U. S. DEPARTMENT
OF TRANSPORTATION
FEDERAL AVIATION
ADMINISTRATION

# Wildlife Strikes to Civil Aircraft in the United States 1990 – 2022

U. S. DEPARTMENT
OF AGRICULTURE
WILDLIFE SERVICES

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The Federal Aviation Administration produced this report in cooperation with the U. S. Department of Agriculture, Wildlife Services, under an interagency agreement (692M15-19-T-00017). The purpose of this agreement is to 1) document wildlife strikes to civil aviation through management of the FAA National Wildlife Strike Database and 2) research, evaluate, and communicate the effectiveness of various habitat management and wildlife control techniques for minimizing wildlife strikes with aircraft at and away from airports. These activities provide a scientific basis for FAA policies, regulatory decisions, and recommendations regarding airport safety and wildlife.

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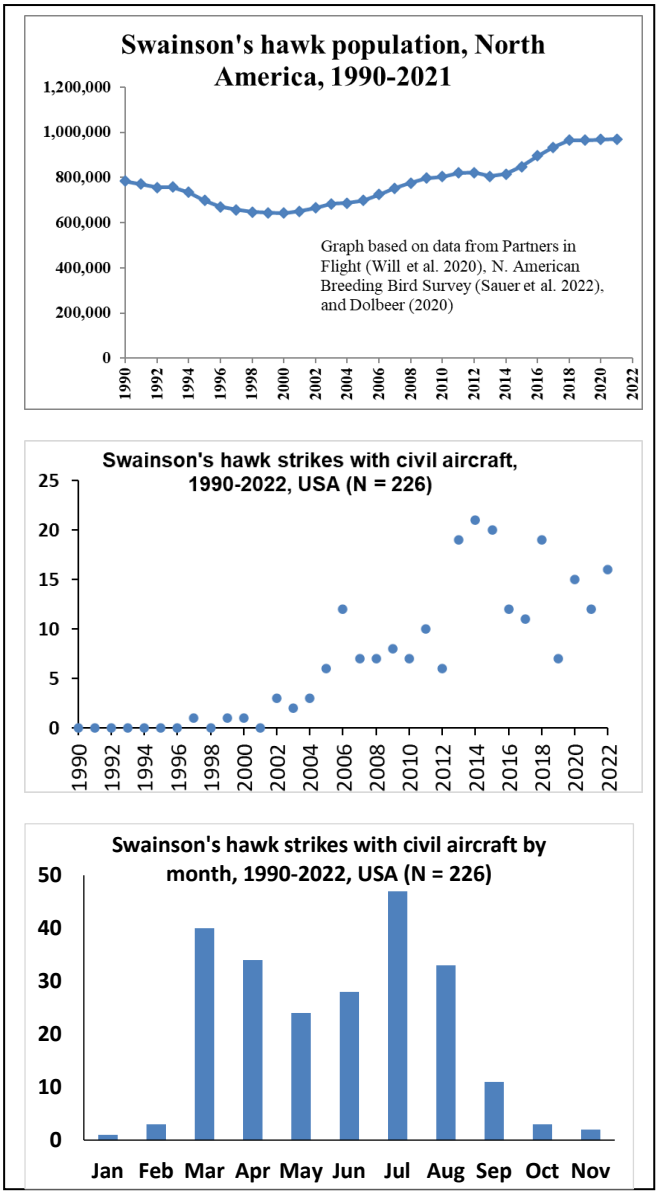
## COVER PAGE

An Airbus 321 ingested a large bird in the #1 engine during a late afternoon take-off run at a western airport, July 2022. The engine suffered catastrophic damage and caught fire. The right main landing gear was damaged by excessive heat from braking. The aircraft was taken out of service, and passengers rebooked on other flights.

Bird remains collected from the damaged engine and sent to the Smithsonian Feather Laboratory were identified as from a Swainson's hawk (mean body mass = 1.1 kg).

The population of Swainson's hawks in North America declined slightly in the 1990s but increased about 50% from 2000-2021. During the past 10 years (2013 -2022), an average of 15 strikes involving Swainson's hawks and civil aircraft were reported per year in USA.

This species breeds across much of the western USA and southwestern Canada and migrates primarily to South America for the winter. Thus, most strikes with aircraft in the USA occur in summer. This transitory behavior makes managing Swainson's hawks around airports a challenging endeavor for airport biologists.




The National Wildlife Strike Database provides the scientific foundation for policies and management programs to mitigate the risk of strikes by Swainson's hawks and other wildlife in ways compliant with the Migratory Bird Treaty Act and other environmental laws at all levels of government.

Photos: **C. Selner** (aircraft); **Steven Mlodinow** (Swainson's hawk).

# ACKNOWLEDGMENTS

The National Wildlife Strike Database (NWSD) office acknowledges the many people who took the time and effort to report the 276,846 wildlife strikes summarized in this report–pilots, mechanics, control tower and airport operations personnel, airline flight safety officers, airport wildlife biologists, and many others. We recognize **Mahalah Schank** (USDA) for her diligence in entering and editing data and editing this report. We acknowledge **Wesley Major** (FAA) for his leadership. and technical advice. We recognize **Marcy Heacker** who retired in 2022 from the Smithsonian Institution Feather Identification Laboratory, for her dedicated service in ensuring accurate species identifications. Special recognition is given to **Sandra Wright**, who managed the NWSD from its inception in 1995 until her retirement in 2015. She set a high standard for data quality and consistency so that analyses such as presented in this report could be accomplished. We also acknowledge **Gene LeBoeuf** (FAA, retired) and **Edward Cleary** (FAA, deceased) for their leadership in initiating and developing the NWSD. Finally, we acknowledge the suggestions and critiques made by various people over the years that have enhanced the usefulness and accuracy of the NWSD and annual reports such as presented here.

Sponsorship and funds for the ongoing maintenance and analysis of the NWSD are provided by the FAA, Office of Airport Safety and Standards, Washington, DC, and the Airport Technology Research and Development Branch, FAA William J. Hughes Technical Center, Atlantic City, NJ.

## EXECUTIVE SUMMARY – PART 1: WILDLIFE STRIKES TO CIVIL AIRCRAFT IN THE UNITED STATES, 1990–2022

Although birds are critical ecologic, economic, and esthetic components of the environment deserving rigorous international protection, they can at times conflict with human activities such as aviation. Aircraft collisions with birds and other wildlife (wildlife strikes) have become a growing concern for aviation safety. Factors that contribute to this threat are increasing populations of large birds and increased air traffic by quieter, turbofan-powered aircraft. Globally, wildlife strikes killed more than 464 people and destroyed over 305 aircraft from 1988-2022.

This report presents an analysis of data from the National Wildlife Strike Database (NWSD) for the 33-year period, 1990 through 2022. A sample of 15 significant wildlife strikes to civil aircraft in the USA during 2022 is also included as Appendix A. Appendix B explains how to report strikes and the role of the Smithsonian Institution Feather Lab in identifying bird and other wildlife species that are struck. Appendix C lists the scientific names and mean body masses for the 774 wildlife species mentioned in the report.

In 2022, 17,190 strikes were reported, an increase of 10 percent compared to the 15,639 strikes reported in 2021. The 10 percent increase was directly related to the respective 10 percent and 4 percent increases in aircraft movements at Part 139 airports (certificated for passenger service) and general aviation airports in 2022 compared to 2021 following relaxation of COVID-19 travel restrictions. For the 33-year period (1990–2022), 276,846 strikes were reported of which 272,016 (98.3 percent) occurred in the USA.

Both Part 139-certificated airports and general aviation airports have recorded significant increases in reported strikes per 100,000 movements from 1990-2022. However, the number of damaging strikes per 100,000 movements below 1,500 feet above ground level has remained stable at Part 139-certificated airports from 2000– 2022 whereas there has been a significant increase in the damaging strike rate at general aviation airports.

In 2022, 73 percent and <1 percent of the 17,190 strike reports were filed using the electronic and paper versions, respectively, of FAA Form 5200-7, Bird/Other Wildlife Strike Report. More than one type of report was filed for the same strike event in 16 percent of the strikes (many of these had at least one FAA Form 5200-7E report filed). Ten percent of reports were submitted via the Air Traffic Organization Mandatory Occurrence Reporting system.

The 693 airports with strikes reported in 2022 were comprised of 429 Part 139-certificated airports and 264 general aviation airports. From 1990-2022, strikes have been reported from 2,062 different USA airports. Commercial transport and general aviation aircraft were involved in 86 and 14 percent of the reported strikes in 2022.

From 1990 to 2022, 54 percent of bird strikes occurred between July and October; 29 percent of deer strikes occurred in October-November. Terrestrial mammals are more likely to be struck at night (62 percent) whereas birds are struck more often during the day

(62 percent). Birds, terrestrial mammals, and bats are all much more likely to be struck during the arrival phase of flight (61, 63, and 85 percent of strikes, respectively) compared to departure (34, 33 and 12 percent, respectively).

For commercial transport and general aviation aircraft, about 70 percent of bird strikes occurred at or below 500 feet AGL from 1990 to 2022. Above 500 feet AGL, the number of strikes declined by 34 percent for each 1,000-foot gain in height for commercial transport aircraft, and by 42 percent for general aviation 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 2022, 639 species of birds, 55 species of terrestrial mammals, 46 species of bats, and 34 species of reptiles were identified as struck by aircraft. Waterfowl, raptors, and gulls 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 7 percent for the 33-year period, this number has declined from a peak of 18 percent in 1995 to 4 percent in 2022.

A negative effect-on-flight was reported in 5 percent and 15 percent of the bird and terrestrial mammal strike reports, respectively, 1990-2022. Precautionary/emergency landing after striking wildlife was the most reported negative effect (8,030 incidents), including 330 incidents in which the pilot either jettisoned fuel (63 incidents, mean of 14,421 gallons), made an overweight landing (135 incidents), or burned fuel in circling pattern (132 incidents). Aborted take-off was the second most reported negative effect (2,976 incidents). These negative incidents included 601 aborted take-offs at $\geq$100 knots. As has the trend for the percentage of strikes causing damage, the percentage of strikes with a reported negative effect-on-flight has declined from a high of 11 percent in 1995-1996 to 3 percent in 2022. For commercial transport aircraft, the number of high-speed ($\geq$100 knots) aborted take-offs declined from a high of 25 in 2000 to 8 in 2022.

For the 33 species of birds most frequently identified as struck by civil aircraft, 1990-2022, there was a strong correlation ($R^2$ = 0.83) 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 percent increase in the likelihood of damage. Thus, body mass is a good predictor of relative hazard level among bird species.

Eighty-one strikes resulted in a destroyed aircraft from 1990-2022 (none in 2022); 46 (57 percent) of these occurred at general aviation airports. The annual cost of wildlife strikes to the USA civil aviation industry in 2022 was projected to be 67,848 hours of aircraft downtime and $385 million in direct and other monetary losses. These projections may be at the high end of actual costs because of the skewed nature of reported cost data. More thorough reporting of strike events and associated costs combined with additional economic analyses are needed to refine the actual costs of wildlife strikes to the aviation industry.

This analysis of 33 years of strike data documents the progress being made in reducing damaging strikes for commercial transport aircraft. Management actions to mitigate the risk have been implemented at many airports since the 1990s; these efforts are likely responsible for the general stabilization or decline in reported strikes with damage and a negative effect-on-flight at Part 139-certificated airports from 2000-2022 despite 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 outside the airport environment, municipalities and the aviation community must first widen their view of wildlife management to minimize hazardous wildlife attractants within 5 miles of airports. Second, the aviation community needs to broaden the view of wildlife strike risks from a ground-based wildlife management problem to an airspace management problem that also encompasses Air Traffic Control, flight crews, and aircraft manufacturers. Long-term goals include the integration of avian radar and bird migration forecasting into airspace management and the development of aircraft lighting systems to enhance detection and avoidance by birds. Finally, there continues to be a need for increased and more detailed strike reporting. When reports are filed, it is important that relevant information be provided whenever possible regarding species identification, number of wildlife struck, time and height of strike, phase of flight, and damage to aircraft components. A problem that is not well defined cannot be properly managed.

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

In 2022, the FAA continued a multifaceted approach for mitigating wildlife strikes both nationally and globally. This included continuing a robust research program, making improvements to the NWSD and outreach, working with the International Civil Aviation Organization (ICAO) headquarters in Montreal, the ICAO Asia Pacific (APAC) region and other foreign destinations as well as providing Airport Improvement Program (AIP) funding to airports to conduct Wildlife Hazard Assessments (Assessments) and develop Wildlife Hazard Management Plans (Plans).

Landmark events such as the emergency forced landing of US Airways Flight 1549 Airbus 320 into the Hudson River on January 15, 2009 demonstrated to the world the severity of aircraft collisions with birds and other wildlife. Comprehensive evaluations have ensured optimal guidance, compliance and risk reduction moving forward. The FAA, in conjunction with the USDA and Smithsonian Institution, has worked to improve strike reporting options, turnaround time from report submission to public availability, data processing and analysis, as well as data access via this report and our web sites. Updated software has allowed strike reports to be vetted and publicly available in the NWSD within 4-5 days of the strike report being submitted. This is a substantial improvement over the historic 1 - 2 month quality assurance delay needed in previous years without the technological

enhancements. The reduced turnaround time has provided immediate benefits to airports, airlines, engine and airframe manufacturers and biologists alike.

In the fourteen-year span 2009 – 2022, over $400 million of Airport Improvement Program (AIP) funds have been allocated for wildlife-related projects such as Assessments, Plans and airport perimeter fencing. All Part 139 certificated airports have successfully completed Assessments followed by Plans. Many of those airports have already updated their original Assessments with new ones while others have chosen to implement Continual Monitoring programs as detailed in Advisory Circular 150/ 5200- 38 - *Protocol for the Conduct and Review of Wildlife Hazard Site Visits, Wildlife Hazard Assessments, and Wildlife Hazard Management Plans* (published August 20, 2018).

In October 2022, the FAA released a new Wildlife Hazards video. This updated outreach endeavor is part of the FAA Airport Safety Information Video Series. It discusses how successful wildlife strike reporting and the National Wildlife Strike Database (jointly administered by USDA and FAA) is reducing the impact of wildlife strikes on both commercial and general aviation.

The FAA dedicated over $30 million in research funds since Flight 1549's emergency forced landing into the Hudson River in 2009. These research funds help us better understand the capabilities of advanced detection and monitoring systems such as avian radars, Foreign Object Debris (FOD) radars and infrared / electro-optical scanning systems. Other research initiatives included aircraft-mounted lighting systems to enhance bird detection and avoidance, wildlife control techniques, habitat management, Canada goose movement analyses, capture and relocation efficacy of raptors, DNA and molecular identifications, and the evaluation of unmanned aerial systems (UAS) for hazing, detection and monitoring hazardous wildlife.

On February 21, 2020, AC 150/5200-33C *Hazardous Wildlife Attractants On or Near Airports* was updated with significant changes. The updated language included clarification of separation criteria, new guidance on land-use practices (e.g., aquaculture, agriculture, dredge spoil, etc.), inclusion of general aviation (GA) airport wildlife responsibilities and a new section *Airport Procedures for Off-site Attractants* that provides step-by-step guidance when proposed land-use changes may provide an attractant to hazardous species.

Continuing international efforts in 2022 included: 1) assisting the ICAO APAC region with the development of a regional wildlife hazard management manual, 2) leading ICAO's ADOP.015.03 Job Card to rewrite the ICAO Birdstrike Information System (IBIS) manual (Doc 9332) as Rapporteur of the Wildlife Hazard Management Expert Group (WHMEG), 3) collaborating on a proposal to permit international strike data access and data sharing and 4) providing assistance to foreign regulators and aerodromes on an as-needed basis.

The Sandy Wright / Richard Dolbeer Excellence in Strike Reporting award was initiated in 2014 to recognize those airports that have exhibited a noteworthy strike-reporting program. For their commitment to the identification and documentation of wildlife / aircraft strike information, the FAA proudly recognizes the strike reporting programs at **Newark Liberty International Airport (EWR)** and **Quonset State Airport (OQU)** as the winners of the 2022 Sandy Wright / Richard Dolbeer Excellence in Strike Reporting award.

Covid-19 impacts to passenger air travel resulted in 62% and 31% reductions in air travel (520 million and 261 million fewer passengers) in 2020 and 2021, respectively, compared to pre-COVID-19 2019. It also resulted in 28% and 11% reductions in aircraft movements at 368 Part 139-certificated airports (10.3 million and 4.0 million fewer movements) in 2020 and 2021, respectively, compared to 2019. Although the decline in aircraft movements resulted in 33% and 9% reductions in reported strikes in 2020 and 2021, respectively, when compared to 2019, the strike rate (strikes/100,000 movements) declined by only 6% in 2020 and increased 2% in 2021 compared to 2019. COVID-19 clearly affected airport personnel and mitigation strategies, but risk reduction from wildlife remained a high priority at the nation's airports. Overall, the percentage of strikes with damage has fluctuated negligibly over the past 4 years (4.4% in 2018 – 2019 and 4.2% in 2020 – 2021). This again, shows why managing wildlife attractants off airport properties out to 5-miles is critical. Eighty-two percent of strikes occur at or below 1,500 feet Above Ground Level (AGL). This altitude falls within the 5-mile separation distance recommended for wildlife attractants, meaning that on-ground wildlife mitigation activities out to 5 miles can have a positive effect on risk reduction for 82 percent of all wildlife strikes.

Strikes occur every day, but when compared to the total number of flights in the system they are rare. Although it is impossible to eliminate all strikes at all times between aircraft and animals, comprehensive assessment, planning and management techniques have successfully mitigated damaging strikes on or near airports. Combined with systematic evaluation and adaptation of techniques, safety can be increased one less strike at a time.

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# PART 1: WILDLIFE STRIKES TO CIVIL AIRCRAFT IN THE UNITED STATES, 1990–2022

## INTRODUCTION

By the end of 2022, the NWSD contained strike records involving civil aircraft and 639 species of birds, 55 species of terrestrial mammals, 46 species of bats, and 34 species of reptiles for a total of 774 wildlife species since 1990. Each species has unique characteristics regarding body mass, physical density, social behavior, habitat use, feeding habits, movement patterns, and response to approaching aircraft. In addition to these factors, about 90 percent of the bird strikes involve species federally protected by the Migratory Bird Treaty Act (MBTA, Dolbeer 2021*a*). Most of the remaining 10 percent of bird species and the various mammal and reptile species have legal protection at the state and local level. This diversity of species, the overlying legal protections, and broad public concern for wildlife require that airports and engine and aircraft manufacturers consider a broad range of elements when mitigating the risk of bird and other wildlife strikes.

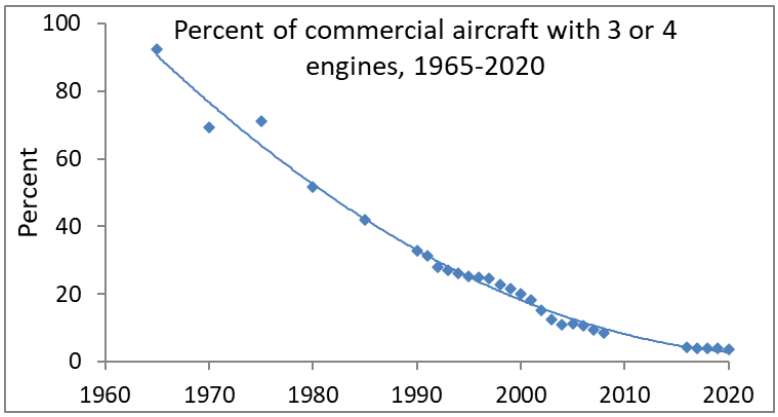
A B-737-800 on approach at night to a Midwest airport at 5000 feet AGL and 250 knots in November 2022 struck multiple Canada geese, causing damage to the radome, both wings, engine cowling, and Pitot tubes (airspeed indicators). The flight crew declared an emergency and landed safely with a visual approach 8 minutes after the strike. Photo, Roger Skorepa.

Although birds and other wildlife are critical ecologic, economic, and esthetic components of the environment deserving rigorous protection (Sekercioglu et al. 2016), they at times conflict with human activities such as agriculture (Linz et al. 2017) and aviation. Aircraft collisions with birds and other wildlife have become an increasing concern for aviation safety in recent years (Bogaisky 2019, Koerner 2020, Ghayad 2022).

The reasons for the increasing concern are complex. A major factor is that due to the MBTA, other environmental initiatives, and land-use changes, populations of most large bird species in North America have increased markedly in the last 3 decades and adapted to urban environments, including airports. Dolbeer (2020) examined the estimated population trends and numbers for the 36 species of birds in North America with mean

body masses ≥1.1 kg and at least 20 reported strikes with civil aircraft, 1990-2018 (certification standards for aircraft engines and airframe components require testing with bird masses from 1.1 kg to 3.6 kg depending on component and aircraft type [Croft 2011, 14 CFR Part 33-77]). Of these 36 larger species, 26 indicated population increases of greater than 10 percent, 5 were unchanged, and 5 showed declines of greater than 10 percent. The net gain in numbers for the 36 species was an estimated 35 million birds (62% increase). Notably, all 9 species with body mass ≥3.6 kg indicated population increases.

As a specific example, the resident population of Canada geese has increased over 4-fold from 1 million in 1990 to 4,5 million in 2021 (Dolbeer 2020, U.S. Fish and Wildlife Service 2022). During the same time, the sandhill crane population has increased about 4-fold from 200,000 to 800,000 (Dubovsky 2018, Dolbeer 2020, Sauer et al. 2022).

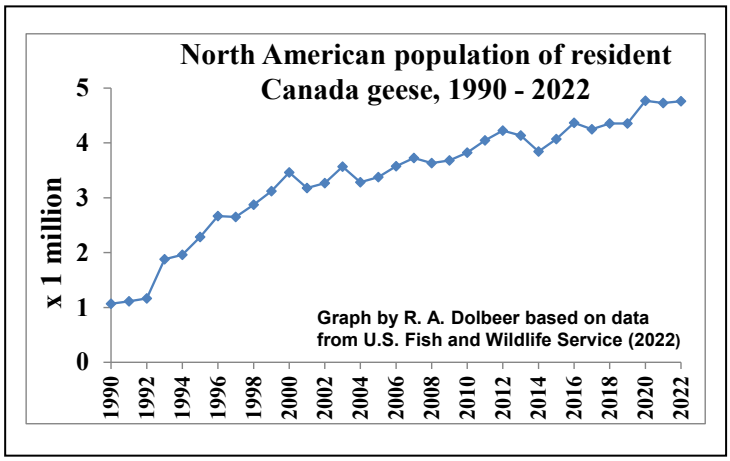



A second factor relates to aircraft and engine design. Commercial air carriers have replaced their older three or four-engine aircraft fleets with more efficient and quieter, two-engine aircraft. In 1965, about 94 percent of the 1,037 turbine-powered transport aircraft in the USA had three or four engines compared to less than 4 percent of the 7,405 aircraft in 2020 (U.S. Department of Transportation 2023, Aeroweb 2023). 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 multiple-engine ingestions, aircraft with two engines may have vulnerabilities not shared by their three or four engine-equipped counterparts (Langston 2019). In addition, bird strikes to critical aircraft sensors connected to flight control systems can be problematic.

Three incidents in the past 14 years highlight these vulnerabilities. On 15 January 2009, US Airways Flight 1549 (Airbus 320) with 155 persons aboard made a forced landing in the Hudson River after ingesting Canada geese into both engines at 2900 feet above ground level after departure from LaGuardia Airport, New York (Marra et al. 2009, National Transportation Safety Board 2010). On 15 August 2019, Ural Airlines Flight 178 (Airbus 321) with 234 persons aboard made a forced landing in a corn field 3 miles from Zhukovsky International Airport, Moscow, Russia after ingesting herring gulls into both engines during take-off (Aviation Safety Network 2023). Incredibly, none of the 389 people was killed in these "Miracle on the Hudson" and "Miracle in the Corn Field" bird-strike events even though both aircraft were damaged beyond repair. However, on 10 March 2019, a Boeing 737 Max 8 crashed shortly after take-off from Addis Ababa Bole International Airport, Ethiopia, killing all 157 people aboard. The U.S. National Transportation Safety Board concluded that the "erroneous Angle of Attack sensor output

[which forced the aircraft into a steep dive] was caused by the separation of the Angle of Attack sensor vane due to impact with a foreign object, which was most likely a bird" (National Transportation Safety Board 2023).

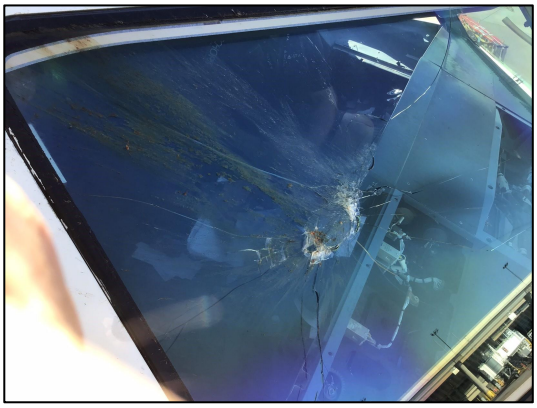
A third complicating factor is that birds are less able to detect and avoid modern jet aircraft with quieter turbofan engines (Chapter 3, International Civil Aviation Organization 1993) compared to older aircraft with noisier (Chapter 2) engines (Burger 1983, Kelly et al. 1999). This is analogous to the demonstrated greater "strike rate" for pedestrians and bicyclists (increases of 35 percent and 57 percent, respectively) with electric vehicles compared to vehicles with noisier internal combustion engines (Wu et al. 2011). In October 2017, the FAA adopted a rule requiring new transport aircraft to have noise levels further reduced by at least 7 decibels compared to the current fleet (Federal Register 2017).




As a result of these factors, experts within the Federal Aviation Administration (FAA), U.S. Department of Agriculture (USDA), and U.S. military expect the risk of bird and other wildlife strikes to be a continuing challenge. Mitigating these risks presents many unique challenges because of the diversity of wildlife species involved, their mobility and adaptability, legal requirements of the MBTA and other environmental laws, and overall public interest in the protection of wildlife. But these challenges must be met. Globally, wildlife strikes have killed more than 464 people and destroyed over 305 civil and military aircraft from 1988–2022 in addition to causing economic losses in the billions of dollars (Allan and Orosz 2001; Richardson and West 2000; Thorpe 2012; Avisure 2023).

The FAA has initiated several programs to address this important safety issue. A foundation of these programs is the collection and analysis of data from wildlife strikes. The FAA began collecting bird and bat strike data in 1965 (expanded to include terrestrial mammals and reptiles in 1990). However, except for cursory examinations of strike reports to determine general trends, the data were never organized and 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 wildlife strike problem for civil aviation. Specialists from the USDA/WS: (1) research all strike reports (FAA Form 5200-7, *Bird/Other Wildlife Strike Report*) received by the FAA since 1990 to ensure consistent, high-quality data; (2) process all edited strike reports into the FAA National Wildlife Strike Database; (3) supplement FAA-reported strikes with additional, non-duplicated strike

reports from other sources; and (4) 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, seasonal patterns, and long-term trends in strikes). 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).



An A-320 struck a migrating bird at night at 12,500 feet AGL and 310 knots during climb from a southern U.S. Airport, September 2022. The bird cracked outer layer of First Officer's windshield. Pilot made a precautionary landing back at airport after burning fuel. Bird remains sent to Smithsonian were identified as Sora (maximum body mass = 126 grams). Photo, C. Boyles.

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 29th report in the series and covers the 33-year period, 1990–2022. The current annual report is accessible as a PDF file at: http://www.faa.gov/airports/airport_safety/wildlife/.

To supplement the statistical summary of data presented in tables and graphs, a sample of 15 significant wildlife strikes to civil aircraft in the USA during 2022 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, 1990–2022, is available at http://www.faa.gov/airports/airport_safety/wildlife/.

Appendix B explains how to report strikes and the role of the Smithsonian Institution Feather Lab in identifying bird and other wildlife species that are struck.

Appendix C lists the common and scientific names for the 774 species of wildlife mentioned in the report, as well as mean and (when available) maximum body masses.

# RESULTS

## NUMBER OF REPORTED STRIKES AND STRIKES WITH DAMAGE

In 2022, 17,190 strikes were reported which was an increase of 10 percent compared to the 15,639 strikes reported in 2022 (Table 1, Figure 1). In 2022, 98.7 percent of the 17,190 strikes occurred in the USA[1]; birds were involved in 94.9 percent of these strikes, bats in 3.0 percent, terrestrial mammals in 1.7 percent, and reptiles in 0.4 percent (Table 2). For the 33-year period (1990–2022), 276,846 strikes were reported of which 272,016 (98.3 percent) occurred in the USA (Table 1).

A BE-400 BJET struck a double-crested cormorant during climb out of a coastal airport in Georgia, July 2022. The aircraft was en route to New York but diverted to an airport in Pennsylvania. The double-crested cormorant population in North America has doubled from about 450,000 to 900,000 birds, 1990-2021 (Dolbeer 2020, Sauer et al. 2022). Photo, Mike Crognale.

The 10 percent increase in reported strikes in 2022 compared to 2021 combined with the 35% increase in 2021 compared to 2020 was directly related to the increase in aircraft movements at Part 139-certificated[2] airports and general aviation airports compared to 2019 (Tables 3, 4). This increase in civil aircraft movements, especially for passenger transport aircraft, was related to relaxation of travel restrictions caused by the COVID-19 pandemic. Passenger traffic in the USA from March – December 2020 was down 72% compared to the same months in 2019 (Dolbeer 2021*b*, Transportation Security Administration 2023).

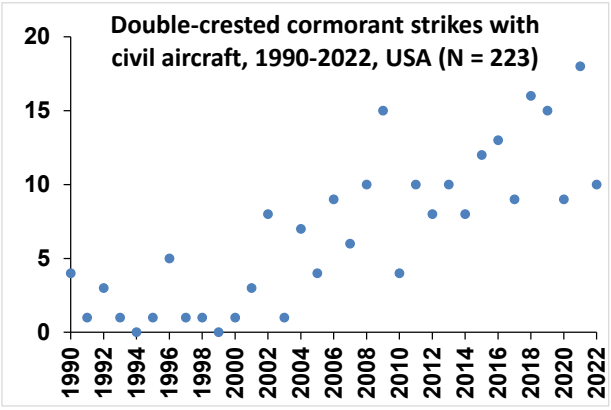
The number of reported strikes per 100,000 movements at Part 139-certificated airports has increased 2.7-fold from 12.70 in 2000 to 34.84 in 2022 (Table 3, Figure 2). However, the number of damaging strikes per 100,000 movements has changed by only 4 percent, from 1.40 in 2000 to 1.46 in 2022.

The number of reported strikes per 100,000 movements at general aviation airports also increased 2.6-fold, from 0.78 in 2000 to 2.80 in 2022 (Table 4, Figure 2). In contrast to Part 139-certificated airports, the damaging strike rate increased 31 percent, from 0.26 in 2000 to 0.34 in 2022.

[1] The database contains strikes involving U.S.- or foreign-registered aircraft in the USA and U.S.-registered aircraft in foreign countries.

[2] The U.S. Code of Federal Regulations (14 CFR Part 139) requires the FAA to issue operating certificates to airports that serve scheduled and unscheduled air carrier aircraft with more than 9 seats or that the FAA Administrator requires to have a certificate. Part 139-certificated airports experiencing hazardous wildlife conditions as defined in Part 139.337 must conduct Wildlife Hazard Assessments and develop Wildlife Hazard Management Plans (Federal Aviation Administration 2023*b*).

The overall stabilization in damaging strike rates at Part 139-certificated airports since 2000 can be attributed the stabilization of damaging strikes in the airport environment (strikes occurring on departure or arrival at ≤1,500 feet above ground level [AGL]). Damaging strikes on departure or arrival at >1,500 feet AGL have shown a significant increase (Figure 3). This stabilization in damaging strikes for transport aircraft in the airport environment has occurred despite an increase in populations of hazardous wildlife species (Dolbeer 2020) and as noted above, a major increase in reported strikes. These data demonstrate progress in wildlife hazard management programs at Part 139-certificated airports (Dolbeer 2011). The data also demonstrate the lack of progress in mitigating the risk of strikes outside the airport environment and the purview of wildlife hazard management plans (aircraft on approach or departure at >1500 feet AGL).




Over the 10-year period, 2013-2022, an average of 12 strikes per year were reported for double-crested cormorants (mean body mass = 2.1 kg) and civil aircraft in USA. At least 16% of the strikes involved multiple birds.

In contrast to Part 139-certificated airports, general aviation airports have seen a significant increase in the damaging strike rate in the airport environment (at ≤1,500 feet AGL) and only a slight increase at >1,500 feet AGL, 1990-2022 (Figure 3).

The significant increase in the number of reported strikes per 100,000 movements at both Part 139-certificated airports and general aviation airports from 2000 to 2022, concurrent with the stabilization in damaging strikes at Part 139-certificated airports, indicate that the aviation industry is doing a better job of documenting all wildlife that are struck. Many of these strikes involve small species that rarely cause damage to civil aircraft. This premise is supported by the fact that the mean mass of birds reported as struck has declined 63 percent from 0.76 kg to 0.28 kg, 2000-2022 (Figure 4).

## METHODS OF REPORTING STRIKES

In 2022, 73 percent and <1 percent of the 17,190 strike reports were filed using the electronic and paper versions, respectively, of FAA Form 5200-7, *Bird/Other Wildlife Strike Report* (Table 5*)*. Sixteen percent of reports came from multiple sources (i.e., more than one type of report was filed for same strike; many of these had at least one 5200-7E report filed). Strike reports submitted to the FAA via the Air Traffic Organization (ATO) Mandatory Occurrence Reporting system comprised 10 percent of reports. Under FAA Order JO 7210.632, (effective 30 Jan 2012), ATO personnel are required to report all bird strikes of which they become aware.

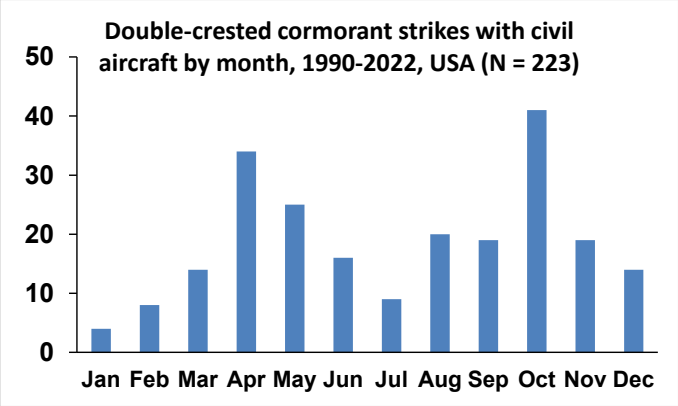
## SOURCE OF REPORTS

In 2022, airport operations personnel filed 66 percent of the strike reports (including "Carcass Found" reports), followed by pilots (18 percent), Air Traffic Control personnel (10 percent), air transport operations personnel (3 percent), and other (3 percent, Table 6). In 2022, about 86 percent of the reported strikes involved commercial transport aircraft; the remainder involved business, private, and government aircraft (Table 7).

In 2022, strikes were reported at 693 USA airports, a decrease of 2 percent compared to the 708 airports in 2021 (Table 8, Figure 5). Of the 693 airports with strikes reported in 2022, 429 were Part 139-certificated airports and 264 were general aviation airports.

From 1990-2022, 237,829 strikes have been reported from 2,062 USA airports (Table 8). In addition, 4,830 strikes involving USA-registered civil aircraft were reported at 330 foreign airports in 113 countries, 1990 – 2022. In 2022, 230 strikes were reported at 91 foreign airports in 53 countries.

## TIMING OF OCCURRENCE AND PHASE OF FLIGHT OF STRIKES




Double-crested cormorants nest primarily in the northern USA and Canada and migrate south during winter months. Strikes peak during migration months.

From 1990–2022, most bird strikes (54 percent) occurred between July and October (Figure 6) which is when birds are migrating, and populations are at their annual peak in North America following the nesting season. Sixty-two percent of bird strikes occurred during the day and 29 percent at night (Table 9). Almost twice as many strikes (61 percent of total) occurred during the arrival (descent, approach, or landing roll) phase of flight compared to 35 percent during departure (take-off run and climb, Table 10).

As with birds, most terrestrial mammal strikes occurred between July and November; with 29 percent of deer strikes concentrated in October-November and 39 percent of coyote strikes in August-October (Figure 7). Most terrestrial mammal strikes (62 percent) occurred at night (Table 9). As with birds, about twice as many strikes (63 percent of total) occurred during the arrival (final approach or landing roll) phase of flight compared to 32 percent during departure (take-off run and initial climb, Table 10).

For bats, 82 percent of strikes occurred at dawn, dusk, or night (Table 9). The difference in numbers of strikes during arrival compared to departure phase of flight was even greater for bats compared to birds and terrestrial mammals. Eighty-five percent of

reported bat strikes occurred during arrival compared to only 12 percent during departure (Table 10).

### HEIGHT ABOVE GROUND LEVEL (AGL) OF STRIKES

**Bird strikes with transport aircraft-** From 1990 – 2022, about 42 percent of bird strikes with transport 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 11). About 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 8). The record height for a reported bird strike involving a transport aircraft in USA was 31,300 feet AGL.

A BE-200 was on initial approach to an airport in Texas at 4500 feet AGL and 248 knots in April 2022 when an American white pelican was struck. The pilot landed the aircraft safely despite substantial damage to the right wing. The AWPE population in North America has increased 4-fold from 1990-2021 (Dolbeer 2020, Sauer et al. 2022). Photo, D. Warschun.

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 46 percent of the damaging strikes (Table 11, Figure 9).

**Bird strikes with general aviation (GA) aircraft-** From 1990 – 2022, about 37 percent of the bird strikes with GA aircraft occurred when the aircraft was at 0 feet AGL, 70 percent occurred at 500 feet or less AGL, and 97 percent occurred at or below 3,500 feet AGL (Table 12). Less than 1 percent of bird strikes occurred above 7,500 feet AGL. Above 500 feet AGL, the number of reported strikes declined consistently by 42 percent for each 1,000-foot gain in height (Figure 8). 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 transport aircraft. Although only 30 percent of the reported strikes were above 500 feet AGL, these strikes represented 52 percent of the damaging strikes (Table 12, Figure 9).

**Terrestrial mammal strikes-** As expected, terrestrial mammal strikes predominately occurred at 0 feet AGL; however, 10 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 10).

### AIRCRAFT COMPONENTS DAMAGED

The aircraft components most commonly reported as struck by birds from 1990 – 2022 were the nose/radome, windshield, wing/rotor, fuselage, and engine (Table 13). Aircraft engines were the component most frequently reported as being damaged by bird strikes (26 percent of all damaged components). There were 23,128 strike events in which a total of 24,169 engines were reported as struck (22,118 events with one engine struck, 986 with two engines struck, 17 with three engines struck, and 7 with four engines struck). In 5,190 damaging bird-strike events involving engines, a total of 5,362 engines was damaged (5,021 events with one engine damaged, 167 with two engines damaged, 1 with three engines damaged, and 1 with four engines damaged).

A CRJ900 struck a red-tailed hawk on departure from a Midwest airport, November 2022. The aircraft continued to its destination where the radome was replaced. In 2022, 235 red-tailed hawk strikes with civil aircraft were reported. Photo C. Mealman, USDA.

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 13).

“Other” components reported as struck (all wildlife species combined) include critical sensors such as pitot tubes (819), antenna (communication, radar, global position; 285), angle of attack vanes (194), and temperature gauges (TAT, RAT, OAT, SAT; 182).

### REPORTED DAMAGE

For the 265,941 strike reports involving birds from 1990–2022, 17,960 (7 percent) indicated damage to the aircraft (Table 14). When classified by level of damage, 7,918 (3 percent) indicated the aircraft suffered minor damage; 6,269 (2 percent) indicated the aircraft suffered an uncertain level of damage; 3,726 (1 percent) reported substantial damage; and 47 reports (less than 1 percent) indicated the aircraft was destroyed because of the bird strike (Table 14).

The pilot of a CL-300 reported striking a bird at 900 feet AGL and 115 knots during a night approach to an east coast airport, February 2022. A ruddy duck was recovered from the nose landing gear. From 1990-2022, 115 strikes involving civil aircraft and ruddy ducks (13 in 2022) were reported. Photo, K. Mousa.

For the 5,667 terrestrial mammal strikes reported, 1,291 (23 percent) indicated damage to the aircraft. When classified by level of damage; 613 (11 percent) indicated the aircraft suffered minor damage; 431 (8 percent) indicated the aircraft suffered substantial damage; 213 (4 percent) reported an uncertain level of damage; and 34 (1 percent) indicated the aircraft was destroyed because of the strike (Table 14). Not surprisingly, a much higher percentage of terrestrial mammal strikes (23 percent) resulted in aircraft damage than did bird strikes (7 percent). Deer (1,345 strikes, of which 1,109 caused damage; Table 18) were involved in 24 percent of the strikes and 82 percent of the damaging strikes involving terrestrial mammals. Canids (coyotes and dogs) caused 6 percent of damaging strikes by terrestrial mammals.

Although the percentage of wildlife strikes (all species) with reported damage has averaged 7 percent for the 33-year period (Table 14), this number has declined from a peak of 18 percent in 1995 to 4 percent in 2022 (Figure 10).

### Reported Negative Effect-on-Flight

A negative effect-on-flight was reported in 5 percent and 15 percent of the bird and terrestrial mammal strike reports, respectively, (Table 15). Precautionary/ emergency landing after striking wildlife was the most reported negative effect (8,030 incidents, 3 percent of strike reports). These precautionary landings included 330 incidents in which the pilot jettisoned fuel (63) or burned fuel in a circling pattern (132) to lighten aircraft weight or in which an overweight landing was made (135, Table 16, Figure 11). In the 63 reported incidents in which fuel was jettisoned, an average of 98,064 pounds (14,421 gallons) of fuel was jettisoned per incident (range 44 – 39,706 gallons). Aborted take-off after striking wildlife was the second most reported negative effect (2,976 incidents, 1 percent of strike reports, Table 15). These negative incidents included 601 aborted take-offs in which the pilot initiated the abort at an aircraft speed of 100 knots (115 miles per hour) or greater (Table 17). For commercial transport aircraft, the number of high-speed aborted take-offs has declined from a high of 25 in 2000 to 8 in 2022 (Figure 12). For general aviation aircraft, the number of high-speed aborted take-offs has averaged about 4 per year (4 in 2022).

As has the trend 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 11 percent in 1995 - 1996 to 3 percent in 2022 (Figure 10).

## WILDLIFE SPECIES INVOLVED IN STRIKES


Carla Dove examines feathers from a strike involving barn swallows. The number of bird strike cases involving civil aircraft processed by the Smithsonian Feather Identification Lab in 2022 was 4,579 with 5,003 separate identifications (some cases involved remains from multiple impact points). DNA analysis was used in 48 percent of civil aviation cases to identify the species and in an additional 17 percent to supplement traditional identification methods using morphology of feathers and body parts. Photo, J., Kegley, Smithsonian.

Table 18 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 the 775 identified wildlife species, 1990-2022. 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 265,941 reported bird strikes, 128,797 (48 percent) identified the bird to species and an additional 24,947 strikes (10 percent) identified the bird at least to species group (e.g., gull, hawk, duck). Species identification has improved from less than 30 percent in the 1990s to 61 percent in 2022 (Figure 13). In all, 639 species of birds have been identified as struck by aircraft, and 313 of these species were reported as causing damage, 1990–2022. In 2022, 383 bird species were identified as struck by civil aircraft (Figure 13).

Doves/pigeons (13 percent), raptors (12 percent), gulls (9 percent), shorebirds (9 percent), and waterfowl (5 percent) were the most frequently struck bird groups (Table 19). Doves/pigeons, raptors, and gulls each were involved in over twice as many strikes as waterfowl. Waterfowl, however, were involved in 4.1 times more damaging strikes than doves/pigeons and 1.1 to 1.6 times more damaging strikes than gulls or raptors. Waterfowl comprised 27 percent of all damaging strikes in which the bird type was identified, 1990–2022. Doves/pigeons and gulls were responsible for the greatest number of bird strikes (3,155 and 2,576, respectively) that involved multiple birds.

