Australian Government
Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY REPORT
Aviation Research and Analysis Report – AR-2009-064
Final

Australian aviation wildlife strike statistics: Bird and animal strikes 2002 to 2009

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Abstract

A significant proportion of all occurrences reported to the Australian Transport Safety Bureau (ATSB) involve aircraft striking wildlife, especially birds. This report provides aviation birdstrike and animal strike occurrence data for the period 1 January 2002 to 31 December 2009. It also describes the results of an ATSB survey of aerodromes concerning current wildlife control measures.

Reported birdstrikes have been generally increasing since 2002. In 2009, there were 1,340 birdstrikes reported to the ATSB. For high capacity aircraft operations, reported birdstrikes have doubled from 2002 to 2009. However, taking into account an increase in aircraft movements, this increase is modest and is probably accounted for by a generally improving reporting culture within this time.

Birdstrikes have increased for the period of study in every Australian state and territory. Queensland, New South Wales, the Northern Territory and Western Australia have the highest birdstrike rates. The higher birdstrike numbers for Queensland and the Northern Territory may be related to bird populations within the tropics, while New South Wales has the highest number of major aerodrome aircraft movements in Australia.

Most birdstrikes occur within the confines of aerodromes (less than 5 km). Major and regional towered aerodromes had significantly higher rates of reported birdstrikes than General Aviation Airport Procedures (GAAP) aerodromes, and had considerably increasing rates from 2002 to 2009. GAAP aerodrome birdstrike rates do not appear to have changed.

Engine ingestion makes up 11 per cent of all birdstrike occurrences in high capacity air transport for the 8-year period, and the highest number of damaging birdstrikes occurs in high capacity air transport. Birdstrikes causing multiple parts damaged were not common throughout the period. General aviation had the highest proportion of damaging birdstrikes, with almost 24 per cent of birdstrikes causing damage. Aeroplane wings and helicopter rotor blades are the most commonly damaged aircraft components across all operational types, particularly in general aviation. There have been eight occurrences from the period of 2002-2009 that have resulted in serious aircraft damage, and four that have resulted in injury.

The most common types of birds struck by aircraft were lapwings/plovers, bats/flying foxes, galahs, and kites. Not surprisingly, larger birds were more likely to result in aircraft damage.

Animal strikes were relatively rare. High capacity air transport had the highest average with 11.5 animal strikes per year, with general aviation having the second highest average with 9.3 animal strikes per year. The most common animals involved in strikes were hares/rabbits, kangaroos, wallabies, and foxes/dogs. Damaging strikes mostly involved kangaroos, wallabies and livestock.

Bird hazard control at aerodromes was found to be mostly related to the control of grass height (short or long) and growing specific plants or grass, and the daily or weekly use or auditory deterrents, especially car horns and shotguns.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The Bureau is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; fostering safety awareness, knowledge and action.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

Purpose of safety investigations

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated. The terms the ATSB uses to refer to key safety and risk concepts are set out in the next section: Terminology Used in this Report.

It is not a function of the ATSB to apportion blame or determine liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

When safety recommendations are issued, they focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on a preferred method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation to a person, organisation or agency, they must provide a written response within 90 days. That response must indicate whether they accept the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes it appropriate. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

1 INTRODUCTION

Each year, the Australian Transport Safety Bureau (ATSB) receives accident and incident notifications from pilots, airlines, aerodrome personnel, air traffic control and others involved in the aviation industry. The reporting of these aviation accidents and incidents, collectively termed occurrences, assists the ATSB in monitoring safety through its core function of independent investigation and the analysis of data to identify emerging trends.

The Transport Safety Investigation Regulations 2003 provide a list of matters reportable to the ATSB. [1] One routine reportable matter is a collision with an animal, including a bird, for:

- all air transport operations (all bird and animal strikes), and
- aircraft operations other than air transport operations when the strike occurs on a licensed aerodrome.

In addition to the above, all accidents[2] are immediately reportable to the ATSB, and all occurrences involving injury or difficulty controlling the aircraft (including from a bird or animal strike) are reportable matters for all operation types.

A significant proportion of all occurrences reported to the ATSB involve aircraft striking wildlife, especially birds. Wildlife strikes represent an ongoing challenge to the aviation industry. Birds and other animals are hazards to aviation that will always be present and so need to be managed, both in terms of reducing the likelihood of a wildlife strike and reducing the consequences of strikes that occur.

