	1	Lappet-faced vulture	1	1	1
Yellow bittern	43	0	0	Black vulture	8	3	5
Egrets	249	30	32	Turkey vulture	122	66	41
Egrets	176	23	26	Osprey	46	15	9
Cattle egret	53	5	6	Kites, eagles, hawks	2	0	0
Great egret	13	0	0	Kites	5	2	0
Snowy egret	6	2	0	Eagles	16	5	3
Little blue heron	1	0	0	Bald eagle	26	10	8
Storks/Ibises	9	2	1	Golden eagle	2	1	1
White stork	1	1	0	Hawks	523	117	70
Wood stork	2	0	0	Red-tailed hawk	284	52	42
Ibises	2	0	0	Rough-legged hawk	5	0	0
Glossy ibis	1	0	0	Red-shouldered hawk	4	0	0
White ibis	3	1	1	Swainson's hawk	4	0	0
Waterfowl	1,647	759	363	Sharp-shinned hawk	2	0	0
Ducks, geese, swans	89	50	23	Cooper's hawk	1	0	0
Ducks	427	149	68	Ferruginous hawk	1	0	0
American wigeon	3	3	2	Northern harrier	20	1	0
Northern pintail	3	1	0	Falcons	17	1	1
Green-winged teal	3	2	2	Gyrfalcon	1	0	0
Blue-winged teal	2	0	0	Peregrine falcon	28	2	1
European wigeon	1	0	0	Merlin	10	0	1
Mallard	196	53	28	American kestrel	411	9	13

Table 15. Page 2 of 4.

Species	11-year totals			Species	11-year totals		
	Struck	Dam- age	Neg. EOF		Struck	Dam- age	Neg. EOF
Gallinaceous birds	78	18	18	Whimbrel	4	1	1
Grouse	5	1	2	Gulls	4,008	713	559
Sharp-tailed grouse	1	1	1	Gulls	3,487	633	493
Ptarmigans	4	2	1	Herring gull	180	33	29
Black francolin	1	0	0	Mew gull	9	2	1
Quails	3	0	1	Ring-billed gull	185	19	17
Northern bobwhite	5	1	3	Glaucous-winged gull	10	4	0
Ring-necked pheasant	37	9	7	Great black-backed gull	19	5	4
Partridges	1	0	0	Franklin's gull	4	1	1
Hungarian partridge	2	1	1	Laughing gull	92	6	7
Guineafowl	1	1	0	Bonaparte's gull	8	2	2
Wild turkey	18	2	2	California gull	4	2	1
Cranes	55	21	14	Western gull	8	5	3
Cranes	22	9	5	Heerman's gull	1	0	0
Sandhill crane	33	12	9	Yellow-legged gull	1	1	1
Rails/gallinules	16	1	0	Terns	39	3	1
Sora	1	0	0	Terns	26	2	0
Common moorhen	1	0	0	Common tern	4	0	0
American coot	10	1	0	Gull-billed tern	1	0	0
Purple gallinules	2	0	0	Arctic tern	4	1	0
Virginia rail	1	0	0	Forster's tern	2	0	1
Clapper rail	1	0	0	Least tern	1	0	0
Shorebirds	536	25	31	Black noddy	1	0	0
Shorebirds	9	0	0	Doves	1,837	172	173
Jacanas	1	0	0	Pigeons, doves	11	1	1
American oystercatcher	4	1	0	Doves	710	44	65
Plovers	58	0	2	Homing pigeon	12	4	2
American golden plover	27	0	2	Rock dove	650	94	81
Black-bellied plover	7	1	0	Mourning dove	425	27	23
Killdeer	287	10	12	Spotted dove	2	2	1
Semipalmated plover	2	0	0	Zebra dove	11	0	0
Pacific golden-plover	6	0	0	Inca dove	10	0	0
Semipalm. sandpiper	2	0	0	Philippine turtle dove	4	0	0
Lapwings	1	1	1	White-winged dove	2	0	0
Sandpipers	71	7	9	Parrots	3	0	0
Least sandpiper	3	0	0	Cuckoos	2	0	0
Upland sandpiper	30	3	4	Cuckoos	1	0	0
Spotted sandpiper	2	0	0	Yellow-billed cuckoo	1	0	0
American avocet	1	0	0	Owls	318	37	18
American woodcock	4	0	0	Owls	159	16	10
Dunlin	2	0	0	Common barn-owl	83	8	3
Common snipe	7	1	0	Snowy owl	22	3	2
Western sandpiper	3	0	0	Short-eared owl	21	1	1
Buff-breasted sandpiper	1	0	0	Long-eared owl	2	0	0
Lesser yellowlegs	2	0	0	Northern saw-whet owl	3	0	0
Short-billed dowitcher	1	0	0	Burrowing owl	6	1	0
Hudsonian godwit	1	1	1	Barred owl	2	1	1

