Rotorcraft Bird Strike Data

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December 2016

DOT/FAA/TC-TN16/48

U.S. Department of Transportation

Federal Aviation Administration

NOTICE

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/TC-TN16/48		
4. Title and Subtitle ROTORCRAFT BIRD STRIKE DATA		5. Report Date December 2016
		6. Performing Organization Code
7. Author(s) Traci Stadtmueller		8. Performing Organization Report No. ANG-E271
9. Performing Organization Name and Address FAA William J. Hughes Technical Center Atlantic City, NJ 08405		10. Work Unit No. (TRAIS)
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration William J. Hughes Technical Center Aviation Research Division ANG-E271 Atlantic City International Airport, NJ 08405		13. Type of Report and Period Covered Technical Note
		14. Sponsoring Agency Code ANG-E271
15. Supplementary Notes		

16. Abstract

Bird strikes to rotorcraft pose a major threat. Not only does a bird strike have the potential to cause significant and costly damage to the aircraft itself, but the potential for human injury or death is also a risk.

Currently, Title 14 Code of Federal Regulations (CFR) Part 29.631 outlines the requirements for continued safe flight and landing after a bird strike occurs. This requires that a rotorcraft must be capable of continued safe flight and landing after a bird strike of a 2.2 lb (1.0 kg) bird. This is at an assumed altitude of up to 8000 feet and a relative velocity equal to the lesser of never exceed speed or maximum speed in level flight with maximum continuous power for Category A certification. For Category B certification, under the same conditions as above, the rotorcraft must be capable of a safe landing subsequent to the bird strike.

Title 14 CFR 29.631 also requires that it be demonstrated, by test or analysis, that rotorcraft windshields are able to withstand the bird strike without penetration. In addition to the windshield, other areas of impact that are of particular interest include flight control surfaces (which includes main and tail rotors) and exposed flight control system components.

The FAA plans to update their guidance material for rotorcraft bird strikes. As the basis for this update, two databases were used to gather data on bird strikes that were specific to rotorcraft. These databases were the FAA Wildlife Strike Database and the Safety Performance Analysis System (SPAS) database. Specifically, in the SPAS database, the Accident/Incident Database Subsystem was used.

The results of the analyses of both databases are presented in this report. The findings can be used as the basis for determining methods of deterrence for keeping birds away from rotorcraft.

17. Key Words	18. Distribution Statement
Rotorcraft, Bird strike	This document is available to the U.S. public through the National Technical Information Service (NTIS), Springfield, Virginia 22161. This document is also available from the Federal Aviation Administration William J. Hughes Technical Center at actlibrary.tc.faa.gov.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	34	

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AIDS	Accident/Incident Database Subsystem
CFR	Code of Federal Regulations
SPAS	Safety Performance Analysis System
VNE	Never exceed speed

EXECUTIVE SUMMARY

Bird strikes to rotorcraft pose a major threat. Currently, Title 14 Code of Federal Regulations (CFR) Part 29.631 outlines the requirements for continued safe flight and landing after a bird strike. This requires that a rotorcraft must be capable of continued safe flight and landing after a bird strike of a 2.2 lb (1.0 kg) bird. This is at an assumed altitude of up to 8000 feet and a relative velocity equal to the lesser of never exceed speed or maximum speed in level flight with maximum continuous power for Category A certification. For Category B certification, under the same conditions as above, the rotorcraft must be capable of a safe landing subsequent to the bird strike.

Title 14 CFR 27.775 does not currently have a requirement for bird strikes; however, it stipulates the use of non-splintering safety glass when glass is used in windshields and for windows to protect crew and passengers in the event that window fracturing occurs. An amendment to this CFR allows the use of materials other than non-splintering safety glass (i.e., plastics). The CFR stipulates that whatever material is used should not break into dangerous fragments on impact.

The FAA plans to update its guidance material for rotorcraft bird strikes. As the basis for this update, two databases were used to gather data on bird strikes that were specific to rotorcraft. These databases were the FAA Wildlife Strike Database and Safety Performance Analysis System (SPAS) database. In the SPAS database, specifically, the Accident/Incident Database Subsystem was used.

The results of the analysis are presented in this report, which summarizes strike locations, strike damage locations, phase of flight, height above ground of the rotorcraft when struck, speed of rotorcraft when struck, time of day the strike occurred, and the type of species struck. This knowledge will enable the FAA to determine what enhancements need to be made to the advisory material. In addition, it will provide details about the time, place, and locations in which strikes are occurring. An understanding of these variables has the potential to help researchers develop methods of deterrence for keeping birds away from rotorcraft.

ROTORCRAFT BIRD STRIKE DATA

BACKGROUND

Bird strikes to rotorcraft pose a major threat. Not only does a bird strike have the potential to cause significant and costly damage to the aircraft itself, but the potential for human injury or death is also a risk. Presently, manufacturers of rotorcraft must assume that birds will strike the vehicle while in flight at speeds up to and including never exceed speed (VNE). Because of this, the FAA has regulations in place to provide for safe flight after a bird strike in the form of Title 14 Code of Federal Regulations (CFR) Part 29.631 [1].

Currently, 14 CFR 29.631 outlines the requirements for continued safe flight and landing subsequent to a bird strike. This requires that a rotorcraft must be capable of continued safe flight and landing after a bird strike of a 2.2 lb (1.0 kg) bird. This is at an assumed altitude of up to 8000 feet and a relative velocity equal to the lesser of VNE or maximum speed in level flight with maximum continuous power for Category A certification. For Category B certification, under the same conditions as above, the rotorcraft must be capable of a safe landing subsequent to the bird strike.

Title 14 CFR 29.631 also requires that it be demonstrated, by test or analysis, that rotorcraft windshields will withstand the bird strike without penetration. In addition to the windshield, other areas of impact that are of particular interest include flight control surfaces (which includes main and tail rotors) and exposed flight control system components.

Title 14 CFR 27.775 [2] does not currently have a requirement for bird strikes; however, it stipulates the use of non-splintering safety glass when glass is used in windshields and windows to protect crew and passengers in the event that window fracturing occurs. An amendment to this CFR allows the use of materials other than non-splintering safety glass (i.e., plastics). Whatever material is used should not break into dangerous fragments on impact.

The FAA plans to update their guidance material for rotorcraft bird strikes. As the basis for this update, data were gathered using two databases on bird strikes that were specific to rotorcraft. These databases were the FAA Wildlife Strike Database [3] and the Safety Performance Analysis System (SPAS) database [4]. In the SPAS, specifically, the Accident/Incident Database Subsystem (AIDS) was used.

The results of the analysis are presented in this report and include summaries of the strike locations, strike damage locations, phase of flight, height above ground of the rotorcraft when struck, speed of rotorcraft when struck, time of day the strike occurred, and type of species struck. This knowledge will allow the FAA to determine what enhancements need to be made to the advisory material. In addition, it will provide details regarding the time, place, and locations in which strikes are occurring. Understanding these variables has the potential to help researchers determine methods of deterrence for keeping birds away from rotorcraft.

FAA WILDLIFE STRIKE DATABASE

The FAA Wildlife Strike Database [3] contains reports of strikes made voluntarily by airlines, airports, and pilots. The database contains reports from 1990–present. For this analysis, strike reports from 1990 through March 2016 were included. To make the data searches more manageable, the data were broken into three time periods: 1990–1999, 2000–2009, and 2010–March 2016.

Figures 1–3 show the location of strikes on rotorcraft during the stated time periods. For each time period, the windshield and rotors were the most commonly struck locations on the rotorcraft. The nose, fuselage, and "other" locations were also commonly struck areas. Figure 4 shows a summary of the location of strikes between 1990 and March 2016.

