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Wildlife Strikes to Civil Aircraft in the United States 1990–2013



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COVER PHOTOGRAPH

A Swainson's hawk was ingested into the #1 engine of an MD-80 at 500 feet AGL on departure from an airport in Texas in late August 2013, causing substantial damage to the fan blades. The pilot declared an emergency and returned the aircraft safely to the airport. The aircraft was out of service for 36 hours for an engine replacement. Swainson's hawks (mean body mass = 0.81 kg, male; 1.11 kg, female) nest throughout western North America and migrate to Argentina in winter. Photo, Cathy Boyles, DFW.

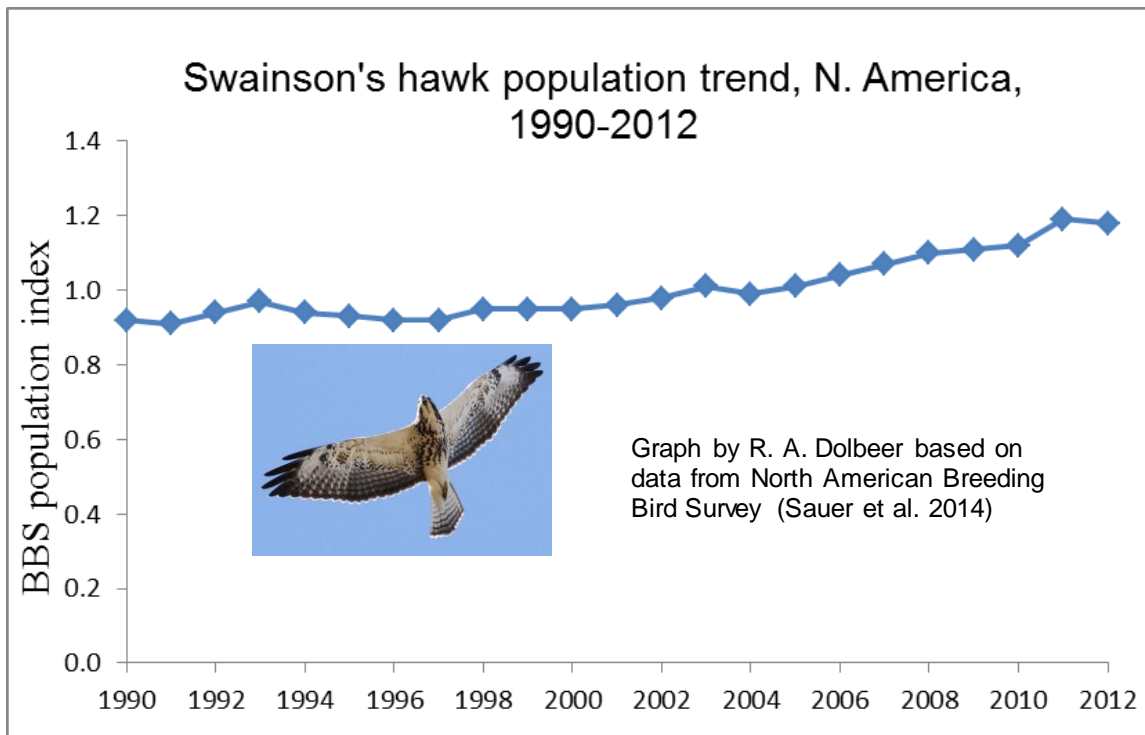


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We acknowledge and thank all of the people who took the time and effort to report the 142,603 wildlife strikes summarized in this report – pilots, mechanics, control tower personnel, airport operations personnel, airline flight safety officers, airport wildlife biologists, and many others. Sponsorship and funds for the ongoing maintenance and analysis of the FAA Wildlife Strike Database are provided by the FAA, Office of Airport Safety and Standards, Washington, DC, and the Airports Research and Development Branch, FAA William J. Hughes Technical Center, Atlantic City, NJ. We acknowledge the suggestions and critiques made by various people over the years that have enhanced the usefulness and accuracy of the report. In particular, we thank Edward Cleary, retired FAA biologist and Roger Nicholson, Boeing Aircraft Company, for timely advice during the development of this and previous reports.

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EXECUTIVE SUMMARY - PART 1: WILDLIFE STRIKES TO CIVIL AIRCRAFT IN THE UNITED STATES, 1990–2013

Increased media attention to wildlife strikes with aircraft, such as the emergency forced landing of US Airways Flight 1549 in the Hudson River on 15 January 2009 after Canada geese were ingested in both engines on the Airbus 320, has dramatically demonstrated to the public that wildlife strikes are a serious but manageable aviation safety issue. However, the civil and military aviation communities have long recognized that the threat from aircraft collisions with wildlife is real and increasing. Globally, wildlife strikes have killed more than 255 people and destroyed over 243 aircraft since 1988. Factors that contribute to this increasing threat are increasing populations of large birds and increased air traffic by quieter, turbofan-powered aircraft.

This report presents a summary analysis of data from the National Wildlife Strike Database for the 24-year period 1990 through 2013. A sample of 29 significant wildlife strikes to civil aircraft in the USA during 2013 is also included as an appendix.

The number of strikes annually reported has increased 6.1-fold from 1,851 in 1990 to a record 11,315 in 2013 (142,603 strikes for 1990-2013). Birds were involved in 97.0 percent of the reported strikes, terrestrial mammals in 2.2 percent, bats in 0.7 percent and reptiles in 0.1 percent (Table 1). Although the number of reported strikes has steadily increased, the number of reported damaging strikes has actually declined from a peak of 764 in 2000 to 601 in 2013. The decline in damaging strikes has been most pronounced for commercial aircraft in the airport environment (at ≤ 500 feet above ground level [AGL]). Damaging strikes have not declined for general aviation (GA) aircraft.

In 2013, 83 percent and 8 percent of the 11,315 strike reports were filed using the electronic and paper versions, respectively, of FAA Form 5200-7, Bird/Other Wildlife Strike Report. Since the online version of this form became available in April 2001, use of the electronic reporting system has climbed dramatically.

The number of USA airports with strikes reported increased from 331 in 1990 to a record 649 in 2013. The 649 airports with strikes reported in 2013 were comprised of 379 airports certificated for passenger service under 14 CFR Part 139 and 270 GA aviation airports. From 1990 - 2013, strikes have been reported from 1,821 USA airports.

Fifty-two percent of bird strikes occurred between July and October; 30 percent of deer strikes occurred in October - November. Terrestrial mammals are more likely to be struck at night (64 percent) whereas birds are struck more often during the day (62 percent). Both birds (61 percent) and terrestrial mammals (64 percent) are more likely to be struck during the landing (i.e., descent, approach or landing roll) phase of flight compared to take-off and climb (35 percent and 33 percent, respectively).

For commercial and GA aircraft, 71 and 74 percent of bird strikes, respectively, occurred at or below 500 feet above ground level (AGL). Above 500 feet AGL, the

number of strikes declined by 34 percent for each 1,000-foot gain in height for commercial aircraft, and by 43 percent for GA aircraft. Strikes occurring above 500 feet were more likely to cause damage than strikes at or below 500 feet. The record height for a reported bird strike was 31,300 feet.

From 1990 to 2013, 503 species of birds, 42 species of terrestrial mammals, 19 species of bats, and 15 species of reptiles were identified as struck by aircraft. Waterfowl, gulls, and raptors are the species groups of birds with the most damaging strikes; Artiodactyls (mainly deer) and carnivores (mainly coyotes) are the terrestrial mammals with the most damaging strikes. Although the percentage of wildlife strikes with reported damage has averaged 9 percent for the 24-year period, this number has declined from 20 percent in 1990 to 5 percent in 2013.

A negative effect-on-flight was reported in 6 percent and 22 percent of the bird and terrestrial mammal strike reports, respectively. Precautionary/emergency landing after striking wildlife was the most commonly reported negative effect (4,916 incidents), including 47 incidents in which the pilot jettisoned fuel (an average of 13,280 gallons) to lighten aircraft weight and 84 incidents in which an overweight landing was made. Aborted takeoff was the second most commonly reported negative effect (2,071 incidents). These negative incidents included 866 aborted takeoffs at ≥ 80 knots. Similar to the trend shown for the percentage of strikes causing damage, the percentage of strikes with a reported negative effect-on-flight has declined from a high of 13 percent in 1996 to 4 percent in 2013. For commercial aircraft, the number of high-speed (≥ 80 knots) aborted take-offs has declined from a high of 39 in 2000 to 19 in 2013.

For the 30 species of birds most frequently identified as struck by civil aircraft, 1990–2013, there was a strong correlation ($R^2 = 0.81$) between mean body mass and the likelihood of a strike causing damage to aircraft. For every 100 gram increase in body mass, there was a 1.28% increase in the likelihood of damage. Thus, body mass is a good predictor of relative hazard level among bird species.

Sixty-six strikes have resulted in a destroyed aircraft; 42 (64 percent) of these occurred at GA airports. The annual cost of wildlife strikes to the USA civil aviation industry is projected to be a minimum of 117,740 hours of aircraft downtime and \$187 million in direct and other monetary losses and may be as high as 588,699 hours of downtime and \$937 million in monetary losses.

This analysis of 24 years of strike data documents the progress being made in reducing damaging strikes for commercial aircraft which primarily use Part 139-certificated airports. Management actions to mitigate the risk have been implemented at many airports since the 1990s; these efforts are likely responsible for the general decline in reported strikes with damage and a negative effect-on-flight from 2000–2013 in spite of continued increases in populations of many large bird species. However, much work remains to be done to reduce wildlife strikes. Management actions at airports should be prioritized based on the hazard level of species observed in the aircraft operating area.

To address strikes above 500 feet AGL, the general public and aviation community must first widen its view of wildlife management to minimize hazardous wildlife attractants within 5 miles of airports. Second, on-going research and mitigation efforts to further develop and incorporate avian radar and bird migration forecasting and to study avian sensory perception to enhance aircraft detection and avoidance by birds should be maintained. Third, Federal guidance on wildlife hazards at airports should continue to be reviewed, and where necessary revised, to incorporate new information about wildlife hazards and wildlife strike reporting trends. Finally, there continues to be a need for increased reporting of wildlife strikes with details provided on species identification, number of wildlife struck, time, phase of flight, height, distance from airport, and damage costs.

EXECUTIVE SUMMARY– PART 2: FAA ACTIVITIES FOR MITIGATING WILDLIFE STRIKES

In 2013, the FAA and USDA continued to make progress with their multifaceted approach for mitigating wildlife strikes. The FAA reported that 100 percent of Part 139 airports have completed a Wildlife Hazard Assessment (Assessment), are in the process of conducting an Assessment, or have taken a Federal grant to conduct an Assessment. Strike reporting continued to increase, especially with general aviation (GA) aircraft, which increased strike reporting by 11 percent between 2011 and 2012 and 4 percent between 2012 and 2013. Overall, GA strike reporting increased 51 percent between 2008 and 2013. The FAA implemented three performance metrics to monitor strike reporting trends and GA wildlife mitigation. The performance metrics include percentage of damaging strikes, strike reporting rates, and tracking of general aviation (GA) airports that conduct Assessments and site visits. We also issued a final Advisory Circular (AC) on strike reporting and draft ACs on Assessment methodology and requirements for federally obligated public airports to conduct Assessments. We have expanded outreach to increase GA strike reporting, continued a robust research program, and incorporated new technology to allow simplified and paperless strike reporting. The FAA also continued to provide Airport Improvement Program (AIP) funding to airports to conduct Assessments and develop Wildlife Hazard Management Plans (Plan). These efforts have led to increased strike reporting in both commercial and general aviation. While strike reporting has increased, damaging strikes have declined.

The FAA continued to distribute the latest “Report Wildlife Strikes” awareness poster throughout 2013 - 2014. Overall, 36,000 posters have been distributed to more than 4,000 Part 139 airports, GA airports, aviation flight schools and the aviation industry in the last four years. The distribution of strike awareness posters is one of several outreach activities to improve strike reporting and safety at airports.

The FAA continues work with industry to encourage all certificated airports to conduct Assessments, even if the certificated airport has not experienced one of the triggering events specified in Part 139.337. The FAA also encourages federally obligated GA

airports to conduct Assessments or Wildlife Hazard Site Visits to provide fundamental wildlife and habitat information for an effective, airport-specific, wildlife hazard mitigation program.

Our research efforts continue. The USDA APHIS WS National Wildlife Research Center (NWRC), through an interagency agreement with FAA, continues its efforts to improve wildlife management techniques and practices on and near airports. These efforts include:

- Alternative habitat management strategies to reduce attraction to airports of hazardous wildlife species,
- Techniques for restricting access of hazardous wildlife species to attractive features like storm water ponds,
- Technologies for harassing and deterring hazardous species,
- Evaluation of avian radar systems for detecting and tracking birds on or near airports,
- Aircraft-mounted lighting systems to enhance bird detection and avoidance of aircraft.

The FAA continues to evaluate the capability of commercially available, low-cost, portable radars to reliably detect and track birds on or near airports. The Center of Excellence for Airport Technology (CEAT) at the University of Illinois has served as the FAA's research partner for the performance assessments of bird radar. The initial avian radar systems have involved Accipiter Radar Technologies Inc. and were deployed at Seattle-Tacoma and Whidbey Island Naval Station in 2007, Chicago O'Hare in 2009, and John F. Kennedy and Dallas-Fort Worth in 2010.

Additional evaluations have continued through FAA's multi-year agreement with USDA who teamed up with the National Center of Atmospheric Research (NCAR) and Indiana State University to further evaluate the performance of bird radar systems. The effort brings together experts in wildlife biology, ornithology, radar engineering, and system integration from government, industry, and academia to evaluate the MERLIN Avian Radar System by DeTect, Inc., one of several radar systems used to detect birds at and near airports. The assessment effort is part of the FAA's overall investigation into the effectiveness of commercially available avian radar detection systems at U.S. civil airports when used in conjunction with other known wildlife management and control techniques. Though it is well established that radar can detect birds, there is little published information concerning the accuracy and detection capabilities related to range, altitude, target size, and effects of weather for avian radar systems.

In November, 2010, the FAA published a performance specification in the form of an Advisory Circular 150/5220-25, Airport Avian Radar Systems, which airports can use to competitively purchase bird radar systems. The guidelines provide the operational considerations of acquiring and using the technology to enhance wildlife hazard mitigation practices on civil airports. Under some circumstances, procurement of bird radar systems may be eligible for funding under the FAA's Airport Improvement Program. A new research effort began at the end of 2011 and continued through 2013

that examined the feasibility and practicality of pilots and air traffic controllers using bird radar data.

The FAA funded and assisted with the development of two new Airport Cooperative Research Program (ACRP) reports to aid airports with the mitigation of wildlife hazards. ACRP Synthesis 39 report *Airport Wildlife Population Management* (2013) and Synthesis 52 report *Habitat Management to deter Wildlife at Airports* (2014) are available from the Transportation Research Board (TRB) of the National Academies at <http://www.trb.org/Publications/Publications.aspx>. These reports provide further guidance to all airports, including GA airfields with the mitigation of wildlife hazards. In October 2011 and early 2012, 2,770 copies of ACRP Report 32, *Guidebook for Addressing Aircraft/ Wildlife Hazards at General Aviation Airports*, and ACRP Synthesis 23, *Bird Harassment, Repellent, and Deterrent Techniques for Use on and Near Airports* were distributed to all federally obligated National Plan of Integrated Airport System (NPIAS) general aviation airports. The reports, published in 2010 and 2011 respectively, provide practical guidance and specific techniques on how to address wildlife strikes at airports with a specific emphasis on the GA community.

In 2010 and continuing through 2012, the FAA, USDA, Airlines for America (formerly the Air Transport Association) and the Air Line Pilots Association developed review methodologies to better understand the wildlife strike/ aviation problem in concert with the Joint Implementation Measurement and Data Analysis Team (JIMDAT).

The Commercial Aviation Safety Team (CAST) determined that JIMDAT would track wildlife strikes and provide periodic monitoring reports to CAST concerning wildlife strikes. During a February 2013 CAST meeting, CAST fully approved JIMDAT “Option 2” Birdstrike monitoring proposal. This included reporting fatality risk values at appropriate intervals and trending egregious events to provide confidence.

Technological advances have helped ease and streamline the strike reporting process. The form used to report wildlife strikes, FAA Form 5200-7, Bird/Other Wildlife Strike Report, has been available online since April 2001. In addition, the FAA developed mobile application software that allows strike reporting from your smart phone. An extension to the mobile application software also placed a Quick Response (QR) Code for smart phones on the bottom of the 2011– 2014 “Report Wildlife Strikes” posters, which allows anyone to report a wildlife strike via the web or their personal data devices. As a result, electronic filings have dramatically increased every year after. Last year, 83 percent of the 11,315 strike reports were filed electronically.

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PART 1: WILDLIFE STRIKES TO CIVIL AIRCRAFT IN THE UNITED STATES, 1990–2013

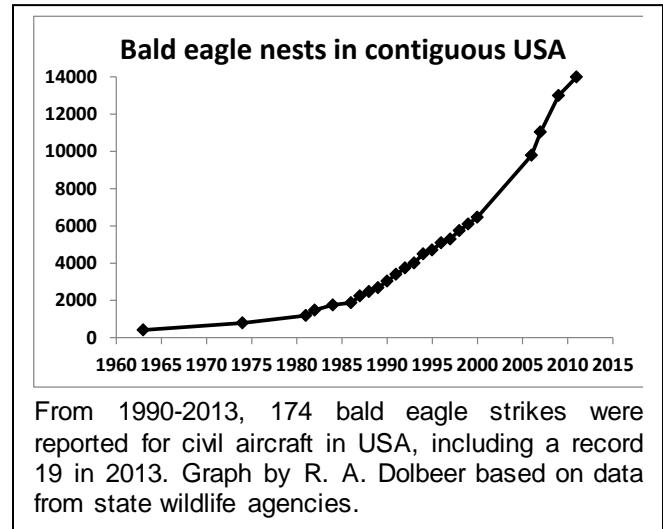


A Beechcraft A36 aircraft struck a flock of Canada geese during landing roll at night at a general aviation airport in Kentucky, September 2013. The multiple impacts of these 6- to 9-lb birds damaged the nose, propeller, alternator, fuselage, wing, landing gear, and tail. The aircraft was out of service 3 months and costs of repairs were at least \$90,000. Photo provide by aircraft owner.

INTRODUCTION

Bird strikes are a serious aviation safety issue as demonstrated in recent years by the emergency forced landing of an Airbus 320 with 159 passengers and crew in the Hudson River in January 2009 after Canada geese were ingested in both engines (National Transportation Safety Board 2010, Marra et al. 2009) and the 19-fatality crash of a Dornier 228-200 in Nepal in September 2012 after a black kite was struck on take-off (Thorpe 2012, Addendum 3). Globally, bird and other wildlife strikes killed more than 255 people and destroyed over 243 aircraft from 1988 – 2013 (Richardson and West 2000; Thorpe 2003; 2005; 2012, Dolbeer, unpublished data). Three factors that contribute to this increasing threat are:

1. Many populations of large bird and mammal species commonly involved in strikes have increased markedly in the last few decades and adapted to living in urban environments, including airports. For example, the resident (non-migratory) Canada goose population in the USA and Canada increased from about 0.5 million to 3.8 million from 1980 to 2013 (Dolbeer et al. 2014, U.S. Fish and Wildlife Service. 2013). During the same time period, the North American snow goose population increased from about 2.1 million to 6.6 million birds (U.S. Fish and Wildlife Service. 2013). Other large-bird species that have shown significant population increases from 1980 to 2012 include bald eagles (6.4 percent annual rate of increase), wild turkeys (9.5 percent), turkey vultures (2.7 percent), American white pelicans (7.9 percent), double-crested cormorants (6.1 percent), sandhill cranes (5.9 percent), great blue herons (1.2 percent), and ospreys (3.0 percent, Sauer et al. 2014). Dolbeer and Begier (2013) examined the estimated population trends and numbers for the 21 species of birds in North America with mean body masses ≥ 4 lbs and at least 10 strikes with civil aircraft from 1990-2012. Of these 21 species, 17 had shown population increases from 1990-2012 with a net gain of 17 million birds. Previous research had documented that 13 of the 14 bird species in North America with mean body masses ≥ 8 lbs showed significant population increases from 1970 to the early 1990s (Dolbeer and Eschenfelder 2003). The white-tailed deer population increased from a low of about 350,000 in 1900 to about 15 million in 1984 and to over 28 million by 2010 (McCabe and McCabe 1997, VerCauteren et al. 2011).



2. Concurrent with population increases of many large bird species, commercial air traffic in the USA increased from about 18 million movements in 1980 to a peak of 29.5 million movements in 2000. Since 2000, commercial air traffic has declined to 24.6 million movements in 2013 (Table 2). Passenger enplanements in the USA increased from about 310 million in 1980 to 705 million in 2000 and 732 million in 2013 (Federal Aviation Administration 2014a). Commercial air traffic in the USA is predicted to grow at a rate of about 1.5 percent per year from 25 million movements in 2013 to 32 million by 2030.
3. Commercial air carriers have replaced their older three or four-engine aircraft fleets with more efficient and quieter, two-engine aircraft. In 1965, about 87 percent of the 1,037 turbine-powered passenger aircraft in the USA had three or four engines. By 1990, the fleet had grown to 5,743 turbine-powered aircraft of which 32 percent had 3 or 4 engines. In 2008, only 8 percent of the 7,371 turbine-powered aircraft had three or four engines (U.S. Department of Transportation 2013). With the steady

advances in technology over the past several decades, today's two-engine aircraft are more powerful and reliable than yesterday's three and four-engine aircraft. However, in the event of a multiple ingestion event (e.g., the US Airways Flight 1549 incident on 15 January 2009), aircraft with two engines may have vulnerabilities not shared by their three or four engine-equipped counterparts. In addition, previous research has indicated that birds are less able to detect and avoid modern jet aircraft with quieter turbofan engines (Chapter 3, International Civil Aviation Organization 1993) than older aircraft with noisier (Chapter 2) engines (Burger 1983, Kelly et al. 1999).

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

The FAA has initiated several programs to address this important safety issue. Among the various programs is the collection and analysis of data from wildlife strikes. The FAA began collecting wildlife strike data in 1965. However, except for cursory examinations of the strike reports to determine general trends, the data were never submitted to rigorous analysis until the 1990s. In 1995, the FAA, through an interagency agreement with the USDA, Wildlife Services, (USDA/WS), initiated a project to obtain more objective estimates of the magnitude and nature of the national wildlife strike problem for civil aviation. This project involves having specialists from the USDA/WS: (1) edit all strike reports (FAA Form 5200-7, *Bird/Other Wildlife Strike*



A Cessna 210 struck an osprey at 100 feet AGL on final approach to a Florida airport in September 2013. Aircraft was out of service 3 days to repair the right wing. The osprey population increased 2.6 fold in North America from 1980 to 2012. Photo, aircraft operator.

Report) received by the FAA since 1990 to ensure consistent, error-free data; (2) enter all edited strike reports in the FAA National Wildlife Strike Database; (3) supplement FAA-reported strikes with additional, non-duplicated strike reports from other sources; (4) provide the FAA with an updated computer file each month containing all edited strike reports; and (5) assist the FAA with the production of annual and special reports summarizing the results of analyses of the data from the National Wildlife Strike Database. Such analyses are critical to determining the economic cost of wildlife strikes, the magnitude of safety issues, and most important, the nature of the problems (e.g., wildlife species involved, types of damage, height and phase of flight during which strikes occur, and seasonal patterns). The information obtained from these analyses provides the foundation for FAA national policies and guidance and for refinements in the development and implementation of integrated research and management efforts to reduce wildlife strikes. Data on the number of strikes causing damage to aircraft or other adverse effects (e.g., aborted take-off) also provide a benchmark for individual

airports to evaluate and improve their Wildlife Hazard Management Plans in the context of a Safety Management System (Dolbeer and Begier 2012).

The first annual report on wildlife strikes to civil aircraft in the USA was completed in November 1995 (Dolbeer et al. 1995). This is the 20th report in the series and covers the 24-year period, 1990–2013. Current and historic annual reports are accessible as PDF files at: http://www.faa.gov/airports/airport_safety/wildlife/

To supplement the statistical summary of data presented in tables and graphs, a sample of 29 significant wildlife strikes to civil aircraft in the USA during 2013 is presented in Appendix A. These recent strike examples demonstrate the widespread and diverse nature of the problem. A more extensive list of significant strike events, 1990–2013, is available at http://www.faa.gov/airports/airport_safety/wildlife/.

RESULTS

NUMBER OF REPORTED STRIKES AND STRIKES WITH DAMAGE

The number of strikes annually reported to the FAA has increased 6.1-fold from 1,851 in 1990 to a record 11,315 in 2013 (Table 1, Figure 1). For the 24-year period (1990–2013), 142,603 strikes were reported. Birds were involved in 97.0 percent of the reported strikes, terrestrial mammals in 2.2 percent, bats in 0.7 percent and reptiles in 0.1 percent (Table 1).

Although the number of reported strikes has steadily increased, it is important to note that the overall number of reported damaging strikes has actually declined since 2000 (Table 1, Figure 2). Whereas the number of reported strikes increased 81 percent from 6,008 in 2000 to 11,315 in 2013, the number of damaging strikes declined 21 percent from 764 to 601.

This decline in damaging strikes has occurred in the commercial aviation sector. While the number and rate (per 100,000 movements) of all strikes with commercial aircraft has increased 51 and 81 percent, respectively, from 2000 to 2013, the number and rate of damaging strikes has declined 37 and 24 percent, respectively (Table 2, Figure 3). The damaging strike rate for commercial aircraft in 2013 (0.98/100,000 movements) was the lowest recorded since 1996.



An Airbus 320 on final approach to an eastern U.S. airport in June 2013 flew through a flock of European starlings. Over 150 starling carcasses were removed from the runway and 30 impact points, including both engines, were identified on the aircraft. Aircraft was out of service for 2 days for inspection and repairs to wing. Photo, Ryan Stewart, USDA.

Overall since 2000, the decline in damaging strikes for commercial aircraft has occurred primarily in the airport environment (strikes occurring on departure or arrival at ≤ 500 feet above ground level [AGL]). Damaging strikes at >500 feet AGL have not shown a pattern of decline until 2013 when the number reported (91) was the lowest since 1999 (Figure 4). These declines in damaging strikes for commercial aviation since 2000 have occurred in spite of an increase in populations of hazardous wildlife species (Dolbeer and Eschenfelder 2003, Dolbeer and Begier 2013) and, as noted above a major increase in reported strikes. These data demonstrate progress in wildlife hazard management programs at airports certificated for passenger traffic under 14 CFR-Part 139 regulations (Dolbeer 2011).

