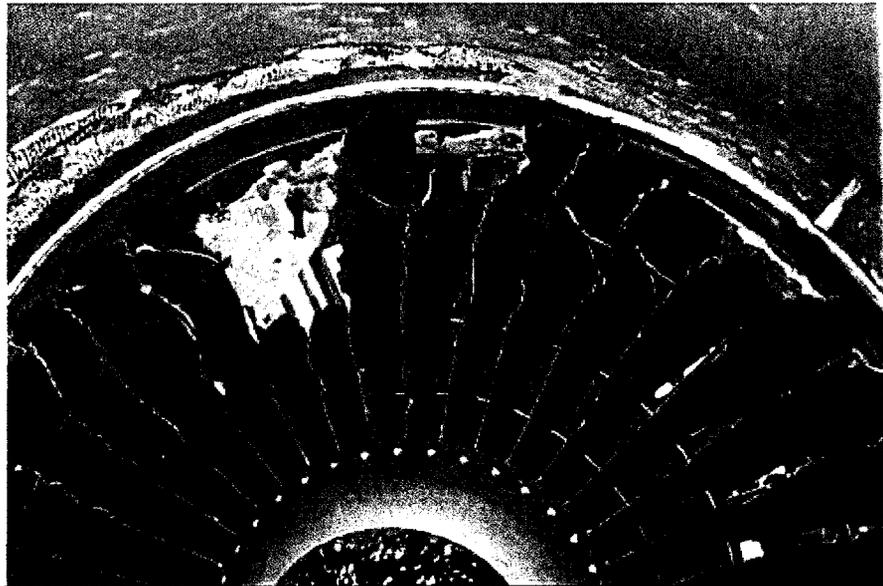




U. S. DEPARTMENT  
OF TRANSPORTATION  
FEDERAL AVIATION  
ADMINISTRATION

# WILDLIFE STRIKES TO CIVIL AIRCRAFT IN THE UNITED STATES 1990-1998



FEDERAL AVIATION ADMINISTRATION  
WILDLIFE AIRCRAFT STRIKE DATABASE  
SERIAL REPORT NUMBER 5

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REPORT PREPARED BY  
EDWARD C. CLEARY → SANDRA E. WRIGHT → RICHARD A. DOLBEER

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REPORT OF THE ASSOCIATE ADMINISTRATOR OF AIRPORTS  
OFFICE OF AIRPORT SAFETY AND STANDARDS  
AIRPORT SAFETY & OPERATIONS,  
WASHINGTON, DC

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## Authors

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Edward C. Cleary, Staff Wildlife Biologist, Office of Airport Safety and Standards, Federal Aviation Administration, 800 Independence Ave. SE, Washington, DC 20591

Sandra E. Wright, Database Manager, U.S. Department of Agriculture, Wildlife Services, National Wildlife Research Center, 6100 Columbus Ave. Sandusky, OH 44870

Richard A. Dolbeer, Project Leader, U.S. Department of Agriculture, Wildlife Services, National Wildlife Research Center, 6100 Columbus Ave. Sandusky, OH 44870

## Cover

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This engine on a Boeing-737 sustained major damage when a female eider duck was ingested during landing at an airport in Maine, 1995. (Photo courtesy National Transportation Safety Board)

All future reports will feature one or more photographs of aircraft damage resulting from a wildlife strike. Anyone with quality photographs of wildlife-aircraft strike damage is encouraged to submit them to one of the authors for consideration. Full credit will be given for all photographs used.

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## PREFACE

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Wildlife strikes to civil aircraft are a serious economic and safety problem in the United States. The Federal Aviation Administration (FAA) has a standard form (FAA Form 5200-7) for the voluntary reporting of bird and other wildlife strikes with aircraft. Although FAA personnel have monitored these reports since 1965 to determine general patterns in wildlife strikes, no quantitative analyses of these data were conducted until 1995.

The FAA, through an interagency agreement with the United States Department of Agriculture's (USDA) National Wildlife Research Center, initiated a project to obtain more objective estimates of the magnitude and nature of the wildlife strike problem nationwide for civil aviation in April 1995. This project includes 1) editing all strike reports (FAA Form 5200-7) sent to the FAA since 1990 to ensure consistent, error-free data; 2) entering all edited strike reports since 1990 in a Wildlife Strike Database; 3) supplementing FAA-reported strikes with additional, non-duplicated strike reports from other sources; 4) providing FAA with an updated computer file each quarter containing all edited strike reports; and 5) assisting the FAA with the production of annual reports summarizing the results of the analyses. Such analyses are critical to determine the economic cost of wildlife strikes, the magnitude of safety issues, and most importantly, the nature of the problems (e.g., bird species, aircraft and engine types, airports, and seasonal patterns) so that corrective actions can be taken.

The first annual report on wildlife strikes to civil aircraft in the USA, covering 1994, was completed in November 1995 (Dolbeer et al. 1995). Subsequent reports covering the years 1993-1995, 1992-1996, and 1991-1997 were issued in 1996, 1997, and 1998, respectively (Cleary, et al. 1996, 1997, 1998). This is the fifth report in the series. It is the intention of the FAA to publish a detailed report covering the 10-year period, 1990-1999, in the year 2000. Subsequent detailed reports will be produced at 5-year intervals. In the interim years, annual reports summarizing data in tabular and graphic form for all available years will be produced.

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# WILDLIFE STRIKES TO CIVIL AIRCRAFT IN THE UNITED STATES 1990-1998

## SYNOPSIS

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This publication presents a synopsis of data on wildlife strikes to United States civil aircraft for 1990-1998. Unless noted, all numbers are totals for the 9-year period, and percentages are of the known total. For the 9-year period, 22,935 ( $\bar{x} = 2,548/\text{year}$ ) strikes were reported to the FAA. Between 1990 and 1998 there was a 107% increase in the number of strikes reported annually (Figure 1). Most reports were filed using FAA Form 5200-7 (Table 1). Pilots and tower personnel filed 28% and 17% of the reports, respectively (Table 2). About 81% of the reported strikes involved commercial aircraft; the remainder involved business, private, and miscellaneous aircraft (Table 3).

Reports were received from all 50 states, from some U.S. territories, and from foreign countries when U.S. registered aircraft were involved. Table 4 shows the distribution of reported bird and mammal strikes for the various states and territories.

Most bird strikes (51%) occurred between July and October (Table 5 and Figure 2); 66% occurred during the day (Table 6 and Figure 3); 53% occurred when the aircraft was on approach or during the landing roll, and 39% occurred during takeoff and climb (Table 7). Fifty-five percent of the bird strikes occurred when the aircraft was at an altitude of less than 100 ft. above ground level (AGL), 78% occurred under 900 ft. AGL, and 87% occurred under 2,000 ft. AGL (Table 8 and Figure 5).

Most mammal strikes (42%) occurred between September and November (Table 5 and Figure 2); 62% occurred at night (Table 6 and Figure 4); 60% occurred when the aircraft was on approach or landing; and 34% occurred during takeoff. Eleven percent of the reported mammal strikes occurred while the aircraft was still in the air, when the aircraft struck deer with the landing gear or encountered bats (Table 7).

The fixed-wing aircraft types most often involved in strikes that had a negative effect-on-flight were Boeing-737, McDonnell-Douglas MD-80/DC-9, British Aerospace-31, and Cessna 172. The aircraft types most often involved in a strike that damaged one or more aircraft

components were Boeing-737, McDonnell-Douglas MD-80/DC-9, Boeing-727, and British Aerospace-31 (Table 9).

The aircraft components most commonly reported as struck by birds were windshield, engine, wing/rotor, and nose. Those components most often reported as damaged were engine, wing/rotor, radome, and windshield. Aircraft components most commonly reported as struck by mammals were landing gear, propeller, wing/rotor, other, and engine. These same components ranked highest for the parts most often reported as damaged (Table 10A).

Of the 22,935 strikes reported, 16,283 reports indicated the strike did not damage the aircraft; 2,086 reports indicated the aircraft suffered minor damage; 1,268 reports indicated the aircraft suffered substantial damage; and 19 reports indicated the aircraft was destroyed as a result of the strike (Table 10B).

Fifteen and 63% of the bird and mammal strike reports, respectively, indicated the strike had an adverse effect on the flight (Table 11).

Birds were involved in 97% of the reported strikes, mammals in 3%, and <1% involved reptiles. Gulls, waterfowl, doves, and raptors were the most commonly struck bird groups (Table 12A). The most commonly struck mammals were deer and coyotes (Table 12B). Gulls were involved in 2.6 times as many strikes as waterfowl, but both groups were involved in essentially the same number of damaging strikes (Table 13).