The ATSB produced a report in 2008, *An analysis of Australian birdstrike occurrences, 2002 to 2006* (AR-2008-027) detailing birdstrikes for the 5-year period 2002 to 2006. The current report builds on this foundation and provides aviation birdstrike and animal strike[3] occurrence data for the period 1 January 2002 to 31 December 2009. It should be noted, however, that the 2008 ATSB report organised the data slightly differently to the current report (detailed in Chapter 2) and so not all tables are directly comparable.

The Australian Aviation Wildlife Hazard Group, the industry group that aims to help control the ongoing hazards of wildlife to aviation, have requested that the ATSB produce regular data on bird and animal strike trends. As a result, this *Australian aviation wildlife strike statistics* report aims to give industry an insight into the number, locations, and types of strikes in Australia, and describe characteristics of the common birds and animals involved, and the consequences of these strikes.

Chapters 3 to 8 detail birdstrike occurrences, while Chapter 9 summarises animal strikes, for the period 2002 to 2009. Chapter 10 describes the results of an ATSB survey of aerodromes concerning wildlife control measures.

This report will be updated biennially.

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[1] Available from the ATSB internet site: http://www.atsb.gov.au/about_atsb/legislation.aspx.

[2] Accident refers to aviation occurrences where (a) a person dies or suffers serious injury, (b) the aircraft is destroyed or seriously damaged; or (c) other property is destroyed or seriously damaged.

[3] For the purposes of this report, birds include all flying animals, including bats, and animals include all ‘terrestrial’ animals, including flightless birds.

2 DATA SOURCES

2.1 ATSB occurrence data

Birdstrike and animal strike occurrence data used in this report have been reported to the Australia Transport Safety Bureau (ATSB) under the provisions of the Transport Safety Investigation Regulations 2003. Only actual strikes are considered to be reportable occurrences - close encounters with birds or other animals are therefore not included in this report.

The ATSB moved to a new occurrence database (the safety investigation information management system or SIIMS) in 2007. As part of the data migration, a major data quality assurance operation was performed for all bird and animal strike data from 2002 onwards. Many reported bird and animal strike reports contained sufficient information on all aspects of interest (for example precise location, aircraft components damaged, number and type of bird or animal, and bird/animal size) to complete this process. However, other reported occurrences required information to be deduced from the data, where it was apparent, by ATSB staff.

Bird and animal types have been grouped by similar species rather than reporting data on specific species. Type groupings were defined by grouping birds and animals of similar species, size, and/or appearance. These groupings were done because similar birds are often reported to the ATSB as an incorrect species. A complete list of bird and animal types is included in Appendix A.

For the purpose of this report, the birdstrike data included all flying animals, so included bats and flying foxes. Animal strikes were considered to involve all terrestrial animals, so included emus.

Bird and animal size were coded as small, medium or large based on common understandings of these categories. For birds, bird types that were typical for the sizes included:

- small birds - wrens, sparrows, and swifts
- medium birds - magpies, silver gulls, flying foxes and galahs
- large birds - pelicans, wedge-tailed eagles and brush turkeys.

For animals, typical sizes were:

- small animals - rabbit/hare, lizards
- medium animals - wallabies, foxes/dogs
- large animals - cattle, kangaroos.

The proximity of the aerodrome to a birdstrike has been coded as either:

- within the aerodrome confines
- 5 to 15 km from the aerodrome
- more than 15 km from the aerodrome.

When not directly indicated by the report, this was determined from phase of flight information, combined with altitude information (where known).

Some of the data presented below have been arranged into operation types. This applies only to data where the aircraft involved in the strike was known. The operation types used were:

- *high capacity air transport* – includes regular public transport (RPT) and charter operations on aircraft certified as having a maximum capacity exceeding 38 seats or a maximum payload exceeding 4,200 kg
- *low capacity air transport* – includes all RPT and charter operations on aircraft other than high capacity
- *general aviation* – all aerial work, flying training, and private, business, and sport (including gliding and ballooning) aviation
- *military* – all military operations.

The operation type groupings differ between the current report and the 2008 ATSB birdstrike report *An analysis of Australian birdstrike occurrences, 2002 to 2006* (AR-2008-027). Furthermore, the data quality process undertaken may result in some further differences in the data presented in this report from the 2008 report.

2.2 Aircraft movements

Aircraft movements were defined as a takeoff, a landing, or a circuit. Therefore, an aircraft completing a single sector will have two movements recorded, one for takeoff and one for landing. Aircraft movements are used in this report as the normalising variable for all birdstrike rate calculations.