Table 20 lists the 33 species of birds identified most frequently as struck by civil aircraft for 1990–2022 and for 2022 only. Mourning doves, killdeer, barn swallows, American kestrels, and horned larks were the 5 most frequently identified species struck by civil

aircraft overall from 1990–2022 and in 2022 only. Canada geese, the 14th most frequently identified species struck overall from 1990–2022, declined to the 24th most frequently struck species in 2022 although the overall population in North America has increased over 2-fold, 1990–2018 (Dolbeer 2020, U.S. Fish and Wildlife Service 2022). 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, Rutledge et al. 2015).

For the 33 species of birds most frequently identified as struck by civil aircraft, 1990-2022, there was a strong correlation ($R^2$ = 0.83) between mean body mass and the likelihood of a strike causing damage to aircraft (Figure 14). For every 100-gram increase in body mass, there was a 1.28 percent 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).

A Learjet-60 departing a Midwest airport struck a flock of sandhill cranes at 1500 feet AGL, December 2022. The aircraft returned to airport with the radome and #1 engine damaged. Photo S. Lehman, USDA.

**Terrestrial mammals, bats, and reptiles-** The most frequently struck terrestrial mammals were Carnivores (40 percent) and Artiodactyls (25 percent; Tables 18, 19). Coyotes and skunks were the most frequently struck Carnivores, and deer were the most frequently struck Artiodactyl. Artiodactyls were responsible for 90 percent of mammal strikes that resulted in damage and 67 percent of mammal strikes that involved multiple animals. In all, 55, 46, and 35 identified species of terrestrial mammals, bats, and reptiles, respectively, were reported struck; 24, 9, and 2 identified species of these respective wildlife taxa caused damage to aircraft (Table 18).

## Human Fatalities and Injuries Due to Wildlife Strikes

For 1990-2022, reports were received of 20 wildlife strikes that resulted in 44 human fatalities (Table 21). Six of these strikes, resulting in 8 fatalities, involved unidentified species of birds. American white pelicans and red-tailed hawks (8 fatalities each), bald eagles (4), snow geese and turkey vultures (3 each), Canada geese, green-winged teal, and rock pigeon (2 each), and white-tailed deer, brown pelicans, gulls, and black vultures (1 each) were responsible for the other 36 fatalities. Reports were received of 269 strikes that resulted in 346 human injuries (Table 21). Waterfowl (ducks and geese; 60 strikes, 68 humans injured), vultures (39 strikes, 48 injuries), and deer (21 strikes, 30 injuries) caused 120 (56 percent) of the 214 strikes resulting in injuries in which the species or species group was identified.

## AIRCRAFT DESTROYED DUE TO WILDLIFE STRIKES

A great blue heron (mean body mass 2 kg) penetrated the radome of a CRJ 900 at 300 feet AGL on approach to a coastal Georgia airport, October 2022. The aircraft landed and was taken out of service for repairs. From 1990-2022, 575 great blue heron strikes with civil aircraft were reported; 20 percent of strikes caused damage. Photo, J. Burke, USDA

For 1990-2022, reports were received of 81 aircraft destroyed or damaged beyond repair due to wildlife strikes (range of 0 to 6 per year, Tables 14, 22, Figure 15). No aircraft was lost to a wildlife strike in 2022. The majority (52 aircraft; 64 percent of total) were small (≤2,250 kg maximum take-off mass) general aviation aircraft. Terrestrial mammals (primarily white-tailed deer) were responsible for 34 (42 percent) of the incidents. Geese and vultures (6 incidents each) were responsible for 38 percent of the 32 incidents involving birds in which the species or species group was identified.

Forty-six (57 percent) of the 81 wildlife strikes resulting in a destroyed aircraft occurred at general aviation airports, 22 occurred en route, 8 occurred at USA airports certificated for passenger service under 14 CFR Part 139, and 3 occurred in miscellaneous situations (taking off from a river, herding cattle, and aerial application of pesticides). Two occurred at a foreign airport (Table 22). General aviation 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 34,261 reports from 1990 – 2022 indicating the strike had an adverse effect on the aircraft and/or flight, 13,220 provided an estimate of the aircraft downtime (1,207,721 hours, mean = 91.3 hours/incident, Tables 18, 23, 24). Regarding monetary losses, 5,014 reports provided an estimate of direct aircraft repair costs ($929.1 million, mean = $185,292/incident), and 4,577 reports gave an estimate of other monetary losses ($134.3 million, mean = $29,348/incident)[3]. 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 three Part 139 airports certificated for passenger service and three airlines for the years 1991-2004 indicated that 11 to 21

[3] Costs from years prior to 2022 are inflation-adjusted to 2022 U.S. dollars.

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). Strike reporting for aircraft at general aviation airports was estimated at less than 5 percent in the 1990s and early 2000s (Dolbeer et al. 2008, Dolbeer 2009). More recent analyses estimated that strike reporting for all civil aircraft combined (commercial transport and general aviation) at Part 139 airports had improved to 39 percent in 2004-2008 and to 47 percent in 2009-2013 (Dolbeer 2009, 2015). Strike reporting for commercial transport aircraft only at Part 139 airports was an estimated 79 percent in 2004-2008 and 91 percent in 2009-2013; reporting of strikes with damage was estimated at 78 percent and 93 percent for these respective time periods. In addition to the underreporting of strikes, only 39 percent of the 34,261 reports from 1990–2022 indicating an adverse effect provided estimates of aircraft downtime. For the 19,294 reports indicating damage, 26 percent provided estimates of repair (direct) costs, and 24 percent provided estimates of other (indirect) costs (these respective percentages were 19 and 25 for 2022 only, Tables 23, 24). Furthermore, some reports providing cost estimates were filed before aircraft damage and downtime had been fully assessed. Lastly, these reported costs do not capture the costs in time and money for aircraft inspections following non-damaging strikes and costs associated with runway closures to inspect for wildlife carcasses after reported strikes. As a result, the information on the number of strikes and associated costs compiled (summarized by species of wildlife struck in Table 18) is believed to underestimate the economic magnitude of the problem.

Assuming (1) all 34,261 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, wildlife strikes annually cost the USA civil aviation industry, on average, 105,843 hours of aircraft downtime and $229 million in monetary losses ($188 million in direct costs and $40 million in other costs), 1990–2022 (Table 24). For 2022 only, the estimates would be 67,848 hours of downtime and $385 million in direct and indirect costs.

Snowy owls from Canada “invade” the USA in some winters and are often attracted to airports. From 1990-2022, 378 snowy owl strikes with civil aircraft were reported, including 18 in 2022. This owl was at an airport in Kansas in 2022. Photo, M. Couchman, USDA.

In contrast to these estimates, a recent analysis by Altringer et al. (2021) using a machine learning approach with cost data from the National Wildlife Strike Database, estimated that wildlife strikes cost the US civil aviation industry a minimum average of $54.3 million in losses annually over the 1990–2018 period. A follow-up analysis by Altringer et al. (2022) estimated that damaging wildlife strike events generate

additional “spillover” costs of around $25 million (2020 US$) each year related to delays in subsequent flights. Estimating the economic costs of wildlife strike is complex because of the many variables involved and the skewed nature of reported strikes and costs. More thorough reporting of strike events and associated costs combined with additional analyses are needed to refine the actual costs of wildlife strikes to the aviation industry.

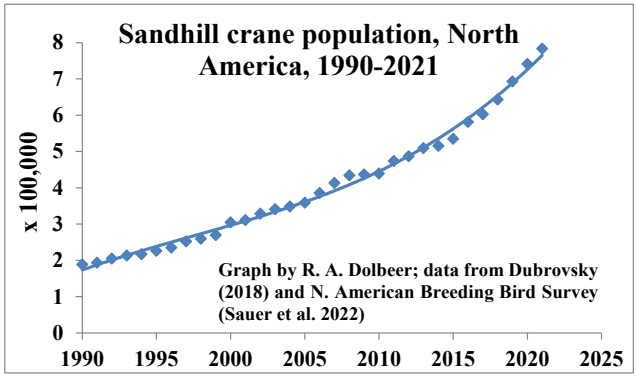
## CONCLUSIONS

The analysis of 33 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 mitigating the risk. 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 manual, Wildlife Hazard Management at Airports, was initially available to airports nationwide (Cleary and Dolbeer 2005). These efforts are likely responsible for the stabilization in reported strikes with damage and negative effects-on-flight from 2000-2022 for commercial transport aircraft (Table 1, Figures 2, 3, 4, 9, 10) in the airport environment (<1,500 feet AGL) despite continued increases in populations of many large bird species. Examples of the work done to mitigate the risk of strikes at airports 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, Rutledge et al. 2015, and Washburn 2019. As another measure of the increase in wildlife management activities, USDA Wildlife Services biologists assisted 813 civil and military airports nationwide in 2022 to mitigate wildlife risks to aviation compared to only 42 airports in 1991 and 193 in 1998 (Begier et al., 2023). However, much work remains to be done to reduce wildlife strikes.

Exhibitors at the Bird Strike Committee-USA meeting in Salt Lake City Utah, July 2022, gave instruction to participants in the safe use of pyrotechnics and other wildlife management equipment for dispersing wildlife from airports. Photo. R. Dolbeer, USDA.

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 wildlife biologists (FAA Advisory Circular 150/5200-36B, Qualifications for Wildlife Biologist Conducting Wildlife Hazard Assessments and Training Curriculums for Airport Personnel Involved in Controlling Wildlife Hazards on Airports). They then must take appropriate actions, under the guidance of these biologists, to minimize risks posed by wildlife. Management actions

should be prioritized based on the hazard level of species (Table 18, Figure 14) observed in the aircraft operating area. The manual *Wildlife Hazard Management at Airports* (Cleary and Dolbeer 2005), available online in English, Spanish, and French at http://wildlife.faa.gov, provides guidance for conducting wildlife hazard assessments and in developing and implementing wildlife hazard management plans. The International Civil Aviation Organization (2020) also provides guidance on wildlife hazard management at airports.




The sandhill crane population in North America has increased 4-fold, 1990-2021. As with other wildlife such as Canada geese, cranes are adapting to human habitats such as this cemetery in Michigan. From 1990-2022, 193 strikes involving sandhill cranes and civil aircraft were reported, USA. Photo, Nov 2022, J. Wharton.

Management efforts to reduce the risks of bird strikes have primarily focused on airports since most civil aircraft strikes occur (during take-off and landing at ≤500 feet AGL (see Tables 11, 12). However, the successful mitigation efforts at Part 139-certificated airports that have stabilized damaging strikes for commercial transport aviation in recent years have done little to reduce strikes outside the airport environment such as occurred with US Airways Flight 1549 in 2009 (Dolbeer 2011).

To mitigate the risk for strikes beyond the airport fence, municipalities and the aviation community must first widen their view of wildlife management to consider habitats and land uses within 5 miles (or sometimes greater distances) of airports (Pfeiffer et al. 2018). For example, wetlands, dredge-spoil containment areas, municipal solid waste landfills, and wildlife refuges typically attract hazardous wildlife. Such land uses, as discussed in FAA Advisory Circular 150/5200-33C, *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 minimize the attraction of hazardous wildlife (e.g., Washburn et al. 2010, Beffre and Washburn 2020).

Second, the aviation community needs to broaden the view of wildlife strike risks from a ground-based wildlife management problem solely dealt with by airports to an airspace management problem that also encompasses Air Traffic Control, flight crews, and aircraft manufacturers (Metz et al. 2021). Long-term goals include the integration of avian radar and bird migration forecasting into airspace management for civil aviation (Nohara et al.

2011, Gerringer et al. 2016, Shamoun-Baranes et al., 2019, Nilsson et al. 2021). The further development of aircraft lighting systems to enhance detection and avoidance by birds (Bernhardt et al. 2010, Blackwell et al. 2012, DeVault et al. 2015, Dolbeer and Barnes 2017, Fedy 2018, Dwyer et al. 2019) is also needed as part of an integrated program.

Finally, there continues to be a need for increased and more detailed strike reporting, especially for general aviation aircraft. When reports are filed, relevant information should be provided whenever possible regarding species identification, number of wildlife struck, time and height of strike, phase of flight, and damage to aircraft components (Dolbeer 2015, see Appendix B: Reporting a Strike and Identifying Species of Wildlife Struck). A problem that is not well defined cannot be properly managed.

# PART 2: FAA ACTIVITIES FOR MITIGATING WILDLIFE STRIKES

In 2022, the FAA continued a multifaceted approach for mitigating wildlife strikes both nationally and globally. This included continuing a robust research program, making improvements to the NWSD and outreach, working with the International Civil Aviation Organization (ICAO), their Asia Pacific (APAC) region and other foreign destinations as well as providing Airport Improvement Program (AIP) funding to airports to conduct Wildlife Hazard Assessments (Assessments) and develop Wildlife Hazard Management Plans (Plans). Noteworthy for 2022, the FAA's wildlife program continued to assist international efforts to further safety for air carriers and travelers alike.

Landmark events such as the emergency forced landing of US Airways Flight 1549 Airbus 320 into the Hudson River on January 15, 2009 demonstrated to the world the severity of aircraft collisions with birds and other wildlife. Comprehensive evaluations have ensured optimal guidance, compliance and risk reduction moving forward. Since the first Advisory Circular 150 / 5200-1 Bird Hazards to Aviation, Bird Hazard Research published March 1, 1965, these types of evaluations have allowed the Federal Aviation Administration (FAA) wildlife program to systematically improve its oversight to reduce risks within the safest aerospace system in the world. The results from reviews conducted post-1549 have enhanced existing regulations and provided beneficial layers of expansion throughout other key FAA wildlife-related areas (e.g., Data collection and analysis, Partnerships, Research, and Outreach).

## FAA Guidance

In the fourteen-year span 2009 – 2022, over $400 million of AIP funds have been allocated for wildlife-related projects such as Wildlife Hazard Assessments (Assessments), Wildlife Hazard Management Plans (Plans) and airport perimeter fencing. All Part 139 certificated airports have successfully completed Assessments followed by Plans. Many of those airports have already updated their original Assessments with new ones while others have chosen to implement Continual Monitoring programs as detailed in Advisory Circular 150/ 5200- 38 (AC-38) - *Protocol for the Conduct and Review of Wildlife Hazard Site Visits, Wildlife Hazard Assessments, and Wildlife Hazard Management Plans* (published August 20, 2018). AC 150/5200-38 defines the minimum acceptable standards for the conduct and preparation of Site Visits, Assessments and Plans. AC 150/5200-38 also clarifies the NEPA process for projects included in an airport's WHMP and provides protocol for the approval (or partial approval) of Plans with regard to NEPA and other environmental laws. The AC gives Airports and Biologists checklists for Assessments and Plans and provides Airport Certification Safety Inspectors guidelines/ templates to review those documents.

AC 150/5200-36B *Qualifications for Wildlife Biologist Conducting Wildlife Hazard Assessments and Training Curriculums for Airport Personnel Involved in Controlling Wildlife Hazards on Airports* was last updated January 24, 2019. This latest version provides for an alternative field experience option of Continual Monitoring to aid Qualified Airport Wildlife Biologists (QAWB) candidates in an era where all certificated airports have finished their initial Assessments and Plans.

The FAA wildlife program assisted with the update of AC No: 150/5200-28G Notice to Air Missions (NOTAMs) for Airport Operators (5/25/2022). The updated guidance stated that "*Birds and other wildlife activity NOTAMs should focus on chronic or persistent problems that are relatively short-lived or seasonal in nature*." NOTAMs of this type are effective at providing timely alerts for seasonal movements including migration (e.g., birds, caribou), nesting (e.g., bald and golden eagles, heron rookeries) and breeding (e.g., deer in the fall and alligators in spring to early summer) or other movement activities contrary to or beyond the scope of published airport data in the Chart Supplement or 5010 Airport Master Records.

On February 21, 2020, AC 150/5200-33C *Hazardous Wildlife Attractants On or Near Airports* was updated with significant changes. The updated language included clarification of separation criteria, new guidance on land-use practices (e.g., aquaculture, agriculture, dredge spoil, etc.), inclusion of general aviation (GA) airport wildlife responsibilities and a new section *Airport Procedures for Off-site Attractants* that provides step-by-step guidance when proposed land-use changes may provide an attractant to hazardous species. The significant changes to AC-33C resulted in outreach / education efforts to the industry and training to the FAA Airport Certification Safety Inspectors (ACSI) that continued into the beginning of 2022.

## FAA Outreach and Information

The FAA's wildlife program excels in direct outreach efforts as well as utilizing partnerships and cooperators to ensure useful, timely information is disseminated to the widest possible audience. In October 2022, the FAA released a new Wildlife Hazards video. This updated outreach endeavor is part of the FAA Airport Safety Information Video Series. It discusses how successful wildlife strike reporting and the National Wildlife Strike Database (jointly administered by USDA and FAA) is reducing the impact of wildlife strikes on both commercial and general aviation.

Outreach efforts in 2022 were diverse and included presentations at the 2022 Bird Strike Committee USA (BSC USA) Annual Meeting / Conference in Salt Lake City, Utah, the 9th Annual Hawaii DOT & USDA Wildlife Hazard Workshop, the National Airspace System Collaboration Forum, the World Birdstrike Association (WBA) Wildlife Forum at the 5th British / Irish Airport Expo in London, Great Britain, the WBA semiannual meeting in Bangkok, Thailandinformational webinars for the WBA, and the 2022 Australian Aviation Wildlife Hazard Group (AAWHG) Forum in Adelaide, Australia.

Additional international efforts in 2022 included assisting the ICAO APAC region with the development of a regional wildlife hazard management manual and providing assistance to several foreign regulators and aerodromes on an as-needed basis. Two related, but separate initiatives were proposed to ICAO in 2000 and officially adopted February 2, 2021. The first proposed to update the ICAO Birdstrike Information System (IBIS) manual while the second proposed to allow / enhance international data access and data sharing. The goal was simple, enhance global aviation safety by improving member State reporting of wildlife / aircraft strike incidents and the submission of that data into IBIS as well as identifying and / or improving pathways to that data. The FAA was asked to Chair these collaborative ICAO projects as defined on the ADOP.015.03 Job Card as

Rapporteur of the Wildlife Hazard Management Expert Group (WHMEG). Also, an interview taped in the fall of 2021 with Australia-based Avisure for its podcast (Avicast) titled "*Wildlife Strikes in the USA*" focused on providing a broad view of wildlife strikes in the US and globally. The podcast, along with many other informative talks and interviews can be found at: https://avisure.com/podcast/.

Members of the ICAO IBIS team Wildlife Hazard Management Expert Group at the Smithsonian Institution's Feather Identification Lab in Washington, DC. Photo, Smithsonian, Nov 2022.

Finally, there were two additional international outreach efforts that occurred in FY2022 but were held at the end of the 2021 calendar year. They included a 2-day FAA / Vietnam Airport Training Program held in Washington, DC and the 19th CAR/SAM Central – South American Regional Bird/Wildlife Hazard Prevention Committee Meeting and Conference (CARSAMPAF/19).

**Wildlife Hazard Assessments and Wildlife Hazard Management Plans**

The FAA encourages all certificated airports to conduct Assessments and develop Plans regardless if a triggering event under 14 CFR Part 139 had been experienced. Joint-use facilities that maintain a Bird/ wildlife Aircraft Strike Hazard (BASH) Plan also completed Assessments as a foundation for their BASH Plans. Wildlife Hazard Assessments are critical because they 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).

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.

GA airports are using guidance within AC 150/5200-38 to develop Plans based on short-duration Site Visits rather than 12-month Assessments. Now, these airports can

effectively outline their wildlife mitigation strategies using an economical, condensed Site Visit investigation. If a GA airport desires to conduct a full Assessment, the FAA will continue to make AIP grant funds available to them.

**Strike Reporting**

Wildlife strikes continue to capture media attention. While impacted pilots and airports are reporting strikes, they might not know the critical role their reports play in understanding wildlife issues and developing wildlife policies.

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 NWSD. The updated software also allows for strike reports to be vetted and publicly available within the NWSD within 4-5 days of the strike report being submitted. This is a substantial improvement over the previous 1 - 2 month quality assurance delay needed in previous years without the technological enhancements. The reduced turnaround time has provided immediate benefits to airports, airlines, engine and airframe manufacturers and biologists alike.

**"Excellence in Strike Reporting" Award**

2014 was the inaugural year for the Sandy Wright / Richard Dolbeer Excellence in Strike Reporting award. The award honors the incomparable dedication of Dr. Richard Dolbeer and Sandy Wright; each being exceptional in the management of the NWSD since the FAA first contracted the USDA in 1995 to oversee the collection, quality control, analysis and summation of strike reports.

The Sandy Wright / Richard Dolbeer Excellence in Strike Reporting award recognizes those airports that have exhibited a noteworthy strike reporting program. The number of USA airports with strikes reported increased from 335 in 1990 to a record 722 in 2019. This number predictably decreased to 665 in 2020 and increased to 693 airports in 2022. The 693 airports with strikes reported were comprised of 429 Part 139-certificated airports and 264 general aviation airports. From 1990-2022, strikes have been reported from 2,062 different USA airports.

The criteria for determining which airports will make the initial cuts are objective and include both quantity and quality of strike data (*keep in mind though that an airport will

not win based solely on number of strikes reported). The criteria include but are not limited to:

1. Number of reports filed and completeness of reports
3. Percentage of reports identified to species
4. Percentage of reports filed on-line
5. Timeliness of reports being submitted
6. Remains collected when available or necessary
7. Consistency filing reports

Further evaluation of the finalist strike reporting programs may include:

1. Modification of filed reports online when new information is discovered
2. Airport follows up with airline or engine manufacturer for missing information
3. Airport has someone on “Notification” list to receive notice when strikes are filed for their airport

For their commitment to the identification and documentation of wildlife / aircraft strike information, the FAA proudly recognizes the strike reporting programs at **Newark Liberty International Airport (EWR)** and **Quonset State Airport (OQU)** as the winners of the 2022 Sandy Wright / Richard Dolbeer Excellence in Strike Reporting award.

| | **AWARD WINNERS** | |
|---|---|---|
| | **PART 139 AIRPORTS** | **GA AIRPORTS** |
| **2014** | DALLAS / FORT WORTH - DFW | MORRISTOWN - MMU |
| **2015** | LAGUARDIA - LGA | VAN NUYS - VNY |
| **2016** | MINNEAPOLIS / ST. PAUL - MSP | CENTENNIAL - APA |
| **2017** | PORTLAND - PDX | HENDERSON FIELD (MIDWAY ATOLL) - MDY |
| **2018** | SEATTLE / TACOMA - SEA | PAGE FIELD - FMY |
| **2019** | Charlotte Douglas - CLT | Kalaeloa Airport (John Rodgers Field) (JRF) |
| **2020** | Chicago O'Hare - ORD | Dekalb/Peachtree Airport (PDK) |
| **2021** | Hartsfield-Jackson Atlanta International Airport (ATL) | Prescott Regional Airport, Ernest A. Love Field (PRC) |
| **2022** | Newark Liberty International Airport (EWR) | Quonset State Airport (OQU) |

## Airport Cooperative Research Program (ACRP) Reports

The FAA recently assisted with the development of two new ACRP reports to aid airports with the mitigation of wildlife hazards. The first report (ACRP Synthesis Report 117 - Agricultural Operations on Airport Grounds) was published in 2022 while the second report ACRP 10-30 Evaluating the Effectiveness of an Airport's Wildlife Hazard Management Program was finalized in 2022 and is awaiting public Prior to this latest wildlife-related report, two other ACRP projects were published in 2018 (ACRP Synthesis 92: Airport Waste Management and Recycling Practices and ACRP Research Report 174 Guidebook and Primer). Other recent reports published were ACRP Report 122 Innovative Airport Responses to Threatened / Endangered Species (2015), ACRP Report 125 Balancing Airport Stormwater and Bird Hazard Management (2015) and ACRP Report 145 Applying an SMS Approach to Wildlife Hazard Management (2015). The FAA is currently involved in three additional ACRP projects: 1) ACRP 10-30: Evaluating the Effectiveness of an Airport's Wildlife Hazard Management Program; 2) ACRP 11-03/Topic S10-17 Agricultural Operations on Airport Grounds and; 3) ACRP 11-03/Topic S10-18 Considerations for Establishing and Maintaining Successful Bee Programs on Airports These, and other wildlife / aviation reports are available from the Transportation Research Board of the National Academies (TRB) at http://www.trb.org/Publications/Publications.aspx.

## Wildlife Hazard Mitigation Research

The FAA dedicated approximately $30 million in research funds since Flight 1549's emergency forced landing into the Hudson River in 2009. These research funds help us better understand the capabilities of advanced detection and monitoring systems such as avian radars, Foreign Object Debris (FOD) radars and infrared / electro-optical scanning systems. Other research initiatives included wildlife control techniques, avian visual acuity and aircraft lighting, habitat management, Canada goose movement analyses, capture and relocation efficacy of raptors, DNA and molecular identifications, and systems integration (Wildlife Surveillance Concept -WiSC) which aims to determine the compatibility of avian radar or similar monitoring technologies warning notice in the Air Traffic Controller's reach. The research efforts designed to improve wildlife management techniques and practices on and near airports include:

- Evaluation of unmanned aerial systems (UAS) for hazing, detecting and monitoring hazardous wildlife.
- 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
- Movement patterns of red-tailed hawks following translocation from an airport
- Evaluation of translocation as a management tool for American kestrels at airports

- Aircraft-mounted lighting systems to enhance bird detection and avoidance of aircraft
- Landscape-level analysis of land cover and bird strike rate across airports

## Bird Strike Committee USA

The FAA participates in the Bird Strike Committee USA (BSC-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. The BSC USA Steering Committee is comprised of 25 diverse, subject-matter experts representing Pilots, Airlines, Airframe and Engine Manufacturers, Wildlife Biologists, Airport Managers, Department of Defense personnel, ATC Personnel, Certification Inspectors, Research, Private Sector and Government Personnel. The BSC USA election class of 2022 continued to bring onboard energetic nominations for Steering Committee and Executive positions. Congratulations are in order to FAA National Wildlife Biologist Amy Anderson as the new Vice-Chair of the Steering Committee.

Throughout 2022, the BSC USA has collaborated with The Wildlife Society (TWS) for the vetting of prospective Qualified Airport Wildlife Biologists (QAWB). In March 2022, TWS announced a collaboration with BSC-USA to develop a designation that would expand TWS' Wildlife Biologist Certification Program's current opportunities. That certification process for QAWB's was recently finalized and is now available to qualified candidates For more information please visit TWS web site: https://wildlife.org/.

BSC USA Executives: Amy Anderson as the new Vice-Chair (right), Nick Atwell as the BSC USA Chair (middle) and John Weller as Past Chair (left).

The BSC USA provides an abundance of outreach to the public and aviation community alike. Along with education / outreach booths at the air shows in Lakeland, FL (Sun-n-Fun) and Oshkosh, WI (EAA Air Venture Oshkosh) the newly updated website http://www.birdstrike.org/ offers many useful resources, a quarterly newsletter to the industry and public and links such as the new one highlighting TWS.

## Performance Metrics

Starting in 2013 the FAA adopted the following performance metric that will measure program efficacy under a voluntary strike reporting environment where the absolute number of bird strikes is not known. These 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 762 in 2000 to 691 in 2022.

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 use 2010 as the baseline data and calculate the performance measure for following years. The table below depicts the results of calculating the data for the 13-year period 2010 - 2022.

| Year | Total strikes reported | Damaging strikes reported | Percentage damaging strikes vs. total strikes |
|---|---|---|---|
| 2010 | 9,889 | 595 | 6.0% |
| 2011 | 10,104 | 542 | 5.4% |
| 2012 | 10,903 | 613 | 5.6% |
| 2013 | 11,406 | 609 | 5.3% |
| 2014 | 13,683 | 587 | 4.3% |
| 2015 | 13,788 | 622 | 4.5% |
| 2016 | 13,353 | 589 | 4.4% |
| 2017 | 14,788 | 667 | 4.5% |
| 2018 | 16,233 | 720 | 4.4% |
| 2019 | 17,381 | 757 | 4.4% |
| 2020 | 11,666 | 486 | 4.2% |
| 2021 | 15,556 | 657 | 4.2% |
| 2022 | 17,190 | 691 | 4.0% |

Metric 2: Monitor estimated reporting rate of wildlife strikes. Analyses by Dolbeer (2009, 2014) identified that overall reporting rates for strikes are much higher at Part 139 airports than at NPIAS GA airports. There is also a major disparity in reporting rates among Part 139 airports. Larger Part 139 airports, especially those that have well-established wildlife hazard management programs, have reporting rates about 4 times higher than other Part 139 airports. We will continue to update the study approximately every five years.

The 17,190 documented strikes in 2022 equated to roughly 47 wildlife strikes every day, of which only about 4.0% are damaging. In 2022, there were 691 damaging strikes; this

averages about 2 damaging strikes per day or about 1 per 22,500 of the estimated 45,000+ flights per day (Commercial passenger, General Aviation Air Taxi, Air Cargo, Military) handled by FAA ATC. Overall, 82% of strikes occur at or below 1,500 feet AGL. This altitude falls within the 5-mile separation distance around airports recommended for wildlife attractants, meaning that on-ground wildlife mitigation activities out to 5 miles can have a positive effect on risk reduction for 82% of all wildlife strikes.

Covid-19 impacts to passenger air travel resulted in 62% and 31% reductions in air travel (520 million and 261 million fewer passengers) in 2020 and 2021, respectively, compared to pre-COVID-19 2019. It also resulted in 28% and 11% reductions in aircraft movements at 368 Part 139-certificated airports (10.3 million and 4.0 million fewer movements) in 2020 and 2021, respectively, compared to 2019. Although the decline in aircraft movements resulted in 33% and 9% reductions in reported strikes in 2020 and 2021, respectively, when compared to 2019, the strike rate (strikes/100,000 movements) declined by only 6% in 2020 and increased 2% in 2021 compared to 2019. COVID-19 clearly affected airport personnel and mitigation strategies, but risk reduction from wildlife remained a high priority at the nation's airports. Overall, the percentage of strikes with damage has fluctuated negligibly over the past 4 years (4.4% in 2018 – 2019 and 4.2% in 2020 – 2021). This again, shows why managing wildlife attractants off airport properties out to 5-miles is critical. Eighty-two percent of strikes occur at or below 1,500 feet Above Ground Level (AGL). This altitude falls within the 5-mile separation distance recommended for wildlife attractants, meaning that on-ground wildlife mitigation activities out to 5 miles can have a positive effect on risk reduction for 82 percent of all wildlife strikes.

Wildlife strikes are rare events that occur every day. Although it is impossible to eliminate all strikes at all times, comprehensive assessment, planning and management techniques have successfully mitigated damaging strikes on or near airports. Combined with systematic evaluation and adaptation of techniques, safety can be increased one less strike at a time.

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# TABLES

Table 1. Number of reported wildlife strikes to civil aircraft in USA and to U.S.-registered civil aircraft in foreign countries, 1990–2022.

| | USA[1] | | Foreign | | Total | |
|---|---|---|---|---|---|---|
| Year | Strikes | Damage strikes | Strikes | Damage strikes | Strikes | Damage strikes |
| 1990 | 2,088 | 366 | 34 | 6 | 2,122 | 372 |
| 1991 | 2,479 | 395 | 37 | 5 | 2,516 | 400 |
| 1992 | 2,614 | 360 | 37 | 5 | 2,651 | 365 |
| 1993 | 2,590 | 395 | 34 | 4 | 2,624 | 399 |
| 1994 | 2,673 | 452 | 35 | 7 | 2,708 | 459 |
| 1995 | 2,773 | 487 | 52 | 11 | 2,825 | 498 |
| 1996 | 2,980 | 493 | 51 | 10 | 3,031 | 503 |
| 1997 | 3,490 | 566 | 69 | 9 | 3,559 | 575 |
| 1998 | 3,741 | 577 | 67 | 10 | 3,808 | 587 |
| 1999 | 5,025 | 687 | 95 | 18 | 5,120 | 705 |
| 2000 | 5,897 | 744 | 128 | 21 | 6,025 | 765 |
| 2001 | 5,697 | 631 | 124 | 15 | 5,821 | 646 |
| 2002 | 6,076 | 659 | 141 | 11 | 6,217 | 670 |
| 2003 | 5,854 | 611 | 137 | 20 | 5,991 | 631 |
| 2004 | 6,407 | 614 | 159 | 16 | 6,566 | 630 |
| 2005 | 7,064 | 591 | 180 | 19 | 7,244 | 610 |
| 2006 | 7,110 | 584 | 163 | 19 | 7,273 | 603 |
| 2007 | 7,598 | 552 | 142 | 16 | 7,740 | 568 |
| 2008 | 7,441 | 513 | 186 | 14 | 7,627 | 527 |
| 2009 | 9,251 | 587 | 251 | 20 | 9,502 | 607 |
| 2010 | 9,668 | 585 | 229 | 18 | 9,897 | 603 |
| 2011 | 9,845 | 521 | 264 | 24 | 10,109 | 545 |
| 2012 | 10,661 | 600 | 266 | 21 | 10,927 | 621 |
| 2013 | 11,212 | 601 | 195 | 12 | 11,407 | 613 |
| 2014 | 13,456 | 570 | 230 | 16 | 13,686 | 586 |
| 2015 | 13,529 | 611 | 242 | 12 | 13,771 | 623 |
| 2016 | 13,156 | 581 | 166 | 11 | 13,322 | 592 |
| 2017 | 14,611 | 667 | 163 | 10 | 14,774 | 677 |
| 2018 | 15,975 | 702 | 222 | 13 | 16,197 | 715 |
| 2019 | 17,157 | 747 | 177 | 9 | 17,334 | 756 |
| 2020 | 11,490 | 479 | 133 | 8 | 11,623 | 487 |
| 2021 | 15,448 | 652 | 191 | 9 | 15,639 | 661 |
| 2022 | 16,960 | 671 | 230 | 20 | 17,190 | 691 |
| **Total** | **272,016** | **18,851** | **4,830** | **439** | **276,846** | **19,290** |

[1] Includes strikes where airport is unknown because strike was en route, or phase of flight was undetermined (see footnote 2 in Table 8). See Table 2 for breakdown of strikes occurring in USA by type of wildlife.

Table 2. Number of reported wildlife strikes to civil aircraft in USA by wildlife group, 1990–2022.

| Year | Birds | Bats | Terrestrial mammals[1] | Reptiles[1] | Total strikes | Strikes with damage[2] |
|---|---|---|---|---|---|---|
| 1990 | 2,030 | 3 | 55 | 0 | 2,088 | 366 |
| 1991 | 2,418 | 3 | 58 | 0 | 2,479 | 395 |
| 1992 | 2,538 | 2 | 73 | 1 | 2,614 | 360 |
| 1993 | 2,518 | 6 | 66 | 0 | 2,590 | 395 |
| 1994 | 2,589 | 2 | 81 | 1 | 2,673 | 452 |
| 1995 | 2,676 | 4 | 85 | 8 | 2,773 | 487 |
| 1996 | 2,887 | 1 | 89 | 3 | 2,980 | 493 |
| 1997 | 3,383 | 1 | 92 | 14 | 3,490 | 566 |
| 1998 | 3,619 | 3 | 112 | 7 | 3,741 | 577 |
| 1999 | 4,921 | 6 | 97 | 1 | 5,025 | 687 |
| 2000 | 5,756 | 15 | 123 | 3 | 5,897 | 744 |
| 2001 | 5,543 | 8 | 138 | 8 | 5,697 | 631 |
| 2002 | 5,923 | 19 | 119 | 15 | 6,076 | 659 |
| 2003 | 5,706 | 20 | 123 | 5 | 5,854 | 611 |
| 2004 | 6,248 | 27 | 126 | 6 | 6,407 | 614 |
| 2005 | 6,899 | 27 | 131 | 7 | 7,064 | 591 |
| 2006 | 6,906 | 46 | 148 | 10 | 7,110 | 584 |
| 2007 | 7,369 | 51 | 171 | 7 | 7,598 | 552 |
| 2008 | 7,210 | 43 | 183 | 5 | 7,441 | 513 |
| 2009 | 8,946 | 66 | 229 | 10 | 9,251 | 587 |
| 2010 | 9,292 | 112 | 253 | 11 | 9,668 | 585 |
| 2011 | 9,491 | 138 | 201 | 15 | 9,845 | 521 |
| 2012 | 10,268 | 161 | 210 | 22 | 10,661 | 600 |
| 2013 | 10,749 | 223 | 207 | 33 | 11,212 | 601 |
| 2014 | 12,942 | 253 | 226 | 35 | 13,456 | 570 |
| 2015 | 12,964 | 316 | 213 | 36 | 13,529 | 611 |
| 2016 | 12,647 | 247 | 226 | 36 | 13,156 | 581 |
| 2017 | 13,872 | 408 | 272 | 59 | 14,611 | 667 |
| 2018 | 15,105 | 507 | 314 | 49 | 15,975 | 702 |
| 2019 | 16,101 | 553 | 416 | 87 | 17,157 | 747 |
| 2020 | 10,921 | 288 | 239 | 42 | 11,490 | 479 |
| 2021 | 14,634 | 451 | 295 | 68 | 15,448 | 652 |
| 2022 | 16,099 | 513 | 282 | 66 | 16,960 | 671 |
| **Total** | **261,170** | **4,523** | **5,653** | **670** | **272,016** | **18,851** |

[1] For terrestrial mammals and reptiles, species with body masses <1 kilogram (2.2 pounds) such as small rodents generally are excluded from database (Dolbeer et al. 2005).

[2] Birds, terrestrial mammals, bats, and reptiles respectively accounted for 17,527 (93.0%), 1,289 (6.8%), 32 (0.2%), and 3 (<0.1%) of the 18,851 damage strikes.

Table 3. Number and rate of reported wildlife strikes and strikes with damage for transport aircraft at 338 Part-139 certificated airports[1], USA, 2000–2022 (see Figure 2).

| | No. of reported strikes[2] | | | Strikes/100,000 movements | |
|---|---|---|---|---|---|
| Year | All strikes | Strikes with damage | Aircraft movements (x 1 million)[3] | All strikes | Strikes with damage |
| 2000 | 3,226 | 355 | 25.41 | 12.70 | 1.40 |
| 2001 | 3,043 | 289 | 24.40 | 12.47 | 1.18 |
| 2002 | 3,269 | 303 | 23.77 | 13.75 | 1.27 |
| 2003 | 3,222 | 281 | 23.58 | 13.67 | 1.19 |
| 2004 | 3,643 | 270 | 24.78 | 14.70 | 1.09 |
| 2005 | 3,733 | 285 | 25.11 | 14.87 | 1.14 |
| 2006 | 3,855 | 301 | 24.36 | 15.82 | 1.24 |
| 2007 | 4,117 | 275 | 24.47 | 16.82 | 1.12 |
| 2008 | 3,894 | 265 | 23.43 | 16.62 | 1.13 |
| 2009 | 5,073 | 297 | 21.51 | 23.58 | 1.38 |
| 2010 | 4,906 | 286 | 21.51 | 22.81 | 1.33 |
| 2011 | 4,862 | 267 | 21.38 | 22.74 | 1.25 |
| 2012 | 5,030 | 285 | 21.03 | 23.92 | 1.36 |
| 2013 | 4,924 | 233 | 20.93 | 23.53 | 1.11 |
| 2014 | 6,295 | 255 | 20.68 | 30.43 | 1.23 |
| 2015 | 6,168 | 246 | 20.91 | 29.50 | 1.18 |
| 2016 | 6,108 | 263 | 21.24 | 28.76 | 1.24 |
| 2017 | 6,245 | 300 | 21.48 | 29.07 | 1.40 |
| 2018 | 6,938 | 325 | 22.11 | 31.38 | 1.47 |
| 2019 | 7,311 | 304 | 22.70 | 32.21 | 1.34 |
| 2020 | 4,127 | 189 | 14.27 | 28.91 | 1.32 |
| 2021 | 6,241 | 267 | 18.54 | 33.67 | 1.44 |
| 2022 | 7,127 | 299 | 20.46 | 34.84 | 1.46 |
| **Total** | **113,357** | **6,440** | **508.06** | **22.31** | **1.27** |

[1] Data are presented for the 338 larger Part 139-certificated airports for which movement data (Federal Aviation Administration 2023*a*) were available in all years, 2000-2022. In 2022, there were 517 Part 139 airports (Federal Aviation Administration 2023*b*).

[2] Strikes involving an unknown operator (77,132 of which 75,540 were “Carcass Found” reports--see Tables 6 and 7) were excluded from this analysis as were all strikes by USA-registered aircraft in foreign countries.

[3] Departures and arrivals for air carrier and air taxi service aircraft (Federal Aviation Administration 2023*a*).

Table 4. Number and rate of reported wildlife strikes and strikes with damage for general aviation aircraft at 116 non-Part-139 certificated (general aviation) airports[1], USA, 2000–2022 (see Figure 2).

| | No. of reported strikes[2] | | | Strikes/100,000 movements | |
|---|---|---|---|---|---|
| Year | All strikes | Strikes with damage | Aircraft movements (x 1 million)[3] | All strikes | Strikes with damage |
| 2000 | 119 | 39 | 15.28 | 0.78 | 0.26 |
| 2001 | 135 | 34 | 14.67 | 0.92 | 0.23 |
| 2002 | 145 | 34 | 14.94 | 0.97 | 0.23 |
| 2003 | 132 | 37 | 14.01 | 0.94 | 0.26 |
| 2004 | 132 | 47 | 13.53 | 0.98 | 0.35 |
| 2005 | 126 | 22 | 13.09 | 0.96 | 0.17 |
| 2006 | 106 | 24 | 12.82 | 0.83 | 0.19 |
| 2007 | 100 | 15 | 12.95 | 0.77 | 0.12 |
| 2008 | 113 | 31 | 12.14 | 0.93 | 0.26 |
| 2009 | 123 | 21 | 10.71 | 1.15 | 0.20 |
| 2010 | 125 | 28 | 10.03 | 1.25 | 0.28 |
| 2011 | 125 | 18 | 9.83 | 1.27 | 0.18 |
| 2012 | 165 | 36 | 9.74 | 1.69 | 0.37 |
| 2013 | 176 | 36 | 9.72 | 1.81 | 0.37 |
| 2014 | 216 | 33 | 9.67 | 2.23 | 0.34 |
| 2015 | 243 | 33 | 9.74 | 2.49 | 0.34 |
| 2016 | 272 | 27 | 9.82 | 2.77 | 0.27 |
| 2017 | 266 | 36 | 9.98 | 2.67 | 0.36 |
| 2018 | 294 | 41 | 10.43 | 2.82 | 0.39 |
| 2019 | 306 | 46 | 10.99 | 2.79 | 0.42 |
| 2020 | 270 | 29 | 9.90 | 2.73 | 0.29 |
| 2021 | 301 | 36 | 10.64 | 2.83 | 0.34 |
| 2022 | 240 | 28 | 11.03 | 2.18 | 0.25 |
| **Total** | **4,230** | **731** | **265.66** | **1.59** | **0.28** |

[1] Data are presented for the 116 larger non-Part 139-certificated (general aviation) airports for which movement data (Federal Aviation Administration 2023*a*) were available in all years, 2000-2022.

[2] Strikes involving an unknown operator (77,132 of which 75,540 were “Carcass Found” reports--see Tables 6 and 7) were excluded from this analysis as were all strikes by USA-registered aircraft in foreign countries.

[3] Itinerant and local departures and arrivals for general aviation aircraft (Federal Aviation Administration 2023*a*).

Table 5. Methods of reporting and source of information for reported wildlife strikes to civil aircraft, USA[1], 2022 only and 1990–2022.

| | 2022 only | | 1990-2022 | |
|---|---|---|---|---|
| Source | Total | % of total | Total | % of total |
| FAA Form 5200-7-E[2] | 12,546 | 73 | 163,384 | 59 |
| Multiple[3] | 2,818 | 16 | 29,080 | 11 |
| Mandatory Occurrence Report (MOR) | 1,684 | 10 | 11,239 | 4 |
| Air Transport Report | 97 | 1 | 16,846 | 6 |
| FAA Form 5200-7 (Paper) | 24 | <1 | 41,732 | 15 |
| Airport Report | 10 | <1 | 7,340 | 3 |
| Other[4] | 9 | <1 | 5,041 | 1 |
| Daily Report | 2 | <1 | 2,184 | 1 |
| **Total** | **17,190** | **100** | **276,846** | **100** |

[1] Includes strikes to U.S.-registered aircraft in foreign countries.