For the 9-year period, 3,773 reports indicated the strike damaged one or more aircraft components (Table 13); and 2,443 reports indicated the strike had a negative effect on the flight (Table 14).

For the 9-year period, reported losses from bird strikes totaled 97,813 hours of aircraft down time (Table 15) and \$67.63 million in monetary losses (Table 16). Reported losses from mammal strikes totaled 65,854 hours of aircraft down time (Table 15) and \$6.78 million in monetary losses (Table 16).

Of the 5,011 reports that indicated the strike had an adverse effect on the aircraft and/or flight, 988 provided an estimate of the aircraft down time ( $\Sigma = 163,667$  hours,  $\bar{x} = 166$  hours/incident), and 759 provided an estimate of the direct and/or other cost ( $\Sigma = \$74.4$  million,  $\bar{x} = \$139,000$  damage/incident). Of the 759 reports providing a damage cost estimate, 681 gave an estimate of direct aircraft damage ( $\Sigma = \$61.89$  million,  $\bar{x} = \$91,000$  damage/incident), and 262 gave an estimate of other

monetary losses ( $\Sigma = \$12.51$  million  $\bar{x} = \$47,000$  lost/incident)  
(Table 17).

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

Assuming all 5,011 reported wildlife-aircraft strikes that had an adverse effect on the aircraft and/or flight engendered similar amounts of down time and/or monetary losses, and that these reports are all of the damaging strikes that occurred, then at a minimum, wildlife-aircraft strikes cost the U.S. civil aviation industry 92,233 hours/year of aircraft down time, \$50.60 million/year in direct monetary losses, and \$26.59 million/year in associated costs.

Further, assuming a 20% reporting rate, the cost of wildlife-aircraft strikes to the U.S. civil aviation industry is estimated to be in excess of 461,165 hours/year of aircraft down time, \$253.02 million/year in direct monetary losses and \$132.96 million/year in associated costs (Table 17).

With the analysis of 9 years of strike data, the magnitude and severity of the wildlife-aircraft strike problem is becoming more obvious. Two important points need to be made. First, airport managers need to be aware of the wildlife hazards on their airports and take appropriate actions, under the guidance of professional biologists trained in wildlife damage management, to minimize the problems. Second, the focus of airport wildlife management needs to be widened to consider habitats and land-uses in proximity to the airport, such as wetlands, waste-disposal facilities, and wildlife refuges that can attract wildlife hazardous to aviation. Such land uses and activities are often incompatible with aviation safety and should be prohibited near airports or designed and operated in a manner that minimizes the attraction of hazardous wildlife.

Finally, there is a need for increased and more detailed reporting of wildlife strikes. For example, our previous analysis indicated <20% of all wildlife strikes involving U.S. civil aircraft are reported. Furthermore, 51% of all reported bird strikes, 1990-1998, provided no information on the species struck and only 15% of strike reports indicating an adverse effect provided an estimate of cost.

Strikes should be reported by pilots, airport operations and aircraft maintenance personnel, or anyone else who has knowledge of the strike. It is important to include as much information as possible on FAA Form 5200-7. All reports are carefully screened to identify duplicate reports prior to being entered into the database. Reports of the same incident filed by different people are combined and provide a more complete documentation of the strike than would be possible if just one report had been filed.

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

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

Please send whole feathers whenever possible as diagnostic characteristics are often found in the downy barbules at the feather base. Beaks, feet, bones, and talons are also useful diagnostic materials.

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

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Table 1. Source of information for reported wildlife strikes to civil aircraft, USA, 1990-1998.

| Source                               | Reported strikes |              | % of total |
|--------------------------------------|------------------|--------------|------------|
|                                      | 9-year total     | 9-year avg.  |            |
| FAA Form 5200-7                      | 17,308           | 1,923        | 75         |
| Multiple <sup>1</sup>                | 1,920            | 213          | 8          |
| Airport Report                       | 1,354            | 150          | 6          |
| Aircraft Incident Report             | 568              | 63           | 2          |
| Other <sup>2</sup>                   | 583              | 65           | 3          |
| Engine Manufacturer                  | 367              | 41           | 2          |
| Preliminary Aircraft Incident Report | 339              | 38           | 1          |
| Airline Report                       | 284              | 32           | 1          |
| Aviation Safety Reporting System     | 104              | 12           | <1         |
| Aircraft Incident Preliminary Notice | 47               | 5            | <1         |
| National Transportation Safety Board | 45               | 5            | <1         |
| Daily Alert Bulletin                 | 16               | 2            | <1         |
| <b>Total</b>                         | <b>22,935</b>    | <b>2,548</b> | <b>100</b> |

<sup>1</sup> More than one report is filed for the same strike.

<sup>2</sup> Various sources such as the media, Commercial Incident Reports, etc.

Table 2. Person filing report of wildlife strike to civil aircraft, USA, 1990-1998.

| Person reporting           | Reported strikes |              | % of total |
|----------------------------|------------------|--------------|------------|
|                            | 9-year total     | 9-year avg.  |            |
| Pilot                      | 6,353            | 706          | 28         |
| Tower                      | 3,878            | 431          | 17         |
| Unknown <sup>1</sup>       | 7,455            | 828          | 33         |
| Carcass found <sup>2</sup> | 1,686            | 187          | 7          |
| Airport Operations         | 1,477            | 164          | 6          |
| Airline Operations         | 1,323            | 147          | 6          |
| Other <sup>3</sup>         | 763              | 85           | 3          |
| <b>Total</b>               | <b>22,935</b>    | <b>2,548</b> | <b>100</b> |

<sup>1</sup> Person filing report did not give their title or position.

<sup>2</sup> Airport operations found wildlife remains on or close to runway that appeared to have been struck by aircraft. No strike report was filed by pilot or other entity.

<sup>3</sup> Persons such as Aviation Safety Inspectors, engine manufacturer, etc.

Table 3. Number of reported wildlife strikes to civil aircraft by type of operator, USA, 1990-1998.

| Operator           | Reported strikes |             | % of total known |
|--------------------|------------------|-------------|------------------|
|                    | 9-year total     | 9-year avg. |                  |
| Commercial         | 16,611           | 1,846       | 81               |
| Business           | 2,814            | 313         | 14               |
| Private            | 961              | 107         | 5                |
| Government /police | 88               | 10          | <1               |
| Total known        | 20,474           | 2,275       | 100              |
| Total unknown      | 2,461            | 273         |                  |
| Total              | 22,935           | 2,548       |                  |

Table 4. Number of reported wildlife strikes to civil aircraft by U.S. state, including Puerto Rico (PR) and the U.S. Virgin Islands (VI), 1990-1998.

| State      | Birds            |             | Mammals          |             |
|------------|------------------|-------------|------------------|-------------|
|            | Reported strikes |             | Reported strikes |             |
|            | 9-year total     | 9-year avg. | 9-year total     | 9-year avg. |
| AK         | 215              | 24          | 5                | 1           |
| AL         | 282              | 31          | 4                | <1          |
| AR         | 125              | 14          | 11               | 1           |
| AZ         | 167              | 19          | 17               | 2           |
| CA         | 2,017            | 224         | 20               | 2           |
| CO         | 261              | 29          | 7                | 1           |
| CT         | 317              | 35          | 13               | 1           |
| DC         | 571              | 63          | 18               | 2           |
| DE         | 14               | 2           | 1                | <1          |
| FL         | 2,056            | 228         | 29               | 3           |
| GA         | 454              | 50          | 9                | 1           |
| HI         | 474              | 53          | 1                | <1          |
| IA         | 172              | 19          | 3                | <1          |
| ID         | 51               | 6           | 4                | <1          |
| IL         | 1,235            | 137         | 43               | 5           |
| IN         | 232              | 26          | 5                | 1           |
| KS         | 66               | 7           | 2                | <1          |
| KY         | 603              | 67          | 4                | <1          |
| LA         | 531              | 59          | 6                | 1           |
| MA         | 326              | 36          | 7                | 1           |
| MD         | 268              | 30          | 16               | 2           |
| ME         | 100              | 11          | 4                | <1          |
| MI         | 409              | 45          | 26               | 3           |
| MN         | 206              | 23          | 6                | 1           |
| MO         | 400              | 44          | 13               | 1           |
| MS         | 100              | 11          | 3                | <1          |
| MT         | 36               | 4           | 1                | <1          |
| NC         | 563              | 63          | 15               | 2           |
| ND         | 45               | 5           | 0                | 0           |
| NE         | 209              | 23          | 7                | 1           |
| NH         | 78               | 9           | 4                | <1          |
| NJ         | 673              | 75          | 27               | 3           |
| NM         | 49               | 5           | 1                | <1          |
| NV         | 116              | 13          | 2                | <1          |
| NY         | 1,445            | 161         | 36               | 4           |
| OH         | 724              | 80          | 15               | 2           |
| OK         | 233              | 26          | 14               | 2           |
| OR         | 301              | 33          | 4                | <1          |
| PA         | 1,040            | 116         | 48               | 5           |
| PR         | 39               | 4           | 0                | 0           |
| RI         | 63               | 7           | 3                | <1          |
| SC         | 125              | 14          | 4                | <1          |
| SD         | 38               | 4           | 3                | <1          |
| TN         | 591              | 66          | 6                | 1           |
| TX         | 1,775            | 197         | 30               | 3           |
| UT         | 240              | 27          | 4                | <1          |
| VA         | 460              | 51          | 18               | 2           |
| VI         | 32               | 4           | 0                | 0           |
| VT         | 16               | 2           | 0                | 0           |
| WA         | 382              | 42          | 8                | 1           |
| WI         | 244              | 27          | 14               | 2           |
| WV         | 75               | 8           | 31               | 3           |
| WY         | 13               | 1           | 2                | <1          |
| U.S. Total | 21,257           | 2,362       | 574              | 64          |
| Foreign    | 1,063            | 118         | 6                | 1           |
| Total      | 22,320           | 2,480       | 580              | 64          |