As with commercial aircraft, there has been a steady increase in the strike rate for general aviation (GA) aircraft, from 0.69 in 2000 to 1.20 in 2013. However, in contrast to commercial aviation, the rate of damaging strikes with GA aircraft has not declined since 2000 but has fluctuated between 0.18 (in 2006) and 0.29 (in 2013, Table 3, Figure 3). There has not been a decline in damaging strikes in the airport environment (at ≤ 500 feet AGL) or at >500 feet AGL for GA aircraft (Figure 4).



A Cessna 414 struck a large bird (likely a turkey vulture) at 1,800 feet AGL on approach to a general aviation airport in Florida in July 2013. There was major damage to left wing and de-icing boot. Photo, J. Ingram.

METHODS OF REPORTING STRIKES

In 2013, 83 percent and 8 percent of the 11,315 strike reports were filed using the electronic and paper versions, respectively, of FAA Form 5200-7, *Bird/Other Wildlife Strike Report*. Since the online version of this form became available in April 2001, use of the electronic reporting system has climbed dramatically. The remaining 9 percent of strike reports filed in 2013 were obtained from various sources (Table 4).

SOURCE OF REPORTS

In 2013, airport operations personnel filed 63 percent of the strike reports (including “Carcass Found” reports), followed by pilots (24 percent), airlines operations personnel (8 percent), Air Traffic Control personnel (4 percent), and other (2 percent, Table 5). In 2013, about 85 percent of the reported strikes involved commercial aircraft; the remainder involved business, private, and government aircraft (Table 6).

The number of USA airports with strikes reported has increased steadily from 331 in 1990 to a record 649 in 2013 (Table 7, Figure 5). The 649 airports with strikes reported in 2013 were comprised of 379 airports certificated for passenger service under 14 CFR Part 139 and 270 general aviation airports. From 1990 - 2013, 123,489 strikes have

been reported from 1,821 USA airports. In addition, 3,098 strikes involving USA-registered civil aircraft were reported at 277 foreign airports in 105 countries, 1990 – 2013 (202 strikes at 85 foreign airports in 52 countries in 2013).

TIMING OF OCCURRENCE AND PHASE OF FLIGHT OF STRIKES

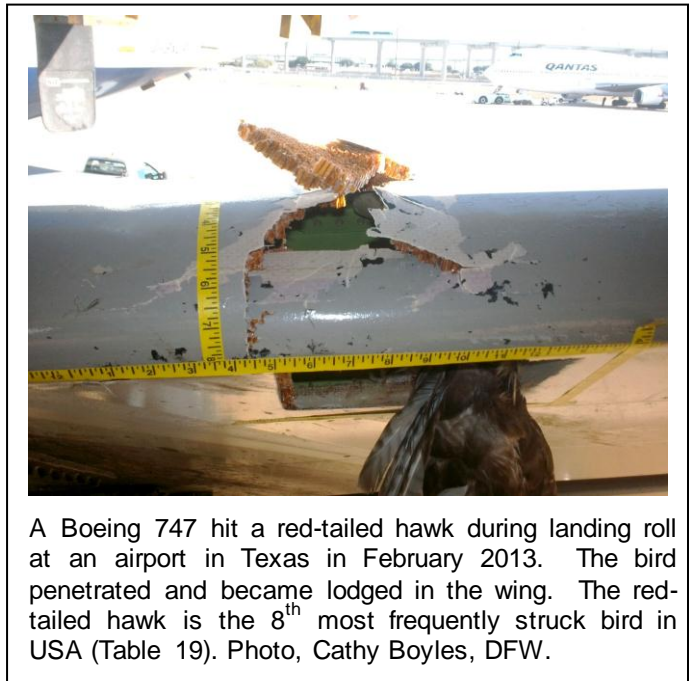
From 1990 – 2013, most bird strikes (52 percent) occurred between July and October (Figure 6) which is when birds are migrating and populations are at their annual peak following the nesting season. Sixty-two percent of bird strikes occurred during the day and 30% at night (Table 8). Almost twice as many strikes (61 percent of total) occurred during the landing (descent, approach, or landing roll) phase of flight compared to 35 percent during takeoff run and climb (Table 9).

Similar to the pattern shown with birds, most terrestrial mammal strikes occurred between July and November; with 30 percent of deer strikes concentrated in October–November (Figure 6). Most terrestrial mammal strikes (64 percent) occurred at night (Table 8). As with birds, almost twice as many strikes (64 percent of total) occurred during the landing (final approach or landing roll) phase of flight compared to 33 percent during takeoff run and climb (Table 9).

HEIGHT ABOVE GROUND LEVEL (AGL) OF STRIKES

Bird strikes with commercial aircraft- From 1990 – 2013, about 41 percent of bird strikes with commercial aircraft occurred when the aircraft was at 0 feet AGL, 71 percent occurred at 500 feet or less AGL, and 92 percent occurred at or below 3,500 feet AGL (Table 10). Less than 1 percent of bird strikes occurred above 9,500 feet AGL. Above 500 feet AGL, the number of reported strikes declined consistently by 34 percent for each 1,000-foot gain in height (Figure 7). The record height for a reported bird strike involving a commercial aircraft in USA was 31,300 feet AGL.

Strikes occurring above 500 feet AGL had a greater probability of causing damage to the aircraft compared to strikes at 500 feet or less. Although only 29 percent of the reported strikes were above 500 feet AGL, these strikes represented 43 percent of the damaging strikes (Table 10, Figure 8).



A Boeing 747 hit a red-tailed hawk during landing roll at an airport in Texas in February 2013. The bird penetrated and became lodged in the wing. The red-tailed hawk is the 8th most frequently struck bird in USA (Table 19). Photo, Cathy Boyles, DFW.

Bird strikes with general aviation (GA) aircraft- From 1990 – 2013, about 37 percent of the bird strikes with GA aircraft occurred when the aircraft was at 0 feet AGL, 74 percent occurred at 500 feet or less AGL, and 97 percent occurred at or below 3,500 feet AGL (Table 11). Less than 1 percent of bird strikes occurred above 6,500 feet AGL. Above 500 feet AGL, the number of reported strikes declined consistently by 43 percent for each 1,000-foot gain in height (Figure 7). The record height for a reported bird strike involving a GA aircraft in USA was 24,000 feet AGL.

Strikes occurring above 500 feet AGL had an even greater probability of causing damage to GA aircraft compared to strikes at 500 feet or less than was shown above for commercial aircraft. Although only 27 percent of the reported strikes were above 500 feet AGL, these strikes represented 49 percent of the damaging strikes (Table 11, Figure 8).

Terrestrial mammal strikes- As expected, terrestrial mammal strikes predominately occurred at 0 feet AGL; however, 9 percent of the reported strikes occurred when the aircraft was in the air immediately after lift-off or before touch down (e.g., when an aircraft struck a deer with the landing gear, Table 9).

AIRCRAFT COMPONENTS DAMAGED



An Airbus 320, on approach to an East Coast airport at 5,000 feet AGL at night in November 2013, hit several Canada geese. The #2 engine cowling was damaged. The aircraft landed safely but was out of service for 2 days. Repair costs were \$120,000. Photo WABC.

The aircraft components most commonly reported as struck by birds from 1990 – 2013 were the nose/radome, windshield, engine, wing/rotor, and fuselage (Table 12). Aircraft engines were the component most frequently reported as being damaged by bird strikes (30 percent of all damaged components). There were 15,086 strike events in which a total of 15,814 engines were reported as struck (14,383 events with one engine struck, 684 with two engines struck, 13 with three engines struck, and 6 with four engines struck). In 4,179 damaging bird-strike events involving engines, a total of 4,321 engines was damaged (4,040 events with one engine damaged, 137 with two engines damaged, 1 with three engines damaged, and 1 with four engines damaged).

Aircraft components most commonly reported as struck by terrestrial mammals were the landing gear, “other”, propeller, and wing/rotor. Aircraft components most commonly reported as damaged were the landing gear, wing/rotor, propeller, and “other” (Table 12).

REPORTED DAMAGE

For the 138,257 strike reports involving birds from 1990–2013, 12,457 (9 percent) indicated damage to the aircraft (Table 13). When classified by level of damage, 6,700 (5 percent) indicated the aircraft suffered minor damage; 3,186 (2 percent) indicated the aircraft suffered substantial damage; 2,535 (2 percent) reported an uncertain level of damage; and 36 reports (less than 1 percent) indicated the aircraft was destroyed as a result of the bird strike (Table 13).

For the 3,149 terrestrial mammal strikes reported, 1,028 (33 percent) indicated damage to the aircraft. When classified by level of damage; 529 (17 percent) indicated the aircraft suffered minor damage; 399 (13 percent) indicated the aircraft suffered substantial damage; 70 (2 percent) reported an uncertain level of damage; and 30 (1 percent) indicated the aircraft was destroyed as a result of the strike (Table 13). Not surprisingly, a much higher percentage of terrestrial mammal strikes (33 percent) resulted in aircraft damage than did bird strikes (9 percent). Deer (1,070 strikes, of which 902 caused damage; Table 17) were involved in 34 percent of the strikes and 88 percent of the damaging strikes involving terrestrial mammals.

Although the percentage of wildlife strikes (all species) with reported damage has averaged 9 percent for the 24-year period, this number has declined from 20 percent in 1990 to 5 percent in 2013 (Figure 9).



USDA Wildlife Services personnel are evaluating management tools, such as live-capture and relocation, to reduce the risk of aircraft collisions with short-eared owls at airports during winter. From 1990-2013, 408 short-eared owl strikes with civil aircraft were reported in USA (Table 17). December was the month with highest number of short-eared owl strikes. Photo, C. Loftis, Dec 2013.

REPORTED NEGATIVE EFFECT-ON-FLIGHT

A negative effect-on-flight was reported in 6 percent and 22 percent of the bird and terrestrial mammal strike reports, respectively, (Table 14). Precautionary/emergency landing after striking wildlife was the most commonly reported negative effect (4,916 incidents, 3 percent of strike reports). These precautionary landings included 180 incidents in which the pilot jettisoned fuel (47) or burned fuel in a circling pattern (49) to lighten aircraft weight or in which an overweight landing was made (84, Table 15, Figure 10). In the 47 reported incidents in which fuel was jettisoned, an average of 90,306 pounds (13,280 gallons) of fuel was dumped per incident (range 515 – 39,706 gallons).

Aborted takeoff after striking wildlife was the second most commonly reported negative effect (2,065 incidents, 1 percent of strike reports, Table 14). These negative incidents

included 866 aborted takeoffs in which the pilot initiated the abort at an aircraft speed of 80 knots (92 miles per hour) or greater (Table 16). In 144 incidents, the aircraft speed at the time of abort was 120 knots (138 miles per hour) or greater. For commercial aircraft, the number of high-speed aborted take-offs has declined from a high of 39 in 2000 to 19 in 2013 (Figure 11). For general aviation aircraft, there has not been a decline in high-speed aborted take-offs in recent years.

Similar to the trend shown for the percent of strikes causing damage, the percentage of wildlife strikes (all species) with a reported negative effect on flight has declined from a high of 13 percent in 1996 to 4 percent in 2013 (Figure 9).

WILDLIFE SPECIES INVOLVED IN STRIKES

Table 17 shows the number of reported strikes, strikes causing damage, strikes having a negative effect-on-flight, strikes involving >1 animal, the reported aircraft down time, and the reported costs by identified wildlife species, 1990 - 2013. This information can be useful in comparing the relative hazard level of bird and other wildlife species encountered during Wildlife Hazard Assessments at airports and in the development of priorities for Wildlife Hazard Management Plans (see also Dolbeer and Wright 2009 and DeVault et al, 2011).

Birds- Of the 138,257 reported bird strikes, 51,951 (38 percent) identified the bird to exact species and an additional 17,826 strikes (13 percent) identified the bird at least to species group (e.g., gull, hawk, duck). Species identification has improved from less than 20 percent in the early 1990s to 60 percent in 2013 (Figure 12). In all, 503 species of birds have been identified as struck by aircraft, and 232 of these species were reported as causing damage, 1990–2013.

Doves/pigeons (15 percent), gulls (14 percent), raptors (13 percent), shorebirds (8 percent), and waterfowl (6 percent) were the most frequently struck bird groups (Table 18). Doves/pigeons, gulls, and raptors each were involved in over 2 times more strikes than waterfowl (9,026-10,185 and 4,418, respectively). Waterfowl, however, were involved in 4.0 times more damaging strikes than doves/pigeons and 1.3-1.4 times more damaging strikes than gulls or raptors. Waterfowl comprised 29 percent of all damaging strikes in which the bird type was identified, 1990-2013. Doves/pigeons and gulls were



The recently opened Smithsonian DNA LAB (Laboratories of Analytical Biology) in Washington D.C. is used extensively by the Feather Lab to identify unknown bird strike samples using DNA techniques. Photo, Smithsonian Institution.

responsible for the greatest number of bird strikes (2,137 and 2,075, respectively) that involved multiple birds.

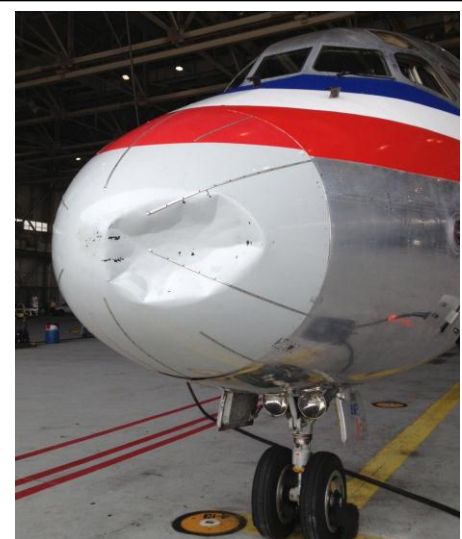
Table 19 lists the 30 species of birds identified most frequently as struck by civil aircraft for 1990-2013 and for 2013 only. Mourning doves, American kestrels, killdeer, European starlings, barn swallows, and horned larks were the 6 most frequently identified species struck by civil aircraft overall from 1990-2013 and in 2013 only. Canada geese, the 9th most frequently identified species struck overall from 1990-2013, declined to the 17th most frequently struck species in 2013 in spite of the fact that the overall population in North America has increased 2.2 fold, 1990-2013 (U.S. Fish and Wildlife Service 2013). This decline is likely related to the integrated management programs implemented in the past decade at many airports to dissuade feeding and nesting by Canada geese (Dolbeer et al. 2014).

For the 30 species of birds most frequently identified as struck by civil aircraft, 1990-2013, there was a strong correlation ($R^2 = 0.81$) between mean body mass and the likelihood of a strike causing damage to aircraft (Figure 13). For every 100 gram increase in body mass, there was a 1.28% increase in the likelihood of damage. Thus, body mass is a good predictor of relative hazard level among bird species, as noted previously by Dolbeer et al. (2000) and DeVault et al (2011).

Terrestrial mammals, bats, and reptiles—The most frequently struck terrestrial mammals were Carnivores – primarily coyotes and Artiodactyls – primarily deer (36 percent each, Tables 17, 18). Artiodactyls were responsible for 92 percent of the mammal strikes that resulted in damage and 76 percent of the mammal strikes that involved multiple animals. In all, 42, 19 and 15 identified species of terrestrial mammals, bats, and reptiles, respectively, were reported struck; 22, 2 and 2 identified species of these respective wildlife taxa caused damage to aircraft (Table 17).

HUMAN FATALITIES AND INJURIES DUE TO WILDLIFE STRIKES

For the 24-year period, reports were received of 12 wildlife strikes that resulted in 26 human fatalities (Table 20). Six of these strikes resulting in 8 fatalities involved unidentified species of birds. Red-tailed hawks (8 fatalities), American white pelicans (5), Canada geese (2), and white-tailed deer, brown-pelicans, and turkey vultures (1 each) were responsible for the other 18 fatalities. Reports were received of 217 strikes that resulted in 379 human injuries (Table 20). Waterfowl (ducks and geese; 52 strikes, 158 humans injured), vultures (32 strikes, 39 injuries), and deer (20 strikes, 29 injuries)



This MD-83 hit a California gull at 50 feet AGL departing a western airport in May 2013. The aircraft continued to an airport in Texas where the radome was replaced. Photo, Cathy Bowles, DFW.

caused 104 (60 percent) of the 174 strikes resulting in injuries in which the species or species group was identified.

AIRCRAFT DESTROYED DUE TO WILDLIFE STRIKES

For the 24-year period, reports were received of 66 aircraft destroyed or damaged beyond repair due to wildlife strikes (Tables 13, 21). The majority (42; 64 percent) were small ($\leq 2,250$ kg maximum takeoff mass) general aviation (GA) aircraft. Terrestrial mammals (primarily white-tailed deer) were responsible for 30 (45 percent) of the incidents. Canada geese (5 incidents) and vultures (4 incidents) were responsible for 43 percent of the 21 incidents involving birds in which the species or species group was identified.

Forty-three (65 percent) of the 66 wildlife strikes resulting in a destroyed aircraft occurred at GA airports, 15 occurred “en-route”, 6 occurred at USA airports certificated for passenger service under 14 CFR Part 139, and 2 occurred at a foreign airport certificated for passenger service (Table 21). GA airports, often located in rural areas with inadequate fencing to exclude large mammals, face unique challenges in mitigating wildlife risks to aviation (DeVault et al. 2008; Dolbeer et al. 2008).

ECONOMIC LOSSES DUE TO WILDLIFE STRIKES

Of the 21,654 reports from 1990 – 2013 that indicated the strike had an adverse effect on the aircraft and/or flight, 7,506 provided an estimate of the aircraft downtime (896,548 hours, mean = 119.4 hours/incident, Tables 17, 22, 23). Regarding monetary losses, 3,517 reports provided an estimate of direct aircraft repair costs (\$587.7 million, mean = \$167,100/incident), and 2,399 reports gave an estimate of other monetary losses (\$71.6 million, mean = \$29,852/incident)¹. Other monetary losses include such expenses as lost revenue, the cost of putting passengers in hotels, re-scheduling aircraft, and flight cancellations.

Analysis of 14 groups of strike reports from 3 Part 139 airports certificated for passenger service and 3 airlines for the years 1991-2004 indicated that 11 to 21 percent of all strikes were reported to the FAA (Cleary et al. 2005, Wright and Dolbeer 2005). An independent analysis of strike data for a certificated airport in Hawaii in the 1990s indicated a similar reporting rate (Linnell et al. 1999). Analyses of strike data from 2004-2008 indicated strike reporting at Part 139



A Bombardier Challenger 300 hit 4 or 5 soaring turkey vultures at 1800 feet AGL on climb from a Florida airport, December 2013. Pilot declared an emergency and landed safely at alternate airport. Repair costs for engine and tail were over \$800,000. Aircraft was out of service for 22 days. Photo courtesy of operator.

¹ Costs from years prior to 2013 are inflation-adjusted to 2013 U.S. dollars.

airports had improved to 39 percent (Dolbeer 2009). Strike reporting for general aviation (GA) aircraft was estimated at less than 5 percent (Dolbeer et al. 2008, Dolbeer 2009). In addition to the underreporting of strikes, only 35 percent of the 21,654 reports from 1990–2013 indicating an adverse effect provided estimates of aircraft downtime, 16 percent provided estimates of direct costs, and 11 percent provided estimates of other (indirect) costs (Tables 22, 23). Furthermore, some reports providing cost estimates were filed before aircraft damage and downtime had been fully assessed. As a result, the information on the number of strikes and associated costs compiled (summarized by species of wildlife struck in Table 17) is believed to significantly underestimate the magnitude of the problem.

Assuming (1) all 21,654 reported wildlife strikes that had an adverse effect on the aircraft and/or flight engendered similar amounts of downtime and/or monetary losses and (2) that these reports are all of the damaging strikes that occurred, then at a minimum, wildlife strikes annually cost the USA civil aviation industry, on average, 117,740 hours of aircraft downtime and \$187 million in monetary losses (\$152 million in direct costs and \$35 million in other costs), 1990–2013 (Table 23). For 2013 only, the minimum estimates would be 144,076 hours of downtime and \$103 million in direct and indirect costs.

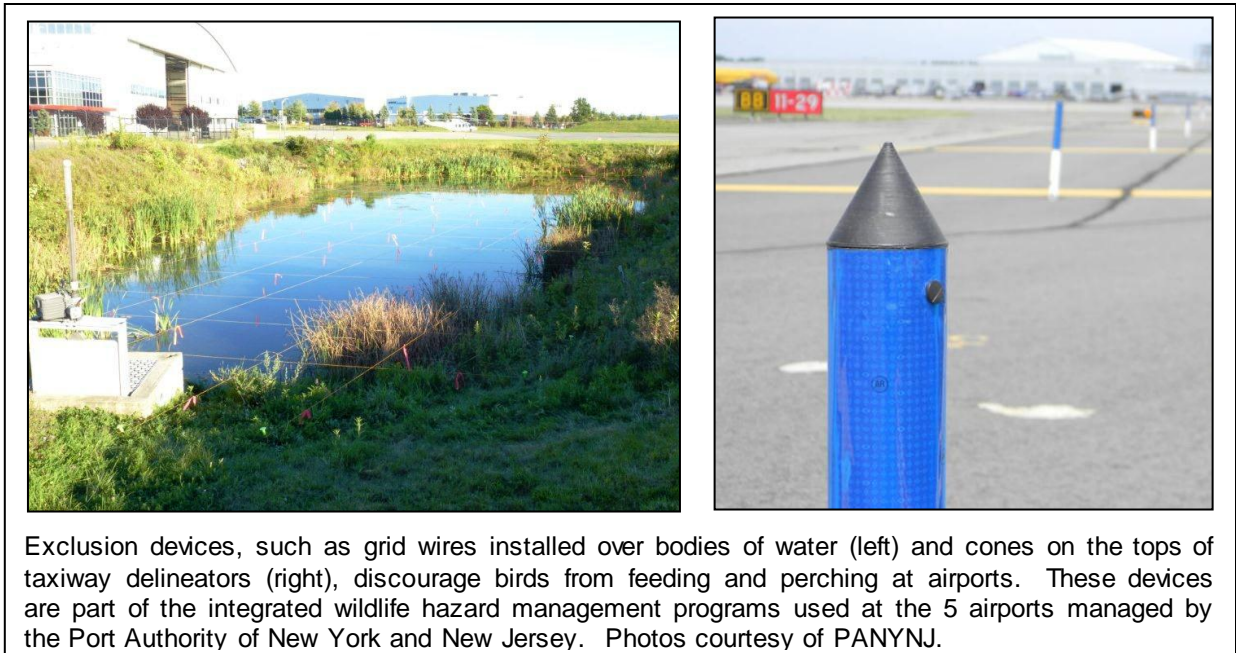
Further, if we assume that the 21,654 reported strikes indicating an adverse effect represent, on average, 20 percent of the total strikes that occurred with commercial and GA aircraft from 1990–2013, the maximum annual cost of wildlife strikes to the USA civil aviation industry is estimated to be 588,699 hours of aircraft downtime and \$937 million in direct and other monetary losses (Table 23).



At the 2013 meeting of Bird Strike Committee-USA in Milwaukee, demonstrations were provided on various wildlife management techniques (e.g., pyrotechnics, left; live traps, right) during a field trip to General Mitchell International Airport. BSC-USA (www.birdstrike.org) is an organization of government and aviation industry members. Photo, R. A. Dolbeer.

CONCLUSIONS

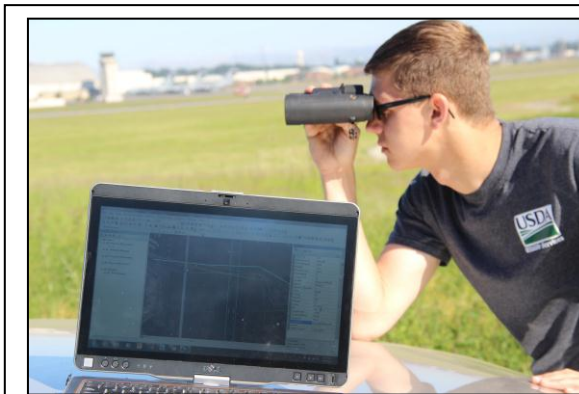
The analysis of 24 years of strike data reveals the magnitude and nature of wildlife strikes with civil aircraft in the USA, and documents that progress is being made in reducing damaging strikes. Although wildlife strikes continue to pose an economic and safety risk for civil aviation in the USA, management actions to mitigate these risks have been implemented at many airports, especially beginning in 2000 when the FAA's manual *Wildlife Hazard Management at Airports* was initially available to airports nationwide (Cleary and Dolbeer 1999, second edition 2005). These efforts (examples of which are documented in Wenning et al. 2004, DeFusco et al. 2005, Dolbeer 2006a, Human Wildlife Conflicts Journal 2009, Human-Wildlife Interactions Journal 2011, Dolbeer 2011, DeVault et al. 2013, Dolbeer et al. 2014) are likely responsible for the general decline in reported strikes with damage and negative effects-on-flight from 2000-2013 for commercial aircraft (Table 1, Figures 2, 3, 4, 9, 11) in spite of continued increases in populations of many large bird species. As another measure of the increase in wildlife management activities, USDA Wildlife Services biologists provided assistance at 837 civil and military airports nationwide in 2013 to mitigate wildlife risks to aviation compared to only 42 airports in 1991 and 193 in 1998 (Begier and Dolbeer 2014). However, much work remains to be done to reduce wildlife strikes.



To address the problem in the airport environment, airport managers first need to assess the wildlife hazards on their airports with the help of qualified airport biologists (FAA Advisory Circular 150/5200-36A). They then must take appropriate actions, under the guidance of professional biologists trained in wildlife damage management at airports, to minimize the risks posed by wildlife. Management actions should be prioritized based on the hazard level of species (Figure 13) observed in the aircraft operating area. The manual *Wildlife Hazard Management at Airports* (Cleary and Dolbeer 2005) provides guidance to airport personnel and biologists for conducting

wildlife hazard assessments and in developing and implementing wildlife hazard management plans. Adobe Acrobat® PDF versions of the manual are available online in English, Spanish, and French at <http://wildlife.faa.gov>.

Management efforts to reduce the risks of bird strikes have primarily focused on airports since various historical analyses of bird strike data for civil aviation have indicated the majority of strikes occur in this environment (during take-off and landing at ≤ 500 feet above ground level). However, the successful mitigation efforts at Part 139-certificated airports that have reduced damaging strikes for commercial aviation in recent years, which must be sustained, have done little to reduce strikes outside the airport such as occurred with US Airways Flight 1549 in 2009 (Dolbeer 2011).



As part of an airport's Wildlife Hazard Management Plan (WHMP), biologists and operations personnel should keep detailed records of wildlife observations, strikes, and management actions in a GIS format. These data can then be used in multiple ways to monitor and improve the WHMP. Photo USDA.