[2] Bird/Other Wildlife Strike Report. Electronic filing of reports (http://wildlife.faa.gov) began in April 2001.

[3] More than one type of report was filed for the same strike (many of these had at least one FAA Form 5200-7E report filed).

[4] Various sources such as news media, Preliminary Aircraft Incident Report, Aviation Safety Reporting System, National Transportation Safety Board, Transport Canada, and engine manufacturers.

Table 6. Person filing report of wildlife strike to civil aircraft, USA[1], 2022 only and 1990–2022.

| | 2022 only | | 1990-2022 | |
|---|---|---|---|---|
| Person filing report | Total | % of total | Total | % of total |
| Airport Operations | 11,322 | 66 | 137,125 | 54 |
| Carcass Found[2] | 5,603 | 49 | 75,540 | 55 |
| Misc. reports[3] | 5,719 | 51 | 61,585 | 45 |
| Pilot | 3,018 | 18 | 50,044 | 20 |
| Tower | 1,789 | 10 | 29,217 | 11 |
| Air Transport Operations[4] | 570 | 3 | 33,037 | 13 |
| Other | 491 | 3 | 6,271 | 2 |
| **Total known** | **17,190** | **100** | **255,694** | **100** |
| **Unknown** | **0** | | **21,152** | |
| **Total** | **17,190** | | **276,846** | |

[1] Includes strikes to U.S.-registered aircraft in foreign countries.

[2] Airport personnel found fresh wildlife remains within 250 feet of a runway centerline or elsewhere on or near airport that appeared to have been struck by aircraft, but no strike was observed or reported by pilot, tower, or airline (FAA Advisory Circular 150/5200-32B).

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

[4] Personnel at air transport companies (other than the pilot/flight crew) involved with flight safety, flight operations, and maintenance.

Table 7. Number of reported wildlife strikes to civil aircraft by type of operator, USA[1], 2022 only and 1990-2022.

| | 2022 only | | 1990-2022 | |
|---|---|---|---|---|
| Type of operator | Total | % of total | Total | % of total |
| **Commercial transport[2]** | 9,829 | 86 | 170,103 | 85 |
| **General Aviation** | 1,653 | 14 | 29,611 | 15 |
| Business | 1,396 | 12 | 23,607 | 12 |
| Private | 107 | 1 | 3,707 | 2 |
| Government/police[3] | 150 | 1 | 2,297 | 1 |
| **Total known** | **11,482** | **100** | **199,714** | **100** |
| **Unknown[4]** | **5,708** | | **77,132** | |
| **Total** | **17,190** | | **276,846** | |

[1] Includes strikes to U.S.-registered aircraft in foreign countries.

[2] Air carrier, commuter, and air taxi service with 3-letter Operator Code.

[3] U.S. Customs and Border Protection (USCBP) and U.S. Coast Guard (USCG) aircraft were respectively involved in 23 percent (536) and 34 percent (783) of the 2,297 Government/police strikes, 1990–2022. For 2022 only, 11 percent (16) and 33 percent (49) of the 150 Government/police strikes involved USCBP and USCG aircraft, respectively.

[4] Ninety-eight percent (75,540) of the 77,132 strikes involving an unknown operator were “Carcass Found” reports, 1990–2022. For 2022 only, 98 percent (5,603) of the 5,708 strikes involving an unknown operator were “Carcass Found” reports (see Table 6).

Table 8. Number of Part 139-certificated airports[1] and general aviation (GA) airports with reported wildlife strikes and number of strikes reported for these airports, civil aircraft, USA, 1990–2022 (see Figure 5)[2].

| | Part 139 airports | | GA airports | | All USA airports | |
|---|---|---|---|---|---|---|
| Year | Airports | Strikes | Airports | Strikes | Airports | Strikes |
| 1990 | 235 | 1,779 | 99 | 163 | 334 | 1,942 |
| 1991 | 260 | 2,116 | 96 | 198 | 356 | 2,314 |
| 1992 | 255 | 2,256 | 107 | 227 | 362 | 2,483 |
| 1993 | 256 | 2,266 | 100 | 218 | 356 | 2,484 |
| 1994 | 264 | 2,294 | 111 | 246 | 375 | 2,540 |
| 1995 | 260 | 2,382 | 120 | 209 | 380 | 2,591 |
| 1996 | 257 | 2,591 | 109 | 194 | 366 | 2,785 |
| 1997 | 283 | 3,011 | 122 | 200 | 405 | 3,211 |
| 1998 | 290 | 3,220 | 144 | 268 | 434 | 3,488 |
| 1999 | 303 | 3,807 | 145 | 257 | 448 | 4,064 |
| 2000 | 310 | 4,487 | 154 | 280 | 464 | 4,767 |
| 2001 | 315 | 4,431 | 152 | 294 | 467 | 4,725 |
| 2002 | 305 | 4,760 | 154 | 309 | 459 | 5,069 |
| 2003 | 305 | 4,642 | 153 | 329 | 458 | 4,971 |
| 2004 | 306 | 5,214 | 175 | 321 | 481 | 5,535 |
| 2005 | 321 | 5,519 | 175 | 330 | 496 | 5,849 |
| 2006 | 319 | 5,949 | 144 | 274 | 463 | 6,223 |
| 2007 | 324 | 6,560 | 164 | 328 | 488 | 6,888 |
| 2008 | 329 | 6,617 | 162 | 310 | 491 | 6,927 |
| 2009 | 361 | 8,010 | 234 | 452 | 595 | 8,462 |
| 2010 | 373 | 8,291 | 219 | 465 | 592 | 8,756 |
| 2011 | 361 | 8,442 | 231 | 501 | 592 | 8,943 |
| 2012 | 384 | 8,924 | 257 | 579 | 641 | 9,503 |
| 2013 | 377 | 9,129 | 274 | 619 | 651 | 9,748 |
| 2014 | 393 | 11,010 | 282 | 705 | 675 | 11,715 |
| 2015 | 404 | 11,089 | 270 | 695 | 674 | 11,784 |
| 2016 | 401 | 10,779 | 262 | 782 | 663 | 11,561 |
| 2017 | 420 | 11,757 | 282 | 829 | 702 | 12,586 |
| 2018 | 419 | 12,843 | 297 | 869 | 716 | 13,712 |
| 2019 | 420 | 13,496 | 310 | 918 | 730 | 14,414 |
| 2020 | 411 | 9,197 | 258 | 916 | 669 | 10,113 |
| 2021 | 429 | 12,353 | 279 | 988 | 708 | 13,341 |
| 2022 | 429 | 13,442 | 264 | 893 | 693 | 14,335 |
| **Total** | **516** | **222,663** | **1,546** | **15,166** | **2,062** | **237,829** |

[1] There were 522 airports in USA certificated for passenger service under CFR Part 139 in January 2023 (FAA 2023*b*).

[2] In addition, 4,830 strikes involving USA-registered aircraft were reported from 330 foreign airports in 113 countries (230 strikes at 91 airports in 53 countries in 2022). Furthermore, 5,148 strikes (5,114 bird and 34 bat strikes) were reported in which aircraft was en route (Table 10). An additional 28,661 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 9. Reported time of occurrence of wildlife strikes with civil aircraft, USA[1], 1990–2022[2].

| | Birds | | Terrestrial mammals | | Bats | |
|---|---|---|---|---|---|---|
| Time of day | 33-year total | % of total known | 33-year total | % of total known | 33-year total | % of total known |
| Dawn | 5,657 | 4 | 125 | 5 | 24 | 2 |
| Day | 97,782 | 62 | 718 | 27 | 251 | 18 |
| Dusk | 6,960 | 4 | 199 | 7 | 58 | 4 |
| Night | 46,088 | 29 | 1,665 | 62 | 1,066 | 76 |
| **Total known** | **156,487** | **100** | **2,707** | **100** | **1,399** | **100** |
| **Unknown[3]** | **109,454** | | **2,960** | | **3,169** | |
| **Total** | **265,941** | | **5,667** | | **4,568** | |

[1] Includes strikes to U.S.-registered aircraft in foreign countries.

[2] In addition, 670 strikes with reptiles were reported from 1990–2022: time not reported (559), day (88), night (17), dusk (4), and dawn (2).

[3] Of the 116,142 strike reports with “Unknown” time of day (all species), 75,540 (65 percent) were “Carcass Found” reports (Table 6).

Table 10. Reported phase of flight at time of occurrence of wildlife strikes with civil aircraft, USA[1], 1990–2022[2].

| | Birds | | Terrestrial mammals[3] | | Bats | |
|---|---|---|---|---|---|---|
| Phase of flight | 33-year total | % of total known | 33-year total | % of total known | 33-year total | % of total known |
| Parked | 110 | <1 | 2 | <1 | | 0 |
| Taxi | 547 | <1 | 77 | 3 | | 0 |
| Take-off Run | 28,149 | 17 | 903 | 30 | 50 | 4 |
| Climb | 26,038 | 16 | 64 | 2 | 76 | 6 |
| Departure[4] | 2,640 | 2 | 6 | <1 | 29 | 2 |
| En Route | 5,114 | 3 | | | 34 | 3 |
| Arrival[4] | 711 | <1 | 7 | <1 | 6 | <1 |
| Descent | 2,211 | 1 | | | 21 | 2 |
| Approach | 71,471 | 43 | 244 | 8 | 873 | 69 |
| Landing Roll | 29,041 | 17 | 1,637 | 55 | 177 | 14 |
| Local[4] | 974 | 1 | 49 | 2 | 5 | <1 |
| **Total known** | **167,006** | **100** | **2,989** | **100** | **1,271** | **100** |
| **Unknown[5]** | **98,935** | | **2,678** | | **3,297** | |
| **Total** | **265,941** | | **5,667** | | **4,568** | |

[1] Includes strikes to U.S.-registered aircraft in foreign countries.

[2] In addition, 670 strikes with reptiles were reported: phase of flight not reported (559), landing roll (47), take-off run (36), taxi (18), approach (7; pilot missed approach because reptile was on runway or hit reptile before aircraft touched down), and local (3).

[3] In some cases, terrestrial mammals (e.g., deer, coyote) was hit after aircraft lifted off runway or just before touchdown, or pilot had a missed approach because mammal was on runway.

[4] Phase of flight was determined to be Arrival, Departure, or Local (i.e., pilot conducting “touch-and-go” operations) but exact phase of flight could not be determined.

[5] Of the 105,469 strike reports with “Unknown” phase of flight (all species), 75,540 (72 percent) were “Carcass Found” reports (Table 6).

Table 11. Number of reported bird strikes to commercial transport aircraft[1] by height above ground level (AGL), USA[2], 1990–2022. See Figure 8 for graphic analysis of strike data from 501 to 18,500 feet AGL[3].

| Height of strike (feet AGL) | All reported strikes | | | Strikes with damage | | |
|---|---|---|---|---|---|---|
| | 33-year total | % of total known | % cum-ulative total[4] | 33-year total | % of total known | % cum-ulative total[4] |
| 0 | 48,984 | 42 | 42 | 2,236 | 27 | 27 |
| 1-500 | 33,509 | 29 | 71 | 2,175 | 27 | 54 |
| 501-1500 | 12,675 | 11 | 82 | 1,229 | 15 | 69 |
| 1501-2500 | 6,798 | 6 | 88 | 771 | 9 | 79 |
| 2501-3500 | 4,925 | 4 | 92 | 501 | 6 | 85 |
| 3501-4500 | 2,975 | 3 | 94 | 319 | 4 | 89 |
| 4501-5500 | 2,060 | 2 | 96 | 231 | 3 | 92 |
| 5501-6500 | 1,375 | 1 | 97 | 159 | 2 | 94 |
| 6501-7500 | 906 | 1 | 98 | 103 | 1 | 95 |
| 7501-8500 | 709 | 1 | 99 | 101 | 1 | 96 |
| 8501-9500 | 377 | <1 | 99 | 48 | 1 | 97 |
| 9501-10500 | 506 | <1 | 99 | 78 | 1 | 98 |
| 10501-11500 | 252 | <1 | 100 | 59 | 1 | 98 |
| >11500[5] | 440 | <1 | 100 | 126 | 2 | 100 |
| **Total known** | **116,491** | **100** | | **8,136** | **100** | |
| **Unknown height** | **49,983** | | | **3,617** | | |
| **Total** | **166,474** | | | **11,753** | | |

[1] Air carrier, commuter, and air taxi service with 3-letter Operator Code (see Table 7); strikes in which height of strike was reported but type of operator was unknown were excluded from analysis.

[2] Includes strikes to U.S.-registered aircraft in foreign countries.

[3] A more detailed analysis of bird strikes by height AGL is provided by Dolbeer (2006*b*).

[4] The cumulative percentage of strikes that occur at or below the upper range of the corresponding 1,000-foot interval.

[5] Thirty-one strikes involving commercial transport aircraft (11 with damage to aircraft) were reported at ≥20,000 feet AGL; the highest was 31,300 feet.

Table 12. Number of reported bird strikes to general aviation aircraft[1] by height above ground level (AGL), USA[2], 1990–2022. See Figure 8 for graphic analysis of strike data from 501 to 12,500 feet AGL[3].

| Height of strike (feet AGL) | All reported strikes | | | Strikes with damage | | |
|---|---|---|---|---|---|---|
| | 33-year total | % of total known | % cumulative total[4] | 33-year total | % of total known | % cumulative total[4] |
| 0 | 8,290 | 37 | 37 | 817 | 16 | 817 |
| 1-500 | 7,655 | 34 | 70 | 1,684 | 32 | 1,684 |
| 501-1500 | 3,755 | 17 | 87 | 1,468 | 28 | 1,468 |
| 1501-2500 | 1,476 | 7 | 94 | 621 | 12 | 621 |
| 2501-3500 | 670 | 3 | 97 | 285 | 5 | 285 |
| 3501-4500 | 311 | 1 | 98 | 144 | 3 | 144 |
| 4501-5500 | 154 | 1 | 99 | 62 | 1 | 62 |
| 5501-6500 | 102 | <1 | 99 | 49 | 1 | 49 |
| 6501-7500 | 77 | <1 | 99 | 28 | 1 | 28 |
| 7501-8500 | 41 | <1 | 100 | 20 | <1 | 20 |
| 8501-9500 | 26 | <1 | 100 | 13 | <1 | 13 |
| 9501-10500 | 32 | <1 | 100 | 17 | <1 | 17 |
| 10501-11500 | 7 | <1 | 100 | 3 | <1 | 3 |
| >11500[5] | 39 | <1 | 100 | 25 | <1 | 25 |
| **Total known** | **22,635** | **100** | | **5,236** | **100** | **5,236** |
| **Unknown height** | **5,337** | | | **843** | | **843** |
| **Total** | **27,972** | | | **6,079** | | **6,079** |

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

[2] Includes strikes to U.S.-registered aircraft in foreign countries.

[3] A more detailed analysis of bird strikes by height AGL is provided by Dolbeer (2006*b*).

[4] The cumulative percentage of strikes that occur at or below the upper range of the corresponding 1,000-foot interval.

[5] Seven strikes involving general aviation aircraft (6 with damage to aircraft) were reported at ≥20,000 feet AGL; the highest was 27,500 feet.

Table 13. Civil aircraft components reported as being struck and damaged by wildlife, USA[1], 1990–2022.

| | Birds (33-year total) | | | | Terrestrial mammals (33-year total) | | | |
|---|---|---|---|---|---|---|---|---|
| Aircraft component | Number struck | % of total | Number damaged | % of total | Number struck | % of total | Number damaged | % of total |
| Windshield | 33,766 | 15 | 1,339 | 6 | 9 | 0 | 17 | 1 |
| Wing/rotor | 31,536 | 14 | 5,340 | 25 | 384 | 10 | 383 | 17 |
| Nose | 31,354 | 14 | 1,477 | 7 | 133 | 4 | 120 | 5 |
| Radome | 25,222 | 11 | 1,965 | 9 | 21 | 1 | 16 | 1 |
| Fuselage | 24,470 | 11 | 932 | 4 | 183 | 5 | 185 | 8 |
| Engine(s)[2] | 24,169 | 11 | 5,362 | 25 | 206 | 6 | 195 | 8 |
| Landing gear | 9,818 | 4 | 683 | 3 | 1,697 | 46 | 561 | 24 |
| Propeller | 4,336 | 2 | 322 | 2 | 395 | 11 | 344 | 15 |
| Tail | 2,719 | 1 | 870 | 4 | 64 | 2 | 87 | 4 |
| Light | 1,328 | 1 | 900 | 4 | 57 | 2 | 59 | 3 |
| Other[3] | 35,460 | 16 | 1,960 | 9 | 552 | 15 | 335 | 15 |
| **Total[4]** | **224,178** | **100** | **21,150** | **100** | **3,701** | **100** | **2,302** | **100** |

[1] Includes strikes to U.S.-registered aircraft in foreign countries.

[2] For birds, 24,169 engines were reported as struck in 23,128 strike events involving engines (22,118 events with one engine struck, 986 with two engines struck, 17 with three engines struck, and 7 with four engines struck). A total of 5,362 engines was damaged in 5,190 bird-strike events with engine damage (5,021 events with one engine damaged, 167 with two engines damaged, 1 with three engines damaged, and 1 with four engines damaged). For terrestrial mammals, 203 engines were reported as struck in 192 strike events (181 events with one engine struck and 11 with two engines struck). A total of 194 engines was damaged in 175 terrestrial mammal strike events with engine damage (156 events with one engine damaged and 19 with two engines damaged). Some engines were damaged without being struck when the landing gear collapsed.

[3] "Other" parts reported struck included 819 Pitot tubes, 461 wiper blades, 285 antennae (communication, radar, or global position), 194 Angle of Attack (AOA) sensors (including SMART sensors), and 182 air temperature probes (TAT, RAT, OAT).

[4] In addition, bat strikes had 2,507 and 37 components reported as struck and damaged, respectively: radome/nose (857, 5), windshield (371, 6), engine (178, 6), propeller (7, 0), wing/rotor (533,11), fuselage (205, 2), tail (32, 3), other (205, 2), landing gear (108, 0), light (11, 2). For reptile strikes, there were 103 and 7 components reported struck and damaged, respectively: windshield (1, 1), wing/rotor (2, 2), fuselage (1, 1), landing gear (83, 1), tail (1, 1), nose (3, 0), other (12, 1).

Table 14. Number of civil aircraft with reported damage resulting from wildlife strikes, USA[1], 1990–2022. See Tables 1-4 and Figures 2, 3, 10, and 15 for trends in damaging strikes, 1990–2022.

| | Reported strikes | | | | | |
|---|---|---|---|---|---|---|
| | Birds | | Terrestrial mammals | | Total (all species)[2] | |
| Damage category[3] | 33-year total | % of total[4] | 33-year total | % of total[4] | 33-year total | % of total[4] |
| **None** | **157,820** | **59** | **1,377** | **24** | **161,367** | **58** |
| **Unknown** | **90,161** | **34** | **2,999** | **53** | **96,189** | **35** |
| **Damage** | **17,960** | **7** | **1,291** | **23** | **19,290** | **7** |
| Minor | 7,918 | 3 | 613 | 11 | 8,543 | 3 |
| Uncertain | 6,269 | 2 | 213 | 4 | 6,504 | 2 |
| Substantial | 3,726 | 1 | 431 | 8 | 4,162 | 2 |
| Destroyed[5] | 47 | <1 | 34 | 1 | 81 | <1 |
| **Total** | **265,941** | **100** | **5,667** | **100** | **276,846** | **100** |

[1] Includes strikes to U.S.-registered aircraft in foreign countries.

[2] Included in totals are 4,568 and 670 strikes involving bats and reptiles, respectively. For bats, 2,078 reports indicated no damage, 2,454 failed to indicate if damage occurred, and 36 indicated damage (10 minor, 22 uncertain level, 4 substantial [caused by megabats at foreign airports]). For reptiles, 92 reports indicated no damage, 575 failed to indicate if damage occurred, and 3 indicated damage (2 minor, 1 substantial).

[3] 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.

[4] The percentage of strikes causing damage is calculated using the total strikes reported as the divisor, including the 96,188 reports that did not indicate if damage occurred or not (Unknown). “Carcass found” reports (see Table 6) comprised 75,540 (79 percent) of these 96,188 reports. If the Unknown reports are excluded from the calculations, then 10, 48, and 11 percent of the strikes caused damage for birds, terrestrial mammals, and all species, respectively.

[5] Includes 1 Government-operated drone destroyed after being attacked by a bald eagle in 2020.

Table 15. Reported effect-on-flight of wildlife strikes to civil aircraft, USA[1], 1990–2022. See Figure 10 for trend in strikes with a negative effect-on-flight, 1990-2022.

| | Reported strikes | | | | | |
|---|---|---|---|---|---|---|
| | Birds | | Terrestrial mammals | | Total[2] | |
| Effect-on-flight[3] | 33-year total | % of total[4] | 33-year total | % of total[4] | 33-year total | % of total[4] |
| **None** | **123,160** | **46** | **1,262** | **22** | **125,733** | **45** |
| **Unknown** | **130,362** | **49** | **3,527** | **62** | **137,786** | **50** |
| **Negative effect** | **12,419** | **5** | **878** | **15** | **13,327** | **5** |
| Precautionary landing[5] | 7,883 | 3 | 132 | 2 | 8,030 | 3 |
| Aborted take-off[5] | 2,681 | 1 | 292 | 5 | 2,976 | 1 |
| Engine shutdown | 388 | <1 | 40 | 1 | 427 | <1 |
| Other | 1,467 | 1 | 414 | 7 | 1,893 | 1 |
| **Total** | **265,941** | **100** | **5,667** | **100** | **276,846** | **100** |

[1] Includes strikes to U.S.-registered aircraft in foreign countries.

[2] Included in totals are 4,049 and 601 strikes involving bats and reptiles, respectively. For bats, 1,109 reports indicated no effect-on-flight, 2,925 failed to indicate if an effect-on-flight occurred, and 15 indicated a negative effect (12 precautionary landings, 3 “Other”). For reptiles, 69 reports indicated no effect-on-flight, 519 failed to indicate if an effect-on-flight occurred, and 11 indicated a negative effect (1 precautionary landing, 2 aborted take-off, 8 “Other”).

[3] 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 take-off 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, evasive maneuver to avoid birds, or aborted landing (go-around); Unknown = report had insufficient information to determine an effect-on-flight (Dolbeer et al. 2000).

[4] The percentage of strikes causing negative effect-on-flight is calculated using the total strikes reported as the divisor, including the 127,199 reports that did not indicate if a negative effect occurred or not (Unknown). “Carcass found” reports (see Table 6) comprised 69,709 (55 percent) of these 127,199 reports. If the Unknown reports are excluded from the calculations, then 10, 42, and 10 percent of the strikes caused a negative effect-on-flight for birds, terrestrial mammals, and all species, respectively.

[5] Includes 80 bird strikes in which 1 engine was shut down before the precautionary landing and 17 bird strikes in which engine was shut down during aborted take-off.

Table 16. Number of reported incidents where pilot made a precautionary or emergency landing after striking wildlife 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), civil aircraft, USA, 1990–2022[1]. See Figure 11 for trends in incidents, 1990–2022.

| Action taken after bird strike on departure | Number of incidents | Comments and number of incidents by aircraft model |
|---|---|---|
| Fuel jettison | 63 | Aircraft: B-747 (22); B-767 (9); B-727 (7); DC-10/MD-11 (8); B-777 (4); B-787 (1); Learjet 31/35 (3); Airbus 330, Gulfstream 200, Gulfstream G150, L-1011, Lockheed P38, CL601, DA-2000, and unknown (1 each). A mean of 98,064 lbs (14,421 gallons) of fuel jettisoned per incident in which amount of fuel jettison was reported (N = 25, range 300–270,000 lbs; 44-39,706 gallons). |
| Fuel burn | 132 | Aircraft: A-319 to A330 (24); EMB-120/145/170/190 (25); B-737 (15); CRJ Regional Jets (12); Learjet 24/60 (6); MD-80/88/90 (6); and 24 other aircraft models with 1-3 each. |
| Overweight landing | 135 | Aircraft: B-737 (38); A-319/330 (29); B-757 (18); MD-80/83 (14); B-767 (10); CRJ-100 to 700 (5); EMB-145/170 (6); A-300, MD-11, and C-500/600 (2 each); and 9 aircraft models (1 each). |
| **Total** | **330** | **A mean of 10.0 (range 0 – 21) incidents (fuel jettison, fuel burn, or overweight landing) per year, 1990 – 2022.** |

[1] Includes strikes to U.S.-registered aircraft in foreign countries.

Table 17. Indicated airspeed (nautical miles/hour [knots])[1] at time pilot aborted take-off after striking or observing wildlife on runway, civil aircraft, USA[2], 1990 – 2022. See Figure 12 for trend in high-speed aborted take-offs at ≥100 knots caused by wildlife, 1990–2022.

| | Commercial transport aircraft[3] | | General aviation aircraft[4] | | All aircraft[5] | |
|---|---|---|---|---|---|---|
| Aircraft speed (knots) | 33-year total | % of total known | 33-year total | % of total known | 33-year total | % of total known |
| 1-49 | 30 | 3 | 114 | 16 | 146 | 9 |
| 50-99 | 473 | 50 | 435 | 62 | 913 | 55 |
| ≥100 | 449 | 47 | 148 | 21 | 601 | 36 |
| **Total known** | **952** | **100** | **697** | **100** | **1,660** | **100** |
| **Unknown** | **735** | | **559** | | **1,316** | |
| **Total** | **1,687** | | **1,256** | | **2,976** | |

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

[2] Includes strikes to U.S.-registered aircraft in foreign countries.

[3] Air carrier, commuter, and air taxi service with 3-letter identifying code (see Table 7).

[4.] Business, Private, or Government aircraft (see Table 7).

[5] Included in totals are 33 aborted take-offs in which type of operator was unknown. For these 33 events, the speed was unreported (22), 1-49 knots (2), 50-99 knots (5), and ≥100 knots (4).

Table 18. Total reported strikes, strikes causing damage, strikes having a negative effect-on-flight (NEOF), strikes involving >1 animal, and reported aircraft downtime and costs by identified wildlife species, civil aircraft, USA[1], 1990–2022 (page 1 of 27).

| Wildlife group or species[2] | 33-year totals (1990–2022) | | | | | |
|---|---|---|---|---|---|---|
| | Number of reported strikes | | | | Reported economic losses[4] | |
| | Total | With dam-age | With NEOF | With multiple animals[3] | Aircraft down time (hrs.) | Reported costs ($) |
| **Birds** | | | | | | |
| **Loons** | **76** | **41** | **23** | **1** | **7,076** | **4,424,573** |
| Loons | 2 | 1 | 1 | | | |
| Common loon | 54 | 31 | 15 | | 6,533 | 4,240,702 |
| Red-throated loon | 18 | 8 | 7 | 1 | 351 | 182,246 |
| Pacific loon | 2 | 1 | | | 192 | 1,625 |
| **Grebes** | **198** | **48** | **23** | **27** | **2,843** | **7,511,678** |
| Grebes | 12 | 2 | | 1 | | |
| Eared grebe | 29 | 6 | 2 | 6 | 586 | 990,703 |
| Western grebe | 36 | 11 | 7 | 8 | 166 | 2,683,158 |
| Pied-billed grebe | 58 | 7 | 3 | 1 | 119 | 52,496 |
| Horned grebe | 22 | 6 | 3 | 2 | 146 | 167,211 |
| Red-necked grebe | 6 | 2 | 2 | 1 | | |
| Clark's grebe | 3 | | | | | |
| Great crested grebe | 1 | | | | | |
| White-tufted grebe | 1 | | | 1 | | |
| Western/Clark's grebe complex | 30 | 14 | 6 | 7 | 1,826 | 3,618,110 |
| **Albatrosses/shearwaters** | **101** | **9** | **4** | **5** | **197** | **97,407** |
| Laysan albatross | 36 | 8 | 3 | 1 | 197 | 97,407 |
| Black-footed albatross | 8 | 1 | | | | |
| Petrels | 2 | | | | | |
| Bonin petrel | 13 | | | 4 | | |
| Hawaiian petrel | 1 | | | | | |
| Northern fulmar | 1 | | | | | |
| Shearwaters | 1 | | | | | |
| Wedge-tailed shearwater | 24 | | 1 | | | |
| Newell's shearwater | 11 | | | | | |
| Storm-petrels | 1 | | | | | |
| Fork-tailed storm-petrel | 2 | | | | | |
| Band-rumped storm-petrel | 1 | | | | | |
| **Tropicbirds** | **41** | **21** | **13** | **1** | **260** | **195,831** |
| Tropicbirds | 11 | 8 | 4 | | 152 | 84,668 |
| White-tailed tropicbird | 26 | 12 | 8 | 1 | 108 | 101,917 |
| Red-tailed tropicbird | 4 | 1 | 1 | | | 9,246 |
| **Pelicans** | **133** | **60** | **40** | **22** | **10,707** | **17,847,460** |
| Pelicans | 11 | 3 | | | 108 | 25,936 |

Table 18. Continued (page 2 of 27)

| Wildlife group or species[2] | 33-year totals (1990–2022) | | | | | |
|---|---|---|---|---|---|---|
| | Number of reported strikes | | | | Reported economic losses[4] | |
| | Total | With dam-age | With NEOF | With multiple animals[3] | Aircraft down time (hrs.) | Reported costs ($) |
| Australian pelican | 1 | 1 | 1 | | | |
| Brown pelican | 88 | 34 | 23 | 11 | 594 | 567,181 |
| American white pelican | 33 | 22 | 16 | 11 | 10,005 | 17,254,343 |
| **Gannets, boobies** | **6** | | | | **13** | |
| Northern gannet | 1 | | | | | |
| Red-footed booby | 4 | | | | | |
| Brown booby | 1 | | | | 13 | |
| **Cormorants** | **235** | **72** | **45** | **38** | **3,404** | **7,728,378** |
| Cormorants | 3 | 1 | | | 12 | 18,525 |
| Great cormorant | 2 | 1 | | 2 | | |
| Double-crested cormorant | 224 | 69 | 44 | 36 | 3,366 | 7,709,853 |
| Pelagic cormorant | 2 | | | | | |
| Brandt's cormorant | 3 | 1 | 1 | | 26 | |
| Neotropic cormorant | 1 | | | | | |
| **Anhinga** | **73** | **37** | **23** | **8** | **347** | **1,262,606** |
| **Frigatebirds** | **26** | **8** | **7** | | **89** | **41,985** |
| Frigatebirds | 1 | | | | | |
| Great frigatebird | 15 | 4 | 3 | | 69 | 34,455 |
| Magnificent frigatebird | 10 | 4 | 4 | | 20 | 7,530 |
| **Herons, egrets, bitterns** | **2,603** | **262** | **245** | **303** | **10,265** | **29,825,806** |
| Herons, egrets, bitterns | 11 | | 1 | | | |
| Herons | 67 | 13 | 9 | 2 | 211 | 5,975 |
| Gray heron | 3 | 1 | 1 | | | |
| Great blue heron | 575 | 111 | 71 | 12 | 4,513 | 18,055,767 |
| Black-crowned night-heron | 150 | 10 | 4 | 8 | 236 | 527,411 |
| Little blue heron | 24 | 1 | 2 | | | 371 |
| Green heron | 48 | 3 | 3 | 1 | | 566 |
| Yellow-crowned night-heron | 104 | 10 | 6 | 6 | 188 | 964,436 |
| Tricolored heron | 10 | | 2 | | | |
| Purple heron | 2 | 1 | | | 36 | |
| American bittern | 24 | 8 | 2 | 1 | 695 | 73,404 |
| Yellow bittern | 176 | | 2 | 15 | | |
| Least bittern | 6 | | 1 | | 2 | |
| Egrets | 380 | 35 | 55 | 94 | 3,627 | 5,679,041 |
| Cattle egret | 805 | 49 | 72 | 147 | 480 | 1,495,069 |
| Great egret | 161 | 14 | 11 | 13 | 178 | 2,965,408 |
| Intermediate egret | 1 | | | | | |
| Snowy egret | 54 | 6 | 3 | 4 | 99 | 58,358 |

Table 18. Continued (page 3 of 27)

| Wildlife group or species[2] | 33-year totals (1990–2022) | | | | | |
|---|---|---|---|---|---|---|
| | Number of reported strikes | | | | Reported economic losses[4] | |
| | Total | With dam-age | With NEOF | With multiple animals[3] | Aircraft down time (hrs.) | Reported costs ($) |
| Reddish egret | 2 | | | | | |
| **Storks** | **26** | **9** | **4** | **4** | **40** | **27,262** |
| White stork | 1 | 1 | | | | |
| Wood stork | 25 | 8 | 4 | 4 | 40 | 27,262 |
| **Ibises, spoonbills** | **80** | **20** | **13** | **14** | **1,990** | **1,377,379** |
| Ibises | 8 | | 1 | 1 | | |
| Glossy ibis | 7 | 1 | 1 | 1 | | 2,548 |
| White ibis | 38 | 5 | 5 | 4 | 134 | 72,864 |
| White-faced ibis | 22 | 13 | 4 | 8 | 1,844 | 1,287,159 |
| Roseate spoonbill | 5 | 1 | 2 | | 12 | 14,808 |
| **Waterfowl** | **7,056** | **2,655** | **1,274** | **2,269** | **190,451** | **326,732,363** |
| Ducks, geese, swans | 148 | 73 | 34 | 59 | 825 | 1,682,886 |
| Ducks | 947 | 311 | 148 | 289 | 10,914 | 10,301,148 |
| American wigeon | 115 | 43 | 14 | 31 | 5,073 | 2,351,403 |
| Northern pintail | 246 | 110 | 43 | 98 | 2,792 | 11,096,921 |
| Green-winged teal | 134 | 30 | 11 | 33 | 1,240 | 1,488,594 |
| Blue-winged teal | 98 | 33 | 12 | 23 | 761 | 1,505,353 |
| Eurasian wigeon | 3 | 1 | | 1 | | |
| Mallard | 1,320 | 261 | 134 | 286 | 15,414 | 25,839,044 |
| Common eider | 6 | 3 | 1 | 2 | 12 | 6,366 |
| Ring-necked duck | 56 | 22 | 9 | 11 | 1,822 | 224,243 |
| Greater scaup | 21 | 4 | 2 | 5 | | |
| Wood duck | 104 | 27 | 8 | 18 | 1,107 | 226,706 |
| Muscovy duck | 5 | 1 | | | 120 | 720,415 |
| Common goldeneye | 11 | 4 | 2 | 2 | | 2,898 |
| Red-breasted merganser | 10 | 2 | 1 | 2 | 3 | |
| Hooded merganser | 23 | 7 | 2 | 3 | 61 | 337,714 |
| Common merganser | 11 | 3 | 4 | 2 | 120 | 4,483 |
| Northern shoveler | 142 | 52 | 16 | 45 | 3,150 | 5,155,349 |
| Gadwall | 131 | 47 | 14 | 39 | 812 | 13,519,698 |
| Canvasback | 32 | 17 | 5 | 10 | 956 | 3,137,645 |
| American black duck | 89 | 9 | 5 | 24 | 2,672 | 1,323,404 |
| Mottled duck | 36 | 6 | 4 | 8 | 25 | 64,800 |
| Lesser scaup | 93 | 38 | 18 | 28 | 2,124 | 415,592 |
| Ruddy duck | 115 | 27 | 9 | 17 | 418 | 336,073 |
| Redhead | 20 | 10 | 4 | 8 | 101 | 276,560 |
| Bufflehead | 39 | 7 | 4 | 4 | 433 | 260,485 |
| Long-tailed duck | 8 | 4 | 3 | 1 | 20 | 58,638 |

Table 18. Continued (page 4 of 27)

| Wildlife group or species[2] | 33-year totals (1990–2022) | | | | | |
|---|---|---|---|---|---|---|
| | Number of reported strikes | | | | Reported economic losses[4] | |
| | Total | With dam-age | With NEOF | With multiple animals[3] | Aircraft down time (hrs.) | Reported costs ($) |
| Philippine duck | 1 | 1 | 1 | 1 | 96 | 14,136,720 |
| Black-bellied whistling-duck | 24 | 7 | 3 | 6 | 120 | |
| Cinnamon teal | 13 | 4 | 1 | 2 | 46 | 40,850 |
| White-winged scoter | 5 | 4 | 3 | 2 | 1,410 | 839,300 |
| Hawaiian duck | 16 | | | 5 | | |
| Harlequin duck | 1 | | | | | |
| Barrow's goldeneye | 3 | | | | | |
| Surf scoter | 4 | 1 | | | 10 | |
| Mallard/A. black duck complex | 20 | 1 | 2 | 3 | 20 | 426 |
| Mallard/mottled duck complex | 4 | 1 | 1 | 1 | 68 | 26,795 |
| Diving duck (Aythya) | 30 | 5 | 2 | 7 | 149 | 309,010 |
| Geese | 471 | 250 | 106 | 167 | 28,093 | 3,996,352 |
| Snow goose | 183 | 127 | 64 | 91 | 13,873 | 41,301,200 |
| Canada goose | 2,045 | 962 | 532 | 819 | 92,293 | 174,276,347 |
| Brant | 64 | 16 | 5 | 19 | 141 | 686,821 |
| Greater white-fronted goose | 84 | 56 | 20 | 47 | 1,192 | 7,335,337 |
| Emperor goose | 2 | 1 | | | | 12,095 |
| Cackling goose | 40 | 18 | 3 | 9 | 274 | 726,080 |
| Hawaiian goose | 6 | 1 | | 2 | 9 | |
| Egyptian goose | 2 | | | 1 | | |
| Ross's goose | 1 | | | 1 | | |
| Snow /Ross's goose complex | 33 | 26 | 8 | 22 | 786 | 641,410 |
| Swans | 3 | 1 | | | | |
| Mute swan | 12 | 2 | 1 | 2 | | |
| Tundra swan | 24 | 17 | 13 | 12 | 824 | 692,502 |
| Trumpeter swan | 2 | 2 | 2 | 1 | 72 | 1,374,700 |
| **Hawks, eagles, vultures** | **9,685** | **2,223** | **1,339** | **291** | **179,885** | **198,696,252** |
| Unidentified raptors | 81 | 26 | 18 | 1 | 6,665 | 272,681 |
| New World vultures | 401 | 229 | 116 | 29 | 27,143 | 16,566,669 |
| Black vulture | 324 | 204 | 94 | 15 | 23,792 | 15,550,813 |
| Turkey vulture | 1,101 | 536 | 319 | 58 | 53,484 | 46,496,809 |
| Osprey | 587 | 128 | 66 | 8 | 4,463 | 2,225,111 |
| Kites, eagles, hawks | 6 | | 2 | | 1 | |
| Kites | 1 | | | | | |
| White-tailed kite | 93 | 4 | 2 | 3 | 46 | 7,245,000 |
| Black kite | 6 | 4 | 1 | | | |
| Mississippi kite | 29 | | 2 | | | |
| Swallow-tailed kite | 8 | 1 | 1 | 1 | 1 | 45 |

Table 18. Continued (page 5 of 27)

| Wildlife group or species[2] | 33-year totals (1990–2022) | | | | | |
|---|---|---|---|---|---|---|
| | Number of reported strikes | | | | Reported economic losses[4] | |
| | Total | With dam-age | With NEOF | With multiple animals[3] | Aircraft down time (hrs.) | Reported costs ($) |
| Eagles | 8 | 3 | 2 | 1 | | |
| Bald eagle | 445 | 162 | 105 | 28 | 13,524 | 34,854,282 |
| White-bellied sea-eagle | 1 | 1 | 1 | | | |
| Golden eagle | 34 | 10 | 6 | 2 | 4,872 | 1,251,295 |
| Wedge-tailed eagle | 1 | 1 | 1 | | | |
| Greater spotted eagle | 1 | 1 | | | | |
| Hawks | 1,633 | 309 | 216 | 40 | 17,559 | 6,931,309 |
| Northern goshawk | 6 | | | | | |
| Red-tailed hawk | 3,845 | 502 | 328 | 84 | 23,144 | 52,650,916 |
| Rough-legged hawk | 133 | 12 | 5 | 2 | 70 | 101,915 |
| Red-shouldered hawk | 104 | 9 | 8 | | 214 | 4,817 |
| Swainson's hawk | 226 | 31 | 17 | 7 | 1,520 | 963,844 |
| Eurasian sparrowhawk | 2 | | | | | |
| Sharp-shinned hawk | 50 | 2 | | 1 | 1,049 | 492,700 |
| Cooper's hawk | 195 | 11 | 10 | 2 | 61 | 248,216 |
| Ferruginous hawk | 69 | 5 | 1 | | 88 | 4,495,078 |
| Broad-winged hawk | 54 | 20 | 10 | 4 | 1,777 | 774,712 |
| Harris's hawk | 6 | | | | | |
| Hawaiian hawk | 3 | 2 | 3 | | 2 | |
| White-tailed hawk | 5 | | | | | |
| Eurasian buzzard | 5 | 1 | | | 26 | |
| Short-tailed hawk | 3 | 1 | | | | |
| Western marsh harrier | 1 | | | | | |
| Northern harrier | 214 | 6 | 4 | 4 | 144 | 398,040 |
| Old World vultures | 3 | 1 | | 1 | | |
| Lappet-faced vulture | 1 | 1 | 1 | | 240 | 7,172,000 |
| **Falcons, caracaras** | **9,377** | **104** | **165** | **389** | **7,912** | **5,962,809** |
| Falcons, caracaras | 57 | 5 | 5 | 2 | 178 | 125,526 |
| Falcons, kestrels, falconets | 23 | 2 | 3 | 3 | 22 | 609 |
| Peregrine falcon | 579 | 34 | 19 | 25 | 346 | 1,073,995 |
| Gyrfalcon | 2 | | | | | |
| Merlin | 210 | 3 | 4 | 9 | 29 | 639,491 |
| Prairie falcon | 36 | 1 | 3 | 2 | | 7,381 |
| American kestrel | 8,430 | 49 | 125 | 344 | 7,272 | 4,115,807 |
| Eurasian kestrel | 7 | 1 | 1 | | | |

Table 18. Continued (page 6 of 27)

| Wildlife group or species[2] | 33-year totals (1990–2022) | | | | | |
|---|---|---|---|---|---|---|
| | Number of reported strikes | | | | Reported economic losses[4] | |
| | Total | With dam-age | With NEOF | With multiple animals[3] | Aircraft down time (hrs.) | Reported costs ($) |
| Crested caracara | 32 | 9 | 5 | 4 | 65 | |
| Yellow-headed caracara | 1 | | | | | |
| **Gallinacious birds** | **420** | **81** | **61** | **73** | **3,682** | **8,849,753** |
| Grouse | 3 | 1 | | | | |
| Greater sage-grouse | 42 | 12 | 6 | 15 | 556 | 602,585 |
| Sharp-tailed grouse | 24 | 1 | 3 | 4 | 24 | 932 |
| Ruffed grouse | 4 | | | | | |
| Spruce grouse | 1 | | | | | |
| Ptarmigans | 3 | 1 | 1 | 2 | 18 | 84,850 |
| Willow ptarmigan | 8 | 3 | 1 | 4 | 207 | 165,906 |
| Rock ptarmigan | 2 | 1 | | | | |
| Quails, pheasants | 3 | 1 | | | | 21,675 |
| New World quail | 9 | | 3 | 2 | | |
| Northern bobwhite | 17 | 3 | 3 | 2 | 93 | 9,835 |
| California quail | 1 | | | | | |
| Scaled quail | 5 | | | | | |
| Gambel's quail | 1 | | | 1 | | |
| Pheasants | 1 | | | 1 | | |
| Ring-necked pheasant | 108 | 19 | 9 | 6 | 883 | 128,760 |
| Greater prairie chicken | 1 | | 1 | | | |
| Partridges | 3 | | | 1 | | |
| Red-legged partridge | 1 | | | | | |
| Gray partridge | 40 | 4 | 4 | 15 | 44 | 6,698,392 |
| Chukar | 4 | | | 1 | | |
| Gray francolin | 8 | 1 | 1 | 1 | 92 | 382,223 |
| Black francolin | 10 | | | | 1 | |
| Helmeted guineafowl | 3 | 1 | | 2 | | |
| Wild turkey | 118 | 33 | 29 | 16 | 1,764 | 754,595 |
| **Cranes** | **195** | **67** | **39** | **51** | **3,927** | **523,483** |
| Cranes | 1 | | | | | |
| Sandhill crane | 193 | 66 | 39 | 51 | 3,879 | 452,560 |
| Whooping crane | 1 | 1 | | | 48 | 70,923 |
| **Limpkin** | **3** | | | | | |
| **Rails, gallinules** | **641** | **102** | **36** | **25** | **5,193** | **10,524,383** |
| Rails | 15 | 1 | 1 | 1 | | |
| Sora | 120 | 9 | 2 | 6 | 171 | 832,876 |
| Common gallinule | 11 | 1 | 1 | | 24 | 1,531 |
| American coot | 418 | 88 | 31 | 16 | 4,843 | 9,556,891 |