Table 5. Number of reported wildlife strikes to civil aircraft by month, USA, 1990–1998. See also Figure 2.

| Month | Birds            |             |            | Mammals          |             |            |
|-------|------------------|-------------|------------|------------------|-------------|------------|
|       | Reported strikes |             |            | Reported strikes |             |            |
|       | 9-year total     | 9-year avg. | % of total | 9-year total     | 9-year avg. | % of total |
| Jan.  | 872              | 97          | 4          | 29               | 3           | 5          |
| Feb.  | 806              | 90          | 4          | 16               | 2           | 3          |
| Mar.  | 1,244            | 138         | 6          | 38               | 4           | 7          |
| Apr.  | 1,415            | 157         | 6          | 30               | 3           | 5          |
| May   | 1,983            | 220         | 9          | 32               | 4           | 6          |
| June  | 1,559            | 173         | 7          | 48               | 5           | 8          |
| July  | 2,280            | 253         | 10         | 51               | 6           | 9          |
| Aug.  | 3,024            | 336         | 14         | 49               | 5           | 8          |
| Sep.  | 3,147            | 350         | 14         | 63               | 7           | 11         |
| Oct.  | 2,975            | 331         | 13         | 81               | 9           | 14         |
| Nov.  | 1,879            | 209         | 8          | 100              | 11          | 17         |
| Dec.  | 1,136            | 126         | 5          | 43               | 5           | 7          |
| Total | 22,320           | 2,480       | 100        | 580              | 64          | 100        |

Table 6. Reported time of occurrence of wildlife strikes to civil aircraft, USA, 1990-1998. See also Figures 3 and 4.

| Time         | Birds            |             |                  | Mammals          |             |                  |
|--------------|------------------|-------------|------------------|------------------|-------------|------------------|
|              | Reported strikes |             |                  | Reported strikes |             |                  |
|              | 9-year total     | 9-year avg. | % of total known | 9-year total     | 9-year avg. | % of total known |
| Dawn         | 824              | 92          | 4                | 10               | 1           | 2                |
| Day          | 13,551           | 1,506       | 66               | 132              | 15          | 26               |
| Dusk         | 1,017            | 113         | 5                | 52               | 6           | 10               |
| Night        | 5,186            | 576         | 25               | 307              | 34          | 62               |
| Total known  | 20,578           | 2,287       | 100              | 501              | 56          | 100              |
| Not reported | 1,742            | 194         |                  | 79               | 9           |                  |
| Total        | 22,320           | 2,480       |                  | 580              | 64          |                  |

Table 7. Reported phase of flight at time of wildlife strikes to civil aircraft, USA, 1990-1998.

| Phase of flight | Birds            |             |                  | Mammals          |             |                  |
|-----------------|------------------|-------------|------------------|------------------|-------------|------------------|
|                 | Reported strikes |             |                  | Reported strikes |             |                  |
|                 | 9-year total     | 9-year avg. | % of total known | 9-year total     | 9-year avg. | % of total known |
| Parked          | 13               | 1           | <1               | 0                | 0           | 0                |
| Taxi            | 87               | 10          | <1               | 11               | 1           | 2                |
| Take-off        | 3,899            | 433         | 20               | 170              | 19          | 34               |
| Climb           | 3,697            | 411         | 19               | 11               | 1           | 2                |
| En route        | 716              | 80          | 4                | 2                | <1          | <1               |
| Descent         | 735              | 82          | 4                | 2                | <1          | <1               |
| Approach        | 7,352            | 817         | 37               | 44               | 5           | 9                |
| Landing roll    | 3,229            | 359         | 16               | 254              | 28          | 51               |
| Total known     | 19,728           | 2,192       | 100              | 494              | 55          | 100              |
| Total unknown   | 2,592            | 288         |                  | 86               | 10          |                  |
| Total           | 22,320           | 2,480       |                  | 580              | 64          |                  |

Table 8. Number of reported bird strikes to civil aircraft by altitude (feet) above ground level (AGL), USA, 1990-1998. See also Figure 5.

| Altitude of strike <sup>1</sup><br>(feet AGL) | Reported strikes |             | % of total<br>known | Cumulative % of<br>total known |
|---|------------------|-------------|---------------------|--------------------------------|
|   | 9-year total     | 9-year avg. |                     |                                |
| 0 -   | 7,177            | 797         | 40                  | 39.8                           |
| 1 - 99  | 2,786            | 310         | 15                  | 55.3                           |
| 100 - 199                                     | 1,226            | 136         | 7                   | 62.1                           |
| 200 - 299                                     | 813              | 90          | 5                   | 66.6                           |
| 300 - 399                                     | 571              | 63          | 3                   | 69.8                           |
| 400 - 499                                     | 328              | 36          | 2                   | 71.6                           |
| 500 - 599                                     | 607              | 67          | 3                   | 75.0                           |
| 600 - 699                                     | 189              | 21          | 1                   | 76.0                           |
| 700 - 799                                     | 137              | 15          | 1                   | 76.8                           |
| 800 - 899                                     | 259              | 29          | 1                   | 78.2                           |
| 900 - 999                                     | 111              | 12          | 1                   | 78.8                           |
| 1,000 - 1,499                                 | 887              | 99          | 5                   | 83.8                           |
| 1,500 - 1,999                                 | 579              | 64          | 3                   | 87.0                           |
| 2,000 - 2,999                                 | 720              | 80          | 4                   | 91.0                           |
| 3,000 - 3,999                                 | 520              | 58          | 3                   | 93.9                           |
| 4,000 - 4,999                                 | 332              | 37          | 2                   | 95.7                           |
| 5,000 - 9,999                                 | 614              | 68          | 3                   | 99.1                           |
| 10,000 - 19,999                               | 145              | 16          | 1                   | 99.9                           |
| 20,000 - 29,999                               | 8                | 1           | <1                  | 100.0                          |
| 30,000 +                                      | 7                | 1           | <1                  | 100.0                          |
| Total known                                   | 18,016           | 2,002       | 100                 |                                |
| Total unknown                                 | 4,304            | 478         |                     |                                |
| Total   | 22,320           | 2,480       |                     |                                |

<sup>1</sup> On 23 October 1991, a DC-8-62 struck a "blue bird with red feet" at 39,000 feet. This is the highest reported altitude for a bird strike in the USA.

