U. S. DEPARTMENT
OF TRANSPORTATION

FEDERAL AVIATION ADMINISTRATION

WILDLIFE STRIKES TO CIVIL AIRCRAFT IN THE UNITED STATES 1990-1999

FEDERAL AVIATION ADMINISTRATION
NATIONAL WILDLIFE STRIKE DATABASE
SERIAL REPORT NUMBER 6

REPORT PREPARED BY
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REPORT OF THE ACTING ASSOCIATE ADMINISTRATOR OF AIRPORTS
OFFICE OF AIRPORT SAFETY AND STANDARDS
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COVER

This engine on a U.S. air carrier Boeing 767 suffered an uncontained failure after ingesting a gull upon departure from a Middle Eastern airport, 1999. (Photo courtesy TWA)

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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ACKNOWLEDGMENTS

The dBase file and support programs used to enter and organize strike data were established by ***E. LeBoeuf*** and ***J. Rapol***, Federal Aviation Administration (FAA), Office of Airport Safety and Standards, Washington, DC. The assistance provided by these above-acknowledged professionals is greatly appreciated. ***S. Agrawal***, and ***M. Hoven***, FAA William J. Hughes Technical Center, Atlantic City, New Jersey, also provided critical support and advice. Finally, we acknowledge and thank all of the people who take the time and effort to report wildlife strikes -- pilots, mechanics, control tower personnel, airport operations personnel, and USDA Wildlife Services biologists – to name but a few. Sponsorship and funds for the ongoing maintenance 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 International Airport, New Jersey.

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PREFACE

When birds and aircraft compete for airspace, they both lose. (Photo by G. Polfliet)

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 1998, Richardson and West 2000, Thorpe 1998). 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. 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 1966 to 1999, the resident (non-migratory) Canada goose population increased at a mean rate of 13% per year; the ring-billed gull population increased at an annual rate of about 5%; the red-tailed hawk population increased at an annual rate of 3%; and the turkey vulture population increased at an annual rate of 1% (Sauer et al. 2000). 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 305 million in 1980 to 680 million in 1998, and USA commercial air traffic increased from 17.8 million aircraft movements in 1980 to 28 million in 1998. Projections predict national increases at current levels of growth (3-4% per year) through the year 2005 (FAA 1999).

This Saab 340 hit two deer when landing at a Michigan airport, April 2000. The engine was torn from its mountings and is being held in place by the oil and fuel lines only. (Photo courtesy Northwest Airlines)

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.

This is a close up of one engine from a Boeing-757. A flock of several hundred European starlings flew in front of the aircraft at rotation from a midwestern airport, February 1999. One engine was destroyed and the other damaged. Over 400 dead starlings were picked up from the runway area following the strike. (Photo courtesy local airport authority.)

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, and 1990-1998 were issued in 1996, 1997, 1998, and 1999, respectively (Cleary et al. 1996, 1997, 1998, 1999). This is the sixth report in the series, and covers the 10-year period 1990-1999.

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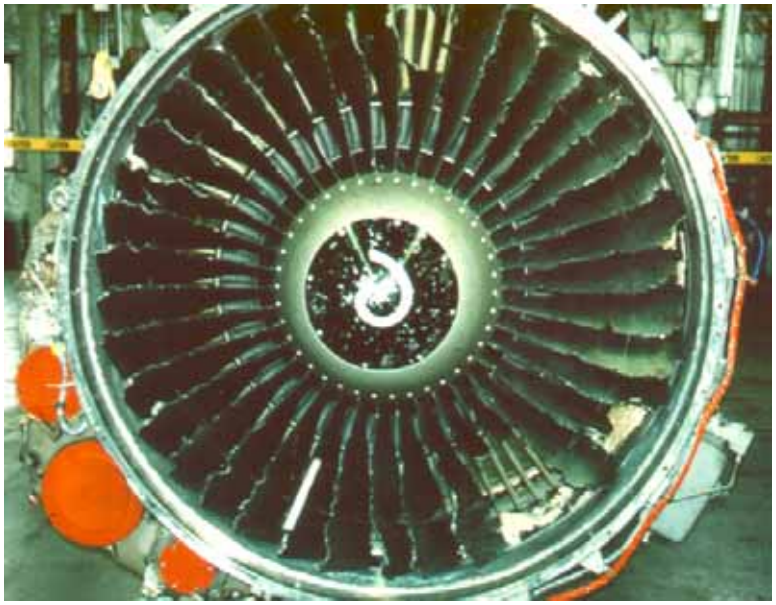
WILDLIFE STRIKES TO CIVIL AIRCRAFT IN THE UNITED STATES, 1990-1999

A gull penetrated the windshield of this experimental aircraft shortly after take off from a California airport, November 1998. The pilot suffered severe head lacerations. (Photo by J. R. Dodd, Airport Manager)

This publication presents an analysis of data from the Federal Aviation Administration's National Wildlife Strike Database for 1990-1999. Unless noted, all totals are for the 10-year period, and percentages are of the total known. Subsequent detailed reports will be produced at 5-year intervals. In the interim years, annual reports summarizing data in tabular and graphic form for all available years will be produced.

Because of the large amount of data involved, most tables in this report present 10-year totals, 1990-1999. Tables 1 to 10 and 12 to 16 showing all 10 years of data are available in Microsoft Excel format from the FAA's Wildlife Hazard web-site: www.faa.gov/arp/hazard.htm. Researchers using these data from the website should cite the Federal Aviation Administration, National Wildlife Strike Database, 1990-1999, as their source.



This Boeing-737 engine suffered severe damage when it ingested a common eider during landing at an airport in Maine, 1996 (see photo page 3). (Photo courtesy NTSB)

Between 1990 and 1999, 28,150 ($\bar{x}$ = 2,815/year) strikes were reported to the FAA. There was a 33% increase in the number of wildlife strikes reported in 1999 over 1998, and a 181% increase in the number of strikes reported between 1990 and 1999 (Figure 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).

The majority (71%) of the 28,150 strike reports were filed using FAA Form 5200-7 (Table 1). Pilots and tower personnel filed 36% and 22% of these 28,150 reports, respectively (Table 2). About 82% of the reported strikes involved commercial aircraft; the remainder involved business, private, and miscellaneous aircraft (Table 3).

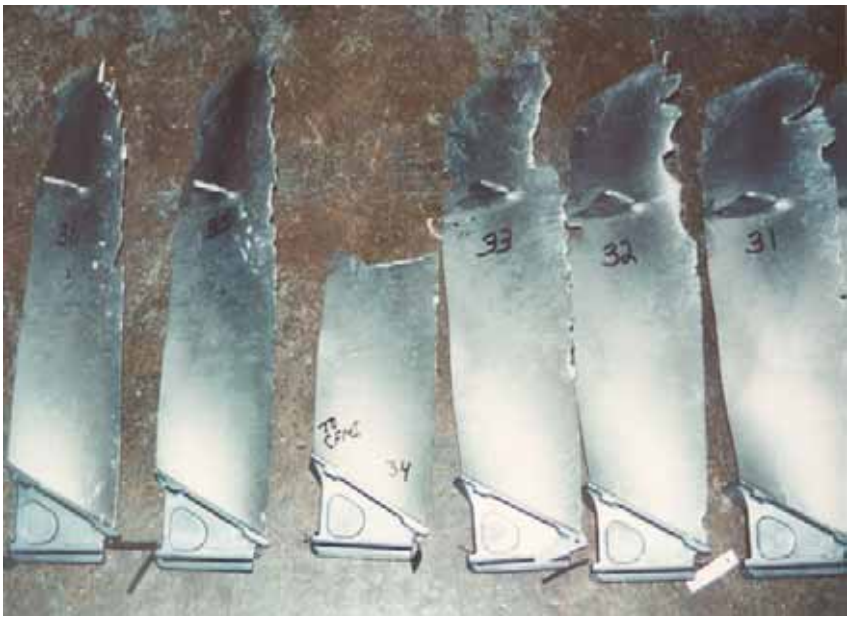
Reports were received from all 50 states, from some USA territories, and from foreign countries when USA registered aircraft were involved. CA, FL, TX, NY, and IL reported the most bird strikes. PA, IL, NY, TX and NJ reported the most mammal strikes. Table 4 shows the distribution of reported bird and mammal strikes for the various states and territories.

Most bird strikes (51%) occurred between July and October (Table 5 and Figure 2); 65% occurred during the day (Table 6 and Figure 3); 53% occurred when the aircraft was on approach or during the landing roll, and 39% occurred during take off and climb (Table 7). 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 900 ft. AGL, and 87% occurred under 2,000 ft. AGL (Table 8 and Figure 4).

Most mammal strikes (42%) occurred between September and November (Table 5 and Figure 2); 63% occurred at night (Table 6 and Figure 3); 50% occurred during the landing roll; 36% occurred during take off. Eleven percent 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 7).

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

The aircraft components most commonly reported as struck by birds were windshield, engine, wing/rotor, and nose. Aircraft engines were the component most frequently reported as being damaged by bird strikes. Of the 4,182 aircraft engines reported as being struck by birds, 41% (1,700) were damaged (Table 10). There were 216 incidents in which two or more engines on a single aircraft were struck by birds; 118 (26%) of the 449 engines involved in multi-engine strikes were damaged.



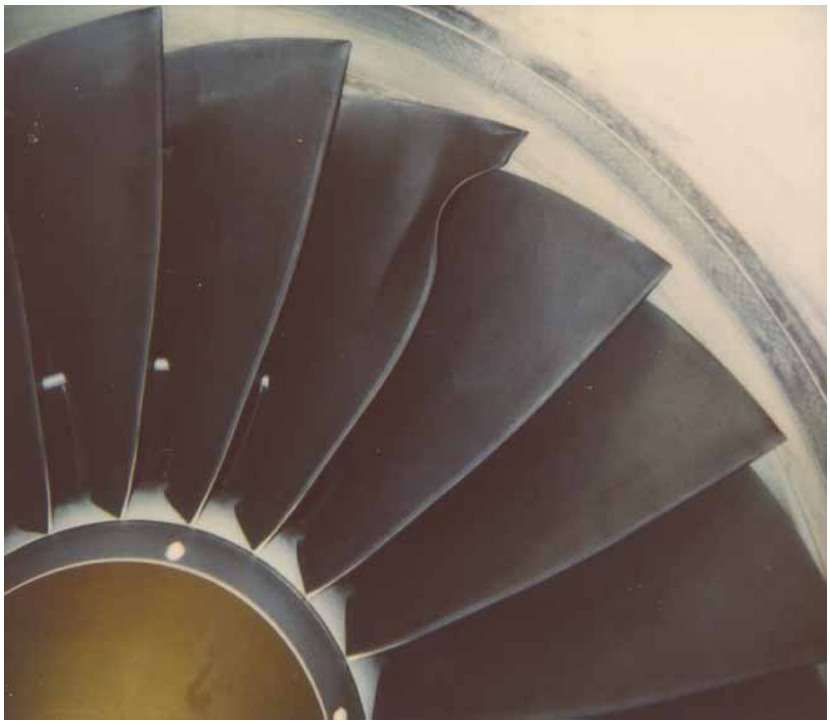
Close-up of blades from the Boeing-737 engine that ingested a common eider during landing at an airport in Maine, 1996 (see photo page 2). (Photo courtesy NTSB)

Of the 4,182 reported bird strikes to engines, 2,384 (57%) involved commercial aircraft with underwing-mounted engines, and 443 (11%) involved commercial aircraft with fuselage-mounted engines. For the 10-year period (1990-1999), commercial aircraft with underwing-mounted engines incurred 35.97 engine strikes per 1 million operations. Commercial aircraft with fuselage-mounted engines incurred only 7.11 engine strikes per 1 million operations (Table 11).

Of the 27,433 bird strikes reported, 23,837 provided some indication as to the nature and extent of any damage. Of the 23,837 reports, 19,690 indicated the strike did not damage the aircraft; 2,155 indicated the aircraft suffered minor damage; 1,331 indicated the aircraft suffered substantial damage; and 7 reports indicated the aircraft was destroyed as a result of the strike (Table 12). Reports were received detailing 67 bird strikes that resulted in 70 human injuries and 6 fatalities (Table 13).

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

Of the 681 mammal strikes reported, 556 provided some indications as to the nature and extent of any damage. Of the 556 reports, 177 indicated the strike did not damage the aircraft; 187 indicated the aircraft suffered minor damage; 157 indicated the aircraft suffered substantial damage; and 12 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 19% respectively. Reports were received of 16 mammal strikes that resulted in 21 human injuries. There were no reports attributing human fatalities to mammal strikes (Table 13).



A single gull damaged this Boeing-757 engine fan blade at a major California airport in February 1998. The blade had to be replaced. (Photo courtesy local airport authority)

Fifteen and 64% of the bird and mammal strike reports, respectively, indicated the strike had an adverse effect-on-flight (Table 14).

Birds were involved in about 97% of the reported strikes, mammals in about 2%, and <1% involved reptiles. Tables 15A and 15B show 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, 1990-1999. Appendix A is an expanded version of Table 15A showing all 10 years of data for identified wildlife species involved in strikes.

Gulls (29%), doves (12%), waterfowl (12%), and raptors (11%) were the most commonly struck bird groups. Gulls were involved in 2.5 times as many strikes as waterfowl, but both groups were involved in essentially the same number of damaging strikes, 642 (30%) and 679 (32%), respectively. The most commonly struck mammals were white-tailed deer (49%) and coyotes (10%) (Table 15A).

Of the 28,150 strikes reported during the 10-year period, 4,528 (16%) reports indicated the strike damaged one or more aircraft components and 2,882 (10%) reports indicated the strike had a negative effect-on-flight (Table 15A).

For the 10-year period, reported losses from bird strikes totaled 117,335 hours of aircraft down time and $80.27 million in monetary losses. Reported losses from mammal strikes totaled 78,958 hours of aircraft down time and $7.26 million in monetary losses (Table 16).