Table 18. Continued (page 7 of 27)

| Wildlife group or species[2] | 33-year totals (1990–2022) | | | | | |
|---|---|---|---|---|---|---|
| | Number of reported strikes | | | | Reported economic losses[4] | |
| | Total | With dam-age | With NEOF | With multiple animals[3] | Aircraft down time (hrs.) | Reported costs ($) |
| Eurasian coot | 1 | | | | | |
| Purple gallinule | 7 | 1 | 1 | | 72 | 35,885 |
| Virginia rail | 44 | 1 | | 1 | 83 | 97,200 |
| Clapper rail | 16 | | | | | |
| Yellow rail | 2 | | | | | |
| King rail | 5 | | | 1 | | |
| Eurasian moorhen | 1 | 1 | | | | |
| Corn crake | 1 | | | | | |
| **Shorebirds** | **14,243** | **247** | **231** | **1,757** | **8,019** | **8,750,811** |
| Shorebirds | 54 | 2 | 1 | 10 | 6 | |
| American oystercatcher | 53 | | | 5 | | |
| Plovers, lapwings | 10 | | | 1 | | |
| Plovers | 108 | 3 | 5 | 16 | 48 | |
| European golden-plover | 5 | | | 1 | | |
| American golden-plover | 298 | 10 | 6 | 69 | 86 | 139,460 |
| Black-bellied plover | 235 | 9 | 7 | 33 | 40 | 251,590 |
| Snowy plover | 4 | | | 2 | 1 | |
| Common ringed plover | 1 | | | | | |
| Lesser sand-plover | 1 | | | | | |
| Killdeer | 9,162 | 77 | 95 | 771 | 2,079 | 4,979,412 |
| Pacific golden-plover | 1,418 | 14 | 19 | 185 | 325 | 444,743 |
| Semipalmated plover | 140 | | 2 | 38 | 7 | |
| Piping plover | 5 | 1 | | 1 | 2 | 279 |
| Wilson's plover | 6 | | | 1 | | |
| Kentish plover | 2 | | | | | |
| Oriental plover | 1 | | | | | |
| Northern lapwing | 1 | 1 | 1 | 1 | 25 | |
| Red-wattled lapwing | 1 | | | | | |
| Southern lapwing | 7 | 2 | 1 | | | 12,704 |
| Spur-winged lapwing | 1 | 1 | | | | |
| Sandpipers, curlews | 372 | 18 | 33 | 108 | 214 | 245,779 |
| Upland sandpiper | 395 | 10 | 7 | 39 | 31 | 3,676 |
| Spotted sandpiper | 52 | 3 | 2 | 9 | 3 | |
| Willet | 21 | | | 2 | | |
| Common snipe | 12 | | | | | |
| American woodcock | 199 | 10 | 4 | 7 | 1,129 | 100,717 |
| Dunlin | 147 | 9 | 9 | 48 | 683 | 395,036 |
| Baird's sandpiper | 74 | 2 | | 9 | 27 | 112,294 |

Table 18. Continued (page 8 of 27)

| Wildlife group or species[2] | 33-year totals (1990–2022) | | | | | |
|---|---|---|---|---|---|---|
| | Number of reported strikes | | | | Reported economic losses[4] | |
| | Total | With dam-age | With NEOF | With multiple animals[3] | Aircraft down time (hrs.) | Reported costs ($) |
| Western sandpiper | 263 | 8 | 5 | 136 | 1,546 | 215,395 |
| Pectoral sandpiper | 62 | 8 | 1 | 16 | 220 | 384,149 |
| Sanderling | 49 | 1 | 3 | 11 | 6 | |
| Buff-breasted sandpiper | 74 | 1 | | 12 | | |
| Surfbird | 1 | 1 | | 1 | | 6,738 |
| Ruddy turnstone | 40 | | 1 | 7 | | |
| Bar-tailed godwit | 1 | | | | | |
| Least sandpiper | 286 | 2 | 4 | 69 | 21 | 7,441 |
| Semipalmated sandpiper | 170 | 2 | 2 | 62 | 1 | 12,267 |
| Lesser yellowlegs | 27 | 7 | 1 | 5 | 105 | 124,608 |
| Short-billed dowitcher | 21 | 5 | 1 | 6 | 19 | 12,740 |
| Hudsonian godwit | 7 | 1 | 1 | 3 | 97 | 41,210 |
| Solitary sandpiper | 17 | 1 | | 2 | | |
| Greater yellowlegs | 27 | 5 | 1 | 3 | 121 | 74,332 |
| Long-billed dowitcher | 16 | 1 | | 5 | 2 | |
| Red knot | 4 | | 1 | | | |
| White-rumped sandpiper | 21 | | | 5 | | |
| Black turnstone | 2 | | | | | |
| Marbled godwit | 11 | 2 | 2 | 2 | 48 | 203,132 |
| Wilson's snipe | 222 | 13 | 6 | 13 | 143 | 48,672 |
| Rock sandpiper | 2 | | | 2 | | |
| South American snipe | 1 | | | | | |
| Stilt sandpiper | 3 | | | 1 | | |
| Purple sandpiper | 1 | | | | | |
| Wood sandpiper | 1 | | | | | |
| Gray-tailed tattler | 1 | | | | | |
| Eurasian curlew | 2 | 1 | | | | |
| Whimbrel | 27 | 2 | 1 | 7 | 360 | 65,000 |
| Long-billed curlew | 12 | 2 | 1 | 1 | 504 | 853,400 |
| Red-necked phalarope | 19 | 3 | 3 | 5 | 74 | |
| Wilson's phalarope | 29 | 8 | 5 | 18 | 46 | 16,037 |
| Red phalarope | 3 | | | | | |
| American avocet | 12 | 1 | | 4 | | |
| Black-necked stilt | 20 | | | 5 | | |
| Red-necked stint | 1 | | | | | |
| Double-striped thick-knee | 2 | | | | | |
| Spotted thick-knee | 1 | 1 | | | | |

Table 18. Continued (page 9 of 27)

| Wildlife group or species[2] | 33-year totals (1990–2022) | | | | | |
|---|---|---|---|---|---|---|
| | Number of reported strikes | | | | Reported economic losses[4] | |
| | Total | With dam-age | With NEOF | With multiple animals[3] | Aircraft down time (hrs.) | Reported costs ($) |
| **Jaegers** | **10** | | | | | |
| Parasitic jaeger | 3 | | | | | |
| Long-tailed jaeger | 7 | | | | | |
| **Gulls** | **14,285** | **1,679** | **1,361** | **2,576** | **64,920** | **75,597,400** |
| Gulls, terns, kittiwakes | 2 | | | | | |
| Gulls | 7,340 | 1,135 | 928 | 1,718 | 41,835 | 31,192,201 |
| Herring gull | 1,963 | 156 | 133 | 182 | 3,542 | 6,357,856 |
| Mew gull | 86 | 8 | 5 | 14 | 49 | 127,166 |
| Ring-billed gull | 2,147 | 142 | 128 | 342 | 9,290 | 5,904,910 |
| Glaucous-winged gull | 203 | 31 | 16 | 20 | 636 | 2,781,674 |
| Great black-backed gull | 179 | 14 | 9 | 13 | 227 | 2,406,732 |
| Franklin's gull | 245 | 20 | 25 | 74 | 467 | 266,445 |
| Laughing gull | 1,139 | 28 | 34 | 100 | 994 | 1,091,580 |
| Bonaparte's gull | 87 | 3 | 6 | 18 | 8 | 110,305 |
| Lesser black-backed gull | 7 | 3 | 1 | 2 | 24 | |
| Western gull | 201 | 23 | 10 | 14 | 751 | 2,570,407 |
| California gull | 296 | 27 | 22 | 36 | 5,141 | 884,340 |
| Heermann's gull | 2 | | | 1 | | |
| Black-headed gull | 12 | | | | | |
| Iceland gull | 3 | | | | | |
| Yellow-legged gull | 3 | 3 | 3 | 3 | 456 | 13,967,531 |
| Glaucous gull | 45 | 4 | 3 | 7 | 561 | 878,667 |
| Vega gull | 1 | 1 | | | 18 | 15,087 |
| White-headed gull complex | 322 | 81 | 38 | 32 | 921 | 7,042,499 |
| Black-headed gull complex | 2 | | | | | |
| **Terns, noddies, kittiwakes** | **381** | **14** | **12** | **62** | **267** | **1,164,081** |
| Terns, noddies | 55 | 3 | 1 | 17 | 1 | 285,425 |
| White-winged tern | 2 | | | 1 | | |
| Little tern | 2 | | | 1 | | |
| Caspian tern | 51 | 2 | 1 | 3 | 24 | 719,900 |
| Common tern | 53 | 2 | | 3 | | 95,550 |
| Sandwich tern | 5 | | | | | |
| Gull-billed tern | 8 | | | 1 | | |
| Black tern | 10 | | | 3 | 2 | |
| White tern | 25 | 3 | 4 | 3 | 154 | 43,105 |
| Arctic tern | 6 | 1 | | 2 | | |
| Roseate tern | 1 | | | | | |
| Forster's tern | 20 | | 1 | 2 | 5 | 239 |

Table 18. Continued (page 10 of 27)

| Wildlife group or species[2] | 33-year totals (1990–2022) | | | | | |
|---|---|---|---|---|---|---|
| | Number of reported strikes | | | | Reported economic losses[4] | |
| | Total | With dam-age | With NEOF | With multiple animals[3] | Aircraft down time (hrs.) | Reported costs ($) |
| Least tern | 40 | | | 5 | | |
| Royal tern | 9 | 1 | 1 | 1 | 33 | |
| Sooty tern | 7 | 1 | 1 | | 48 | 19,760 |
| Elegant tern | 4 | | | | | |
| Noddies | 8 | | | 3 | | |
| Black noddy | 25 | | 2 | 9 | | 102 |
| Brown noddy | 16 | | 1 | 4 | | |
| Black-legged kittiwake | 2 | | | | | |
| Red-legged kittiwake | 1 | | | | | |
| Black skimmer | 31 | 1 | | 4 | | |
| **Alcidae** | **3** | | **1** | | **1** | **126** |
| Pigeon guillemot | 1 | | | | | |
| Common murre | 1 | | | | | |
| Horned puffin | 1 | | 1 | | 1 | 126 |
| **Pigeons, doves** | **20,334** | **644** | **764** | **3,155** | **33,029** | **29,954,045** |
| Pigeons, doves | 50 | 5 | 8 | 16 | 1,638 | 1,139 |
| Pigeons | 24 | 2 | 2 | 8 | 7 | 150 |
| Common wood-pigeon | 11 | 1 | | 2 | | |
| Band-tailed pigeon | 32 | 10 | 1 | 5 | 233 | 434,277 |
| Rock pigeon | 4,107 | 298 | 311 | 1,111 | 16,759 | 16,023,179 |
| Picazuro pigeon | 1 | | | | | |
| White-crowned pigeon | 2 | | | | | |
| Bare-eyed pigeon | 1 | | | | | |
| Scaly-naped pigeon | 3 | | 1 | | 1 | |
| Speckled pigeon | 1 | | | | | |
| Doves | 1,235 | 50 | 82 | 250 | 609 | 662,174 |
| Eurasian collared dove | 85 | 3 | 3 | 12 | 26 | 1,235 |
| Mourning dove | 13,814 | 261 | 332 | 1,675 | 12,251 | 12,384,382 |
| Spotted dove | 265 | 4 | 8 | 14 | 157 | 426,852 |
| Zebra dove | 453 | 5 | 14 | 46 | 1,212 | 17,865 |
| Inca dove | 15 | | | 1 | | |
| Sunda collared dove | 8 | | | | | |
| White-winged dove | 143 | 4 | | 12 | 104 | 2,792 |
| Common ground dove | 48 | | 1 | | | |
| Zenaida dove | 26 | 1 | 1 | 1 | 32 | |
| Ruddy ground dove | 1 | | | | | |
| Eared dove | 3 | | | | | |
| Philippine collared dove | 4 | | | 1 | | |

Table 18. Continued (page 11 of 27)

| Wildlife group or species[2] | 33-year totals (1990–2022) | | | | | |
|---|---|---|---|---|---|---|
| | Number of reported strikes | | | | Reported economic losses[4] | |
| | Total | With dam-age | With NEOF | With multiple animals[3] | Aircraft down time (hrs.) | Reported costs ($) |
| African collared dove | 2 | | | 1 | | |
| **Parrots** | **46** | | | **7** | **5** | **9,255** |
| Parrots | 5 | | | 1 | | |
| Budgerigar | 20 | | | 1 | | |
| Monk parakeet | 5 | | | 1 | | |
| Olive-throated parakeet | 1 | | | 1 | | |
| Brown-throated parakeet | 1 | | | | | |
| Lilac-crowned parrot | 1 | | | 1 | | |
| Red-crowned amazon | 1 | | | | | |
| Nanday parakeet | 7 | | | 1 | 5 | 9,255 |
| Red-masked parakeet | 3 | | | | | |
| Yellow-chevroned parakeet | 1 | | | 1 | | |
| Rose-ringed parakeet | 1 | | | | | |
| **Cuckoos, roadrunners** | **183** | **25** | **6** | **14** | **802** | **625,942** |
| Cuckoos | 41 | 6 | 2 | 5 | 687 | 451,872 |
| Yellow-billed cuckoo | 117 | 17 | 4 | 8 | 96 | 174,070 |
| Common cuckoo | 1 | | | | | |
| Black-billed cuckoo | 16 | 1 | | | 19 | |
| Philippine drongo-cuckoo | 1 | | | | | |
| Dark-billed cuckoo | 1 | 1 | | | | |
| Greater roadrunner | 6 | | | 1 | | |
| **Owls** | **4,418** | **202** | **108** | **60** | **4,193** | **17,253,222** |
| Owls | 392 | 34 | 22 | 9 | 1,499 | 620,600 |
| Barn owl | 1,938 | 61 | 31 | 27 | 782 | 3,846,227 |
| Snowy owl | 378 | 32 | 20 | 3 | 1,024 | 3,224,778 |
| Little owl | 1 | | | | | |
| Short-eared owl | 819 | 15 | 14 | 9 | 207 | 1,966,913 |
| Long-eared owl | 21 | 4 | | | 24 | 63,700 |
| Northern saw-whet owl | 10 | 2 | | | 96 | |
| Burrowing owl | 410 | 5 | 6 | 10 | 9 | 996 |
| Barred owl | 49 | 1 | 1 | | | 201 |
| Northern pygmy-owl | 1 | | | | | |
| Great gray owl | 4 | 1 | | | | |
| Flammulated owl | 2 | 1 | | | | |
| Eastern screech-owl | 6 | 2 | | | 24 | 15,758 |
| Western screech-owl | 3 | | | | | |
| Great horned owl | 382 | 44 | 14 | 2 | 528 | 7,514,049 |

Table 18. Continued (page 12 of 27)

| Wildlife group or species[2] | 33-year totals (1990–2022) | | | | | |
|---|---|---|---|---|---|---|
| | Number of reported strikes | | | | Reported economic losses[4] | |
| | Total | With dam-age | With NEOF | With multiple animals[3] | Aircraft down time (hrs.) | Reported costs ($) |
| Northern hawk owl | 2 | | | | | |
| **Nightjars** | **1,328** | **9** | **3** | **58** | **123** | **239** |
| Nightjars | 25 | | | | 1 | |
| Eastern whip-poor-will | 17 | | | 2 | | |
| Common poorwill | 20 | 1 | | 1 | | |
| Lesser nighthawk | 33 | | | 2 | 12 | |
| Chuck-will's-widow | 21 | 1 | | | 1 | |
| Common nighthawk | 1,185 | 7 | 3 | 52 | 109 | 239 |
| Common pauraque | 17 | | | 1 | | |
| Nacunda nighthawk | 2 | | | | | |
| Antillean nighthawk | 8 | | | | | |
| **Swifts** | **1,744** | **23** | **17** | **117** | **1,351** | **265,363** |
| Swifts | 26 | 1 | | 2 | 1 | 343 |
| Black swift | 6 | | | 1 | | |
| Chimney swift | 1,495 | 17 | 14 | 109 | 1,292 | 133,457 |
| Common swift | 25 | 2 | | 2 | 2 | 17,160 |
| Vaux's swift | 78 | | | 1 | 25 | |
| Pallid swift | 2 | | | | | |
| White-throated swift | 99 | 3 | 3 | 2 | 31 | 114,403 |
| Alpine swift | 1 | | | | | |
| Little swift | 1 | | | | | |
| Antillean palm swift | 11 | | | | | |
| **Hummingbirds** | **140** | | | **5** | **3** | **12** |
| Hummingbirds | 16 | | | | | 12 |
| Ruby-throated hummingbird | 72 | | | 2 | 1 | |
| Rufous hummingbird | 23 | | | 1 | | |
| Anna's hummingbird | 15 | | | 2 | 2 | |
| Black-chinned hummingbird | 6 | | | | | |
| Allen's hummingbird | 2 | | | | | |
| Calliope hummingbird | 2 | | | | | |
| Broad-tailed hummingbird | 1 | | | | | |
| Costa’s hummingbird | 3 | | | | | |
| **Belted kingfisher** | **17** | | | | | |
| **Woodpeckers** | **412** | **31** | **7** | **16** | **815** | **345,974** |
| Woodpeckers | 15 | 1 | 1 | | 1 | |
| Northern flicker | 199 | 13 | | 3 | 489 | 159,405 |
| Yellow-bellied sapsucker | 157 | 13 | 3 | 12 | 242 | 154,824 |
| Hairy woodpecker | 3 | | | | | |

Table 18. Continued (page 13 of 27)

| Wildlife group or species[2] | 33-year totals (1990–2022) | | | | | |
|---|---|---|---|---|---|---|
| | Number of reported strikes | | | | Reported economic losses[4] | |
| | Total | With dam-age | With NEOF | With multiple animals[3] | Aircraft down time (hrs.) | Reported costs ($) |
| Red-naped sapsucker | 6 | 3 | 2 | | | 22,425 |
| Downy woodpecker | 14 | | | | 1 | |
| Red-bellied woodpecker | 11 | | | 1 | 10 | |
| Red-breasted sapsucker | 4 | | | | | |
| Red-headed woodpecker | 1 | | | | | |
| Ladder-backed woodpecker | 1 | 1 | 1 | | 72 | 9,320 |
| Golden-fronted woodpecker | 1 | | | | | |
| **Unidentified passiformes** | **1,533** | **47** | **25** | **104** | **298** | **266,399** |
| **Old World flycatchers** | **7** | | | | | |
| Spotted flycatcher | 1 | | | | | |
| Blue-and-white swallow | 3 | | | | | |
| Black redstart | 1 | | | | | |
| Rufous-tailed robin | 2 | | | | | |
| **Tyrant flycatchers** | **1,566** | **17** | **11** | **94** | **118** | **27,010** |
| Tyrant flycatchers | 57 | | | 7 | 1 | 1,398 |
| Eastern wood-pewee | 48 | 1 | 1 | 6 | | |
| Gray kingbird | 22 | 1 | | 1 | | |
| Great crested flycatcher | 38 | 3 | | 1 | 73 | 540 |
| Eastern kingbird | 100 | 1 | 2 | 9 | 2 | 17,137 |
| Scissor-tailed flycatcher | 348 | 1 | 4 | 18 | 1 | 802 |
| Acadian flycatcher | 21 | | | 2 | | |
| Say's phoebe | 34 | | | | | |
| Western kingbird | 509 | 4 | 3 | 30 | 6 | 3,919 |
| Ash-throated flycatcher | 13 | | | | | |
| Great kiskadee | 3 | | | 1 | | |
| Western wood-pewee | 12 | | | | | |
| Sulphur-bellied flycatcher | 5 | 1 | | 1 | 12 | |
| Eastern phoebe | 60 | 1 | | 5 | | |
| Yellow-bellied flycatcher | 37 | 1 | | 3 | 1 | 1,336 |
| Least flycatcher | 46 | 1 | | 2 | 2 | |
| Hammond's flycatcher | 27 | | | | 1 | |
| Pacific-slope flycatcher | 64 | | | 3 | 10 | 1,853 |
| Gray flycatcher | 6 | | | 1 | 1 | 25 |
| White-crested elaenia | 3 | 1 | | | | |
| Willow flycatcher | 15 | | | 1 | 1 | |
| Alder flycatcher | 24 | | | 1 | | |
| Cordilleran flycatcher | 3 | | | | 1 | |
| Dusky flycatcher | 4 | | 1 | | | |

Table 18. Continued (page 14 of 27)

| Wildlife group or species[2] | 33-year totals (1990–2022) | | | | | |
|---|---|---|---|---|---|---|
| | Number of reported strikes | | | | Reported economic losses[4] | |
| | Total | With dam-age | With NEOF | With multiple animals[3] | Aircraft down time (hrs.) | Reported costs ($) |
| Couch's kingbird | 3 | | | | | |
| Thick-billed kingbird | 2 | | | | | |
| Olive-sided flycatcher | 5 | | | | 6 | |
| Loggerhead kingbird | 1 | | | | | |
| Black phoebe | 7 | | | | | |
| Tropical kingbird | 3 | | | | | |
| Olivaceous elaenia | 1 | | | | | |
| Brown-crested flycatcher | 4 | | | 1 | | |
| Alder/willow flycatcher complex | 41 | 1 | | 1 | | |
| **Larks** | **7,714** | **36** | **69** | **1,080** | **1,774** | **1,333,919** |
| Larks | 5 | | | 1 | | |
| Eurasian skylark | 141 | | 3 | 7 | 3 | 1,131 |
| Horned lark | 7,566 | 36 | 66 | 1,072 | 1,771 | 1,332,788 |
| Hume's short-toed lark | 1 | | | | | |
| Black-crowned sparrow lark | 1 | | | | | |
| **Swallows** | **15,751** | **80** | **179** | **3,001** | **4,594** | **2,440,079** |
| Swallows | 1,497 | 11 | 45 | 391 | 160 | 162,003 |
| Purple martin | 338 | 17 | 9 | 65 | 331 | 1,723,912 |
| Bank swallow | 774 | 2 | 8 | 271 | 54 | 14,463 |
| Barn swallow | 9,029 | 37 | 74 | 1,549 | 829 | 165,792 |
| Common house-martin | 2 | | | | | |
| Cliff swallow | 2,684 | 7 | 27 | 402 | 3,139 | 368,096 |
| Tree swallow | 1,162 | 1 | 12 | 293 | 53 | 5,463 |
| Violet-green swallow | 51 | 2 | 1 | 3 | 2 | 350 |
| N. rough-winged swallow | 139 | 1 | 2 | 9 | 2 | |
| Cave swallow | 74 | 2 | 1 | 18 | 24 | |
| Gray-breasted martin | 1 | | | | | |
| **Black drongo** | **21** | | | **3** | | |
| **Starlings, mynas** | **6,064** | **160** | **219** | **1,832** | **5,790** | **9,435,520** |
| European starling | 5,916 | 155 | 215 | 1,798 | 5,734 | 9,435,520 |
| Mynas | 2 | 1 | | | | |
| Common myna | 146 | 4 | 4 | 34 | 56 | |
| **Crows, ravens** | **991** | **89** | **75** | **113** | **10,997** | **3,516,426** |
| Crows, ravens | 9 | 2 | | 1 | 55 | |
| Crows | 222 | 21 | 12 | 34 | 434 | 149,032 |
| American crow | 674 | 50 | 53 | 71 | 7,276 | 2,461,049 |
| Carrion crow | 3 | 1 | | | 35 | 6,090 |
| Hooded crow | 1 | 1 | 1 | | | |

Table 18. Continued (page 15 of 27)

| Wildlife group or species[2] | 33-year totals (1990–2022) | | | | | |
|---|---|---|---|---|---|---|
| | Number of reported strikes | | | | Reported economic losses[4] | |
| | Total | With dam-age | With NEOF | With multiple animals[3] | Aircraft down time (hrs.) | Reported costs ($) |
| Rook | 1 | | | | | |
| Fish crow | 5 | | | | | |
| Common raven | 76 | 14 | 9 | 7 | 3,197 | 900,255 |
| **Jays, magpies** | **88** | **4** | **2** | **7** | **3** | **1,446** |
| Blue jay | 50 | 1 | | 2 | 2 | 350 |
| Canada jay | 1 | | | | | |
| Yellow-billed magpie | 9 | | 1 | 3 | | |
| Black-billed magpie | 28 | 3 | 1 | 2 | 1 | 1,096 |
| **Titmice, chickadees** | **42** | **1** | **1** | **10** | | |
| Tufted titmouse | 2 | | | | | |
| Chickadees | 1 | | | | | |
| Black-capped chickadee | 27 | 1 | 1 | 7 | | |
| Mountain chickadee | 6 | | | 1 | | |
| Gray-headed chickadee | 1 | | | 1 | | |
| Carolina chickadee | 3 | | | 1 | | |
| Bushtit | 2 | | | | | |
| **Nuthatches, creepers** | **14** | | | | | |
| White-breasted nuthatch | 2 | | | | | |
| Red-breasted nuthatch | 8 | | | | | |
| Brown creeper | 4 | | | | | |
| **Leaf warblers** | **2** | | | | | |
| Yellow-browed warbler | 1 | | | | | |
| Greenish warbler | 1 | | | | | |
| **Red-vented bulbul** | **7** | | | **2** | | |
| **Wrens** | **298** | **5** | **4** | **25** | **376** | **41,772** |
| Wrens | 74 | 1 | 3 | 11 | 2 | |
| Marsh wren | 46 | 1 | 1 | 3 | 34 | 37,904 |
| House wren | 89 | 1 | | 6 | 1 | 628 |
| Carolina wren | 15 | 1 | | 1 | 1 | |
| Rock wren | 9 | | | 1 | | |
| Cactus wren | 7 | | | | | |
| Winter wren | 30 | | | | 2 | |
| Bewick's wren | 3 | | | | | |
| Sedge wren | 18 | 1 | | 3 | 336 | 3,240 |
| Pacific wren | 7 | | | | | |
| **Mimics** | **677** | **12** | **8** | **42** | **267** | **2,610,177** |
| Brown thrasher | 49 | 3 | 2 | 1 | 178 | 2,596,089 |
| Sage thrasher | 6 | | | | | |

Table 18. Continued (page 16 of 27)

| Wildlife group or species[2] | 33-year totals (1990–2022) | | | | | |
|---|---|---|---|---|---|---|
| | Number of reported strikes | | | | Reported economic losses[4] | |
| | Total | With dam-age | With NEOF | With multiple animals[3] | Aircraft down time (hrs.) | Reported costs ($) |
| Curve-billed thrasher | 2 | | | | | |
| Long-billed thrasher | 10 | | | 4 | | |
| Pearly-eyed thrasher | 1 | | | | | |
| Mockingbirds | 2 | | | | | |
| Northern mockingbird | 189 | 3 | 2 | 11 | 3 | |
| Tropical mockingbird | 1 | | | | | |
| Gray catbird | 417 | 6 | 4 | 26 | 86 | 14,088 |
| **Thrushes** | **3,677** | **233** | **53** | **257** | **6,384** | **8,185,591** |
| Thrushes | 66 | 4 | | 3 | 16 | 43,597 |
| Western bluebird | 20 | 1 | | 2 | 21 | 1,419 |
| Swainson's thrush | 577 | 32 | 5 | 45 | 433 | 3,257,803 |
| Redwing | 2 | | | | | |
| American robin | 2,114 | 153 | 36 | 134 | 4,410 | 4,557,119 |
| Song thrush | 2 | | | 1 | | |
| Hermit thrush | 409 | 12 | 4 | 29 | 749 | 69,519 |
| Eastern bluebird | 32 | | | 2 | | |
| Gray-cheeked thrush | 73 | 1 | 1 | 5 | 8 | 300 |
| Varied thrush | 111 | 14 | 2 | 10 | 48 | 43,306 |
| Wood thrush | 96 | 6 | 2 | 9 | 72 | 136,928 |
| Mountain bluebird | 85 | 1 | 1 | 13 | | |
| Veery | 84 | 7 | 2 | 4 | 627 | 75,600 |
| Townsend's solitaire | 4 | 2 | | | | |
| Bicknell's thrush | 2 | | | | | |
| **Old World warblers** | **90** | | **2** | **4** | **4** | |
| Garden warbler | 1 | | | | | |
| Wrentit | 1 | | | | | |
| Blue-gray gnatcatcher | 86 | | 2 | 4 | 4 | |
| Lesser whitethroat | 1 | | | | | |
| Lanceolated warbler | 1 | | | | | |
| **Kinglets** | **368** | | **1** | **18** | **22** | **907** |
| Golden-crowned kinglet | 94 | | | 4 | | |
| Ruby-crowned kinglet | 274 | | 1 | 14 | 22 | 907 |
| **Pipits** | **382** | **2** | **3** | **63** | **101** | **139** |
| Meadow pipit | 3 | 1 | | | 68 | |
| American pipit | 369 | 1 | 3 | 63 | 33 | 139 |
| Sprague's pipit | 8 | | | | | |
| Olive-backed pipit | 1 | | | | | |
| Tree pipit | 1 | | | | | |

Table 18. Continued (page 17 of 27)

| Wildlife group or species[2] | 33-year totals (1990–2022) | | | | | |
|---|---|---|---|---|---|---|
| | Number of reported strikes | | | | Reported economic losses[4] | |
| | Total | With dam-age | With NEOF | With multiple animals[3] | Aircraft down time (hrs.) | Reported costs ($) |
| **Waxwings** | **527** | **13** | **8** | **105** | **372** | **436,088** |
| Bohemian waxwing | 3 | | | 2 | | |
| Cedar waxwing | 524 | 13 | 8 | 103 | 372 | 436,088 |
| **Shrikes** | **70** | | **2** | **2** | **1** | |
| Northern shrike | 3 | | | | | |
| Loggerhead shrike | 67 | | 2 | 2 | 1 | |
| **Vireos** | **507** | **10** | **5** | **26** | **107** | **48,273** |
| Vireos | 4 | | | | | |
| White-eyed vireo | 11 | | | 1 | 2 | 12 |
| Blue-headed vireo | 41 | 3 | | 2 | 5 | |
| Yellow-throated vireo | 7 | | | 1 | | |
| Warbling vireo | 66 | 2 | | 2 | 8 | 15,849 |
| Red-eyed vireo | 357 | 5 | 5 | 20 | 92 | 32,412 |
| Cassin's vireo | 6 | | | | | |
| Philadelphia vireo | 13 | | | | | |
| Bell's vireo | 1 | | | | | |
| Gray vireo | 1 | | | | | |
| **Japanese white-eye** | **3** | | | | | |
| **New World wood-warblers** | **3,274** | **25** | **19** | **202** | **2,866** | **540,991** |
| New World wood-warblers | 133 | 1 | | 7 | 7 | 3,614 |
| Canada warbler | 32 | | 1 | | 2 | 127 |
| Yellow-breasted chat | 56 | 1 | 1 | 2 | 4 | 263 |
| Pine warbler | 40 | | | 3 | | |
| Black-and-white warbler | 91 | 1 | | 4 | | |
| Northern parula | 80 | | | 2 | 32 | 3,133 |
| Ovenbird | 222 | 4 | 1 | 15 | 19 | 5,743 |
| Wilson's warbler | 176 | 1 | | 5 | 4 | 7,097 |
| Common yellowthroat | 277 | 3 | 1 | 21 | 124 | 478,810 |
| Yellow-rumped warbler | 639 | 4 | 6 | 38 | 2,313 | 6,664 |
| Blackpoll warbler | 152 | 1 | 2 | 12 | 9 | 13,147 |
| Mourning warbler | 12 | | | | | |
| American redstart | 147 | 1 | 1 | 13 | 14 | 972 |
| Orange-crowned warbler | 88 | | | 3 | 5 | 24 |
| Yellow warbler | 161 | 2 | | 12 | 178 | |
| Cape May warbler | 35 | | | 2 | | |
| Hooded warbler | 10 | 1 | | | | |
| Prairie warbler | 22 | | | | | |
| Northern waterthrush | 76 | 2 | | 4 | 60 | 8,650 |

Table 18. Continued (page 18 of 27)

| Wildlife group or species[2] | 33-year totals (1990–2022) | | | | | |
|---|---|---|---|---|---|---|
| | Number of reported strikes | | | | Reported economic losses[4] | |
| | Total | With dam-age | With NEOF | With multiple animals[3] | Aircraft down time (hrs.) | Reported costs ($) |
| Nashville warbler | 73 | | 1 | 4 | 23 | |
| Townsend's warbler | 35 | | | 2 | | 123 |
| Louisiana waterthrush | 4 | 1 | | | | |
| Palm warbler | 156 | | 2 | 8 | 8 | 9,487 |
| Magnolia warbler | 64 | | 2 | 6 | 25 | 462 |
| Black-throated blue warbler | 77 | | | 5 | 1 | |
| Prothonotary warbler | 5 | | 1 | | 4 | 274 |
| MacGillivray's warbler | 28 | | | | | |
| Yellow-throated warbler | 43 | 1 | | 5 | 2 | |
| Black-throated gray warbler | 8 | | | | 2 | |
| Black-throated green warbler | 52 | | | 1 | 1 | 611 |
| Hermit warbler | 8 | | | | | |
| Tennessee warbler | 105 | | | 7 | 2 | |
| Chestnut-sided warbler | 39 | | | 5 | 1 | 1,218 |
| Blackburnian warbler | 37 | | | 8 | | |
| Bay-breasted warbler | 47 | | | 4 | 24 | 572 |
| Connecticut warbler | 7 | | | 1 | | |
| Kentucky warbler | 18 | | | 2 | 2 | |
| Worm-eating warbler | 8 | 1 | | | | |
| Blue-winged warbler | 2 | | | | | |
| Golden-winged warbler | 2 | | | 1 | | |
| Lawrence's warbler | 2 | | | | | |
| Cerulean warbler | 1 | | | | | |
| Kirtland's warbler | 1 | | | | | |
| Swainson's warbler | 2 | | | | | |
| Virginia's warbler | 1 | | | | | |
| **Meadowlarks** | **7,045** | **64** | **83** | **554** | **835** | **1,282,024** |
| Meadowlarks | 785 | 5 | 12 | 63 | 20 | 19,002 |
| Eastern meadowlark | 3,942 | 30 | 35 | 258 | 379 | 780,025 |
| Western meadowlark | 2,318 | 29 | 36 | 233 | 436 | 482,997 |
| **Blackbirds, grackles** | **3,325** | **127** | **137** | **666** | **1,904** | **2,280,673** |
| Blackbirds | 1,334 | 84 | 87 | 374 | 756 | 1,852,106 |
| Red-winged blackbird | 707 | 7 | 18 | 80 | 99 | 32,733 |
| Yellow-headed blackbird | 30 | 5 | 2 | 3 | 7 | 30,850 |
| Brewer's blackbird | 89 | 3 | 1 | 10 | 1 | |
| Brown-headed cowbird | 454 | 3 | 6 | 91 | 37 | 7,809 |
| Bobolink | 56 | 1 | 2 | 4 | 2 | |
| Rusty blackbird | 20 | | | | | |

Table 18. Continued (page 19 of 27)

| Wildlife group or species[2] | 33-year totals (1990–2022) | | | | | |
|---|---|---|---|---|---|---|
| | Number of reported strikes | | | | Reported economic losses[4] | |
| | Total | With dam-age | With NEOF | With multiple animals[3] | Aircraft down time (hrs.) | Reported costs ($) |
| Tricolored blackbird | 1 | | | | | |
| Grackles | 171 | 13 | 6 | 33 | 769 | 268,073 |
| Common grackle | 314 | 8 | 11 | 54 | 181 | 88,732 |
| Boat-tailed grackle | 74 | 1 | 2 | 9 | 32 | |
| Great-tailed grackle | 74 | 2 | 2 | 8 | 20 | 370 |
| Greater Antillean grackle | 1 | | | | | |
| **Orioles** | **84** | **1** | **3** | **7** | **8** | **328** |
| Orioles | 6 | | | | | |
| Baltimore oriole | 47 | 1 | 2 | 5 | 8 | 328 |
| Orchard oriole | 16 | | | 2 | | |
| Bullock's oriole | 11 | | 1 | | | |
| Hooded oriole | 4 | | | | | |
| **Neotropical tanagers** | **14** | | | **1** | **1** | |
| Red-crested cardinal | 6 | | | 1 | 1 | |
| Morelet’s seedeater | 2 | | | | | |
| Saffron finch | 5 | | | | | |
| Blue-black grassquit | 1 | | | | | |
| **Finches, euphonias** | **667** | **8** | **11** | **79** | **946** | **4,417** |
| Finches, euphonias | 139 | 2 | 3 | 25 | 7 | 11 |
| Common chaffinch | 5 | | | | | |
| Island canary | 1 | | | | | |
| Pine siskin | 49 | 2 | 1 | 13 | 3 | 113 |
| Common redpoll | 11 | | 1 | 3 | 3 | 1,234 |
| Purple finch | 21 | | | 3 | | |
| Red crossbill | 6 | 1 | 1 | 3 | | 1,697 |
| Evening grosbeak | 1 | | | | | |
| American goldfinch | 165 | | 2 | 8 | 4 | |
| House finch | 224 | 1 | 2 | 18 | 921 | 1,099 |
| White-winged crossbill | 5 | 1 | 1 | 2 | 4 | |
| Lesser goldfinch | 11 | | | | | |
| Cassin's finch | 4 | | | 1 | | |
| Pine grosbeak | 1 | | | | | |
| Gray-crowned rosy-finch | 1 | | | | | |
| Blue grosbeak | 15 | 1 | | 1 | 4 | 263 |
| Hoary redpoll | 2 | | | 1 | | |
| Eurasian siskin | 1 | | | | | |
| Yellow-fronted canary | 2 | | | 1 | | |
| Lawrence's goldfinch | 2 | | | | | |

Table 18. Continued (page 20 of 27)

| Wildlife group or species[2] | 33-year totals (1990–2022) | | | | | |
|---|---|---|---|---|---|---|
| | Number of reported strikes | | | | Reported economic losses[4] | |
| | Total | With dam-age | With NEOF | With multiple animals[3] | Aircraft down time (hrs.) | Reported costs ($) |
| European goldfinch | 1 | | | | | |
| **Cardinalidae** | **428** | **13** | **5** | **31** | **1,264** | **31,696** |
| Cardinalidae | 1 | | | | | |
| Northern cardinal | 17 | | | 1 | | |
| Rose-breasted grosbeak | 56 | 1 | 1 | 5 | 4 | 1,007 |
| Black-headed grosbeak | 35 | 2 | | 2 | 24 | |
| Dickcissel | 38 | 1 | | 5 | | 1,379 |
| Indigo bunting | 88 | 1 | 2 | 7 | 1,118 | 1,005 |
| Lazuli bunting | 10 | | | | | |
| Painted bunting | 7 | | | | | |
| Scarlet tanager | 76 | 3 | | 3 | 87 | 108 |
| Western tanager | 89 | 5 | 2 | 6 | 31 | 27,511 |
| Summer tanager | 11 | | | 2 | | 686 |
| **Black-faced bunting** | **1** | | | **1** | | |
| **New World sparrows** | **8,477** | **114** | **157** | **1,117** | **1,833** | **1,538,308** |
| Sparrows | 4,082 | 58 | 134 | 877 | 765 | 110,939 |
| Harris's sparrow | 8 | | | 1 | | |
| Swamp sparrow | 192 | 3 | 1 | 7 | 255 | 6,045 |
| Savannah sparrow | 1,377 | 11 | 9 | 66 | 86 | 28,096 |
| Fox sparrow | 125 | 5 | 2 | 7 | 47 | 73,174 |
| White-throated sparrow | 500 | 9 | 2 | 38 | 63 | 48,371 |
| White-crowned sparrow | 119 | 5 | 1 | 6 | 66 | 275,375 |
| Golden-crowned sparrow | 25 | | | 1 | 5 | |
| W-c/g-c sparrow complex | 110 | 4 | | 4 | 343 | 828,483 |
| Field sparrow | 81 | | 1 | 7 | 1 | |
| Lark sparrow | 51 | 1 | 1 | 7 | | 18,525 |
| Grasshopper sparrow | 157 | 2 | 1 | 6 | 19 | 40,481 |
| Vesper sparrow | 112 | 1 | | 6 | 1 | |
| Chipping sparrow | 205 | 4 | | 10 | 6 | 395 |
| Lincoln's sparrow | 178 | 3 | 2 | 9 | 19 | 20,188 |
| Song sparrow | 459 | 3 | | 26 | 22 | 73,258 |
| Bell's sparrow | 7 | | | | 1 | |
| American tree sparrow | 47 | | | 2 | | 314 |
| Nelson's sparrow | 7 | | | | 1 | 268 |
| Black-throated sparrow | 9 | | | | 1 | |
| Brewer's sparrow | 33 | | 2 | 1 | | |
| LeConte's sparrow | 10 | | | | | |
| Cassin's sparrow | 9 | | | | | |

Table 18. Continued (page 21 of 27)

| Wildlife group or species[2] | 33-year totals (1990–2022) | | | | | |
|---|---|---|---|---|---|---|
| | Number of reported strikes | | | | Reported economic losses[4] | |
| | Total | With dam-age | With NEOF | With multiple animals[3] | Aircraft down time (hrs.) | Reported costs ($) |
| Clay-colored sparrow | 26 | | | | | |
| Baird's sparrow | 7 | | | | | |
| Olive sparrow | 2 | | | | | |
| Sagebrush sparrow | 2 | | | | | |
| Lark bunting | 152 | 2 | | 20 | 26 | |
| Dark-eyed junco | 384 | 3 | 1 | 16 | 106 | 14,396 |
| Seaside sparrow | 1 | | | | | |
| **Towhees** | **63** | **3** | | **3** | **27** | **20,925** |
| Eastern towhee | 39 | 2 | | 3 | 27 | 20,925 |
| Green-tailed towhee | 11 | 1 | | | | |
| California towhee | 3 | | | | | |
| Spotted towhee | 10 | | | | | |
| **Longspurs, buntings** | **564** | **7** | **37** | **276** | **202** | **30,404** |
| Longspurs, snow buntings | 1 | | | | | |
| Lapland longspur | 121 | 1 | 6 | 35 | 33 | |
| Chestnut-collared longspur | 6 | | | | | |
| Smith's longspur | 9 | | | 1 | | |
| Thick-billed longspur | 4 | | | | | |
| Snow bunting | 422 | 6 | 30 | 239 | 169 | 30,404 |
| McKay's bunting | 1 | | 1 | 1 | | |
| **Estrildid finches** | **373** | **2** | **2** | **114** | **24** | **12,071** |
| Waxbills, mannikins | 4 | | | | | |
| Common waxbill | 15 | | 1 | 5 | | |
| African silverbill | 3 | | | 1 | | |
| Munias | 119 | | | 11 | | |
| Scaly-breasted munia | 134 | 1 | 1 | 58 | 21 | 8,343 |
| Chestnut munia | 83 | 1 | | 32 | 3 | 3,728 |
| White-throated munia | 5 | | | 4 | | |
| Java sparrow | 1 | | | | | |
| Red avadavat | 9 | | | 3 | | |
| **House sparrow** | **511** | **5** | **4** | **48** | **153** | **52,676** |
| **Total known birds** | **153,744** | **9,771** | **6,989** | **21,235** | **583,080** | **789,734,137** |
| **Total unknown birds** | **112,197** | **8,189** | **5,430** | **10,037** | **284,996** | **186,992,790** |
| Unknown bird -unkn size | 23,055 | 1,112 | 1,101 | 1,048 | 21,802 | 8,511,994 |
| Unknown bird - large | 3,624 | 1,340 | 628 | 357 | 63,395 | 78,125,293 |
| Unknown bird - medium | 37,971 | 4,461 | 2,083 | 2,983 | 132,892 | 74,784,865 |
| Unknown bird - small | 47,547 | 1,276 | 1,618 | 5,649 | 66,907 | 25,570,638 |
| **Total birds[5]** | **265,941** | **17,960** | **12,419** | **31,272** | **868,076** | **976,726,927** |