Aircraft movement information for total aircraft movements for operation types was provided to the ATSB by the Bureau of Infrastructure, Transport and Regional Economics. Movements were calculated by doubling the recorded departures.

Movement data for specific aerodromes was obtained from movement data published by Airservices Australia.[4]

2.3 ATSB survey of aerodromes

During the 3 months between March and May 2010, the ATSB conducted a survey of bird control strategies at selected Australian aerodromes. The general purpose of the survey was to provide a picture of the strategies aerodrome operators use to control birdstrikes. A particular objective of the survey was to highlight any emerging or useful strategies used by aerodrome operators around Australia.

[4] Located at website: http://www.airservices.gov.au/projectsservices/reports/maa.asp?id=2010 (accessed 26 May 2010)

The survey asked questions about how frequently specific types of control measures were used in areas covering:

- habitat modification
- auditory deterrents
- visual repellents
- chemical repellents
- tactile repellents
- exclusion and removal.

An open-ended text box was provided for each main strategy to allow for responses not included in the strategy list. Respondents were also asked if the aerodrome was planning to replace or introduce additional birdstrike mitigation strategies in the next year, and how they specifically address problem bird species.

A copy of the survey is reproduced in Appendix B.

Respondents

Twenty-nine aerodrome operators were emailed a questionnaire, and 25 aerodrome operators returned the completed survey. The aerodrome operators were from both tropical and temperate areas, and from aerodromes of varying sizes and functions.

Analyses

Aerodrome operators were divided into three groups, based on movements and the nature of their operation. This classification process allowed the data to be summarised and in addition, ensured the aerodrome responses were de-identified.

Aerodromes were divided into low and high aircraft movement categories based on aircraft movements. Those aerodromes with more than 50,000 movements annually (as a general trend over the period between 2002 and 2009) were placed in the high movement category, and the rest were placed in the low movement category. In addition, as Chapter 3 shows that GAAP aerodromes have a lower reported birdstrike rate than aerodromes which service larger aircraft, GAAP aerodromes were separated into their own group.

Aerodromes were also divided into tropical and temperate climates, based on the Tropic of Capricorn, at approximately 23º 26′ south of the equator. Although this climatic division is relatively coarse, using other climate classification systems, such as Koppen[5], produced too few aerodromes in each category. This would have meant that specific aerodrome responses would have been identifiable.

[5] A six category climate classification system described at http://www.bom.gov.au/lam/climate/levelthree/ausclim/koeppen2.htm

3 BIRDSTRIKES BY OPERATION TYPE

The number of birdstrikes reported to the ATSB by year and operation type is shown in Table 1 and Figure 1. There was some year-on-year variability, but a general increase in the number of reported strikes was observed. In particular, high capacity air transport birdstrikes have doubled in 8 years from 400 in 2002 to 810 birdstrikes in 2009 (explained on page 8 below).

Table 1: Number of birdstrikes per year by operation type

Operation Type	2002	2003	2004	2005	2006	2007	2008	2009
High capacity air transport	400	414	596	684	644	649	762	810
Low capacity air transport	163	167	194	204	200	215	218	257
General aviation	96	92	97	124	91	130	158	182
Military	6	9	11	15	16	31	10	26
Unknown	115	151	186	251	283	236	192	202
Total	**780**	**833**	**1,084**	**1,278**	**1,234**	**1,261**	**1,340**	**1,477**