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Species	11-year totals			Species	11-year totals		
	Struck	Dam- age	Neg. EOF		Struck	Dam- Age	Neg. EOF
Great horned owl	1	1	0	Yellow-billed magpie	7	0	0
Eastern screech owl	19	6	1	Chickadees	4	0	0
Nightjars	31	1	0	Wrens	23	1	0
Common nighthawk	27	0	0	Thrushes	153	8	8
Nightjars	1	1	0	Brown thrasher	2	0	0
Whip-poor-will	2	0	0	Northern mockingbird	24	1	2
Common poorwill	1	0	0	Gray catbird	2	0	0
Swifts	28	2	0	Thrushes	6	2	0
Swifts	7	1	0	Swainson's thrush	4	1	0
Chimney swift	15	1	0	American robin	112	4	6
Vaux's swift	1	0	0	Hermit thrush	1	0	0
White-throated swift	5	0	0	Eastern bluebird	1	0	0
Kingfishers	6	0	0	Gray-cheeked thrush	1	0	0
Belted kingfisher	6	0	0	Pipits	1	0	0
Woodpeckers	16	0	2	Waxwings	2	0	0
Woodpeckers	5	0	1	Cedar waxwing	2	0	0
Northern flicker	9	0	0	Shrikes	2	0	0
Yell.-bellied sapsucker	2	0	1	Shrikes	1	0	0
Perching birds	1	0	0	Loggerhead shrike	1	0	0
Tyrant flycatchers	10	0	2	Warblers	14	0	0
Tyrant flycatchers	1	0	0	Wood warblers	10	0	0
Great-crsted flycatcher	1	0	0	Canada warbler	1	0	0
Scissor-tailed flycatcher	8	0	2	Yellow-breasted chat	2	0	0
Kingbirds	1	0	0	Black and white warbler	1	0	0
Eastern kingbird	1	0	0	Meadowlark	189	4	9
Larks	49	4	2	Meadowlarks	23	0	2
Larks	9	1	0	Eastern meadowlark	116	2	3
Horned lark	40	3	2	Western meadowlark	50	2	4
Swallows	397	8	14	Blackbirds	804	63	60
Swallows	204	3	12	Blackbirds	720	54	52
Purple martin	29	2	0	Red-winged blackbird	19	1	2
Bank swallow	2	0	0	Yell.-headed blackbird	4	1	1
Barn swallow	100	2	1	Brewer's blackbird	1	0	0
Cliff swallow	16	1	1	Orioles	4	0	0
Tree swallow	46	0	0	Grackles	36	7	5
Starlings	771	40	50	Common grackle	6	0	0
European starling	761	39	49	Boat-tailed grackle	2	0	0
Myna	8	1	1	Great-tailed grackle	2	0	0
Common myna	2	0	0	Brown-headed cowbird	9	0	0
Crows	248	24	22	Bobolink	1	0	0
Crows	196	18	14	Finches	31	0	2
American crow	52	6	8	Finches	16	0	2
Jays/Ravens	21	3	3	Lapland longspur	1	0	0
Blue jay	3	0	0	Dark-eyed junco	1	0	0
Ravens	7	0	2	Rose-brsted grosbeak	1	0	0
Common raven	2	1	0				
Black-billed magpie	2	2	1				

Table 16. Reported aircraft down time (hours) and monetary losses (cost of damage, lost revenue and other losses) resulting from wildlife strikes to civil aircraft by identified wildlife groups, USA, 1990-2000.