Table 18. Continued (page 22 of 27)

| Wildlife group or species[2] | 33-year totals (1990–2022) | | | | | |
|---|---|---|---|---|---|---|
| | Number of reported strikes | | | | Reported economic losses[4] | |
| | Total | With dam-age | With NEOF | With multiple animals[3] | Aircraft down time (hrs.) | Reported costs ($) |
| | | | | | | |
| **Flying mammals (bats)** | | | | | | |
| **Bats (mega or micro)** | **1** | **1** | | | | **11,603** |
| **Megabats (fruit bats)** | **15** | **3** | **2** | **4** | **99** | **5,353,418** |
| Megabats (unkn species) | 11 | 2 | 1 | 4 | 99 | 5,353,418 |
| Flying foxes | 1 | | | | | |
| Little red flying fox | 1 | | | | | |
| Indian flying fox | 2 | 1 | 1 | | | |
| **Microbats (echo locating)** | **4,552** | **32** | **15** | **296** | **367** | **836,716** |
| Microbats | 1,439 | 6 | 6 | 131 | 80 | 6,543 |
| Vesper bats | 216 | 2 | 1 | 7 | 31 | 1,611 |
| Eastern red bat | 552 | 4 | 2 | 27 | 68 | 18,590 |
| Hoary bat | 195 | 8 | | 6 | 25 | 248,179 |
| Eastern small-footed myotis | 1 | | | | | |
| Little brown bat | 353 | | | 13 | | |
| Big brown bat | 265 | | 2 | 14 | 1 | |
| Silver-haired bat | 107 | 1 | | 5 | 19 | 1,122 |
| Seminole bat | 27 | | | 1 | 2 | |
| Tri-colored bat | 40 | | | | | |
| Northern yellow bat | 17 | | | 4 | | |
| Evening bat | 74 | 1 | | 4 | | |
| Indiana bat | 5 | | | | | |
| Yuma myotis | 2 | | | | | |
| Long-eared myotis | 2 | | | | | |
| Western yellow bat | 1 | | | | | |
| Common pipistrelle | 2 | | | | | |
| Long-legged myotis | 3 | | | | | |
| Western small-footed myotis | 4 | | | 1 | | |
| Kuhl’s pipistrelle | 1 | | | | | |
| Western red bat | 1 | | | | | |
| Western pipistrelle | 2 | | | | | |
| Indian pipistrelle | 4 | | | | | |
| African yellow bat | 1 | | | | | |
| Kelaart’s pipistrelle | 1 | | | | | |
| Spotted bat | 2 | | | | | |
| California myotis | 2 | | | | | |
| Gray bat | 10 | | | 2 | | |
| Free-tailed bats | 163 | | | 4 | 12 | 713 |

Table 18. Continued (page 23 of 27)

| Wildlife group or species[2] | 33-year totals (1990–2022) | | | | | |
|---|---|---|---|---|---|---|
| | Number of reported strikes | | | | Reported economic losses[4] | |
| | Total | With dam-age | With NEOF | With multiple animals[3] | Aircraft down time (hrs.) | Reported costs ($) |
| Brazilian free-tailed bat | 1,026 | 7 | 4 | 74 | 97 | 26,048 |
| Pocketed free-tailed bat | 4 | | | | | |
| Big free-tailed bat | 1 | | | | | |
| Western mastiff bat | 7 | 2 | | | 24 | 411,585 |
| Florida bonneted bat | 1 | | | | | |
| Pallas's mastiff bat | 4 | | | 1 | | |
| Egyptian free-tailed bat | 4 | | | | | |
| Black mastiff bat | 1 | 1 | | | 8 | 122,325 |
| Angolan free-tailed bat | 1 | | | 1 | | |
| Broad-eared bat | 1 | | | | | |
| Sinaloan mastiff bat | 1 | | | | | |
| Gray sac-winged bat | 1 | | | | | |
| Naked-rumped tomb bat | 1 | | | | | |
| Mauritian tomb bat | 1 | | | | | |
| Jamaican fruit bat | 3 | | | 1 | | |
| Antillean fruit-eating bat | 1 | | | | | |
| Lesser bulldog bat | 1 | | | | | |
| Sooty mustached bat | 1 | | | | | |
| **Total Megabats** | **15** | **3** | **2** | **4** | **99** | **5,353,418** |
| **Total Microbats** | **4,552** | **32** | **15** | **296** | **367** | **836,716** |
| **Unknown bat** | **1** | **1** | | | | **11,603** |
| **Total bats[6]** | **4,568** | **36** | **17** | **300** | **466** | **6,201,737** |
| | | | | | | |
| **Terrestrial mammals** | | | | | | |
| **Virginia opossum** | **433** | **1** | **1** | **6** | | |
| **Nine-banded armadillo** | **54** | **1** | **4** | | **11** | **1,547** |
| **Lagomorphs** | **1,083** | **11** | **12** | **11** | **37** | **153,920** |
| Lagomorphs | 9 | 2 | | | | |
| Hares | 8 | | 1 | | 1 | |
| Black-tailed jackrabbit | 547 | 6 | 4 | 3 | 28 | 40,898 |
| White-tailed jackrabbit | 154 | | 1 | 3 | 1 | |
| Antelope jackrabbit | 2 | | | | | |
| Snowshoe hare | 1 | | | | | |
| Rabbits | 66 | | 2 | 3 | 1 | |
| Eastern cottontail | 207 | 3 | 4 | | 6 | 113,022 |
| Desert cottontail | 89 | | | 2 | | |
| **Rodents** | **422** | **3** | **12** | **5** | **6** | **8,751** |
| North American beaver | 4 | | | | | |

Table 18. Continued (page 24 of 27)

| Wildlife group or species[2] | 33-year totals (1990–2022) | | | | | |
|---|---|---|---|---|---|---|
| | Number of reported strikes | | | | Reported economic losses[4] | |
| | Total | With dam-age | With NEOF | With multiple animals[3] | Aircraft down time (hrs.) | Reported costs ($) |
| Black-tailed prairie dog | 91 | | 2 | 2 | | |
| White-tailed prairie dog | 5 | | | | | |
| Gunnison's prairie dog | 18 | | 1 | 3 | | |
| Woodchuck | 197 | 3 | 9 | | 6 | 8,751 |
| Yellow-bellied marmot | 6 | | | | | |
| Squirrels | 2 | | | | | |
| Tree Squirrels | 4 | | | | | |
| Fox squirrel | 1 | | | | | |
| American red squirrel | 1 | | | | | |
| Eastern gray squirrel | 2 | | | | | |
| Ground squirrels | 3 | | | | | |
| Piute ground squirrel | 1 | | | | | |
| California ground squirrel | 14 | | | | | |
| 13-lined ground squirrel | 2 | | | | | |
| Richardson's ground squirrel | 2 | | | | | |
| Muskrat | 45 | | | | | |
| N. American porcupine | 21 | | | | | |
| Coypu (nutria) | 3 | | | | | |
| **Carnivores** | **2,229** | **103** | **252** | **29** | **22,286** | **5,941,362** |
| Canids | 5 | 1 | 1 | | | |
| Coyote | 824 | 66 | 177 | 9 | 16,830 | 4,650,500 |
| Domestic dog | 55 | 16 | 28 | 1 | 559 | 473,123 |
| Foxes | 37 | 3 | 5 | | 10 | 1,273 |
| Red fox | 284 | 6 | 27 | 1 | 364 | 72,041 |
| Common gray fox | 24 | 2 | 2 | | 5 | 636 |
| Kit fox | 4 | | | | | |
| Raccoon | 180 | 5 | 5 | 8 | 4,395 | 69,713 |
| White-nosed coati | 1 | | | | | |
| Skunks | 19 | | | | | |
| Striped skunk | 716 | 2 | 2 | 9 | 3 | |
| River otter | 2 | 1 | | | | |
| American badger | 7 | | | | | |
| American mink | 6 | | | | | |
| Mink | 1 | | | | | |
| Long-tailed weasel | 1 | | | | | |
| Least weasel | 1 | | | | | |
| Domestic cat | 47 | | 2 | 1 | | |
| Small Indian mongoose | 10 | | | | | |

Table 18. Continued (page 25 of 27)

| Wildlife group or species[2] | 33-year totals (1990–2022) | | | | | |
|---|---|---|---|---|---|---|
| | Number of reported strikes | | | | Reported economic losses[4] | |
| | Total | With dam-age | With NEOF | With multiple animals[3] | Aircraft down time (hrs.) | Reported costs ($) |
| American black bear | 3 | | 2 | | | |
| Brown bear | 1 | 1 | | | 120 | 674,076 |
| Bearded seal | 1 | | 1 | | | |
| **Artiodactyls** | **1,400** | **1,156** | **583** | **106** | **315,828** | **74,301,892** |
| Deer | 16 | 13 | 8 | | 1,488 | 168,916 |
| White-tailed deer | 1,237 | 1,018 | 504 | 93 | 262,322 | 62,023,902 |
| Mule deer | 91 | 78 | 39 | 3 | 22,057 | 1,921,810 |
| Axis deer | 1 | | 1 | | | |
| Wapiti (elk) | 12 | 12 | 6 | 2 | 11,660 | 9,034,322 |
| Moose | 6 | 5 | 5 | | | |
| Caribou | 3 | 2 | 2 | | | |
| Cattle | 12 | 12 | 8 | 4 | 9,215 | 597,183 |
| Domestic sheep | 1 | 1 | 1 | | | |
| Pronghorn | 9 | 8 | 6 | 2 | 5,298 | 355,781 |
| Swine (pig) | 7 | 5 | 2 | 1 | 3,788 | 199,978 |
| Collared peccary | 5 | 2 | 1 | 1 | | |
| **Perissodactyls (horse)** | **5** | **4** | **4** | **1** | **1,008** | **43,453** |
| **Total known t. mammals** | **5,626** | **1,279** | **868** | **158** | **339,176** | **80,450,925** |
| **Total unknown t. mammal** | **41** | **12** | **10** | **1** | | |
| **Total t. mammals[7]** | **5,667** | **1,291** | **878** | **159** | **339,176** | **80,450,925** |
| | | | | | | |
| **Reptiles** | | | | | | |
| **Turtles** | **446** | **1** | **5** | **4** | | |
| Turtles | 132 | | 3 | | | |
| Florida softshell turtle | 14 | 1 | | 1 | | |
| Common box turtle | 33 | | | | | |
| Common snapping turtle | 60 | | 2 | | | |
| Diamondback terrapin | 69 | | | 3 | | |
| Painted turtle | 57 | | | | | |
| Florida red-bellied cooter | 3 | | | | | |
| Gopher tortoise | 48 | | | | | |
| Alligator snapping turtle | 6 | | | | | |
| Coastal plain cooter | 3 | | | | | |
| Pond slider | 11 | | | | | |
| Eastern mud turtle | 1 | | | | | |
| Chicken turtle | 1 | | | | | |
| Striped mud turtle | 3 | | | | | |
| Ornate box turtle | 2 | | | | | |

Table 18. Continued (page 26 of 27)

| Wildlife group or species[2] | 33-year totals (1990–2022) | | | | | |
|---|---|---|---|---|---|---|
| | Number of reported strikes | | | | Reported economic losses[4] | |
| | Total | With dam-age | With NEOF | With multiple animals[3] | Aircraft down time (hrs.) | Reported costs ($) |
| Spiny softshell turtle | 2 | | | | | |
| River cooter | 1 | | | | | |
| American alligator | 30 | 2 | 2 | | 3 | |
| Spectacled caiman | 1 | | | | | |
| **Green iguana** | **40** | | **5** | | | |
| **Snakes** | **153** | | **1** | | | |
| Snakes | 33 | | 1 | | | |
| Gopher snake | 93 | | | | | |
| Northern water snake | 3 | | | | | |
| E. diamondback rattlesnake | 3 | | | | | |
| Water moccasin | 1 | | | | | |
| Eastern pine snake | 1 | | | | | |
| W. diamondback rattlesnake | 5 | | | | | |
| Prairie rattlesnake | 1 | | | | | |
| Black rat snake | 3 | | | | | |
| Plains garter snake | 4 | | | | | |
| California kingsnake | 1 | | | | | |
| Common kingsnake | 1 | | | | | |
| Western hognose snake | 1 | | | | | |
| Diamondback water snake | 1 | | | | | |
| Corn snake | 1 | | | | | |
| Eastern hognose snake | 1 | | | | | |
| **Total reptiles[8]** | **670** | **3** | **13** | **4** | **3** | |
| | | | | | | |
| **Total known (all species)** | **164,607** | **11,088** | **7,887** | **21,697** | **922,725** | **876,375,196** |
| **Total (unknown species)** | **112,239** | **8,202** | **5,440** | **10,038** | **284,996** | **187,004,393** |
| **Grand total** | **276,846** | **19,290** | **13,327** | **31,735** | **1,207,721** | **1,063,379,589[9]** |

[1] Includes strikes to U.S.-registered aircraft in foreign countries.

[2] The scientific (taxonomic) name and mean and maximum body mass for each species is listed in Appendix C.

[3] More than 1 animal was struck by the aircraft.

Table 18. Continued (page 27 of 27)

[4] 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. More recent analyses estimated that strike reporting for all civil aircraft combined (commercial and general aviation) at Part 139 airports had improved to 39 percent in 2004-2008 and to 47 percent in 2009-2013 (Dolbeer 2009, 2015). Strike reporting for commercial aircraft only at Part 139 airports was an estimated 79 percent in 2004-2008 and 91 percent in 2009-2013; reporting of strikes with damage was estimated at 78 percent and 93 percent for these respective time periods. In addition, only about 60 percent of reported strikes identified the wildlife species (50 percent) or species group (10 percent) responsible, 1990–2022. Furthermore, of the 19,294 reports indicating damage to the aircraft, only 26 percent (5,014) also provided an estimate of repair costs, and only 39 percent (13,220) of the 34,261 strikes indicating an adverse effect estimated the downtime (see Tables 23, 24). Finally, even when cost estimates were provided, some reports were filed before aircraft damage had been fully assessed. See Tables 23 and 24 for a more detailed projection of actual economic losses.

[5] Of the 265,941 reported bird strikes, 128,797 (48 percent) identified the bird to exact species (a total of 639 species of birds of which 323 caused damage) and an additional 24,947 strikes (9 percent) identified the bird at least to species group (e.g., gull, hawk, duck). Exact species identification has improved from less than 20 percent in the early 1990s to 61 percent in 2022 (Figure 7).

[6] Of the 4,568 reported bat strikes, 2,737 (60 percent) identified the bat to exact species (46 species total of which 8 caused damage) and 1,830 (40 percent) identified the bat to species group (12 megabats [old world fruit bats] and 1,818 microbats [echo-locating bats]) of which 1,439 were microbats of unknown species, 163 were free-tailed bats (Molossidae) and 216 were vesper bats (Vespertilionidae). One bat strike was classified as unknown bat (either megabat or microbat).

[7] Of the 5,667 reported terrestrial mammal strikes, 5,457 (96 percent) identified the mammal to exact species (a total of 55 species of which 24 caused damage), 169 (3 percent) identified the mammal at least to species group, and 41 (<1 percent) were unknown species group.

[8] All of the 670 reported reptile strikes were identified to species group and 505 (75 percent) were identified to exact species (34 species total of which 2 caused damage).

[9] Reported costs of $1,063,379,589 include $929,054,647 in direct repair costs and $134,324,942 in other costs.

Table 19. Number of reported strikes, strikes with damage, and strikes involving multiple animals for the five most struck bird groups and three most struck terrestrial mammal groups, civil aircraft, USA[1], 1990–2022.

| | Reported strikes | | Strikes with damage | | Strikes with >1 animal | |
|---|---|---|---|---|---|---|
| Species group[2] | 33-year total | % of total known | 33-year total | % of total known | 33-year total | % of total known |
| **Birds** | | | | | | |
| Pigeons, doves | 20,334 | 13 | 644 | 7 | 3,155 | 15 |
| Raptors[3] | 19,062 | 12 | 2,327 | 24 | 680 | 3 |
| Gulls | 14,285 | 9 | 1,679 | 17 | 2,576 | 12 |
| Shorebirds | 14,243 | 9 | 247 | 3 | 1,757 | 8 |
| Waterfowl | 7,056 | 5 | 2,655 | 27 | 2,269 | 11 |
| All other known | 78,764 | 51 | 2,219 | 23 | 10,798 | 51 |
| **Total known** | **153,744** | **100** | **9,771** | **100** | **21,235** | **100** |
| **Total unknown** | **112,197** | | **8,189** | | **10,037** | |
| **Total birds** | **265,941** | | **17,960** | | **31,272** | |
| **Terrestrial mammals** | | | | | | |
| Carnivores | 2,229 | 40 | 103 | 8 | 29 | 18 |
| Artiodactyls | 1,400 | 25 | 1,156 | 90 | 106 | 67 |
| Lagomorphs | 1,083 | 19 | 11 | 1 | 11 | 7 |
| All other known | 914 | 16 | 9 | 1 | 12 | 8 |
| **Total known** | **5,626** | **100** | **1,279** | **100** | **158** | **100** |
| **Total unknown** | **41** | | **12** | | **1** | |
| **Total Terr. Mammals** | **5,667** | | **1,291** | | **159** | |

[1] Includes strikes to U.S.-registered aircraft in foreign countries.

[2] See Table 18 for listing of species within each species group and Table 20 for the most frequently struck species.

[3] Hawks, eagles, vultures, falcons, and caracaras.

Table 20. The 33 species of birds identified most frequently as struck by civil aircraft in USA, 1990–2022 and 2022 only. See Figure 14 for relation between mean body mass and percent of strikes causing damage for these 33 species, 1990-2022.

| | Strikes (1990–2022)[1] | | | Strikes (2022 only)[1] | | |
|---|---|---|---|---|---|---|
| Rank | Bird species | Number | % with damage | Bird species | Number | % with damage |
| 1 | Mourning dove | 13,814 | 1.9 | Mourning dove | 932 | 1.1 |
| 2 | Killdeer | 9,162 | 0.8 | Horned lark | 846 | 0.2 |
| 3 | Barn swallow | 9,029 | 0.4 | Barn swallow | 804 | 0.5 |
| 4 | American kestrel | 8,430 | 0.6 | Killdeer | 685 | 0.6 |
| 5 | Horned lark | 7,566 | 0.5 | American kestrel | 647 | 0.6 |
| 6 | European starling | 5,916 | 2.6 | Eastern meadowlark | 335 | 0.9 |
| 7 | Rock pigeon | 4,107 | 7.3 | European starling | 303 | 1.3 |
| 8 | Eastern meadowlark | 3,942 | 0.8 | Red-tailed hawk | 235 | 13.2 |
| 9 | Red-tailed hawk | 3,845 | 13.1 | American robin | 227 | 6.2 |
| 10 | Cliff swallow | 2,684 | 0.3 | Rock pigeon | 195 | 5.6 |
| 11 | Western meadowlark | 2,318 | 1.3 | Western meadowlark | 170 | 0.6 |
| 12 | Ring-billed gull | 2,147 | 6.7 | Chimney swift | 160 | 2.5 |
| 13 | American robin | 2,114 | 7.2 | Cliff swallow | 154 | 0.6 |
| 14 | Canada goose | 2,045 | 47.0 | Savannah sparrow | 143 | 0.7 |
| 15 | Herring gull | 1,963 | 7.9 | Barn owl | 136 | 1.5 |
| 16 | Barn owl | 1,938 | 3.1 | Ring-billed gull | 99 | 2.0 |
| 17 | Chimney swift | 1,495 | 1.1 | Common nighthawk | 98 | 1.0 |
| 18 | Pacific golden-plover | 1,418 | 1.0 | Yellow-rumped warbler | 90 | 2.2 |
| 19 | Savannah sparrow | 1,377 | 0.8 | Herring gull | 81 | 7.4 |
| 20 | Mallard | 1,320 | 19.8 | Tree swallow | 78 | 0.0 |
| 21 | Common nighthawk | 1,185 | 0.6 | Swainson's thrush | 77 | 5.2 |
| 22 | Tree swallow | 1,162 | 0.1 | Mallard | 67 | 23.9 |
| 23 | Laughing gull | 1,139 | 2.5 | Cattle egret | 66 | 3.0 |
| 24 | Turkey vulture | 1,101 | 48.7 | Canada goose | 66 | 22.7 |
| 25 | Short-eared owl | 819 | 1.8 | Turkey vulture | 66 | 47.0 |
| 26 | Cattle egret | 805 | 6.1 | Gray catbird | 60 | 0.0 |
| 27 | Bank swallow | 774 | 0.3 | White-throated sparrow | 60 | 1.7 |
| 28 | Red-winged blackbird | 707 | 1.0 | Red-winged blackbird | 59 | 0.0 |
| 29 | American crow | 674 | 7.4 | Red-eyed vireo | 56 | 0.0 |
| 30 | Yellow-rumped warbler | 639 | 0.6 | Bank swallow | 52 | 0.0 |
| 31 | Osprey | 587 | 21.8 | Brown-headed cowbird | 51 | 0.0 |
| 32 | Peregrine falcon | 579 | 5.9 | Western kingbird | 50 | 2.0 |
| 33 | Swainson's thrush | 577 | 5.5 | Short-eared owl | 49 | 0.0 |

[1] Actual number struck was higher for each species because only 48 and 61 percent of the bird strike reports from 1990–2022 and in 2022, respectively, identified the bird to species (an additional 10 and 5 percent of the reports, respectively, identified the bird to species group). As examples, the species of gull was not identified in 7,666 (54 percent) of 14,285 gull strikes reported from 1990-2022, and the species of vulture (turkey or black) was not identified in 401 (22 percent) of the 1,826 new-world vulture strikes (Table 18).

Table 21. Number of strikes to civil aircraft causing human fatality and number of fatalities by wildlife species, USA[1], 1990–2022.[2]

| Species group | Number of strikes | Human fatalities |
|---|---|---|
| **Birds** | **19** | **43** |
| Raptors[3] | 5 | 16 |
| Pelicans[4] | 3 | 9 |
| Waterfowl[5] | 3 | 7 |
| Misc. birds[6] | 2 | 3 |
| Unknown bird | 6 | 8 |
| **Terrestrial mammals** | **1** | **1** |
| White-tailed deer | 1 | 1 |
| **Total** | **20** | **44** |

[1] Includes strikes to U.S.-registered aircraft in foreign countries.

[2] In addition, there were 269 strikes in which 346 humans received injuries (e.g., facial lacerations). Waterfowl (60 strikes, 68 injuries), vultures (39, 48), and deer (21, 30) were responsible for 42 percent of the injuries.

[3] Black vulture (1, 1); turkey vulture (2, 3); bald eagle (1, 4); red-tailed hawk (1, 8).

[4] American white pelican (2, 8); brown pelican (1, 1).

[5] Green-winged teal (1, 2); snow goose (1, 3); Canada goose (1, 2).

[6] Rock dove (1,1); gull (1, 1).

Table 22. Number of civil aircraft lost (destroyed or damaged beyond repair) after striking wildlife by wildlife species and aircraft mass category, USA[1], 1990–2022. See Figure 15 for number of lost aircraft by year, 1990–2022.

| Wildlife species or species group | Aircraft[2] mass category (Maximum take-off mass in kilograms) ≤2,250 | 2,251-5,700 | 5,701-27,000 | >27,000 | Total aircraft lost |
|---|---|---|---|---|---|
| **Birds[3]** | **31** | **10** | **4** | **2** | **47** |
| Raptors | 12 | 1 | 0 | 1 | 14 |
| Waterfowl | 3 | 4 | 1 | 1 | 9 |
| Pelicans | 2 | 1 | 0 | 0 | 3 |
| Gulls | 1 | 2 | 0 | 0 | 3 |
| Other birds | 2 | 0 | 1 | 0 | 3 |
| Unknown bird | 11 | 2 | 2 | 0 | 15 |
| **Terrestrial mammals[4]** | **21** | **7** | **6** | **0** | **34** |
| Artiodactyls | 19 | 7 | 5 | 0 | 31 |
| Other T. mammals | 2 | 0 | 1 | 0 | 3 |
| **Total[5]** | **52** | **17** | **10** | **2** | **81** |

[1] Includes strikes to U.S.-registered aircraft in foreign countries.

[2] Engine types on the 81 destroyed aircraft were piston (56), turbofan (11), turboprop (6), turboshaft (4), turbojet (3), and electric (drone, 1). Aircraft operators were business (45), private (29), commercial transport (5), and government (2).

[3] Canada goose (5); bald eagle and turkey vulture (4 each); American white pelican and hawks (2 each); black vulture (1), Eurasian kestrel, New World vultures, red-tailed hawk, ducks, green-winged teal, redhead, snow goose, brown pelican, double-crested cormorant, mourning dove, and rock pigeon (1 each).

[4] White-tailed deer (26); cattle (3); mule deer, wapiti, eastern cottontail, domestic dog, and coyote (1 each).

[5] Forty-six (57 percent) of the 81 wildlife strikes resulting in a destroyed aircraft occurred at USA general aviation airports, 22 occurred “en route”, 8 occurred at USA airports certificated for passenger service under 14 CFR Part 139, 3 occurred in miscellaneous situations (taking off from river, herding cattle, aerial application of pesticides) and 2 occurred at foreign airports.

Table 23. Number of reported wildlife strikes indicating damage, a negative effect-on-flight (NEOF), aircraft downtime, repair costs, and other costs; and the mean losses per report in hours of downtime and inflation-adjusted U.S. dollars, civil aircraft, USA[1], 1990–2022.

| | Number of reports indicating: | | | | | Mean losses per report[2] | | |
|---|---|---|---|---|---|---|---|---|
| Year | Dam-age | NEOF | Aircraft down time | Repair costs | Other costs | Down-time (hours) | Repair costs ($) | Other costs ($) |
| 1990 | 372 | 144 | 60 | 33 | 16 | 56.4 | 257,746 | 73,989 |
| 1991 | 400 | 175 | 61 | 49 | 25 | 79.8 | 87,424 | 47,126 |
| 1992 | 365 | 212 | 81 | 51 | 28 | 111.9 | 125,075 | 6,294 |
| 1993 | 399 | 231 | 67 | 57 | 19 | 277.9 | 106,279 | 11,218 |
| 1994 | 459 | 259 | 103 | 73 | 29 | 388.4 | 91,476 | 109,236 |
| 1995 | 498 | 300 | 95 | 62 | 33 | 96.3 | 601,783 | 262,713 |
| 1996 | 503 | 336 | 144 | 86 | 39 | 137.3 | 100,901 | 30,194 |
| 1997 | 575 | 362 | 182 | 126 | 47 | 230.7 | 90,971 | 47,619 |
| 1998 | 587 | 383 | 205 | 135 | 54 | 119.5 | 239,604 | 34,163 |
| 1999 | 705 | 411 | 282 | 179 | 79 | 148.8 | 131,859 | 24,978 |
| 2000 | 765 | 445 | 351 | 205 | 93 | 195.2 | 117,266 | 136,550 |
| 2001 | 646 | 411 | 293 | 157 | 65 | 142.6 | 339,276 | 46,536 |
| 2002 | 670 | 436 | 383 | 165 | 63 | 135.6 | 181,170 | 76,548 |
| 2003 | 631 | 411 | 353 | 171 | 81 | 109.9 | 191,918 | 50,982 |
| 2004 | 630 | 396 | 324 | 213 | 92 | 166.9 | 125,486 | 27,089 |
| 2005 | 610 | 386 | 327 | 227 | 125 | 88.0 | 318,681 | 91,806 |
| 2006 | 603 | 373 | 333 | 172 | 102 | 116.8 | 255,754 | 15,905 |
| 2007 | 568 | 398 | 364 | 178 | 135 | 165.2 | 205,838 | 39,627 |
| 2008 | 527 | 353 | 371 | 156 | 141 | 116.2 | 140,705 | 16,714 |
| 2009 | 607 | 471 | 563 | 195 | 193 | 80.8 | 446,530 | 17,491 |
| 2010 | 603 | 412 | 526 | 174 | 164 | 66.5 | 155,166 | 16,486 |
| 2011 | 545 | 438 | 526 | 180 | 208 | 70.8 | 284,912 | 18,041 |
| 2012 | 621 | 441 | 689 | 228 | 263 | 75.4 | 131,458 | 10,083 |
| 2013 | 613 | 452 | 802 | 238 | 304 | 75.7 | 78,008 | 14,882 |
| 2014 | 586 | 502 | 717 | 210 | 277 | 63.2 | 166,531 | 12,728 |
| 2015 | 623 | 498 | 705 | 208 | 293 | 50.0 | 178,595 | 23,208 |
| 2016 | 592 | 489 | 585 | 154 | 221 | 87.4 | 79,866 | 15,031 |
| 2017 | 677 | 538 | 634 | 193 | 261 | 50.3 | 209,267 | 14,939 |
| 2018 | 715 | 590 | 636 | 170 | 295 | 66.1 | 69,845 | 9,387 |
| 2019 | 756 | 596 | 709 | 160 | 249 | 31.6 | 124,449 | 23,778 |
| 2020 | 488 | 441 | 481 | 119 | 188 | 38.0 | 112,104 | 9,210 |
| 2021 | 664 | 445 | 625 | 160 | 223 | 101.8 | 237,910 | 17,403 |
| 2022 | 691 | 592 | 643 | 130 | 172 | 43.4 | 155,330 | 91,124 |
| **Total** | 19,294 | 13,327 | 13,220 | 5,014 | 4,577 | | | |
| **Mean** | 585 | 404 | 401 | 152 | 139 | 91.3 | 185,292 | 29,348 |

[1] Includes strikes to U.S.-registered aircraft in foreign countries.

[2] See Table 18 for actual losses reported in total and by species of wildlife, 1990-2022.

Table 24. Projected annual losses in aircraft downtime (hours) and in repair and other costs (inflation-adjusted U.S. dollars) from wildlife strikes with civil aircraft, USA[1], 1990–2022. Losses are projected from mean reported losses per incident (Table 23). (Page 1 of 2).

| Year | No. of adverse incidents[4] | Projected losses[2, 3] | | | |
|---|---|---|---|---|---|
| | | Down-time (hours) | Repair costs (x $1 million) | Other costs (x $1 million) | Total costs (x $1 million)[5] |
| 1990 | 429 | 24,174 | 111 | 32 | 142 |
| 1991 | 481 | 38,362 | 42 | 23 | 65 |
| 1992 | 487 | 54,508 | 61 | 3 | 64 |
| 1993 | 506 | 140,623 | 54 | 6 | 59 |
| 1994 | 579 | 224,905 | 53 | 63 | 116 |
| 1995 | 654 | 62,953 | 394 | 172 | 565 |
| 1996 | 681 | 93,479 | 69 | 21 | 89 |
| 1997 | 776 | 178,992 | 71 | 37 | 108 |
| 1998 | 802 | 95,841 | 192 | 27 | 220 |
| 1999 | 967 | 143,864 | 128 | 24 | 152 |
| 2000 | 1,103 | 215,289 | 129 | 151 | 280 |
| 2001 | 974 | 138,886 | 330 | 45 | 376 |
| 2002 | 1,080 | 146,451 | 196 | 83 | 278 |
| 2003 | 987 | 108,458 | 189 | 50 | 240 |
| 2004 | 942 | 157,180 | 118 | 26 | 144 |
| 2005 | 951 | 83,697 | 303 | 87 | 390 |
| 2006 | 928 | 108,392 | 237 | 15 | 252 |
| 2007 | 956 | 157,971 | 197 | 38 | 235 |
| 2008 | 889 | 103,268 | 125 | 15 | 140 |
| 2009 | 1,175 | 94,967 | 525 | 21 | 545 |
| 2010 | 1,114 | 74,077 | 173 | 18 | 191 |
| 2011 | 1,132 | 80,116 | 323 | 20 | 343 |
| 2012 | 1,311 | 98,907 | 172 | 13 | 186 |
| 2013 | 1,428 | 108,111 | 111 | 21 | 133 |
| 2014 | 1,434 | 90,687 | 239 | 18 | 257 |
| 2015 | 1,445 | 72,249 | 258 | 34 | 292 |
| 2016 | 1,321 | 115,437 | 106 | 20 | 125 |
| 2017 | 1,435 | 72,187 | 300 | 21 | 322 |
| 2018 | 1,576 | 104,106 | 110 | 15 | 125 |
| 2019 | 1,644 | 51,892 | 205 | 39 | 244 |
| 2020 | 1,110 | 42,207 | 124 | 10 | 135 |
| 2021 | 1,402 | 142,741 | 334 | 24 | 358 |
| 2022 | 1,562 | 67,848 | 243 | 142 | 385 |
| **Total** | 34,261 | 3,492,825 | 6,222 | 1,334 | 7,556 |
| **Mean** | 1,038 | 105,843 | 188 | 40 | 229 |

Table 24. Continued (page 2 of 2)

[1] Includes strikes to U.S.-registered aircraft in foreign countries.

[2] Values assume that all 34,261 reported strikes (mean of 1,038/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, 1990–2022.

[3] 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). Strike reporting for general aviation aircraft at general aviation airports was estimated at less than 5 percent in the 1990s and early 2000s (Dolbeer et al. 2008, Dolbeer 2009). More recent analyses estimated that strike reporting for all civil aircraft combined (commercial and general aviation) at Part 139 airports had improved to 39 percent in 2004-2008 and to 47 percent in 2009-2013 (Dolbeer 2009, 2015). Strike reporting for commercial transport aircraft only at Part 139 airports was an estimated 79 percent in 2004-2008 and 91 percent in 2009-2013; reporting of strikes with damage was estimated at 78 percent and 93 percent for these respective time periods.

[4] Number of reports indicating one or more of the following: damage, negative effect on flight (EOF), downtime, repair costs, other costs.

[5] Altringer et al. (2022) estimated that damaging wildlife strike events generate additional "spillover" costs of around $25 million (2020 US$) each year related to delays in subsequent flights.

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## Figures

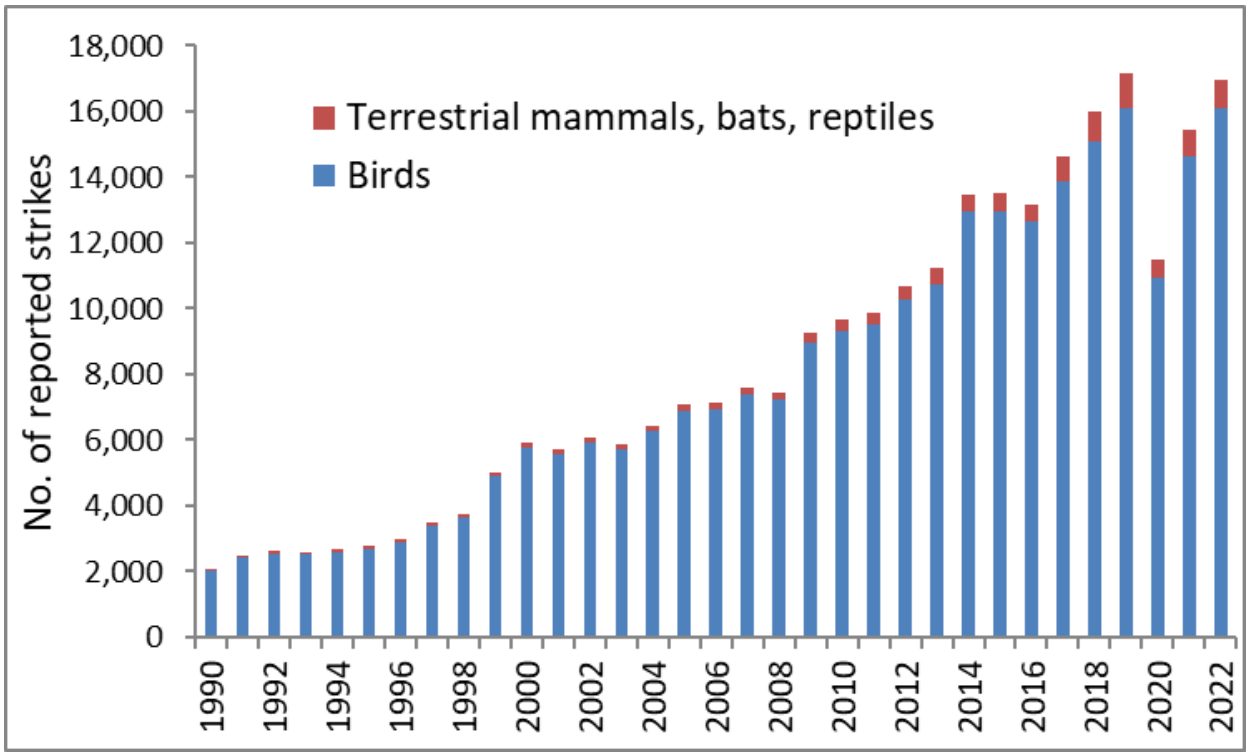
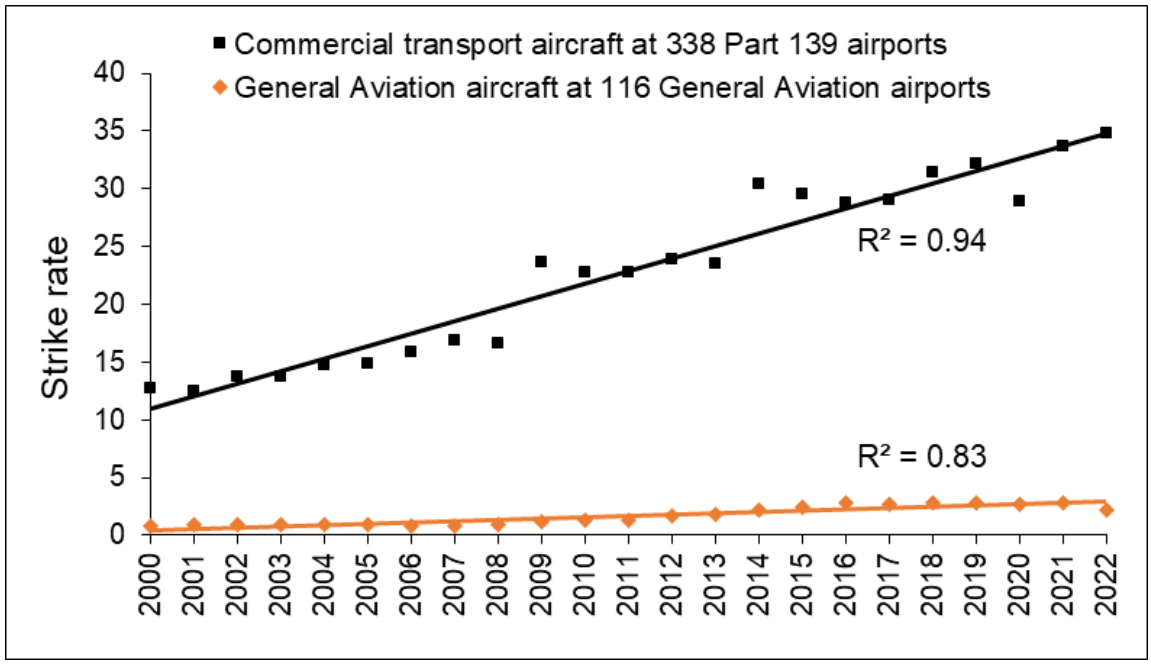



Figure 1. Number of reported wildlife strikes with civil aircraft, USA, 1990–2022. The 272,016 strikes involved birds (261,170), terrestrial mammals (5,653), bats (4,523), and reptiles (670). An additional 4,830 strikes were reported for U.S.-registered aircraft in foreign countries for a total of 276,846 strikes (see Tables 1, 2, and 18).



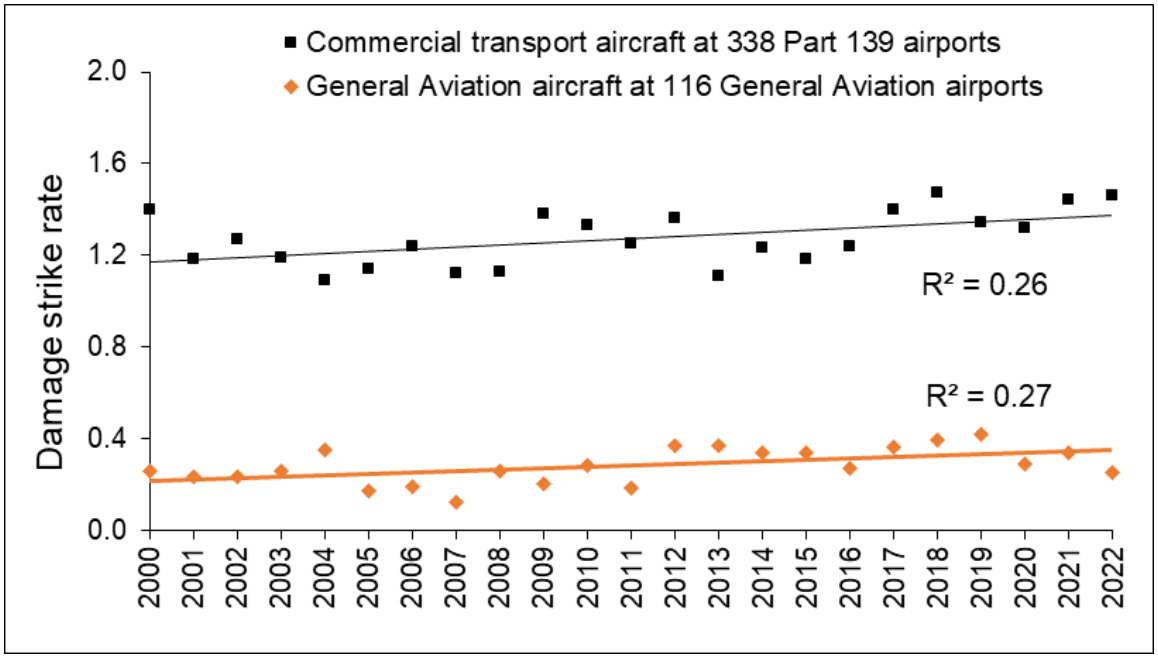
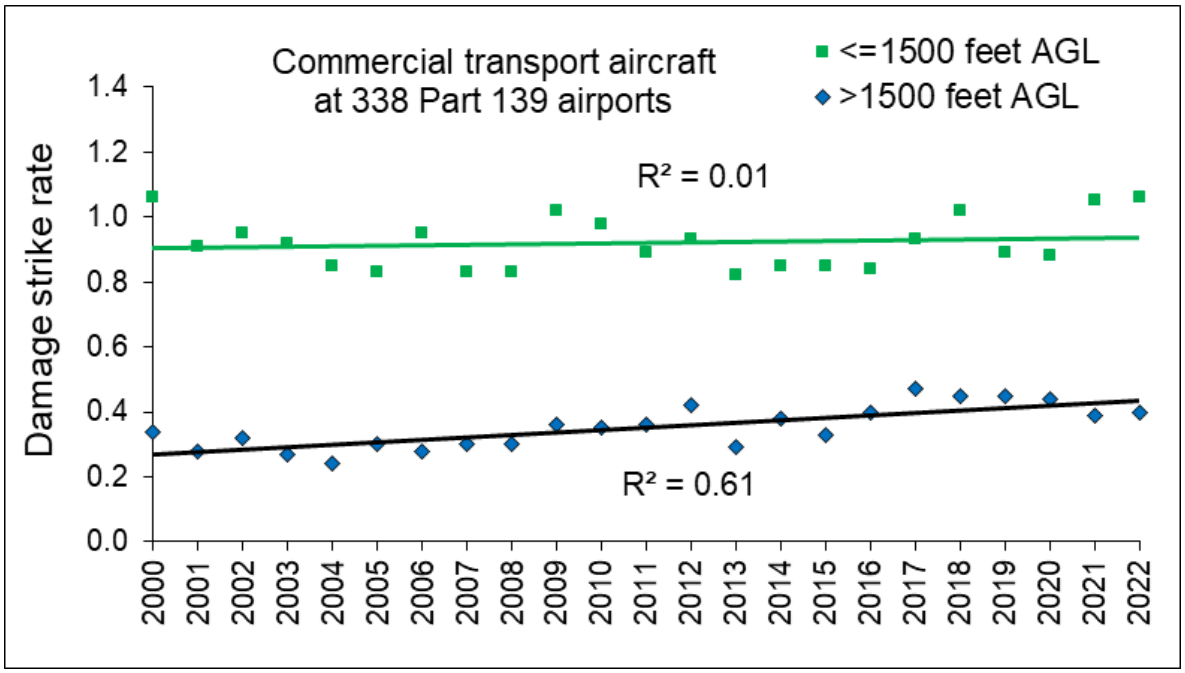




Figure 2. The strike rate and damaging strike rate (number of reported strikes and damaging strikes per 100,000 aircraft movements) for commercial (air carrier and air taxi service) transport aircraft at 338 Part 139-certificated airports and general aviation aircraft at 116 general aviation airports, USA, 2000 – 2022. Strikes involving U.S.-registered aircraft in foreign countries are excluded. $R^2$ values greater than 0.17 and 0.28 indicate significant trends at the 0.05 and 0.01 levels of probability, respectively (Steele and Torrie 1960; see Tables 3 and 4 for complete data).