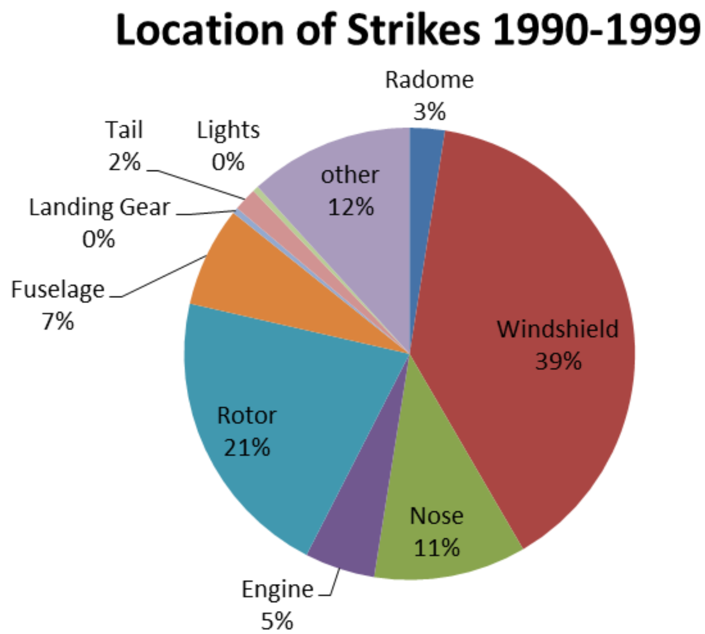

Figure 1. Location of strikes on rotorcraft between 1990 and 1999

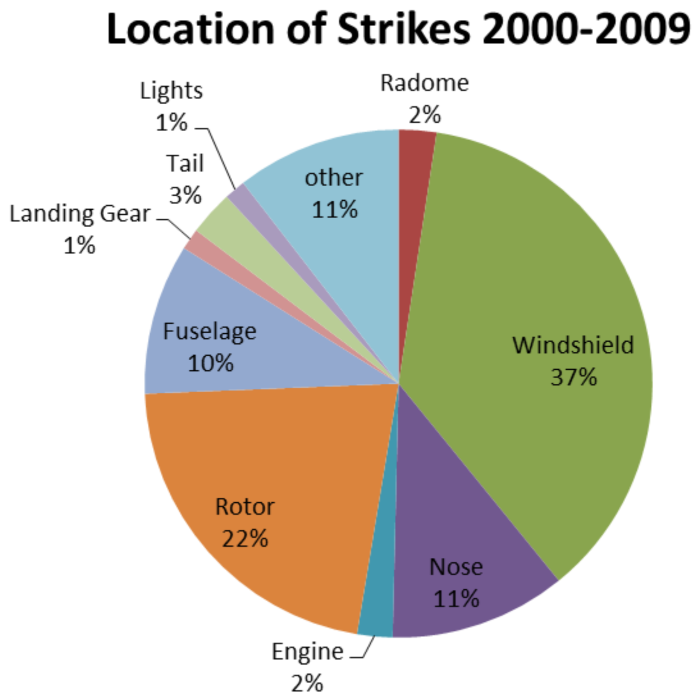

Figure 2. Location of strikes on rotorcraft between 2000 and 2009

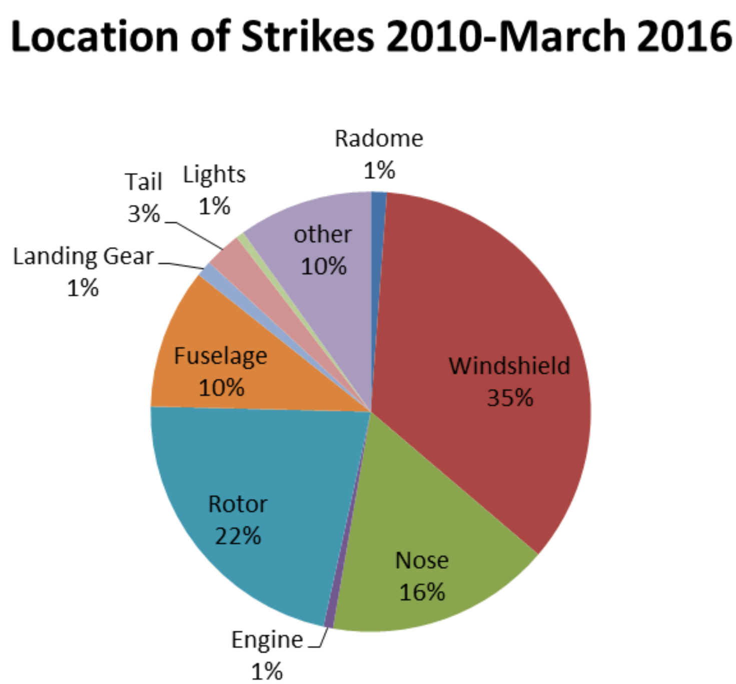

Figure 3. Location of strikes on rotorcraft between 2010 and March 2016

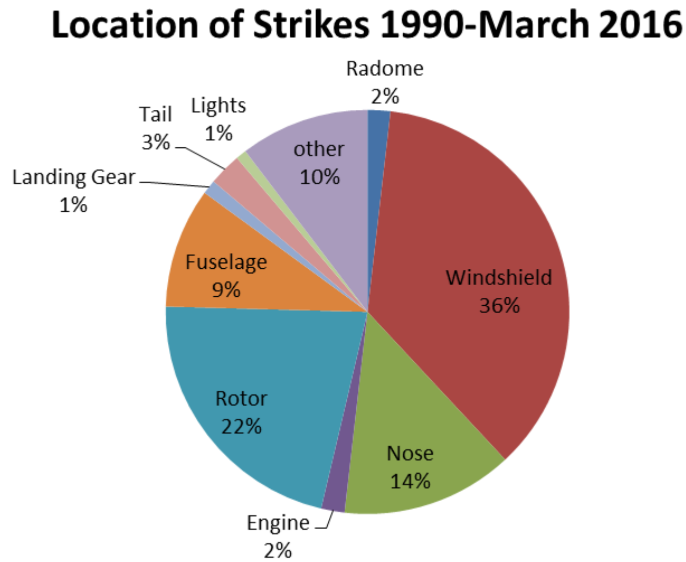

Figure 4. Location of strikes on rotorcraft between 1990 and March 2016

Figures 5–7 show the location of damage on rotorcraft during the stated time periods. Because most strikes occurred to the windshields or rotors, it is logical that these are also the most common location for damage to occur. The nose, rotor, and "other" locations are also identified as other commonly damaged locations. Figure 8 shows a summary of location of damage on rotorcraft between 1990 and March 2016.

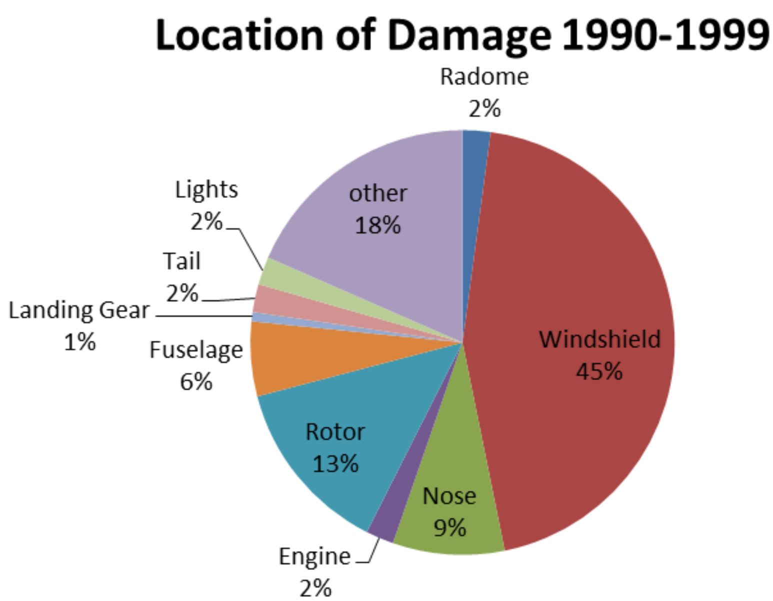

Figure 5. Location of damage on rotorcraft between 1990 and 1999

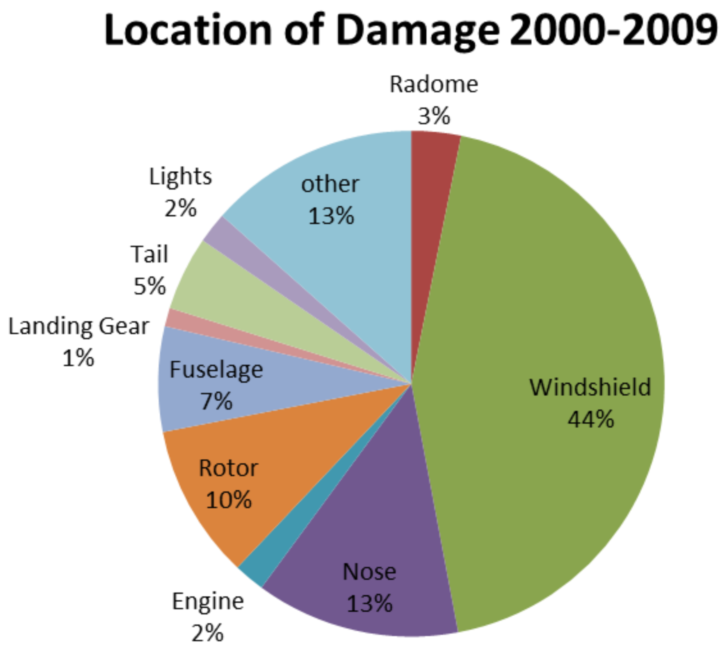

Figure 6. Location of damage on rotorcraft between 2000 and 2009

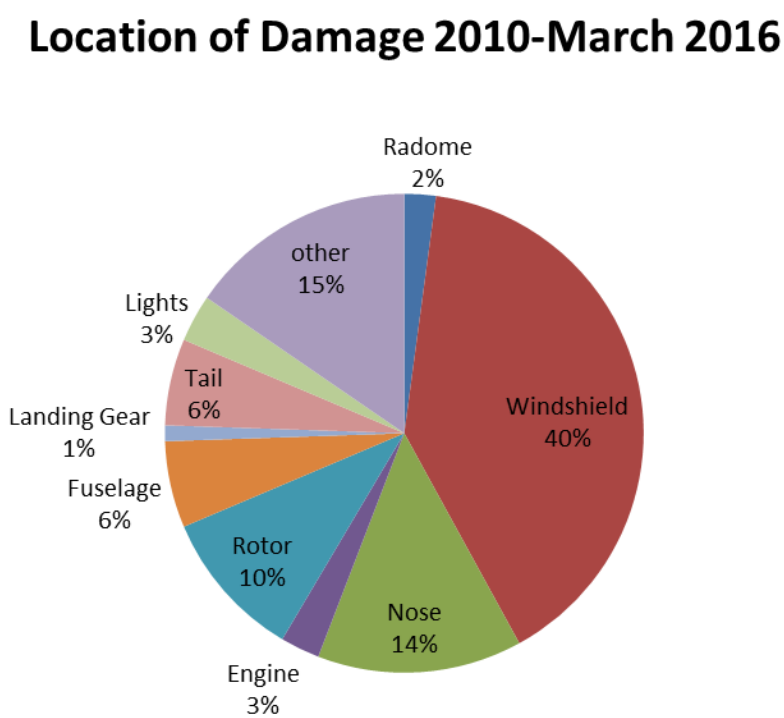

Figure 7. Location of damage on rotorcraft between 2010 and March 2016

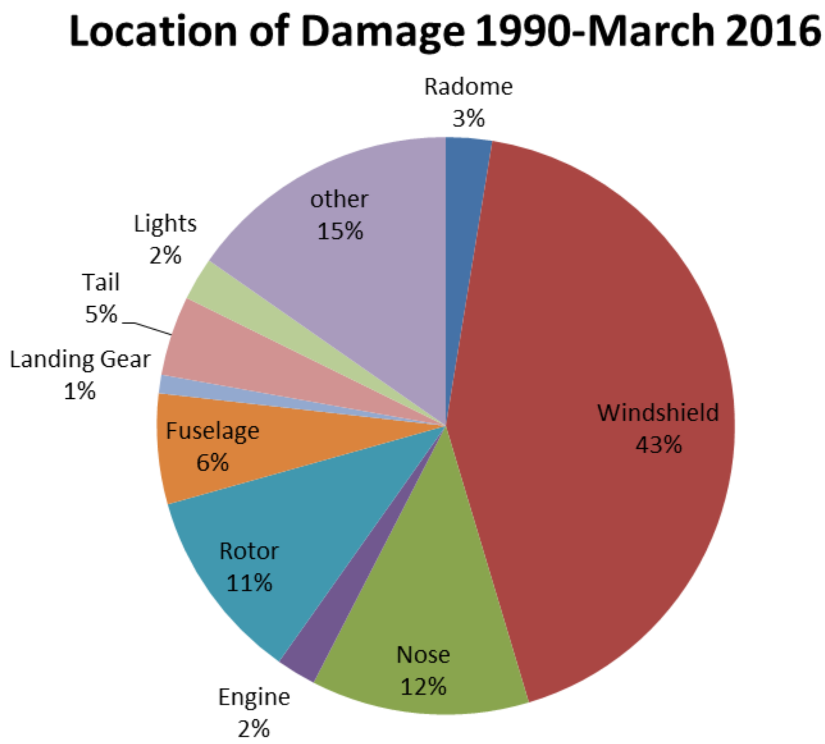

Figure 8. Location of damage on rotorcraft between 1990 and March 2016

Table 1 shows the raw data for the strike and damage locations for 1990–March 2016. The data show that the windshield had the most reported strikes of any location and, consequently, the most damage reported. Rotors were the second most reported strike location; however, they did not constitute the second highest reported category for damage. After windshields, the most damage reported was to the rotor, followed by the nose.