To mitigate the risk for strikes above 500 feet, the general public and aviation community must first widen its view of wildlife management to consider habitats and land uses within 5 miles of airports. Wetlands, dredge-spoil containment areas, municipal solid waste landfills, and wildlife refuges can attract hazardous wildlife. Such land uses, as discussed in FAA Advisory Circular 150/5200-33B, Hazardous Wildlife Attractants on or Near Airports, are often incompatible with aviation safety and should either be prohibited near airports or designed and operated in a manner that minimizes the attraction of hazardous wildlife. Second, on-going research and mitigation efforts to further develop and incorporate avian radar

and bird migration forecasting and to study avian sensory perception to enhance aircraft detection and avoidance by birds should be maintained (e.g., Nohara et al. 2011, Blackwell et al. 2012). Third, Federal guidance on wildlife hazards at airports should continue to be reviewed, and where necessary revised, to incorporate new information about wildlife hazards and wildlife strike reporting trends. Finally, there continues to be a need for increased and more detailed reporting of information about wildlife strikes, such as species identification and number of wildlife struck, time and height of strike, and damage costs (see Appendix B: Reporting a Strike and Identifying Species of Wildlife Struck).

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TABLES

Table 1. Number of reported wildlife strikes to civil aircraft by wildlife group, USA, 1990–2013 (see Figures 1 and 2).

Year	Birds	Bats	Terrestrial mammals ¹	Reptiles ¹	Total strikes	Strikes with damage
1990	1,795	4	52	0	1,851	372
1991	2,336	3	54	0	2,393	401
1992	2,499	2	73	1	2,575	368
1993	2,504	6	66	0	2,576	399
1994	2,554	2	82	1	2,639	462
1995	2,675	5	84	8	2,772	498
1996	2,852	1	91	3	2,947	505
1997	3,353	1	95	14	3,463	581
1998	3,689	3	111	7	3,810	587
1999	5,020	7	96	1	5,124	707
2000	5,866	16	123	3	6,008	764
2001	5,676	8	138	8	5,830	649
2002	6,099	19	119	15	6,252	674
2003	5,886	20	127	5	6,038	635
2004	6,409	27	129	6	6,571	628
2005	7,090	27	132	7	7,256	609
2006	7,053	49	141	10	7,253	598
2007	7,536	53	172	7	7,768	571
2008	7,417	46	183	5	7,651	529
2009	9,231	67	232	10	9,540	607
2010	9,557	113	246	11	9,927	599
2011	9,774	139	199	15	10,127	542
2012	10,530	165	203	19	10,917	611
2013	10,856	225	201	33	11,315	601
Total	138,257	1,008	3,149	189	142,603	13,497

¹ For terrestrial mammals and reptiles, species with body masses <1 kilogram (2.2 pounds) are excluded from database (Dolbeer et al. 2005).

Table 2. Number and rate of reported wildlife strikes and strikes with damage for commercial air carrier aircraft, USA, 1990–2013 (see Figure 3).

Year	No. of reported strikes ¹			Strikes/100,000 movements	
	All strikes	Strikes with damage	Aircraft movements (x 1 million) ²	All strikes	Strikes with damage
1990	1,245	178	23.26	5.35	0.77
1991	1,659	208	24.77	6.70	0.84
1992	1,709	197	25.17	6.79	0.78
1993	1,714	213	25.56	6.71	0.83
1994	1,802	250	26.58	6.78	0.94
1995	1,849	270	27.04	6.84	1.00
1996	1,911	264	27.57	6.93	0.96
1997	2,216	318	27.75	7.98	1.15
1998	2,294	300	28.00	8.19	1.07
1999	2,898	342	28.74	10.08	1.19
2000	3,331	380	29.53	11.28	1.29
2001	3,160	311	29.15	10.84	1.07
2002	3,402	318	27.61	12.32	1.15
2003	3,363	307	27.89	12.06	1.10
2004	3,761	288	28.87	13.03	1.00
2005	3,856	307	29.23	13.19	1.05
2006	3,969	313	28.29	14.03	1.11
2007	4,257	295	28.46	14.96	1.04
2008	4,026	281	27.96	14.40	1.01
2009	5,246	317	25.46	20.60	1.25
2010	5,073	303	25.12	20.20	1.21
2011	5,022	279	25.11	20.00	1.11
2012	5,222	300	24.89	20.98	1.21
2013	5,031	241	24.60	20.45	0.98
Total	78,016	6,539	646.61	12.07	1.01

¹ Strikes involving an unknown operator (32,091 of which 30,967 were “Carcass Found” reports--see Tables 5 and 6) were excluded from this analysis as were all strikes by USA-registered aircraft in foreign countries.

² Departures and arrivals by fiscal year (1 Oct-30 Sep) for air carrier, commuter, and air taxi service aircraft (Federal Aviation Administration 2014a).

Table 3. Number and rate of reported wildlife strikes and strikes with damage for general aviation aircraft, USA, 1990–2013 (see Figure 3).

Year	No. of reported strikes ¹		Aircraft movements (x 1 million) ²	Strikes/100,000 movements	
	All strikes	Strikes with damage		All strikes	Strikes with damage
1990	288	114	77.52	0.37	0.15
1991	356	117	83.51	0.43	0.14
1992	394	136	82.30	0.48	0.17
1993	406	141	80.38	0.51	0.18
1994	430	148	79.17	0.54	0.19
1995	439	153	77.19	0.57	0.20
1996	460	155	78.96	0.58	0.20
1997	450	165	79.94	0.56	0.21
1998	512	179	84.23	0.61	0.21
1999	558	184	85.33	0.65	0.22
2000	597	201	87.08	0.69	0.23
2001	616	160	85.90	0.72	0.19
2002	661	155	85.76	0.77	0.18
2003	607	175	83.43	0.73	0.21
2004	618	169	82.67	0.75	0.20
2005	595	152	81.13	0.73	0.19
2006	598	145	80.15	0.75	0.18
2007	576	163	80.22	0.72	0.20
2008	552	151	78.06	0.71	0.19
2009	715	156	73.63	0.97	0.21
2010	665	153	71.27	0.93	0.21
2011	718	146	69.93	1.03	0.21
2012	799	158	69.61	1.15	0.23
2013	831	203	69.39	1.20	0.29
Total	13,441	3,779	1906.77	0.70	0.20

¹ Strikes involving an unknown operator (32,091 of which 30,967 were “Carcass Found” reports--see Tables 5 and 6) were excluded from this analysis as were all strikes by USA-registered aircraft in foreign countries.

² Itinerant and local departures and arrivals by fiscal year (1 Oct-30 Sep) for general aviation aircraft (Federal Aviation Administration 2014a).

Table 4. Methods of reporting and source of information for reported wildlife strikes to civil aircraft, USA, 1990–2013, and 2013 only.

Source	1990–2013		2013 only	
	Total	% of total	Total	% of total
FAA Form 5200-7E (Electronic) ¹	62,863	44	9,376	83
FAA Form 5200-7 (Paper) ¹	42,436	30	918	8
Airline report	14,660	10	219	2
Multiple ²	10,856	8	500	4
Airport report	6,080	4	114	1
Other ³	1,795	1	52	<1
Daily Report (FAA)	1,116	1	128	1
Preliminary Aircraft Incident Report	885	1	1	<1
Engine manufacturer	823	1	0	0
Aircraft Incident Report	714	1	3	<1
Aviation Safety Reporting System	196	<1	0	0
National Transportation Safety Board	85	<1	3	<1
Aircraft Incident Preliminary Notice	68	<1	1	<1
Transport Canada	22	<1	0	0
U.S. Air Force (BASH)	4	<1	0	0
Total	142,603	100	11,315	100

¹ Bird/Other Wildlife Strike Report. Electronic filing of reports (<http://wildlife.faa.gov>) began in April 2001. In 2001, 0.4 percent of reports were filed electronically compared to 20, 28, 32, 38, 46, 62, 67, 71, 78, 84, 86, and 83 percent in 2002–2013, respectively. The paper version of FAA Form 5200-7 (mailed to FAA headquarters) declined from 57 percent of all reports in 2001 to 21 percent in 2006 and 8 percent in 2013.

² More than one type of report was filed for the same strike.

³ Various sources such as news media and Commercial Incident Reports.

Table 5. Person filing report of wildlife strike to civil aircraft, USA, 1990–2013, and 2013 only.

Person filing report	1990–2013		2013 only	
	Total	% of total	Total	% of total
Airport Operations	51,699	42	6,869	63
Carcass Found ¹	30,967	25	3,773	35
Other Reports ²	20,732	17	3,096	28
Pilot	28,208	23	2,561	24
Airline Operations	27,407	22	843	8
Tower	11,596	10	386	4
Other	3,060	3	219	2
Total known	121,970	100	10,878	100
Unknown	20,633		437	
Total	142,603		11,315	

¹ Airport personnel found fresh wildlife remains within 250 feet of a runway centerline that appeared to have been struck by aircraft, but no strike was observed or reported by pilot, tower, or airline.

² Airport personnel observed strike or reported a strike that had been communicated to them by pilot, tower, or airline.

Table 6. Number of reported wildlife strikes to civil aircraft by type of operator, USA, 1990–2013, and 2013 only.

Type of operator	1990–2013		2013 only	
	Total	% of total	Total	% of total
Commercial¹	94,696	86	6,421	85
General aviation	15,816	14	1,102	15
Business	12,388	11	926	12
Private	2,369	2	85	1
Government/ Police ²	1,059	1	91	1
Total known	110,512	100	7,523	100
Unknown³	32,091		3,792	
Total	142,603		11,315	

¹ Air carrier, commuter, and air taxi service with 3-letter Operator Code.

² U.S. Customs and Border Protection (USCBP) and U.S. Coast Guard (USCG) aircraft were respectively involved in 35 percent (371) and 27 percent (288) of the 1,059 Government/police strikes, 1990-2013. For 2013 only, 45 and 32 percent of the 91 Government/police strikes involved USCBP and USCG aircraft, respectively.

³ Ninety-seven percent (30,967) of the 32,091 strikes involving an unknown operator were “Carcass Found” reports, 1990-2013. For 2013 only, 99 percent (3,773) of the 3,792 strikes involving an unknown operator were “Carcass Found” reports (see Table 5).

Table 7. Number of Part 139-certificated airports¹ and general aviation (GA) airports with reported wildlife strikes and number of strikes reported, civil aircraft, 1990–2013 (see also Figure 5)².

Year	Part 139 airports		GA airports		All USA airports	
	Airports	Strikes	Airports	Strikes	Airports	Strikes
1990	234	1,505	97	166	331	1,671
1991	259	1,981	96	207	355	2,188
1992	255	2,177	107	231	362	2,408
1993	259	2,219	98	221	357	2,440
1994	266	2,221	108	248	374	2,469
1995	261	2,316	119	224	380	2,540
1996	259	2,496	109	204	368	2,700
1997	284	2,903	124	213	408	3,116
1998	292	3,219	143	272	435	3,491
1999	302	3,804	146	265	448	4,069
2000	313	4,462	149	286	462	4,748
2001	317	4,431	150	301	467	4,732
2002	306	4,782	154	315	460	5,097
2003	305	4,664	154	347	459	5,011
2004	309	5,216	174	324	483	5,540
2005	321	5,511	175	339	496	5,850
2006	322	5,924	144	281	466	6,205
2007	328	6,570	164	337	492	6,907
2008	330	6,638	164	313	494	6,951
2009	365	8,026	231	459	596	8,485
2010	377	8,305	212	472	589	8,777
2011	367	8,449	226	501	593	8,950
2012	386	8,909	253	581	639	9,490
2013	379	9,039	270	615	649	9,654
Total	531	115,767	1,290	7,722	1,821	123,489

¹ There were 543 airports in USA certificated for passenger service in 2013 under CFR Part 139 regulations (FAA 2014b).

² In addition, 3,098 strikes involving USA-registered aircraft were reported from 277 foreign airports in 105 countries. Furthermore, 2,583 strikes (2,576 bird and 7 bat strikes) were reported in which aircraft was en route when strike occurred (Table 9). An additional 13,433 strikes were reported in which either evidence of strike was discovered on aircraft after landing but phase of flight where strike occurred could not be determined or an airport was not named on reporting form.

Table 8. Reported time of occurrence of wildlife strikes with civil aircraft, USA, 1990–2013¹.

Time of day	Birds		Terrestrial mammals	
	24-year total	% of total known	24-year total	% of total known
Dawn	3,154	4	53	3
Day	54,958	62	440	25
Dusk	3,977	5	145	8
Night	26,153	30	1,127	64
Total known	88,242	100	1,765	100
Unknown²	50,015		1,384	
Total	138,257		3,149	

¹ In addition, 1,008 strikes with bats were reported from 1990–2013: time not reported (730), night (230), dusk (14), day (31), and dawn (3). Also, 189 strikes with reptiles were reported from 1990–2013: time not reported (159), day (23), night (5), dusk (1), and dawn (1).

² Of the 52,288 strike reports with “Unknown” time of day (all species), 30,965 (59 percent) were “Carcass Found” reports (Table 5).

Table 9. Reported phase of flight at time of occurrence of wildlife strikes with civil aircraft, USA, 1990–2013¹.

Phase of flight	Birds		Terrestrial mammals	
	24-year total	% of total known	24-year total	% of total known
Parked	70	<1	3	<1
Taxi	315	<1	41	2
Take-off Run	17,500	18	607	31
Climb	16,561	17	41 ²	2
En Route	2,576	3		0
Descent	3,022	3		0
Approach	38,662	41	140 ²	7
Landing Roll	16,116	17	1,097	57
Total known	94,822	100	1,929	100
Unknown³	43,435		1,220	
Total	138,257		3,149	

¹ In addition, 1,008 strikes with bats were reported from 1990–2013: phase of flight not reported (728), approach (192), landing roll (29), climb (29), take-off run (16), descent (7), and en route (7). Also, 189 strikes with reptiles were reported: phase of flight not reported (147), take-off run (15), landing roll (14), taxi (8), and approach (5; pilot had a missed approach because reptile was on the runway).

² A terrestrial mammal (e.g., deer, coyote) was hit after aircraft had lifted off runway or just before touchdown, or pilot had a missed approach because terrestrial mammal was on the runway.

³ Of the 45,530 strike reports with “Unknown” phase of flight (all species), 30,911 (68 percent) were “Carcass Found” reports (Table 5).

Table 10. Number of reported bird strikes to commercial civil aircraft¹ by height above ground level (AGL), USA, 1990–2013. See Figure 7 for graphic analysis of strike data from 501 to 18,500 feet AGL².

Height of strike (feet AGL)	All reported strikes			Strikes with damage		
	24-year total	% of total known	% cumulative total	24-year total	% of total known	% cumulative total
0	28,706	41	41	1,729	29	29
1-500	21,545	31	71	1,650	28	57
501-1500	7,580	11	82	868	15	72
1501-2500	3,899	6	88	521	9	80
2501-3500	2,888	4	92	336	6	86
3501-4500	1,718	2	94	195	3	89
4501-5500	1,245	2	96	159	3	92
5501-6500	843	1	97	114	2	94
6501-7500	567	<1	98	78	1	95
7501-8500	426	<1	99	72	1	97
8501-9500	226	<1	99	31	<1	97
9501-10500	297	<1	>99	53	<1	98
10501-11500	160	<1	>99	40	<1	99
>11500 ³	261	<1	100	83	1	100
Total known	70,361	100		5,929	100	
Unknown height	23,075			2,513		
Total	93,436			8,442		

¹ Air carrier, commuter, and air taxi service with 3-letter Operator Code (see Table 6); 962 strikes in which height of strike was reported but type of operator was unknown were excluded from analysis.

² A more detailed analysis of bird strikes by height AGL is provided by Dolbeer (2006b).

³ Twenty strikes involving commercial aircraft (8 with damage to aircraft) were reported at $\geq 20,000$ feet AGL; the highest was 31,300 feet.

Table 11. Number of reported bird strikes to general aviation aircraft¹ by height above ground level (AGL), USA, 1990–2013. See Figure 7 for graphic analysis of strike data from 501 to 12,500 feet AGL².

Height of strike (feet AGL)	All reported strikes			Strikes with damage		
	24-year total	% of total known	% cumulative total	24-year total	% of total known	% cumulative total
0	4,785	37	37	588	17	17
1-500	4,786	37	74	1,170	34	51
501-1500	1,892	15	88	880	26	77
1501-2500	768	6	94	388	11	88
2501-3500	346	3	97	183	5	94
3501-4500	180	1	98	90	3	96
4501-5500	89	<1	99	43	1	97
5501-6500	53	<1	>99	26	<1	98
6501-7500	45	<1	>99	18	<1	99
7501-8500	20	<1	>99	10	<1	99
8501-9500	15	<1	>99	9	<1	>99
9501-10500	14	<1	>99	9	<1	>99
10,501-11500	4	<1	>99	2	<1	>99
>11500 ³	20	<1	100	14	<1	100
Total known	13,017	100		3,430	100	
Unknown height	1,706			465		
Total	14,723			3,895		

¹ Private, Business, and Government/Police aircraft (see Table 6); 962 strikes in which height of strike was reported but type of operator was unknown were excluded from analysis.

² A more detailed analysis of bird strikes by height AGL is provided by Dolbeer (2006b).

³ Three strikes involving general aviation aircraft (all with damage to aircraft) were reported at $\geq 20,000$ feet AGL; the highest was 24,000 feet.

Table 12. Civil aircraft components reported as being struck and damaged by wildlife, USA, 1990–2013.

Aircraft component	Birds (24-year total)				Terrestrial mammals (24-year total)			
	Number struck	% of total	Number damaged	% of total	Number struck	% of total	Number damaged	% of total
Windshield	20,302	16	926	6	7	<1	15	<1
Engine(s) ¹	15,814	13	4,321	29	177	7	174	9
Nose	17,654	14	931	6	101	4	99	5
Wing/rotor	16,743	14	3,508	24	281	11	296	16
Radome	15,415	13	1,433	10	14	<1	15	<1
Fuselage	15,046	12	607	4	135	5	144	8
Other	11,381	9	1,156	8	327	13	276	15
Landing gear	5,526	4	483	3	1,083	43	451	24
Propeller	2,783	2	252	2	314	12	294	16
Tail	1,617	1	603	4	61	2	81	4
Light	850	<1	625	4	40	2	46	2
Total²	123,131	100	14,845	100	2,540	100	1,891	100

¹ For birds, 15,814 engines were reported as struck in 15,086 strike events involving engines (14,383 events with one engine struck, 684 with two engines struck, 13 with three engines struck, and 6 with four engines struck). A total of 4,321 engines was damaged in 4,179 bird-strike events with engine damage (4,040 events with one engine damaged, 137 with two engines damaged, 1 with three engines damaged, and 1 with four engines damaged). For terrestrial mammals, 177 engines were reported as struck in 167 strike events (157 events with one engine struck and 10 with two engines struck). A total of 174 engines was damaged in 155 terrestrial mammal strike events with engine damage (136 events with one engine damaged and 19 with two engines damaged). Some engines were damaged without being struck when the landing gear collapsed.

² In addition, bat strikes had 458 and 11 components reported as struck and damaged, respectively: radome/nose (163, 1), windshield (82, 2), engine (32, 3), propeller (1, 0), wing/rotor (74, 4), fuselage (45, 0), tail (8, 0), other (27, 0), landing gear (18, 0), light (4, 1). For reptile strikes, there were 38 and 6 components reported struck and damaged, respectively: windshield (1, 1), wing/rotor (2, 1), fuselage (1, 1), landing gear (31, 1); tail (1, 1), other (2, 1).

Table 13. Number of civil aircraft with reported damage resulting from wildlife strikes, USA, 1990–2013. See Tables 1, 2 and 3 and Figures 2, 3, 4 and 9 for trends in damaging strikes from 1990–2013.

Damage category ²	Reported strikes					
	Birds		Terrestrial mammals		Total (all species) ¹	
	24-year total	% of total ³	24-year total	% of total ³	24-year total	% of total ³
None	88,542	64	808	26	89,758	63
Unknown	37,258	27	1,313	42	39,348	28
Damage	12,457	9	1,028	33	13,497	9
Minor	6,700	5	529	17	7,236	5
Uncertain	2,535	2	70	2	2,606	2
Substantial	3,186	2	399	13	3,589	3
Destroyed	36	<1	30	1	66	<1
Total	138,257	100	3,149	100	142,603	100

¹ Included in totals are 1,008 and 189 strikes involving bats and reptiles, respectively. For bats, 378 reports indicated no damage, 620 failed to indicate if damage occurred, and 10 indicated damage (6 minor, 1 uncertain level, 3 substantial [caused by megabats at foreign airports]). For reptiles, 30 reports indicated no damage, 157 failed to indicate if damage occurred, and 2 indicated damage (1 minor, 1 substantial).

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

³ The percentage of strikes causing damage is calculated using the total strikes reported as the divisor, including the 39,348 reports that did not indicate if damage occurred or not (Unknown). "Carcass found" reports (see Table 5) comprised 30,964 (79 percent) of these 39,348 reports. If the Unknown reports are excluded from the calculations, then 12, 56, and 13 percent of the strikes caused damage for birds, terrestrial mammals, and all species, respectively.

Table 14. Reported effect-on-flight of wildlife strikes to civil aircraft, USA, 1990–2013.

Effect-on-flight ²	Reported strikes					
	Birds		Terrestrial mammals		Total ¹	
	24-year total	% of total ³	24-year total	% of total ³	24-year total	% of total ³
None	74,472	54	753	24	75,587	53
Unknown	54,915	40	1,712	54	57,445	40
Negative effect	8,870	6	684	22	9,571	7
Precautionary landing	4,807	3	102	3	4,916	3
Aborted takeoff	1,847	1	218	7	2,065 ⁴	1
Engine shutdown	391	<1	31	1	422	<1
Other	1,825	1	333	11	2,168	2
Total	138,257	100	3,149	100	142,603	100

¹ Included in totals are 1,008 and 189 strikes involving bats and reptiles, respectively. For bats, 329 reports indicated no effect-on-flight, 671 failed to indicate if an effect-on-flight occurred, and 8 indicated a negative effect (6 precautionary landings, 2 “Other”). For reptiles, 33 reports indicated no effect-on-flight, 147 failed to indicate if an effect-on-flight occurred, and 9 indicated a negative effect (1 precautionary landing, 8 “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 take-off on departure runway after initiating takeoff run (aircraft may have become airborne but pilot landed on departing runway without doing a “go around”); Precautionary landing (includes “declared emergency” landings) = pilot completed take-off but returned to land at departure airport or landed at an “other-than-destination” airport after strike; Engine shut down = pilot shut down engine or engine stopped running because of strike; Other = miscellaneous effects, such as reduced speed because of shattered windshield, flight delays, or crash landing; Unknown = report did not give sufficient information to determine an effect-on-flight (Dolbeer et al. 2000).

³ The percentage of strikes causing negative effect-on-flight is calculated using the total strikes reported as the divisor, including the 57,445 reports that did not indicate if a negative effect occurred or not (Unknown). “Carcass found” reports (see Table 5) comprised 30,964 (54 percent) of these 57,445 reports. If the Unknown reports are excluded from the calculations, then 11, 48, and 11 percent of the strikes caused a negative effect-on-flight for birds, terrestrial mammals, and all species, respectively.

⁴ In 6 incidents, the effect-on-flight was classified as “Engine shutdown” but the pilot also aborted the take-off.

Table 15. Number of reported incidents where pilot made a precautionary or emergency landing after striking birds during departure in which fuel was jettisoned or burned (circling pattern) to lighten aircraft weight or in which an overweight (greater than maximum landing weight) landing was made (no fuel jettison or burn), USA civil aircraft, 1990–2013. See Figure 10 for trend in incidents, 1990–2013.

Action taken after bird strike on departure	Number of incidents	Comments and number of incidents by aircraft model
Fuel jettison	47	A mean of 90,306 lbs (13,280 gallons) of fuel jettisoned per incident (range 3,500 – 270,000 lbs; 515 - 39,706 gallons). Aircraft: B-747 (18), B-767 (7), B-727 (6), DC-10/MD-11 (8), B-777 (3), Learjet 31/35 (2), L-1011 (1) DA-2000 (1), unknown (1).
Fuel burn	49	Aircraft: CL-RJ 100/700/900 (7), EMB-120/145/170/190 (8), A-319/320/321 (5), B-737 (4); MD-80/88 (3); B-747, DHC8-Dash 8, and PA-28 (2 each); and 16 other aircraft types with 1 each.
Overweight landing	84	Aircraft: B-737 (23), A-320/330 (16), B-757 (14), MD-80/82 (10), B-767 (8), EMB-145/170 (3), A-300, MD-11, and C-500/600 (2 each), and CL-RJ 900, CRJ-400, DA-50 Falcon, and Dornier 328 (1 each).
Total	180	A mean of 7.5 (range 0 – 16) incidents (fuel jettison, fuel burn, or overweight landing) per year, 1990 – 2013.

Table 16. Aircraft speed (nautical miles/hour [knots])¹ at time pilot aborted takeoff after striking or observing a bird or other wildlife species on runway, civil aircraft, USA, 1990–2013. See Figure 11 for trend in aborted take-offs at ≥ 80 knots caused by birds or other wildlife, 1990–2013.

Aircraft speed (knots)	Commercial aircraft ²		General aviation aircraft ³		All aircraft ⁴	
	24-year total	% of total known	24-year total	% of total known	24-year total	% of total known
1-39	15	2	25	5	41	3
40-79	131	17	219	46	353	28
80-119	518	66	200	42	722	57
≥ 120	116	15	27	6	144	11
Total known	780	100	471	100	1260	100
Unknown	521		271		811	
Total	1,301		742		2,071⁵	

¹ A speed of 100 knots equals 185 kilometers/hour (115 miles/hour).

² Air carrier, commuter, and air taxi service with 3-letter identifying code (see Table 6).

³ Business, Private, or Government aircraft (see Table 6).

⁴ Included in totals are 28 aborted takeoffs in which type of operator was unknown. For these 28 events, the speed was unreported (19), 1-39 knots (1), 40-79 knots (3), 80-119 knots (4), and ≥ 120 knots (1).

⁵ Includes 6 incidents in which effect-on-flight was classified as “Engine shutdown” (Table 14) but pilot also aborted take-off.

Table 17. Total reported strikes, strikes causing damage, strikes having a negative effect-on-flight (EOF), strikes involving >1 animal, aircraft downtime, and costs by identified wildlife species for civil aircraft, USA, 1990–2013 (page 1 of 21).