Figure 1: Number of birdstrikes per year by operation type

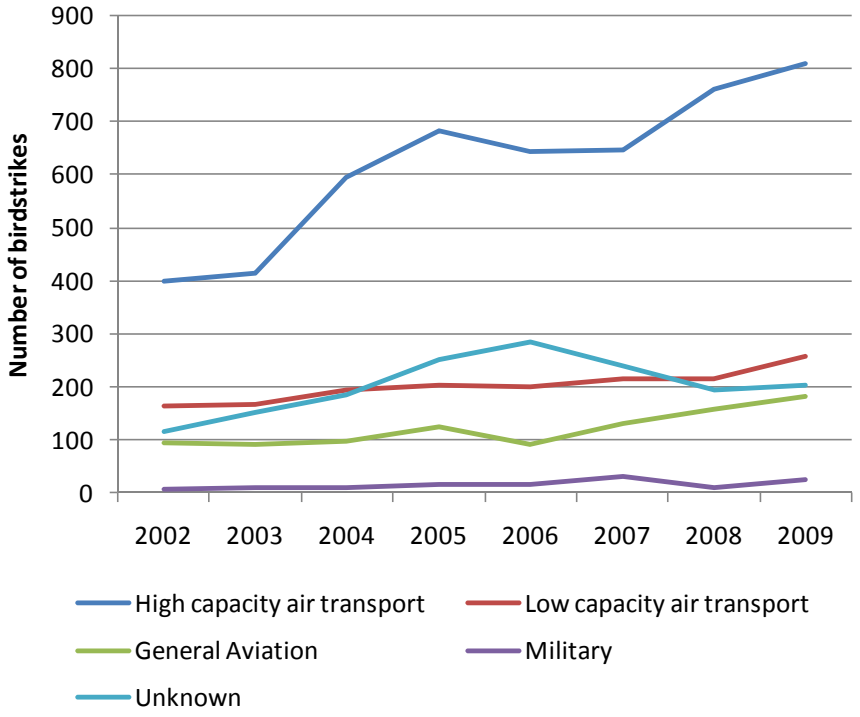


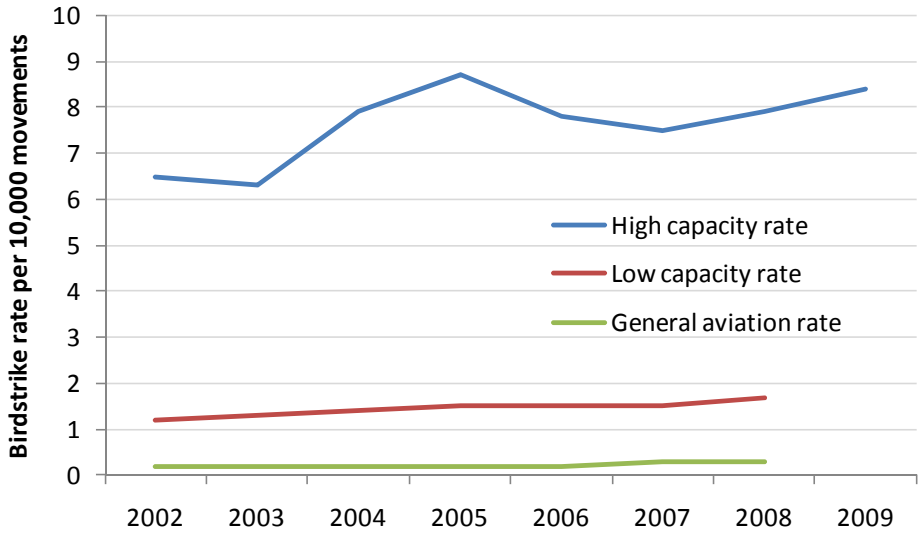
Table 2 and Figure 2 show the rate of birdstrikes per 10,000 aircraft movements[6]. The high capacity air transport rate is significantly higher than all other operation types. This probably relates, in part, to the higher air and ground speeds, and larger surface areas of high capacity aircraft.

Compared to Figure 1 above, the rate of high capacity aircraft birdstrikes shown in Figure 2 has not increased as dramatically. This suggests that aircraft movements influence the number of high capacity birdstrikes, as there has been an increase in aircraft movements over the study period. Furthermore, there has been a general increase in the number and rate of most types of incidents reported to the ATSB since the introduction of the Transport Safety Regulations in July 2003. Therefore, the slightly increasing rates of birdstrikes may simply reflect an improved reporting culture among pilots and aerodrome staff.

Table 2: Birdstrike rate per 10,000 movements per year by operation type

Operation Type	2002	2003	2004	2005	2006	2007	2008	2009[7]
High capacity rate	6.5	6.3	7.9	8.7	7.8	7.5	7.9	8.4
Low capacity rate	1.2	1.3	1.4	1.5	1.5	1.5	1.7	
General aviation rate	0.2	0.2	0.2	0.2	0.2	0.3	0.3	

Figure 2: Birdstrike rate per 10,000 movements per year by operation type



[6] Aircraft movements for operation type rates were estimated as two departures to indicate one takeoff and one landing.

[7] Movements data for low capacity and general aviation was only available up to 2008.

4 BIRDSTRIKES IN AUSTRALIAN STATES AND TERRITORIES

Birdstrikes have increased for the period of study in every Australian state and territory. Table 3 shows that Queensland, New South Wales, the Northern Territory and Western Australia have the highest birdstrike rates, with Queensland making up over one third of all birdstrikes for the period.