Table 1. Summary of location of strikes and damage between 1990 and March 2016

Location of strikes and damage between 1990 and March 2016		
Location	# of reported strikes/% of total	# of reported damage/% of total
Windshield	637/36%	249/43%
Rotor	382/22%	63/11%
Nose	242/14%	71/12%
Other	182/10%	89/15%
Fuselage	169/10%	36/6%
Subtotal	**1612/92%**	**508/87%**
Tail	46/3%	26/5%
Engine	33/2%	13/2%
Radome	32/2%	15/3%
Landing Gear	20/1%	6/1%
Lights	15/1%	14/2%
Subtotal	**146/8%**	**74/13%**
Total	**1758**	**582**

Figures 9–11 show the types of birds that were reported struck. For each of the three time periods, unknown birds of small and medium size were most reported. Gulls also appear to have been highly problematic during all time periods. When comparing the earlier time period data with the 2010–March 2016 time period data, there is a significant increase in the types of species reported. This may be attributed to the ability of the individuals reporting strikes in more recent years to send bird remains to the Smithsonian Institute for species identification.

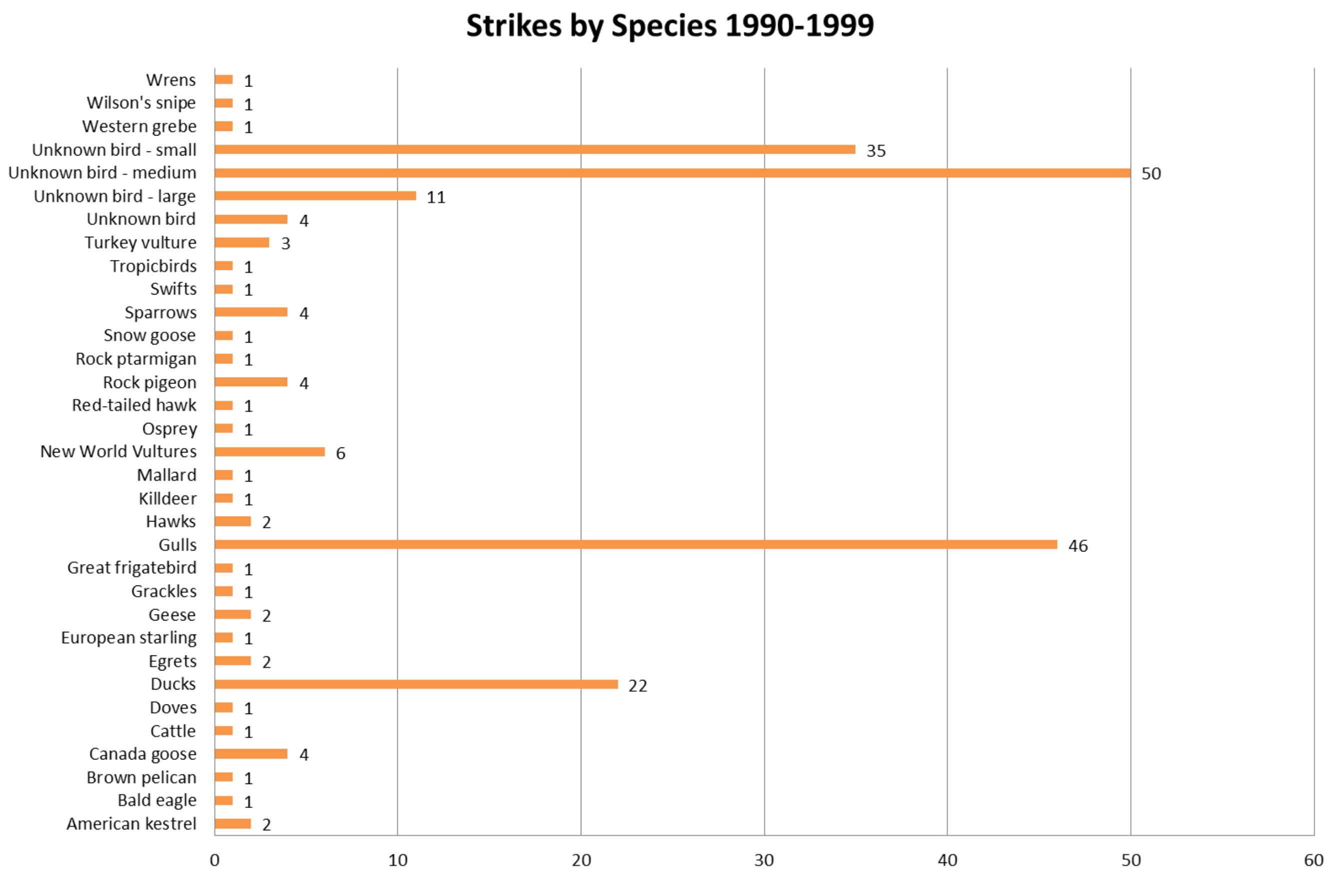

Figure 9. Types of species struck by rotorcraft between 1990 and 1999

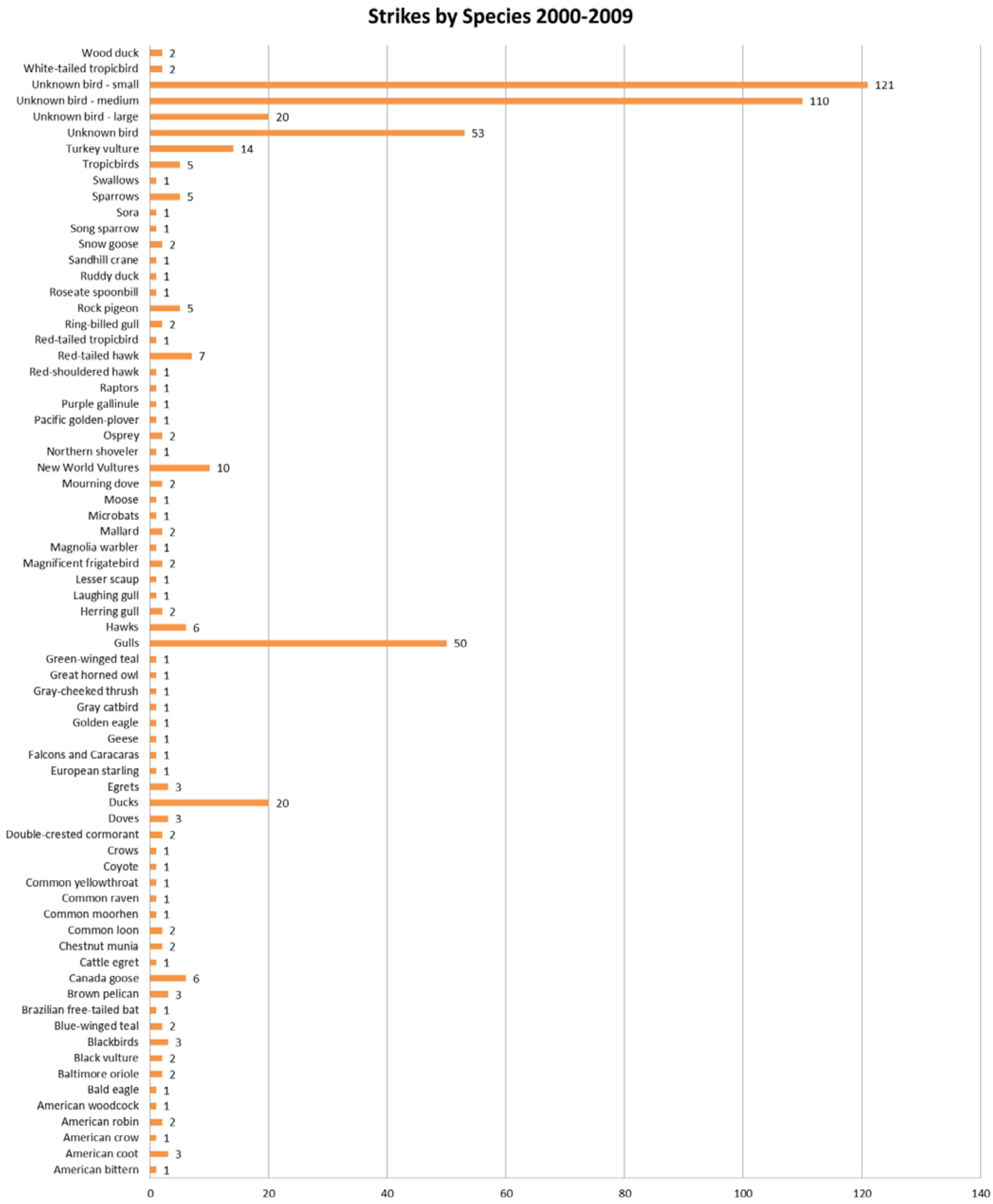

Figure 10. Types of species struck by rotorcraft between 2000 and 2009

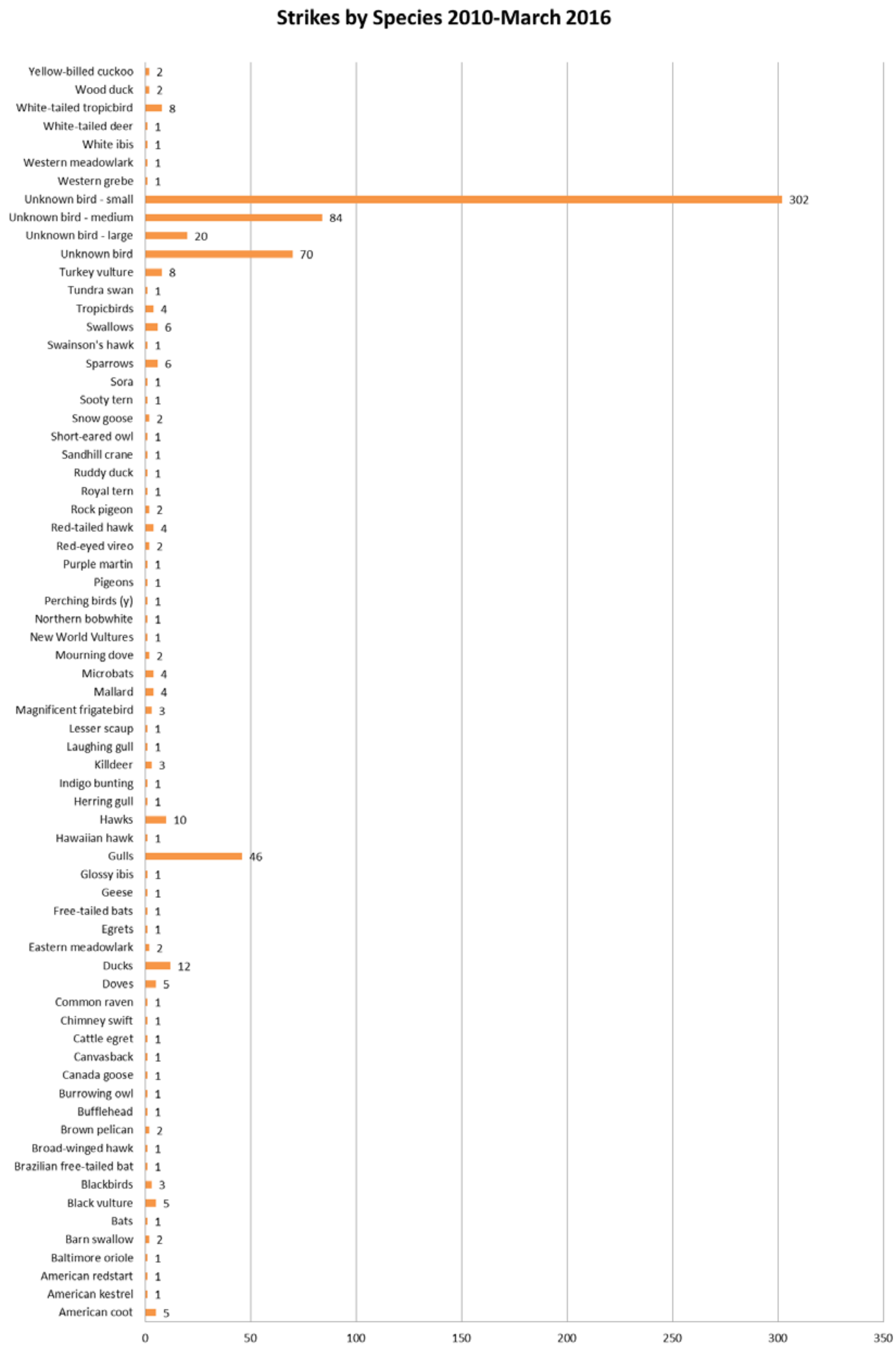

Figure 11. Types of species struck by rotorcraft between 2010 and March 2016

In addition, more strikes were being reported as time passed, thereby increasing the variety of species reported. Table 2 summarizes the number of unknown species struck between 1990 and March 2016. For this time period, 63% of all birds struck were reported as unknown. It is possible they could not be identified or their remains were never found for identification.

Table 2. Summary of unknown bird strikes between 1990 and March 2016