Wildlife group or species	24-year totals (1990–2013)					
	Number of reported strikes				Reported economic losses ¹	
	Total	With damage	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
Birds						
Loons	37	23	17	0	3,271	3,039,679
Loons	2	1	1			
Common loon	29	18	12		2,861	3,020,678
Red-throated loon	5	3	4		218	17,683
Pacific loon	1	1			192	1,318
Grebes	86	18	10	10	1,650	3,029,746
Grebes	14	3	1	1	1,476	522,850
Eared grebe	9	1		1	10	144,633
Western grebe	21	9	6	6	90	2,226,181
Pied-billed grebe	28	1	1			
Horned grebe	9	3	1	1	74	136,082
Red-necked grebe	3	1	1	1		
Clark's grebe	1					
Great crested grebe	1					
Albatrosses, shearwaters	73	8	6	3	197	80,176
Laysan albatross	36	7	5	1	197	80,176
Black-footed albatross	5	1				
Bonin petrel	9			2		
Wedge-tailed shearwater	10		1			
Townsend's shearwater	11					
Fork-tailed storm-petrel	1					
Band-rumped storm-petrel	1					
Tropicbirds	20	11	10		204	108,519
Tropicbirds	10	7	5		148	61,092
White-tailed tropicbird	7	3	4		56	39,743
Red-tailed tropicbird	3	1	1			7,684
Pelicans	82	41	34	14	4,857	10,561,729
Pelicans	4	2			80	
Australian pelican	1	1	1			
Brown pelican	63	27	22	8	497	462,548
American white pelican	14	11	11	6	4,280	10,099,181
Red-footed booby	1					
Cormorants	116	41	28	21	1,980	4,018,959
Cormorants	2					
Great cormorant	2	1		2		

Wildlife Strikes to Civil Aircraft in the United States, 1990–2013

Table 17. Continued (Page 2 of 21)

Wildlife group or species	24-year totals (1990–2013)					
	Number of reported strikes				Reported economic losses ¹	
	Total	With damage	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
Double-crstd cormorant	110	39	27	19	1,956	4,018,959
Pelagic cormorant	1					
Brandt's cormorant	1	1	1		24	
Anhinga	28	14	10	4	239	767,251
Frigatebirds	17	7	4		41	29,707
Frigatebirds	6	3	2		20	16,236
Great frigatebird	8	2	1		3	7,471
Magnificent frigatebird	3	2	1		18	6,000
Herons, bitterns	559	95	73	24	4,555	6,824,063
Herons	52	13	10	4	99	4,250
Gray heron	1	1	1			
Great blue heron	326	69	54	8	3,743	6,425,605
Blk-crowned night-heron	60	5	3	3	49	320,568
Little blue heron	7					
Green heron	13			1		
Y-crowned night-heron	18	4	2	2	18	19,395
Tricolored heron	2					
American bittern	7	3	2		646	54,245
Yellow bittern	72		1	6		
Least bittern	1					
Egrets	722	76	104	158	4,113	7,053,666
Egrets	324	32	50	85	3,611	4,501,202
Cattle egret	290	27	43	62	239	76,740
Great egret	77	13	8	10	164	2,429,224
Intermediate egret	1					
Snowy egret	30	4	3	1	99	46,500
Storks	16	5	2	3	24	22,224
White stork	1	1				
Wood stork	15	4	2	3	24	22,224
Ibises/spoonbills	37	12	11	9	148	59,782
Ibises	6	1	1	1		
Glossy ibis	2	1	1	1		2,053
White ibis	14	3	4	2	132	57,729
White-faced ibis	13	7	4	5	15	
Roseate spoonbill	2		1		1	
Waterfowl	4,418	1,849	943	1,554	178,882	216,768,401
Ducks, geese, swans	140	68	32	56	823	1,386,261
Ducks	784	269	128	254	9,800	6,260,656

Wildlife Strikes to Civil Aircraft in the United States, 1990–2013

Table 17. Continued (Page 3 of 21)

Wildlife group or species	24-year totals (1990–2013)					
	Number of reported strikes				Reported economic losses ¹	
	Total	With damage	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
American wigeon	57	25	9	19	5,059	1,943,240
Northern pintail	129	62	36	60	1,947	2,451,598
Green-winged teal	52	14	7	17	774	888,374
Blue-winged teal	30	14	6	11	284	1,034,873
Eurasian wigeon	1			1		
Mallard	749	170	91	169	11,630	16,257,946
Common eider	3	2	1	1		
Ring-necked duck	21	7	4	7	1,116	90,443
Greater scaup	11	3	3	5		
Wood duck	45	14	6	8	468	120,232
Muscovy duck	1	1			120	592,454
Common goldeneye	5	2	1			2,405
Red-breasted merganser	4	1		1	2	
Hooded merganser	8	3		1	54	253,851
Common merganser	3	2	2	1	120	3,712
Northern shoveler	59	24	8	20	2,234	2,190,055
Gadwall	53	20	10	15	670	8,386,600
Canvasback	21	11	4	8	603	2,584,009
American black duck	46	5	2	13	2,400	72,153
Mottled duck	24	4	4	5	25	
Lesser scaup	41	18	11	12	1,479	259,285
Ruddy duck	48	12	4	8	164	98,510
Redhead	4	2		2	17	54,114
Bufflehead	12	1	2	1	40	5,416
Long-tailed duck	4	3	3	1	3	1,222
Philippine duck	1	1	1	1	96	11,675,885
B-bellied whistling-duck	3	1	1	1	48	
Cinnamon teal	4	1		1	20	6,653
White-winged scoter	1	1	1	1	1,400	503,681
Hawaiian duck	12			3		
Harlequin duck	1					
Barrow's goldeneye	1					
Surf scoter	1					
Geese	351	210	93	125	28,002	3,266,868
Snow goose	113	88	45	65	13,200	31,029,815
Canada goose	1,470	732	407	617	94,627	118,008,876
Brant	30	10	3	7	108	59,087
Gr. white-fronted goose	43	27	9	24	892	5,525,841

Wildlife Strikes to Civil Aircraft in the United States, 1990–2013

Table 17. Continued (Page 4 of 21)

Wildlife group or species	24-year totals (1990–2013)					
	Number of reported strikes				Reported economic losses ¹	
	Total	With damage	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
Emperor goose	2	1				10,056
Cackling goose	6	4		2	101	133,181
Swans	2	1				
Mute swan	8	2	1	2		
Tundra swan	12	11	6	8	484	470,127
Trumpeter swan	2	2	2	1	72	1,140,922
Hawks, eagles, vultures	5,038	1,250	818	173	116,561	92,882,179
Hawks, eagles, vultures	30	17	7	1	2,559	23,461
New World Vultures	298	174	88	27	25,777	11,882,477
Black vulture	109	70	43	10	11,291	4,918,218
Turkey vulture	537	277	183	30	34,859	11,506,284
Osprey	264	58	37	4	2,672	425,210
White-tailed kite	27	4	2		46	6,013,185
Black kite	3	2	1			
Mississippi kite	2					
Swallow-tailed kite	4		1		1	36
Eagles	7	3	2	1		
Bald eagle	174	73	50	13	7,977	24,468,315
White-bellied sea-eagle	1	1	1			
Golden eagle	17	3	4	1	3,700	943,988
Hawks	1,235	246	168	33	11,873	5,379,422
Northern goshawk	2					
Red-tailed hawk	1,874	282	204	44	13,110	16,573,990
Rough-legged hawk	77	7	3		6	43,488
Red-shouldered hawk	40	2	4		42	1,519
Swainson's hawk	96	14	10	2	1,035	444,757
Sharp-shinned hawk	22	1			1,000	379,488
Cooper's hawk	62	2	3	1	5	
Ferruginous hawk	21	3	1		26	3,651,019
Broad-winged hawk	17	5	2	2	315	5,411
Harris's hawk	2					
Hawaiian hawk	1		1		2	
White-tailed hawk	2					
Eurasian buzzard	2	1			24	
Northern harrier	108	2	2	3	1	282,042
Old world vultures	3	2		1		
Lappet-faced vulture	1	1	1		240	5,939,869

Wildlife Strikes to Civil Aircraft in the United States, 1990–2013

Table 17. Continued (Page 5 of 21)

Wildlife group or species	24-year totals (1990–2013)					
	Number of reported strikes				Reported economic losses ¹	
	Total	With damage	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
Falcons, caracaras	3,988	50	87	170	1,731	3,151,361
Falcons	46	3	4	2	82	55,118
Peregrine falcon	247	18	13	11	198	658,973
Gyr falcon	2					
Merlin	65	1	3	3	23	514,089
Crested caracara	10	2	1		41	
Prairie falcon	20	1	1	2		5,953
American kestrel	3,593	24	64	152	1,387	1,917,228
Eurasian kestrel	5	1	1			
Gallinaceous birds	245	63	50	50	2,744	1,182,395
Grouse	5	2		3		
Greater sage-grouse	34	12	6	13	556	494,188
Sharp-tailed grouse	5	1	1		24	783
Ruffed grouse	1					
Spruce grouse	1					
Ptarmigans	3	1	1	2	18	70,435
Willow ptarmigan	6	3	1	4	207	134,052
Rock ptarmigan	1	1				
Quails	9		3	2		
Northern bobwhite	9	2	3	1	73	1,127
Scaled quail	3					
Ring-necked pheasant	77	17	13	5	883	107,750
Red-legged partridge	1					
Gray partridge	14	3	3	4	28	209
Chukar	3		1	1		
Gray francolin	3					
Black francolin	4					
Helmeted guineafowl	1	1		1		
Wild turkey	65	20	18	14	955	373,851
Cranes	119	48	30	36	2,411	297,776
Sandhill crane	118	47	30	36	2,363	238,857
Whooping crane	1	1			48	58,919
Rails, gallinules	228	48	26	12	4,104	7,480,256
Rails	5	1	1	1		
Sora	25	1	1	1	68	19,501
Common moorhen	5	1	1		24	1,255
American coot	173	44	22	10	3,937	7,429,689
Eurasian coot	1					

Wildlife Strikes to Civil Aircraft in the United States, 1990–2013

Table 17. Continued (Page 6 of 21)

Wildlife group or species	24-year totals (1990–2013)					
	Number of reported strikes				Reported economic losses ¹	
	Total	With damage	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
Purple gallinule	5	1	1		72	29,811
Virginia rail	8				3	
Clapper rail	6					
Shorebirds	5,691	126	154	858	3,189	6,236,355
Shorebirds	21			9		
American oystercatcher	22			2		
Plovers, lapwings	1			1		
Plovers	53	3	4	9	24	
European golden-plover	6			1		
American golden-plover	129	5	5	36	82	111,171
Black-bellied plover	111	7	5	20	27	198,486
Snowy plover	2			1	1	
Killdeer	3,369	42	62	342	797	3,990,619
Pacific golden-plover	805	8	12	112	208	326,756
Semipalmated plover	65			19		
Piping plover	1	1		1	2	216
Wilson's plover	3					
Northern lapwing	1	1	1	1	25	
Southern lapwing	1	1	1			10,413
Sandpipers, allies	245	14	25	84	179	202,621
Upland sandpiper	177	7	6	17	16	2,539
Spotted sandpiper	20	2	1	3		
Willet	6			2		
Common snipe	6			1		
American woodcock	67	2	2	4	20	11,573
Dunlin	60	4	3	19	507	253,608
Baird's sandpiper	22			2		
Western sandpiper	87	4	5	59	100	143,184
Pectoral sandpiper	22	2	1	6		351
Sanderling	23	1	3	9	6	
Buff-breasted sandpiper	30	1		8		
Ruddy turnstone	15			1		
Least sandpiper	94	1	5	29	8	
Semipalmated sandpiper	53		1	24	1	
Lesser yellowlegs	11	2		3		
Short-billed dowitcher	9	3		2	6	10,267
Hudsonian godwit	5	1	1	2	96	33,982
Solitary sandpiper	3			1		

Wildlife Strikes to Civil Aircraft in the United States, 1990–2013

Table 17. Continued (Page 7 of 21)

Wildlife group or species	24-year totals (1990–2013)					
	Number of reported strikes				Reported economic losses ¹	
	Total	With damage	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
Greater yellowlegs	4	1			48	8,890
Long-billed dowitcher	9			4	1	
Red knot	4		1			
White-rumped sandpiper	7			1		
Black turnstone	1					
Marbled godwit	2	1	1	1	48	168,751
Wilson's snipe	64	4	3	4	27	17,490
Rock sandpiper	1			1		
Eurasian curlew	1					
Whimbrel	16	2	1	3	360	52,707
Long-billed curlew	6	1	1	1	504	680,000
Red-necked phalarope	7	2	1	3	60	
Wilson's phalarope	8	2	3	4	36	12,731
Red phalarope	1					
American avocet	5	1		3		
Black-necked stilt	9			3		
Dble-striped thick-knee	1					
Gulls, jaegers	9,656	1,373	1,134	2,075	59,078	53,464,710
Parasitic jaeger	2					
Long-tailed jaeger	2					
Gulls	6,265	1,064	857	1,569	42,935	27,949,648
Herring gull	1,065	104	97	113	2,161	3,221,626
Mew gull	61	6	4	9	28	101,296
Ring-billed gull	1,296	107	92	230	6,561	4,429,462
Glaucous-winged gull	98	22	14	15	301	1,763,671
Great black-backed gull	98	11	7	8	123	434,817
Franklin's gull	95	5	10	35	20	176,427
Laughing gull	364	18	22	50	731	711,528
Bonaparte's gull	35	2	3	10		91,566
L. black-backed gull	6	2	1	1		
Western gull	107	11	7	11	203	1,971,421
California gull	133	17	15	17	5,058	693,554
Heermann's gull	1			1		
Black-headed gull	5					
Thayer's gull	3					
Yellow-legged gull	3	3	3	3	456	11,603,454
Glaucous gull	17	1	2	3	501	316,240

Wildlife Strikes to Civil Aircraft in the United States, 1990–2013

Table 17. Continued (Page 8 of 21)

Wildlife group or species	24-year totals (1990–2013)					
	Number of reported strikes				Reported economic losses ¹	
	Total	With damage	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
Terns, kittiwakes	162	5	3	31	6	77,059
Terns	43	2		15		
Little tern	2			1		
Caspian tern	20			1		
Common tern	18	1		3		77,059
Sandwich tern	1					
Gull-billed tern	4					
Black tern	2				2	
Fairy tern	3					
White tern	4		1	1		
Arctic tern	4	1		2		
Roseate tern	1					
Forster's tern	11		1	2	4	
Least tern	20			2		
Black noddy	3			2		
Brown noddy	8		1	1		
Royal tern	3					
Sooty tern	3					
Black-legged kittiwake	2					
Red-legged kittiwake	1					
Black skimmer	9	1		1		
Puffins	1		1		1	100
Pigeons, doves	10,185	461	566	2,137	26,092	20,811,339
Pigeons, doves	22	2	3	12	36	660
Pigeons	13	1	1	5	6	
Common wood-pigeon	4			1		
Band-tailed pigeon	13	5		3	179	188,858
Rock pigeon	2,514	237	240	831	14,371	11,499,992
Doves	964	44	79	223	627	631,132
Eurasian collared dove	6					
Mourning dove	6,124	161	231	1,024	10,577	8,139,882
Spotted dove	181	4	6	10	133	347,679
Zebra dove	274	3	6	26	32	1,082
Inca dove	11					
Island turtle-dove	4					
White-winged dove	47	3		2	102	2,054
Common ground-dove	6					
Zenaida dove	1	1			29	

Wildlife Strikes to Civil Aircraft in the United States, 1990–2013

Table 17. Continued (Page 9 of 21)

Wildlife group or species	24-year totals (1990–2013)					
	Number of reported strikes				Reported economic losses ¹	
	Total	With damage	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
Ruddy ground-dove	1					
Parrots	21			2		
Parrots	3			1		
Budgerigar	13					
Monk parakeet	4			1		
Nanday parakeet	1					
Cuckoos, roadrunners	33	6	1	5	37	127,563
Cuckoos	4	2		1	12	76,495
Yellow-billed cuckoo	24	4	1	4	25	51,068
Common cuckoo	1					
Black-billed cuckoo	3					
Greater roadrunner	1					
Owls	2,153	120	76	22	2,322	8,067,306
Owls	294	30	19	4	963	489,302
Barn owl	959	36	24	12	344	2,985,755
Snowy owl	122	12	9		354	454,418
Little owl	1					
Short-eared owl	408	9	12	3	83	1,410,570
Long-eared owl	15	3	1		24	51,336
Northern saw-whet owl	7	1			96	
Burrowing owl	134	1		2	8	805
Barred owl	21	1	1			162
Northern pygmy-owl	1					
Great gray owl	1					
Eastern screech-owl	3	2			24	13,147
Western screech-owl	2					
Great horned owl	184	25	10	1	426	2,661,811
Northern hawk owl	1					
Nightjars	448	3	3	25	69	
Nightjars	8					
Whip-poor-will	6			2		
Common poorwill	9					
Lesser nighthawk	8					
Chuck-will's-widow	8		1		1	
Common nighthawk	404	3	2	23	68	
Common pauraque	4					
Nacunda nighthawk	1					

Wildlife Strikes to Civil Aircraft in the United States, 1990–2013

Table 17. Continued (Page 10 of 21)

Wildlife group or species	24-year totals (1990–2013)					
	Number of reported strikes				Reported economic losses ¹	
	Total	With damage	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
Swifts	400	9	10	34	1,248	14,186
Swifts	9	1	1	2	1	
Black swift	3					
Chimney swift	328	6	7	30	1,221	14,186
Common swift	5	1		1		
Vaux's swift	29				24	
White-throated swift	26	1	2	1	2	
Hummingbirds	26					
Hummingbirds	1					
R-throated hummingbird	12					
Rufous hummingbird	4					
Anna's hummingbird	6					
B-chinned hummingbird	1					
Allen's hummingbird	1					
Calliope hummingbird	1					
Belted kingfisher	10					
Woodpeckers	137	9	7	4	180	23,531
Woodpeckers	11		1			
Northern flicker	78	6	1	2	10	2,238
Yellow-bellied sapsucker	39	2	2	2	169	2,772
Hairy woodpecker	3					
Red-naped sapsucker	2	1	2			18,521
Downy woodpecker	2		1		1	
Red-bellied woodpecker	1					
Red-breasted sapsucker	1					
Unidentified passeriforms	420	15	12	35	88	113,894
Flycatchers	434	4	5	32	3	15,796
Tyrant flycatchers	31			6	1	500
Eastern wood-pewee	5			1		
Great crested flycatcher	5					
Eastern kingbird	27	1	1			13,096
Scissor-tailed flycatcher	150	1	3	9		100
Acadian flycatcher	3					
Say's phoebe	5					
Western kingbird	170	2	1	12	2	1,500
Ash-throated flycatcher	3					
Western wood-pewee	3					
Sulphur-bellied flycatcher	1					

Wildlife Strikes to Civil Aircraft in the United States, 1990–2013

Table 17. Continued (Page 11 of 21)

Wildlife group or species	24-year totals (1990–2013)					
	Number of reported strikes				Reported economic losses ¹	
	Total	With damage	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
Eastern phoebe	8			1		
Yellow-bellied flycatcher	5			2		600
Least flycatcher	2					
Hammond's flycatcher	1					
Pacific-slope flycatcher	7					
Gray flycatcher	2			1		
Olive-sided flycatcher	1					
White-crested elaenia	1					
Willow flycatcher	1					
Alder flycatcher	3					
Larks	2,734	17	31	475	212	889,346
Sky lark	65			2		
Horned lark	2,669	17	31	473	212	889,346
Swallows	5,619	32	92	1,247	461	170,077
Swallows	866	7	34	268	58	181
Purple martin	144	7	3	35	54	87,665
Bank swallow	271	2	5	105	8	2,067
Barn swallow	2,863	12	37	541	286	58,104
Cliff swallow	941	3	9	158	42	19,980
Tree swallow	474		4	134	11	2,080
Violet-green swallow	17			1		
N. rough-winged swallow	33	1		1	2	
Cave swallow	10			4		
Black drongo	11			2		
Starlings, mynas	3,432	118	166	1,227	3,045	6,865,043
European starling	3,348	116	162	1,202	3,002	6,865,043
Common myna	84	2	4	25	43	
Crows, ravens	638	63	56	82	9,669	2,611,392
Crows, ravens	2	1		1		
Crows	193	20	15	33	18	122,799
American crow	395	31	34	44	6,462	1,785,709
Carrion crow	2					
Hooded crow	1	1	1			
Northwestern crow	6			1		
Rook	1					
Common raven	38	10	6	3	3,189	702,884
Jays, magpies	36	2	2	5	2	916
Blue jay	18			1	1	

Wildlife Strikes to Civil Aircraft in the United States, 1990–2013

Table 17. Continued (Page 12 of 21)

Wildlife group or species	24-year totals (1990–2013)					
	Number of reported strikes				Reported economic losses ¹	
	Total	With damage	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
Gray jay	1					
Yellow-billed magpie	8			2		
Black-billed magpie	9	2	2	2	1	916
Chickadees, nuthatches	30	1		9		
Chickadees	1					
Black-capped chickadee	22	1		6		
Mountain chickadee	2			1		
Gray-headed chickadee	1			1		
Carolina chickadee	2			1		
Bushtit	1					
White-breasted nuthatch	1					
Red-vented bulbul	3			1		
Wrens	102	1	2	11	2	500
Wrens	48	1	1	9		
Marsh wren	13		1	1		
House wren	22			1	1	500
Carolina wren	5					
Rock wren	1					
Cactus wren	4					
Winter wren	6				1	
Bewick's wren	1					
Sedge wren	2					
Mimics	170	2	2	7	7	1,561
Brown thrasher	15			1		220
Sage thrasher	2					
Curve-billed thrasher	1					
Northern mockingbird	80	2	2	1		
Tropical mockingbird	1					
Gray catbird	71			5	7	1,341
Thrushes	1,007	72	43	77	2,308	3,336,677
Thrushes	27	3	1	1	7	32,327
Western bluebird	4				3	
Swainson's thrush	105	8	3	9	53	2,486,701
Redwing	1					
American robin	689	49	29	50	2,151	776,780
Song thrush	1			1		
Hermit thrush	77	3	3	3	59	5,451
Eastern bluebird	7			1		

Wildlife Strikes to Civil Aircraft in the United States, 1990–2013

Table 17. Continued (Page 13 of 21)

Wildlife group or species	24-year totals (1990–2013)					
	Number of reported strikes				Reported economic losses ¹	
	Total	With dam- age	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
Gray-cheeked thrush	14		2	2		
Varied thrush	35	9	2	5	32	35,072
Wood thrush	14		1	2		346
Mountain bluebird	16			3		
Veery	17		2		3	
Wrentits, gnatcatchers	11		1		2	
Wrentit	1					
Blue-gray gnatcatcher	10		1		2	
Kinglets	64		2	3	7	
Golden-crowned kinglet	19					
Ruby-crowned kinglet	45		2	3	7	
Pipits	81		1	20	3	
American pipit	78		1	20	3	
Sprague's pipit	3					
Waxwings	114	5	5	25	75	191,544
Bohemian waxwing	2			1		
Cedar waxwing	112	5	5	24	75	191,544
Loggerhead shrike	15		1	1		
Vireos	79	2	2	5	8	8,484
Vireos	4					
White-eyed vireo	3				2	
Blue-headed vireo	4					
Yellow-throated vireo	1					
Warbling vireo	14	1		1	3	8,484
Red-eyed vireo	48	1	2	4	3	
Cassin's vireo	2					
Philadelphia vireo	3					
Japanese white-eye	2					
Warblers	596	6	12	43	239	19,046
Wood warblers	55	1		6		1,889
Canada warbler	16		2		2	103
Yellow-breasted chat	7					
Pine warbler	12			1		
Black-and-white warbler	15			1		
Northern parula	9			1	24	2,108
Ovenbird	46	1	2	1	3	1,390
Wilson's warbler	27			1	4	5,277
Common yellowthroat	42		1	1	2	250

Wildlife Strikes to Civil Aircraft in the United States, 1990–2013

Table 17. Continued (Page 14 of 21)

Wildlife group or species	24-year totals (1990–2013)					
	Number of reported strikes				Reported economic losses ¹	
	Total	With damage	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
Yellow-rumped warbler	96		2	10	7	50
Blackpoll warbler	31			3	2	492
Mourning warbler	5					
American redstart	19	1		3	11	
Orange-crowned warbler	13					
Yellow warbler	26	2		3	168	
Cape May warbler	2					
Hooded warbler	2	1				
Prairie warbler	3					
Northern waterthrush	14				1	
Nashville warbler	16		1	1		
Townsend's warbler	9		1	1		100
Palm warbler	23		2	3	3	7,187
Magnolia warbler	28		1	1	6	200
Bk-throated blue warbler	10					
Prothonotary warbler	2					
MacGillivray's warbler	5					
Yellow-throated warbler	15			2		
Bk-throated gray warbler	2				2	
Bk-throated grn warbler	8					
Hermit warbler	1					
Tennessee warbler	10				2	
Chestnut-sided warbler	6			1		
Blackburnian warbler	4					
Bay-breasted warbler	2			1		
Connecticut warbler	1					
Kentucky warbler	14			2	2	
Meadowlarks	2,361	22	45	234	405	972,917
Meadowlarks	401	3	10	41	14	713
Eastern meadowlark	1,182	8	22	106	171	617,064
Western meadowlark	778	11	13	87	220	355,140
Blackbirds, grackles	2,042	108	124	509	1,557	1,718,275
Blackbirds	1,271	80	89	363	609	1,411,553
Red-winged blackbird	229	5	11	30	34	21,137
Yellow-headed blackbird	10	1	1	2		
Brewer's blackbird	44	1	1	7	1	
Brown-headed cowbird	155	2	3	46	11	6,038
Bobolink	24		1	2	2	

Wildlife Strikes to Civil Aircraft in the United States, 1990–2013

Table 17. Continued (Page 15 of 21)

Wildlife group or species	24-year totals (1990–2013)					
	Number of reported strikes				Reported economic losses ¹	
	Total	With damage	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
Rusty blackbird	2					
Tricolored blackbird	1					
Grackles	125	11	5	26	728	207,494
Common grackle	122	5	9	26	124	72,053
Boat-tailed grackle	22	2	3	2	48	
Great-tailed grackle	37	1	1	5		
Orioles	33	1	3	2	2	211
Orioles	5					
Baltimore oriole	19	1	2	2	2	211
Orchard oriole	3					
Bullock's oriole	4		1			
Hooded oriole	2					
Tanagers	26	1	1	3	5	
Scarlet tanager	12	1		2	1	
Western tanager	10		1		4	
Summer tanager	4			1		
Finches	802	12	38	236	239	32,115
Finches	73	1	4	19	5	
Lapland longspur	42	1	4	18	25	
Chstnt-collared longspur	2					
Dark-eyed junco	91	2	2	6	75	11,172
Rose-breasted grosbeak	7			1	1	513
Common Chaffinch	1					
Island canary	1					
Pine siskin	14	1		6	1	
Purple finch	3					
Red crossbill	2			1		
Evening grosbeak	1					
American goldfinch	46		2	2	3	
House finch	91	1	2	7	15	
Smith's longspur	6			1		
Dickcissel	12	1		1		1,000
White-winged crossbill	1					
Red avadavat	5			3		
McCown's longspur	1					
Lesser goldfinch	3					
Black-headed grosbeak	4					
Cassin's finch	1					