Of the 6,053 reports that indicated the strike had an adverse effect on the aircraft and/or flight, 1,259 provided an estimate of the aircraft down time (Σ = 196,293 hours, $\bar{x}$ = 156 hours down time/incident), and 1,195 provided an estimate of the direct and/or other cost (Σ = $87.61 million, $\bar{x}$ = $129,000 damage/incident). Of the 1,195 reports providing a damage cost estimate, 816 gave an estimate of direct aircraft damage (Σ = $72.56 million, $\bar{x}$ = $84,000 damage/incident), and 334 gave an estimate of other monetary losses (Σ = $15.06 million $\bar{x}$ = $45,000 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.

This radome on a Boeing-767 suffered extensive damage when the aircraft struck a bird, December 1999. Note the feathers caught at the top of the puncture. (Photo courtesy B. Mackenzie)

Assuming all 6,053 reported wildlife strikes that had an adverse effect on the aircraft and/or flight engendered 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 94,373 hours/year of aircraft down time, $51.01 million/year in direct monetary losses, and $27.28 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 471,867 hours/year of aircraft down time, $255.03 million/year in direct monetary losses and $136.42 million/year in associated costs (Table 17).

CANADA GEESE: A SPECIAL PROBLEM

Canada geese were identified as being involved in 2.3% (286) of all reported strikes where bird identification was provided. An additional 451 (3.6%) birds were simply identified as "geese." Snow geese were identified in 30 strikes (0.2% of all reported strikes where the bird was identified). Because snow geese made up only 9% of the identified geese (Canada geese and snow geese), we believe it reasonable to assume the vast majority of birds identified only as "geese," were in fact Canada geese. We have merged the two groups (Canada geese and "geese") for the purpose of the following analysis.

There should be zero tolerance for geese on airports. Not only are geese a threat to aircraft safety, but at this eastern airport, they have destroyed the infield vegetation. (Photo courtesy FAA)

The resident Canada goose population increased at a mean annual rate of 13.1% in the USA from 1966-1999 (Sauer et al. 2000). The resident Canada goose population in the USA quadrupled from about 0.5 million in 1984 to over 2 million in 1998 (Alge 1999). There has be an upward trend in the number of reported Canada goose strikes over the last 10 years that closely parallels the increase in the resident Canada goose population (Figure 5).

Canada geese were involved in 6% of all reported bird strikes where the bird was identified (Table 15A). Being the most massive bird (typically weighing 8-15 lbs.) commonly struck by civil aircraft, Canada geese were responsible for a disproportionately large amount of damage. Strikes involving Canada geese resulted in 27% of the total reported aircraft down time, 24% of the total reported direct aircraft damage, and 43% of the total reported other costs (Table 18). About 64% of all engines struck by geese were damaged whereas only 40% of engines sustained damage when struck by other birds (Table 19).

Additionally, there were 835 goose strikes to aircraft components, excluding engines. About 55% of these strikes resulted in damage to the aircraft. Only 14% of strikes by birds other than geese resulted in damage to an aircraft component, excluding engines (Table 20).

T. Boudreau (FAA, Manager, Engine and Propeller Standards Staff, personal communication) has calculated that if present trends continue, (i.e. resident Canada goose population continues to increase at present rate; the current rate of goose ingestions continues; and the number of aircraft operations continues to increase at present rate), the probability of a major goose strike incident such as uncontrolled fire or loss of 2 or more engines on a single aircraft will double in the next 10 years. Thus, the rapidly increasing resident (non-migratory) Canada goose population probably represents the single most serious bird threat to aircraft safety at this time (Alge 1999).

CONCLUSIONS

With the analysis of 10 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 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 mallard penetrated the windshield on this aircraft, necessitating a forced landing. The pilot suffered facial lacerations. Note remains of the duck in the upper right corner of photograph. (Photo courtesy USAF)

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.

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, 51% of all reported bird strikes, 1990-1999, provided no information on the species struck and only 15% of strike reports indicating an adverse effect provided an estimate of cost.

This Piper 28 Warrior struck an American bittern on approach to an airport in New Jersey, October 1999. (Photo courtesy of C. Boggs, USDA)

Pilots, airport operations and aircraft maintenance personnel, or anyone else having knowledge of the strike should report strikes. 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 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:

Federal Aviation Administration
Office of Airport Safety and Standards, AAS-310
800 Independence Avenue, SW
Washington, DC 20591

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. Please do not send entire bird carcasses through the mail.

Strikes can also be reported via the Internet (http://www.faa.gov/arp/birdstrike), in addition to the traditional means of filling out and mailing FAA Form 5200-7. FAA Form 5200-7 can be accessed and printed at http://www.faa.gov/arp/pdf/bform.pdf

This engine on a Boeing-747 ingested a lappet-faced vulture upon departure from Nairobi, Kenya, January 1998, and suffered an uncontained failure. The aircraft was grounded for two weeks for repairs. On take off following repairs, the aircraft ingested another bird and lost a second engine. (Photos by R. Dolbeer)

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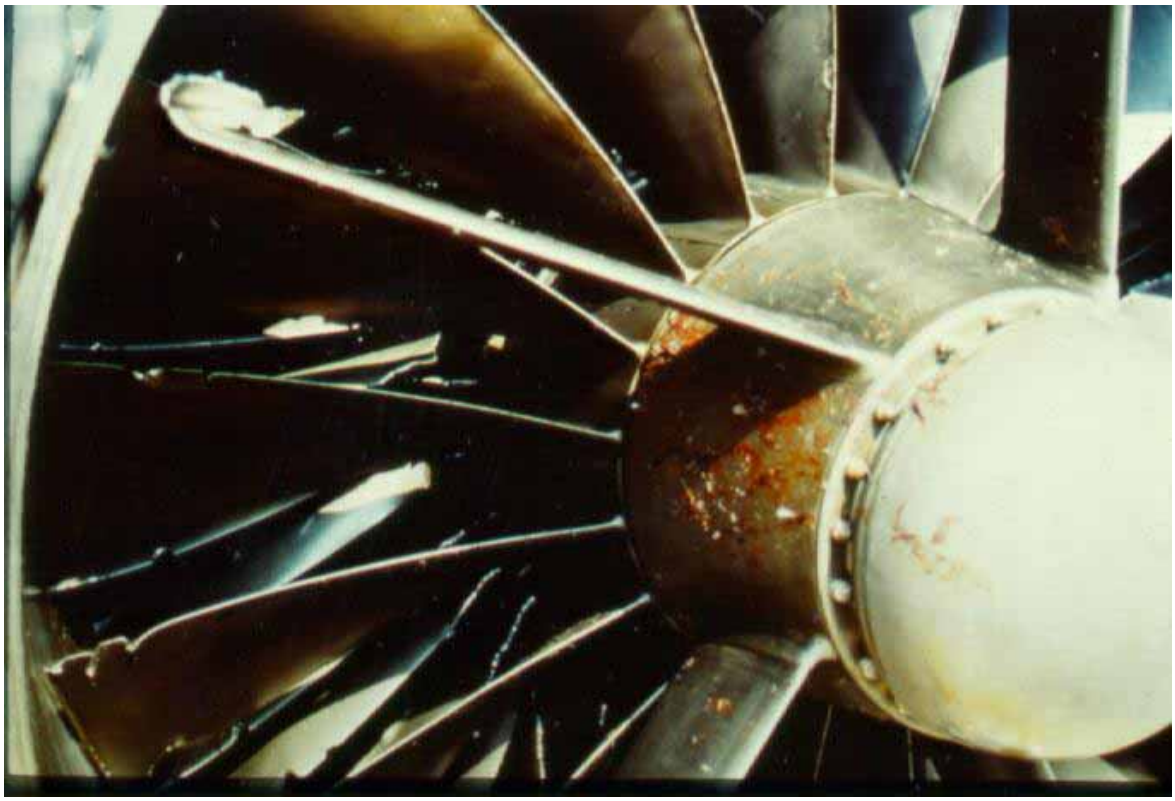
SELECTED SIGNIFICANT STRIKES TO CIVIL AIRCRAFT IN THE UNITED STATES, 1990-1999



This engine on a Concorde suffered an uncontained failure after striking one or more Canada geese upon landing at an airport in New York, June 1995. (Photo courtesy USDA)

The following examples, two from each year for the last 10 years, 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: www.faa.gov/arp/hazard.htm. 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. Many of the strike examples reported here occurred off airport property during approach or departure.

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: **09 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 (FL)
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-37
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 head 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: **03 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: **December 13, 1996**
Aircraft: Beach 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.

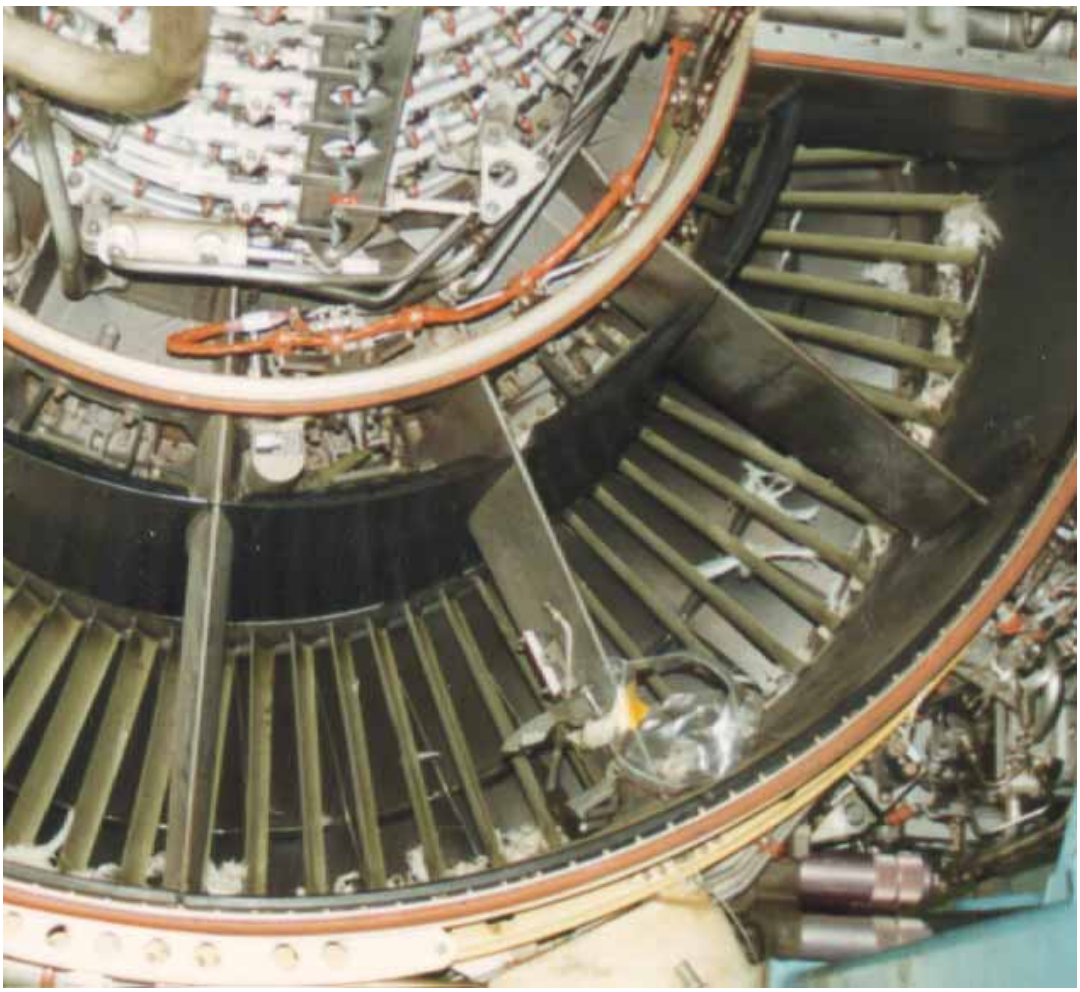
Date: **15 November 1997**
Aircraft: Airbus 320
Airport: John Wayne (CA)
Phase of Flight: Take off
Effect on Flight: Precautionary landing
Damage: Engine
Wildlife Species: Large bird
Comments from Report: A large bird was ingested into one of the two engines causing a fire. Passengers heard a loud boom, 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: **09 January 1998**
Aircraft: Boeing-727
Airport: Houston 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: **07 May 1998**
Aircraft: Boeing-727
Airport: Colorado Springs Metro (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: **04 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.



A gull was ingested into this engine on a USAF KC-10 aircraft during taxiing. The engine, although not damaged had to be disassembled and inspected. (Photo courtesy NTSB)

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TABLES

Table 1. Source of information for reported wildlife strikes to civil aircraft, USA, 1990-1999.

Source	Reported strikes	
	10-year total	% of total known
FAA Form 5200-7	19,996	71
Multiple[1]	2,350	8
Airline report	1,674	6
Airport report	1,608	6
Other[2]	672	2
Engine manufacturer	617	2
Aircraft Incident Report	607	2
Preliminary Aircraft Incident Report	406	1
Aviation Safety Reporting System	104	<1
Aircraft Incident Preliminary Notice	55	<1
National Transportation Safety Board	45	<1
Daily Alert Bulletin	16	<1
Total	28,150	100

1. More than one report is filed for the same strike
2. Various sources such as the media, Commercial Incident Reports, etc.

Table 2. Person filing report of wildlife strike to civil aircraft, USA, 1990-1999.

	Reported strikes	
Person filing report	10-year total	% of total known
Pilot	7,121	36
Tower	4,336	22
Carcass found[1]	2,216	11
Airport operations	1,836	9
Airline operations	3,110	16
Other	1,108	6
Total known	19,727	100
Unknown	8,423	
Total	28,150	

[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 3. Number of reported wildlife strikes to civil aircraft by type of operator, USA, 1990-1999.