Table 9. Number of reported strikes that had an adverse effect on the flight of the aircraft, or damaged an aircraft component, for the 25 most frequently reported aircraft types, USA, 1990-1998.

| Negative effect-on-flight |                     |                  |             | Damaged aircraft component |                     |                  |             |
|---------------------------|---------------------|------------------|-------------|----------------------------|---------------------|------------------|-------------|
| Aircraft                  |                     | Reported strikes |             | Aircraft                   |                     | Reported strikes |             |
| Type                      | Engine <sup>1</sup> | 9-year total     | 9-year avg. | Type                       | Engine <sup>1</sup> | 9-year total     | 9-year avg. |
| B-737                     | TF/TJ               | 451              | 50          | B-737                      | TF/TJ               | 763              | 85          |
| MD-80/DC-9                | TF                  | 187              | 21          | MD-80/DC-9                 | TF                  | 304              | 33          |
| BA-31                     | TP                  | 102              | 11          | B-727                      | TJ                  | 156              | 17          |
| C-172                     | PS                  | 85               | 9           | BA-31 Jetstrm              | TP                  | 153              | 17          |
| Saab 340                  | TP                  | 81               | 9           | B-757                      | TF                  | 146              | 16          |
| B-727                     | TJ                  | 77               | 9           | PA-28                      | PS                  | 109              | 12          |
| B-757                     | TF                  | 68               | 8           | C-172                      | PS                  | 108              | 12          |
| PA-28                     | PS                  | 64               | 7           | B-747                      | TF                  | 98               | 11          |
| B-747                     | TF                  | 52               | 6           | BE-1900                    | TF                  | 97               | 11          |
| BE-1900                   | TF                  | 50               | 6           | B-767                      | TF                  | 65               | 7           |
| C-152                     | PS                  | 49               | 5           | Citation 2/3               | TF                  | 64               | 7           |
| DHC8 Dash 8               | TP                  | 45               | 5           | C-152                      | PS                  | 55               | 6           |
| EMB-120                   | TP                  | 39               | 4           | Saab-340                   | TP                  | 49               | 5           |
| Citation 2                | TF                  | 34               | 4           | FK-100                     | TF                  | 42               | 5           |
| Bell 206                  | TS                  | 32               | 4           | DC-10                      | TF                  | 40               | 4           |
| Helicopter                |                     | 28               | 3           | A-320                      | TF                  | 39               | 4           |
| ATR-42                    | TP                  | 26               | 3           | EMB-120                    | TP                  | 39               | 4           |
| B-767                     | TF                  | 26               | 3           | C-182                      | PS                  | 38               | 4           |
| C-150                     | PS                  | 24               | 3           | PA-31                      | PS                  | 37               | 4           |
| Learjet-31/35             | TF                  | 24               | 3           | A-300                      | TF                  | 35               | 4           |
| C-310                     | PS                  | 23               | 3           | C-310                      | PS                  | 35               | 4           |
| FK-100                    | TF                  | 22               | 2           | Bell-206                   | TS                  | 34               | 4           |
| Learjet-25                | TJ                  | 22               | 2           | BE-58                      | PS                  | 33               | 4           |
| C-402                     | PS                  | 21               | 2           | Learjet-31/35              | TF                  | 33               | 4           |
| Total known               |                     | 1,632            | 181         | Total known                |                     | 2,572            | 286         |
| Total unknown/other       |                     | 802              | 89          | Total unknown/other        |                     | 1,201            | 133         |
| Total                     |                     | 2,434            | 270         | Total                      |                     | 3,773            | 419         |

<sup>1</sup> TF = Turbo-fan, TJ = Turbo-jet, TP = Turbo-prop, PS = Piston.

Table 10 A. Civil aircraft components reported as being struck and damaged by wildlife, USA, 1990-1998.

| Parts of aircraft | Birds            |             | Mammals          |             |
|-------------------|------------------|-------------|------------------|-------------|
|                   | Reported strikes |             | Reported strikes |             |
|                   | 9-year total     | 9-year avg. | 9-year total     | 9-year avg. |
| Radome            |                  |             |                  |             |
| Struck            | 2,149            | 239         | 6                | 1           |
| Damaged           | 353              | 39          | 5                | 1           |
| Windshield        |                  |             |                  |             |
| Struck            | 3,539            | 393         | 7                | 1           |
| Damaged           | 308              | 34          | 4                | <1          |
| Nose              |                  |             |                  |             |
| Struck            | 2,538            | 282         | 27               | 3           |
| Damaged           | 218              | 24          | 22               | 2           |
| Engines           |                  |             |                  |             |
| Struck            | 3,201            | 356         | 51               | 6           |
| Damaged           | 1,357            | 151         | 49               | 5           |
| Propeller         |                  |             |                  |             |
| Struck            | 722              | 80          | 82               | 9           |
| Damaged           | 86               | 10          | 72               | 8           |
| Wing/rotor        |                  |             |                  |             |
| Struck            | 2,544            | 283         | 63               | 7           |
| Damaged           | 873              | 97          | 65               | 7           |
| Fuselage          |                  |             |                  |             |
| Struck            | 2,107            | 234         | 35               | 4           |
| Damaged           | 136              | 15          | 33               | 4           |
| Landing Gear      |                  |             |                  |             |
| Struck            | 1,049            | 117         | 187              | 21          |
| Damaged           | 147              | 16          | 122              | 14          |
| Tail              |                  |             |                  |             |
| Struck            | 298              | 33          | 21               | 2           |
| Damaged           | 145              | 16          | 24               | 3           |
| Lights            |                  |             |                  |             |
| Struck            | 184              | 20          | 6                | 1           |
| Damaged           | 157              | 17          | 6                | 1           |
| Other             |                  |             |                  |             |
| Struck            | 610              | 68          | 55               | 6           |
| Damaged           | 298              | 33          | 55               | 6           |
| Total struck      | 18,941           | 2,105       | 540              | 60          |
| Total damaged     | 4,078            | 453         | 457              | 51          |
| Total             | 23,019           | 2,558       | 997              | 111         |

Table 10 B. Reported damage<sup>1</sup> resulting from wildlife strikes to civil aircraft, USA, 1990-1998.

| Damage                   | Reported strikes |             | % of total known |
|--------------------------|------------------|-------------|------------------|
|                          | 9-year total     | 9-year avg. |                  |
| None                     | 16,283           | 1,809       | 81               |
| Minor <sup>2</sup>       | 2,086            | 232         | 10               |
| Minor? <sup>3</sup>      | 400              | 44          | 2                |
| Substantial <sup>4</sup> | 1,268            | 141         | 6                |
| Destroyed <sup>5</sup>   | 19               | 2           | <1               |
| Total known              | 20,056           | 2,228       | 100              |
| Not reported             | 2,879            | 320         |                  |
| Total                    | 22,935           | 2,548       |                  |

<sup>1</sup> The damage codes and descriptions follow the *Manual on the International Civil Aviation Organization Bird Strike Information System*

<sup>2</sup> The aircraft can be rendered airworthy by simple repairs or replacements and an extensive inspection is not necessary.

<sup>3</sup> The aircraft was damaged, but details as to the extent of the damage are lacking.

<sup>4</sup> The aircraft incurs damage or structural failure which adversely affects the structure strength, performance or flight characteristics of the aircraft and which would normally require major repair or replacement of the affected component. Specifically excluded are: Bent fairings or cowlings; small dents or puncture holes in the skin; damage to wing tips; antenna, tires or brakes; engine blade damage not requiring blade replacement.

<sup>5</sup> The damage sustained makes it inadvisable to restore the aircraft to an airworthy condition.

Table 11. Reported effect-on-flight of wildlife strikes to civil aircraft, USA. 1990-1998.

| Effect-on-flight      | Birds            |             |                  | Mammals          |             |                  |
|-----------------------|------------------|-------------|------------------|------------------|-------------|------------------|
|                       | Reported strikes |             |                  | Reported strikes |             |                  |
|                       | 9-year total     | 9-year avg. | % of total known | 9-year total     | 9-year avg. | % of total known |
| None                  | 13,290           | 1,477       | 86               | 135              | 15          | 37               |
| Aborted takeoff       | 557              | 62          | 4                | 66               | 7           | 18               |
| Precautionary landing | 1,126            | 125         | 7                | 39               | 4           | 11               |
| Engine shut down      | 128              | 14          | 1                | 8                | 1           | 2                |
| Other                 | 391              | 43          | 3                | 119              | 13          | 32               |
| Total known           | 15,492           | 1,721       | 100              | 367              | 40          | 100              |
| Not reported          | 6,828            | 759         |                  | 213              | 24          |                  |
| Total                 | 22,320           | 2,480       |                  | 580              | 64          |                  |

Table 12A. Identified bird groups involved in reported wildlife strikes to civil aircraft, USA, 1990-1998.