Wildlife Strikes to Civil Aircraft in the United States, 1990–2013

Table 17. Continued (Page 16 of 21)

Wildlife group or species	24-year totals (1990–2013)					
	Number of reported strikes				Reported economic losses ¹	
	Total	With damage	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
Pine grosbeak	1					
Gy-crowned Rosy-Finch	1					
Blue grosbeak	1					
Red-crested cardinal	5			1	1	
Northern cardinal	11					
Snow bunting	247	4	21	150	107	19,430
Indigo bunting	15		2	2	4	
Lazuli bunting	4					
Lark bunting	107	1		16	2	
McKay's bunting	1		1	1		
Painted bunting	1					
Black-faced bunting	1			1		
Sparrows	3,725	60	116	766	1,102	859,265
Sparrows	2,878	49	106	695	658	69,106
Harris's sparrow	4			1		
Swamp sparrow	35			1		
Savannah sparrow	314	4	2	21	20	18,374
Fox sparrow	32	2		1	25	58,078
White-throated sparrow	104	1	2	14	23	2,842
Gldn-crowned sparrow	4			1		
Field sparrow	29			2		
Lark sparrow	17			2		
White-crowned sparrow	40	2	2	1	362	660,800
Grasshopper sparrow	40	1	1	2	4	33,002
Java sparrow	3			1		
Vesper sparrow	30			2		
Chipping sparrow	39	1		5		103
Lincoln's sparrow	26		2	2	4	16,000
Song sparrow	96			12	4	494
Sage sparrow	6				1	
American tree sparrow	13		1	2		250
Nelson's s-tailed sparrow	4				1	216
Black-throated sparrow	1					
Brewer's sparrow	6			1		
Le Conte's sparrow	1					
Cassin's sparrow	1					
Clay-colored sparrow	2					

Wildlife Strikes to Civil Aircraft in the United States, 1990–2013

Table 17. Continued (Page 17 of 21)

Wildlife group or species	24-year totals (1990–2013)					
	Number of reported strikes				Reported economic losses ¹	
	Total	With damage	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
Towhees	19	1		1	9	14,614
Eastern towhee	16	1		1	9	14,614
Green-tailed towhee	2					
California towhee	1					
Waxbills, mannikins	249		1	72	10	4,956
Waxbills, mannikins	3					
Common waxbill	5			1		
Mannikins	126			14		
Nutmeg mannikin	63			31	8	1,825
Black-headed munia	47		1	22	2	3,131
White-throated munia	5			4		
House sparrow	169	3	2	20	30	2,168
Total known birds	69,777	6,319	4,983	12,584	439,424	464,008,815
Total unknown birds	68,480	6,138	3,887	7,029	150,918	132,729,045
Unknown bird - ? size	3,601	310	265	197	8,305	2,687,676
Unknown bird - large	2,549	1,008	485	274	45,292	48,558,389
Unknown bird - medium	33,709	3,962	2,069	2,644	84,535	64,139,510
Unknown bird - small	28,621	858	1,068	3,914	12,786	17,343,470
Total birds³	138,257	12,457	8,870	19,613	590,342	596,737,860
Flying mammals (bats)						
Megabats (fruit bats)	13	2	2	4	99	4,443,944
Microbats (echo-locating)	991	7	6	63	53	4,929
Microbats (unkn species)	534	5	3	43	42	1,200
Vesper bats	38				1	300
Red bat	73	1		4	2	16
Hoary bat	24				1	2,000
E. small-footed myotis	1					
Little brown bat	60			1		
Big brown bat	50		1	5		
Silver-haired bat	23			1	2	308
Seminole bat	3					
Eastern pipistrelle	8					
Northern yellow bat	3					
Evening bat	2					
Indiana bat	2					
Yuma myotis	1					
Free-tailed bats	35			3		300

Wildlife Strikes to Civil Aircraft in the United States, 1990–2013

Table 17. Continued (Page 18 of 21)

Wildlife group or species	24-year totals (1990–2013)					
	Number of reported strikes				Reported economic losses ¹	
	Total	With damage	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
Brazilian free-tailed bat	126	1	2	5	5	805
Pocketed free-tailed bat	2					
Big free-tailed bat	1					
Western mastiff bat	1					
Florida bonneted bat	1					
Gray sac-winged bat	1					
Jamaican fruit bat	2			1		
Total known bats	1,004	9	8	67	152	4,448,873
Total unkn-Mega or Micro	4	1				9,568
Total bats⁴	1,008	10	8	67	152	4,458,441
<u>Terrestrial mammals</u>						
Marsupials (Vir. opossum)	155	1		1		
Xenarthras (armadillo)	28	1	5		11	1,269
Lagomorphs	464	7	8	7	20	127,176
Lagomorphs	1	1				
Hares	6					
Black-tailed jackrabbit	229	3	2	1	12	33,370
White-tailed jackrabbit	38			2	1	
Antelope jackrabbit	1					
Rabbits	97		2	4	1	
Eastern cottontail	69	3	4		6	93,806
Desert cottontail	23					
Rodents	234	2	7	5	6	475
North American beaver	2					
Black-tailed prairie dog	45		1	2		
White-tailed prairie dog	5					
Gunnison's prairie dog	15		1	3		
Woodchuck	126	2	5		6	475
Yellow-bellied marmot	1					
Fox squirrel	1					
Muskrat	25					
N. American porcupine	14					
Carnivores	1,130	66	139	16	16,907	4,168,452
Canids	3		1			
Coyote	443	40	91	5	14,129	3,667,729
Domestic dog	41	12	22	1	264	383,311
Foxes	65	4	7	1	10	1,057

Wildlife Strikes to Civil Aircraft in the United States, 1990–2013

Table 17. Continued (Page 19 of 21)

Wildlife group or species	24-year totals (1990–2013)					
	Number of reported strikes				Reported economic losses ¹	
	Total	With damage	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
Red fox	133	4	11		340	57,782
Common gray fox	7	1	1		2	269
Kit fox	4					
Raccoon	93	4	4	3	2,160	58,304
White-nosed coati	1					
Ringtail	1					
Skunks	53		1	2	2	
Striped skunk	243			4		
River otter	2	1				
Badger	4					
Mink	4					
Domestic cat	29					
Small Indian mongoose	3					
American black bear	1		1			
Artiodactyls	1,112	941	514	91	288,099	53,776,415
Deer	22	20	11		696	268,757
White-tailed deer	978	820	446	80	238,058	43,888,843
Mule deer	70	63	32	3	20,652	1,419,617
Wapiti (elk)	11	11	6	1	11,660	7,428,745
Moose	5	4	4			
Caribou	2	2	1			
Cattle	11	11	8	4	9,215	495,150
Pronghorn	9	8	5	2	5,130	239,150
Swine (pigs)	2	1			2,688	36,153
Collared peccary	2	1	1	1		
Perissodactyls	4	4	3		1,008	36,361
Horse	3	3	3		1,008	36,361
Burro	1	1				
Total known t. mammals	3,127	1,022	676	120	306,051	58,110,148
Total unknown t. mammals	22	6	8	1		
Total terrestrial mammals⁵	3,149	1,028	684	121	306,051	58,110,148
Reptiles						
Turtles	158	1	3	2		
Turtles (unkn species)	47		2			
Florida soft shell turtle	10	1	1			
Pond slider	2					
Eastern mud turtle	1					

Wildlife Strikes to Civil Aircraft in the United States, 1990–2013

Table 17. Continued (Page 20 of 21)

Wildlife group or species	24-year totals (1990–2013)					
	Number of reported strikes				Reported economic losses ¹	
	Total	With damage	With neg. EOF	With multiple animals ²	Aircraft down time (hrs)	Reported costs (\$)
Chicken turtle	1					
Eastern box turtle	11					
Common snapping turtle	19					
Diamondback terrapin	41			2		
Painted turtle	13					
Florida red-bellied cooter	1					
Gopher tortoise	8					
Alligator snapping turtle	1					
Coastal plain cooter	3					
American alligator	19	1	2		3	
Green iguana	9		4			
Bull snake	3					
Total reptiles⁶	189	2	9	2	3	
Total known (all species)	74,097	7,352	5,676	12,773	745,630	526,567,836
Total (unknown species)	68,506	6,145	3,895	7,030	150,918	132,738,613
Grand total	142,603	13,497	9,571	19,803	896,548	659,306,449⁷

¹ These reported economic losses by species and species groups should be considered as relative indices of losses and not as actual estimated losses. For commercial aviation, an estimated 20 percent of strikes were reported in the 1990s and about 39 percent from 2004–2008. General aviation reporting rates are much lower than for commercial aviation. In addition, only about 52 percent of reported strikes identified the wildlife species or species group responsible, 1990–2013. Furthermore, of the 13,497 reports indicating damage to the aircraft, only 26 percent (3,517) also provided an estimate of repair costs, and only 35 percent (7,506) of the 21,654 strikes indicating an adverse effect estimated the downtime (see Table 22). Finally, even when cost estimates were provided, some reports were filed before aircraft damage had been fully assessed. See Tables 22 and 23 for a more detailed projection of actual economic losses.

² More than 1 animal was struck by the aircraft.

³ Of the 138,257 reported bird strikes, 51,951 (38 percent) identified the bird to exact species (503 species total of which 232 caused damage) and an additional 17,826 strikes (13 percent) identified the bird at least to species group. Species identification has improved from less than 20 percent in the early 1990s to 60 percent in 2013 (Figure 7).

⁴ Of the 1,008 reported bat strikes, 384 (38 percent) identified the bat to exact species (19 species total of which 2 caused damage) and 620 (62 percent) identified the bat to species group (13 megabats [old world fruit bats], 607 microbats [echo-locating bats]). There were 4 bat strikes classified as unknown bat (either megabat or microbat).

Table 17. Continued (Page 21 of 21)

⁵ Of the 3,149 reported terrestrial mammal strikes, 2,880 (91 percent) identified the mammal to exact species (42 species total of which 22 caused damage) and 247 (8 percent) identified the mammal at least to species group.

⁶ All of the 189 reported reptile strikes were identified to species group and 142 (75 percent) were identified to exact species (15 species total of which 2 caused damage).

⁷ Reported costs of \$659,306,449 include \$587,690,499 in direct repair costs and \$71,615,950 in other costs.

Table 18. Number of reported strikes, strikes with damage, and strikes involving multiple animals for the five most commonly struck bird groups and three most commonly struck terrestrial mammal groups, civil aircraft, USA, 1990–2013.

Species group ¹	Reported strikes		Strikes with damage		Strikes with >1 animal	
	24-year total	% of total known	24-year total	% of total known	24-year total	% of total known
<u>Birds</u>						
Doves/pigeons	10,185	15	461	7	2,137	17
Gulls	9,656	14	1,373	22	2,075	16
Raptors ²	9,026	13	1,300	21	343	3
Shorebirds	5,691	8	126	2	858	7
Waterfowl	4,418	6	1,849	29	1,554	12
All other known	30,801	44	3,260	52	5,413	43
Total known birds	69,777	100	6,319	100	12,584	100
Unknown birds	68,480		6,137		7,029	
Total birds	138,257		12,456		19,613	
<u>Terrestrial mammals</u>						
Artiodactyls	1,112	36	940	92	91	76
Carnivores	1,130	36	66	6	16	13
Lagomorphs	464	15	7	1	7	6
All other known	421	13	8	1	6	5
Total known t. mammals	3,127	100	1,021	100	120	100
Unknown t. mammals	22		6		1	
Total t. mammals	3,149		1,027		121	

¹ See Table 17 for listing of species within each species group and Table 19 for the most frequently struck species.² Hawks, eagles, vultures, falcons, and caracaras.

Table 19. The 30 species of birds identified most frequently as struck by civil aircraft in USA, 1990-2013 and 2013 only. See Figure 13 for relation between mean body mass and percent of strikes causing damage.

Rank	Bird species	Strikes (1990-2013) ¹		Bird species	Strikes (2013 only) ¹	
		Num- ber	% causing damage		Num- ber	% causing damage
1	Mourning dove	6,124	3	Mourning dove	752	1
2	American kestrel	3,593	1	Barn swallow	504	<1
3	Killdeer	3,369	1	Horned lark	479	<1
4	European starling	3,348	3	Killdeer	442	<1
5	Barn swallow	2,863	<1	American kestrel	352	0
6	Horned lark	2,669	1	European starling	281	2
7	Rock pigeon	2,514	9	Eastern meadowlark	228	1
8	Red-tailed hawk	1,874	15	Red-tailed hawk	215	15
9	Canada goose	1,470	50	Rock pigeon	179	4
10	Ring-billed gull	1,296	8	Cliff swallow	165	0
11	Eastern meadowlark	1,182	1	American robin	107	7
12	Herring gull	1,065	10	Ring-billed gull	101	8
13	Barn owl	959	4	Western meadowlark	91	0
14	Cliff swallow	941	<1	Common nighthawk	84	0
15	Pacific golden-plover	805	1	Savannah sparrow	76	1
16	W. meadowlark	778	1	Barn owl	72	1
17	Mallard	749	23	Canada goose	68	44
18	American robin	689	7	Herring gull	67	10
19	Turkey vulture	537	52	Tree swallow	62	2
20	Tree swallow	474	<1	Chimney swift	62	0
21	Short-eared owl	408	2	Mallard	59	20
22	Common nighthawk	404	1	Pacific golden-plover	52	4
23	American crow	395	8	Turkey vulture	49	55
24	Laughing gull	364	5	Short-eared owl	49	0
25	Chimney swift	328	2	Bank swallow	44	0
26	Great blue heron	326	21	Red-winged blackbird	43	0
27	Savannah sparrow	314	1	Snowy owl	38	11
28	Cattle egret	290	9	Yellow-rumped warbler	35	0
29	Zebra dove	274	1	Snow bunting	34	3
30	Bank swallow	271	1	Western kingbird	31	6

¹ Actual number struck was higher for each species because only 38% and 60% of the bird strike reports from 1990-2013 and in 2013, respectively, identified the bird to species.

Table 20. Number of strikes to civil aircraft causing human fatality or injury and number of injuries and fatalities by wildlife species, USA, 1990–2013.

Species of wildlife	No. of strikes	No. of humans		Species of wildlife	No. of strikes	No. of humans
<u>Strikes causing fatalities</u>				<u>Strikes causing injuries (continued)</u>		
Unknown bird	6	8		American coot	3	3
Red-tailed hawk	1	8		Herring gull	3	3
A. white pelican	1	5		Rock pigeon	3	3
Canada goose	1	2		Domestic dog	1	2
White-tailed deer	1	1		Mule deer	1	2
Brown pelican	1	1		Red-throated loon	1	2
Turkey vulture	1	1		Grebes	1	2
Total (fatalities)	12	26		Osprey	2	2
<u>Strikes causing injuries</u>				Sharp-tailed grouse	1	2
Canada goose	15	117		Eastern cottontail	1	1
Unknown bird	43	51		Horse	1	1
White-tailed deer	19	27		Western grebe	1	1
Ducks	16	19		Horned grebe	1	1
Turkey vulture	15	18		Tropicbirds	1	1
Black vulture	7	11		Red-tailed tropicbird	1	1
New World Vultures	10	10		Frigatebirds	1	1
Gulls	8	9		Great frigatebird	1	1
Red-tailed hawk	6	8		Egrets	1	1
Ring-billed gull	2	8		Snowy egret	1	1
Geese	7	7		White ibis	1	1
Bald eagle	4	7		Long-tailed duck	1	1
Mallard	5	6		Cackling goose	1	1
Hawks	3	5		Sandhill crane	1	1
American kestrel	1	5		Franklin's gull	1	1
Anhinga	3	4		Doves	1	1
Lesser scaup	4	4		Mourning dove	1	1
Golden eagle	2	4		Owls	1	1
Eurasian kestrel	1	4		American robin	1	1
Spotted dove	1	4		Great-tailed grackle	1	1
Cattle	2	3		Sparrows	1	1
D.-crstd cormorant	3	3				
Snow goose	3	3		Total (injuries)	217	379

Table 21. Number of civil aircraft lost (destroyed or damaged beyond repair) after striking wildlife by wildlife species and aircraft mass category, USA, 1990–2013¹.

Wildlife species or species group	Aircraft ² mass category (Maximum takeoff mass)				Total aircraft lost
	≤2,250 kg	2,251-5,700 kg	5,701-27,000 kg	>27,000 kg	
White-tailed deer	14	6	2		22
Unknown bird	11	2	2		15
Canada goose	1	3		1	5
Cattle	2	1			3
Turkey vulture	3				3
Bald eagle	2				2
Hawks	2				2
Eastern cottontail	1				1
Coyote			1		1
Domestic dog	1				1
Mule deer	1				1
Wapiti (elk)			1		1
Brown pelican	1				1
A. white pelican		1			1
D.-crested cormorant	1				1
Ducks	1				1
New World Vultures	1				1
Red-tailed hawk		1			1
Eurasian kestrel				1	1
Ring-billed gull		1			1
Mourning dove			1		1
Total	42	15	7	2	66

¹ Forty three (64 percent) of the 66 wildlife strikes resulting in a destroyed aircraft occurred at general aviation airports, 15 occurred “enroute”, 6 occurred at USA airports certificated for passenger service under 14 CFR Part 139, and 2 occurred at a foreign airport certificated for passenger service.

² Engine types on the 66 destroyed aircraft were piston (48), turbofan (7), turboprop (5), turbojet (3), and turboshaft (3). Aircraft operators were business (37), private (23), commercial transport (5), and Government (1).

Wildlife Strikes to Civil Aircraft in the United States, 1990–2013

Table 22. Number of reported wildlife strikes indicating damage, a negative effect-on-flight (EOF), aircraft downtime, repair costs, and other costs; and the mean losses per report in hours of downtime and inflation-adjusted U.S. dollars, for civil aircraft, USA, 1990–2013.

Year	Number of reports indicating:					Mean losses per report		
	Dam- age	Neg. EOF	Aircraft down time	Repair costs	Other costs	Down- time (hours)	Repair costs (\$)	Other costs (\$)
1990	372	146	61	33	16	55.6	211,170	60,619
1991	401	187	61	49	25	79.8	72,686	39,181
1992	368	221	81	51	28	111.9	104,344	5,250
1993	399	240	67	57	19	277.9	88,915	9,385
1994	462	274	103	73	29	388.4	76,504	91,358
1995	498	309	96	62	33	103.2	505,935	220,022
1996	505	372	144	86	39	137.3	84,734	25,357
1997	581	386	184	126	47	228.2	76,123	39,847
1998	587	403	205	136	54	119.5	197,036	28,294
1999	707	447	284	179	79	147.8	108,762	20,596
2000	764	477	352	206	93	195.0	152,947	113,353
2001	649	435	294	156	65	155.7	283,727	38,674
2002	674	502	387	167	63	134.2	147,576	62,952
2003	635	443	359	173	82	110.8	157,406	41,278
2004	628	431	325	214	92	172.2	103,011	22,213
2005	609	458	329	227	125	87.5	263,207	75,825
2006	598	432	333	172	102	116.8	212,270	13,201
2007	571	458	366	178	135	164.3	170,999	32,920
2008	529	412	372	157	142	115.9	117,495	13,964
2009	607	522	563	195	193	80.8	364,037	14,259
2010	599	468	529	175	165	65.0	124,469	13,218
2011	542	499	526	179	208	70.8	227,077	14,629
2012	611	540	687	228	263	75.7	105,941	8,126
2013	601	509	798	238	302	100.7	59,961	11,920
Total	13,497	9,571	7,506	3,517	2,399			
Mean	562	399	313	147	100	119.4	167,100	29,852

Wildlife Strikes to Civil Aircraft in the United States, 1990–2013

Table 23. Projected annual losses in aircraft downtime (hours) and in repair and other costs (inflation-adjusted U.S. dollars) caused by wildlife strikes with civil aircraft, USA, 1990–2013. Losses are projected from mean reported losses per incident (see Table 22).

Year	No. of adverse incidents ³	Minimum projected losses ¹				Maximum projected losses ²	
		Downtime (hours)	Repair costs (x \$1 million)	Other costs (x \$1 million)	Total costs (x \$1 million)	Downtime (hours)	Total costs (x \$1 million)
1990	427	23,758	90	26	116	118,790	580
1991	487	38,840	35	19	54	194,201	272
1992	497	55,627	52	3	54	278,136	272
1993	509	141,456	45	5	50	707,282	250
1994	585	227,236	45	53	98	1,136,178	491
1995	659	68,014	333	145	478	340,071	2,392
1996	691	94,854	59	18	76	474,271	380
1997	790	180,262	60	31	92	901,308	458
1998	810	96,797	160	23	183	483,985	913
1999	983	145,259	107	20	127	726,295	636
2000	1,114	217,274	170	126	297	1,086,372	1,483
2001	981	152,756	278	38	316	763,779	1,581
2002	1,110	148,992	164	70	234	744,962	1,168
2003	1,006	111,445	158	42	200	557,223	999
2004	954	164,258	98	21	119	821,291	597
2005	983	85,990	259	75	333	429,950	1,666
2006	944	110,261	200	12	213	551,305	1,064
2007	982	161,381	168	32	200	806,903	1,001
2008	911	105,551	107	13	120	527,756	599
2009	1,192	96,317	434	17	451	481,585	2,255
2010	1,131	73,551	141	15	156	367,757	779
2011	1,146	81,107	260	17	277	405,534	1,385
2012	1,331	100,691	141	11	152	503,455	759
2013	1,431	144,076	86	17	103	720,378	514
Total	21,654	2,825,753	3,651	848	4,499	14,128,766	22,497
Mean	902	117,740	152	35	187	588,699	937

Table 23. Continued (Page 2 of 2).

¹ Minimum values are based on the assumption that all 21,654 reported strikes (mean of 902/year) indicating an adverse effect (see footnote 3) incurred similar amounts of damage and/or downtime and that these reports are all of the adverse-effect strikes that occurred, 1990–2013.

² Analyses of strike data from 1991-2004 indicated that 11 to 21 percent of strikes were reported for air carrier aircraft at Part 139 airports certificated for passenger traffic (Linnell et al. 1999, Cleary et al. 2005, Wright and Dolbeer 2005). Analyses of strike data from 2004-2008 indicated strike reporting at Part 139 airports had improved to 39 percent (Dolbeer 2009). Strike reporting for general aviation (GA) aircraft was estimated at less than 5 percent (Dolbeer et al. 2008, Dolbeer 2009). Maximum values for reported losses are based on the assumption that the 21,654 reported strikes indicating an adverse effect represent, on average, 20 percent of the total strikes that occurred with commercial and GA aircraft from 1990–2013.

³ Number of reports indicating 1 or more of the following: damage, negative effect on flight (EOF), downtime, repair costs, other costs.

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Figures

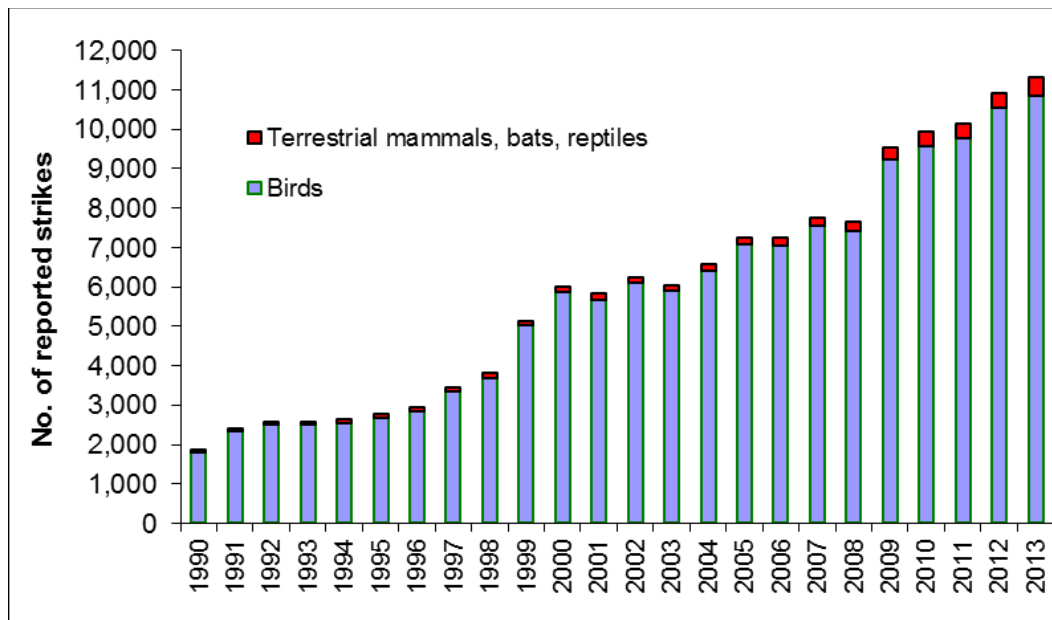


Figure 1. Number of reported wildlife strikes with civil aircraft, USA, 1990–2013. The 142,603 strikes involved birds (138,257), terrestrial mammals (3,149), bats (1,008), and reptiles (189, see Tables 1 and 17).

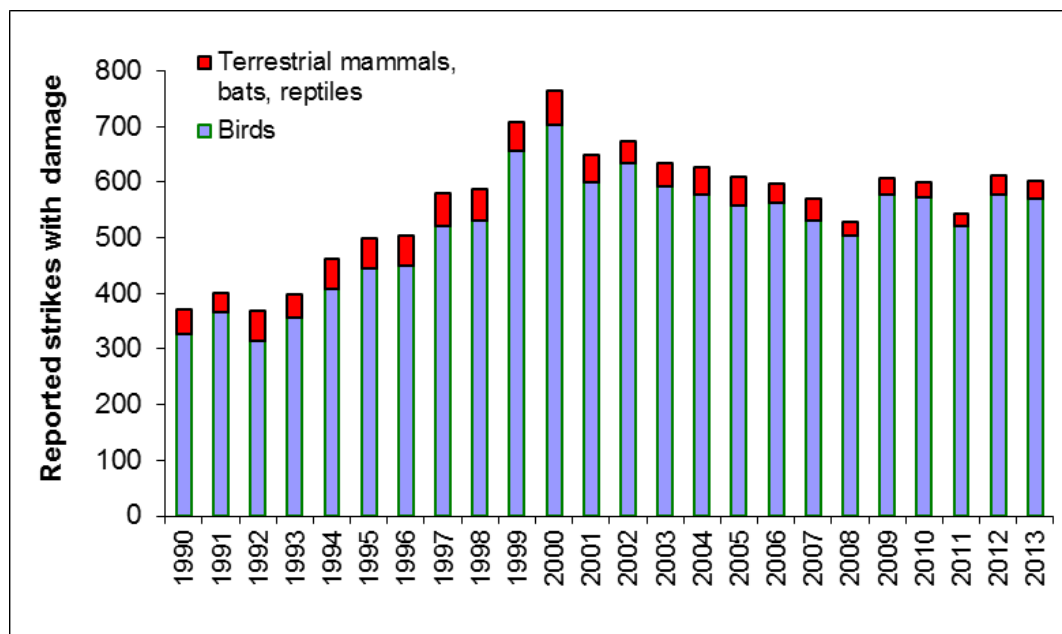


Figure 2. Number of reported wildlife strikes causing damage to civil aircraft, USA, 1990–2013. The 13,497 damaging strikes involved birds (12,457), terrestrial mammals (1,028), bats (10), and reptiles (2, see Tables 1 and 17).