	Reported strikes	
Type of Operator	10-year total	% of total known
Commercial	20,610	82
Business	3,299	13
Private	1,056	4
Government/Police	112	<1
Total known	25,077	100
Unknown	3,073	
Total	28,150	

Table 4. Number of reported wildlife strikes to civil aircraft by USA state, including Puerto Rico (PR) and the U.S. Virgin Islands (VI), 1990-1999.

State	Reported strikes			State	Reported strikes		
	Birds	Mammals	Total		Birds	Mammals	Total
AK	244	5	249	NC	632	17	649
AL	317	6	323	ND	63	1	64
AR	135	11	146	NE	262	7	269
AZ	231	18	249	NH	98	5	103
CA	2,516	24	2,540	NJ	779	36	815
CO	390	7	397	NM	56	1	57
CT	372	15	387	NV	137	2	139
DC	705	19	724	NY	1,733	44	1,777
DE	16	1	17	OH	883	21	904
FL	2,367	32	2,399	OK	293	16	309
GA	542	10	552	OR	405	5	410
HI	559	1	560	PA	1,235	49	1,284
IA	216	6	222	PR	48	0	48
ID	63	4	67	RI	71	3	74
IL	1,482	47	1,529	SC	141	4	145
IN	294	4	298	SD	49	5	54
KS	87	2	89	TN	685	8	693
KY	723	9	732	TX	2,044	39	2,083
LA	607	7	614	UT	289	4	293
MA	390	8	398	VA	500	20	520
MD	310	18	328	VI	33	0	33
ME	111	5	116	VT	27	0	27
MI	523	33	556	WA	444	7	451
MN	253	7	260	WI	276	20	296
MO	480	18	498	WV	78	33	111
MS	114	3	117	WY	19	4	23
MT	41	2	43				
				Total USA known	25,368	673	26,041
				Foreign[1]	480	1	481
				Unknown	1,585	7	1,592
				Total	27,433	681	28,114

[1.] Reported strikes to USA air carriers at foreign airports.

Table 5. Number of reported wildlife strikes to civil aircraft by month, USA, 1990-1999 (see also Figure 2).

	Reported strikes			
	Birds		Mammals	
Month	10-year total	% of total known	10-year total	% of total known
Jan	1,077	4	34	5
Feb	1,023	4	18	3
Mar	1,530	6	46	7
Apr	1,776	6	36	5
May	2,440	9	35	5
Jun	1,857	7	53	8
Jul	2,783	10	59	9
Aug	3,647	13	63	9
Sep	3,824	14	74	11
Oct	3,727	14	96	14
Nov	2,331	8	114	17
Dec	1,418	5	53	8
Total	27,433	100	681	100

Table 6. Reported time of occurrence of wildlife strikes to civil aircraft, USA, 1990-1999 (see also Figure 3).

	Reported strikes			
	Birds		Mammals	
Time of day	10-year total	% of total known	10-year total	% of total known
Dawn	892	4	11	2
Day	14,363	65	125	24
Dusk	1,102	5	55	11
Night	5,890	26	331	63
Total known	22,247	100	522	100
Unknown	5,186		159	
Total	27,433		681	

Table 7. Reported phase of flight at time of wildlife strikes to civil aircraft, USA, 1990-1999.

	Reported strikes			
	Birds		Mammals	
Phase of flight	10-year total	% of total known	10-year total	% of total known
Parked	14	<1	0	0
Taxi	104	<1	15	3
Take off	4,564	20	207	36
Climb	4,370	19	14	2
En route	825	4	1	<1
Descent/approach	9,508	41	48	8
Landing roll	3,751	16	288	50
Total known	23,136	100	573	100
Unknown	4,297		108	
Total	27,433		681	

Table 8. Number of reported bird strikes to civil aircraft by altitude (feet) above ground level (AGL), USA, 1990-1999 (see also Figure 4).

Altitude of strike (Feet AGL)	Reported strikes		
	10-year total	% of total known	% cumulative total
0	8,400	40	40.2
1 - 99	3,185	15	55.4
100 - 199	1,395	7	62.1
200 - 299	910	4	66.5
300 - 399	662	3	69.7
400 - 499	378	2	71.5
500 - 599	701	3	74.8
600 - 699	222	1	75.9
700 - 799	160	1	76.6
800 - 899	304	1	78.1
900 - 999	127	1	78.7
1,000 - 1,499	1,006	5	83.5
1,500 - 1,999	664	3	86.7
2,400 - 2,499	561	3	89.4
2,500 - 2,999	304	1	90.8
3,000 - 3,499	480	2	93.1
3,500 - 3,999	150	1	93.8
4,000 - 4,999	381	2	95.7
5,000 - 9,999	704	3	99.0
10,000 - 19,999	188	1	99.9
20,000 - 29,999	8	<1	100.0
≥30,000	2	<1	100.0
Total known	20,893	100	
Unknown	6,540		
Total	27,433		

Table 9. Number of reported strikes that damaged aircraft component(s), or had an adverse effect-on-flight of the aircraft, for the 25 most frequently reported fixed-wing aircraft types, USA, 1990-1999.

Reported strikes					
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	918	20.6	B-737	529	19.1
MD-80	203	4.6	MD-80	122	4.4
B-757	202	4.5	BA-31	112	4.1
B-727	196	4.4	Saab-340	105	3.8
BA-31	144	3.2	C-172	96	3.5
DC-9	143	3.2	B-757	89	3.2
B-747	130	2.9	MD DC-9	86	3.1
PA-28	126	2.8	B-727	80	2.9
C-172	125	2.8	PA-28	72	2.6
BE-1900	124	2.8	B-747	66	2.4
B-767	94	2.1	BE-1900	64	2.3
Citation II	64	1.4	C-152	51	1.8
Saab-340	62	1.4	DHC8 Dash 8	51	1.8
C-152	61	1.4	EMB-120	44	1.6
MD DC-10	58	1.3	B-767	42	1.5
FK 100	49	1.1	Citation II	34	1.2
A 320	48	1.1	ATR-42	30	1.1
EMB-120	48	1.1	CL-RJ 100/200	27	1.0
PA-31	46	1.0	Learjet 35	27	1.0
MD DC-8	40	0.9	C-150	26	0.9
C-182	39	0.9	BE-200	25	0.9
A 300	38	0.9	FK 100	25	0.9
Learjet 35	38	0.9	PA-31	25	0.9
BE-200	35	0.8	C-402	24	0.9
BE-58	34	0.8	C-310	22	0.8
Total top 25	3,065	68.8	Total top 25	1,874	67.8
Other aircraft	1,390	31.2	Other aircraft	892	32.2
Total known	4,455	100.0	Total known	2,766	100.0
Unknown	74		Unknown	65	
Total	4,529		Total	2,831	

Table 10. Civil aircraft components reported as being struck and damaged by wildlife, USA, 1990-1999.

Aircraft component	Birds 10-year total		Mammals 10-year total	
	Components struck (% of total)	Components damaged (% of total)	Components struck (% of total)	Components damaged (% of total)
Radome/nose	5,906 (25)	678 (14)	45 (6)	37 (6)
Windshield	4,367 (18)	341 (7)	9 (1)	6 (1)
Engines	4,182 (18)	1,700 (35)	60 (8)	59 (10)
Wing/rotor	3,192 (13)	1,015 (21)	83 (12)	88 (14)
Fuselage	2,751 (12)	161 (3)	57 (8)	56 (9)
Landing gear	1,231 (5)	160 (3)	251 (35)	158 (26)
Propellers	856 (4)	100 (2)	109 (15)	99 (16)
Other	657 (3)	321 (7)	71 (10)	68 (11)
Tail	362 (2)	170 (4)	22 (3)	26 (4)
Lights	212 (1)	173 (4)	9 (1)	10 (2)
Total	23,716	4,819	716	607

Table 11. Number of reported engine strikes and number of USA operations[1] for commercial aircraft with fuselage-mounted engines and underwing-mounted engines, USA, 1990-1999.

Engine placement and aircraft	10-year totals		Engine strikes per 1 million operations
	Reported engine strikes	USA operations	
Fuselage-mounted engines			
Boeing-727	106	20,870,968	5.08
Canadair RJ	21	263,378	79.73
Embraer EMB-145	4	456,839	8.76
Fokker 100	29	3,564,453	8.14
Fokker F-28	14	1,595,824	8.77
McDonnell Douglas DC-9	122	15,579,613	7.83
MD-80	145	19,700,541	7.36
MD-90	2	288,824	6.92
Total	443	62,320,440	7.11
Underwing-mounted engines			
Airbus A 300	35	830,812	42.13
Airbus A 310	8	301,266	26.55
Airbus A 319	9	158,210	56.89
Airbus A 320	59	2,457,521	24.01
Boeing-707	2	63,218	31.64
Boeing-737	1,469	42,062,964	34.92
Boeing-747	209	1,138,212	183.62
Boeing-757	253	9,438,572	26.80
Boeing-767	121	2,854,455	42.39
Boeing-777	25	202,309	123.57
British Aerospace.-146	12	1,093,026	10.98
Lockheed L-1011	22	1,397,402	15.74
McDonnell Douglas DC-10	71	2,657,884	26.71
McDonnell Douglas DC-8	74	1,278,887	57.86
McDonnell Douglas MD-11	14	311,627	44.93
Total	2,383	66,246,365	35.97

1. An operation is either a landing at, or a take-off from a USA airport.

Table 12. Number of civil aircraft with reported damage resulting from wildlife strikes, USA, 1990-1999.

	Reported Strikes					
	Birds		Mammals		Total[1]	
Damage category[2]	10-year total	% of total known	10-year total	% of total known	10-year total	% of total known
Minor	2,155	9	187	34	2,342	10
Uncertain	654	3	23	4	677	3
Substantial	1,331	6	157	28	1,489	6
Destroyed	7	<1	12	2	19	<1
None	19,690	83	177	32	19,902	81
Total known	23,837	100	556	100	24,429	100
Unknown	3,596		125		3,721	
Total	27,433		681		28,150	

1. Included are 36 strikes involving reptiles in which 35 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, 1990-1999.

	Birds			Mammals			Totals		
Year	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	2	1	1	0	10	8	2
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
Total	67	70	6	16	21	0	83	91	6

Table 14. Reported effect-on-flight of wildlife strikes to civil aircraft, USA, 1990-1999.

	Reported strikes					
	Birds		Mammals		Total	
Effect-on-flight[1]	10-year total	% of total known	10-year total	% of total known	10-year total	% of total known
None	15,360	85	149	36	15,509	84
Aborted take off	653	4	79	19	732	4
Precautionary landing	1,344	7	49	12	1,393	8
Engines shut down	156	1	9	2	165	1
Other	461	3	128	31	589	3
Total known	17,974	100	414	100	18,388	100
Unknown	9,459		267		9,726	
Total	27,433		681		28,114	

1. 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 15A. 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, 1990-1999. Page 1 of 4.

Species	10-year totals Struck	Damage	Neg. EOF
Birds			
Loons	**2**	**1**	
Loons	1	1	
Common loon	1		
Grebes	**9**	**2**	**1**
Grebes	4		
Eared grebe	4	1	
Western grebe	1	1	1
Tropicbirds	**1**	**1**	**1**
Albatrosses	**1**	**1**	
Pelicans	**22**	**12**	**7**
Pelicans	20	10	5
Australian pelican	1	1	1
Brown pelican	1	1	1
Cormorants	**28**	**8**	**4**
Cormorants	9	2	1
Double-crested cormorant	7	3	1
Anhingas	8	2	1
Frigatebirds	4	1	1
Waterfowl	**1,447**	**679**	**317**
Ducks, geese, swans	83	50	21
Ducks	388	144	65
Blue-winged teal	2		
Green-winged teal	2	2	2
American wigeon	3	3	2
European wigeon	1		
Northern pintail	1	1	
Lesser scaup	1	1	
Mallard	174	47	26
Common eider	1	1	1
Ring-necked duck	2	1	1
American black duck	1	1	
Common merganser	1	1	1
Canvasback	1	1	
Mottled duck	1	1	1
Wood duck	4	1	
Gadwall	1		
Geese	451	241	95
Snow goose	30	21	10
Canada goose	286	153	90
Brant	7	5	2
Gr'ter white-fronted goose	1	1	
Swans	2	1	
Mute swan	1		
Tundra swan	2	2	
Raptors	**1,379**	**320**	**199**
Hawks, eagles, vultures	17	9	5
Vultures	129	73	37
Lappet-faced vulture	1	1	1
Black vulture	5		2
Turkey vulture	99	55	33
Osprey	36	11	6
Kites, eagles, hawks	2		
Kites	3	2	
Eagles	13	5	2
Bald eagle	23	8	6
Golden eagle	1		
Hawks	445	101	58
Red-tailed hawk	220	41	34
Red-shouldered hawk	3		
Rough-legged hawk	5		
Swainson's hawk	2		
Cooper's hawk	1		
Sharp-shinned hawk	1		
Northern harrier	14		
Falcons	13	2	
Gyrfalcon	1		
Peregrine falcon	22	2	1
Merlin	9		2
American kestrel	314	10	11
Gallinaceous birds	**70**	**19**	**14**
Grouse	4	1	1
Sharp-tailed grouse	1	1	1
Grouse, ptarmigans	1	1	1
Ptarmigans	2	1	
Quail	7	1	3
Northern bobwhite	1		
Black francolin	1		
Ring-necked pheasant	34	8	5
Partridges	1		
Hungarian partridge	2	2	1
Guineafowl	1	1	
Wild turkey	15	3	2
Herons	**159**	**21**	**17**
Herons, storks, ibises	2		
Herons	31	9	5
Great blue heron	71	11	11
Yellow bittern	43		
Bl'k-crowned night-heron	4		
Wood stork	2		
Ibises	2		
Glossy ibis	1		
White ibis	3	1	1
Egrets	**227**	**27**	**29**
Egrets	162	20	23
Cattle egret	49	5	6
Great egret	12		
Snowy egret	4	2	

Table 15A. Page 2 of 4.