	1990-1999	2000-2009	2010-March 2016	Total 1990-March 2016
Total number of birds struck	215	515	669	1399
Identified as unknown bird	4	53	70	127
Identified as unknown bird–large	11	20	20	51
Identified as unknown bird–medium	50	110	84	244
Identified as unknown bird–small	35	121	302	458
Total unknown and large, medium, and small unknown birds struck	100	304	476	880
% of birds struck identified as unknown	47%	59%	71%	63%

Figures 12–14 show that strikes most often occur during the en route phase of flight. This is most likely because rotorcraft fly en route at significantly lower altitudes than large fixed-wing transport aircraft. Rotorcraft tend to cruise at altitudes between 500 and 5000 feet. Typically, rotorcraft fly at approximate altitudes of 500 feet in non-congested areas and between 1000 and 1500 feet in congested areas. When flying under instrument flight rules, altitude can vary from 2000–5000 feet. Because they are unpressurized, it is rare for rotorcraft to fly higher than 8000–9000 feet. Figure 15 shows a summary of the phase of flight when strikes occurred from 1990 through March 2016, with 69% of strikes occurring in the en route phase.

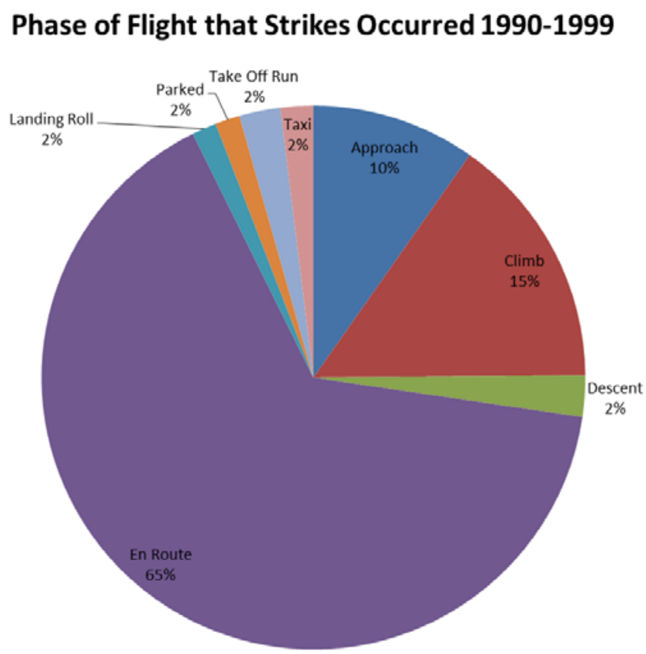

Figure 12. Phase of flight in which bird strikes occurred between 1990 and 1999

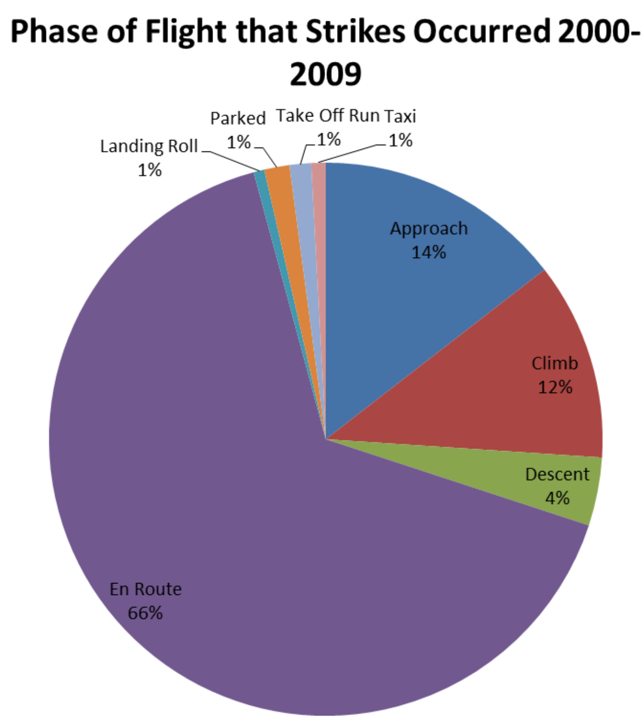

Figure 13. Phase of flight in which bird strikes occurred between 2000 and 2009

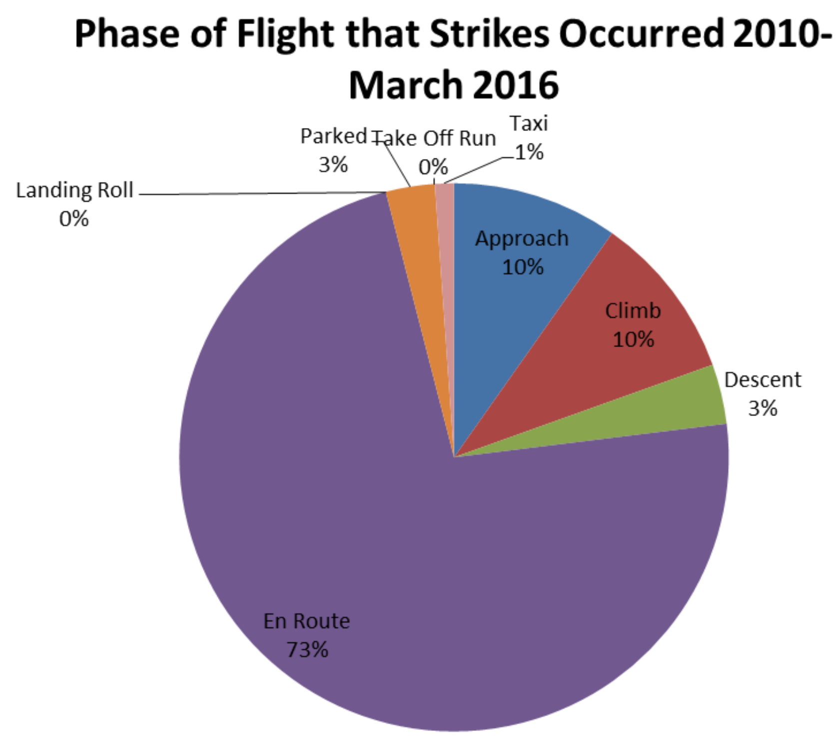

Figure 14. Phase of flight in which bird strikes occurred between 2010 and March 2016

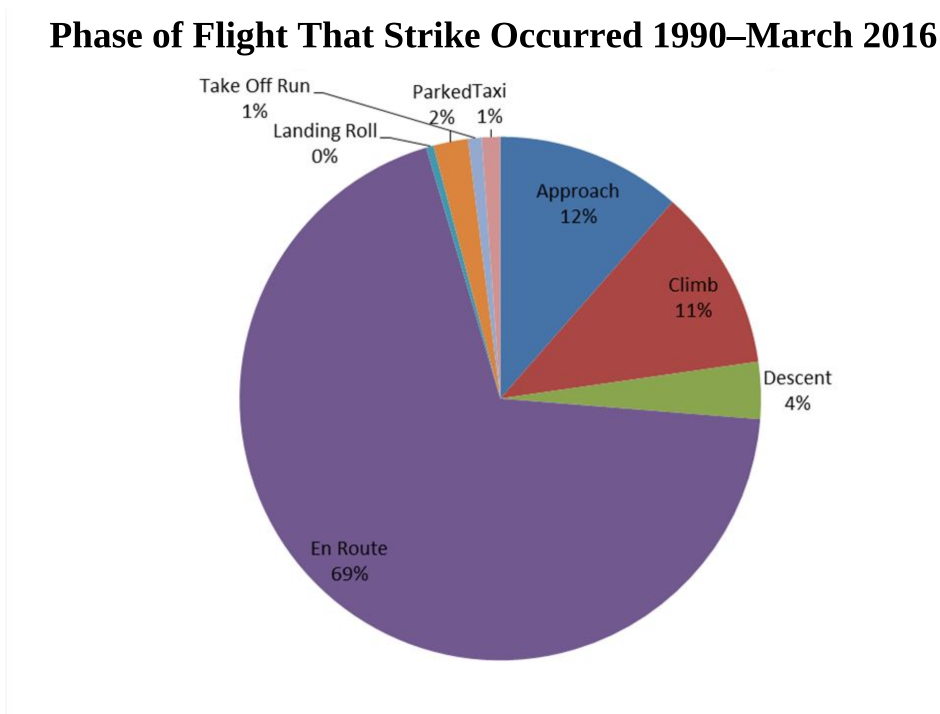

Figure 15. Phase of flight in which bird strikes occurred between 1990 and March 2016

Table 3 shows the raw data for the specific phases of flight when strikes occurred for the three time periods and a total for all combined time periods.