The higher birdstrike numbers for Queensland and the Northern Territory may be related to a number of factors, including bird populations and the effectiveness of control measure for problem species within the tropics. New South Wales has the highest number of major aerodrome aircraft movements in Australia, which may explain the high frequency of birdstrikes for the state.[8] The 'other' category showed a large relative increase in 2008-2009, which was due to an increase in reported birdstrikes at Christmas and Cocos (Keeling) islands.

Table 3: Number of birdstrikes per year by state

State	2002	2003	2004	2005	2006	2007	2008	2009	Total
ACT	11	9	20	33	48	38	31	25	**215**
NSW	153	168	212	218	227	272	275	304	**1,829**
NT	121	96	124	160	114	118	123	169	**1,025**
QLD	232	309	371	452	409	433	491	477	**3,174**
SA	76	65	112	119	99	98	98	142	**809**
TAS	36	30	27	54	41	64	59	53	**364**
VIC	69	62	103	131	132	89	127	142	**855**
WA	81	94	115	109	161	144	127	156	**987**
Other[9]	1	-	-	2	3	5	9	9	**29**
Total	**780**	**833**	**1,084**	**1,278**	**1,234**	**1,261**	**1,340**	**1,477**	**9,287**

[8] Refer to pages 12-13 of this report for Table 4 to Table 6 which describes the rates at significant Australian aerodromes.

[9] 'Other' indicates birdstrikes occurring outside the Australian mainland and Tasmania, but within Australian territories, that is Christmas, Cocos (Keeling) and Norfolk Islands.

Figure 3 shows the average number of birdstrikes per year from 2002 to 2009 compared with the most recent average from 2008 to 2009. All states and territories had more strikes between 2008 and 2009 when compared with the average for the entire study period.

In descending order, New South Wales, Victoria, Tasmania and Queensland had the highest increase in 2008-2009 above their 8-year average.