| Bird groups                 | 9-year total | Bird groups               | 9-year total |
|-----------------------------|--------------|---------------------------|--------------|
| Loons                       | 2            | Shorebirds                | 330          |
| Grebes                      | 8            | Shorebirds                | 7            |
| Grebes                      | 4            | Common snipe              | 2            |
| Eared grebe                 | 3            | Jacanas                   | 1            |
| Western grebe               | 1            | Oystercatchers            | 2            |
| Tropicbirds                 | 1            | Plovers                   | 38           |
| Albatrosses                 | 1            | Lesser golden-plover      | 11           |
| Pelicans                    | 20           | Black-bellied plover      | 4            |
| Cormorants                  | 27           | Killdeer                  | 185          |
| Cormorants                  | 8            | Pacific golden-plover     | 5            |
| Double-crested cormorant    | 7            | Sandpipers                | 47           |
| Anhingas                    | 8            | Upland sandpiper          | 17           |
| Frigatebirds                | 4            | Spotted sandpiper         | 1            |
| Waterfowl                   | 1,243        | Semipalmated sandpiper    | 1            |
| Ducks, geese, swans         | 73           | Least sandpiper           | 1            |
| Ducks                       | 342          | American woodcock         | 2            |
| Blue-winged teal            | 2            | Lesser yellowlegs         | 1            |
| American wigeon             | 2            | Dunlin                    | 1            |
| European wigeon             | 1            | Short-billed dowitcher    | 1            |
| Northern pintail            | 2            | Whimbrel                  | 2            |
| Mallard                     | 142          | Avocets                   | 1            |
| Common eider                | 1            | Terns                     | 30           |
| Ring-necked duck            | 1            | Terns                     | 20           |
| American black duck         | 1            | Common tern               | 2            |
| Common merganser            | 1            | Gull-billed tern          | 1            |
| Canvasback                  | 1            | Arctic tern               | 4            |
| Ring-necked duck            | 1            | Forster's tern            | 2            |
| Mottled duck                | 1            | Least tern                | 1            |
| Wood duck                   | 2            | Gulls                     | 3,222        |
| Gadwall                     | 1            | Gulls                     | 2,912        |
| Geese                       | 399          | Herring gull              | 89           |
| Snow goose                  | 20           | Mew gull                  | 6            |
| Canada goose                | 240          | Ring-billed gull          | 114          |
| Brant                       | 6            | Glaucous-winged gull      | 8            |
| Greater white-fronted goose | 1            | Greater black-backed gull | 11           |
| Swans                       | 2            | Franklin's gull           | 4            |
| Tundra swan                 | 1            | Laughing gull             | 65           |
| Cranes                      | 40           | Bonaparte's gull          | 6            |
| Cranes                      | 16           | Western gull              | 6            |
| Sandhill crane              | 24           | California gull           | 1            |
| Rails/gallinules            | 6            | Woodpeckers               | 9            |
| American coot               | 4            | Woodpeckers               | 2            |
| Common moorhen              | 1            | Northern flicker          | 5            |
| Purple gallinule            | 1            | Yellow-bellied sapsucker  | 2            |

Table 12A. Continued

|                      |       |                           |       |
|----------------------|-------|---------------------------|-------|
| Larks                | 32    | Gallinaceous birds        | 61    |
| Larks                | 8     | Grouse                    | 5     |
| Horned lark          | 24    | Grouse, ptarmigans        | 3     |
| Swallows             | 264   | Quails                    | 6     |
| Swallows             | 145   | Ring-necked pheasant      | 30    |
| Purple martin        | 24    | Hungarian partridge       | 3     |
| Barn swallow         | 57    | Guineafowl                | 1     |
| Cliff swallow        | 4     | Turkeys                   | 13    |
| Tree swallow         | 34    | Hérons                    | 90    |
| Jays                 | 9     | Hérons                    | 31    |
| Blue jay             | 2     | Great blue heron          | 57    |
| Magpie               | 5     | Black-crowned night-heron | 2     |
| Yellow-billed magpie | 2     | Egrets                    | 202   |
| Crows                | 190   | Egrets                    | 140   |
| Crows                | 152   | Cattle egret              | 43    |
| American crow        | 33    | Great egret               | 11    |
| Ravens               | 5     | Snowy egret               | 1     |
| Chickadees           | 2     | Wood stork                | 2     |
| Wrens                | 17    | White ibis                | 5     |
| Mockingbirds         | 24    | Doves                     | 1,241 |
| Mockingbirds         | 20    | Pigeons, doves            | 12    |
| Gray catbird         | 1     | Doves                     | 523   |
| Brown thrasher       | 3     | Rock dove                 | 473   |
| Raptors              | 1,150 | Mourning dove             | 223   |
| Hawks, eagles        | 15    | Barred ground-dove        | 8     |
| Vultures             | 128   | Inca dove                 | 1     |
| Lappet-faced vulture | 1     | Spotted dove              | 1     |
| Black vulture        | 5     | Owls                      | 215   |
| Turkey vulture       | 79    | Owls                      | 135   |
| Osprey               | 28    | Barn-owl                  | 36    |
| Kites, eagles, hawks | 5     | Snowy owl                 | 16    |
| Eagles               | 12    | Eastern screech owl       | 1     |
| Bald eagle           | 20    | Short-eared owl           | 12    |
| Golden eagle         | 1     | Burrowing owl             | 2     |
| Hawks                | 395   | Barred owl                | 2     |
| Red-tailed hawk      | 170   | Long-eared owl            | 2     |
| Red-shouldered hawk  | 3     | Great horned owl          | 8     |
| Rough-legged hawk    | 4     | Northern saw-whet owl     | 1     |
| Swainson's hawk      | 1     | Thrushes                  | 98    |
| Cooper's hawk        | 1     | Thrushes                  | 4     |
| Sharp-shinned hawk   | 1     | Swainson's thrush         | 1     |
| Northern harrier     | 8     | American robin            | 91    |
| Falcons              | 11    | Hermit thrush             | 1     |
| Peregrine falcon     | 19    | Eastern bluebird          | 1     |
| Merlin               | 8     |                           |       |
| American kestrel     | 235   |                           |       |

Table 12A. Continued

|                          |     |                        |        |
|--------------------------|-----|------------------------|--------|
| Nighthawks               | 22  | Meadowlarks            | 118    |
| Common nighthawk         | 19  | Bobolink               | 1      |
| Whip-poor-will           | 2   | Meadowlarks            | 28     |
| Nightjars                | 1   | Eastern meadowlark     | 76     |
| Parrots                  | 3   | Western meadowlark     | 13     |
| Kingfishers              | 4   | Finches                | 52     |
| Perching birds           | 44  | Finches                | 12     |
| Tyrant flycatchers       | 2   | American goldfinch     | 5      |
| Tyrant fly-catchers      | 1   | House sparrow          | 5      |
| Great-crested flycatcher | 1   | Rose-breasted grosbeak | 1      |
| Swifts                   | 14  | Red-created cardinal   | 1      |
| Swifts                   | 4   | Snow bunting           | 27     |
| Chimney swift            | 10  | Rufous-sided towhee    | 1      |
| Waxwings                 | 1   | Sparrows               | 788    |
| Cedar waxwing            | 1   | Sparrows               | 775    |
| Starlings                | 544 | Savannah sparrow       | 8      |
| European starling        | 535 | Golden crowned sparrow | 1      |
| Mynas                    | 9   | Field sparrow          | 1      |
| Warblers                 | 2   | White-throated sparrow | 2      |
| Wood warblers            | 1   | Fox sparrow            | 1      |
| Canada warbler           | 1   | Mannikins              | 25     |
| Blackbirds               | 678 | Mannikins              | 9      |
| Blackbirds               | 618 | Nutmeg mannikin        | 6      |
| Red-winged blackbird     | 17  | Chestnut mannikin      | 10     |
| Brewer's blackbird       | 1   |                        |        |
| Grackles                 | 35  |                        |        |
| Brown-headed cowbird     | 3   |                        |        |
| Orioles                  | 4   |                        |        |
|                          |     | Total known birds      | 10,830 |
|                          |     | Total unknown birds    | 11,490 |
|                          |     | Total birds            | 22,320 |

Table 12B. Identified mammal and reptile groups involved in reported wildlife strikes to civil aircraft, USA, 1990-1998.