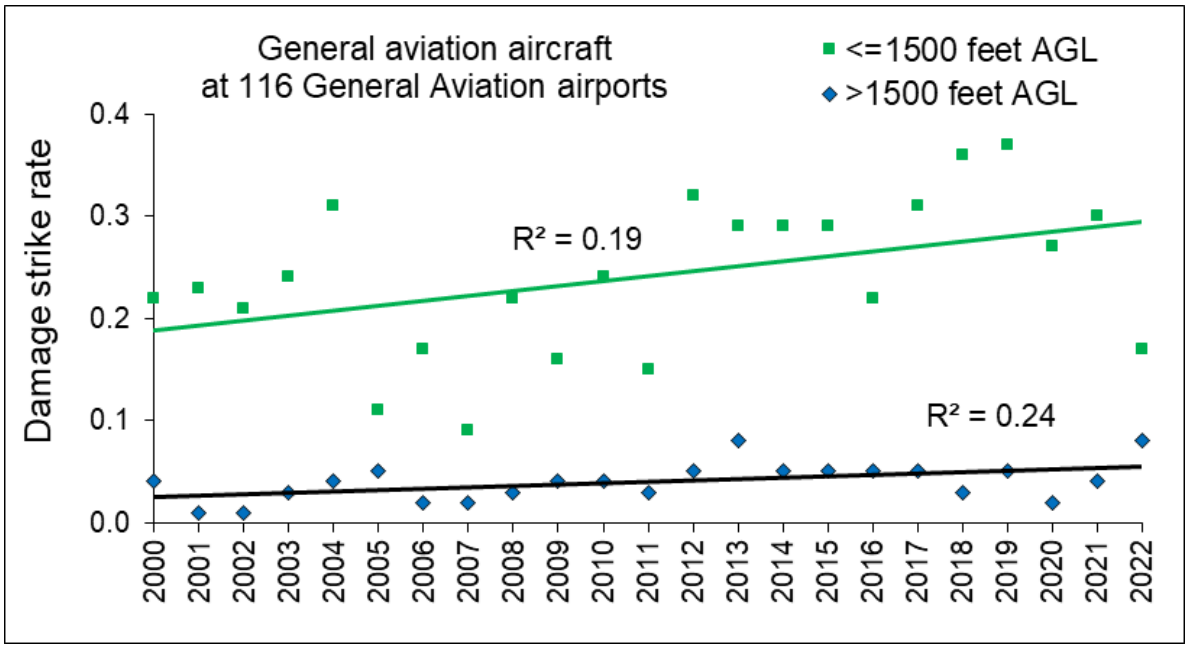




Figure 3. The damage strike rate (number of reported damaging strikes per 100,000 aircraft movements) with commercial transport aircraft at 338 Part 139-certificated airports (top graph) and general aviation aircraft at 116 general aviation airports (bottom graph) occurring at ≤ and >1500 feet above ground level (AGL) for all wildlife species, USA, 2000 – 2022. Strikes with unknown height AGL are included with strikes at ≤1500 feet AGL. Strikes involving U.S.-registered aircraft in foreign countries are excluded. $R^2$ values greater than 0.17 and 0.28 indicate significant trends at the 0.05 and 0.01 levels of probability, respectively (Steele and Torrie 1960).

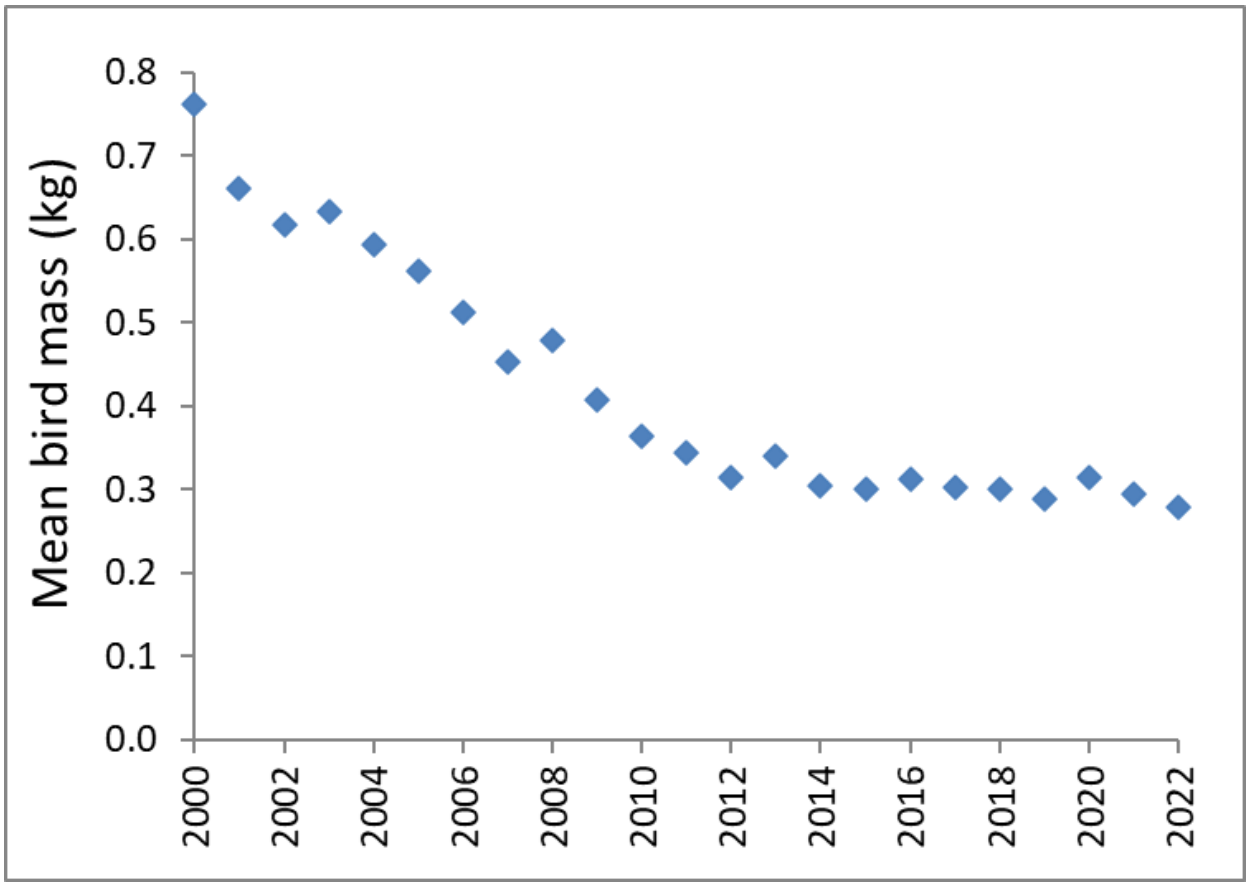



Figure 4. The mean body mass of birds reported as struck by civil aircraft in USA has declined by 63 percent from 2000 to 2022. This indicates that airports, pilots, and commercial transport aviation in general, are doing a better job of documenting all wildlife that are struck, many of which are small species that rarely cause damage. Means were calculated from all strikes in USA in which the bird was identified to species. See Figure 13 for number of identified bird species struck each year and Table 18 and Appendix C for a list of species struck.

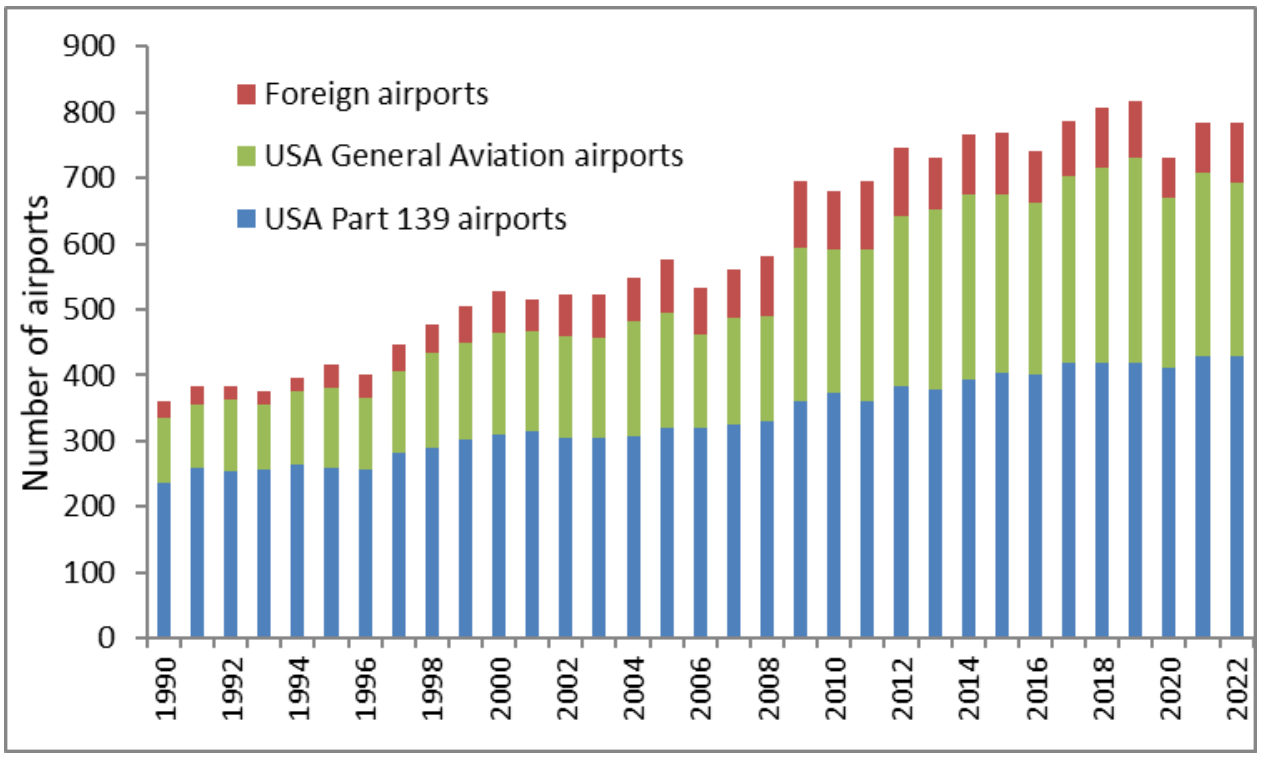
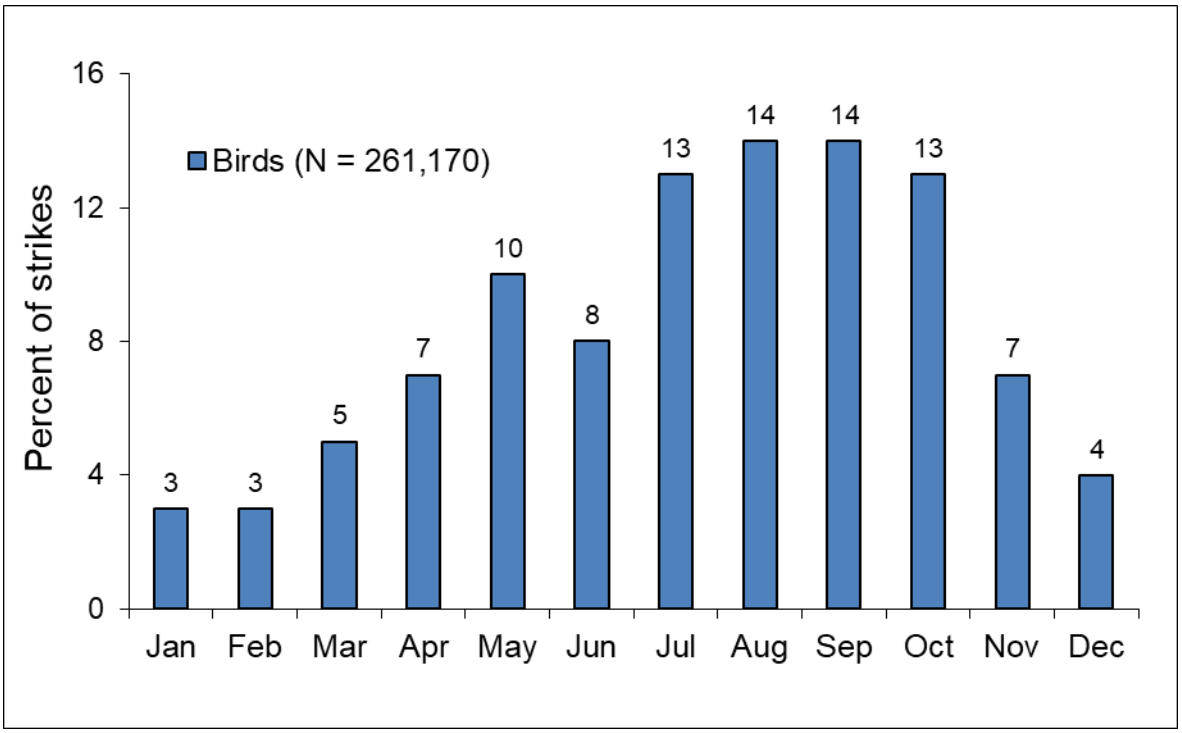



Figure 5. Number of Part 139-certificated airports and general aviation (GA) airports in USA with reported wildlife strikes and number of foreign airports at which strikes were reported for U.S.-registered civil aircraft, 1990–2022. Strikes were reported from 2,062 USA airports (516 Part 139-certificated, 1,546 GA) and 330 foreign airports in 113 countries, 1990-2022 (Table 8).



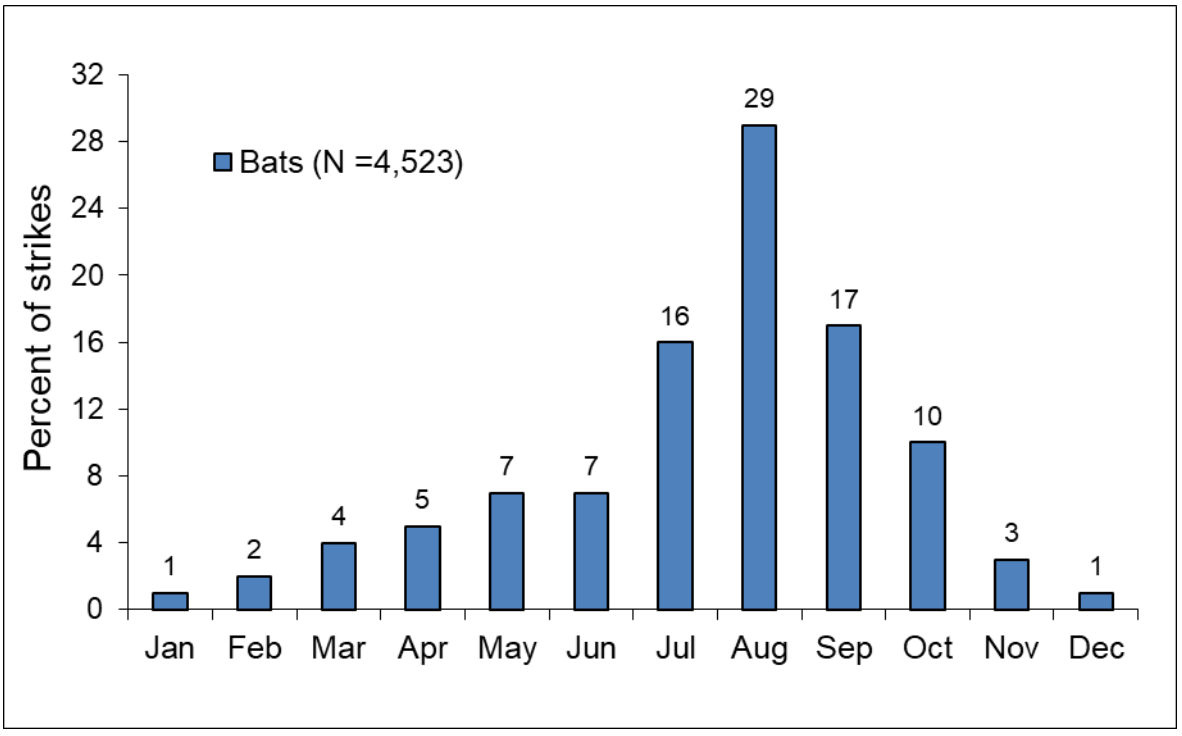
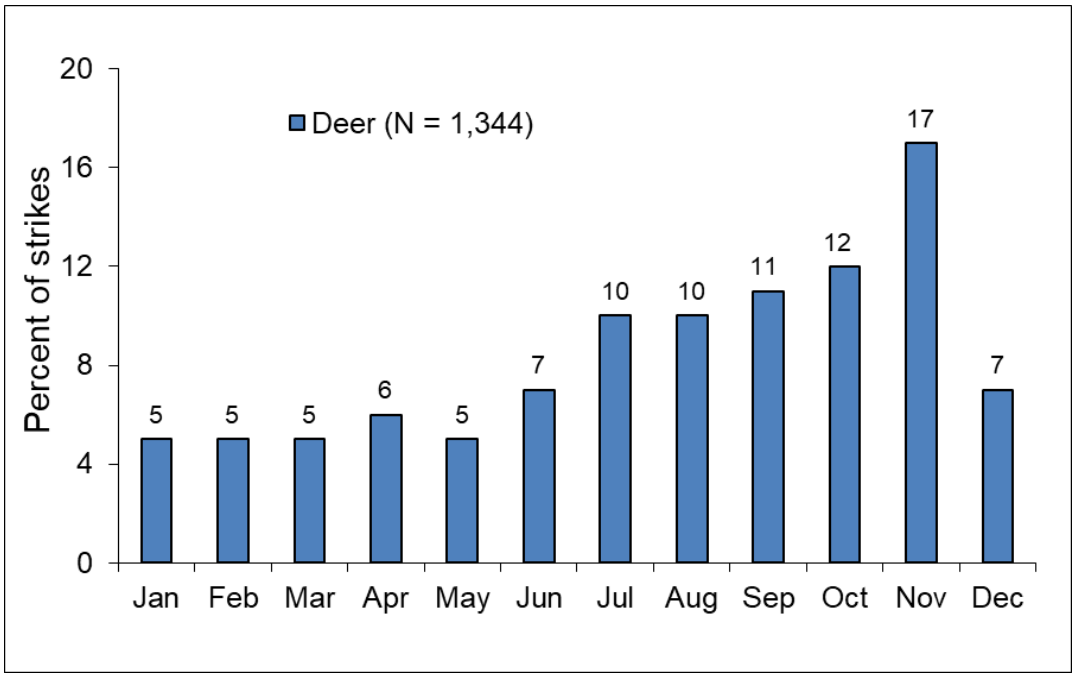




Figure 6. Percentage of reported bird (top graph) and bat (bottom graph) strikes with civil aircraft by month, USA, 1990–2022. In addition, 670 strikes with reptiles were reported of which 58 percent occurred in May–July. Strikes reported for U.S.-registered aircraft in foreign countries were excluded.



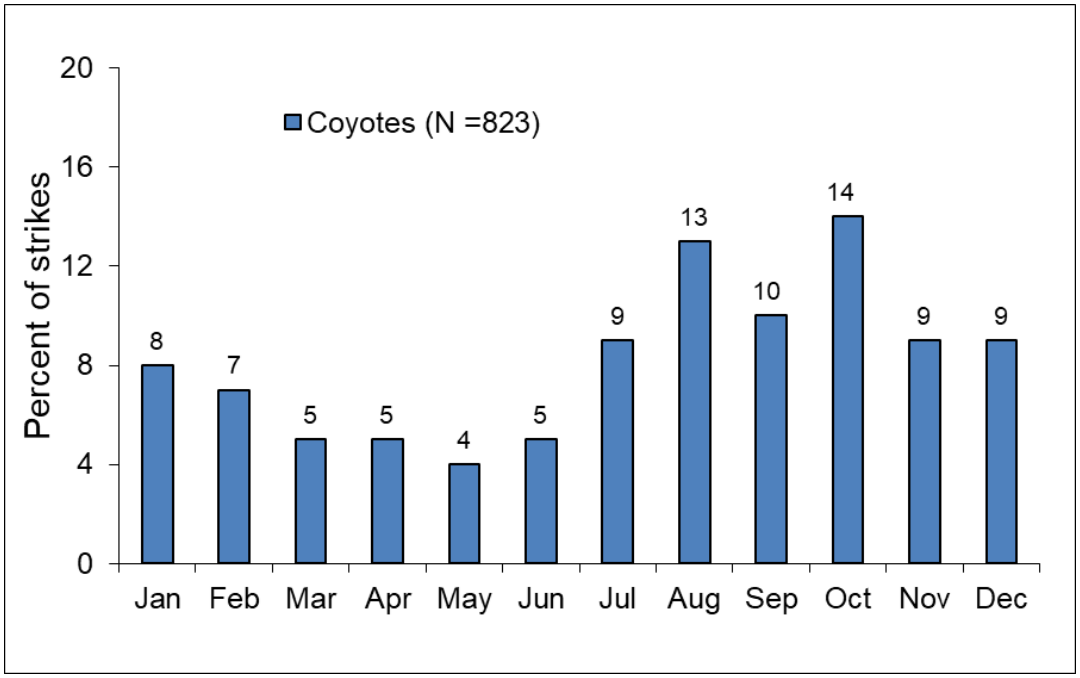
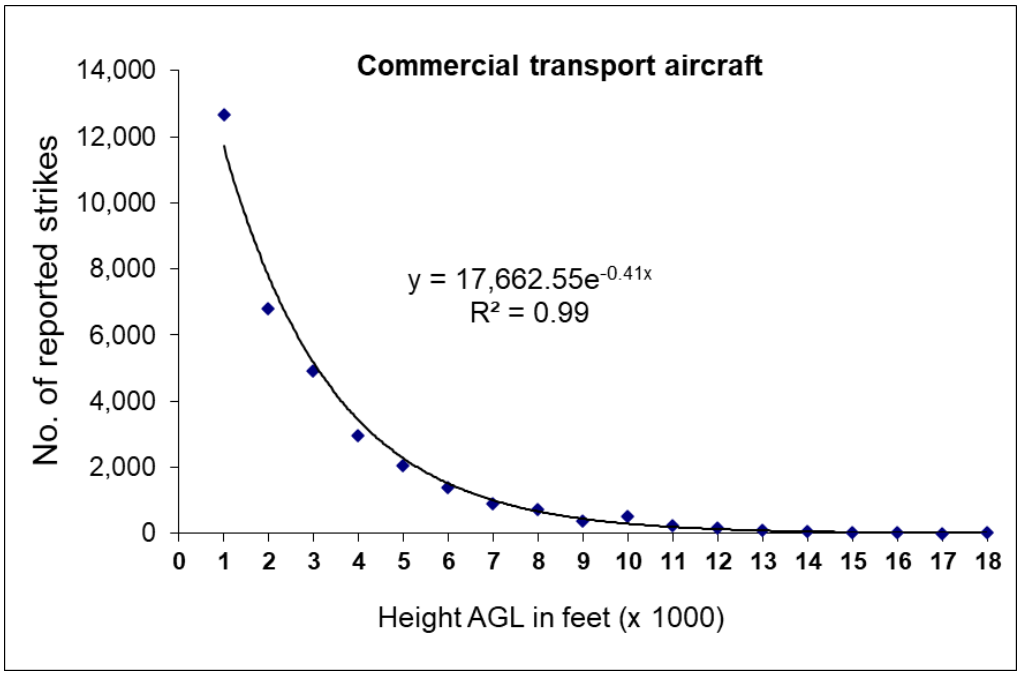




Figure 7. Percentage of reported deer (top graph) and coyote (bottom graph) strikes with civil aircraft by month, USA, 1990–2022. One deer and 1 coyote strike reported for U.S.-registered aircraft in foreign countries were excluded. Deer (1,237 white-tailed, 91 mule, 1 axis, 16 unidentified to species) and coyotes are the most frequently struck terrestrial mammals (Table 18). Biondi et al. (2011) provide a more detailed analysis of deer strikes with civil aircraft in the USA; Ball et al. (2021) summarize data on mammal strikes worldwide.



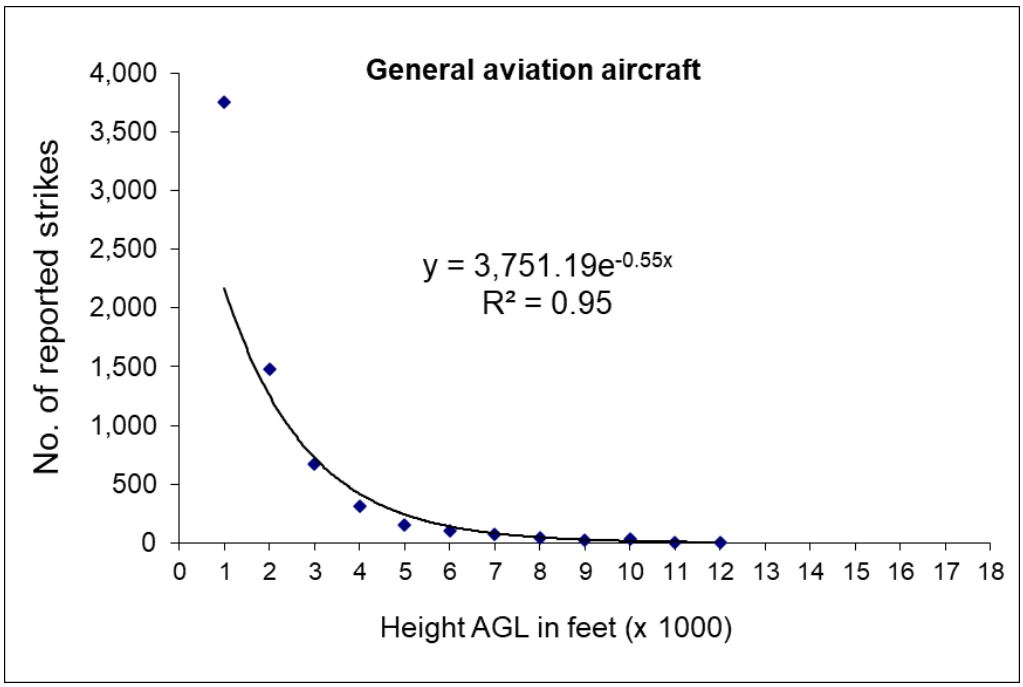
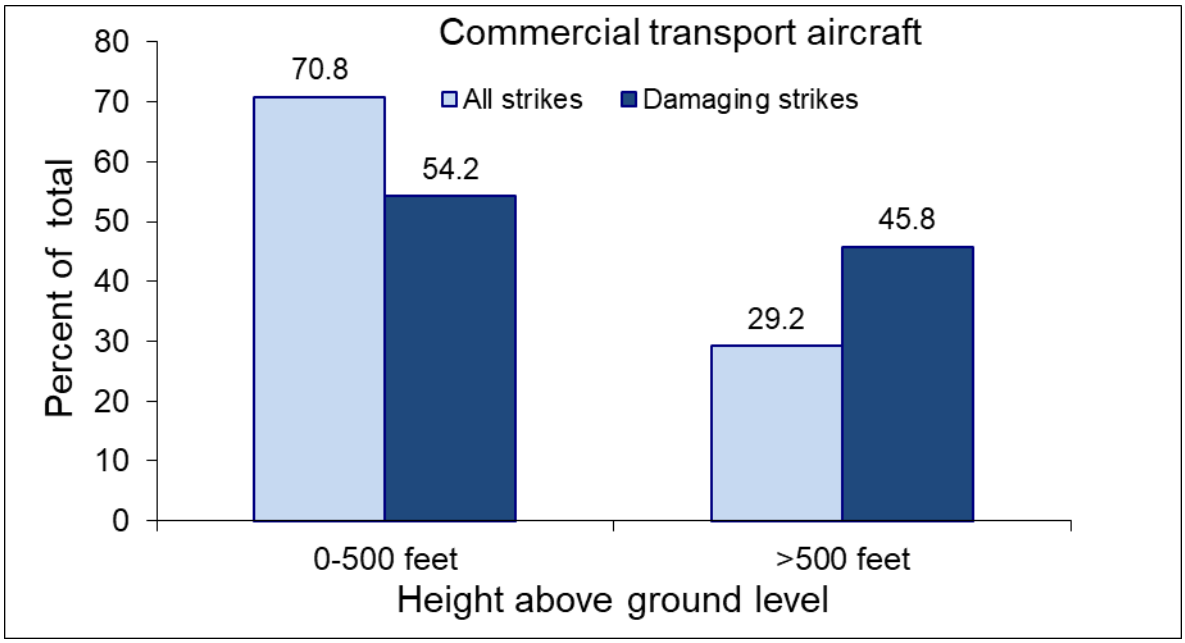




Figure 8. Number of reported bird strikes with commercial transport (top graph) and general aviation (GA) aircraft (bottom graph) in USA by 1,000-foot height intervals above ground level from 501—1,500 feet (interval 1) to 17,501—18,500 feet (interval 18) for commercial transport aircraft and to 11,501—12,500 feet (interval 12) for GA aircraft, 1990-2022. These graphs exclude strikes at ≤500 feet. Above 500 feet, the number of reported strikes declined consistently by 34 percent and 42 percent for each 1,000-foot gain in height for commercial transport and GA aircraft, respectively. The exponential equations explained 95 to 99 percent of the variation in number of strikes by 1,000-foot intervals from 501 to 18,500 feet for commercial transport aircraft and 501 to 12,500 feet for GA aircraft. See Tables 11 and 12 for sample sizes.



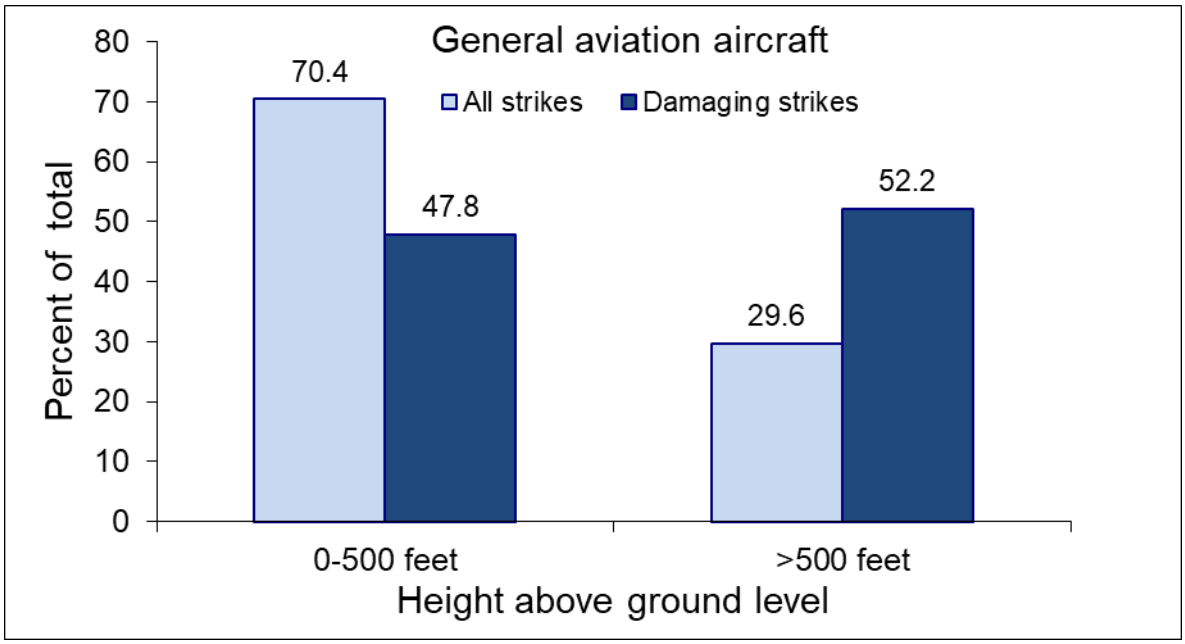




Figure 9. Percentages of total strikes and total damaging strikes occurring at 500 feet or less and above 500 feet for commercial transport (top graph) and general aviation (bottom graph) aircraft in USA, 1990–2022. See Tables 11 and 12 for sample sizes.

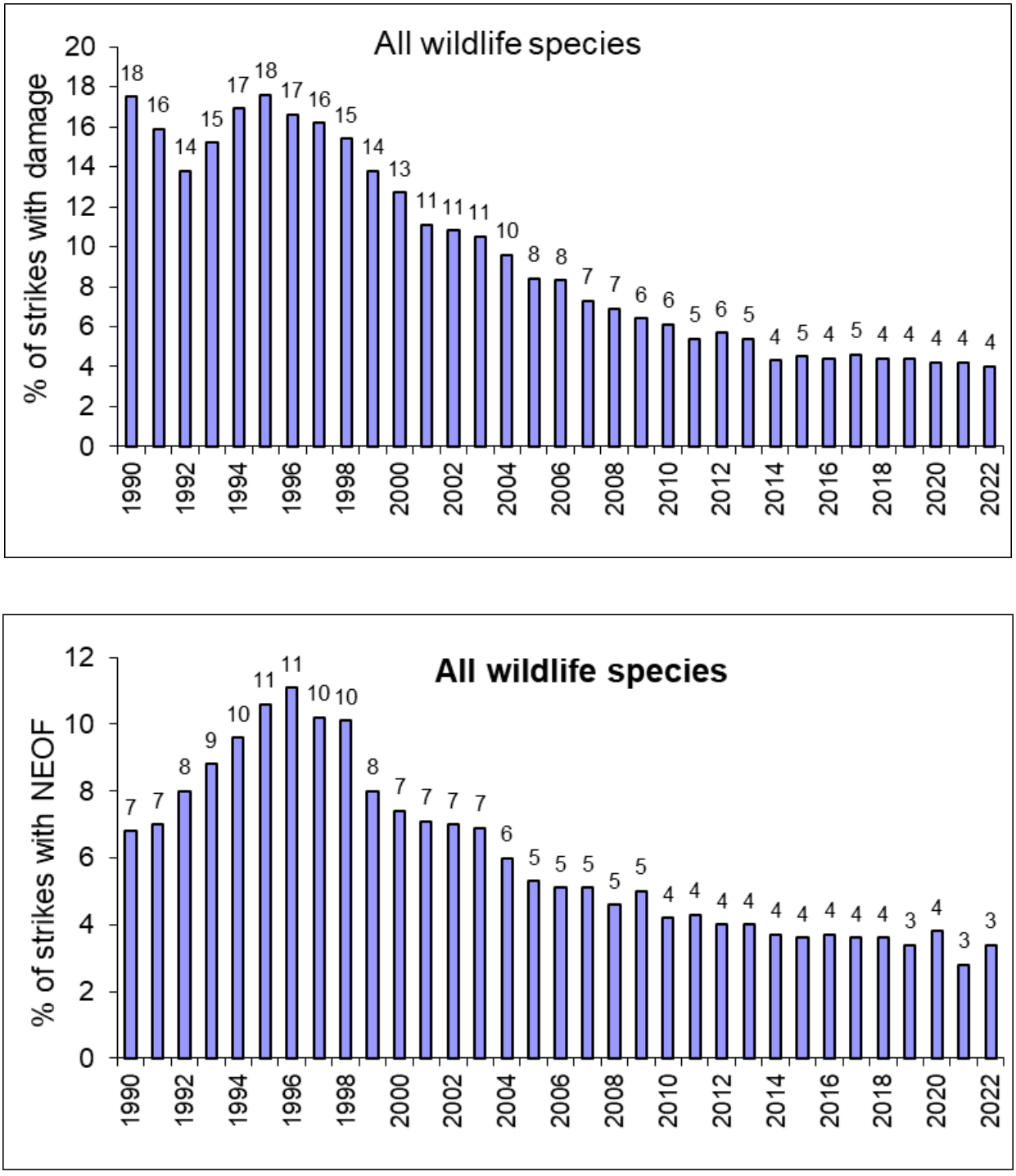



Figure 10. Percentage of reported strikes that indicated damage to the civil aircraft (top graph) or a negative effect-on-flight (NEOF, bottom graph), USA, 1990–2022. See Tables 1, 14, and 15 for sample sizes and classifications of damage and negative effects-on-flight.

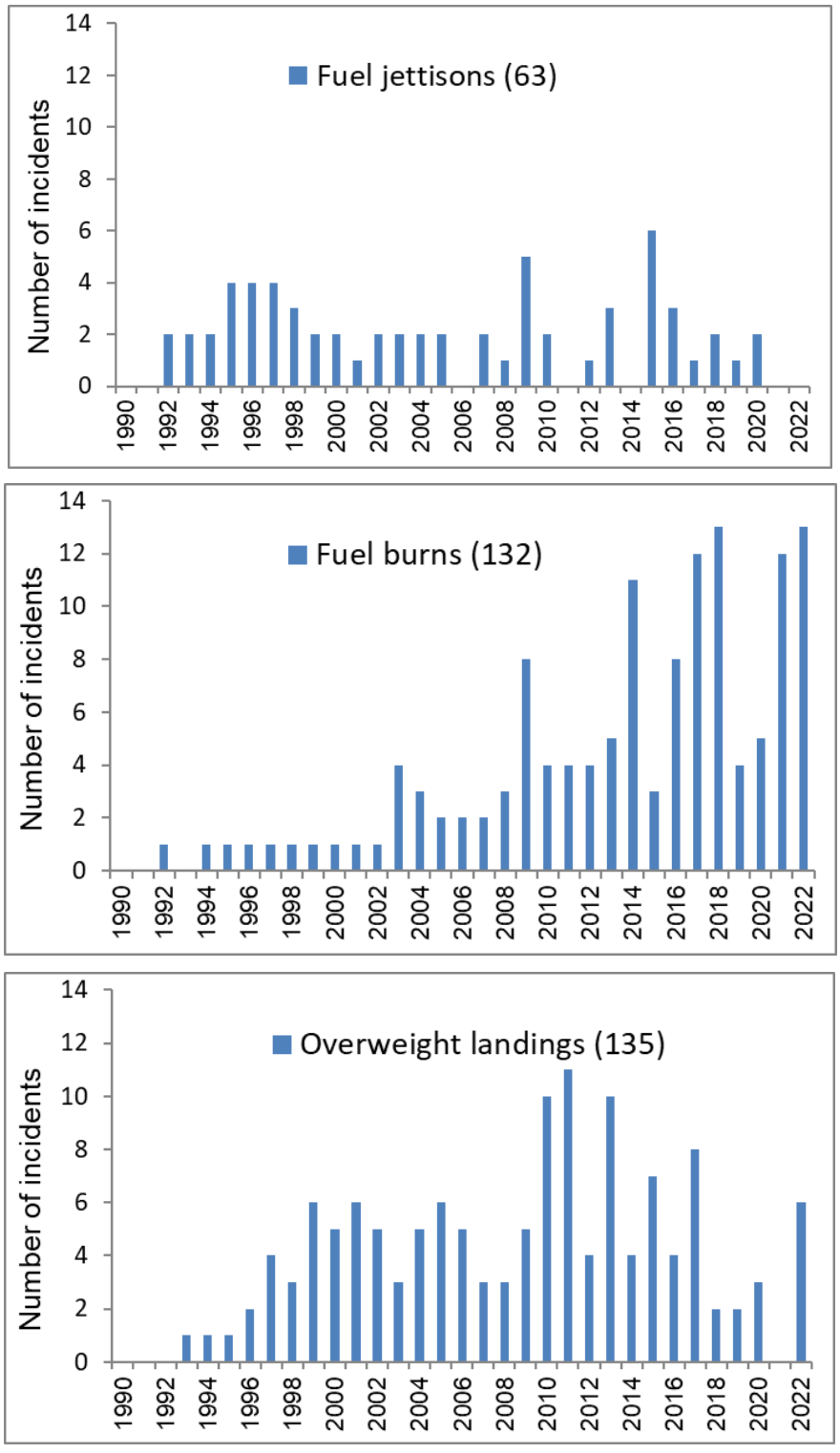



Figure 11. Number of reported incidents where pilot made an emergency or precautionary landing after striking wildlife during departure in which fuel was jettisoned or burned (circling pattern) to lighten aircraft weight or in which an overweight (greater than maximum landing weight) landing was made (no fuel jettison or burn), USA civil aircraft, 1990–2022. See Table 16 for details on aircraft involved and amount of fuel jettisoned.

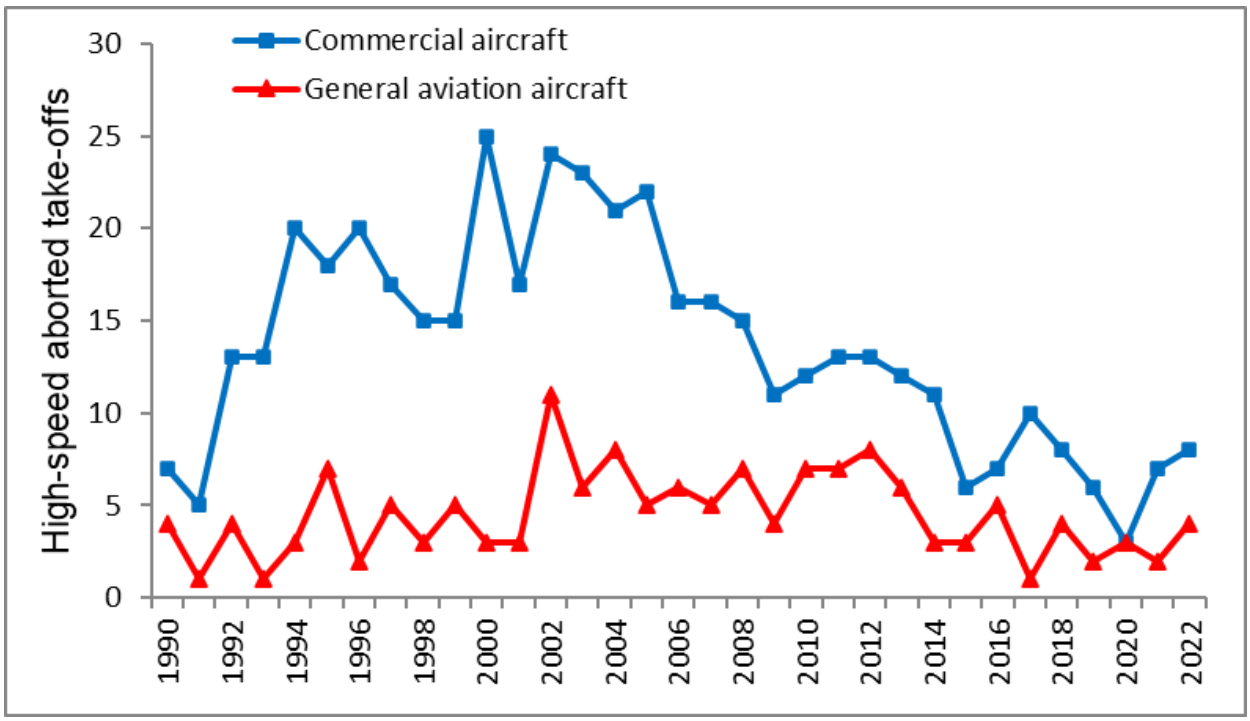



Figure 12. Number of reported incidents in which pilot made a high-speed aborted take-off (≥100 knots) after striking or observing wildlife during take-off run, USA civil aircraft, 1990–2022. See Table 17 for classification of aborted take-offs by indicated airspeed.