Figure 3: Average birdstrikes per year by state

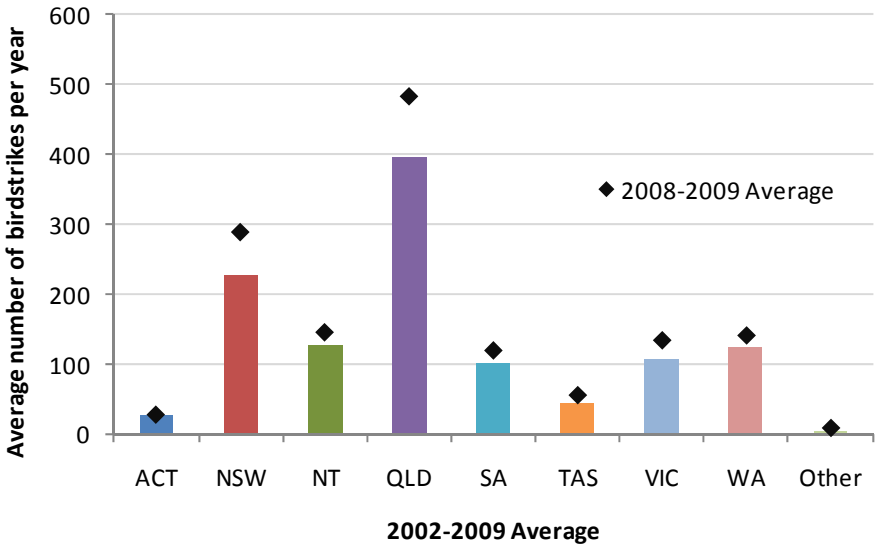
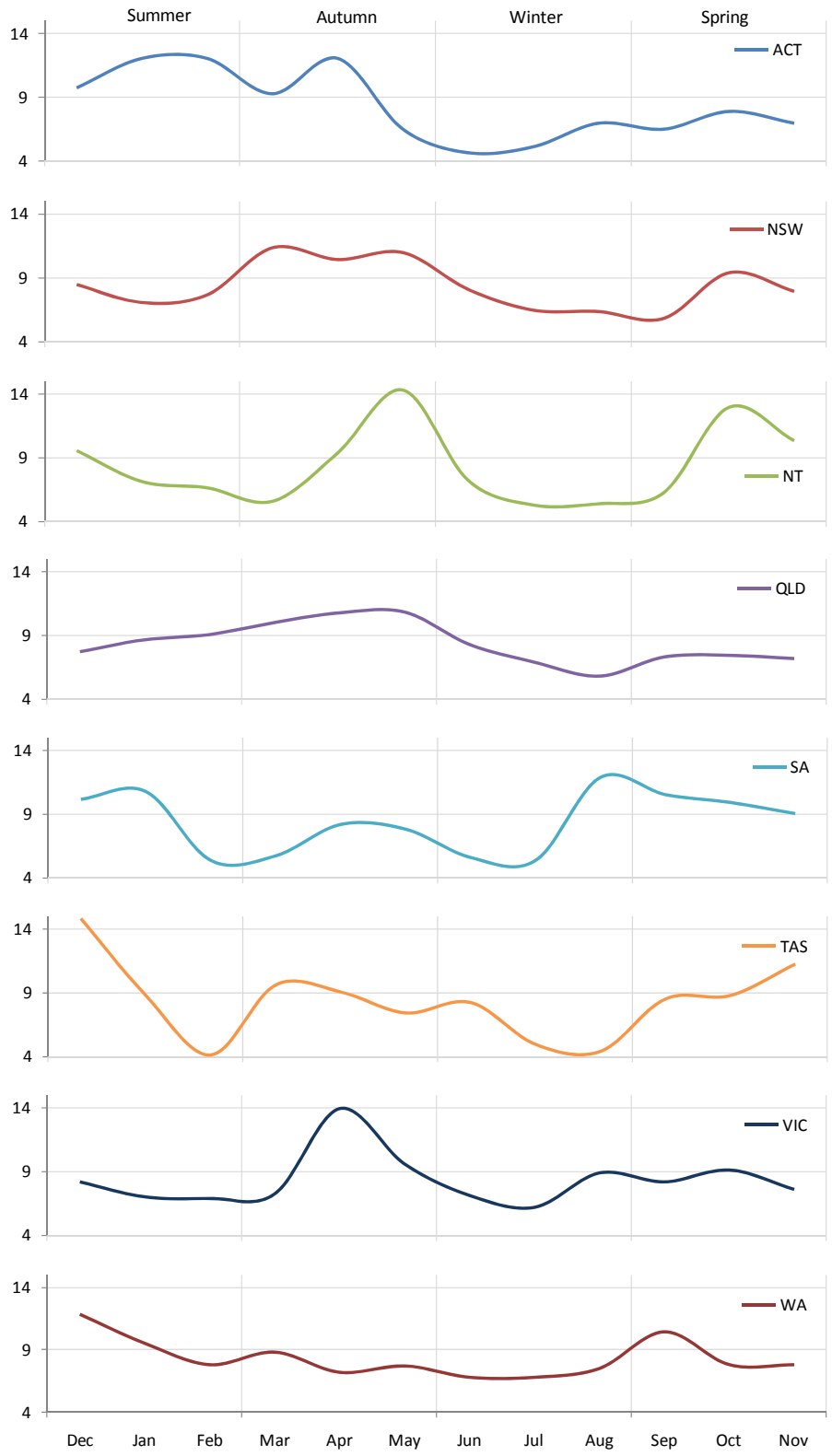


Figure 4 records birdstrikes by season and state. Considering all states together, there is a distinct decline in bird strikes during the early winter months of June and July. All states display some variability in relation to the percentage of birdstrikes recorded by seasonal category, but most states have one or two distinct 'peak' periods.