Species	10-year totals Struck	Damage	Neg. EOF
Cranes	**45**	**18**	**10**
Cranes	17	7	3
Sandhill crane	28	11	7
Rails, gallinules	**13**	**1**	
Sora	1		
Clapper rail	1		
Virginia rail	1		
American coot	7	1	
Common moorhen	1		
Purple gallinule	2		
Shorebirds	**420**	**24**	**25**
Shorebirds	7		
Lapwings	1	1	1
Common snipe	3	1	
American woodcock	4		
Jacanas	1		
Oystercatchers	2		
Plovers	55		2
Lesser golden-plover	20		2
Black-bellied plover	6	1	
Killdeer	223	11	9
Pacific golden-plover	6		
Sandpipers	57	7	8
Upland sandpiper	21	3	3
Spotted sandpiper	1		
Semipalmated sandpiper	2		
Least sandpiper	2		
Western sandpiper	1		
Lesser yellowlegs	1		
Dunlin	2		
Short-billed dowitcher	1		
Whimbrel	3		
Avocets	1		
Gulls	**3,570**	**643**	**493**
Gulls, Terns	8	3	
Gulls	3,144	574	441
Common Gull	2	1	
Herring gull	139	27	24
Heerman's gull	1		
Mew gull	7	1	1
Ring-billed gull	141	17	13
Glaucous-winged gull	9	4	
Greater black-backed gull	14	5	4
Franklin's gull	4	1	1
Laughing gull	87	5	6
Bonaparte's gull	6		
Western gull	6	3	2
California gull	2	2	1

Species	10-year totals Struck	Damage	Neg. EOF
Terns	**36**	**3**	**2**
Terns	24	2	1
Common tern	4		
Gull-billed tern	1		
Arctic tern	4	1	
Forster's tern	2		1
Least tern	1		
Doves	**1,473**	**154**	**151**
Pigeons, doves	12	2	1
Doves	604	43	56
Homing pigeon	10	3	2
Rock dove	539	83	73
Mourning dove	288	21	18
Barred ground-dove	11		
Philippine turtle dove	4		
Inca dove	3		
Spotted dove	2	2	1
Cuckoos	**1**		
Yellow-billed cuckoo	1		
Owls	**262**	**35**	**20**
Owls	146	16	12
Barn-owl	61	8	3
Snowy owl	17	3	2
Eastern screech owl	1	1	
Short-eared owl	17	1	1
Burrowing owl	3		
Barred owl	2	1	1
Long-eared owl	2		
Great horned owl	11	5	1
Northern saw-whet owl	2		
Nighthawks	**25**	**2**	
Common nighthawk	21		
Whip-poor-will	2	1	
Common poorwill	1		
Nightjars	1	1	
Swifts	**18**	**2**	
Swifts	5	1	
Vaux's swift	1		
White-throated swift	1		
Chimney swift	11	1	
Parrots	**3**		
Kingfishers	**5**		
Kingfishers	3		
Belted kingfishers	2		
Woodpeckers	**12**		**2**
Woodpeckers, Piculets	3		1
Northern flicker	7		
Yellow-bellied sapsucker	2		1

Table 15A. Page 3 of 4.

Species	10-year totals Struck	Damage	Neg. EOF
Tyrant fly-catchers	**2**		
Tyrant fly-catchers	1		
Great crested flycatcher	1		
Kingbirds	**1**		
Eastern kingbird	1		
Larks	**41**	**4**	**2**
Larks	8	1	
Horned lark	33	3	2
Swallows	**312**	**5**	**10**
Swallows	169	3	9
Purple martin	24	1	
Barn swallow	74	1	
Bank swallow	1		
Cliff swallow	5		1
Tree swallow	39		
Jays, magpies	**12**	**2**	**1**
Blue jay	3		
Magpies	7	2	1
Yellow-billed magpie	2		
Crows	**223**	**20**	**17**
Crows	175	17	12
American crow	41	2	3
Common raven	1		
Ravens	6	1	2
Chickadees	**2**		
Wrens	**20**		
Mockingbirds/thrashers	**25**	**1**	**2**
Mockingbirds	21	1	2
Gray catbird	2		
Thrashers	1		
Brown thrasher	1		
Thrushes	**114**	**8**	**4**
Thrushes	6	2	
Swainson's thrush	4	1	
American robin	102	5	4
Hermit thrush	1		
Eastern bluebird	1		
Waxwings	**1**		
Cedar waxwing	1		
Shrikes	**1**		
Starlings	**636**	**29**	**42**
European starling	627	28	40
Common myna	2		1
Mynas	7	1	1

Species	10-year totals Struck	Damage	Neg. EOF
Warblers	**5**		
Wood warblers	2		
Canada warbler	1		
Yellow-breasted chat	2		
Blackbirds	**730**	**52**	**52**
Blackbirds, Orioles	3	46	1
Blackbirds	661		45
Red-winged blackbird	16	1	2
Yellow-headed blackbird	3		
Brewer's blackbird	1		
Common grackle	4		
Grackles	32	5	4
Boat-tailed grackle	2		
Brown-headed cowbird	5		
Orioles	3		
Meadowlarks	**138**	**4**	**6**
Bobolink	1		
Meadowlarks	39	1	3
Eastern meadowlark	77	2	3
Western meadowlark	21	1	
Finches	**68**	**3**	**7**
Finches	13		2
American goldfinch	5		
House sparrow	6		
Rose-breasted grosbeak	1		
Red crested cardinals	1		
Buntings	2	1	
Snow bunting	36	2	5
Lazuli bunting	1		
Green-tailed towhee	1		
Rufous-sided towhee	2		
Sparrows	**916**	**20**	**37**
Sparrows	894	20	37
Savannah sparrow	15		
Golden crowned sparrow	1		
Field sparrow	1		
Lark sparrow	1		
White-throated sparrow	2		
Fox sparrow	1		
Dark-eyed junco	1		
Mannikins	**30**		**1**
Mannikins	12		
Nutmeg mannikin	7		
Chestnut mannikin	11		1
Total known birds	**12,504**	**2,121**	**1,473**
Unknown birds	**14,929**	**2,027**	**1,142**
Total birds	**27,433**	**4,148**	**2,615**

Table 15A. Page 4 of 4.

Species	10-year totals Struck	Damage	Neg. EOF
Mammals			
Edentates	**11**		
Chiropteras	**33**	**3**	**1**
Carnivores	**135**	**12**	**25**
Canids	1		
Coyotes	71	6	13
Dog	14	3	9
Fox	19	1	1
Raccoon	10	1	2
White-nosed coatis	1		
Striped skunk	14		
House cat	4		
River otter	1	1	
Marsupials	**15**		
Rodents	**23**		**1**
Woodchuck	18		1
Muskrat	3		
Porcupine	1		
Rodents	1		
Lagomorphs	**9**	**1**	**2**
Rabbits, hares	9	1	2
Ungulates	**442**	**355**	**231**
Caribou	1	1	1
Cattle	5	5	4
Deer	88	73	48
Elk	6	6	4
Horse	3	3	2
Moose	2	2	2
Mule deer	2		1
Peccary	1	1	
Pronghorn	3	2	3
Swine	1		
White-tailed deer	330	262	166
Total known mammals	**668**	**371**	**260**
Unknown mammals	**13**	**8**	**5**
Total mammals	**681**	**379**	**265**
Reptiles/Amphibians			
Turtles	**26**		**1**
Turtles	20		1
Florida soft shell turtle	3		
Box turtle	3		
Alligators	**10**	**1**	**1**
Total reptiles	**36**	**1**	**2**
All species			
Total known	**13,208**	**2,493**	**1,735**
Total unknown	**14,942**	**2,035**	**1,147**
Total	**28,150**	**4,528**	**2,882**

Table 15B. Number of wildlife strikes, strikes causing damage, and strikes having a negative effect-on-flight (EOF) by identified wildlife group for civil aircraft, USA, 1990-1999.

	10-year totals		
Species group	Struck	Damage	Neg. EOF
Birds			
Loons	2	1	0
Grebes	9	2	1
Tropicbirds	1	1	1
Albatrosses	1	1	0
Pelicans	22	12	7
Cormorants	28	8	4
Waterfowl	1,447	679	317
Raptors	1,379	320	199
Gallinaceous birds	70	19	14
Herons	159	21	17
Egrets	227	27	29
Cranes	45	18	10
Rails, gallinules	13	1	0
Shorebirds	420	24	25
Gulls	3,570	643	493
Terns	36	3	2
Doves	1,473	154	151
Cuckoos	1	0	0
Owls	262	35	20
Nighthawks	25	2	0
Swifts	18	2	0
Parrots	3	0	0
Kingfishers	5	0	0
Woodpeckers	12	0	2
Tyrant fly-catchers	2	0	0
Kingbirds	1	0	0
Larks	41	4	2
Swallows	312	5	10
Jays, magpies	12	2	1
Crows	223	20	17
Chickadees	2	0	0
Wrens	20	0	0
Mockingbirds	25	1	2
Thrushes	114	8	4
Waxwings	1	0	0
Shrikes	1	0	0
Starlings	636	29	42
Warblers	5	0	0
Blackbirds	730	52	52
Meadowlarks	138	4	6
Finches	68	3	7
Sparrows	916	20	37
Mannikins	30	0	1
Total known birds	**12,504**	**2,121**	**1,473**
Unknown birds	**14,929**	**2,027**	**1,142**
Total birds	**27,433**	**4,148**	**2,615**

	10-year totals		
Species group	Struck	Damage	Neg. EOF
Mammals			
Edentates	11	0	0
Chiropteras	33	3	1
Marsupials	15	0	0
Rodents	23	0	1
Lagomorphs	9	1	2
Ungulates	442	355	231
Carnivores	135	12	25
Total known mammals	668	371	260
Unknown mammals	13	8	5
Total mammals	681	379	265
Reptiles/Amphibians		0	0
Turtles	26	0	1
Alligators	10	1	1
Total reptiles	36	1	2
All species			
Total known	13,208	2,493	1,735
Total unknown	14,942	2,035	1,147
Grand total	28,150	4,528	

Table 16. Reported down time (hours) and monetary losses (cost of damage, lost revenue and other monetary losses) resulting from wildlife strikes to civil aircraft, USA, 1990-1999.

	Reported losses			
	Down time (hours)		Monetary (U.S. dollars)	
Species group	10-year total	% of total known	10-year total	% of total known
Birds				
Loons	504	0.5	11,200	<0.1
Grebes (eared)	10	<0.1	100,000	0.2
Tropicbirds	10	<0.1	5,200	<0.1
Pelicans	145	0.2	36,000	0.1
Cormorants	30	<0.1	6,700	<0.1
Herons	175	0.2	507,000	0.8
Egrets	1,514	1.6	223,040	0.4
Waterfowl	38,683	40.8	33,501,528	54.2
Raptors	24,717	26.1	8,227,281	13.3
Gallinaceous birds	94	0.1	5,120	<0.1
Cranes	1,101	1.2	263,160	0.4
Shorebirds	204	0.2	232,902	0.4
Gulls	19,741	20.8	11,600,451	18.8
Doves	5,643	5.9	4,810,664	7.8
Owls	852	0.9	961,308	1.6
Thrashers	0	0	120	<0.1
Swallows	43	<0.1	21,500	<0.1
Starlings	287	0.3	204,381	0.3
Crows	78	0.1	87,500	0.1
Blackbirds	978	1.0	869,745	1.4
Meadowlarks	26	<0.1	136,952	0.2
Finches	2	<0.1	0	0
Snow bunting	12	<0.1	0	0
Sparrows	21	<0.1	4,950	<0.1
Mannikins	3	<0.1	0	0
Total known birds	**94,866**	**100.0**	**61,816,702**	**100.0**
Unknown birds	**22,469**		**18,528,956**	
Total all birds	**117,335**		**80,345,658**	
Mammals				
Bats	0	0	6,615	0.1
Carnivores	11,550	14.6	694,948	9.6
Ungulates	67,408	85.4	6,559,562	90.3
Total mammals	**78,958**	**100.0**	**7,261,125**	**100.0**
All species				
Total known	**173,824**		**69,077,827**	
Total unknown	**22,469**		**18,528,956**	
Grand total	**196,293**		**87,606,783**	

Table 17. Number of reported wildlife strikes indicating damage or an effect-on-flight (EOF) and reported losses in hours of down time and U. S. dollars for civil aircraft, USA, 1990-1999.

	Reported strikes							
	Total reports	Reports indicating damage	Reports indicating EOF	Reports indicating damage or EOF (%)	Lost time in hours (No. of reports)	Cost in millions of dollars (No. of reports)		
						Direct	Other	Total
10-year total	28,150	4,527	2,880	6,053	196,293	72.551	15.055	87.606
				(22)	(1,259)	(861)	(334)	(1,195)
Mean losses per incident					156	0.084	0.045	0.129
Estimated annual losses								
Minimum[1]					94,373	51.005	27.284	78.289
Maximum[2]					471,867	255.025	136.419	391.444

[1.] Minimum values are based on the assumption that all 6,053 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 6,053 reported strikes having an adverse effect represent only 20% of the total.

Table 18. Aircraft down time (hours) and monetary losses (U. S. dollars) due to bird strikes for all birds excluding Canada geese (N = 26,696) and Canada geese only (N = 737), for civil aircraft, USA, 1990-1999.