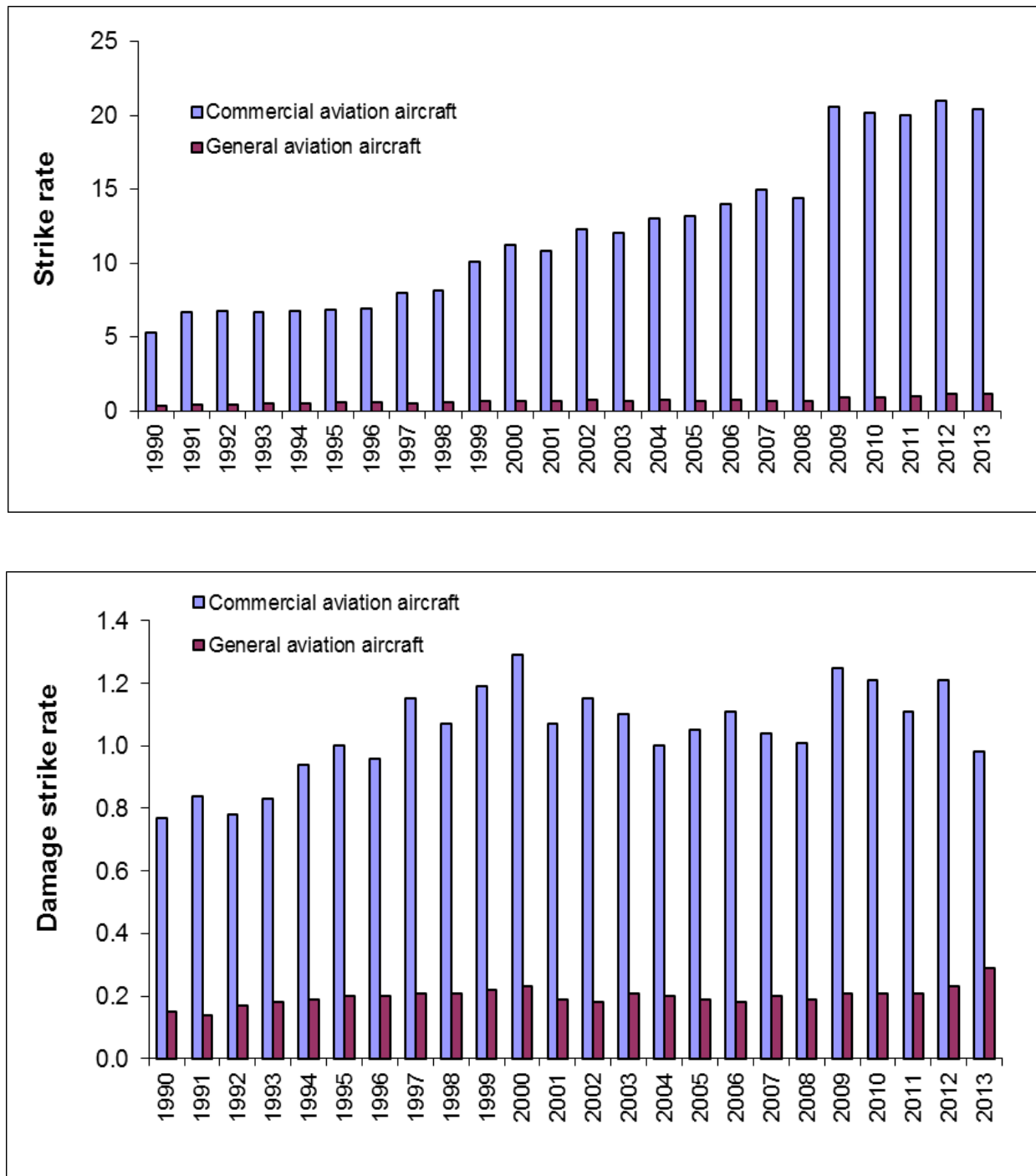


Figure 3. The strike rate (number of reported wildlife strikes per 100,000 aircraft movements, top graph) and damaging strike rate (number of reported damaging wildlife strikes per 100,000 aircraft movements, bottom graph) for commercial (air carrier, commuter, and air taxi service) and general aviation aircraft, USA, 1990–2013 (see Tables 2 and 3).

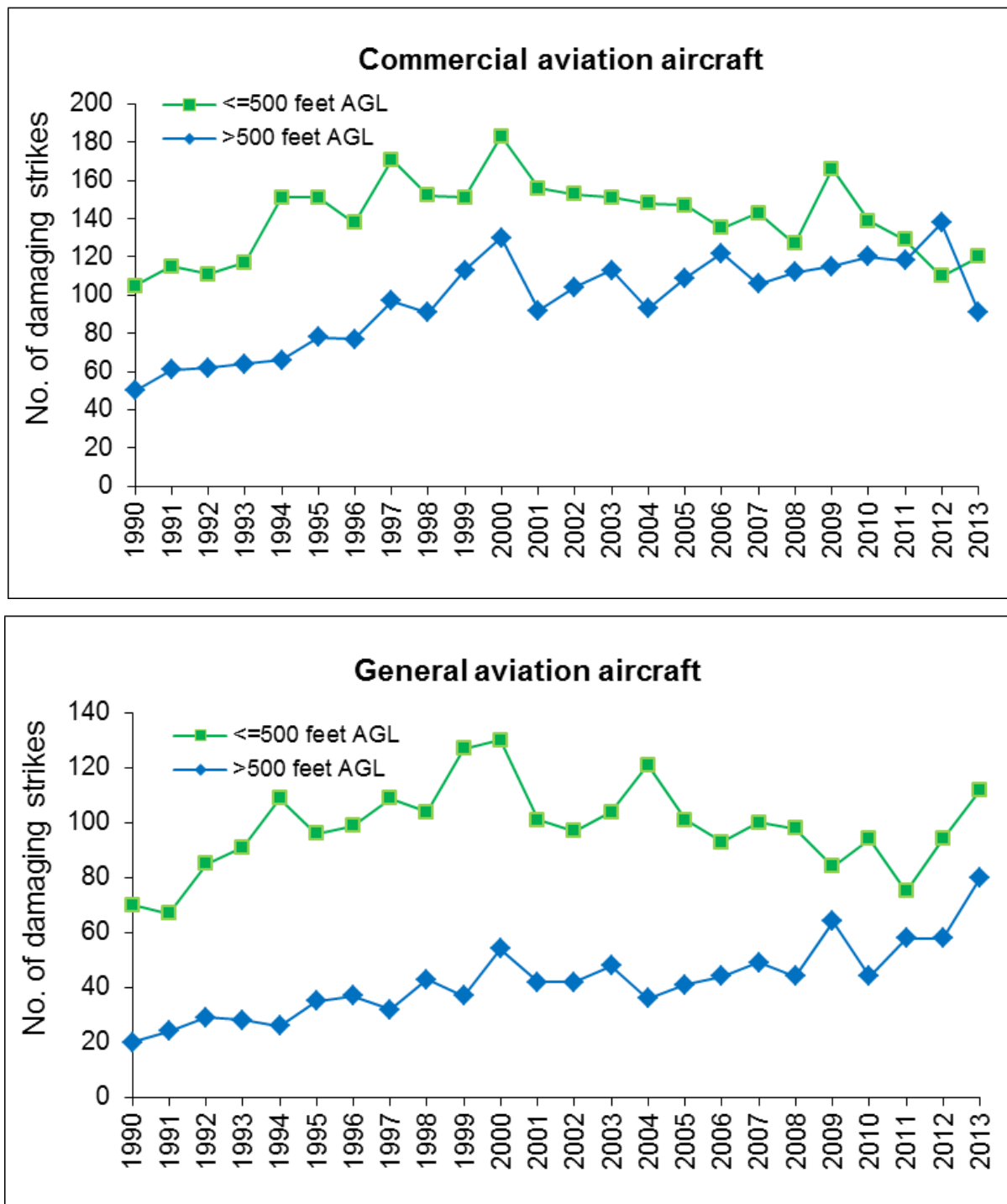


Figure 4. The number of damaging strikes with commercial (top graph) and general aviation (bottom graph) aircraft occurring at \leq and >500 feet above ground level, USA, 1990–2013. Strikes with unknown height AGL reported are excluded. See Tables 2 and 3 for sample sizes and Table 13 for classifications of damage.

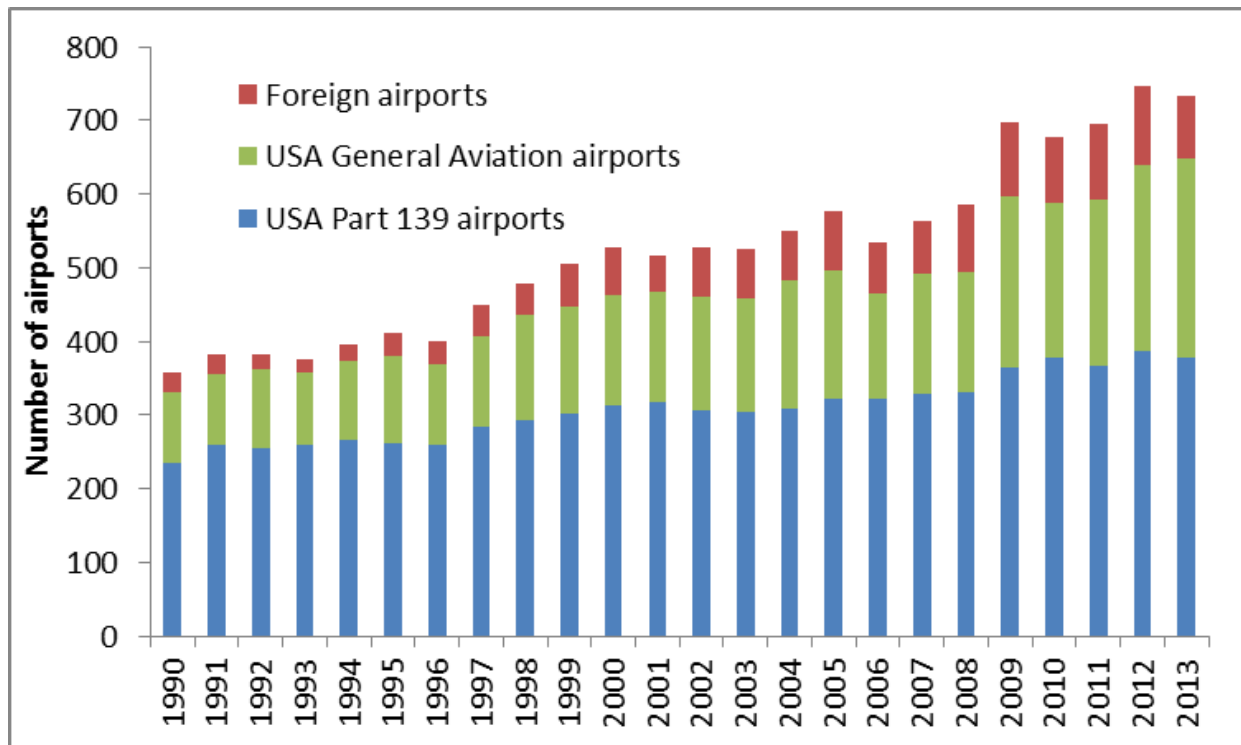


Figure 5. Number of Part 139-certificated airports and general aviation (GA) airports in USA with reported wildlife strikes and number of foreign airports at which strikes were reported for USA-registered civil aircraft, 1990–2013. Strikes were reported from 1,821 USA airports (531 Part 139-certificated, 1,290 GA) and 277 foreign airports in 105 countries, 1990 - 2013 (Table 7).

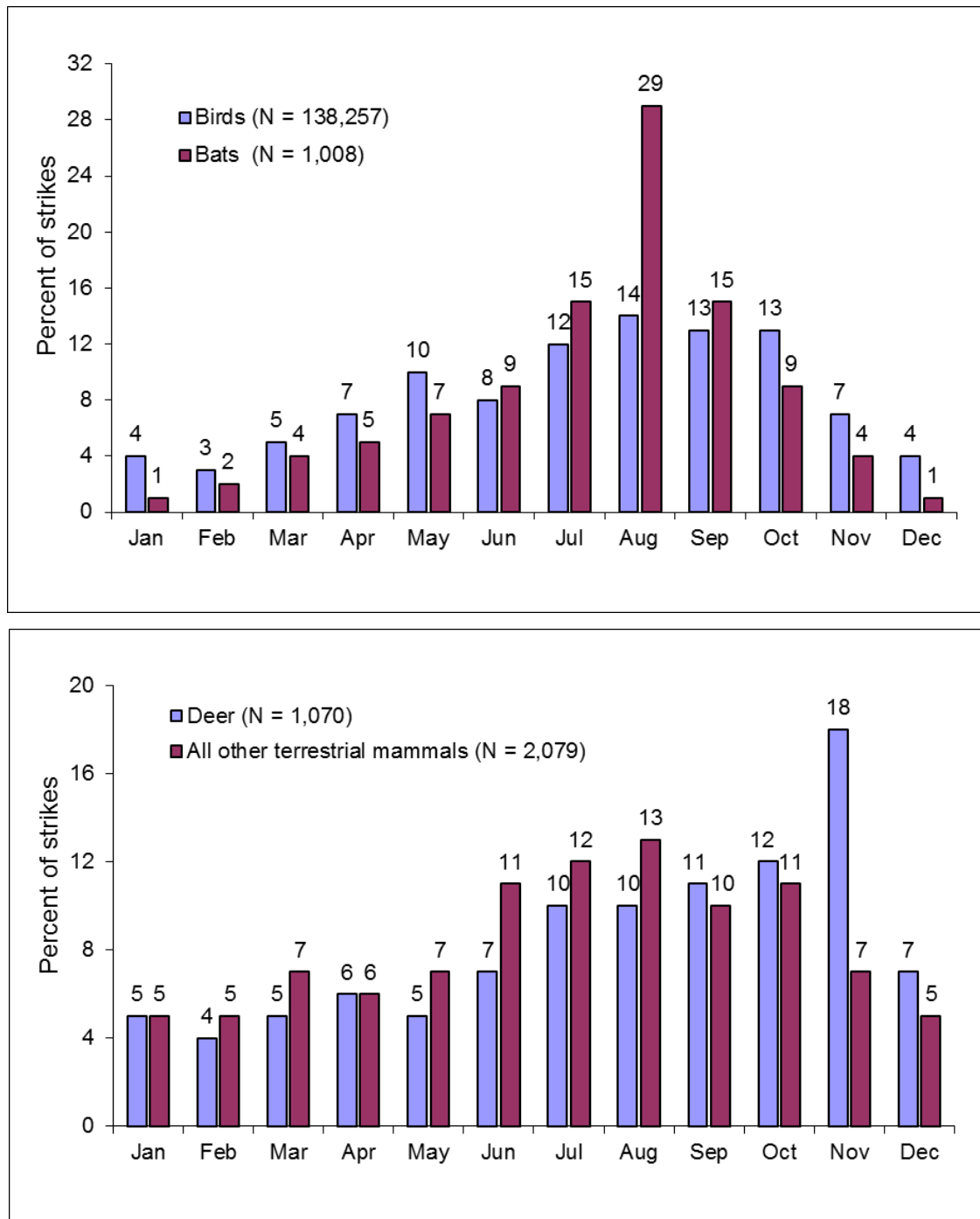


Figure 6. The percentage of reported bird and bat strikes (top graph) and deer and other terrestrial mammal strikes (bottom graph) with civil aircraft by month, USA, 1990–2013. In addition, 189 strikes with reptiles were reported of which 60 percent occurred in May - July. Deer strikes comprised 978 white-tailed deer, 70 mule deer, and 22 deer not identified to species (Table 17). Biondi et al. (2011) provide a more detailed analysis of deer strikes with civil aircraft in the USA.

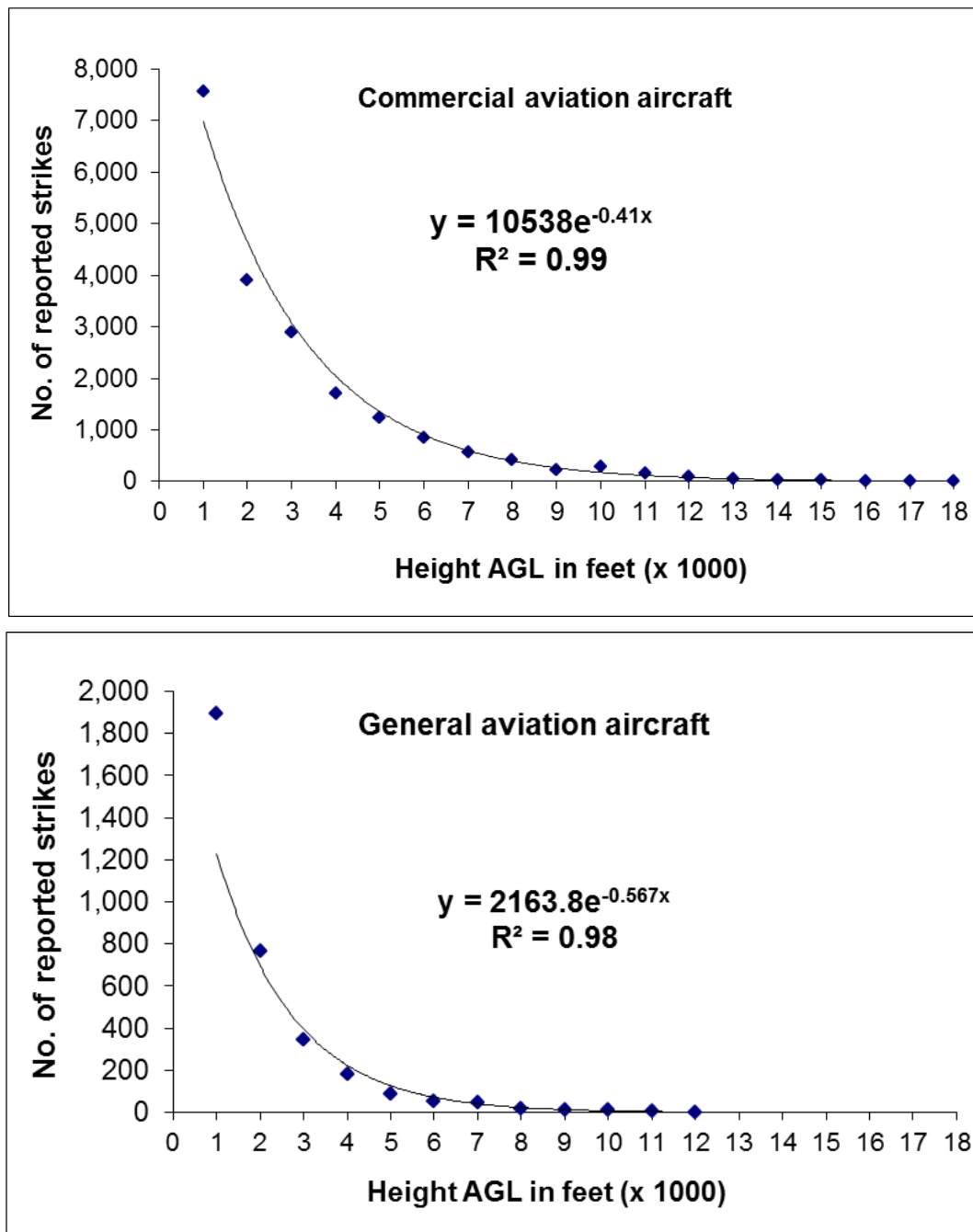


Figure 7. Number of reported bird strikes with commercial (top graph) and general aviation (GA) aircraft (bottom graph) in USA from 1990–2013 by 1,000-foot height intervals above ground level from 501–1,500 feet (interval 1) to 17,501–18,500 feet (interval 18) for commercial aircraft and to 11,500–12,500 feet (interval 12) for GA aircraft. These graphs exclude strikes occurring at ≤ 500 feet. Above 500 feet, the number of reported strikes declined consistently by 34 percent and 43 percent for each 1,000 foot gain in height for commercial and GA aircraft, respectively. The exponential equations explained 98 to 99 percent of the variation in number of strikes by 1,000-foot intervals from 501 to 18,500 feet for commercial aircraft and 501 to 12,500 feet for GA aircraft. See Tables 10 and 11 for sample sizes.

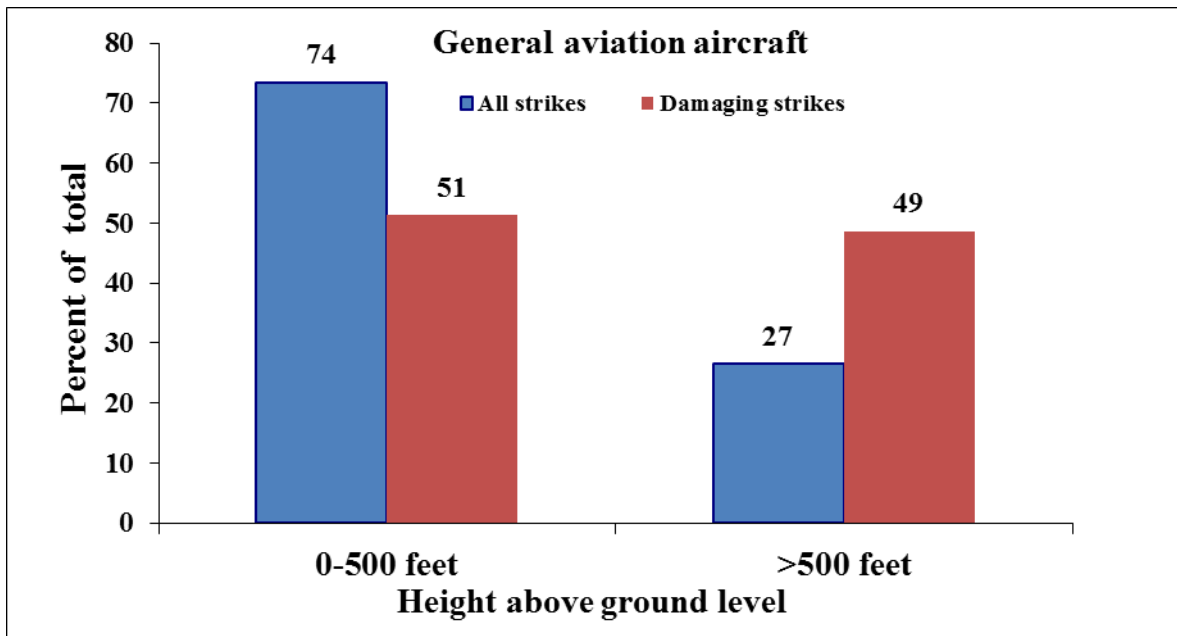
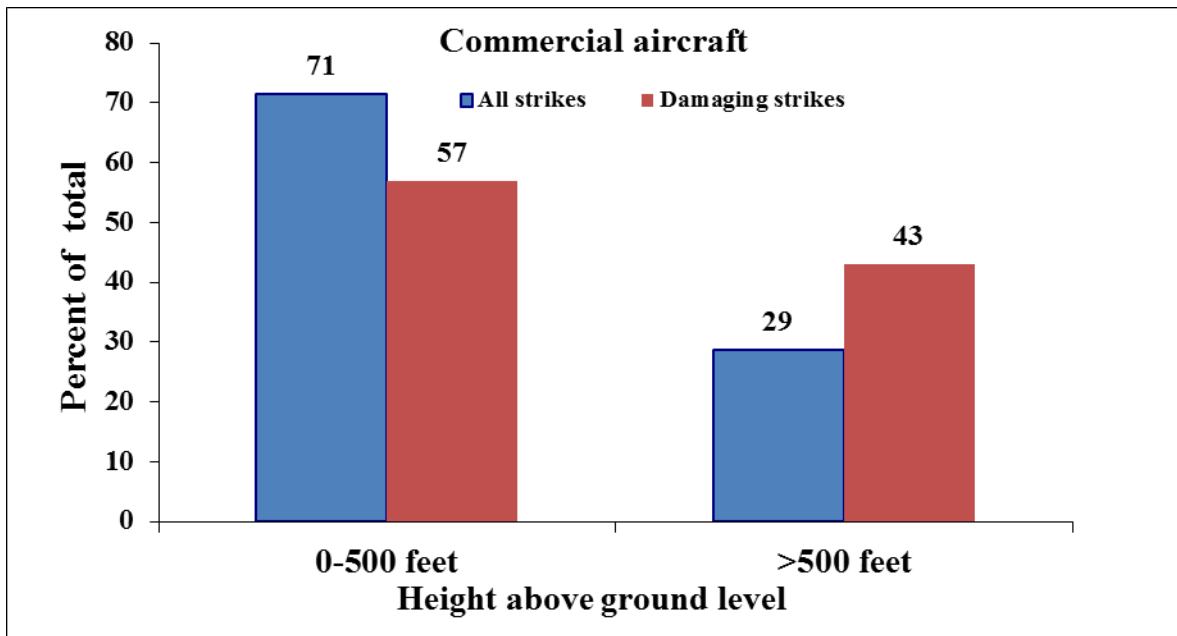


Figure 8. Percentage of total strikes and percentage of total damaging strikes occurring at 500 feet or less and above 500 feet for commercial (top graph) and general aviation (bottom graph) aircraft in USA, 1990-2013. See Tables 10 and 11 for sample sizes.