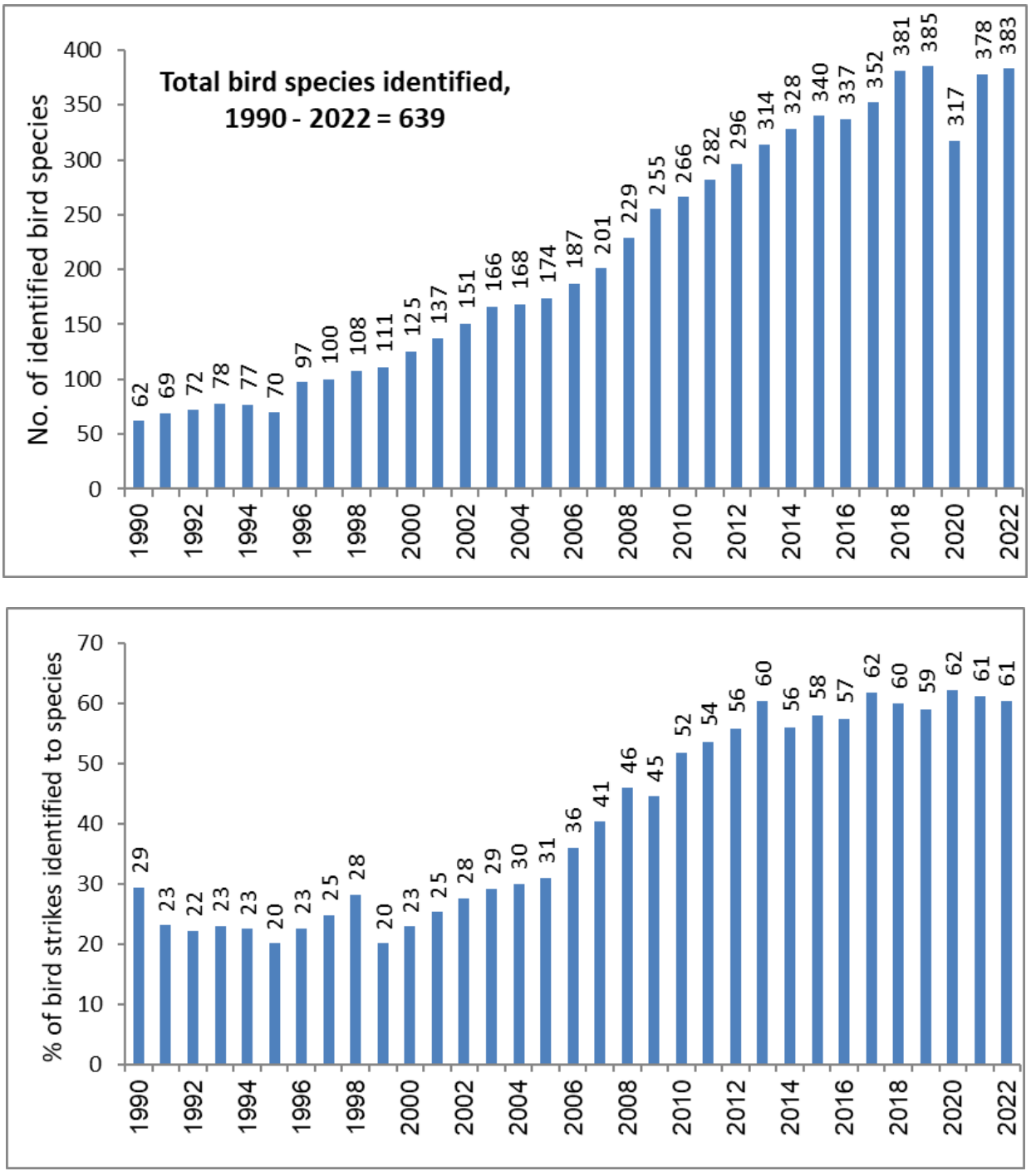



Figure 13. Number of identified bird species struck by civil aircraft each year (top graph) and the percentage of reported bird strikes in which the bird was identified to species (bottom graph), 1990–2022. From 1990 through 2022, 639 species of birds have been identified. See Tables 1 and 18 for sample sizes and list of species.

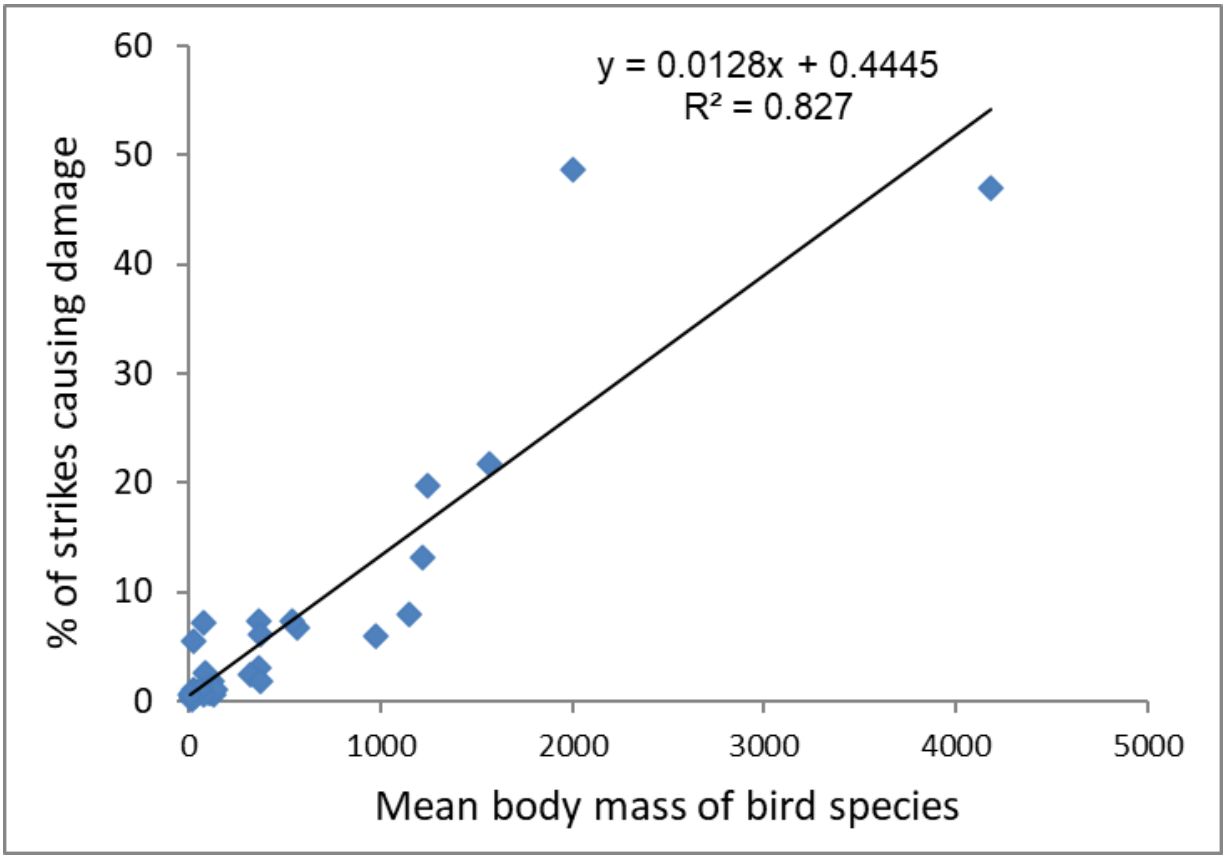



Figure 14. Relation between mean body mass (Dunning 2008) and likelihood of a strike causing damage to aircraft for the 33 species of birds most frequently identified as struck by civil aircraft in USA, 1990-2022 (Table 20). The linear regression equation explained 83 percent of the variation in the likelihood of damage among the 33 species. For every 100-gram increase in body mass, there was a 1.28 percent increase in the likelihood of damage.

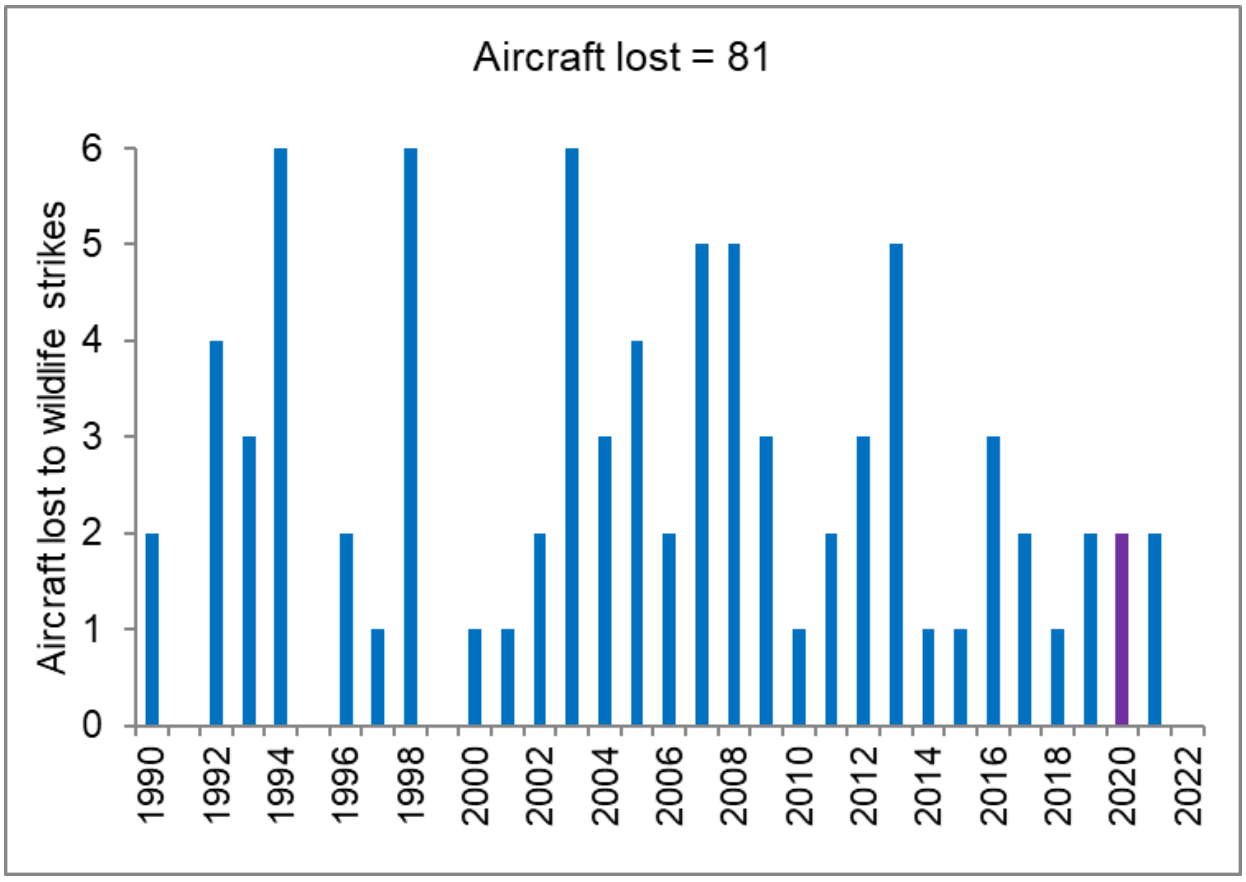



Figure 15. Number of civil aircraft destroyed or damaged beyond repair after striking wildlife, USA, 1990–2022. From 1990-2022, 81 aircraft have been lost (52 with maximum take-off mass ≤2,250 kg; 17, 2,251-5,700 kg; 10, 5,701-27,000 kg; 2, >27,000 kg). See Table 22 for wildlife species and types of aircraft and airports associated with these events. The graph includes 1 government-owned, unmanned aerial vehicle (drone) destroyed in 2020 after being attacked by a bald eagle while doing a shoreline erosion survey on Lake Michigan. No aircraft losses to wildlife were reported in 2022.

# APPENDIX A.

## SELECTED SIGNIFICANT WILDLIFE STRIKES TO U.S. CIVIL AIRCRAFT, 2022

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 2022, 276,846 strike reports from 2,062 USA airports and 330 foreign airports in 113 countries have been entered in the database (17,190 strikes from 693 USA and 91 foreign airports in 53 countries in 2022), Tables 1, 8; Figure 6). The following 15 examples from the database in 2022 are presented to show the serious impact that strikes by birds or other wildlife can have on aircraft. These examples 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, departure or en route. For more information on wildlife strikes or to report a strike, visit *www.birdstrike.org* and *http://wildlife.faa.gov*.

| Date | Aircraft | Airport/location | Phase of flight | Effect on flight | Damage | Wildlife species | Remarks from report |
|---|---|---|---|---|---|---|---|
| 1/4/2022 | Learjet-35 | Teterboro Airport (NJ) | Climb (800 feet AGL) | None | Wing, Fuselage | Unknown medium bird | Reported time out of service 3,000 hours; repair costs 100,000; other costs $100,000. |
| 2/19/2022 | B-767-300 | Metro Oakland International (CA) | Climb (100 feet AGL) | Precautionary landing | Engine #1 | Western gull | Multiple birds struck including engine ingestion, resulting in return to OAK. Remains retrieved off runway; operator maintenance removed remains from nose landing gear. Two engine blades damaged and replaced. USDA confirmed identification of birds. Time out of service 24 hours. |

Appendix A. (page 2 of 5)

| Date | Aircraft | Airport/location | Phase of flight | Effect on flight | Damage | Wildlife species | Remarks from report |
|---|---|---|---|---|---|---|---|
| 3/8/2022 | EC-135 | 10 miles from KLNK (NE) | En route | Precautionary landing | Windshield | Snow goose | Multiple points of impacts suggest more than one snow goose struck. Bird remains stuck in windscreen. |
| 4/9/22 | AW 109 | Riverton Hospital Heliport (UT) | Approach (600 feet AGL) | Precautionary landing | Windshield | Ruddy duck | Aircraft approaching Riverton Hospital to pick up patient when strike occurred. Nurse on aircraft struck in face by bird. Aircraft diverted to South Valley Regional. Reported time out of service 6 hours; repair costs $2,000; other costs $5,000. ID by Smithsonian Feather Lab. |
| 5/28/2022 | BE-35 | Laconia Municipal (NH) | Climb (200 feet AGL) | Precautionary landing | Wing, Landing gear, Tail | Canada goose | Multiple birds struck on climb. Two pilots onboard. Side window damage and a hole in wing. Reported repair costs $40,000. |
| 6/7/2022 | EC-135 | 3 miles from 4B0 (NY) | En route (800 feet AGL) | Precautionary landing | Windshield, Fuselage | Canada goose | Broken left windscreen and cockpit roof fairing was damaged. Reported time out of service 240 hours. |

Appendix A. (page 3 of 5)

| Date | Aircraft | Airport/location | Phase of flight | Effect on flight | Damage | Wildlife species | Remarks from report |
|---|---|---|---|---|---|---|---|
| 7/20/2022 | A-320 | Stewart Intl Airport (NY) | Climb | Precautionary landing, Fuel burn, high vibration | Engine #1 | Eastern meadowlark | Multiple bird strikes to engine #1 at lift off. Aircraft burned fuel and returned to airport due to high engine vibration. Damage to some N1 fan blades. ID by Smithsonian Feather Lab. |
| 7/26/2022 | A-321 | Denver International (CO) | Take-off run | Aborted take-off | Engine, landing gear | Swainson's hawk | Aircraft struck large bird on take-off run. Aircraft aborted take-off and engine # 1 suffered catastrophic damage and fire. Right main gear, outer tire was damaged by excessive heat from braking. ID by Smithsonian Feather Lab. |
| 8/9/2022 | A-300 | Salt Lake City Intl (UT) | Approach | None | Wing | Eared grebe | Areas struck include left engine with ingestion, fuselage, right wing #1 slat and right engine cowl. Reported time out of service 96 hours; repair costs $700,000. ID by Smithsonian Feather Lab. |

Appendix A. (page 4 of 5)

| Date | Aircraft | Airport/location | Phase of flight | Effect on flight | Damage | Wildlife species | Remarks from report |
|---|---|---|---|---|---|---|---|
| 8/13/2022 | B-717 | Outagamie Co. Regional (WI) | Take-off run | Precautionary landing | Landing gear | Bald eagle | Pilot reported possible bird strike at rotation on flight to ATL. During flight, crew noticed loss of hydraulic pressure and declared emergency. Landed at ATL with landing gears stuck in down position. Aircraft towed to gate where a large bird covered in hydraulic fluid was found wedged into right landing gear strut. Both landing gear doors were damaged; aircraft taken out of service. IDed by Smithsonian Feather Lab. |
| 9/3/2022 | C-182 | Kissimmee Gateway Airport (FL) | Climb (2,000 feet AGL) | Emergency landing | Windshield | Anhinga | Pilot suffered laceration to forehead requiring stitches, slight concussion and blood loss. Bird was decapitated upon entering aircraft; interior covered with blood from pilot's injuries. ID by Smithsonian Feather Lab from photos. |

Appendix A. (page 5 of 5)

| Date | Aircraft | Airport/location | Phase of flight | Effect on flight | Damage | Wildlife species | Remarks from report |
|---|---|---|---|---|---|---|---|
| 9/18/2022 | Space X Falcon 9 | Cape Canaveral Space Force Station Skid Strip Airport (FL) | Climb | None | None | Yellow-billed cuckoo | Bird feathers and snarge were observed on forward facing sections of the 1st stage booster fuselage during recover/refurbishment operations. Samples collected and sent to Smithsonian. No damage to structure observed. ID by Smithsonian Feather Lab. |
| 10/07/2022 | EC135 | Little Hope, PA | En route (800 feet AGL) | Precautionary landing | Windshield | Wood duck | Pilot's windscreen penetrated and passenger compartment sliding door push-out window jettisoned from aircraft, likely due to pressure change in aircraft. One crewmember suffered minor laceration to the face. All declined medical evaluation. ID by Smithsonian Feather Lab. |
| 12/01/2022 | BE-36 | Florence Regional Airport (SC) | Landing roll | Engine shutdown | Nose, Wing, Landing gear, Lights | White-tailed deer | Aircraft sustained damage to front landing gear and landing gear light, right wing, and right landing gear. Reported time out of service 24 hours; repair costs $2,000. |
| 12/18/2022 | Learjet-60 | Chicago Midway (IL) | Climb (1500 ft AGL) | Precautionary landing | Nose, engine | Sandhill crane | Aircraft struck a flock of birds on climb out of MDW; made precautionary landing back at MDW. Damage to nose, engine #1; bird remains found in engine #2. IDed by Smithsonian Feather Lab. |

# 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 Wildlife Strike Database (http://wildlife.faa.gov) using the electronic FAA Form 5200-7. Form 5200- 7 should be printed for each report that has remains submitted to the Smithsonian for identification.

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 National Museum of Natural History, Smithsonian Institution, has the 3rd largest bird collection in the world with over 640,000 specimens. The collection has representatives of about 80% of the 9,600 known species in the world's avifauna.

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 feathers and other remains to the Smithsonian Institution Feather Identification Lab:
:

| **Material sent via Courier Service (e.g., UPS, FedEx, DHL):** | **Material sent via U.S. Postal Service:** |
|---|---|
| Feather Identification Lab<br>Smithsonian Institution NMNH<br>E600, MRC 116<br>10th & Constitution Ave. NW<br>Washington, D.C. 20560-0116<br>(label package “safety investigation material”)<br>Phone # 202-633-0801 | Feather Identification Lab<br>Smithsonian Institution, NMNH<br>E600, MRC 116<br>P.O. Box 37012<br>Washington, D.C. 20013-7012 |

Whenever possible, send whole feathers as the diagnostic microscopic characteristics are often found in the downy barbules at the feather base. Wing feathers, as well as breast and tail feathers, should be sent whenever possible. Beaks and feet 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 intact carcass or carcass remains (e.g., wing, head), which can be uploaded to the on-line 5200-7 when filing a strike report, can be useful supplemental documentation. Photographs should include a reference marker (e.g., ruler, coin) to gauge size of the carcass or body part.

**Guidelines for Collecting Bird Strike Material**

- Always include any feather material available.
- Include the printed report (FAA 5200-7) with the QR code in the upper right corner. This is necessary for tracking samples through the lab.
- Always secure all remains in re-sealable plastic bag, collect bird remains (samples) from different impact points or each birds in separate bags

**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"):**

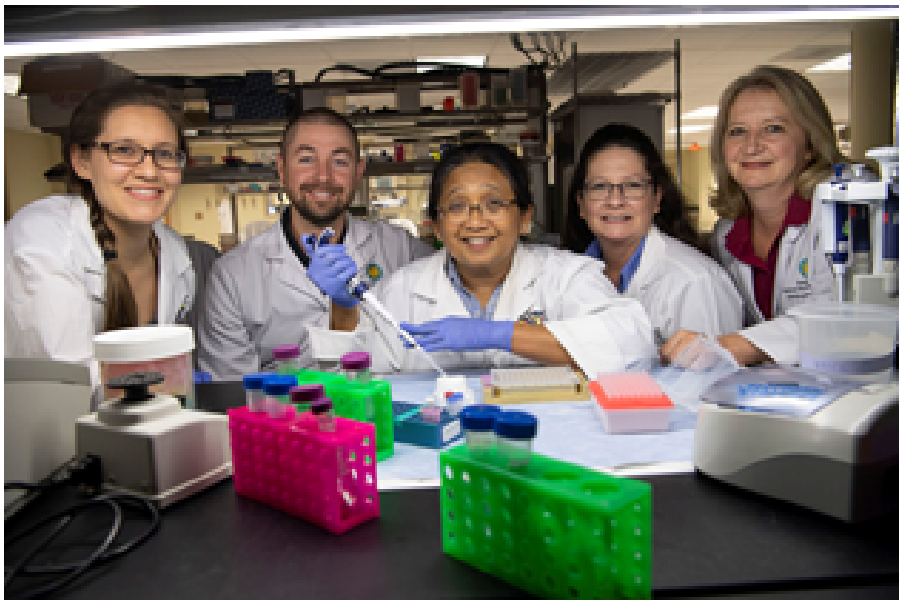
- Dry material – Scrape or wipe off into a clean re-closeable bag or wipe area with pre-packaged alcohol wipe or spray with alcohol to loosen material then wipe with clean cloth/gauze. (Do not use water, bleach, or other cleansers; they destroy DNA.)
- Fresh material – Wipe area with alcohol wipe and/or clean cloth/gauze or apply fresh tissue/blood to an FTA® DNA collecting card.

Additional information on sending bird remains to the Smithsonian is available at https://www.faa.gov/airports/airport_safety/wildlife/smithsonian/.

**Cases Processed by Feather Lab in FY 2022**

The number of bird strike cases involving civil aircraft processed by the Smithsonian Feather Identification Lab in FY 2022 was 4,579 with 5,003 separate identifications (some cases involved remains from multiple impact points). This compares to 3,412 cases with 3,760 separate identifications in FY 2021, 3,381 cases with 3,797 separate identifications in FY 2020 and 4,682 cases with 5,167 separate identifications in FY 2019 (Dove et al. 2023). In addition, the Lab processed 2,943 cases involving 3,742 identifications for the U.S. Air Force and 1,089 cases involving 1,204 identifications for the U.S. Navy in FY 2022 (not discussed in this report). DNA analysis (Dove et al. 2008, Luttrell et al. 2020) was used in 48 percent of civil aviation cases in FY 2022 to identify the species and in an

additional 17 percent to supplement or verify traditional identification methods using morphology of feathers and body parts (e.g., talons, beaks).



Scientists at the Smithsonian Feather Lab use a combination of forensic methods, including mitochondrial DNA analysis, to determine the species of birds, bats, and other wildlife involved in strikes with civil and military aircraft. Photo, J. Kegley, Smithsonian

## Appendix C.

### Scientific Names and Body Masses for Identified Wildlife Species Struck by Civil Aircraft in USA or by USA-registered Aircraft in Foreign Countries, 1990-2022.[1]

| | Common name | Scientific name | Body mass (grams) | |
|---|---|---|---|---|
| | | | Mean | Max |
| # | **Flying mammals (bats)** | | | |
| 1 | African yellow bat | Scotophilus dinganii | 25 | 25 |
| 2 | Angolan free-tailed bat | Mops condylurus | 23 | |
| 3 | Antillean fruit-eating bat | Brachyphylla cavernarum | 45 | |
| 4 | Big brown bat | Eptesicus fuscus | 14 | |
| 5 | Big free-tailed bat | Nyctinomops macrotis | 30 | |
| 6 | Black mastiff bat | Molossus rufus | 65 | 70 |
| 7 | Brazilian free-tailed bat | Tadarida brasiliensis | 15 | |
| 8 | Broad-eared bat | Nyctinomops laticaudatus | 11 | 14 |
| 9 | California myotis | Myotis californicus | 4 | 5 |
| 10 | Common pipistrelle | Pipestrellus pipistrellus | 6 | 8 |
| 11 | Eastern red bat | Lasiurus borealis | 14 | |
| 12 | Eastern small-footed myotis | Myotis leibii | 7 | |
| 13 | Egyptian free-tailed bat | Tadarida aegyptiaca | 17 | 21 |
| 14 | Evening bat | Nycticeius humeralis | 14 | |
| 15 | Florida bonneted bat | Eumops floridanus | 40 | 55 |
| 16 | Gray bat | Myotis grisescens | 12 | 16 |
| 17 | Gray sac-winged bat | Balantiopteryx plicata | 7 | |
| 18 | Hoary bat | Lasiurus cinereus | 35 | |
| 19 | Indian flying fox | Pteropus giganteus | 1100 | 1,600 |
| 20 | Indian pipistrelle | Pipistrellus coromandra | 11 | 13 |
| 21 | Indiana bat | Myotis sodalis | 6 | 10 |
| 22 | Jamaican fruit bat | Artibeus jamaicensis | 50 | 60 |
| 23 | Kelaart’s pipistrelle | Pipistrellus ceylonicus | 4 | 5 |
| 24 | Kuhl’s pipistrelle | Pipistrellus kuhlii | 6 | |
| 25 | Lesser bulldog bat | Noctilio albiventris | 30 | 44 |
| 26 | Little brown bat | Myotis lucifugus | 8 | |
| 27 | Little red flying fox | Pteropus scapulatus | 400 | |
| 28 | Long-eared myotis | Myotis evotis | 8 | |
| 29 | Long-legged myotis | Myotis volans | 8 | 10 |
| 30 | Mauritian tomb bat | Taphozous mauritianus | 36 | |
| 31 | Naked-rumped tomb bat | Taphozous nudiventris | 34 | |
| 32 | Northern yellow bat | Lasiurus intermedius | 17 | 20 |
| 33 | Pallas's mastiff bat | Molossus molossus | 13 | |
| 34 | Pocketed free-tailed bat | Nyctinomops femorosacca | 14 | |
| 35 | Seminole bat | Lasiurus seminolus | 11 | |
| 36 | Silver-haired bat | Lasionycteris noctivagans | 9 | |
| 37 | Sinaloan mastiff bat | Molossus sinaloae | 24 | 28 |
| 38 | Sooty mustached bat | Pteronotus quadridens | 5 | |
| 39 | Spotted Bat | Euderma maculatum | 18 | 20 |
| 40 | Tri-colored bat | Perimyotis subflavus | 5 | |
| 41 | Western mastiff bat | Eumops perotis | 57 | 73 |
| 42 | Western pipistrelle | Parastrellus hesperus | 5 | 6 |
| 43 | Western red bat | Lasiurus blossevillii | 13 | 15 |
| 44 | Western small-footed myotis | Myotis ciliolabrum | 5 | 7 |

Appendix C. Continued (page 2 of 16)

| | Common name | Scientific name | Body mass (grams) | |
|---|---|---|---|---|
| | | | Mean | Max |
| 45 | Western yellow bat | Lasiurus xanthinus | 12 | |
| 46 | Yuma myotis | Myotis yumanensis | 6 | 7 |
| | **Terrestrial mammals** | | | |
| 1 | American badger | Taxidea taxus | 12,000 | |
| 2 | American black bear | Ursus americanus | 135,000 | 200,000 |
| 3 | American mink | Mustela vison | 1,000 | 1,300 |
| 4 | American red squirrel | Tamiasciurus hudonsonicus | 300 | 400 |
| 5 | Antelope jackrabbit | Lepus alleni | 4,000 | 5,900 |
| 6 | Axis deer | Axis axis | 90,000 | 110,000 |
| 7 | Bearded seal | Erignathus barbatus | 315,000 | 430,000 |
| 8 | Black-tailed jackrabbit | Lepus californicus | 2,268 | |
| 9 | Black-tailed prairie dog | Cynomys ludovicianus | 1,050 | 1,400 |
| 10 | Brown bear | Ursus arctos | 217,000 | 400,000 |
| 11 | California ground squirrel | Otospermophilus beecheyi | 500 | 750 |
| 12 | Caribou | Rangifer arcticus | 119,297 | |
| 13 | Cattle | Bos taurus | 753,430 | |
| 14 | Collared peccary | Pecari tajacu | 20,412 | |
| 15 | Common gray fox | Urocyon cinereoargenteus | 4,536 | |
| 16 | Coyote | Canis latrans | 15,876 | |
| 17 | Coypu (nutria) | Myocaster coypus | 6,000 | 17,000 |
| 18 | Desert cottontail | Sylvilagus audubonii | 1,247 | |
| 19 | Domestic cat | Felis catus | 4,309 | |
| 20 | Domestic dog | Canis familiaris | 34,927 | |
| 21 | Domestic sheep | Ovis aries | 100,000 | 160,000 |
| 22 | Eastern cottontail | Sylvilagus floridanus | 1,361 | |
| 23 | Eastern gray squirrel | Sciurus carolinensis | 500 | 600 |
| 24 | Fox squirrel | Sciurus niger | 800 | 1,000 |
| 25 | Gunnison's prairie dog | Cynomys gunnisoni | 816 | 1,350 |
| 26 | Horse | Equus caballus | 1,147,608 | |
| 27 | Kit fox | Vulpes macrotis | 2,000 | 2,700 |
| 28 | Least weasel | Mustela nivalis | 100 | 250 |
| 29 | Long-tailed weasel | Mustela frenata | 260 | 300 |
| 30 | Mink | Mustela vison | 1,000 | 1,300 |
| 31 | Moose | Alces alces | 389,189 | |
| 32 | Mule deer | Odocoileus hemionus | 92,000 | |
| 33 | Muskrat | Ondatr zibethicus | 1,361 | |
| 34 | Nine-banded armadillo | Dasypus novemcinctus | 5,670 | |
| 35 | North American beaver | Castor canadensis | 20,000 | |
| 36 | North American porcupine | Erethizon dorsatum | 8,618 | |
| 37 | Piute ground squirrel | Urocitellus mollis | 500 | |
| 38 | Pronghorn | Antilocapra americana | 46,721 | |
| 39 | Raccoon | Procyon lotor | 10,660 | |
| 40 | Red fox | Vulpes fulva | 5,670 | |
| 41 | Richardson's ground squirrel | Urocitellus richardsonii | 500 | 750 |
| 42 | River otter | Lutra canadensis | 7,938 | |
| 43 | Small Indian mongoose | Herpestes javanicus | 650 | |
| 44 | Snowshoe hare | Lepus americanus | 1,300 | 1,800 |
| 45 | Striped skunk | Mephitis mephitis | 4,536 | |
| 46 | Swine (pigs) | Sus scrofa | 199,584 | |

Appendix C. Continued (page 3 of 16)

| | Common name | Scientific name | Body mass (grams) | |
|---|---|---|---|---|
| | | | Mean | Max |
| 47 | Thirteen-lined ground squirrel | Ictidomys tridecemlineatus | 500 | 700 |
| 48 | Virginia opossum | Didelphus virginianus | 4,990 | |
| 49 | Wapiti (elk) | Cervis elaphus | 317,520 | |
| 50 | White-nosed coati | Nasua narica | 9,072 | |
| 51 | White-tailed deer | Odocoileus virginianus | 88,000 | |
| 52 | White-tailed jackrabbit | Lepus townsendii | 3,402 | |
| 53 | White-tailed prairie dog | Cynomys leucurus | 1,000 | 1,136 |
| 54 | Woodchuck | Marmota monax | 3,402 | |
| 55 | Yellow-bellied marmot | Marmota flaviventris | 5,000 | |
| | **Reptiles** | | | |
| 1 | Alligator snapping turtle | Macrochelys temminckii | 75,000 | 100,000 |
| 2 | American alligator | Alligator mississippie | 136,080 | |
| 3 | Black rat snake | Pantherophis obsoletus | 1,000 | 2,500 |
| 4 | California kingsnake | Lampropeltis getula | 1,000 | 1,500 |
| 5 | Chicken turtle | Deirochelys reticularia | 800 | |
| 6 | Coastal plain cooter | Pseudemys floridana | 3,000 | 3,500 |
| 7 | Common box turtle | Terrapene carolina | 350 | |
| 8 | Common kingsnake | Lampropeltis getula | 1,000 | 1,500 |
| 9 | Common snapping turtle | Chelydra serpentina | 9,979 | |
| 10 | Corn snake | Pantherophis guttatus | 900 | |
| 11 | Diamondback terrapin | Malaclemys terrapin | 455 | |
| 12 | Diamondback water snake | Nerodia rhombifer | 400 | 600 |
| 13 | E. diamondback rattlesnake | Crotalus adamanteus | 2,300 | 4,900 |
| 14 | Eastern hognose snake | Heterodon platirhinos | 100 | 120 |
| 15 | Eastern mud turtle | Kinosternon subrubrum | 207 | 291 |
| 16 | Eastern pine snake | Pituophis melanoleucus | 1,000 | |
| 17 | Florida red-bellied cooter | Pseudemys nelsoni | 4,000 | |
| 18 | Florida softshell turtle | Apalone ferox | 6,650 | 43,000 |
| 19 | Gopher snake | Pituophis catenifer | 2,300 | 4,500 |
| 20 | Gopher tortoise | Gopherus polyphemus | 4,000 | 4,500 |
| 21 | Green iguana | Iguana iguana | 5,000 | |
| 22 | Northern water snake | Nerodia sipedon | 1,361 | 1,814 |
| 23 | Ornate box turtle | Terrapene ornata | 310 | 431 |
| 24 | Painted turtle | Chrysemys picta | 350 | |
| 25 | Plains garter snake | Thamnophis radix | 300 | 400 |
| 26 | Pond slider | Trachemys scripta | 1,000 | |
| 27 | Prairie rattlesnake | Crotalus viridis | 1,000 | |
| 28 | River cooter | Pseudemys concinna | 2,000 | 5,000 |
| 29 | Spectacled caiman | Caiman crocodilus | 20,000 | 40,000 |
| 30 | Spiny softshell turtle | Apalone spinifera | 4,000 | 10,000 |
| 31 | Striped mud turtle | Kinosternon baurii | 203 | |
| 32 | Water moccasin | Agkistrodon piscivorus | 580 | 4,600 |
| 33 | W. diamondback rattlesnake | Crotalus atrox | 1,500 | 6,700 |
| 34 | Western hognose snake | Heterodon nasicus | 350 | 500 |
| | **Birds** | | | |
| 1 | Acadian flycatcher | Empidonax virescens | 13 | 14 |
| 2 | African collared dove | Streptopelia roseogrisea | 155 | 172 |
| 3 | African silverbill | Euodice cantans | 12 | 14 |

Appendix C. Continued (page 4 of 16)

| | Common name | Scientific name | Body mass (grams) | |
|---|---|---|---|---|
| | | | Mean | Max |
| 4 | Alder flycatcher | Empidonax alnorum | 13 | 15 |
| 5 | Allen's hummingbird | Selasphorus sasin | 3 | 4 |
| 6 | Alpine swift | Tachymarptis melba | 104 | 120 |
| 7 | American avocet | Recurvirostra americana | 307 | 382 |
| 8 | American bittern | Botaurus lentiginosus | 706 | 1,072 |
| 9 | American black duck | Anas rubripes | 1,400 | 1,800 |
| 10 | American coot | Fulica americana | 724 | 848 |
| 11 | American crow | Corvus brachyrhynchos | 538 | |
| 12 | American golden-plover | Pluvialis dominica | 154 | 166 |
| 13 | American goldfinch | Spinus tristis | 13 | 17 |
| 14 | American kestrel | Falco sparverius | 132 | |
| 15 | American oystercatcher | Haematopus palliatus | 638 | 720 |
| 16 | American pipit | Anthus rubescens | 22 | 26 |
| 17 | American redstart | Setophaga ruticilla | 8 | 10 |
| 18 | American robin | Turdus migratorius | 79 | 112 |
| 19 | American tree sparrow | Spizelloides arborea | 19 | 28 |
| 20 | American white pelican | Pelecanus erythrorhynchos | 6,329 | 8,000 |
| 21 | American wigeon | Mareca americana | 792 | 1,036 |
| 22 | American woodcock | Scolopax minor | 219 | 278 |
| 23 | Anhinga | Anhinga anhinga | 1,235 | |
| 24 | Anna's hummingbird | Calypte anna | 5 | 6 |
| 25 | Antillean nighthawk | Chordeiles gundlachii | 50 | |
| 26 | Antillean palm swift | Tachornis phoenicobia | 10 | 11 |
| 27 | Arctic tern | Sterna paradisaea | 110 | 127 |
| 28 | Ash-throated flycatcher | Myiarchus cinerascens | 28 | 38 |
| 29 | Australian pelican | Pelecanus conspicillatus | 5,505 | 6,800 |
| 30 | Baird's sandpiper | Calidris bairdii | 44 | |
| 31 | Baird's sparrow | Centronyx bairdii | 18 | 20 |
| 32 | Bald eagle | Haliaeetus leucocephalus | 5,350 | 6,400 |
| 33 | Baltimore oriole | Icterus galbula | 34 | 39 |
| 34 | Band-rumped storm-petrel | Hydrobates castro | 45 | 54 |
| 35 | Band-tailed pigeon | Patagioenas fasciata | 398 | 515 |
| 36 | Bank swallow | Riparia riparia | 14 | 19 |
| 37 | Bare-eyed pigeon | Patagioenas corensis | 273 | 283 |
| 38 | Barn owl | Tyto alba | 370 | |
| 39 | Barn swallow | Hirundo rustica | 19 | |
| 40 | Barred owl | Strix varia | 801 | 1,051 |
| 41 | Barrow's goldeneye | Bucephala islandica | 1,130 | 1,314 |
| 42 | Bar-tailed godwit | Limosa lapponica | 332 | 400 |
| 43 | Bay-breasted warbler | Setophaga castanea | 12 | 14 |
| 44 | Bell's sparrow | Artemisiospiza belli | 15 | 17 |
| 45 | Bell's vireo | Vireo bellii | 9 | 10 |
| 46 | Belted kingfisher | Megaceryle alcyon | 148 | 215 |
| 47 | Bewick's wren | Thryomanes bewickii | 10 | 12 |
| 48 | Bicknell's thrush | Catharus bicknelli | 28 | 37 |
| 49 | Black drongo | Dicrurus macrocercus | 48 | 59 |
| 50 | Black francolin | Francolinus francolinus | 482 | 566 |
| 51 | Black kite | Milvus migrans | 870 | 920 |

Appendix C. Continued (page 5 of 16)

| | Common name | Scientific name | Body mass (grams) | |
|---|---|---|---|---|
| | | | Mean | Max |
| 52 | Black noddy | Anous minutus | 116 | 130 |
| 53 | Black phoebe | Sayornis nigricans | 20 | 22 |
| 54 | Black redstart | Phoenicurus ochruros | 17 | 20 |
| 55 | Black skimmer | Rynchops niger | 349 | 392 |
| 56 | Black swift | Cypseloides niger | 46 | 53 |
| 57 | Black tern | Chlidonias niger | 65 | 74 |
| 58 | Black turnstone | Arenaria melanocephala | 135 | 169 |
| 59 | Black vulture | Coragyps atratus | 2,159 | |
| 60 | Black-and-white warbler | Mniotilta varia | 11 | 13 |
| 61 | Black-bellied plover | Pluvialis squatarola | 250 | 283 |
| 62 | Black-bellied whistling-duck | Dendrocygna autumnalis | 796 | 950 |
| 63 | Black-billed cuckoo | Coccyzus erythropthalmus | 51 | 65 |
| 64 | Black-billed magpie | Pica hudsonia | 189 | 209 |
| 65 | Blackburnian warbler | Setophaga fusca | 10 | |
| 66 | Black-capped chickadee | Poecile atricapillus | 11 | 13 |
| 67 | Black-chinned hummingbird | Archilochus alexandri | 4 | 5 |
| 68 | Black-crowned night-heron | Nycticorax nycticorax | 810 | 1,014 |
| 69 | Black-crowned sparrow lark | Eremopterix nigriceps | 14 | 16 |
| 70 | Black-faced bunting | Emberiza spodocephala | 20 | 24 |
| 71 | Black-footed albatross | Phoebastria nigripes | 3,400 | 4,300 |
| 72 | Black-headed grosbeak | Pheucticus melanocephalus | 48 | |
| 73 | Black-headed gull | Chroicocephalus ridibundus | 284 | 327 |
| 74 | Black-legged kittiwake | Rissa tridactyla | 421 | 525 |
| 75 | Black-necked stilt | Himantopus mexicanus | 170 | 202 |
| 76 | Blackpoll warbler | Setophaga striata | 12 | 13 |
| 77 | Black-throated blue warbler | Setophaga caerulescens | 11 | 12 |
| 78 | Black-throated gray warbler | Setophaga nigrescens | 9 | 10 |
| 79 | Black-throated green warbler | Setophaga virens | 9 | 10 |
| 80 | Black-throated sparrow | Amphispiza bilineata | 14 | 16 |
| 81 | Blue grosbeak | Passerina caerulea | 28 | 41 |
| 82 | Blue jay | Cyanocitta cristata | 88 | 101 |
| 83 | Blue-and-white swallow | Pygochelidon cyanoleuca | 10 | 11 |
| 84 | Blue-black grassquit | Volatinia jacarina | 10 | 12 |
| 85 | Blue-gray gnatcatcher | Polioptila caerulea | 6 | 7 |
| 86 | Blue-headed vireo | Vireo solitarius | 15 | 17 |
| 87 | Blue-winged teal | Spatula discors | 380 | |
| 88 | Blue-winged warbler | Vermivora cyanoptera | 9 | 10 |
| 89 | Boat-tailed grackle | Quiscalus major | 206 | 239 |
| 90 | Bobolink | Dolichonyx oryzivorus | 34 | |
| 91 | Bohemian waxwing | Bombycilla garrulus | 56 | 69 |
| 92 | Bonaparte's gull | Chroicocephalus philadelphia | 222 | |
| 93 | Bonin petrel | Pterodroma hypoleuca | 176 | 220 |
| 94 | Brandt's cormorant | Phalacrocorax penicillatus | 2,570 | 2,682 |
| 95 | Brant | Branta bernicla | 1,370 | 1,790 |
| 96 | Brewer's blackbird | Euphagus cyanocephalus | 67 | 73 |
| 97 | Brewer's sparrow | Spizella breweri | 11 | |
| 98 | Broad-tailed hummingbird | Selasphorus platycercus | 4 | |
| 99 | Broad-winged hawk | Buteo platypterus | 490 | |
| 100 | Brown booby | Sula leucogaster | 1,360 | |