	Losses (% total)			
Category	Down time (hours)	Direct cost (x $1 million)	Other cost (x $1 million)	Total cost (x $1 million)
All birds except Canada geese	85,235 (73)	51.11 (76)	7.,40 (58)	58.51 (73)
Canada geese	32,100 (27)	16.40 (24)	5.43 (42)	21.84 (27)
All birds	117,335	67.52	12.83	80.35

Table 19. Civil aircraft engines reported as struck and damaged by birds for all birds excluding Canada geese (N = 26,696) and Canada geese (N = 737), USA, 1990-1999.

Number of engines struck on the aircraft	Number of incidents (% of strikes resulting in damage)					
	All birds excluding Canada geese		Canada geese		Total	
	Struck	Damaged	Struck	Damaged	Struck	Damaged
1	3,604	1,492 (41)	129	90 (70)	3,733	1,582 (42)
2	189	49 (26)	14	6 (43)	203	55 (27)
3	8	0 (0)	1	0 (0)	9	0 (0)
4	4	2 (50)	0	0 (0)	4	2 (50)
Total engines struck	4,022	1,598 (40)	160	102 (64)	4,182	1,700 (41)

Table 20. Aircraft components (excluding engines) reported struck and damaged for all birds excluding Canada geese (N = 26,696) and for Canada geese only (N = 737) for civil aircraft, USA, 1990-1999.

Category	Number of strikes reported (% of total)	Number of strikes reported as causing damage (% of total)
All birds except Canada geese	18,699 (96)	2,659 (14)
Canada geese	835 (4)	460 (55)
Total	19,534	3,119 (16)

FIGURES

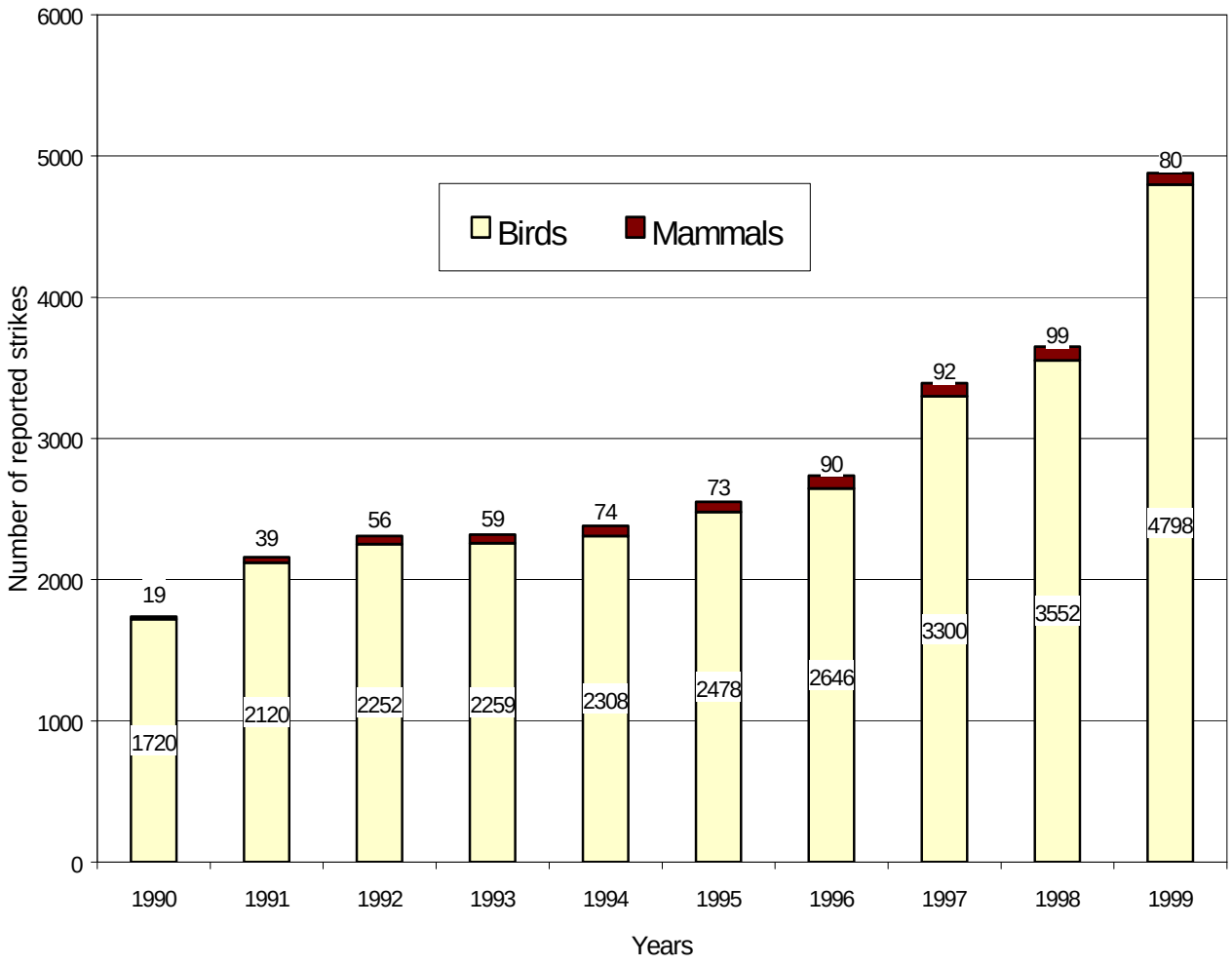
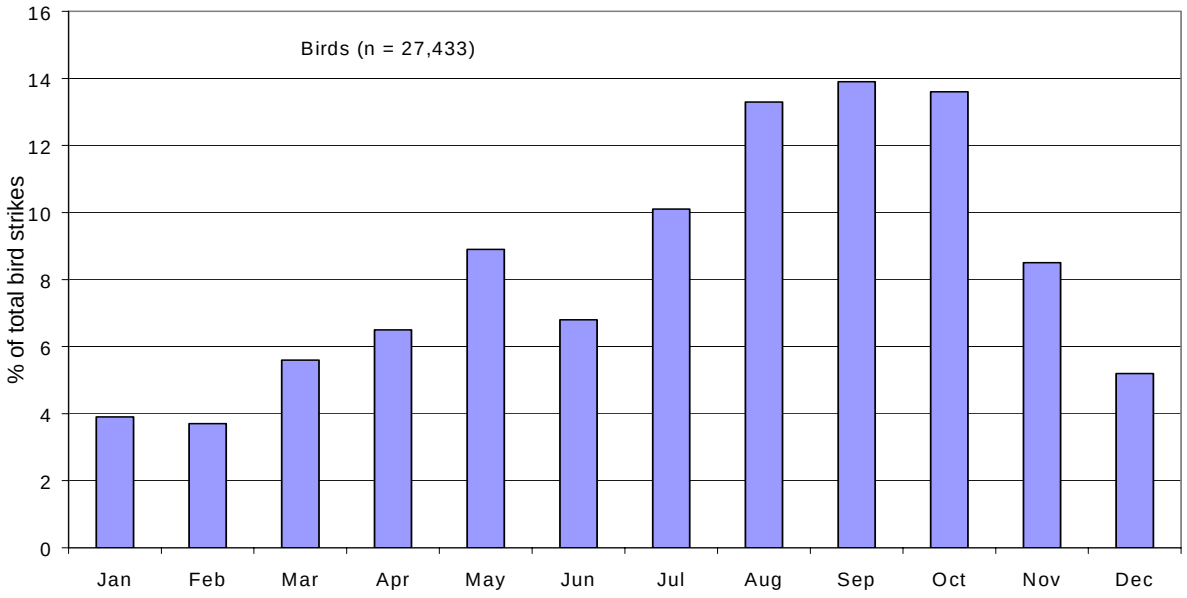


Figure 1. Reported bird (N = 27,433) and mammal (N = 681) strikes to civil aircraft, USA, 1990-1999. An additional 36 reptile strikes were reported.



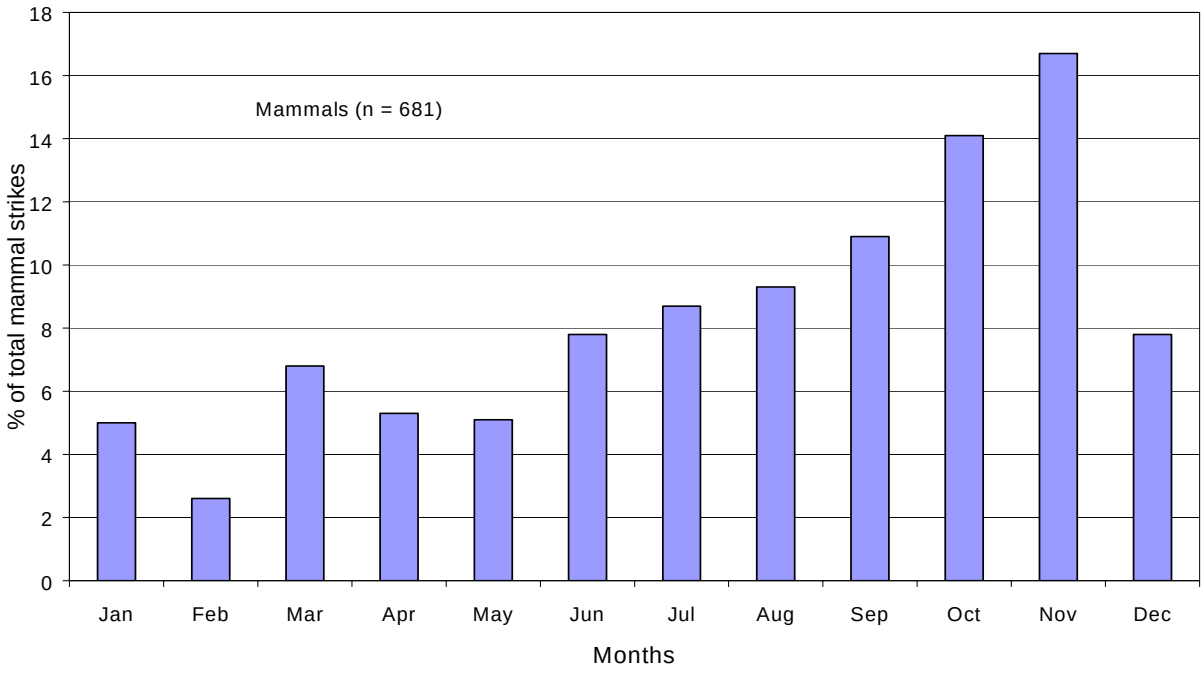
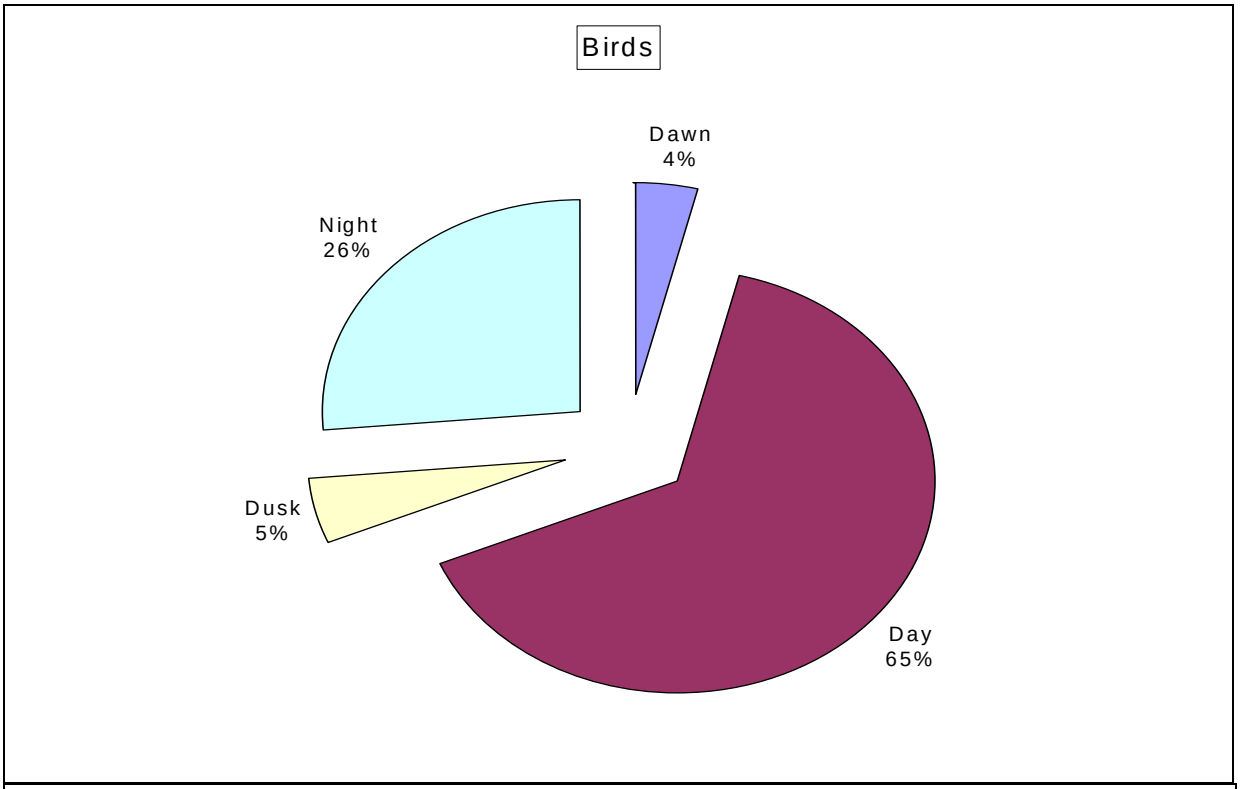


Figure 2. Percent of bird (N= 27,433) and mammal (N = 681) strikes to civil aircraft by month, USA, 1990-1999. An additional 36 reptile strikes were reported.