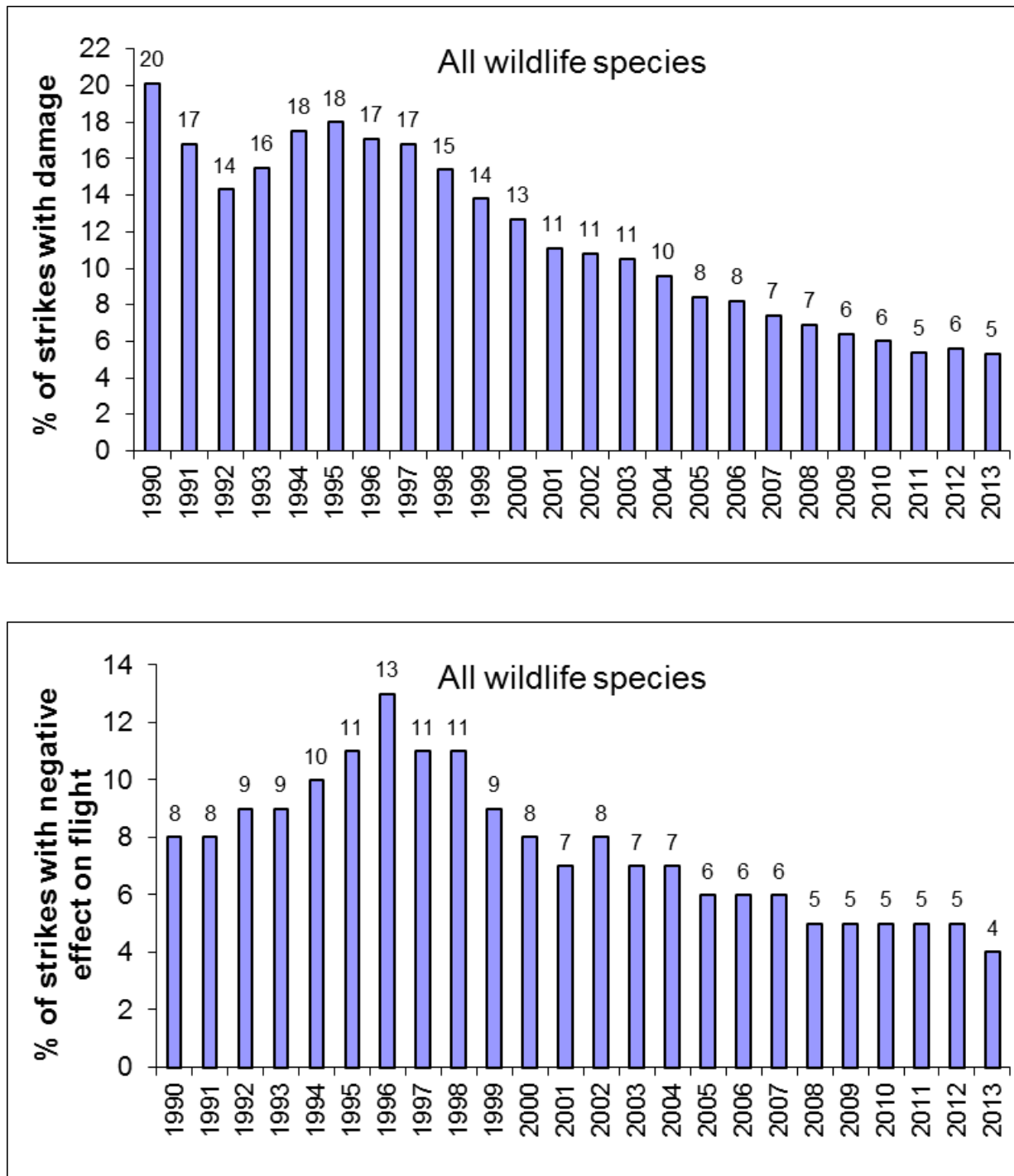


Figure 9. The percentage of reported strikes that indicated damage to the civil aircraft (top graph) or a negative effect-on-flight (bottom graph), USA, 1990–2013. See Tables 1, 13, and 14 for sample sizes and classifications of damage and negative effects-on-flight.

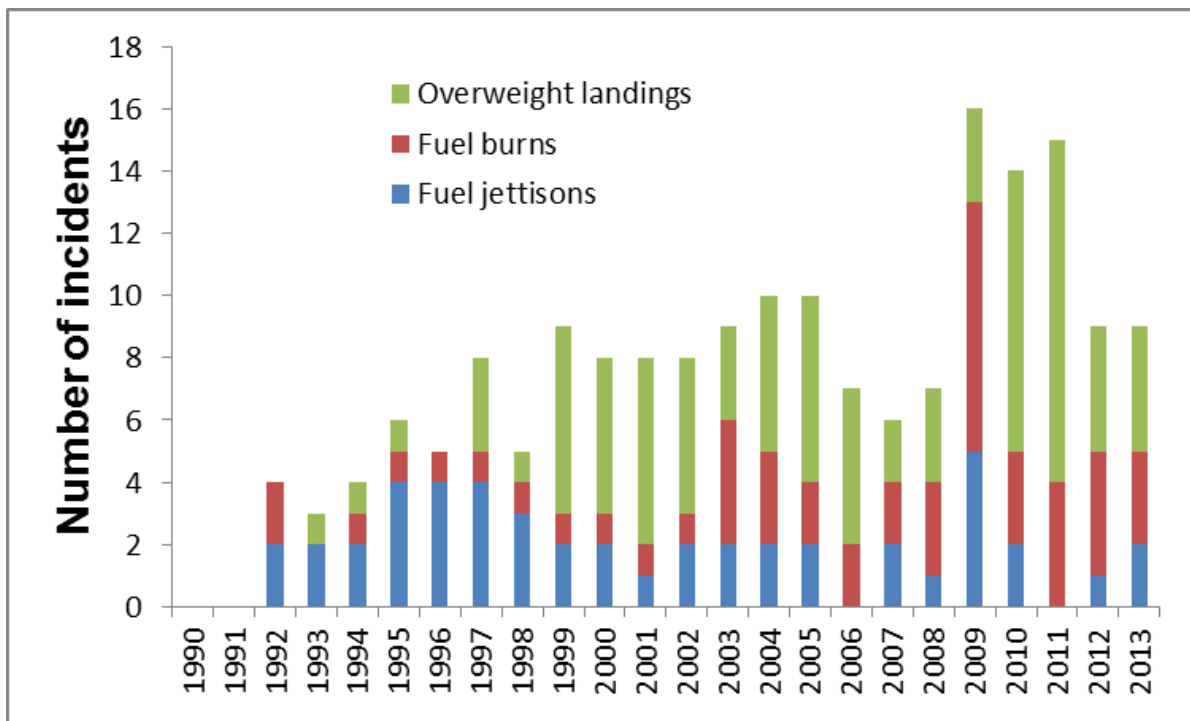


Figure 10. Number of reported incidents where pilot made an emergency or precautionary landing after striking birds during departure in which fuel was jettisoned or burned (circling pattern) to lighten aircraft weight or in which an overweight (greater than maximum landing weight) landing was made (no fuel jettison or burn), USA civil aircraft, 1990–2013. See Table 15 for details on aircraft involved and amount of fuel jettisoned.

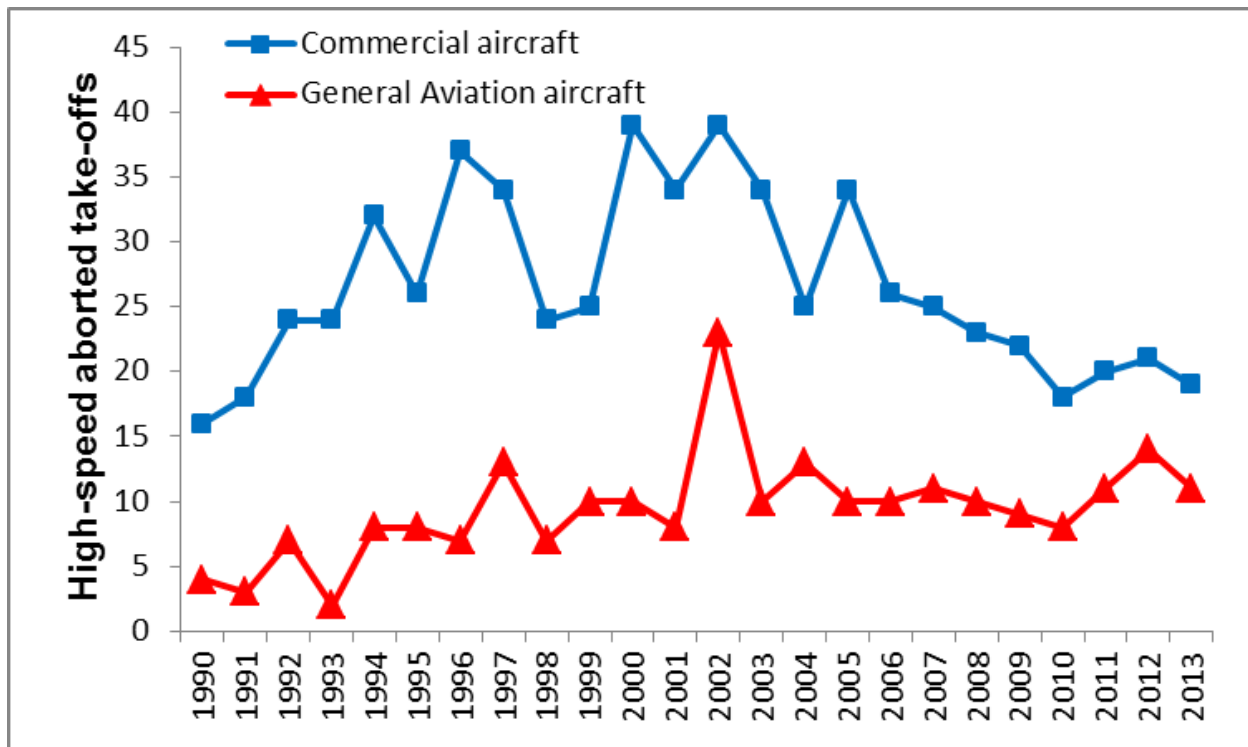


Figure 11. Number of reported incidents in which pilot made an aborted take-off at ≥ 80 knots after striking birds or other wildlife during take-off run, USA civil aircraft, 1990–2013. See Table 16 for classification of aborted take-offs by speed of aircraft.

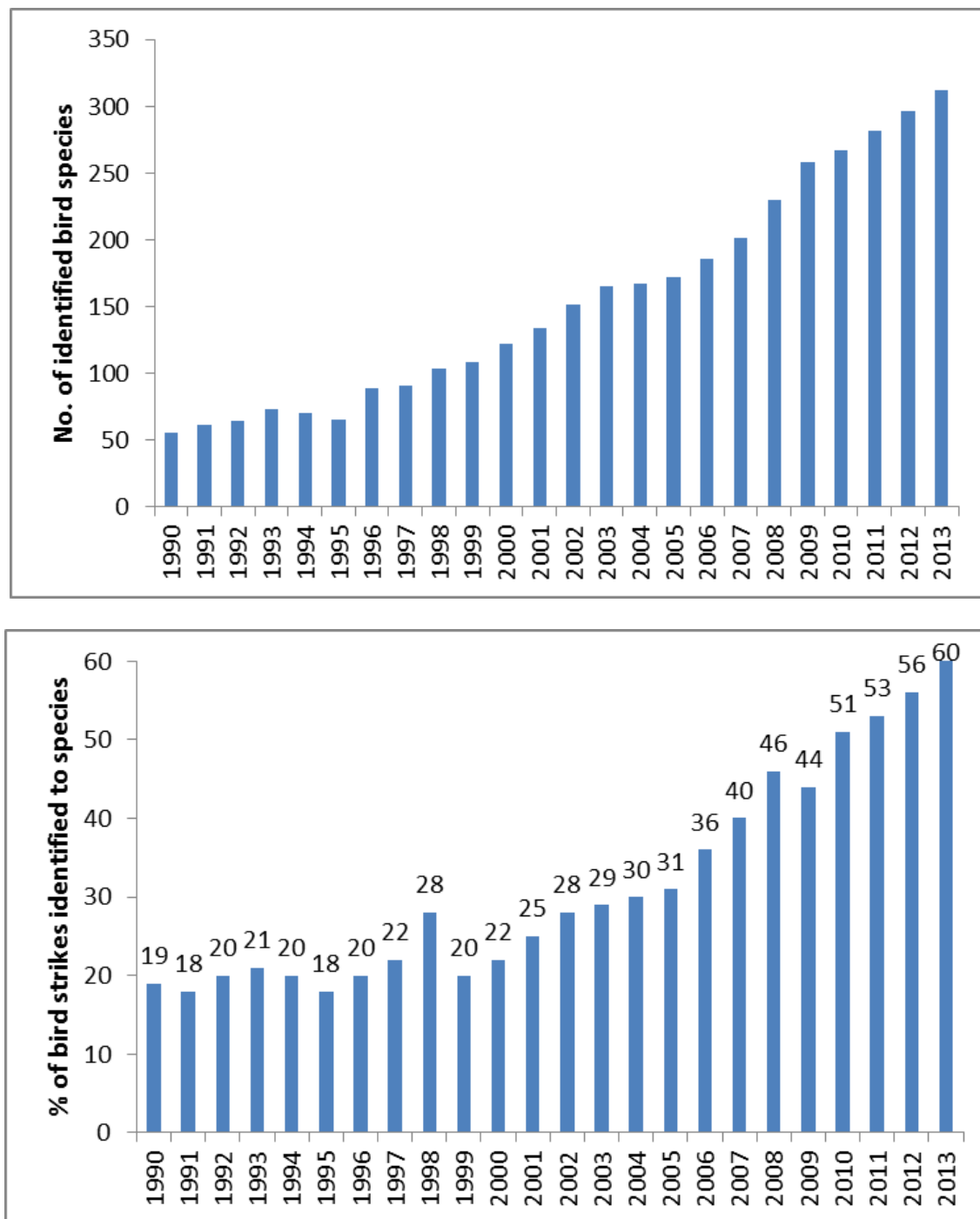


Figure 12. The number of identified bird species struck by civil aircraft each year (top graph) and the percentage of reported bird strikes in which the bird was identified to species (bottom graph), USA, 1990–2013. From 1990 through 2013, 503 different species of birds have been identified. See Tables 1 and 17 for sample sizes and list of species.

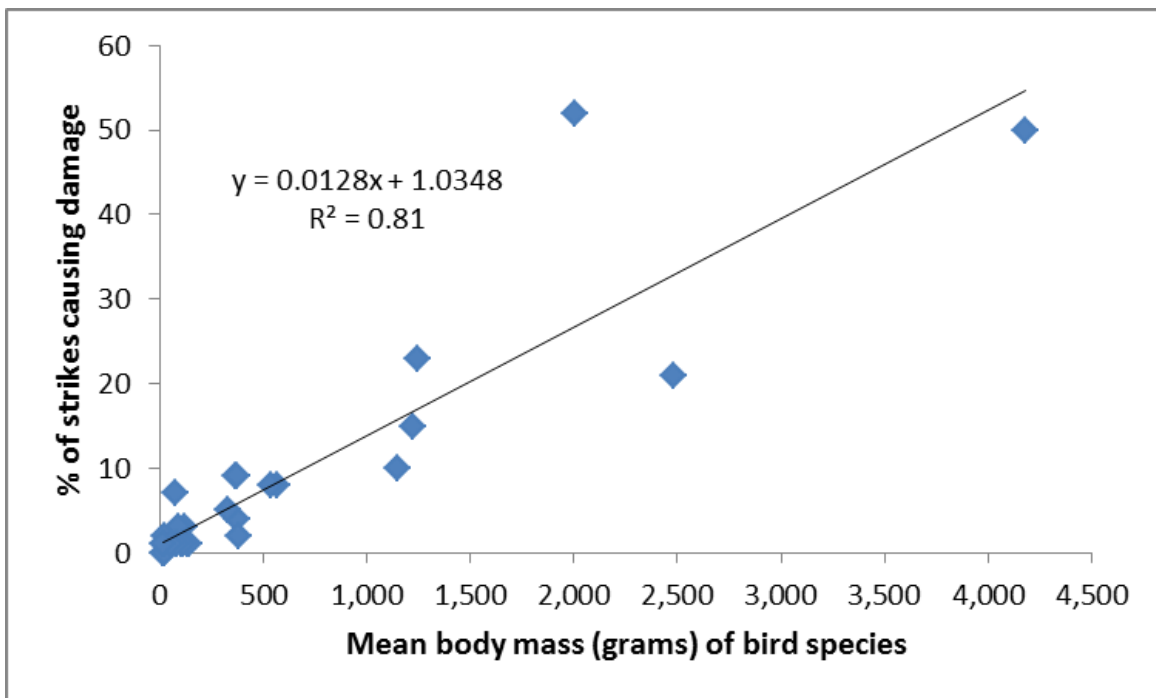


Figure 13. Relation between mean body mass (Dunning 2008) and likelihood of a strike causing damage to aircraft for the 30 species of birds most frequently identified as struck by civil aircraft in USA, 1990-2013 (Table 19). The linear regression equation explained 81% of the variation in the likelihood of damage among the 30 species. For every 100 gram increase in body mass, there was a 1.28% increase in the likelihood of damage.

Part 2: FAA Activities for Mitigating Wildlife Strikes

In 2013, the FAA continued a multifaceted approach for mitigating wildlife strikes. This included continuing a robust research program, making improvements to the National Wildlife Strike Database (NWSD) and outreach, incorporating new technology to increase and simplify strike reporting, and providing Airport Improvement Program (AIP) funding to airports to conduct Wildlife Hazard Assessments (Assessments) and develop Wildlife Hazard Management Plans (Plans).

Strike Reporting

The FAA has continued to update and improve the existing NWSD website (<http://wildlife.faa.gov>) to make it more user-friendly and to allow more advanced data mining. Search fields enable users to find data on specific airports, airlines, aircraft and engine types, as well as damage incurred, date of strike, species struck, and state without having to download the entire database. Similarly, the FAA has continued modifications to provide in-depth wildlife guidance at http://www.faa.gov/airports/airport_safety/wildlife.

This guidance includes Advisory Circulars and Certalerts, FAA NWSD analysis reports, the manual *Wildlife Hazard Management at Airports*, Airport Cooperative Research Program (ACRP) wildlife reports, hazardous wildlife mitigation and habitat attractants, Bird Hazard Mitigation Systems (e.g., AHAS and BAM), Frequently Asked Questions and Answers on Wildlife Strikes, and more.

The FAA also developed software to make strike reporting easier. Now, anyone who needs to report a wildlife strike can do so via the new web site or their mobile devices at <http://www.faa.gov/mobile>. When airline and airport employees report a wildlife strike, the information is automatically sent to the FAA's wildlife strike database.

The FAA continued to distribute the latest *Report Wildlife Strikes* awareness poster. Designed in 2013, it is being distributed throughout 2014. Overall, 36,000 posters have been distributed to more than 4,000 Part 139 airports, General Aviation (GA) airports, aviation flight schools and the aviation industry in the last four years. The renewal of strike awareness posters is one of several outreach efforts to improve strike reporting and safety at certificated and GA airports. As an extension to the mobile application software developed by the FAA to make strike reporting easier, the FAA also placed a QR code on the bottom of the "Report Wildlife Strikes" posters which allows anyone to report a wildlife strike via the web or their personal data devices. Outreach



materials such as informational placards and quick-reference thumb guides are also being developed for distribution.

FAA Guidance

Advisory Circular No: 150/5200-32B (AC-32B) *Reporting Wildlife Aircraft Strikes* was updated and published May 31, 2013. The AC provided clarification that a wildlife strike should be reported when 1) a strike between wildlife and aircraft has been witnessed; 2) evidence or damage from a strike has been identified on an aircraft or; 3) bird or other



The FAA published Certalert No.14-01 *Seasonal Mitigation of Hazardous Species at Airports: Attention to Snowy Owls* to heighten awareness of transient hazardous wildlife such as snowy owls. Photo courtesy Christopher Castillo.

wildlife remains, whether in whole or in part, are found within 250 feet of a runway centerline or within 1,000 feet of a runway end unless another reason for the animal's death is identified or suspected. Advisory Circular 150/5200-36A *Qualifications for Wildlife Biologist Conducting Wildlife Hazard Assessments and Training Curriculums for Airport Personnel Involved in Controlling Wildlife Hazards on Airports* (01/31/2012) received minor updates on January 31, 2013. The primary change added language requiring certificated airports to maintain documentation of airport wildlife biologist qualifications. Advisory Circular 150/5200-38 *Protocol for the Conduct and Review of Wildlife Hazard Site Visits, Wildlife Hazard Assessments, and Wildlife Hazard Management Plans* is scheduled for publication in FY 2014. This new AC defines the minimum acceptable standards for the conduct and preparation of Wildlife Hazard Site Visits (Site Visits), Assessments and Plans. This AC provides guidelines that state when a Site Visit should be conducted, and when an Assessment must

be conducted. The AC further defines and explains continual monitoring programs and provides checklists to help people evaluate Site Visits, Assessments and Plans.

Certalert No. 13-01 *Federal and State Depredation Permit Assistance* issued in January 2013 provided assistance to airport operators with the acquisition of Federal or State depredation permits. The Certalert supplied users with state fish, wildlife and natural resource agency web sites, contact information for USDA and United States Fish And Wildlife Service (USFWS) regional and state offices, USFWS Migratory Bird Permits Regulation 50 CFR § 21.41 and a copy of USFWS Migratory Bird Depredation Permit application form (Form 3-200-13). The FAA also published Certalert No.14-01 *Seasonal Mitigation of Hazardous Species at Airports: Attention to Snowy Owls* to heighten awareness of transient hazardous wildlife such as snowy owls.

The FAA funded and assisted with the development of two new ACRP reports to aid airports with the mitigation of wildlife hazards. ACRP Synthesis 39 report *Airport Wildlife Population Management* (2013) and Synthesis 52 report *Habitat Management to deter Wildlife at Airports* (2014) are available from the Transportation Research Board (TRB) of the National Academies at <http://www.trb.org/Publications/Publications.aspx>.

Wildlife Hazard Mitigation Research

For the last 18 years, the FAA and the USDA have provided a research program to make airports safer by reducing the risks of aircraft-wildlife collisions. The USDA APHIS WS National Wildlife Research Center (NWRC), through an interagency agreement with FAA, continues its efforts to improve wildlife management techniques and practices on and near airports. These efforts include:

- Alternative habitat management strategies to reduce attraction to airports of hazardous wildlife species,
- Techniques for restricting access of hazardous wildlife species to attractive features like storm water ponds,
- Technologies for harassing and deterring hazardous species,
- Evaluation of avian radar systems for detecting and tracking birds on or near airports,
- Aircraft-mounted lighting systems to enhance bird detection and avoidance of aircraft.



Management of raptors at airports has increasingly involved capture and relocation techniques. Studies by USDA and others have provided invaluable information on capture methods, the effects of species, age and season on raptor return rates to airports, and the overall efficacy of translocation to mitigate raptor hazards. Photos courtesy Amy Johnson.

Avian or Bird Radar Technology

In 2001, the FAA began working with the U.S. Air Force to develop a radar system for detecting and tracking birds on or near airports. In 2006, the FAA refocused the radar research to evaluate the capability of commercially available, low-cost, portable radars to reliably detect and track birds on or near airports.

The Center of Excellence for Airport Technology (CEAT) at the University of Illinois has served as the FAA's research partner for the performance assessments of bird radar. The initial avian radar systems have involved Accipiter Radar Technologies Inc. and

were deployed at Seattle-Tacoma and Whidbey Island Naval Station in 2007, Chicago O'Hare in 2009, and John F. Kennedy and Dallas-Fort Worth in 2010.

Additional evaluations have continued through FAA's multi-year agreement with USDA who teamed up with the National Center of Atmospheric Research (NCAR) and Indiana State University to further evaluate the performance of bird radar systems. The effort brings together experts in wildlife biology, ornithology, radar engineering, and system integration from government, industry, and academia to evaluate the MERLIN Avian Radar System by DeTect, Inc., one of several radar systems used to detect birds at and near airports. The assessment effort is part of the FAA's overall investigation into the effectiveness of commercially available avian radar detection systems at U.S. civil airports when used in conjunction with other known wildlife management and control techniques. Though it is well established that radar can detect birds, there is little published information concerning the accuracy and detection capabilities related to range, altitude, target size, and effects of weather for avian radar systems. These studies involve 1) a technical evaluation of the candidate radar system, including sensor components and associated data delivery systems, 2) field evaluations of system accuracy using remote controlled aircraft and wild birds, 3) an assessment of the integration of radar technology with other, more traditional aspects of wildlife hazard management at airports, and 4) a behavioral study on the potential effects of radar energy on bird behavior.

In November, 2010, the FAA published a performance specification in the form of an Advisory Circular 150/5220-25 *Airport Avian Radar Systems*, which airports can use to competitively purchase bird radar systems. The guidelines provide the operational considerations of acquiring and using the technology to enhance wildlife hazard mitigation practices on civil airports. Under some circumstances, procurement of bird radar systems may be eligible for funding under the FAA's Airport Improvement Program (AIP). The FAA will continue to evaluate commercially available avian radars and emerging sensor technologies. A new research effort began at the end of 2011 and continued through 2013 that examined the feasibility and practicality of pilots and air traffic controllers using bird radar data.

Wildlife Hazard Assessments and Wildlife Hazard Management Plans

The FAA has encouraged all certificated airports to conduct Assessments and develop Plans regardless if they have experienced a triggering event under 14 CFR Part 139. To date, 100% of Part 139 airports have completed an Assessment, are in the process of conducting an Assessment, or have taken a Federal grant to conduct an Assessment. Wildlife hazard assessments will allow an airport to:

- Identify trends in wildlife use of the airport (habitat preferences, seasonal composition and abundance of wildlife species, geography of strikes, seasonality of strikes, time and phase of flight of strikes, etc.)
- Prevent future strikes through operational changes, habitat (attractant) modifications, customized harassment, and/ or species removal

- Evaluate the overall risk level of wildlife strikes and the efficacy of the airport's wildlife hazard mitigation program (e.g., determine redundancy of species specific hazards, monitor reduction of onsite damaging strikes, monitor wildlife program communication and response efficiency, and improve overall program through annual review).



Federal and State Threatened or Endangered Species, Candidate Species and Species of Concern increasingly affect mitigation strategies of wildlife hazards on airports; often demanding innovative techniques to reduce risk. Solutions designed to attract greater sage-grouse away from the Jackson Hole Airport (JAC) airfield and onto habitats removed from its boundaries include the establishment of new food sources and brood-rearing habitat, restoration of historic lek sites and creation of a new lek site. Photo courtesy Ray Bishop JAC airport; inset photo USFWS.

An Assessment provides fundamental wildlife and habitat information for an effective, airport-specific Plan. The Plan outlines a plan of action to minimize the risk to aviation safety, airport structures or equipment, or human health posed by populations of hazardous wildlife on and around an airport. To be effective, Plans must not only be fully implemented but routinely evaluated and modified to address an airport's changing environment, hazards and capabilities. The FAA supports completion of Assessments and Plans by providing financial assistance from the AIP.