Figure 4: Per cent of birdstrikes occurring each month by state



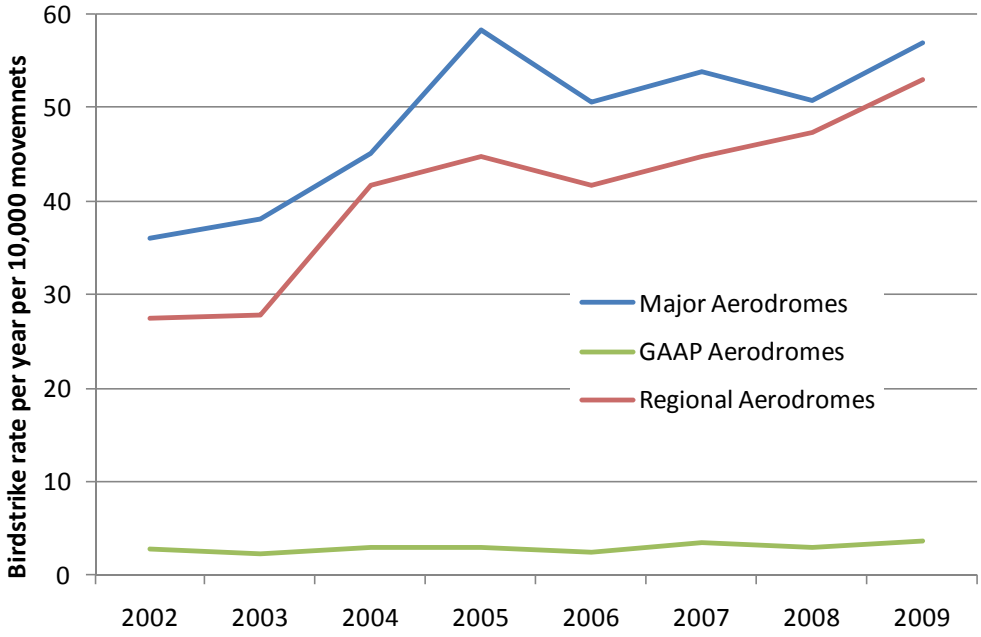
5 BIRDSTRIKES AT AUSTRALIAN AERODROMES

This chapter reviews birdstrikes at, and around, Australian aerodromes for all types of aircraft. The majority of birdstrikes occur within the confines of an aerodrome, that is, within 5 km from the aerodrome and on the aerodrome. This is attributed to birds and aircraft more commonly sharing the same airspace while the aircraft is on the runway for takeoff and landing, and during the climb and approach phases of flight. In addition, even when pilots are not aware of a birdstrike on the ground or in the aerodrome confines, it will often be found and reported by ground staff.

Most birdstrikes occur within the confines of aerodromes (less than 5 km) for all types of aerodromes. A full list of birdstrikes at each aerodrome within the confines of the aerodrome, at 5 to 15 km, and greater than 15 km, is provided in Appendix C in Table 30 (major aerodromes), Table 31 (General Aviation Airport Procedures (GAAP) aerodromes[10]), and Table 32 (towered regional aerodromes).

Similar trends in total birdstrikes exist for aerodromes as that for the states in Table 3 above, which are influenced by total movements and the geographical location. Major and regional aerodromes had a significantly higher rate of reported birdstrikes than GAAP aerodromes, and had notably increasing rates from 2002 to 2009. GAAP birdstrike rates do not appear to have changed. This can be seen in Figure 5, which shows the rates of birdstrikes for every 10,000 movements at each aerodrome category. The following figures and tables also show this information for each specific aerodrome. Only birdstrikes within the confines of aerodromes have been included.

Figure 5: Total rate of strikes (inside aerodrome confines only) summed across all operation types per 10,000 movements



[10] General Aviation Airport Procedures were active for the period of study of this report. As of 3 June 2010 these aerodromes were changed to Class D Controlled Airspace.

For major aerodromes, Table 4 shows an overall increase in the birdstrike rate at most aerodromes over the period of study. The rates for individual aerodromes appear to fluctuate, however, there are distinct peaks in the data; for example Darwin shows a peak birdstrike rate in 2005. Canberra has had a decreasing reported birdstrike rate from 2007.

Figure 6 shows that Darwin, Hobart and Cairns aerodromes have the three highest average birdstrike rates for major airports respectively. This can be explained for Darwin and Cairns due to higher bird populations in the tropical latitudes. It is unclear why Hobart airport has a relatively high rate of birdstrikes.

Table 4: Rate of birdstrikes each year at major airports (inside aerodrome confines only) per 10,000 movements

Aerodrome	2002	2003	2004	2005	2006	2007	2008	2009	Average
Adelaide	3.09	3.55	5.82	5.80	5.44	4.61	4.29	7.40	**5.00**
Brisbane	4.39	4.43	3.98	4.13	4.01	4.21	6.19	5.75	**4.64**
Canberra	1.05	0.57	2.32	3.88	5.38	4.58	3.32	2.56	**2.96**
Cairns	2.85	4.49	5.51	7.50	4.14	8.13	8.20	8.09	**6.11**
Darwin	8.67	8.20	11.73	13.86	7.93	8.11	8.70	12.97	**10.02**
Gold Coast	2.32	3.55	1.71	3.73	3.82	4.53	2.12	2.40	**3.02**
Hobart	7.99	5.62	3.62	9.23	9.16	11.33	7.39	7.24	**7.70**
Melbourne	2.38	1.89	3.09	3.38	3.89	1.95	3.81	3.23	**2.95**
Perth	1.63	3.41	4.35	3.84	4.22	3.38	3.91	3.37	**3.51**
Sydney	1.66	2.32	3.03	2.95	2.58	3.00	2.82	3.90	**2.78**

Figure 6 also shows that the average birdstrike rate for 2008-2009 is slightly higher than the 8-year average for most airports, in particular, Cairns and Brisbane. However, Canberra and Perth have remained stable and the Gold Coast and Hobart had a lower birdstrike rate in the 2008-2009 period.