Table 3. Phase of flight data for time frame between 1990 and March 2016

Phase of Flight	1990–1999	2000–2009	2010–present	Total 1990–March 2016
Approach	20	69	61	150
Climb	31	55	61	147
Descent	5	19	22	46
En Route	134	313	456	903
Landing Roll	3	3	0	6
Parked	3	7	18	28
Take Off Run	5	6	0	11
Taxi	4	4	7	15

Figures 16–18 show the height, measured in feet above ground, at which most strikes occurred. Most occurred below 2000 feet, with the majority occurring below 1000 feet. Because it is most common for rotorcraft to cruise at or below 1000 feet above ground level, it is logical that most strikes would occur below this threshold. Again, this coincides with rotorcraft flying at altitudes of approximately 500 feet in non-congested areas and between 1000 and 1500 feet in congested areas. Figure 19 shows a summary of the height of strikes for the time frame between 1990 and March 2016.

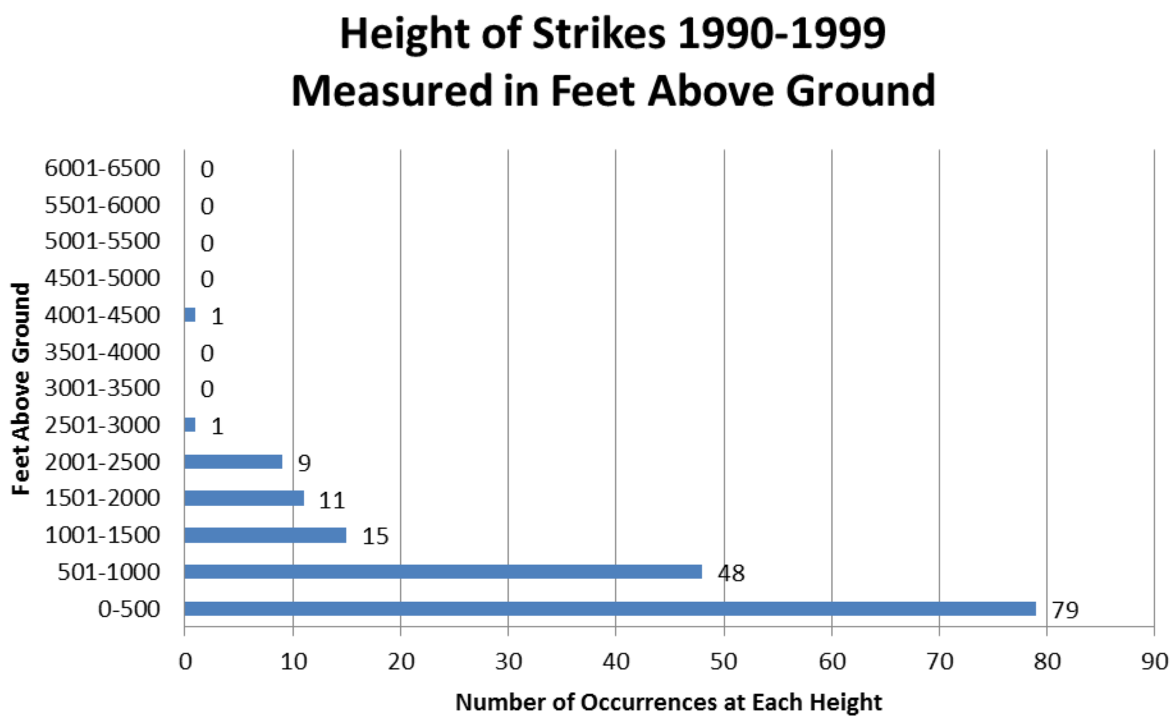

Figure 16. Height at which strikes occurred between 1990 and 1999

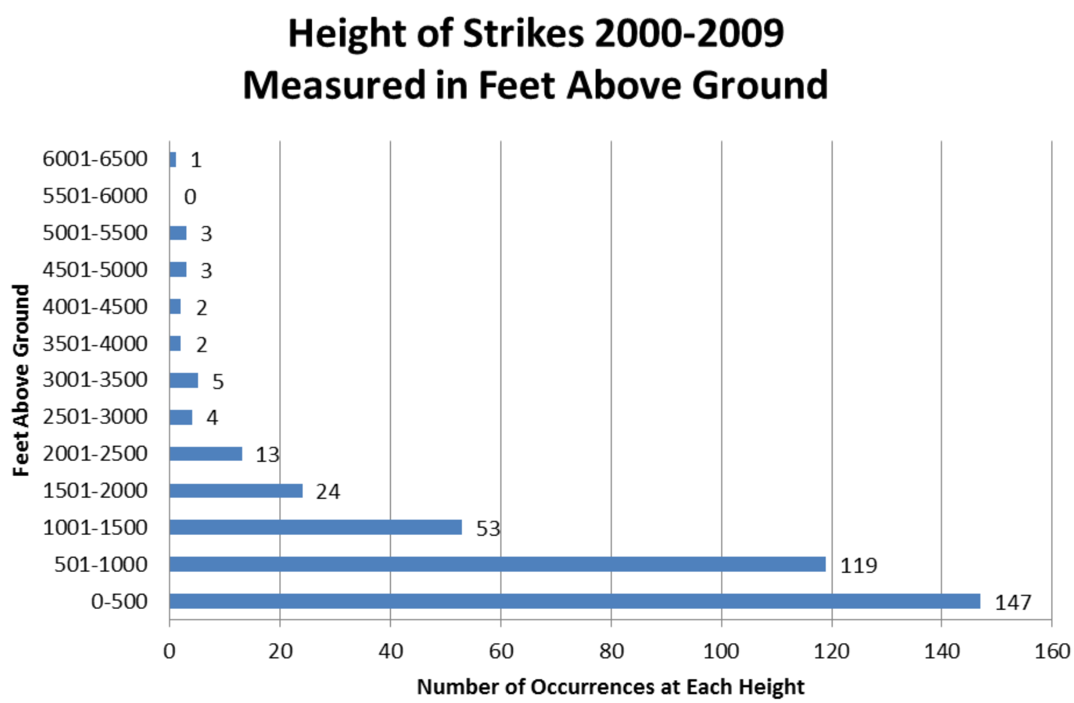

Figure 17. Height at which strikes occurred between 2000 and 2009

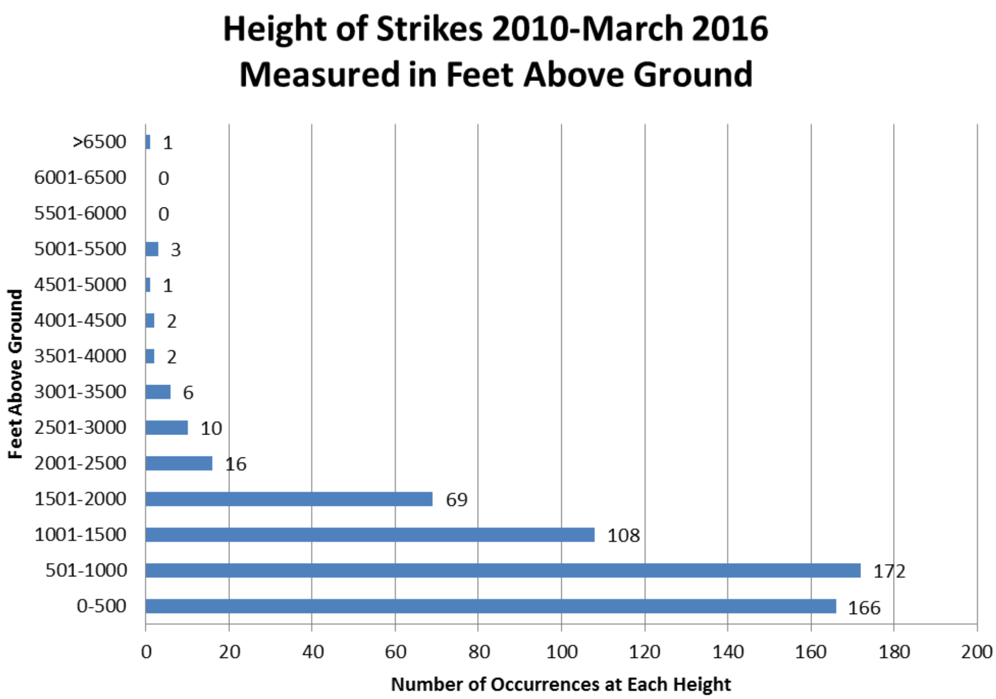

Figure 18. Height at which strikes occurred between 2010 and March 2016

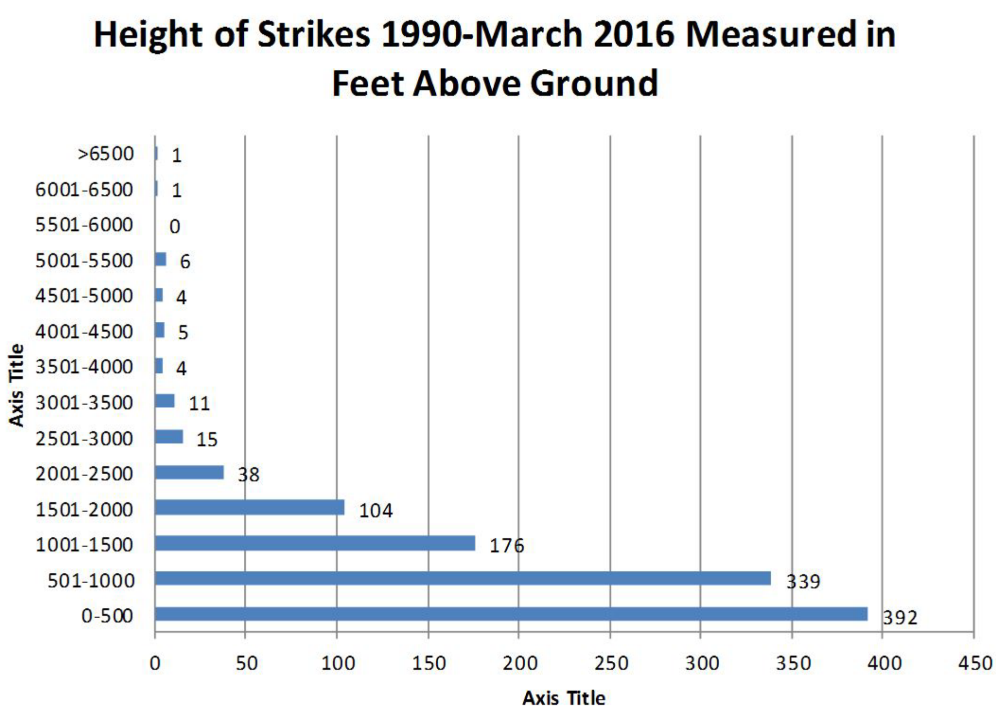

Figure 19. Height at which strikes occurred between 1990 and March 2016

Table 4 shows the raw data for each of the heights at which strikes occurred during each time period. This table also shows that most strikes have occurred at low altitude, with more than 95% of the reported strikes occurring below 2500 ft.