| <b>Mammals</b>               | <b>9-year total</b> |
|------------------------------|---------------------|
| Edentates (Armadillo)        | 11                  |
| Chiropteras (Bats)           | 27                  |
| Carnivores                   | 112                 |
| Coyotes                      | 61                  |
| Dog                          | 12                  |
| Fox                          | 18                  |
| Raccoon                      | 7                   |
| Coatis                       | 1                   |
| Striped skunk                | 8                   |
| House cat                    | 3                   |
| River otter                  | 2                   |
| Marsupial (Opossum)          | 14                  |
| Rodents                      | 18                  |
| Woodchuck                    | 15                  |
| Muskrat                      | 2                   |
| Rodents                      | 1                   |
| Lagomorphs (hares, rabbits)  | 6                   |
| Ungulates                    | 385                 |
| Caribou                      | 1                   |
| Cattle                       | 5                   |
| Deer                         | 79                  |
| Mule deer                    | 1                   |
| White-tailed deer            | 284                 |
| Elk                          | 6                   |
| Horse                        | 3                   |
| Moose                        | 2                   |
| Peccary                      | 1                   |
| Pronghorn                    | 3                   |
| <b>Total known mammals</b>   | <b>573</b>          |
| <b>Total unknown mammals</b> | <b>7</b>            |
| <b>Total mammals</b>         | <b>580</b>          |
| <b>Reptiles</b>              |                     |
| Turtles                      | 25                  |
| Turtle                       | 19                  |
| Florida soft shell turtle    | 3                   |
| Box turtle                   | 3                   |
| Alligators                   | 10                  |
| <b>Total reptiles</b>        | <b>35</b>           |

Table 13. Number of reported wildlife strikes damaging one or more components of a civil aircraft by wildlife group, USA, 1990-1998.

| <b>Birds</b>       | 9-year total | % of total known | <b>Mammals</b>  | 9-year total | % of total known |
|--------------------|--------------|------------------|-----------------|--------------|------------------|
| Waterfowl          | 578          | 31.2             | Ungulates       | 311          | 96.3             |
| Gulls              | 576          | 31.1             | Carnivores      | 10           | 3.1              |
| Raptors            | 277          | 14.9             | Chiropteras     | 2            | 0.6              |
| Doves              | 134          | 7.2              | Total known     | 323          | 100.0            |
| Blackbirds         | 49           | 2.6              | Total unknown   | 3            |                  |
| Herons             | 44           | 2.4              | Total mammals   | 326          |                  |
| Owls               | 30           | 1.6              |                 |              |                  |
| Starlings          | 23           | 1.2              | <b>Reptiles</b> |              |                  |
| Shorebirds         | 21           | 1.1              | Alligators      | 1            | 100.0            |
| Crows              | 20           | 1.1              | Total reptiles  | 1            |                  |
| Gallinaceous birds | 19           | 1.0              |                 |              |                  |
| Cranes             | 17           | 0.9              |                 |              |                  |
| Sparrows           | 17           | 0.9              |                 |              |                  |
| Pelicans           | 11           | 0.6              |                 |              |                  |
| Cormorants         | 8            | 0.4              |                 |              |                  |
| Thrushes           | 7            | 0.4              |                 |              |                  |
| Larks              | 6            | 0.3              |                 |              |                  |
| Swallows           | 3            | 0.2              |                 |              |                  |
| Terns              | 2            | 0.1              |                 |              |                  |
| Nighthawks         | 2            | 0.1              |                 |              |                  |
| Perching birds     | 2            | 0.1              |                 |              |                  |
| Finches            | 2            | 0.1              |                 |              |                  |
| Loons              | 1            | <0.1             |                 |              |                  |
| Grebes             | 1            | <0.1             |                 |              |                  |
| Tropicbirds        | 1            | <0.1             |                 |              |                  |
| Albatrosses        | 1            | <0.1             |                 |              |                  |
| Rails              | 1            | <0.1             |                 |              |                  |
| Swifts             | 1            | <0.1             |                 |              |                  |
| Mockingbirds       | 1            | <0.1             |                 |              |                  |
| Total known        | 1,855        | 100.0            |                 |              |                  |
| Total unknown      | 1,591        |                  |                 |              |                  |
| Total birds        | 3,446        |                  |                 |              |                  |

Table 14. Number of wildlife strikes having a negative effect on the flight of a civil aircraft, USA, 1990-1998.

| <b>Birds</b>       | 9-year total | % of total known | <b>Mammals</b>  | 9-year total | % of total known |
|--------------------|--------------|------------------|-----------------|--------------|------------------|
| Grebes             | 1            | 0.1              | Carnivores      | 22           | 9.6              |
| Tropicbirds        | 1            | 0.1              | Lagomorphs      | 1            | <1               |
| Pelicans           | 6            | 0.5              | Rodents         | 1            | <1               |
| Cormorants         | 3            | 0.2              | Ungulates       | 204          | 89.5             |
| Waterfowl          | 264          | 21.1             | Total known     | 228          | 100.0            |
| Raptors            | 168          | 13.4             | Total unknown   | 4            |                  |
| Gallinaceous birds | 13           | 1.0              | Total mammals   | 232          |                  |
| Hérons             | 16           | 1.3              |                 |              |                  |
| Egrets             | 7            | 0.6              | <b>Reptiles</b> |              |                  |
| Cranes             | 9            | 0.7              | Alligators      | 1            | 50.0             |
| Shorebirds         | 20           | 1.6              | Turtles         | 1            | 50.0             |
| Gulls              | 424          | 33.8             | Total reptiles  | 2            | 100.0            |
| Terns              | 2            | 0.2              |                 |              |                  |
| Doves              | 136          | 10.9             |                 |              |                  |
| Owls               | 20           | 1.6              |                 |              |                  |
| Woodpeckers        | 2            | 0.2              |                 |              |                  |
| Larks              | 8            | 0.6              |                 |              |                  |
| Swallows           | 4            | 0.3              |                 |              |                  |
| Starlings          | 37           | 3.0              |                 |              |                  |
| Crows              | 15           | 1.2              |                 |              |                  |
| Mockingbirds       | 2            | 0.2              |                 |              |                  |
| Thrushes           | 3            | 0.2              |                 |              |                  |
| Perching birds     | 1            | 0.1              |                 |              |                  |
| Blackbirds         | 50           | 4.0              |                 |              |                  |
| Finches            | 6            | 0.5              |                 |              |                  |
| Snow bunting       | 4            | 0.3              |                 |              |                  |
| Sparrows           | 30           | 2.4              |                 |              |                  |
| Mannikins          | 1            | 0.1              |                 |              |                  |
| Total known birds  | 1,253        | 100.0            |                 |              |                  |
| Unknown birds      | 956          |                  |                 |              |                  |
| Total birds        | 2,209        |                  |                 |              |                  |

Table 15. Reported aircraft down time (hours) resulting from wildlife strikes to civil aircraft, USA, 1990-1998.

| Birds                      | Reported down time (hours) |               | % of total known |
|----------------------------|----------------------------|---------------|------------------|
|                            | 9-year total               | 9-year avg.   |                  |
| Loons                      | 504                        | 56            | 0.6              |
| Tropicbirds                | 10                         | 1             | <0.1             |
| Anhingas                   | 16                         | 2             | <0.1             |
| Frigatebirds               | 3                          | <1            | <0.1             |
| Pelicans                   | 137                        | 15            | 0.2              |
| Hérons                     | 175                        | 19            | 0.2              |
| Egrets                     | 1,413                      | 157           | 1.7              |
| Cranes                     | 379                        | 42            | 0.5              |
| Waterfowl                  | 29,837                     | 3,315         | 36.8             |
| Raptors                    | 23,244                     | 2,583         | 28.6             |
| Gallinaceous birds         | 69                         | 8             | 0.1              |
| Shorebirds                 | 150                        | 17            | 0.2              |
| Terns                      | 4                          | <1            | <0.1             |
| Gulls                      | 17,666                     | 1,963         | 21.8             |
| Doves                      | 5,370                      | 597           | 6.6              |
| Owls                       | 851                        | 95            | 1.0              |
| Swallows                   | 16                         | 2             | <0.1             |
| Perching birds             | 31                         | 3             | <0.1             |
| Starlings                  | 168                        | 19            | 0.2              |
| Crows                      | 78                         | 9             | 0.1              |
| Blackbirds                 | 976                        | 108           | 1.2              |
| Snow buntings              | 12                         | 1             | <0.1             |
| Finches                    | 2                          | <1            | <0.1             |
| Sparrows                   | 19                         | 2             | <0.1             |
| Mannikins                  | 3                          | <1            | <0.1             |
| <b>Total known birds</b>   | <b>81,133</b>              | <b>9,015</b>  | <b>100.0</b>     |
| <b>Total unknown birds</b> | <b>16,680</b>              | <b>1,853</b>  |                  |
| <b>Total birds</b>         | <b>97,813</b>              | <b>10,868</b> |                  |
| <b>Mammals</b>             |                            |               |                  |
| Carnivores                 | 7,950                      | 883           | 12.1             |
| Ungulates                  | 57,904                     | 6,434         | 87.9             |
| <b>Total mammals</b>       | <b>65,854</b>              | <b>7,317</b>  | <b>100.0</b>     |
| <b>Grand total</b>         | <b>163,667</b>             | <b>18,185</b> |                  |

Table 16. Reported monetary losses (cost of damage, lost revenue, and other monetary losses) in U.S. dollars, resulting from wildlife strikes to civil aircraft, USA, 1990-1998.