Appendix C. Continued (page 6 of 16)

| | Common name | Scientific name | Body mass (grams) | |
|---|---|---|---|---|
| | | | Mean | Max |
| 101 | Brown creeper | Certhia americana | 8 | 10 |
| 102 | Brown noddy | Anous stolidus | 189 | 232 |
| 103 | Brown pelican | Pelecanus occidentalis | 3,702 | |
| 104 | Brown thrasher | Toxostoma rufum | 69 | 89 |
| 105 | Brown-crested flycatcher | Myiarchus tyrannulus | 44 | 54 |
| 106 | Brown-headed cowbird | Molothrus ater | 49 | 57 |
| 107 | Brown-throated parakeet | Eupsittula pertinax | 84 | 102 |
| 108 | Budgerigar | Melopsittacus undulatus | 29 | |
| 109 | Buff-breasted sandpiper | Calidris subruficollis | 69 | 78 |
| 110 | Bufflehead | Bucephala albeola | 473 | 551 |
| 111 | Bullock's oriole | Icterus bullockii | 38 | 43 |
| 112 | Burrowing owl | Athene cunicularia | 156 | |
| 113 | Bushtit | Psaltriparus minimus | 5 | 6 |
| 114 | Cackling goose | Branta hutchinsii | 2,180 | |
| 115 | Cactus wren | Campylorhynchus brunneicapillus | 39 | 47 |
| 116 | California gull | Larus californicus | 841 | 1,045 |
| 117 | California quail | Callipepla californica | 186 | 230 |
| 118 | California towhee | Melozone crissalis | 54 | 61 |
| 119 | Calliope hummingbird | Selasphorus calliope | 3 | 3 |
| 120 | Canada goose | Branta canadensis | 4,181 | 4,727 |
| 121 | Canada jay | Perisoreus canadensis | 76 | 82 |
| 122 | Canada warbler | Cardellina canadensis | 10 | 12 |
| 123 | Canvasback | Aythya valisineria | 1,252 | 1,600 |
| 124 | Cape May warbler | Setophaga tigrina | 10 | 13 |
| 125 | Carolina chickadee | Poecile carolinensis | 10 | |
| 126 | Carolina wren | Thryothorus ludovicianus | 21 | 27 |
| 127 | Carrion crow | Corvus corone | 570 | |
| 128 | Caspian tern | Hydroprogne caspia | 655 | 782 |
| 129 | Cassin's finch | Haemorhous cassinii | 27 | 38 |
| 130 | Cassin's sparrow | Peucaea cassinii | 19 | 24 |
| 131 | Cassin's vireo | Vireo cassinii | 15 | 21 |
| 132 | Cattle egret | Bubulcus ibis | 372 | 512 |
| 133 | Cave swallow | Petrochelidon fulva | 24 | |
| 134 | Cedar waxwing | Bombycilla cedrorum | 33 | 40 |
| 135 | Cerulean warbler | Setophaga cerulea | 9 | 10 |
| 136 | Chestnut munia | Lonchura atricapilla | 13 | 14 |
| 137 | Chestnut-collared longspur | Calcarius ornatus | 20 | 22 |
| 138 | Chestnut-sided warbler | Setophaga pensylvanica | 10 | 11 |
| 139 | Chimney swift | Chaetura pelagica | 24 | 30 |
| 140 | Chipping sparrow | Spizella passerina | 12 | 15 |
| 141 | Chuck-will's-widow | Antrostomus carolinensis | 109 | 188 |
| 142 | Chukar | Alectoris chukar | 541 | 580 |
| 143 | Cinnamon teal | Spatula cyanoptera | 383 | 470 |
| 144 | Clapper rail | Rallus crepitans | 290 | 314 |
| 145 | Clark's grebe | Aechmophorus clarkii | 1,341 | 1,685 |
| 146 | Clay-colored sparrow | Spizella pallida | 11 | 15 |
| 147 | Cliff swallow | Petrochelidon pyrrhonota | 22 | 27 |
| 148 | Common chaffinch | Fringilla coelebs | 22 | 29 |
| 149 | Common cuckoo | Cuculus canorus | 117 | |

Appendix C. Continued (page 7 of 16)

| | Common name | Scientific name | Body mass (grams) | |
|---|---|---|---|---|
| | | | Mean | Max |
| 150 | Common eider | Somateria mollissima | 2,218 | 2,895 |
| 151 | Common gallinule | Gallinula galeata | 339 | 493 |
| 152 | Common goldeneye | Bucephala clangula | 1,120 | 1,329 |
| 153 | Common grackle | Quiscalus quiscula | 120 | 142 |
| 154 | Common ground dove | Columbina passerina | 37 | |
| 155 | Common house-martin | Delichon urbicum | 15 | 20 |
| 156 | Common loon | Gavia immer | 5,460 | 6,130 |
| 157 | Common merganser | Mergus merganser | 1,709 | 2,054 |
| 158 | Common murre | Uria aalge | 1,066 | 1,202 |
| 159 | Common myna | Acridotheres tristis | 127 | 140 |
| 160 | Common nighthawk | Chordeiles minor | 79 | |
| 161 | Common pauraque | Nyctidromus albicollis | 53 | |
| 162 | Common poorwill | Phalaenoptilus nuttallii | 50 | |
| 163 | Common raven | Corvus corax | 1,097 | |
| 164 | Common redpoll | Acanthis flammea | 13 | 15 |
| 165 | Common ringed plover | Charadrius hiaticula | 65 | 75 |
| 166 | Common snipe | Gallinago gallinago | 113 | 153 |
| 167 | Common swift | Apus apus | 38 | 43 |
| 168 | Common tern | Sterna hirundo | 120 | 145 |
| 169 | Common waxbill | Estrilda astrild | 9 | 11 |
| 170 | Common wood-pigeon | Columba palumbus | 490 | 614 |
| 171 | Common yellowthroat | Geothlypis trichas | 10 | 12 |
| 172 | Connecticut warbler | Oporornis agilis | 13 | 16 |
| 173 | Cooper's hawk | Accipiter cooperii | 529 | 588 |
| 174 | Cordilleran flycatcher | Empidonax occidentalis | 12 | 15 |
| 175 | Corn crake | Crex crex | 169 | 202 |
| 176 | Costa’s hummingbird | Calypte costae | 3 | 5 |
| 177 | Couch's kingbird | Tyrannus couchii | 39 | |
| 178 | Crested caracara | Caracara cheriway | 1,220 | 1,355 |
| 179 | Curve-billed thrasher | Toxostoma curvirostre | 81 | 94 |
| 180 | Dark-billed cuckoo | Coccyzus melacoryphus | 54 | 67 |
| 181 | Dark-eyed junco | Junco hyemalis | 19 | 24 |
| 182 | Dickcissel | Spiza americana | 28 | |
| 183 | Double-crested cormorant | Nannopterum auritum | 2,089 | |
| 184 | Double-striped thick-knee | Burhinus bistriatus | 787 | |
| 185 | Downy woodpecker | Dryobates pubescens | 28 | 29 |
| 186 | Dunlin | Calidris alpina | 60 | |
| 187 | Dusky flycatcher | Empidonax oberholseri | 10 | 11 |
| 188 | Eared dove | Zenaida auriculata | 136 | 155 |
| 189 | Eared grebe | Podiceps nigricollis | 422 | 521 |
| 190 | Eastern bluebird | Sialia sialis | 28 | 38 |
| 191 | Eastern kingbird | Tyrannus tyrannus | 43 | 55 |
| 192 | Eastern meadowlark | Sturnella magna | 112 | 131 |
| 193 | Eastern phoebe | Sayornis phoebe | 20 | 23 |
| 194 | Eastern screech-owl | Megascops asio | 194 | 235 |
| 195 | Eastern towhee | Pipilo erythrophthalmus | 41 | 47 |
| 196 | Eastern whip-poor-will | Antrostomus vociferus | 57 | |
| 197 | Eastern wood-pewee | Contopus virens | 14 | 15 |
| 198 | Egyptian goose | Alopochen aegyptiaca | 1,873 | 2,100 |

Appendix C. Continued (page 8 of 16)

| | Common name | Scientific name | Body mass (grams) | |
|---|---|---|---|---|
| | | | Mean | Max |
| 199 | Elegant tern | Thalasseus elegans | 260 | 325 |
| 200 | Emperor goose | Anser canagicus | 2,370 | |
| 201 | Eurasian buzzard | Buteo buteo | 969 | 1,364 |
| 202 | Eurasian collared dove | Streptopelia decaocto | 152 | 184 |
| 203 | Eurasian coot | Fulica atra | 902 | 1,200 |
| 204 | Eurasian curlew | Numenius arquata | 869 | 1,050 |
| 205 | Eurasian kestrel | Falco tinnunculus | 201 | 260 |
| 206 | Eurasian moorhen | Gallinula chloropus | 415 | 493 |
| 207 | Eurasian siskin | Spinus spinus | 14 | 19 |
| 208 | Eurasian skylark | Alauda arvensis | 43 | 51 |
| 209 | Eurasian sparrowhawk | Accipiter nisus | 325 | |
| 210 | Eurasian wigeon | Mareca penelope | 819 | 1,073 |
| 211 | European golden-plover | Pluvialis apricaria | 214 | 260 |
| 212 | European goldfinch | Carduelis carduelis | 16 | 20 |
| 213 | European starling | Sturnus vulgaris | 88 | 100 |
| 214 | Evening grosbeak | Coccothraustes vespertinus | 60 | 72 |
| 215 | Ferruginous hawk | Buteo regalis | 1,776 | 2,047 |
| 216 | Field sparrow | Spizella pusilla | 13 | 15 |
| 217 | Fish crow | Corvus ossifragus | 300 | 332 |
| 218 | Flammulated owl | Psiloscops flammeolus | 66 | 96 |
| 219 | Fork-tailed storm-petrel | Hydrobates furcatus | 54 | 68 |
| 220 | Forster's tern | Sterna forsteri | 149 | 173 |
| 221 | Fox sparrow | Passerella iliaca | 35 | 39 |
| 222 | Franklin's gull | Leucophaeus pipixcan | 280 | 335 |
| 223 | Gadwall | Mareca strepera | 968 | 1,250 |
| 224 | Gambel's quail | Callipepla gambelii | 170 | 207 |
| 225 | Garden warbler | Sylvia borin | 18 | 25 |
| 226 | Glaucous gull | Larus hyperboreus | 1,855 | 2,060 |
| 227 | Glaucous-winged gull | Larus glaucescens | 1,180 | |
| 228 | Glossy ibis | Plegadis falcinellus | 663 | 768 |
| 229 | Golden eagle | Aquila chrysaetos | 4,627 | 5,280 |
| 230 | Golden-crowned kinglet | Regulus satrapa | 6 | 8 |
| 231 | Golden-crowned sparrow | Zonotrichia atricapilla | 32 | |
| 232 | Golden-fronted woodpecker | Melanerpes aurifrons | 85 | 99 |
| 233 | Golden-winged warbler | Vermivora chrysoptera | 10 | 11 |
| 234 | Grasshopper sparrow | Ammodramus savannarum | 18 | |
| 235 | Gray catbird | Dumetella carolinensis | 35 | 44 |
| 236 | Gray flycatcher | Empidonax wrightii | 12 | 14 |
| 237 | Gray francolin | Francolinus pondicerianus | 274 | |
| 238 | Gray heron | Ardea cinerea | 1,443 | 2,073 |
| 239 | Gray kingbird | Tyrannus dominicensis | 47 | 69 |
| 240 | Gray partridge | Perdix perdix | 418 | 483 |
| 241 | Gray vireo | Vireo vicinior | 13 | 15 |
| 242 | Gray-breasted martin | Progne chalybea | 43 | 48 |
| 243 | Gray-cheeked thrush | Catharus minimus | 33 | 45 |
| 244 | Gray-crowned rosy-finch | Leucosticte tephrocotis | 25 | |
| 245 | Gray-headed chickadee | Poecile cinctus | 11 | 13 |
| 246 | Gray-tailed tattler | Tringa brevipes | 127 | 160 |
| 247 | Great black-backed gull | Larus marinus | 1,829 | 2,272 |

Appendix C. Continued (page 9 of 16)

| | Common name | Scientific name | Body mass (grams) | |
|---|---|---|---|---|
| | | | Mean | Max |
| 248 | Great blue heron | Ardea herodias | 2,480 | |
| 249 | Great cormorant | Phalacrocorax carbo | 3,240 | |
| 250 | Great crested flycatcher | Myiarchus crinitus | 32 | 40 |
| 251 | Great crested grebe | Podiceps cristatus | 738 | 813 |
| 252 | Great egret | Ardea alba | 935 | |
| 253 | Great frigatebird | Fregata minor | 1,662 | |
| 254 | Great gray owl | Strix nebulosa | 1,267 | 1,700 |
| 255 | Great horned owl | Bubo virginianus | 1,555 | 2,046 |
| 256 | Great kiskadee | Pitangus sulphuratus | 74 | |
| 257 | Greater Antillean grackle | Quiscalus niger | 94 | 100 |
| 258 | Greater prairie chicken | Tympanuchus cupido | 933 | 1,200 |
| 259 | Greater roadrunner | Geococcyx californianus | 376 | 538 |
| 260 | Greater sage-grouse | Centrocercus urophasianus | 3,190 | |
| 261 | Greater scaup | Aythya marila | 1,054 | 1,316 |
| 262 | Greater spotted eagle | Clanga clanga | 2,678 | |
| 263 | Greater white-fronted goose | Anser albifrons | 3,000 | |
| 264 | Greater yellowlegs | Tringa melanoleuca | 153 | |
| 265 | Great-tailed grackle | Quiscalus mexicanus | 222 | 253 |
| 266 | Green heron | Butorides virescens | 212 | |
| 267 | Greenish warbler | Phylloscopus trochiloides | 9 | 11 |
| 268 | Green-tailed towhee | Pipilo chlorurus | 30 | 37 |
| 269 | Green-winged teal | Anas crecca | 364 | 454 |
| 270 | Gull-billed tern | Gelochelidon nilotica | 170 | 184 |
| 271 | Gyrfalcon | Falco rusticolus | 1,752 | 2,000 |
| 272 | Hairy woodpecker | Dryobates villosus | 79 | |
| 273 | Hammond's flycatcher | Empidonax hammondii | 11 | 13 |
| 274 | Harlequin duck | Histrionicus histrionicus | 610 | 680 |
| 275 | Harris's hawk | Parabuteo unicinctus | 1,047 | 1,203 |
| 276 | Harris's sparrow | Zonotrichia querula | 37 | |
| 277 | Hawaiian duck | Anas wyvilliana | 644 | |
| 278 | Hawaiian goose | Branta sandvicensis | 2,165 | 3,050 |
| 279 | Hawaiian hawk | Buteo solitarius | 606 | |
| 280 | Hawaiian petrel | Pterodroma sandwichensis | 434 | 500 |
| 281 | Heermann's gull | Larus heermanni | 500 | 643 |
| 282 | Helmeted guineafowl | Numida meleagris | 1,350 | |
| 283 | Hermit thrush | Catharus guttatus | 30 | 36 |
| 284 | Hermit warbler | Setophaga occidentalis | 10 | 13 |
| 285 | Herring gull | Larus argentatus | 1,147 | 1,775 |
| 286 | Hoary redpoll | Acanthis hornemanni | 13 | 16 |
| 287 | Hooded crow | Corvus cornix | 570 | |
| 288 | Hooded merganser | Lophodytes cucullatus | 680 | 879 |
| 289 | Hooded oriole | Icterus cucullatus | 24 | 33 |
| 290 | Hooded warbler | Setophaga citrina | 11 | 13 |
| 291 | Horned grebe | Podiceps auritus | 453 | 528 |
| 292 | Horned lark | Eremophila alpestris | 32 | |
| 293 | Horned puffin | Fratercula corniculata | 556 | |
| 294 | House finch | Haemorhous mexicanus | 21 | 26 |
| 295 | House sparrow | Passer domesticus | 28 | 35 |
| 296 | House wren | Troglodytes aedon | 11 | 13 |

Appendix C. Continued (page 10 of 16)

| | Common name | Scientific name | Body mass (grams) | |
|---|---|---|---|---|
| | | | Mean | Max |
| 297 | Hudsonian godwit | Limosa haemastica | 289 | |
| 298 | Hume's short-toed lark | Calandrella acutirostris | 21 | 23 |
| 299 | Iceland gull | Larus glaucoides | 1,021 | 1,100 |
| 300 | Inca dove | Columbina inca | 48 | 57 |
| 301 | Indigo bunting | Passerina cyanea | 15 | 19 |
| 302 | Intermediate egret | Ardea intermedia | 516 | 562 |
| 303 | Island canary | Serinus canaria | 24 | 30 |
| 304 | Japanese white-eye | Zosterops japonicus | 11 | |
| 305 | Java sparrow | Lonchura oryzivora | 25 | 28 |
| 306 | Kentish plover | Charadrius alexandrinus | 42 | 58 |
| 307 | Kentucky warbler | Geothlypis formosa | 14 | 17 |
| 308 | Killdeer | Charadrius vociferus | 101 | 121 |
| 309 | King rail | Rallus elegans | 415 | |
| 310 | Kirtland's warbler | Setophaga kirtlandii | 14 | 16 |
| 311 | Ladder-backed woodpecker | Dryobates scalaris | 34 | 41 |
| 312 | Lanceolated warbler | Locustella lanceolata | 11 | 11 |
| 313 | Lapland longspur | Calcarius lapponicus | 28 | 35 |
| 314 | Lappet-faced vulture | Torgos tracheliotus | 6,969 | 8,500 |
| 315 | Lark bunting | Calamospiza melanocorys | 38 | 52 |
| 316 | Lark sparrow | Chondestes grammacus | 29 | 33 |
| 317 | Laughing gull | Leucophaeus atricilla | 327 | 371 |
| 318 | Lawrence's goldfinch | Spinus lawrencei | 11 | 14 |
| 319 | Lawrence's warbler | Vermivora chrysoptera X cyanoptera | 10 | 11 |
| 320 | Laysan albatross | Phoebastria immutabilis | 3,310 | 4,100 |
| 321 | Lazuli bunting | Passerina amoena | 16 | 20 |
| 322 | Least bittern | Ixobrychus exilis | 86 | |
| 323 | Least flycatcher | Empidonax minimus | 10 | 12 |
| 324 | Least sandpiper | Calidris minutilla | 24 | 26 |
| 325 | Least tern | Sternula antillarum | 49 | 62 |
| 326 | LeConte's sparrow | Ammospiza leconteii | 13 | 16 |
| 327 | Lesser black-backed gull | Larus fuscus | 880 | 1,000 |
| 328 | Lesser goldfinch | Spinus psaltria | 10 | 12 |
| 329 | Lesser nighthawk | Chordeiles acutipennis | 50 | 64 |
| 330 | Lesser sand-plover | Charadrius mongolus | 64 | 71 |
| 331 | Lesser scaup | Aythya affinis | 850 | 1,050 |
| 332 | Lesser whitethroat | Curruca curruca | 12 | 18 |
| 333 | Lesser yellowlegs | Tringa flavipes | 78 | 96 |
| 334 | Lilac-crowned parrot | Amazona finschi | 302 | 312 |
| 335 | Limpkin | Aramus guarauna | 1,080 | 1,270 |
| 336 | Lincoln's sparrow | Melospiza lincolnii | 17 | 19 |
| 337 | Little blue heron | Egretta caerulea | 364 | |
| 338 | Little owl | Athene noctua | 164 | 193 |
| 339 | Little swift | Apus affinis | 25 | 30 |
| 340 | Little tern | Sternula albifrons | 57 | 63 |
| 341 | Loggerhead kingbird | Tyrannus caudifasciatus | 44 | 52 |
| 342 | Loggerhead shrike | Lanius ludovicianus | 48 | 59 |
| 343 | Long-billed curlew | Numenius americanus | 642 | 689 |
| 344 | Long-billed dowitcher | Limnodromus scolopaceus | 109 | 119 |
| 345 | Long-billed thrasher | Toxostoma longirostre | 68 | |

Appendix C. Continued (page 11 of 16)

| | Common name | Scientific name | Body mass (grams) | |
|---|---|---|---|---|
| | | | Mean | Max |
| 346 | Long-eared owl | Asio otus | 337 | 409 |
| 347 | Long-tailed duck | Clangula hyemalis | 932 | |
| 348 | Long-tailed jaeger | Stercorarius longicaudus | 307 | 444 |
| 349 | Louisiana waterthrush | Parkesia motacilla | 20 | 23 |
| 350 | MacGillivray's warbler | Geothlypis tolmiei | 10 | 13 |
| 351 | Magnificent frigatebird | Fregata magnificens | 1,704 | |
| 352 | Magnolia warbler | Setophaga magnolia | 8 | 10 |
| 353 | Mallard | Anas platyrhynchos | 1,246 | 1,580 |
| 354 | Marbled godwit | Limosa fedoa | 391 | 454 |
| 355 | Marsh wren | Cistothorus palustris | 12 | 14 |
| 356 | McKay's bunting | Plectrophenax hyperboreus | 55 | 62 |
| 357 | Meadow pipit | Anthus pratensis | 18 | 23 |
| 358 | Merlin | Falco columbarius | 218 | 281 |
| 359 | Mew gull | Larus canus | 432 | 552 |
| 360 | Mississippi kite | Ictinia mississippiensis | 311 | 339 |
| 361 | Monk parakeet | Myiopsitta monachus | 120 | |
| 362 | Morelet’s seedeater | Sporophila morelleti | 9 | 12 |
| 363 | Mottled duck | Anas fulvigula | 1,043 | 1,241 |
| 364 | Mountain bluebird | Sialia currucoides | 30 | |
| 365 | Mountain chickadee | Poecile gambeli | 12 | 15 |
| 366 | Mourning dove | Zenaida macroura | 123 | |
| 367 | Mourning warbler | Geothlypis philadelphia | 12 | 14 |
| 368 | Muscovy duck | Cairina moschata | 2,858 | |
| 369 | Mute swan | Cygnus olor | 11,800 | 14,300 |
| 370 | Nacunda nighthawk | Chordeiles nacunda | 159 | 188 |
| 371 | Nanday parakeet | Aratinga nenday | 128 | 141 |
| 372 | Nashville warbler | Leiothlypis ruficapilla | 8 | 10 |
| 373 | Nelson's sparrow | Ammospiza nelsoni | 17 | 20 |
| 374 | Neotropic cormorant | Nannopterum brasilianum | 1,393 | 1,550 |
| 375 | Newell's shearwater | Puffinus newelli | 323 | 358 |
| 376 | Northern bobwhite | Colinus virginianus | 178 | |
| 377 | Northern cardinal | Cardinalis cardinalis | 44 | 52 |
| 378 | Northern flicker | Colaptes auratus | 128 | 143 |
| 379 | Northern fulmar | Fulmarus glacialis | 649 | 773 |
| 380 | Northern gannet | Morus bassanus | 3,067 | 3,610 |
| 381 | Northern goshawk | Accipiter gentilis | 1,137 | 1,364 |
| 382 | Northern harrier | Circus hudsonius | 515 | 661 |
| 383 | Northern hawk owl | Surnia ulula | 340 | 454 |
| 384 | Northern lapwing | Vanellus vanellus | 226 | 317 |
| 385 | Northern mockingbird | Mimus polyglottos | 49 | 56 |
| 386 | Northern parula | Setophaga americana | 9 | 10 |
| 387 | Northern pintail | Anas acuta | 1,006 | 1,245 |
| 388 | Northern pygmy-owl | Glaucidium gnoma | 73 | 87 |
| 389 | N. rough-winged swallow | Stelgidopteryx serripennis | 16 | 18 |
| 390 | Northern saw-whet owl | Aegolius acadicus | 131 | |
| 391 | Northern shoveler | Spatula clypeata | 636 | 908 |
| 392 | Northern shrike | Lanius borealis | 63 | 81 |
| 393 | Northern waterthrush | Parkesia noveboracensis | 16 | 20 |
| 394 | Olivaceous elaenia | Elaenia mesoleuca | 17 | 20 |

Appendix C. Continued (page 12 of 16)

| | Common name | Scientific name | Body mass (grams) | |
|---|---|---|---|---|
| | | | Mean | Max |
| 395 | Olive sparrow | Arremonops rufivirgatus | 23 | 30 |
| 396 | Olive-backed pipit | Anthus hodgsoni | 21 | 26 |
| 397 | Olive-sided flycatcher | Contopus cooperi | 32 | 42 |
| 398 | Olive-throated parakeet | Eupsittula nana | 77 | 84 |
| 399 | Orange-crowned warbler | Leiothlypis celata | 9 | 12 |
| 400 | Orchard oriole | Icterus spurius | 19 | 28 |
| 401 | Oriental plover | Charadrius veredus | 98 | |
| 402 | Osprey | Pandion haliaetus | 1,568 | 1,900 |
| 403 | Ovenbird | Seiurus aurocapilla | 19 | 21 |
| 404 | Pacific golden-plover | Pluvialis fulva | 140 | 168 |
| 405 | Pacific loon | Gavia pacifica | 1,830 | 2,450 |
| 406 | Pacific wren | Troglodytes pacificus | 9 | 12 |
| 407 | Pacific-slope flycatcher | Empidonax difficilis | 11 | 14 |
| 408 | Painted bunting | Passerina ciris | 13 | 19 |
| 409 | Pallid swift | Apus pallidus | 42 | 50 |
| 410 | Palm warbler | Setophaga palmarum | 10 | 13 |
| 411 | Parasitic jaeger | Stercorarius parasiticus | 478 | 604 |
| 412 | Pearly-eyed thrasher | Margarops fuscatus | 104 | 138 |
| 413 | Pectoral sandpiper | Calidris melanotos | 98 | |
| 414 | Pelagic cormorant | Phalacrocorax pelagicus | 2,072 | 2,440 |
| 415 | Peregrine falcon | Falco peregrinus | 977 | 1,194 |
| 416 | Philadelphia vireo | Vireo philadelphicus | 12 | 13 |
| 417 | Philippine collared dove | Streptopelia dusumieri | 153 | 174 |
| 418 | Philippine drongo-cuckoo | Surniculus velutinus | 38 | 47 |
| 419 | Philippine duck | Anas luzonica | 891 | 977 |
| 420 | Picazuro pigeon | Columba picazuro | 279 | 402 |
| 421 | Pied-billed grebe | Podilymbus podiceps | 474 | 568 |
| 422 | Pigeon guillemot | Cepphus columba | 530 | |
| 423 | Pine grosbeak | Pinicola enucleator | 56 | 62 |
| 424 | Pine siskin | Spinus pinus | 13 | 15 |
| 425 | Pine warbler | Setophaga pinus | 12 | 17 |
| 426 | Piping plover | Charadrius melodus | 55 | 64 |
| 427 | Prairie falcon | Falco mexicanus | 908 | 1,133 |
| 428 | Prairie warbler | Setophaga discolor | 8 | 11 |
| 429 | Prothonotary warbler | Protonotaria citrea | 14 | |
| 430 | Purple finch | Haemorhous purpureus | 23 | 28 |
| 431 | Purple gallinule | Porphyrio martinicus | 257 | |
| 432 | Purple heron | Ardea purpurea | 1,112 | 1,150 |
| 433 | Purple martin | Progne subis | 54 | |
| 434 | Purple sandpiper | Calidris maritima | 68 | 85 |
| 435 | Red avadavat | Amandava amandava | 10 | 10 |
| 436 | Red crossbill | Loxia curvirostra | 41 | 48 |
| 437 | Red knot | Calidris canutus | 148 | 206 |
| 438 | Red phalarope | Phalaropus fulicarius | 62 | |
| 439 | Red-bellied woodpecker | Melanerpes carolinus | 73 | |
| 440 | Red-breasted merganser | Mergus serrator | 1,135 | 1,317 |
| 441 | Red-breasted nuthatch | Sitta canadensis | 10 | 12 |
| 442 | Red-breasted sapsucker | Sphyrapicus ruber | 58 | |
| 443 | Red-crested cardinal | Paroaria coronata | 40 | 44 |

Appendix C. Continued (page 13 of 16)

| | Common name | Scientific name | Body mass (grams) | |
|---|---|---|---|---|
| | | | Mean | Max |
| 444 | Red-crowned amazon | Amazona viridigenalis | 316 | 345 |
| 445 | Reddish egret | Egretta rufescens | 614 | 869 |
| 446 | Red-eyed vireo | Vireo olivaceus | 17 | 21 |
| 447 | Red-footed booby | Sula sula | 1,223 | |
| 448 | Redhead | Aythya americana | 1,118 | 1,320 |
| 449 | Red-headed woodpecker | Melanerpes erythrocephalus | 72 | 91 |
| 450 | Red-legged kittiwake | Rissa brevirostris | 377 | 489 |
| 451 | Red-legged partridge | Alectoris rufa | 540 | 547 |
| 452 | Red-masked parakeet | Psittacara erythrogenys | 151 | |
| 453 | Red-naped sapsucker | Sphyrapicus nuchalis | 45 | 55 |
| 454 | Red-necked grebe | Podiceps grisegena | 1,023 | 1,270 |
| 455 | Red-necked phalarope | Phalaropus lobatus | 39 | |
| 456 | Red-necked stint | Calidris ruficollis | 27 | 31 |
| 457 | Red-shouldered hawk | Buteo lineatus | 670 | 774 |
| 458 | Red-tailed hawk | Buteo jamaicensis | 1,224 | |
| 459 | Red-tailed tropicbird | Phaethon rubricauda | 659 | |
| 460 | Red-throated loon | Gavia stellata | 1,486 | 1,923 |
| 461 | Red-vented bulbul | Pycnonotus cafer | 46 | 59 |
| 462 | Red-wattled lapwing | Vanellus indicus | 181 | 230 |
| 463 | Redwing | Turdus iliacus | 61 | 80 |
| 464 | Red-winged blackbird | Agelaius phoeniceus | 65 | 72 |
| 465 | Ring-billed gull | Larus delawarensis | 566 | 650 |
| 466 | Ring-necked duck | Aythya collaris | 730 | 1,180 |
| 467 | Ring-necked pheasant | Phasianus colchicus | 1,317 | 1,861 |
| 468 | Rock pigeon | Columba livia | 369 | |
| 469 | Rock ptarmigan | Lagopus muta | 550 | 640 |
| 470 | Rock sandpiper | Calidris ptilocnemis | 106 | 130 |
| 471 | Rock wren | Salpinctes obsoletus | 17 | |
| 472 | Rook | Corvus frugilegus | 489 | 560 |
| 473 | Roseate spoonbill | Platalea ajaja | 1,490 | 1,800 |
| 474 | Roseate tern | Sterna dougallii | 112 | 128 |
| 475 | Rose-breasted grosbeak | Pheucticus ludovicianus | 42 | 51 |
| 476 | Rose-ringed parakeet | Psittacula krameri | 119 | 134 |
| 477 | Ross's goose | Anser rossii | 1,640 | 2,040 |
| 478 | Rough-legged hawk | Buteo lagopus | 1,065 | 1,660 |
| 479 | Royal tern | Thalasseus maximus | 470 | |
| 480 | Ruby-crowned kinglet | Corthylio calendula | 7 | 7 |
| 481 | Ruby-throated hummingbird | Archilochus colubris | 3 | 4 |
| 482 | Ruddy duck | Oxyura jamaicensis | 629 | |
| 483 | Ruddy ground dove | Columbina talpacoti | 47 | 57 |
| 484 | Ruddy turnstone | Arenaria interpres | 138 | |
| 485 | Ruffed grouse | Bonasa umbellus | 566 | |
| 486 | Rufous hummingbird | Selasphorus rufus | 4 | 5 |
| 487 | Rufous-tailed robin | Larvivora sibilans | 17 | 20 |
| 488 | Rusty blackbird | Euphagus carolinus | 64 | 80 |
| 489 | Saffron finch | Sicalis flaveola | 20 | 23 |
| 490 | Sage thrasher | Oreoscoptes montanus | 44 | 50 |
| 491 | Sagebrush sparrow | Artemisiospiza nevadensis | 19 | 22 |
| 492 | Sanderling | Calidris alba | 51 | |

Appendix C. Continued (page 14 of 16)

| | Common name | Scientific name | Body mass (grams) | |
|---|---|---|---|---|
| | | | Mean | Max |
| 493 | Sandhill crane | Antigone canadensis | 4,800 | |
| 494 | Sandwich tern | Thalasseus sandvicensis | 208 | 238 |
| 495 | Savannah sparrow | Passerculus sandwichensis | 21 | |
| 496 | Say's phoebe | Sayornis saya | 21 | 24 |
| 497 | Scaled quail | Callipepla squamata | 191 | 234 |
| 498 | Scaly-breasted munia | Lonchura punctulata | 14 | 15 |
| 499 | Scaly-naped pigeon | Patagioenas squamosa | 312 | 388 |
| 500 | Scarlet tanager | Piranga olivacea | 28 | 34 |
| 501 | Scissor-tailed flycatcher | Tyrannus forficatus | 39 | |
| 502 | Seaside sparrow | Ammospiza maritima | 24 | 29 |
| 503 | Sedge wren | Cistothorus platensis | 8 | 9 |
| 504 | Semipalmated plover | Charadrius semipalmatus | 47 | 57 |
| 505 | Semipalmated sandpiper | Calidris pusilla | 28 | |
| 506 | Sharp-shinned hawk | Accipiter striatus | 174 | 208 |
| 507 | Sharp-tailed grouse | Tympanuchus phasianellus | 953 | 1,090 |
| 508 | Short-billed dowitcher | Limnodromus griseus | 116 | 154 |
| 509 | Short-eared owl | Asio flammeus | 378 | 475 |
| 510 | Short-tailed Hawk | Buteo brachyurus | 480 | 710 |
| 511 | Smith's longspur | Calcarius pictus | 28 | 32 |
| 512 | Snow bunting | Plectrophenax nivalis | 42 | 56 |
| 513 | Snow goose | Anser caerulescens | 2,744 | |
| 514 | Snowy egret | Egretta thula | 371 | |
| 515 | Snowy owl | Bubo scandiacus | 2,279 | 2,951 |
| 516 | Snowy plover | Charadrius nivosus | 42 | 58 |
| 517 | Solitary sandpiper | Tringa solitaria | 48 | 65 |
| 518 | Song sparrow | Melospiza melodia | 21 | 23 |
| 519 | Song thrush | Turdus philomelos | 69 | 89 |
| 520 | Sooty tern | Onychoprion fuscatus | 175 | 224 |
| 521 | Sora | Porzana carolina | 75 | 126 |
| 522 | South American snipe | Gallinago paraguaiae | 113 | 145 |
| 523 | Southern lapwing | Vanellus chilensis | 327 | 426 |
| 524 | Speckled pigeon | Columba guinea | 352 | 371 |
| 525 | Spotted dove | Streptopelia chinensis | 159 | 194 |
| 526 | Spotted flycatcher | Muscicapa striata | 16 | 21 |
| 527 | Spotted sandpiper | Actitis macularius | 40 | 60 |
| 528 | Spotted thick-knee | Burhinus capensis | | |
| 529 | Spotted towhee | Pipilo maculatus | 39 | 46 |
| 530 | Sprague's pipit | Anthus spragueii | 26 | 30 |
| 531 | Spruce grouse | Falcipennis canadensis | 492 | 513 |
| 532 | Spur-winged lapwing | Vanellus spinosus | 192 | |
| 533 | Stilt sandpiper | Calidris himantopus | 61 | 68 |
| 534 | Sulphur-bellied flycatcher | Myiodynastes luteiventris | 47 | 57 |
| 535 | Summer tanager | Piranga rubra | 30 | 34 |
| 536 | Sunda collared dove | Streptopelia bitorquata | 153 | 174 |
| 537 | Surf scoter | Melanitta perspicillata | 1,148 | |
| 538 | Surfbird | Calidris virgata | 216 | 251 |
| 539 | Swainson's hawk | Buteo swainsoni | 1,109 | 1,367 |
| 540 | Swainson's thrush | Catharus ustulatus | 30 | 36 |
| 541 | Swainson's warbler | Limnothlypis swainsonii | 19 | 20 |

Appendix C. Continued (page 15 of 16)

| | Common name | Scientific name | Body mass (grams) | |
|---|---|---|---|---|
| | | | Mean | Max |
| 542 | Swallow-tailed kite | Elanoides forficatus | 442 | 510 |
| 543 | Swamp sparrow | Melospiza georgiana | 16 | 19 |
| 544 | Tennessee warbler | Leiothlypis peregrina | 9 | 14 |
| 545 | Thick-billed kingbird | Tyrannus crassirostris | 56 | 59 |
| 546 | Thick-billed longspur | Rhynchophanes mccownii | 27 | |
| 547 | Townsend's solitaire | Myadestes townsendi | 33 | 39 |
| 548 | Townsend's warbler | Setophaga townsendi | 9 | 11 |
| 549 | Tree pipit | Anthus trivialis | 25 | 29 |
| 550 | Tree swallow | Tachycineta bicolor | 21 | 26 |
| 551 | Tricolored blackbird | Agelaius tricolor | 68 | 79 |
| 552 | Tricolored heron | Egretta tricolor | 415 | |
| 553 | Tropical kingbird | Tyrannus melancholicus | 37 | 43 |
| 554 | Tropical mockingbird | Mimus gilvus | 58 | 66 |
| 555 | Trumpeter swan | Cygnus buccinator | 11,900 | 14,500 |
| 556 | Tufted titmouse | Baeolophus bicolor | 22 | 26 |
| 557 | Tundra swan | Cygnus columbianus | 7,200 | |
| 558 | Turkey vulture | Cathartes aura | 2,006 | |
| 559 | Upland sandpiper | Bartramia longicauda | 164 | 218 |
| 560 | Varied thrush | Ixoreus naevius | 80 | 100 |
| 561 | Vaux's swift | Chaetura vauxi | 17 | 21 |
| 562 | Veery | Catharus fuscescens | 32 | 37 |
| 563 | Vega gull | Larus vegae | 1,147 | 1,385 |
| 564 | Vesper sparrow | Pooecetes gramineus | 27 | |
| 565 | Violet-green swallow | Tachycineta thalassina | 14 | 16 |
| 566 | Virginia rail | Rallus limicola | 84 | 124 |
| 567 | Virginia's warbler | Leiothlypis virginiae | 8 | 11 |
| 568 | Warbling vireo | Vireo gilvus | 14 | 18 |
| 569 | Wedge-tailed eagle | Aquila audax | 3,800 | 4,750 |
| 570 | Wedge-tailed shearwater | Ardenna pacifica | 388 | 510 |
| 571 | Western bluebird | Sialia mexicana | 27 | 32 |
| 572 | Western grebe | Aechmophorus occidentalis | 1,429 | 1,826 |
| 573 | Western gull | Larus occidentalis | 1,136 | |
| 574 | Western kingbird | Tyrannus verticalis | 40 | 44 |
| 575 | Western marsh harrier | Circus aeruginosus | 814 | 1,030 |
| 576 | Western meadowlark | Sturnella neglecta | 112 | |
| 577 | Western sandpiper | Calidris mauri | 29 | |
| 578 | Western screech-owl | Megascops kennicottii | 236 | 305 |
| 579 | Western tanager | Piranga ludoviciana | 28 | 35 |
| 580 | Western wood-pewee | Contopus sordidulus | 13 | 15 |
| 581 | Whimbrel | Numenius phaeopus | 404 | 459 |
| 582 | White ibis | Eudocimus albus | 1,036 | 1,261 |
| 583 | White stork | Ciconia ciconia | 3,571 | 4,400 |
| 584 | White tern | Gygis alba | 111 | 139 |
| 585 | White-bellied sea-eagle | Haliaeetus leucogaster | 3,300 | 3,900 |
| 586 | White-breasted nuthatch | Sitta carolinensis | 21 | 23 |
| 587 | White-crested elaenia | Elaenia albiceps | 15 | 18 |
| 588 | White-crowned pigeon | Patagioenas leucocephala | 253 | |
| 589 | White-crowned sparrow | Zonotrichia leucophrys | 29 | 39 |
| 590 | White-eyed vireo | Vireo griseus | 11 | 14 |

Appendix C. Continued (page 16 of 16)

| | Common name | Scientific name | Body mass (grams) | |
|---|---|---|---|---|
| | | | Mean | Max |
| 591 | White-faced ibis | Plegadis chihi | 697 | 807 |
| 592 | White-rumped sandpiper | Calidris fuscicollis | 49 | |
| 593 | White-tailed hawk | Geranoaetus albicaudatus | 928 | |
| 594 | White-tailed kite | Elanus leucurus | 346 | |
| 595 | White-tailed tropicbird | Phaethon lepturus | 367 | |
| 596 | White-throated munia | Euodice malabarica | 12 | 14 |
| 597 | White-throated sparrow | Zonotrichia albicollis | 24 | 30 |
| 598 | White-throated swift | Aeronautes saxatalis | 32 | 36 |
| 599 | White-tufted grebe | Rollandia rolland | 424 | 450 |
| 600 | White-winged crossbill | Loxia leucoptera | 26 | |
| 601 | White-winged dove | Zenaida asiatica | 153 | 187 |
| 602 | White-winged scoter | Melanitta deglandi | 1,917 | 2,128 |
| 603 | White-winged tern | Chlidonias leucopterus | 54 | 66 |
| 604 | Whooping crane | Grus americana | 5,826 | 6,356 |
| 605 | Wild turkey | Meleagris gallopavo | 7,800 | 10,400 |
| 606 | Willet | Tringa semipalmata | 283 | 327 |
| 607 | Willow flycatcher | Empidonax traillii | 14 | 16 |
| 608 | Willow ptarmigan | Lagopus lagopus | 613 | |
| 609 | Wilson's phalarope | Phalaropus tricolor | 68 | 85 |
| 610 | Wilson's plover | Charadrius wilsonia | 55 | 80 |
| 611 | Wilson's snipe | Gallinago delicata | 128 | 156 |
| 612 | Wilson's warbler | Cardellina pusilla | 7 | 7 |
| 613 | Winter wren | Troglodytes hiemalis | 9 | 12 |
| 614 | Wood duck | Aix sponsa | 681 | 907 |
| 615 | Wood sandpiper | Tringa glareola | 73 | 130 |
| 616 | Wood stork | Mycteria americana | 2,702 | 2,780 |
| 617 | Wood thrush | Hylocichla mustelina | 53 | 76 |
| 618 | Worm-eating warbler | Helmitheros vermivorum | 15 | 17 |
| 619 | Wrentit | Chamaea fasciata | 15 | 18 |
| 620 | Yellow bittern | Ixobrychus sinensis | 94 | 120 |
| 621 | Yellow rail | Coturnicops noveboracensis | 61 | 70 |
| 622 | Yellow warbler | Setophaga petechia | 10 | 12 |
| 623 | Yellow-bellied flycatcher | Empidonax flaviventris | 12 | 16 |
| 624 | Yellow-bellied sapsucker | Sphyrapicus varius | 50 | 62 |
| 625 | Yellow-billed cuckoo | Coccyzus americanus | 64 | 85 |
| 626 | Yellow-billed magpie | Pica nuttalli | 174 | 189 |
| 627 | Yellow-breasted chat | Icteria virens | 25 | 28 |
| 628 | Yellow-browed warbler | Phylloscopus inornatus | 7 | 8 |
| 629 | Yellow-chevroned parakeet | Brotogeris chiriri | 62 | 68 |
| 630 | Yellow-crowned night-heron | Nyctanassa violacea | 716 | |
| 631 | Yellow-fronted canary | Crithagra mozambica | 13 | 16 |
| 632 | Yellow-headed blackbird | Xanthocephalus xanthocephalus | 80 | 86 |
| 633 | Yellow-headed caracara | Milvago chimachima | 329 | |
| 634 | Yellow-legged gull | Larus michahellis | 1,275 | 1,500 |
| 635 | Yellow-rumped warbler | Setophaga coronata | 12 | 15 |
| 636 | Yellow-throated vireo | Vireo flavifrons | 18 | 21 |
| 637 | Yellow-throated warbler | Setophaga dominica | 10 | 11 |
| 638 | Zebra dove | Geopelia striata | 57 | 62 |
| 639 | Zenaida dove | Zenaida aurita | 156 | 205 |

[1] Body masses for birds from Dunning (2008). Body masses for mammals and reptiles from miscellaneous sources.