Table 4. Summary of heights at which strikes occurred between 1990 and March 2016

Feet above ground	1990–1999	2000–2009	2010–March 2016	Total
0–500	79	147	166	392
501–1000	48	119	172	339
1001–1500	15	53	108	176
1501–2000	11	24	69	104
2001–2500	9	13	16	38
2501–3000	1	4	10	15
3001–3500	0	5	6	11
3501–4000	0	2	2	4
4001–4500	1	2	2	5
4501–5000	0	3	1	4
5001–5500	0	3	3	6
5501–6000	0	0	0	0
6001–6500	0	1	0	1
>6500	0	0	1	1

Figures 20–22 show the speeds at which the rotorcraft were traveling when bird strikes occurred during each of the three time periods. It appears that most strikes occurred during speeds of 80–140 knots, with the majority of them at approximately 100–130 knots. Figure 23 shows a summary of the speed in knots for all three time periods.

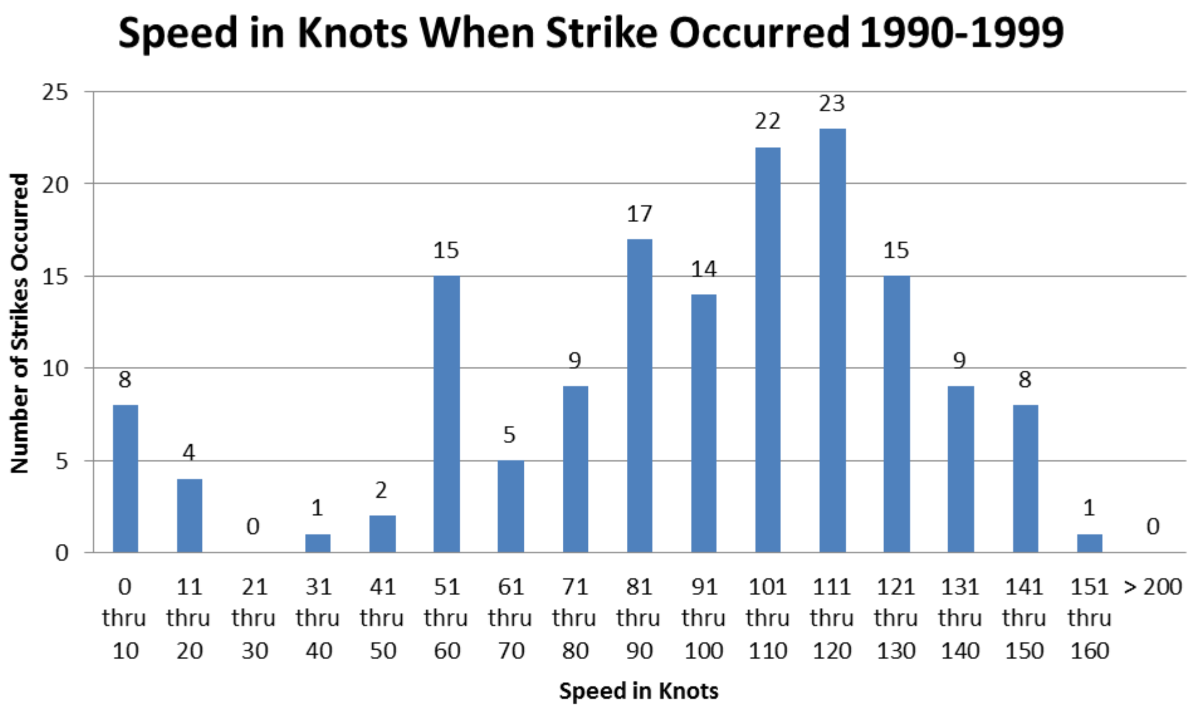

Figure 20. Speed of rotorcraft when bird strike occurred between 1990 and 1999

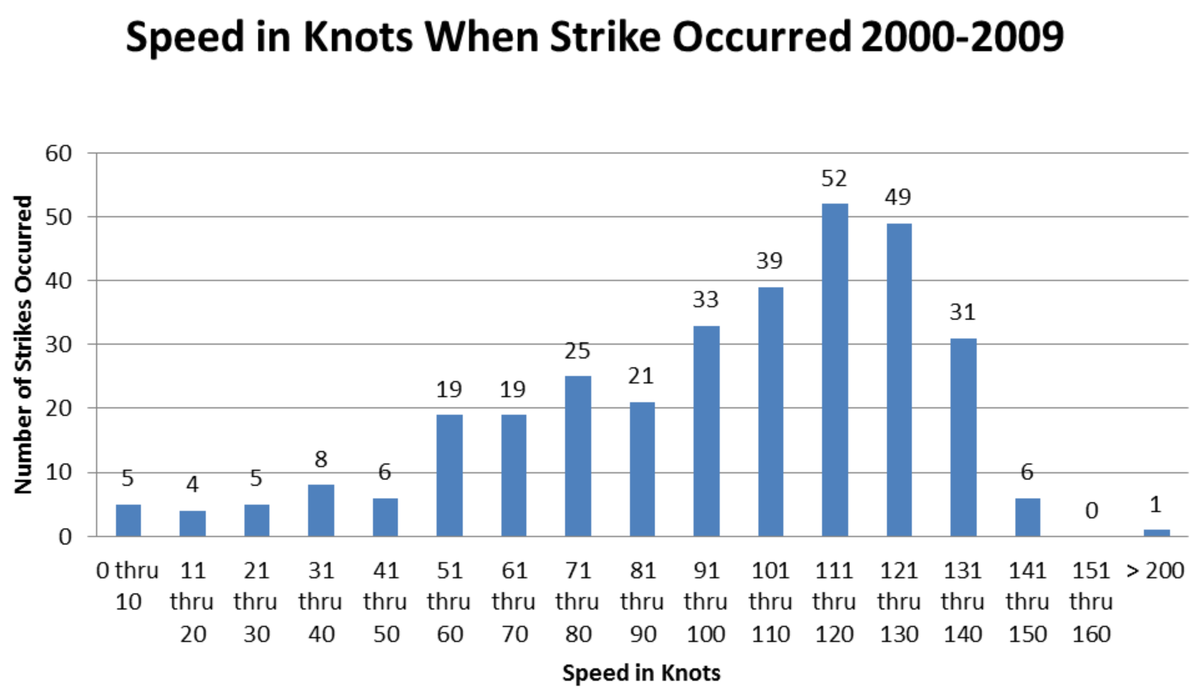

Figure 21. Speed of rotorcraft when bird strike occurred between 2000 and 2009

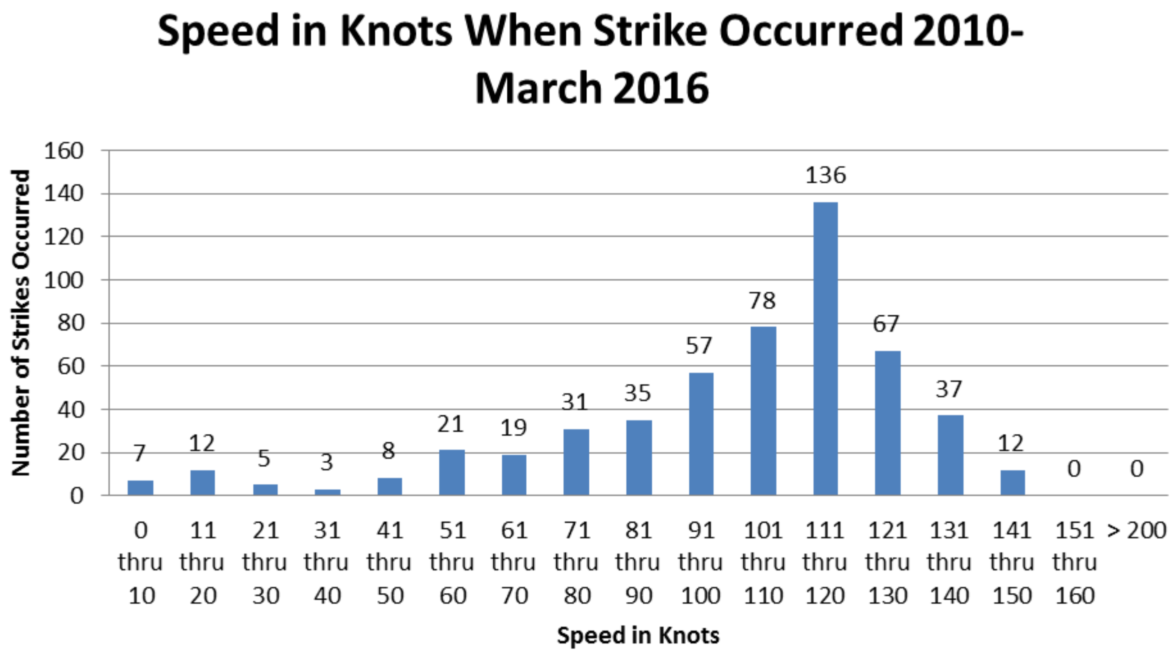

Figure 22. Speed of rotorcraft when bird strike occurred between 2010 and March 2016