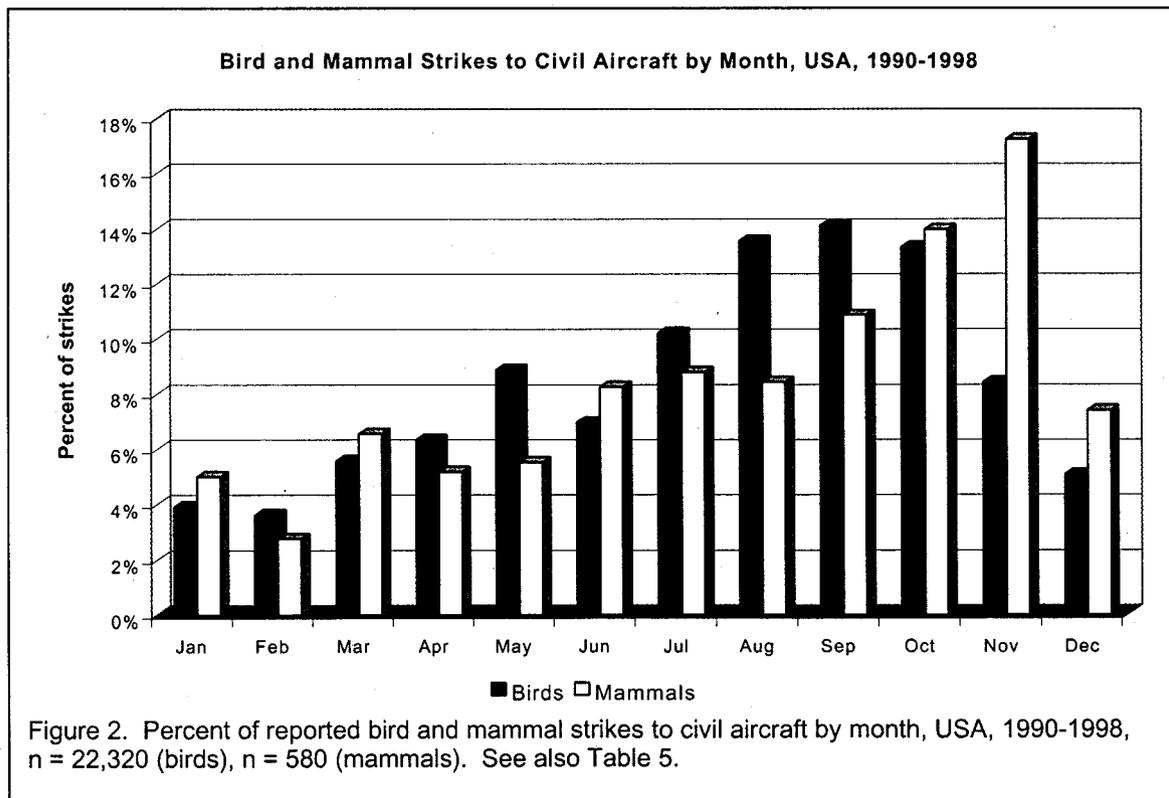
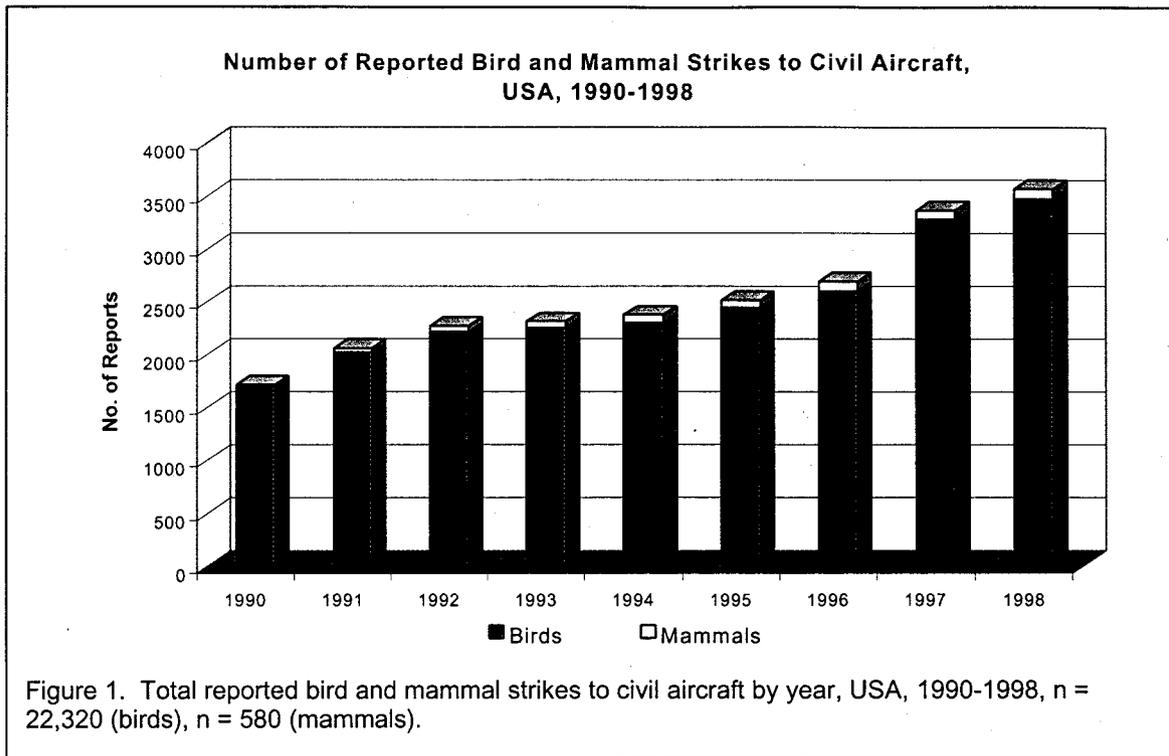
| Birds                | Reported monetary losses (\$) |                  |              |
|----------------------|-------------------------------|------------------|--------------|
|                      | 9-year total                  | 9-year avg.      | % of known   |
| Loons                | 11,200                        | 1,244            | <0.1         |
| Tropicbirds          | 5,200                         | 578              | <0.1         |
| Anhingas             | 1,800                         | 200              | <0.1         |
| Frigatebirds         | 4,900                         | 544              | <0.1         |
| Pelicans             | 34,000                        | 3,778            | 0.1          |
| Hérons               | 507,000                       | 56,333           | 1.0          |
| Egrets               | 135,540                       | 15,060           | 0.3          |
| Cranes               | 255,660                       | 28,407           | 0.5          |
| Waterfowl            | 27,854,250                    | 3,094,917        | 53.5         |
| Raptors              | 6,303,267                     | 700,363          | 12.1         |
| Gallinaceous birds   | 5,120                         | 569              | <0.1         |
| Shorebirds           | 232,902                       | 25,878           | 0.4          |
| Gulls                | 10,102,777                    | 1,122,531        | 19.4         |
| Doves                | 4,456,164                     | 495,129          | 8.6          |
| Owls                 | 900,408                       | 100,045          | 1.7          |
| Thrashers            | 120                           | 13               | <0.1         |
| Starlings            | 31,550                        | 3,506            | 0.1          |
| Crows                | 7,905                         | 878              | <0.1         |
| Perching birds       | 300,000                       | 33,333           | 0.6          |
| Blackbirds           | 864,250                       | 96,028           | 1.7          |
| Sparrows             | 2,950                         | 328              | <0.1         |
| Mannikins            | 2,000                         | 222              | <0.1         |
| <b>Total known</b>   | <b>52,018,963</b>             | <b>5,779,885</b> | <b>100.0</b> |
| <b>Total unknown</b> | <b>15,612,047</b>             | <b>1,734,672</b> |              |
| <b>Total birds</b>   | <b>67,631,010</b>             | <b>7,514,557</b> |              |
| <b>Mammals</b>       |                               |                  |              |
| Carnivores           | 140,120                       | 15,569           | 2.07         |
| Ungulates            | 6,636,745                     | 737,416          | 97.93        |
| <b>Total mammals</b> | <b>6,776,865</b>              | <b>752,985</b>   | <b>100.0</b> |
| <b>Grand total</b>   | <b>74,407,875</b>             | <b>8,267,542</b> |              |