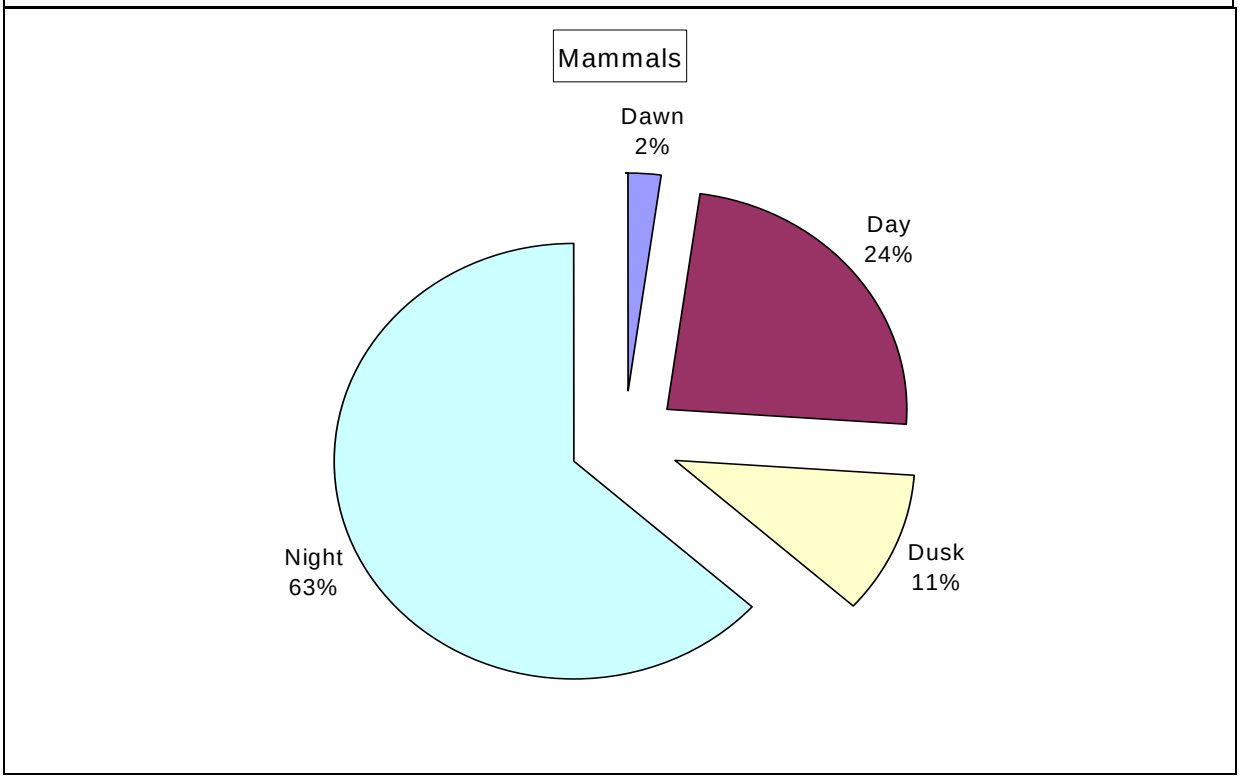


Figure 3. Reported time of occurrence of bird (N = 22,247) and mammal (N = 522) strikes to civil aircraft, USA, 1990-1999. There were 5,186 bird strike and 159 mammal strike reports that did not give the time of occurrence.

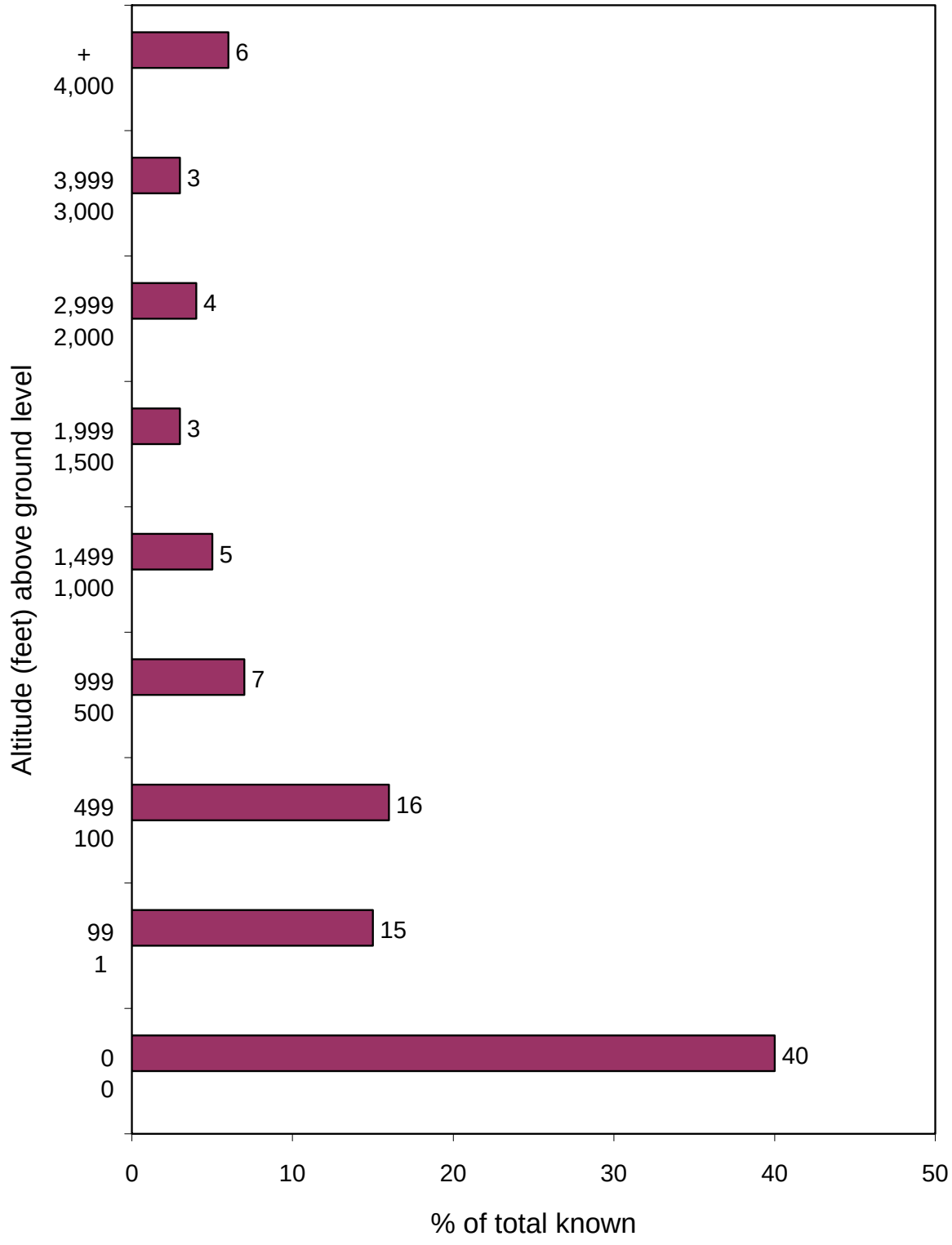


Figure 4. Percent of reported bird strikes (N = 20,893) to civil aircraft by altitude of occurrence, USA, 1990-1999. There were 6,540 reports that did not indicate the altitude of the strike.

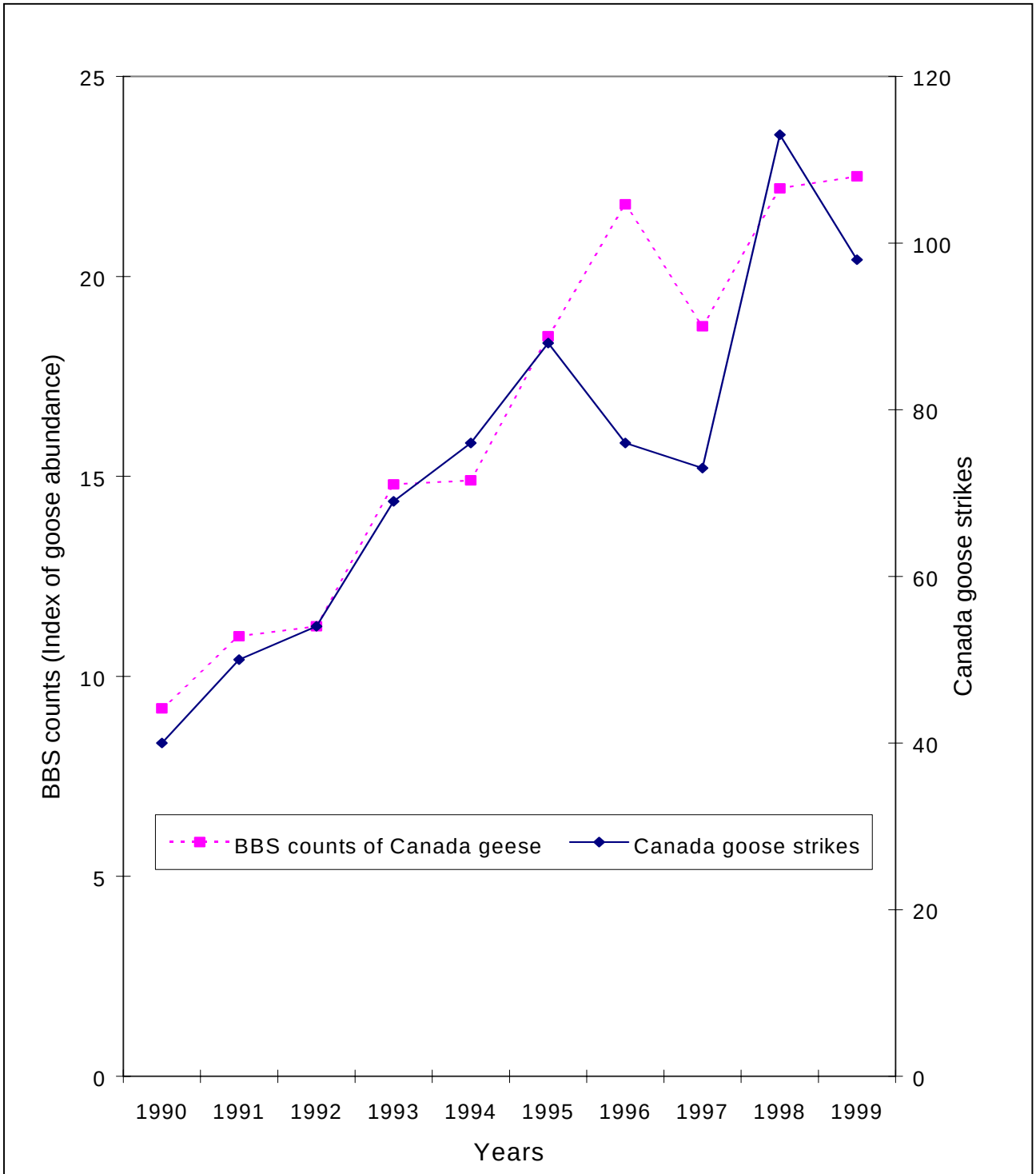


Figure 5. Number of reported Canada goose strikes to civil aircraft and mean Breeding Bird Survey (BBS) counts of Canada geese (Sauer et al. 2000), 1990-1999, USA.

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Appendix A

Identified wildlife species
involved in reported strikes
to civil aircraft by year,
USA, 1990-1999

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Appendix A. Identified wildlife species involved in strikes to civil aircraft by year, USA, 1990-1999. Page 1 of 9.

Species	Number of reported strikes										10-yr. total	% of total
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999		
Birds												
Loons	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**2**	**0.0**
Loons	0	0	1	0	0	0	0	0	0	0	1	0.0
Common loon	0	0	0	0	0	0	0	0	1	0	1	0.0
Grebes	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**6**	**1**	**9**	**0**
Grebes	0	0	0	0	1	1	0	0	2	0	4	0.0
Eared grebe	0	0	0	0	0	0	0	0	3	1	4	0.0
Western grebe	0	0	0	0	0	0	0	0	1	0	1	0.0
Tropicbirds	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**0.0**
Albatrosses	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**0.0**
Pelicans	**0**	**3**	**4**	**1**	**4**	**3**	**4**	**1**	**1**	**1**	**22**	**0.2**
Pelicans	0	3	4	1	3	3	3	1	1	1	20	0.2
Australian pelican	0	0	0	0	0	0	1	0	0	0	1	0.0
Brown pelican	0	0	0	0	1	0	0	0	0	0	1	0.0
Cormorants	**3**	**1**	**5**	**2**	**1**	**3**	**6**	**3**	**3**	**1**	**28**	**0.2**
Cormorants	1	0	1	1	0	2	2	1	0	1	9	0.1
Double-crested cormorant	1	0	2	0	0	0	3	0	1	0	7	0.1
Anhingas	0	1	2	1	1	1	0	1	1	0	8	0.1
Frigatebirds	1	0	0	0	0	0	1	1	1	0	4	0.0
Waterfowl	**81**	**104**	**110**	**147**	**152**	**148**	**151**	**159**	**197**	**198**	**1,447**	**11.6**
Ducks, geese, swans	5	5	9	11	7	10	10	11	6	9	83	0.7
Ducks	25	42	35	38	40	29	44	48	39	48	388	3.1
Blue-winged teal	0	0	1	0	0	0	0	0	1	0	2	0.0
Green-winged teal	0	0	0	0	0	0	0	1	1	0	2	0.0
American wigeon	0	0	0	0	0	1	1	0	0	1	3	0.0
European wigeon	0	0	0	1	0	0	0	0	0	0	1	0.0
Northern pintail	0	0	0	0	1	0	0	0	0	0	1	0.0
Lesser scaup	0	0	0	0	0	1	0	0	0	0	1	0.0
Mallard	9	4	10	21	24	14	14	21	29	28	174	1.4
Common eider	0	0	0	0	0	1	0	0	0	0	1	0.0
Ring-necked duck	0	0	0	0	0	0	1	1	0	0	2	0.0
American black duck	0	0	0	0	0	0	0	1	0	0	1	0.0
Common merganser	0	0	0	0	0	0	0	0	1	0	1	0.0
Canvasback	0	0	0	0	0	1	0	0	0	0	1	0.0
Mottled duck	0	0	0	0	0	0	0	0	1	0	1	0.0
Wood duck	0	0	0	0	0	0	1	1	0	2	4	0.0
Gadwall	0	0	0	0	0	0	0	1	0	0	1	0.0
Geese	22	38	38	44	48	54	52	44	58	53	451	3.6
Snow goose	2	2	1	4	2	1	3	1	4	10	30	0.2
Canada goose	18	12	16	25	28	34	24	29	55	45	286	2.3
Brant	0	1	0	2	0	2	0	0	2	0	7	0.1
Gr'ter white-fronted goose	0	0	0	1	0	0	0	0	0	0	1	0.0
Swans	0	0	0	0	1	0	1	0	0	0	2	0.0