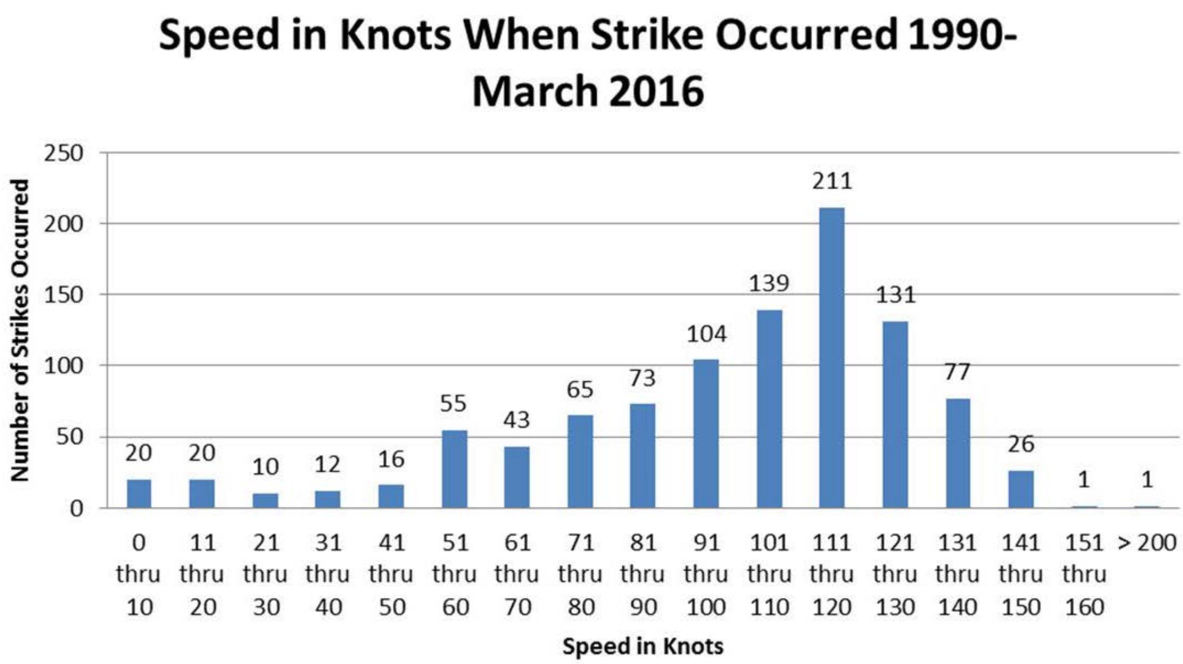

Figure 23. Speed of rotorcraft when bird strike occurred between 1990 and March 2016

The airspeed of rotorcraft during cruise ranges from 90–140 knots. Therefore, 100–130 knots captures most cruise speeds. This also coincides with most strikes occurring during the en route phase. Also of note is that the bigger the rotorcraft, the faster the en route speed when compared to smaller rotorcraft.

Another variable that was analyzed was the time of day when the strike occurred. The results are shown in figures 24–26. For the time periods of 1990–1999 and 2000–2009, the majority of the strikes occurred during the day. However, for the time period 2010–March 2016, the breakdown encompassed strikes occurring 48% of the time during the day and 48% at night. For all three time periods, few strikes were reported at dawn or dusk; this may be attributed to those reporting events using the more generic classifications of day or night. Figure 27 shows that for 1990–March 2016, 54% of strikes occurred during the day, with 42% occurring at night.

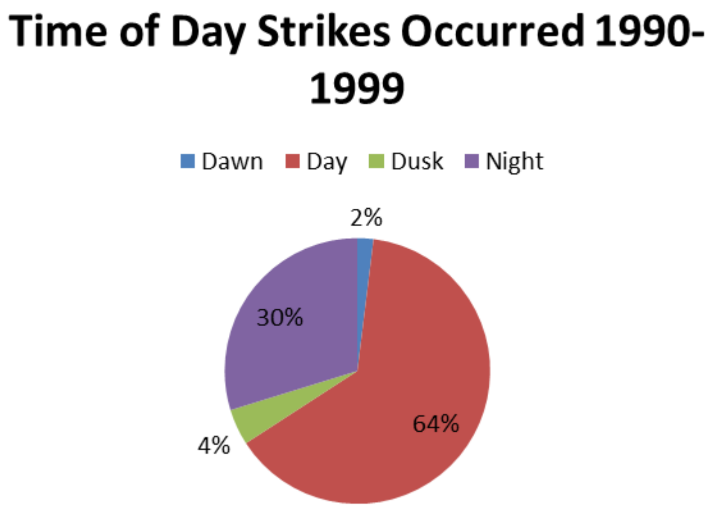

Figure 24. Time of day rotorcraft strikes occurred between 1990 and 1999

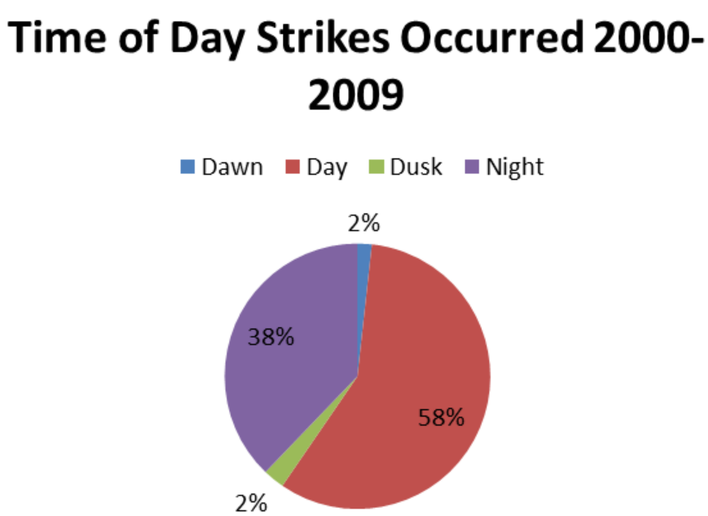

Figure 25. Time of day rotorcraft strikes occurred between 2000 and 2009

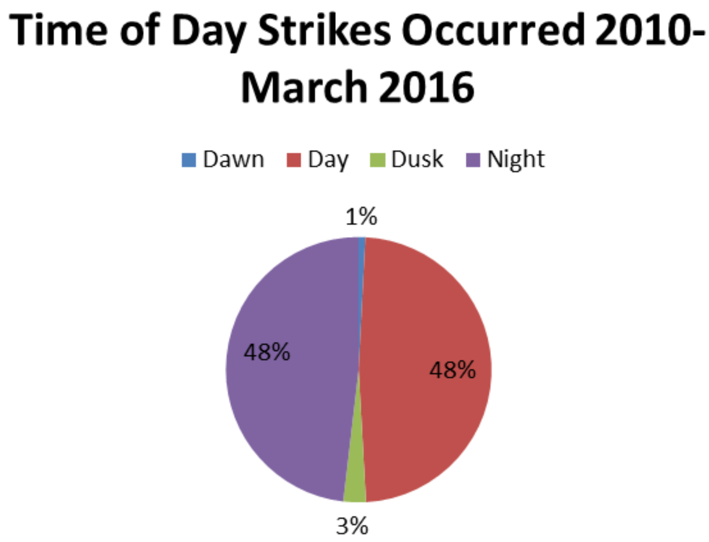

Figure 26. Time of day rotorcraft strikes occurred between 2010 and March 2016

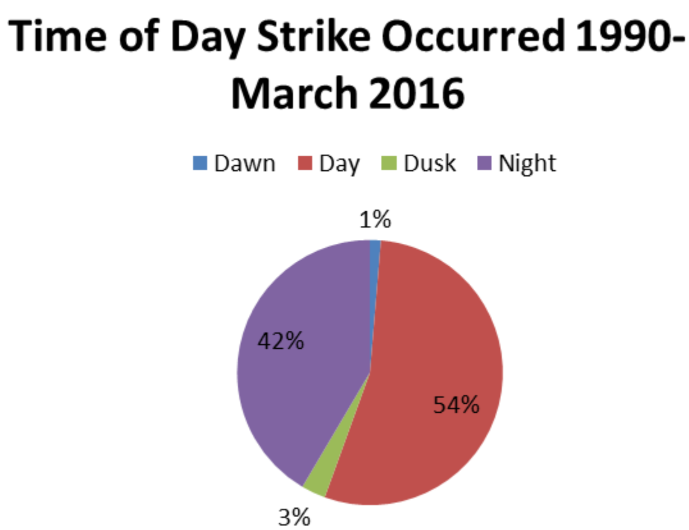

Figure 27. Time of day rotorcraft strikes occurred between 1990 and March 2016

The type of operation for which the rotorcraft was being used when the strike occurred was also analyzed. Figure 28 shows that for the years 1990–March 2016, the majority of strikes occurred during business operations, followed by transport services (which includes medical transport).

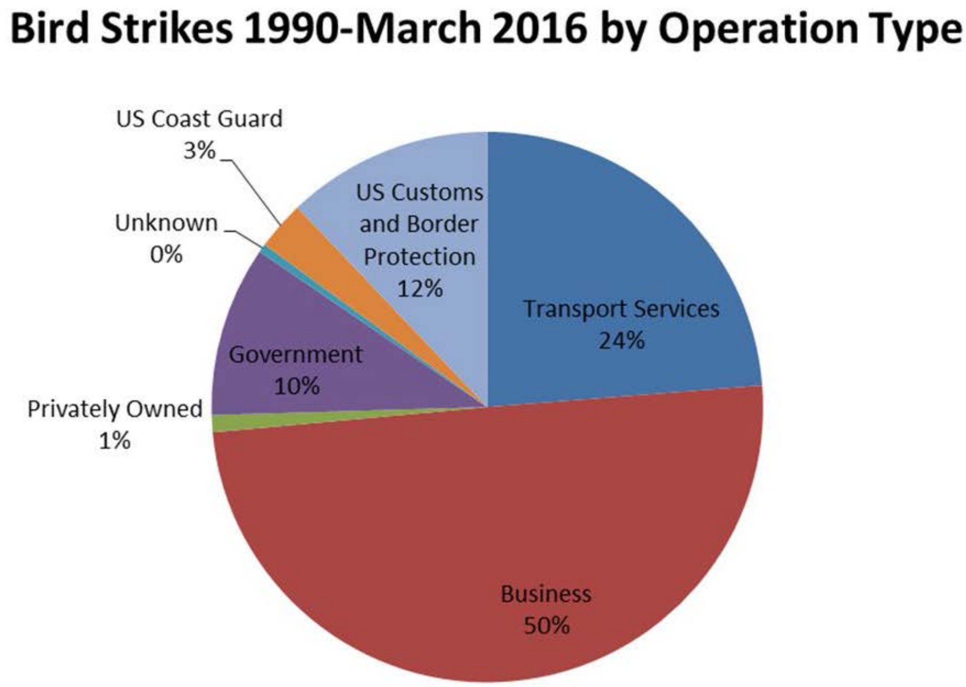

Figure 28. Bird strikes by operation between 1990 and March 2016

Table 5 shows the breakdown of accidents involving medical transport rotorcraft for the time period between 1990 and March 2016. The data in the FAA Wildlife Strike Database show, with all three time periods combined, 29% of bird strikes involved medical transport rotorcraft.

Table 5. Number of strikes involving medical transport rotorcraft

	1990–1999	2000–2009	2010–March 2016	1990–March 2016
Total reports	163	514	669	1346
Number of medical transport rotorcraft involved	8	108	281	397
Percentage	5%	21%	42%	29%

ANALYSIS OF FAA WILDLIFE DATABASE FINDINGS

From 1990–March 2016, the data show that windshields were the most prevalent location for bird strikes (see figures 1–4). Windshields were also the most likely location for damage to occur (see figures 5–8). The FAA currently considers windshields a prominent strike location, as evidenced by 14 CFR 29.631 [1], which currently requires that windshields withstand a bird strike without penetration. In addition, 14 CFR 27.775 [2] stipulates the use of non-splintering safety glass when glass is used in windshields and windows to protect crew and passengers in the event that window fracturing occurs.