Table 17. Number of reported wildlife strikes and reported losses by category of effect and category of losses to civil aircraft, USA, 1990-1998.

| Year                    | Number of reported strikes  |       |             |       |                        |                       |                                  |              |              |       | Cost in millions of dollars (No. reports) |            |            |
|-------------------------|-----------------------------|-------|-------------|-------|------------------------|-----------------------|----------------------------------|--------------|--------------|-------|---|------------|------------|
|                         | With effect on flight (EOF) |       | With damage |       | Damage and EOF and EOF | % with damage and EOF | Lost time in hours (No. reports) | Direct       |              | Other | Total                                     |            |            |
|                         | Total                       | 125   | 315         | 359   |                        |                       |                                  | 21           | 3,248 (60)   |       |   | 3,798 (32) | 0.529 (15) |
| 1990                    | 1,720                       | 125   | 315         | 359   | 21                     | 3,248 (60)            | 3,798 (32)                       | 0.529 (15)   | 4,327 (42)   |       |   |            |            |
| 1991                    | 2,064                       | 162   | 323         | 405   | 20                     | 4,529 (60)            | 1,985 (50)                       | 0.542 (23)   | 2,527 (54)   |       |   |            |            |
| 1992                    | 2,275                       | 214   | 319         | 446   | 20                     | 8,849 (78)            | 2,902 (51)                       | 0.083 (26)   | 2,985 (66)   |       |   |            |            |
| 1993                    | 2,317                       | 242   | 371         | 478   | 21                     | 18,574 (66)           | 2,494 (56)                       | 0.105 (20)   | 2,599 (61)   |       |   |            |            |
| 1994                    | 2,380                       | 284   | 420         | 540   | 23                     | 40,218 (102)          | 3,439 (77)                       | 1.604 (25)   | 5,033 (83)   |       |   |            |            |
| 1995                    | 2,526                       | 310   | 451         | 608   | 24                     | 9,792 (95)            | 18,734 (64)                      | 4.501 (29)   | 23,235 (74)  |       |   |            |            |
| 1996                    | 2,696                       | 350   | 472         | 647   | 24                     | 20,111 (146)          | 4,385 (89)                       | 0.623 (35)   | 5,009 (99)   |       |   |            |            |
| 1997                    | 3,381                       | 368   | 561         | 765   | 23                     | 34,725 (182)          | 8,016 (133)                      | 1.421 (38)   | 9,437 (145)  |       |   |            |            |
| 1998                    | 3,576                       | 381   | 536         | 763   | 21                     | 23,621 (199)          | 16,140 (129)                     | 3.104 (51)   | 19,244 (135) |       |   |            |            |
| 9-year total            | 22,935                      | 2,436 | 3,768       | 5,011 |                        | 163,667 (988)         | 61,894 (681)                     | 12.513 (262) | 74,398 (759) |       |   |            |            |
| 9-year avg.             | 2,548                       | 271   | 419         | 557   | 22                     | 18,185 (110)          | 6,877 (76)                       | 1.390 (29)   | 8,226 (84)   |       |   |            |            |
| Losses/incident         |                             |       |             |       |                        | 166                   | 0.091                            | 0.047        | 0.139        |       |   |            |            |
| Estimated annual losses |                             |       |             |       |                        |                       |                                  |              |              |       |   |            |            |
| Minimum <sup>1</sup>    |                             |       |             |       |                        | 92,233                | 50,604                           | 26,592       | 77,196       |       |   |            |            |
| Maximum <sup>2</sup>    |                             |       |             |       |                        | 461,165               | 253,018                          | 132,96       | 385,978      |       |   |            |            |

<sup>1</sup> Minimum values are based on the assumption that all 5,011 reported strikes having an adverse effect on the flight and/or aircraft engendered similar amounts of damage and/or down time, and that these reports are all of the damaging strikes that occurred.

<sup>2</sup> Maximum values are based on the assumption that the 5,011 reported strikes having an adverse effect represent 20% of all strikes that had an adverse effect.



### Time of Occurrence of Bird Strikes

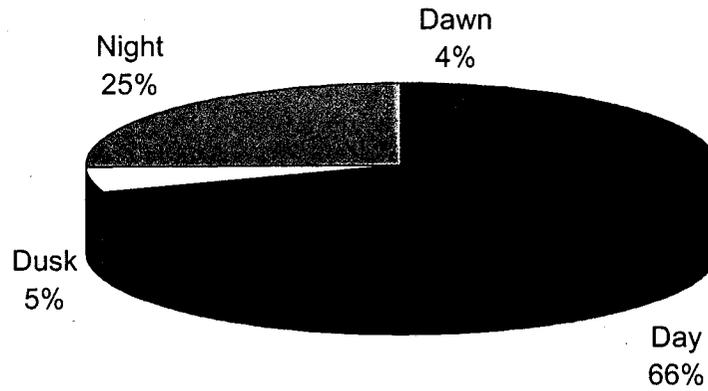


Figure 3. Percent of reported bird strikes to civil aircraft by time of occurrence, USA, 1990-1998, n = 20,578. See also Table 6.

### Time of Occurrence of Mammal Strikes

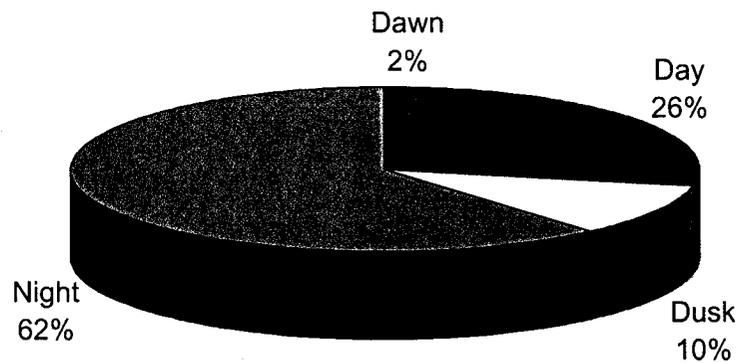


Figure 4. Percent of reported mammal strikes to civil aircraft by time of occurrence, USA, 1990-1998, n = 501. See also Table 6.

### Altitude of Occurrence of Bird Strikes

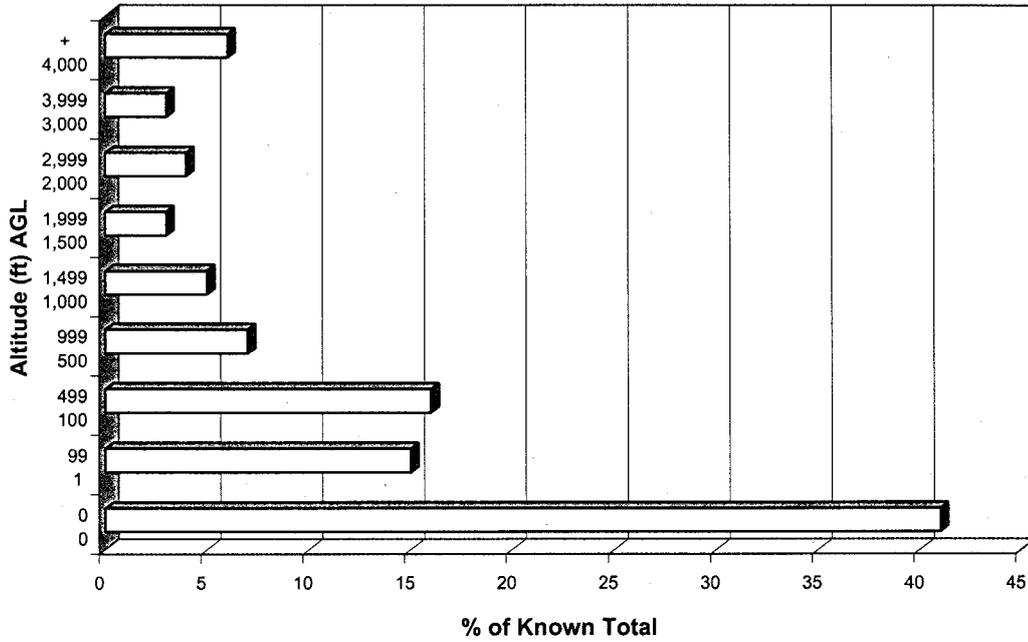


Figure 5. Percent of reported bird strikes to civil aircraft by altitude above ground level (AGL) of occurrence, USA, 1990-1998, n = 18,016. See also Table 8.