Wildlife Hazard Assessments at GA Airports

On March 4, 2008, a catastrophic wildlife strike involving a Cessna 500 Citation and an unknown number of migratory white pelicans resulted in five fatalities approximately four miles from a GA airport. Following the investigation, the NTSB provided the FAA Recommendation [A-09-73](#):

“Verify that all federally obligated general aviation airports that are located near woodlands, water, wetlands, or other wildlife attractants are complying with the requirements to perform wildlife hazard assessments as specified in Federal Aviation Administration Advisory Circular 150/5200-33B, Hazardous Wildlife Attractants On or Near Airports”

In response to this recommendation the FAA initiated the modification of AC 150/5200-33B to encourage federally obligated National Plan of Integrated Airport System/General Aviation (NPIAS/GA) airports, to conduct Assessments and Site Visits. The FAA has established a program and schedule that outlines the implementation of

these assessments based on the number of operations and based jet aircraft. It will take several years to complete Assessments and Site Visits at the more than 2,700 GA airports. To assist the GA airports in conducting Assessments, we will make AIP grant funds available to them.

Mitigating Strikes at GA Airports

The FAA funded and assisted with the development of two ACRP reports to aid GA airports with the mitigation of wildlife hazards. From October 2011 to early 2012, 2,770 copies of ACRP Report 32 *Guidebook for Addressing Aircraft/ Wildlife Hazards at General Aviation Airports* and ACRP report *Synthesis 23 Bird Harassment, Repellent, and Deterrent Techniques for Use on and Near Airports* were distributed to all federally obligated NPIAS/GA airports. The reports, published in 2010 and 2011 respectively, provide practical guidance and specific techniques on how to address wildlife strikes at airports with a specific emphasis on the general aviation community and are still available at <http://www.trb.org/Publications/Publications.aspx>.

Bird Strike Committee USA

The FAA participates in the Bird Strike Committee-USA as part of its continued public outreach and education effort to increase awareness within the aviation community about wildlife hazards. A Memorandum of Understanding between the FAA and the BSC-USA was signed May 2012 to formalize this cooperative relationship.

Commercial Aviation Safety Team (CAST)

In 2010, the FAA Airports Safety and Standards (AAS), USDA and the Air Transport Association (now Airlines for America) requested that the Commercial Aviation Safety Team (CAST) formally charter a Joint Safety Analysis Team or similar effort to review the wildlife strike/ aviation problem. CAST determined that the Joint Implementation Measurement and Data Analysis Team (JIMDAT) group would track wildlife strikes and provide periodic monitoring reports to CAST concerning wildlife strikes.

During a February 2013 CAST meeting, CAST fully approved JIMDAT “Option 2” Birdstrike monitoring proposal. This included reporting fatality risk values at appropriate intervals and trending egregious events to provide confidence. Egregious event categories to monitor are: A/C Controllability, Fire, Multiple Systems Damaged, High Risk RTO, Loss of/Unreliable Cockpit Data, Cockpit Intrusion (Risk of Pilot Incapacitation), and Encountered Many Large Birds. Event categories were chosen by a SME panel as safety significant event precursors.

Performance Metrics

Starting in FY 2013 the FAA adopted the following performance metrics that will measure program efficacy under a voluntary strike reporting environment where the absolute number of bird strikes is not known. These three performance metrics allow the FAA to monitor multiple factors that affect strike reporting and overall strike reporting

trends and the effectiveness of GA wildlife mitigation programs. To date, strike reporting trends continue to show an increase in overall reporting contrasted with an actual decline in damaging strikes from 764 in 2000 to 601 in 2013. Further analysis of strike reporting trends will be completed in FY2014 following completion of Metric 2.

Metric 1: Monitor the ratio between the numbers of strikes with damage compared to total reported strikes. This ratio is independent of the total number of strikes reported and is a good measure of the effectiveness of overall mitigation procedures. We will use 2010 as the baseline data and calculate the performance measure for 2011, 2012, 2013 and future years. The table below depicts the results of calculating the data for FYs 2010, 2011, 2012 and 2013.

	Total Strikes Reported	Damaging Strikes Reported	Percentage Damaging Strikes vs. Total Strikes
FY 10	9,927	599	6.0%
FY 11	10,127	542	5.4%
FY 12	10,917	611	5.6%
FY 13	11,315	601	5.3%

Metric 2: Monitor estimated reporting rate of wildlife strikes. In FY 2014, we will update the study (Dolbeer 2009) that estimated the 39 percent reporting rate to determine if our outreach efforts have increased the reporting rate. We will continue to update the study every 3 years thereafter.

Metric 3: We will monitor the number of GA airport Assessments or Site Visits initiated. This is an important metric as we are just starting an initiative to complete Assessments or Site Visits at more than 2,700 GA airports. This initiative will run for more than 10 years, and it is important to track our progress. We are in the process of implementing procedures to collect data on GA airports conducting Assessments. The data will be included in the next report.

APPENDIX A.

SELECTED SIGNIFICANT WILDLIFE STRIKES TO U.S. CIVIL AIRCRAFT, 2013

The U.S. Department of Agriculture, through an interagency agreement with the Federal Aviation Administration, compiles a database of all reported wildlife strikes to U.S. civil aircraft and to foreign carriers experiencing strikes in the USA. From 1990 through 2013, 142,603 strike reports from 1,821 USA airports and 277 foreign airports have been entered in the database (11,315 strikes from 649 USA and 85 foreign airports in 2013, Tables 1, 7; Figure 5). The following 29 examples from the database in 2013 are presented to show the serious impact that strikes by birds or other wildlife can have on aircraft. These examples, from throughout the USA, demonstrate the widespread and diverse nature of the problem. The examples are not intended to highlight or criticize individual airports because, as documented above, strikes have occurred on almost every airport in the USA. Some of the strike examples reported here occurred off airport property during approach or departure. For more information on wildlife strikes or to report a strike, visit www.birdstrike.org and <http://wildlife.faa.gov>.

Date:	24 January 2013
Aircraft	B-737-700
Airport:	Sacramento International (CA)
Phase of Flight:	Climb (1,500 feet AGL)
Effect on Flight:	Precautionary landing
Damage:	Engine
Wildlife Species:	Snow goose
Comments from Report: The aircraft had multiple strikes on climb-out, declared an emergency due to vibration in the #2 engine. They returned to land safely. The #2 engine had significant fan blade damage and the #1 engine had bird remains. ID by Smithsonian, Division of Birds. Time out of service was 24 hours. Cost of repairs reported as \$20,000 and other costs \$25,000.	

Date:	8 February 2013
Aircraft	Eurocopter EC 135
Airport:	Near Viera, FL
Phase of Flight:	En Route (1,000 feet AGL)
Effect on Flight:	Precautionary landing
Damage:	Windshield, rotor, fuselage
Wildlife Species:	Ducks
Comments from Report: There was a large explosion and a bird hit the pilot in the face during a night flight. His goggles were knocked off and he was bleeding. The front canopy had blown out. The aircraft was slowed and they made a precautionary landing without incident. A second bird broke out the left side co/pilot's window and that duck hit the nurse in the back seat injuring his arm. A couple of birds went through the rotor system damaging the blades and took a chunk out of the main rotor hub hat. The pilot was taken to the hospital. Time out of service was 2 weeks. Cost of repairs totaled \$70,000 and other costs totaled \$35,000.	

Wildlife Strikes to Civil Aircraft in the United States, 1990–2013

Date:	13 February 2013
Aircraft	Avions Fairey Topsy Nipper
Airport:	Near Winters, CA
Phase of Flight:	En Route
Effect on Flight:	Impacted ground
Damage:	Aircraft destroyed
Wildlife Species:	Turkey vulture
Comments from Report: The experimental aircraft was destroyed when it impacted terrain after being struck by a turkey vulture. The pilot was fatally injured. Witnesses saw the aircraft wing separate from the aircraft after hearing a loud crack. ID by Smithsonian, Division of Birds. NTSB investigated.	

Date:	7 March 2013
Aircraft	Airbus 320
Airport:	Charlotte/Douglas International (NC)
Phase of Flight:	Take-off run
Effect on Flight:	Aborted take-off
Damage:	Engine, landing gear
Wildlife Species:	Red-tailed hawk
Comments from Report: Take off was aborted when a red-tailed hawk was ingested into the #2 engine. The aircraft had to be towed back to the gate due to a flat tire caused by hot brakes from the high-speed aborted take-off. Fire Department trucks were called to the scene. Several fan blades were bent. Replaced fan set and repaired acoustical liner. ID by Smithsonian, Division of Birds. Time out of service 4 days.	

Date:	24 March 2013
Aircraft	CRJ700
Airport:	Calgary International (Canada)
Phase of Flight:	Climb (500 feet AGL)
Effect on Flight:	Engine shut down, precautionary landing
Damage:	Engine
Wildlife Species:	Canada goose
Comments from Report: During initial climb a Canada goose was ingested into the #2 engine. The crew shut the engine down and returned to Calgary for a safe landing. Post flight inspection showed fan blade damage with a number of blade tips missing. Damage on the engine cowl suggests the blade tips exited through the top cowl. ID by Smithsonian, Division of Birds. Time out of service 17 days. Cost estimated to be \$1 million.	

Wildlife Strikes to Civil Aircraft in the United States, 1990–2013

Date:	19 April 2013
Aircraft	Piper 42
Airport:	Edwin A Link Field (NY)
Phase of Flight:	Take-off run
Effect on Flight:	Aborted take-off
Damage:	Propeller
Wildlife Species:	Wild turkey
Comments from Report: Significant damage to the right propeller. Engine and rest of airframe while splattered with remains, were not damaged. Time out of service was 10 days. Costs of repairs totaled \$90,000.	

Date:	25 May 2013
Aircraft	Eurocopter AS 350
Airport:	near Nevada, MO
Phase of Flight:	En route (1,200 feet AGL)
Effect on Flight:	Precautionary landing
Damage:	Nose
Wildlife Species:	American coot
Comments from Report: Bird was struck at night causing a large hole in the nose on the left side. ID by Smithsonian, Division of Birds. Time out of service was 12 days. Cost estimated to be \$55,000.	

Date:	8 June 2013
Aircraft	Vans RV7
Airport:	Vinton Veterans Memorial Airpark (IA)
Phase of Flight:	Landing roll
Effect on Flight:	None
Damage:	Wing, fuel tank, fuselage
Wildlife Species:	White-tailed deer
Comments from Report: Just after touchdown, pilot saw three deer and hit one. Pilot was able to maintain directional control.	

Date:	17 August 2013
Aircraft	Cessna 172
Airport:	Greater Kankakee (IL)
Phase of Flight:	Climb (10 feet AGL)
Effect on Flight:	Precautionary landing
Damage:	Nose, propeller, fuselage, landing gear
Wildlife Species:	White-tailed deer
Comments from Report: Aircraft was out of service at least a month. Costs estimated at \$15,000.	

Wildlife Strikes to Civil Aircraft in the United States, 1990–2013

Date:	22 August 2013
Aircraft	MD-82
Airport:	Dallas/Fort Worth International (TX)
Phase of Flight:	Climb (500 feet AGL)
Effect on Flight:	Precautionary landing
Damage:	Engine
Wildlife Species:	Swainson's hawk
Comments from Report: Struck a bird on departure, declared an emergency and returned for an uneventful, overweight landing. Taxied to gate under own power. Fan blades were heavily damaged. It appeared more than one bird might have been ingested. ID by Smithsonian, Division of Birds. Aircraft out of service 35.5 hours.	

Date:	24 August 2013
Aircraft	MD-11
Airport:	Newark Liberty International (NJ)
Phase of Flight:	Approach (400 feet AGL)
Effect on Flight:	None
Damage:	Radome
Wildlife Species:	Herring gull
Comments from Report: Bird was struck on short final. Pilots saw bird strike radome then radar cut out. Radome was destroyed. ID by Smithsonian, Division of Birds. Aircraft was out of service for 3 days. Costs totaled \$17,240	

Date:	29 August 2013
Aircraft	Cessna Citation 750
Airport:	Napa County (CA)
Phase of Flight:	Landing roll
Effect on Flight:	None
Damage:	Wing
Wildlife Species:	Mule deer
Comments from Report: Aircraft struck a deer upon landing and exited the runway without assistance. There was substantial damage to the right wing. Pilot did not see the deer, only felt a slight bump. Co-pilot saw the deer approaching from the right but did not have time to warn the pilot. Time out of service was 1 month. Cost estimated to be between \$230,000 and \$250,000.	

Wildlife Strikes to Civil Aircraft in the United States, 1990–2013

Date:	1 September 2013
Aircraft	BE-A36
Airport:	Ashland Regional (KY)
Phase of Flight:	Landing roll
Effect on Flight:	None
Damage:	Nose, propeller, spinner, alternator, wings, fuselage, landing gear, tail
Wildlife Species:	Canada goose
Comments from Report: Airport removed 16 birds from the runway. Aircraft was not airworthy after the strike. Time out of service and costs not reported.	

Date:	2 September 2013
Aircraft	B-737-700
Airport:	Raleigh-Durham International (NC)
Phase of Flight:	Take-off run
Effect on Flight:	Engine shut down, precautionary landing
Damage:	Engine
Wildlife Species:	Canada goose
Comments from Report: During take-off run, at least one large bird was ingested in the #1 engine. Tower advised that there was smoke and flame. There were erratic engine indications. The engine was shut down and the aircraft made an emergency landing safely. One fan blade was replaced. Cost of repairs was \$12,500. Cost of re-routing passengers not reported.	

Date:	2 September 2013
Aircraft	B-737-700
Airport:	Bishop (MI)
Phase of Flight:	Take-off run
Effect on Flight:	Precautionary landing
Damage:	Angle of attack vane, wing, engine
Wildlife Species:	Herring gull
Comments from Report: During rotation at take-off, several birds were struck. The aircraft made a safe landing. Aircraft had lost some systems and needed to make easy turns to come back. The Captains' AOA vane was sheared off. Bird remains were found in the left wing, #1 engine inboard cell. Another aircraft was used to continue the flight. Time out of service was 24 hours. Cost totaled \$37,688.	

Wildlife Strikes to Civil Aircraft in the United States, 1990–2013

Date:	7 September 2013
Aircraft	Bell 206
Airport:	Near Amistad, NM
Phase of Flight:	En route (300 feet AGL)
Effect on Flight:	Avoidance maneuver
Damage:	Destroyed
Wildlife Species:	Unknown large birds
Comments from Report: Not a strike but effected flight. Pilot tried to avoid multiple large black birds in the flight path. The abrupt maneuver resulted in an impact with terrain. Both the pilot and a crew member received minor injuries. The aircraft was destroyed. It was valued at over \$800,000. NTSB investigated.	

Date:	12 September 2013
Aircraft	Citation 525
Airport:	Porter County Municipal (IN)
Phase of Flight:	Take-off run
Effect on Flight:	Aborted take-off
Damage:	Engine
Wildlife Species:	Red-tailed hawk
Comments from Report: Bird was ingested during take-off. Extensive internal damage to the engine. Time out of service was 19 days. Cost totaled \$330,000.	

Date:	13 September 2013
Aircraft	Piper 28
Airport:	Near Princeton, MN
Phase of Flight:	En Route
Effect on Flight:	Precautionary landing
Damage:	Destroyed
Wildlife Species:	Bald eagle
Comments from Report: During flight instruction, a bald eagle struck the right horizontal stabilizer. The instructor took the controls and declared an emergency. He proceeded to land at the nearest airport. The rudder controls were impaired. A large dent was found on the right horizontal stabilizer with feathers embedded in it. The tail cone had been pushed upward and was in contact with the rudder, impeding its movement. The insurance company determined the aircraft as a total loss based on cost of repairs. Repairs cost would have exceeded \$45,000.	

Wildlife Strikes to Civil Aircraft in the United States, 1990–2013

Date:	22 September 2013
Aircraft	Cessna 172
Airport:	College Park (MD)
Phase of Flight:	Approach (800 feet AGL)
Effect on Flight:	Aircraft controls effected
Damage:	Windshield
Wildlife Species:	Unknown medium bird
Comments from Report: Bird struck propeller and destroyed the windshield when aircraft was approximately 7 miles from the airport. Pilot and front seat passenger sustained minor cuts. The strike required emergency approach as the aerodynamics were significantly affected. Navigation and communication were almost impossible with the wind in the cockpit. Costs totaled \$9,400.	

Date:	8 October 2013
Aircraft	B-767-300
Airport:	John F. Kennedy International (NY)
Phase of Flight:	Approach (100 feet AGL)
Effect on Flight:	Schedule interruption
Damage:	Engine, wing fuel dump nozzle
Wildlife Species:	Canada goose
Comments from Report: Pilot saw and struck 20-30 birds on approach. Engine ingested numerous birds causing compressor damage. The engine was replaced. Left wing fuel dump nozzle was also damaged. Passengers were put up in a hotel and flight departed the next day.	

Date:	9 October 2013
Aircraft	Cessna 310
Airport:	Leo Goetz County (MI)
Phase of Flight:	Approach (5 feet AGL)
Effect on Flight:	Landing gear collapsed
Damage:	Destroyed
Wildlife Species:	White-tailed deer
Comments from Report: Pilot was in the landing flare just prior to touchdown when he saw 3 deer run onto the runway. One was struck by the left main landing gear. The collision folded the gear aft and the left wing contacted the runway as the plane touched down. The aircraft slid down the runway and veered off the left side before coming to rest. Substantial damage to the left wing and aileron. Aircraft was salvaged. Repairs costs reported to be approximately \$180,000.	

Wildlife Strikes to Civil Aircraft in the United States, 1990–2013

Date:	12 October 2013
Aircraft	Cessna 525
Airport:	Lincoln (NE)
Phase of Flight:	Climb (1,200 feet AGL)
Effect on Flight:	Precautionary landing
Damage:	Wing
Wildlife Species:	American white pelican
Comments from Report: During climb, the flight crew noted a flock of birds 7-8 miles northeast of the airport. They struck one with the right outboard wing. After noting substantial wing damage, they returned to the airport and landed without incident. Costs totaled \$258,083. NTSB investigated. ID by Smithsonian, Division of Birds.	

Date:	18 October 2013
Aircraft	B-747-400
Airport:	Dallas/Fort Worth International (TX)
Phase of Flight:	Take-off run or climb
Effect on Flight:	Engine shut down
Damage:	Engine, flight diverted
Wildlife Species:	American coot
Comments from Report: On departure struck birds in the #1 engine. Engine shut down, flight was diverted to KLAX and the flight to BNE was cancelled. Engine vibration. Fuel was dumped. Two fan blades were replaced, later entire engine was changed out. Passengers were put up in hotels overnight. Aircraft was out of service for two days. Cost for engine repairs was \$40,000. ID by Smithsonian, Division of Birds.	

Date:	20 October 2013
Aircraft	Eurocopter AS 350
Airport:	Near Madison, MS
Phase of Flight:	En Route
Effect on Flight:	Emergency landing
Damage:	Windshield, dash, doors
Wildlife Species:	Black vulture
Comments from Report: Pilot was climbing through 1,300 feet when he felt an explosion in his face that knocked his visor up affecting his visibility and crew communications. He landed safely in a field. Both windshields were blown out, the cabin shell was damaged. Both cabin doors were blown open and came off the top sliding track. Onboard medical equipment was missing. All 3 crew members received minor injuries after being struck by pieces of the windscreen or dash. There was no patient onboard. ID by Smithsonian, Division of Birds. Cost estimated to be \$175,000. Aircraft still out of service as of March 11, 2014.	

Wildlife Strikes to Civil Aircraft in the United States, 1990–2013

Date:	15 November 2013
Aircraft	MD 83
Airport:	Mineta San Jose International (CA)
Phase of Flight:	Climb (900 feet AGL)
Effect on Flight:	Engine shut down
Damage:	Engine
Wildlife Species:	White-headed gull
Comments from Report: Multiple birds were struck during climb. At least one bird was ingested. The engine was shut down as a precaution. The crew declared an emergency and returned to land safely. ID by Smithsonian, Division of Birds as white-headed gull (Larus sp.). Insufficient diagnostic material for more specific ID.	

Date:	1 December 2013
Aircraft	Beech G35
Airport:	Placerville (CA)
Phase of Flight:	Landing roll
Effect on Flight:	Ran off runway
Damage:	Destroyed
Wildlife Species:	Mule deer
Comments from Report: Aircraft struck a deer with the right wing during landing roll and veered off the runway down an embankment. The aircraft was destroyed.	

Date:	5 December 2013
Aircraft	CJR200
Airport:	LaGuardia (NY)
Phase of Flight:	Approach (7,000 feet AGL)
Effect on Flight:	None
Damage:	Radome
Wildlife Species:	White-headed gull
Comments from Report: Multiple birds were struck during climb. At least one bird was ingested. The engine was shut down as a precaution. The crew declared an emergency and returned to land safely. ID by Smithsonian, Division of Birds as white-headed gull (Larus sp.). Insufficient diagnostic material for more specific ID.	

Wildlife Strikes to Civil Aircraft in the United States, 1990–2013

Date:	20 December 2013
Aircraft	Challenger 300
Airport:	Naples Municipal (FL)
Phase of Flight:	Climb (1,800 feet AGL)
Effect on Flight:	Precautionary landing
Damage:	Engine, tail
Wildlife Species:	Turkey vulture
<p>Comments from Report: About 2 minutes after take-off at 1,800 feet AGL, a large (50+) kettle of turkey vultures was encountered. Bottom edge of the kettle was impacted. Estimate 4-5 birds struck. Upon impact to left engine and vertical stabilizer, a very significant increase in noise and vibration was noted. Engine parameters were fairly normal with the exception of EICAS message for vibration. An emergency was declared and a normal landing was made at KRSW. At least one bird was ingested. The engine was shut down by the pilot upon exiting the runway. ID by Smithsonian, Division of Birds. Damage costs = \$800,000 and other costs = \$90,000.</p>	

Date:	23 December 2013
Aircraft	B-737-300
Airport:	Lambert-St. Louis International (MO)
Phase of Flight:	Climb (1,500 feet AGL)
Effect on Flight:	Engine shut down, precautionary landing
Damage:	Engine, wing
Wildlife Species:	Mallard
<p>Comments from Report: Multiple birds were struck during climb. At least one bird was ingested. The engine was shut down as a precaution. The flight returned to land safely. There was a 12 to 14 inch hole in the leading edge of the right wing. Fan blades are missing or bent. A full set of fan blades was replaced. ID by Smithsonian, Division of Birds. Time out of service was 3 days. Costs totaled \$493,584.</p>	

APPENDIX B.

REPORTING A STRIKE AND IDENTIFYING SPECIES OF WILDLIFE STRUCK

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

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

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

Material sent via Express Mail Service:	Material sent via U.S. Postal Service:
Feather Identification Lab Smithsonian Institution NMNH E600, MRC 116 10 th & Constitution Ave. NW Washington, D.C. 20560-0116 (label package “safety investigation material”) Phone #s 202-633-0787 or 202-633-0791	Feather Identification Lab Smithsonian Institution, NMNH E600, MRC 116 P.O. Box 37012 Washington, D.C. 20013-7012 (not recommended for priority cases)

The number of bird strike cases processed by the Smithsonian Feather Identification Lab for the FAA (civil aviation) in 2013 was 2,474 with 2,620 separate identifications of species (some cases involved remains from multiple impact points). This compares to 2,072 cases in 2012, 1,580 cases in 2011 and 1,268 cases in 2010 (Dove et al. 2014). In addition, the Lab processed 4,643 identifications for the U.S. Air Force and 676 identifications for the U.S. Navy (not discussed in this report). DNA analysis was used in 1,627 (62 percent) of all identifications for civil aviation to identify, supplement, or verify traditional identification methods.

Whenever possible, reporters should send whole feathers as diagnostic characteristics are often found in the downy barbs at the feather base. Wings, as well as breast and

tail feathers, should be sent whenever possible. Beaks, feet, bones, and talons are also useful diagnostic materials. Even blood smears can provide material for DNA analysis (Dove et al. 2008). Do not send entire bird carcasses through the mail. However, photographs of the carcasses can be useful supplemental documentation.

Guidelines for Collecting Bird Strike Material

- Always include any feather material available.
- Include copy of report (FAA 5200-7).
- Always secure all remains in re-sealable plastic bag.

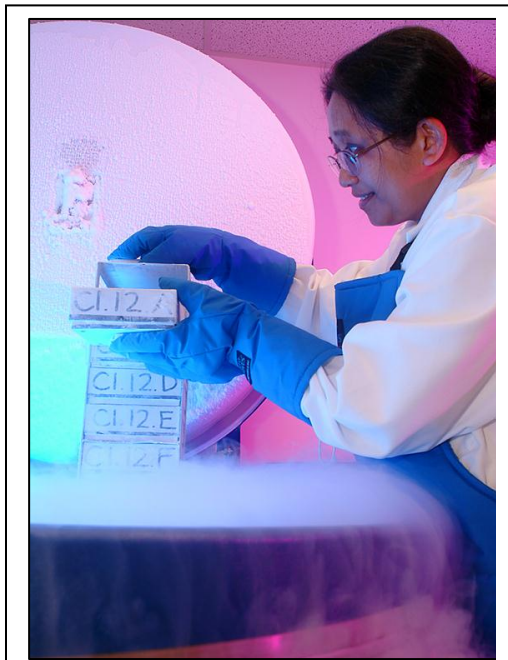
Feathers:

Whole Bird – Pluck a variety of feathers (breast, back, wing, tail)

Partial Bird – Collect a variety of feathers with color or pattern

Feathers only – Send all material available. Do not cut feathers from the bird (downy part at the base of the feathers is needed). Do not use any sticky substance (no tape or glue).

Tissue/blood (“Snarge”):



A scientist uses avian tissues in the Smithsonian's Biorepository to help build a library of DNA sequences. These known sequences are used to match unknown bird strike samples that contain only blood or tissue evidence. Photo by Smithsonian Institution.

Dry material – Scrape or wipe off into a clean re-closeable bag **or** wipe area with pre-packaged alcohol wipe **or** spray with alcohol to loosen material then wipe with clean cloth/gauze. (Do not use water, bleach, or other cleansers; they destroy DNA.)

Fresh material – Wipe area with alcohol wipe and/or clean cloth/gauze **or** apply fresh tissue/blood to an FTA® DNA collecting card.

FTA® Micro Card and Sterile Applicators

If you send a lot of fresh blood/ tissue samples for DNA identification, you may want to consider getting Whatman FTA® DNA cards. The material is sampled with a sterile applicator and placed onto the surface of the card that “fixes” the DNA in the sample. For more information on ordering these items contact the Feather Lab.

Note: If you only occasionally send blood/ tissue samples, a paper towel with alcohol or alcohol wipe is still a good option for this type of material.

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

APPENDIX C.

“REPORTING WILDLIFE STRIKES” POSTER



Report Wildlife Strikes

 <http://wildlife.faa.gov>  <http://www.faa.gov/wireless>