Species	Number of reported strikes											
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	10-yr. total	% of total
Waterfowl (continued)												
Mute swan	0	0	0	0	0	0	0	0	0	1	1	0.0
Tundra swan	0	0	0	0	1	0	0	0	0	1	2	0.0
Raptors	**59**	**90**	**101**	**95**	**117**	**132**	**123**	**172**	**268**	**222**	**1,379**	**11.0**
Hawks, eagles, vultures	0	4	1	1	2	0	1	1	5	2	17	0.1
Vultures	8	15	14	8	10	15	20	9	17	13	129	1.0
Lappet-faced vulture	0	0	0	0	0	0	0	0	1	0	1	0.0
Black vulture	1	0	0	1	0	0	0	1	2	0	5	0.0
Turkey vulture	5	9	10	9	12	6	5	15	21	7	99	0.8
Osprey	2	3	1	3	2	0	6	8	3	8	36	0.3
Kites, eagles, hawks	0	0	0	0	1	1	0	0	0	0	2	0.0
Kites	0	0	0	0	0	1	1	0	1	0	3	0.0
Eagles	1	3	1	1	1	0	2	1	2	1	13	0.1
Bald eagle	0	0	2	0	5	4	2	2	5	3	23	0.2
Golden eagle	0	0	0	1	0	0	0	0	0	0	1	0.0
Hawks	34	33	50	40	52	39	32	62	54	49	445	3.6
Red-tailed hawk	3	10	10	11	13	30	21	30	47	45	220	1.8
Red-shouldered hawk	0	0	0	0	0	1	0	1	1	0	3	0.0
Rough-legged hawk	0	0	0	0	0	0	4	0	0	1	5	0.0
Swainson's hawk	0	0	0	0	0	0	0	1	0	1	2	0.0
Cooper's hawk	0	0	0	0	0	0	0	0	1	0	1	0.0
Sharp-shinned hawk	0	0	0	0	0	0	0	1	0	0	1	0.0
Northern harrier	0	1	0	1	2	1	2	1	0	6	14	0.1
Falcons	1	0	0	1	0	3	0	1	5	2	13	0.1
Gyrfalcon	0	0	0	0	0	0	0	0	0	1	1	0.0
Peregrine falcon	0	2	1	2	3	2	3	0	6	3	22	0.2
Merlin	0	0	0	0	0	1	0	1	6	1	9	0.1
American kestrel	4	10	11	16	14	28	24	37	91	79	314	2.5
Gallinaceous birds	**8**	**8**	**7**	**8**	**3**	**3**	**7**	**10**	**9**	**7**	**70**	**0.6**
Grouse	0	0	0	1	0	1	0	2	0	0	4	0.0
Sharp-tailed grouse	0	0	0	0	0	0	1	0	0	0	1	0.0
Grouse, ptarmigans	0	0	1	0	0	0	0	0	0	0	1	0.0
Ptarmigans	0	0	0	1	0	0	1	0	0	0	2	0.0
Quail	0	0	1	0	1	0	1	2	1	1	7	0.1
Northern bobwhite	0	0	0	0	0	0	0	0	0	1	1	0.0
Black francolin	0	0	0	0	0	0	0	1	0	0	1	0.0
Ring-necked pheasant	8	6	3	4	2	2	1	3	2	3	34	0.3
Partridges	0	0	0	0	0	0	0	0	1	0	1	0.0
Hungarian partridge	0	1	1	0	0	0	0	0	0	0	2	0.0
Guineafowl	0	0	0	1	0	0	0	0	0	0	1	0.0
Wild turkey	0	1	1	1	0	0	3	2	5	2	15	0.1

Species	Number of reported strikes											
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	10-yr. total	% of total
Herons	**1**	**7**	**8**	**10**	**11**	**11**	**15**	**26**	**46**	**24**	**159**	**1.3**
Herons, storks, ibises	0	0	0	0	1	1	0	0	0	0	2	0.0
Herons	0	4	4	4	2	2	5	3	5	2	31	0.2
Great blue heron	1	3	4	5	7	5	6	13	15	12	71	0.6
Yellow bittern	0	0	0	0	0	0	3	9	24	7	43	0.3
Bl'k-crowned night-heron	0	0	0	0	0	0	1	0	1	2	4	0.0
Wood stork	0	0	0	0	0	1	0	1	0	0	2	0.0
Ibises	0	0	0	0	1	0	0	0	1	0	2	0.0
Glossy ibis	0	0	0	0	0	0	0	0	0	1	1	0.0
White ibis	0	0	0	1	0	2	0	0	0	0	3	0.0
Egrets	**11**	**23**	**16**	**25**	**25**	**24**	**28**	**25**	**20**	**30**	**227**	**1.8**
Egrets	10	18	12	19	21	21	18	13	7	23	162	1.3
Cattle egret	1	2	4	4	2	2	7	11	10	6	49	0.4
Great egret	0	0	0	2	2	1	2	1	3	1	12	0.1
Snowy egret	0	3	0	0	0	0	1	0	0	0	4	0.0
Cranes	**2**	**2**	**2**	**4**	**2**	**5**	**8**	**6**	**9**	**5**	**45**	**0.4**
Cranes	1	1	0	0	0	3	4	1	6	1	17	0.1
Sandhill crane	1	1	2	4	2	2	4	5	3	4	28	0.2
Rails, gallinules	**0**	**1**	**1**	**0**	**1**	**0**	**1**	**1**	**2**	**6**	**13**	**0.1**
Sora	0	1	0	0	0	0	0	0	0	0	1	0.0
Clapper rail	0	0	0	0	0	0	0	0	0	1	1	0.0
Virginia rail	0	0	0	0	0	0	0	0	0	1	1	0.0
American coot	0	0	1	0	1	0	0	0	2	3	7	0.1
Common moorhen	0	0	0	0	0	0	1	0	0	0	1	0.0
Purple gallinule	0	0	0	0	0	0	0	1	0	1	2	0.0
Shorebirds	**12**	**23**	**13**	**26**	**32**	**24**	**37**	**64**	**108**	**81**	**420**	**3.4**
Shorebirds	1	1	0	0	0	0	3	1	1	0	7	0.1
Lapwings	0	1	0	0	0	0	0	0	0	0	1	0.0
Common snipe	1	1	0	0	0	0	0	0	0	1	3	0.0
American woodcock	0	0	0	0	1	0	0	1	0	2	4	0.0
Jacanas	0	0	0	0	0	0	0	0	1	0	1	0.0
Oystercatchers	0	0	0	0	0	0	0	0	2	0	2	0.0
Plovers	2	3	1	1	2	2	5	8	15	16	55	0.4
Lesser golden-plover	0	0	1	0	0	1	5	7	5	1	20	0.2
Black-bellied plover	0	0	0	0	0	0	1	2	1	2	6	0.0
Killdeer	6	8	9	17	21	14	18	40	50	40	223	1.8
Pacific golden-plover	0	1	0	0	0	0	0	0	4	1	6	0.0
Sandpipers	2	5	2	6	7	7	2	2	14	10	57	0.5
Upland sandpiper	0	2	0	1	0	0	2	1	11	4	21	0.2
Spotted sandpiper	0	0	0	0	1	0	0	0	0	0	1	0.0
Semipalmated sandpiper	0	0	0	1	0	0	0	0	0	1	2	0.0

Species	Number of reported strikes											
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	10-yr. total	% of total
Shorebirds (continued)												
Least sandpiper	0	0	0	0	0	0	0	1	1	0	2	0.0
Western sandpiper	0	0	0	0	0	0	0	0	0	1	1	0.0
Lesser yellowlegs	0	0	0	0	0	0	1	0	0	0	1	0.0
Dunlin	0	0	0	0	0	0	0	0	1	1	2	0.0
Short-billed dowitcher	0	0	0	0	0	0	0	0	1	0	1	0.0
Whimbrel	0	0	0	0	0	0	0	1	1	1	3	0.0
Avocets	0	1	0	0	0	0	0	0	0	0	1	0.0
Gulls	**337**	**364**	**378**	**373**	**322**	**325**	**371**	**394**	**373**	**333**	**3,570**	**28.6**
Gulls, Terns	4	0	0	1	2	1	0	0	0	0	8	0.1
Gulls	303	345	363	342	308	306	319	325	292	241	3,144	25.1
Common Gull	0	0	1	0	0	1	0	0	0	0	2	0.0
Herring gull	10	12	8	7	4	5	9	14	29	41	139	1.1
Heerman's gull	0	0	0	0	0	0	0	0	0	1	1	0.0
Mew gull	0	0	0	0	0	0	0	5	1	1	7	0.1
Ring-billed gull	6	1	3	13	3	8	23	28	32	24	141	1.1
Glaucous-winged gull	0	0	0	0	0	0	0	5	3	1	9	0.1
Greater black-backed gull	1	0	0	0	0	0	4	4	2	3	14	0.1
Franklin's gull	2	0	0	0	0	0	2	0	0	0	4	0.0
Laughing gull	9	6	3	8	5	4	13	9	9	21	87	0.7
Bonaparte's gull	0	0	0	2	0	0	0	4	0	0	6	0.0
Western gull	2	0	0	0	0	0	0	0	4	0	6	0.0
California gull	0	0	0	0	0	0	1	0	1	0	2	0.0
Terns	**3**	**8**	**2**	**2**	**6**	**2**	**4**	**2**	**2**	**5**	**36**	**0.3**
Terns	2	8	2	1	5	1	0	0	2	3	24	0.2
Common tern	0	0	0	1	0	0	1	0	0	2	4	0.0
Gull-billed tern	0	0	0	0	0	0	0	1	0	0	1	0.0
Arctic tern	1	0	0	0	1	0	2	0	0	0	4	0.0
Forster's tern	0	0	0	0	0	0	1	1	0	0	2	0.0
Least tern	0	0	0	0	0	1	0	0	0	0	1	0.0
Doves	**100**	**123**	**114**	**127**	**151**	**120**	**145**	**166**	**212**	**215**	**1,473**	**11.8**
Pigeons, doves	0	0	0	2	9	0	0	1	0	0	12	0.1
Doves	38	53	49	62	83	42	73	57	69	78	604	4.8
Homing pigeon	0	0	0	1	0	0	2	1	4	2	10	0.1
Rock dove	51	62	49	39	42	55	48	52	70	71	539	4.3
Mourning dove	10	7	16	23	17	22	20	54	61	58	288	2.3
Barred ground-dove	0	0	0	0	0	1	2	1	4	3	11	0.1
Philippine turtle dove	0	0	0	0	0	0	0	0	3	1	4	0.0
Inca dove	0	0	0	0	0	0	0	0	1	2	3	0.0
Spotted dove	1	1	0	0	0	0	0	0	0	0	2	0.0
Cuckoos	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0.0**
Yellow-billed cuckoo	0	0	0	0	0	0	0	0	0	1	1	0.0

Species	Number of reported strikes											
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	10-yr. total	% of total
Owls	**12**	**18**	**27**	**25**	**15**	**23**	**34**	**30**	**35**	**43**	**262**	**2.1**
Owls	10	12	21	17	9	13	18	16	17	13	146	1.2
Barn-owl	1	3	2	1	3	4	5	10	11	21	61	0.5
Snowy owl	0	3	3	4	1	0	5	0	1	0	17	0.1
Eastern screech owl	0	0	1	0	0	0	0	0	0	0	1	0.0
Short-eared owl	1	0	0	0	0	3	5	2	1	5	17	0.1
Burrowing owl	0	0	0	0	1	1	0	0	0	1	3	0.0
Barred owl	0	0	0	0	0	1	0	0	1	0	2	0.0
Long-eared owl	0	0	0	1	0	0	1	0	0	0	2	0.0
Great horned owl	0	0	0	1	1	1	0	2	4	2	11	0.1
Northern saw-whet owl	0	0	0	1	0	0	0	0	0	1	2	0.0
Nighthawks	**1**	**1**	**2**	**2**	**1**	**6**	**2**	**5**	**3**	**2**	**25**	**0.2**
Common nighthawk	0	1	2	2	0	6	1	5	3	1	21	0.2
Whip-poor-will	0	0	0	0	1	0	1	0	0	0	2	0.0
Common poorwill	0	0	0	0	0	0	0	0	0	1	1	0.0
Nightjars	1	0	0	0	0	0	0	0	0	0	1	0.0
Swifts	**2**	**0**	**0**	**2**	**0**	**3**	**1**	**3**	**3**	**4**	**18**	**0.1**
Swifts	2	0	0	1	0	1	0	0	0	1	5	0.0
Vaux's swift	0	0	0	0	0	0	0	0	0	1	1	0.0
White-throated swift	0	0	0	0	0	0	0	0	0	1	1	0.0
Chimney swift	0	0	0	1	0	2	1	3	3	1	11	0.1
Parrots	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**3**	**0.0**
Kingfishers	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**2**	**1**	**5**	**0.0**
Kingfishers	0	0	0	0	0	2	0	0	0	1	3	0.0
Belted kingfishers	0	0	0	0	0	0	0	0	2	0	2	0.0
Woodpeckers	**0**	**2**	**0**	**0**	**0**	**1**	**1**	**2**	**3**	**3**	**12**	**0.1**
Woodpeckers, Piculets	0	0	0	0	0	0	1	1	0	1	3	0.0
Northern flicker	0	2	0	0	0	0	0	1	2	2	7	0.1
Yellow-bellied sapsucker	0	0	0	0	0	1	0	0	1	0	2	0.0
Tyrant fly-catchers	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**2**	**0.0**
Tyrant fly-catchers	0	0	0	0	0	0	0	0	1	0	1	0.0
Great crested flycatcher	0	0	0	0	0	0	0	0	1	0	1	0.0
Kingbirds	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0.0**
Eastern kingbird	0	0	0	0	0	0	0	0	0	1	1	0.0
Larks	**3**	**2**	**4**	**4**	**2**	**6**	**3**	**4**	**4**	**9**	**41**	**0.3**
Larks	3	2	1	0	0	0	1	0	1	0	8	0.1
Horned lark	0	0	3	4	2	6	2	4	3	9	33	0.3
Swallows	**15**	**16**	**25**	**31**	**24**	**33**	**25**	**54**	**42**	**47**	**312**	**2.5**
Swallows	9	11	15	17	14	24	13	19	24	23	169	1.4
Purple martin	1	2	2	3	3	1	5	4	3	0	24	0.2
Barn swallow	1	2	7	9	5	4	4	15	9	18	74	0.6