Based on the data analysis, this is an area on which the FAA needs to remain focused—particularly because strikes to the windshield that penetrate through can also impact the flight controls, causing potentially devastating effects, such as loss of control of the rotorcraft.

Figures 9–11 show the types of birds that are being struck. Knowing what specific species are being struck is important in developing methods of deterrence, whether on the ground or in the air. Previous research has shown that specific species of birds react differently to deterrence methods. Therefore, possessing this information has the potential to facilitate the tailoring of specific deterrence methods to meet the needs of certain geographical areas where a particular species is more common.

Figures 12–15 show that most rotorcraft bird strikes occurred during the en route phase of flight. These can likely be attributed to rotorcraft flying at significantly lower altitudes during the en route phase as compared with a fixed-wing transport aircraft. Transport fixed-wing aircraft cruise at altitudes of approximately 35,000 feet. Rotorcraft tend to cruise at altitudes between 500 and 5000 feet, and most tend to stay below 3000 feet above ground level.

Figures 16–19 show that most rotorcraft bird strikes occurred at 1000 feet or below. This coincides with the fact that it is common for rotorcraft to cruise at or below 1000 feet above ground level. This coincides with rotorcraft flying at approximately 500 feet in non-congested areas and between 1000 and 1500 feet in congested areas.

Figures 20–23 show that the majority of rotorcraft strikes occurred at speeds of approximately 100–130 knots. The airspeed of rotorcraft in cruise varies from 90–140 knots. Therefore, the strikes occurring in the 100–130 knots range capture most cruise speeds. This also coincides with most strikes occurring during the en route phase.

Figures 24–27 show the time of day that rotorcraft strikes occurred. For time periods 1990–1999 and 2000–2009, the majority of strikes occurred during the day. However, for the time period of 2010–March 2016, the breakdown encompassed strikes occurring 48% of the time during the day and 48% at night. Knowing the time of day that strikes occurred is significant in developing appropriate methodologies to deter birds. For example, because most strikes occurred during the day, it might be better to use sound as a deterrent than lights, which may not be seen clearly during the day.

Figure 28 shows that for the years 1990–March 2016, the majority of strikes occurred during business operations, followed by transport services (which include medical transport). Table 5 shows the breakdown of accidents involving medical transport rotorcraft for the time period between 1990 and March 2016. The data show that for the three time periods combined, 29% of bird strikes involved medical transport rotorcraft.

ANALYSIS OF SPAS DATABASE

The SPAS database, specifically the AIDS component of the database, was also searched. SPAS is a Web-based database that allows users to view current and historical safety-related aviation data [4]. It is maintained by the FAA and the Department of Transportation. The SPAS database compiles data over time to reveal trends and help FAA inspectors detect anomalies. The data in the SPAS database come from multiple FAA and other government databases [5]. The AIDS data in the SPAS database are collected during FAA investigations of accidents and incidents.

Analyzing the AIDS data in the SPAS database generated 65 reports of rotorcraft bird strikes from the time period 1986–2015. The data contained in this database are not as detailed as the data from the FAA Wildlife Strike Database. Instead of specific categories of information—such as type of species struck, altitude, speed of rotorcraft, and time of day—there is a remarks column. The individual making the report can enter any information in the remarks column. However, because there is no format, most of it is generic, stating a strike occurred and sometimes indicating the location of the strike relative to the rotorcraft. Consequently, the only information that was captured was the number of reports per rotorcraft brand (see figure 29) and where on the rotorcraft the strike occurred (see figure 30).

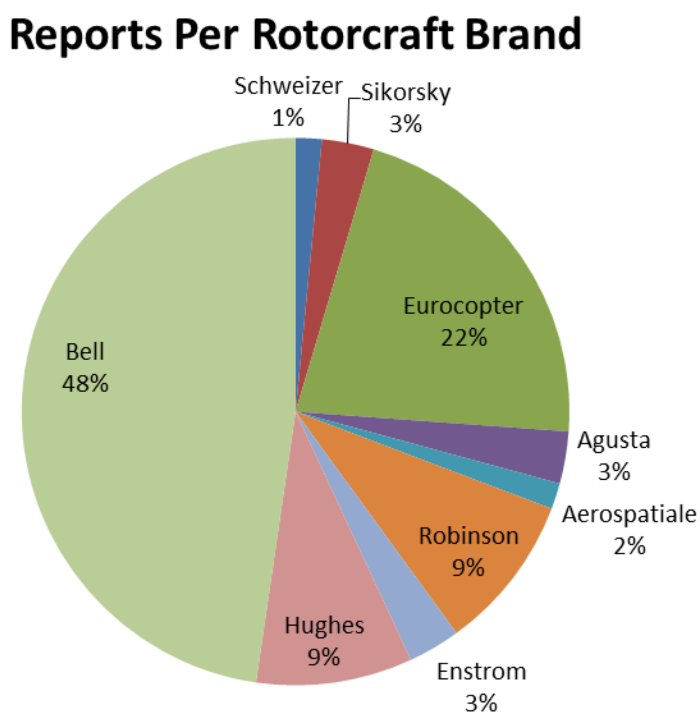

Figure 29. Reports per rotorcraft brand between 1986 and 2015

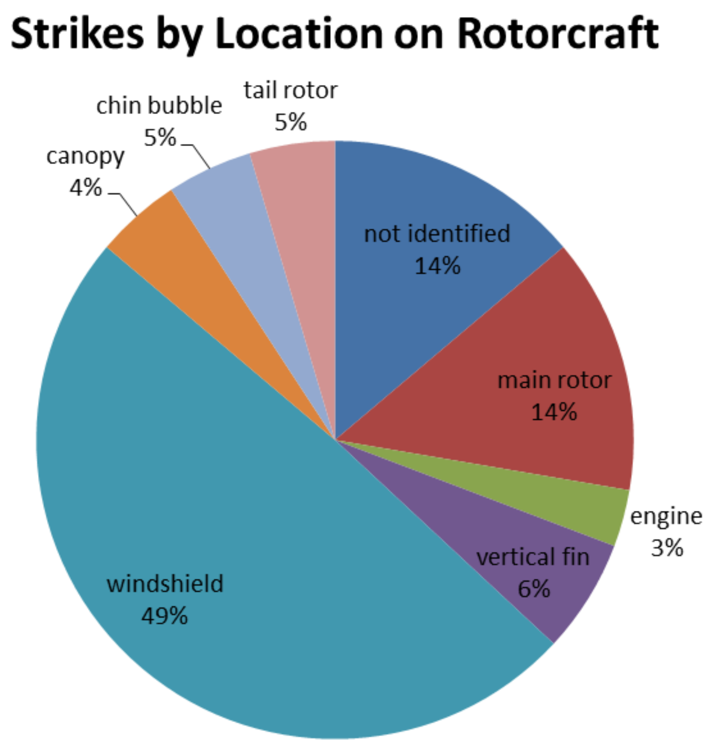

Figure 30. Strikes by location on rotorcraft between 1986 and 2015

Figure 30 shows that 49% of reported strikes occurred to the windshield. Similar results were seen from the analysis of the FAA Wildlife Strike Database. There were also a significant number of strikes, 14%, for which the location was not identified.

Unfortunately, the AIDS data in the SPAS database contained very limited information. It was difficult to ascertain anything beyond the location of the strike on the rotorcraft.

CONCLUSION

The data from the FAA Wildlife Database and Safety Performance Analysis System show that windshields were the most prevalent locations for bird strikes. The FAA Wildlife Database also showed that windshields were the most likely location for damage to occur. The FAA already considers windshields a prominent location for strikes and damage, as evidenced by Title 14 Code of Federal Regulations (CFR) Part 29.631 [1] and 14 CFR 27.775 [2]. Based on these data, it is an area on which the FAA should remain focused for potential enhancements to existing guidance to improve safety. In addition, this should remain an area on which the FAA focuses because strikes to the windshields that penetrate through can also impact the flight controls, causing potentially devastating effects, such as loss of control.

The FAA Wildlife Strike Database has done an excellent job in identifying the types of birds that are being struck. Recent data indicate that more specific species are being identified as opposed to just classifying birds as small, medium, large, and unknown, which was previously more common. Knowing what specific species are being struck is important in developing methods of deterrence, whether on the ground or in the air. Previous research has shown that specific species of birds react differently to deterrence methods. Therefore, possessing this information has the potential to facilitate tailoring deterrence methodologies to meet the needs of certain geographical areas where a particular species is more common.

The FAA Wildlife Database shows that 69% of the reported rotorcraft bird strikes occurred during the en route phase of flight. These can likely be attributed to rotorcraft flying at significantly lower altitudes during the en route phase as compared to fixed-wing transport aircraft. This coincides with rotorcraft tending to cruise at altitudes between 500 and 5000 feet, and 95% were below the 2500 feet above-ground-level threshold. Understanding the phase of flight at which most strikes occur can help the FAA develop technology, such as radar, to detect birds in flight to prevent strikes. Because the data show that 69% of the strikes were en route and 95% took place below 2500 feet, one potential future investigation might be have a discussion with an operator to determine if flying above 2500 feet is plausible, and fly a test program for a year to see if this reduces the number of strikes.

The FAA Wildlife Database showed that most rotorcraft bird strikes occurred at 1000 feet or below. This coincides with rotorcraft flying at approximately 500 feet in noncongested areas and between 1000–1500 feet in congested areas. Similar to knowing during which phase of flight strikes occur, understanding the altitude at which most strikes occur can help the FAA develop technology, such as radar, to detect birds in flight and prevent strikes.

The FAA Wildlife Database showed that the majority of rotorcraft strikes occurred at speeds of approximately 100–130 knots. The airspeed of rotorcraft in cruise varies from 90–140 knots. Therefore, the strikes occurring in the 100–130 knots range capture most cruise speeds. This also coincides with most strikes occurring during the en route phase. Knowing the speeds at which strikes occur may also be helpful when developing methods of bird deterrence in air.

The FAA Wildlife Database shows that in the time periods 1990–1999 and 2000–2009, the majority of strikes occurred during the day. However, for the time period between 2010 and March 2016, the breakdown encompassed strikes occurring 48% of the time during the day and 48% at night. Knowing the time of day at which strikes occurred is significant in developing appropriate technology to deter birds. For example, because most strikes occurred during the day, it might be better to use sounds as a deterrence method instead of lights, which may not be seen clearly during the day.

REFERENCES

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