Wildlife group	Reported down time (hours)			Reported losses (\$)		
	11-year total	11-year avg.	% of total known	11-year total	11-year avg.	% of total known
Birds						
Loons	504	46	0.40	11,200	1,018	0.02
Grebes	10	1	0.01	100,000	9,091	0.14
Tropicbirds	10	1	0.01	1,200	109	0.00
Pelicans	117	11	0.09	36,000	3,273	0.05
Cormorants	23	2	0.02	6,700	609	0.01
Hérons	679	62	0.54	510,200	46,382	0.74
Egrets	1,515	138	1.20	223,040	20,276	0.32
Waterfowl	46,520	4,229	36.96	39,482,748	3,589,341	57.21
Raptors	41,806	3,801	33.21	10,267,920	933,447	14.88
Gallinaceous birds	159	14	0.13	55,920	5,084	0.08
Cranes	1,141	104	0.91	263,760	23,978	0.38
Shorebirds	399	36	0.32	305,268	27,752	0.44
Gulls	24,174	2,198	19.20	10,262,127	932,921	14.87
Terns	4	<.5	0.00	0	0	0
Doves	5,925	539	4.71	4,542,024	412,911	6.58
Owls	852	77	0.68	935,408	85,037	1.36
Swallows	101	9	0.08	40,532	3,685	0.06
Starlings	390	35	0.31	738,306	67,119	1.07
Crows	242	22	0.19	187,500	17,045	0.27
Jays	73	7	0.06	25,455	2,314	0.04
Thrushes	24	2	0.02	120	11	0.00
Meadowlarks	29	3	0.02	136,952	12,450	0.20
Blackbirds	1,141	104	0.91	872,821	79,347	1.26
Finches	2	<.5	0.00	0	0	0
Buntings	12	1	0.01	0	0	0
Sparrows	24	2	0.02	2,950	268	0.00
Mannikins	3	<.5	0.0	2,000	182	0.00
Total known birds	125,879	11,444	100.0	69,010,151	6,273,650	100.0
Unknown birds	33,007	3,001		33,881,761	3,080,160	
Total birds	158,886	14,444		102,891,912	9,353,810	
Mammals						
Chiropteras (Bats)	72	7	0.07	3,069,400	279,036	26.30
Carnivores	11,567	1,052	10.83	696,564	63,324	5.97
Ungulates	95,207	8,655	89.11	7,906,345	718,759	67.74
Total Mammals	106,846	9,713		11,672,309	1,061,119	100.0
Grand total						
Total known	232,725	21,157		80,682,460	7,334,769	
Total unknown	33,007	3,001		33,881,761	3,080,160	
Total	265,732	24,157		114,564,221	10,414,929	

Table 17. Number of reported wildlife strikes indicating damage or a negative effect-on-flight (EOF), and reported losses in hours of down time and U. S. dollars, for civil aircraft, USA, 1990-2000.

	Reported strikes					Cost in millions of dollars (No. of reports)		
	Total reports	Reports indicating adverse effect (%)	Reports indicating an EOF	Reports indicating aircraft damage	Lost time in hours (No. of reports)	Direct cost	Other cost	Total
11-year total	34,370	6,996 (20)	3,346	5,097	265,723 (1,587)	95.987 (1,048)	18.595 (414)	114.582 (1,174)
11-year average	3,125	636 (20)	304	463	24,157 (144)	8.726 (95)	1.690 (38)	10.417 (107)
Mean losses per reported incident					167	0.916	0.449	0.137
Estimated annual losses								
Minimum ¹					106,490	58.251	28.567	86.818
Maximum ²					532,451	291.257	142.833	434.090

¹ Minimum values are based on the assumption that all 6,996 reported strikes having an adverse effect-on-flight and/or the aircraft engendered similar amounts of damage and/or down time, and that these reports are all of the damaging strikes that occurred.

² Maximum values are based on the assumption that the 6,996 reported strikes having an adverse effect represent only 20% of the total strikes that occurred.

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