Species	Number of reported strikes											
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	10-yr. total	% of total
Swallows (continued)												
Bank swallow	0	0	0	0	0	0	0	1	0	0	1	0.0
Cliff swallow	0	0	0	0	1	0	0	0	3	1	5	0.0
Tree swallow	4	1	1	2	1	4	3	15	3	5	39	0.3
Jays, magpies	**1**	**1**	**2**	**2**	**4**	**0**	**1**	**0**	**0**	**1**	**12**	**0.1**
Blue jay	0	1	0	0	0	0	1	0	0	1	3	0.0
Magpies	1	0	1	2	3	0	0	0	0	0	7	0.0
Yellow-billed magpie	0	0	1	0	1	0	0	0	0	0	2	0.0
Crows	**15**	**20**	**17**	**23**	**26**	**33**	**14**	**16**	**26**	**33**	**223**	**1.8**
Crows	14	17	15	14	24	17	14	12	22	26	175	1.4
American crow	1	2	2	8	1	15	0	4	3	5	41	0.3
Common raven	0	0	0	0	0	0	0	0	0	1	1	0.0
Ravens	0	1	0	1	1	1	0	0	1	1	6	0.0
Chickadees	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**2**	**0.0**
Wrens	**2**	**3**	**1**	**1**	**0**	**2**	**4**	**2**	**3**	**2**	**20**	**0.2**
Mockingbirds/Thrashers	**1**	**0**	**4**	**4**	**1**	**0**	**3**	**6**	**5**	**1**	**25**	**0.2**
Mockingbirds	0	0	3	4	1	0	3	6	4	0	21	0.2
Gray catbird	0	0	0	0	0	0	0	0	1	1	2	0.0
Thrashers	1	0	0	0	0	0	0	0	0	0	1	0.0
Brown thrasher	0	0	1	0	0	0	0	0	0	0	1	0.0
Thrushes	**19**	**20**	**10**	**13**	**11**	**6**	**9**	**6**	**8**	**12**	**114**	**0.9**
Thrushes	1	1	0	0	2	1	0	0	0	1	6	0.0
Swainson's thrush	2	1	0	0	0	0	0	0	0	1	4	0.0
American robin	16	18	10	12	9	4	9	6	8	10	102	0.8
Hermit thrush	0	0	0	1	0	0	0	0	0	0	1	0.0
Eastern bluebird	0	0	0	0	0	1	0	0	0	0	1	0.0
Waxwings	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**0.0**
Cedar waxwing	0	0	0	0	0	0	0	0	1	0	1	0.0
Shrikes	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0.0**
Starlings	**45**	**50**	**58**	**57**	**62**	**49**	**66**	**79**	**78**	**92**	**636**	**5.1**
European starling	44	50	58	57	62	48	64	77	75	92	627	5.0
Common myna	0	0	0	0	0	1	0	0	1	0	2	0.0
Mynas	1	0	0	0	0	0	2	2	2	0	7	0.1
Warblers	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**3**	**5**	**0.0**
Wood warblers	0	0	0	0	0	1	0	0	0	1	2	0.0
Canada warbler	0	0	0	0	0	0	0	0	1	0	1	0.0
Yellow-breasted chat	0	0	0	0	0	0	0	0	0	2	2	0.0
Blackbirds	**59**	**77**	**78**	**84**	**66**	**75**	**67**	**80**	**94**	**50**	**730**	**5.8**
Blackbirds, Orioles	0	1	0	0	0	0	0	2	0	0	3	0.0
Blackbirds	57	73	72	79	64	72	57	63	82	42	661	5.3
Red-winged blackbird	0	3	3	2	1	2	2	2	1	0	16	0.1

Species	Number of reported strikes											
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	10-yr. total	% of total
Blackbirds (continued)												
Yellow-headed blackbird	0	0	0	0	0	0	0	1	0	2	3	0.0
Brewer's blackbird	0	0	0	0	0	0	0	0	1	0	1	0.0
Common grackle	0	0	0	0	0	0	0	2	1	1	4	0.0
Grackles	1	0	1	3	1	1	5	10	8	2	32	0.3
Boat-tailed grackle	0	0	1	0	0	0	1	0	0	0	2	0.0
Brown-headed cowbird	1	0	0	0	0	0	2	0	1	1	5	0.0
Orioles	0	0	1	0	0	0	0	0	0	2	3	0.0
Meadowlarks	**3**	**7**	**10**	**11**	**13**	**14**	**17**	**20**	**21**	**22**	**138**	**1.1**
Bobolink	0	0	0	0	0	0	0	1	0	0	1	0.0
Meadowlarks	3	0	2	5	6	0	1	1	10	11	39	0.3
Eastern meadowlark	0	5	8	6	6	13	11	14	6	8	77	0.6
Western meadowlark	0	2	0	0	1	1	5	4	5	3	21	0.2
Finches	**4**	**1**	**3**	**3**	**1**	**13**	**7**	**8**	**13**	**15**	**68**	**0.5**
Finches	0	0	0	2	0	5	2	2	1	1	13	0.1
American goldfinch	0	1	0	0	0	0	2	0	2	0	5	0.0
House sparrow	0	0	0	0	0	0	1	1	3	1	6	0.0
Rose-breasted grosbeak	1	0	0	0	0	0	0	0	0	0	1	0.0
Red crested cardinals	0	0	0	0	0	0	1	0	0	0	1	0.0
Buntings	0	0	0	0	0	0	0	1	0	1	2	0.0
Snow bunting	3	0	3	1	1	7	1	4	7	9	36	0.3
Lazuli bunting	0	0	0	0	0	0	0	0	0	1	1	0.0
Green-tailed towhee	0	0	0	0	0	0	0	0	0	1	1	0.0
Rufous-sided towhee	0	0	0	0	0	1	0	0	0	1	2	0.0
Sparrows	**77**	**94**	**89**	**91**	**96**	**85**	**87**	**78**	**94**	**125**	**916**	**7.3**
Sparrows	77	94	88	90	95	85	85	76	87	117	894	7.1
Savannah sparrow	0	0	0	1	0	0	1	1	5	7	15	0.1
Golden crowned sparrow	0	0	0	0	0	0	0	0	1	0	1	0.0
Field sparrow	0	0	0	0	0	0	0	0	1	0	1	0.0
Lark sparrow	0	0	0	0	0	0	0	0	0	1	1	0.0
White-throated sparrow	0	0	0	0	0	0	1	1	0	0	2	0.0
Fox sparrow	0	0	1	0	0	0	0	0	0	0	1	0.0
Dark-eyed junco	0	0	0	0	1	0	0	0	0	0	1	0.0
Mannikins	**0**	**0**	**8**	**0**	**2**	**2**	**5**	**4**	**4**	**5**	**30**	**0.2**
Mannikins	0	0	2	0	2	2	2	1	0	3	12	0.1
Nutmeg mannikin	0	0	3	0	0	0	2	0	1	1	7	0.1
Chestnut mannikin	0	0	3	0	0	0	1	3	3	1	11	0.1
Total known birds	**876**	**1,069**	**1,102**	**1,173**	**1,152**	**1,155**	**1,247**	**1,427**	**1,701**	**1,602**	**12,504**	**100.0**
Unknown birds	**844**	**1,051**	**1,150**	**1,086**	**1,156**	**1,323**	**1,399**	**1,873**	**1,851**	**3,196**	**14,929**	
Total birds	**1,720**	**2,120**	**2,252**	**2,259**	**2,308**	**2,478**	**2,646**	**3,300**	**3,552**	**4,798**	**27,433**	

Species	Number of reported strikes											
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	10-yr. total	% of total
Mammals												
Edentates	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**2**	**6**	**0**	**11**	**1.6**
Chiropteras	**4**	**3**	**2**	**6**	**2**	**5**	**1**	**1**	**3**	**6**	**33**	**4.9**
Carnivores	**2**	**6**	**5**	**6**	**13**	**18**	**24**	**17**	**23**	**21**	**135**	**20.2**
Canids	0	0	0	0	0	0	0	0	0	1	1	0.1
Coyotes	2	3	1	4	9	10	11	9	14	8	71	10.6
Dog	0	0	1	0	1	4	4	0	2	2	14	2.1
Fox	0	3	1	0	2	2	5	4	1	1	19	2.8
House cat	0	0	2	0	0	0	0	0	1	1	4	0.6
Raccoon	0	0	0	1	1	1	0	3	1	3	10	1.5
River otter	0	0	0	0	0	0	0	0	1	0	1	0.1
Striped skunk	0	0	0	0	0	1	4	1	3	5	14	2.1
White-nosed coati	0	0	0	1	0	0	0	0	0	0	1	0.1
Marsupials	**0**	**0**	**0**	**3**	**0**	**2**	**1**	**4**	**4**	**1**	**15**	**2.2**
Rodents	**1**	**0**	**1**	**4**	**0**	**7**	**0**	**1**	**4**	**5**	**23**	**3.4**
Muskrat	0	0	0	0	0	1	0	0	1	1	3	0.4
Porcupine	0	0	0	0	0	0	0	0	0	1	1	0.1
Rodents	0	0	0	0	0	0	0	0	1	0	1	0.1
Woodchuck	1	0	1	4	0	6	0	1	2	3	18	2.7
Lagomorphs	**0**	**1**	**1**	**0**	**1**	**1**	**0**	**1**	**1**	**3**	**9**	**1.3**
Rabbits, hares	0	1	1	0	1	1	0	1	1	3	9	1.3
Ungulates	**12**	**27**	**47**	**39**	**57**	**40**	**60**	**62**	**55**	**43**	**442**	**66.2**
Caribou	0	0	0	1	0	0	0	0	0	0	1	0.1
Cattle	0	0	1	2	0	1	1	0	0	0	5	0.7
Deer	2	7	8	6	7	7	16	15	12	8	88	13.2
Elk	0	0	1	0	1	0	2	1	1	0	6	0.9
Horse	0	0	0	0	0	0	0	1	2	0	3	0.4
Moose	0	0	0	0	0	1	0	1	0	0	2	0.3
Mule deer	0	0	0	0	0	0	0	1	0	1	2	0.3
Peccary	0	0	0	0	0	0	0	1	0	0	1	0.1
Pronghorn	0	0	0	1	0	1	0	1	0	0	3	0.4
Swine	0	0	0	0	0	0	0	0	0	1	1	0.1
White-tailed deer	10	20	37	29	49	30	41	41	40	33	330	49.4
Total known mammals	**19**	**37**	**56**	**58**	**73**	**73**	**89**	**88**	**96**	**79**	**668**	**100.0**
Unknown mammals	**0**	**2**	**0**	**1**	**1**	**0**	**1**	**4**	**3**	**1**	**13**	
Total mammals	**19**	**39**	**56**	**59**	**74**	**73**	**90**	**92**	**99**	**80**	**681**	

Species	Number of reported strikes											
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	10-yr. total	% of total
Reptiles												
Turtles	**0**	**0**	**1**	**0**	**0**	**6**	**2**	**11**	**5**	**1**	**26**	**72.2**
Turtles	0	0	1	0	0	4	1	8	5	1	20	55.6
Florida soft shell turtle	0	0	0	0	0	2	0	1	0	0	3	8.3
Box turtle	0	0	0	0	0	0	1	2	0	0	3	8.3
Alligators	**0**	**0**	**0**	**0**	**1**	**2**	**1**	**4**	**2**	**0**	**10**	**27.8**
Total reptiles	**0**	**0**	**1**	**0**	**1**	**8**	**3**	**15**	**7**	**1**	**36**	**100.0**
All species												
Total known	**895**	**1,106**	**1,159**	**1,231**	**1,226**	**1,236**	**1,339**	**1,530**	**1,804**	**1,682**	**13,208**	
Total unknown	**844**	**1,053**	**1,150**	**1,087**	**1,157**	**1,323**	**1,400**	**1,877**	**1,854**	**3,197**	**14,942**	
Total	**1,739**	**2,159**	**2,309**	**2,318**	**2,383**	**2,559**	**2,739**	**3,407**	**3,658**	**4,879**	**28,150**	

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