Figure 6: Average rate of birdstrikes for major aerodromes (inside aerodrome confines only) per 10,000 movements from 2002 to 2009 and 2008 to 2009

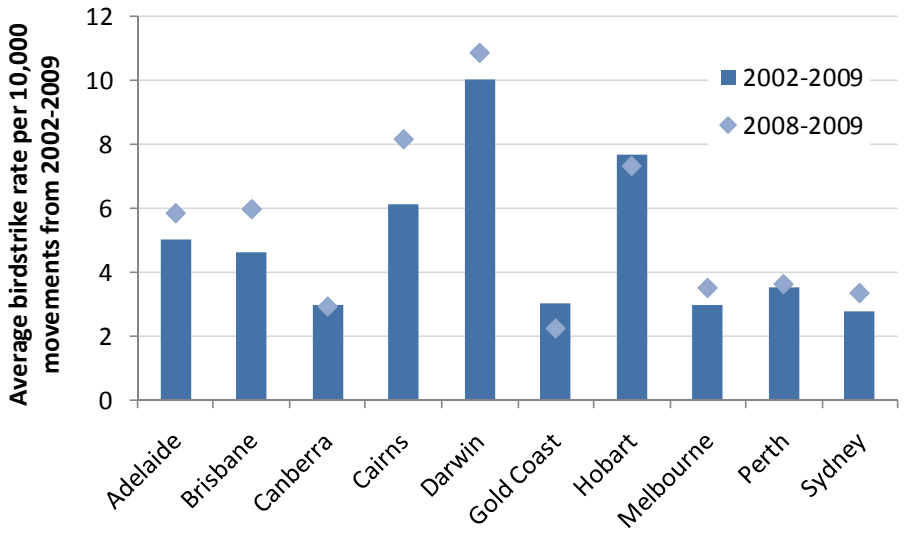


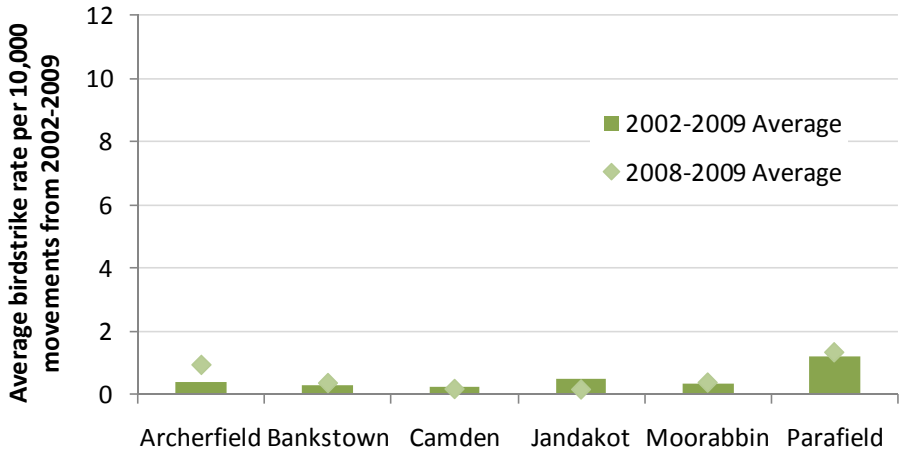
Table 5 shows very little change in the rate of reported birdstrikes at most GAAP aerodromes, which, as mentioned above, have birdstrike rates significantly lower than major and towered regional aerodromes. Archerfield aerodrome has the highest increase over the period of study.

The average rate of birdstrikes for GAAP aerodromes between 2002 and 2009 is shown in Figure 7. This shows that Parafield aerodrome has the highest average birdstrike rate. However, the birdstrike rate for Parafield appears to be stable. This figure also shows that Archerfield has had a relatively high bird strike rate over the past 2 years.

Table 5: Rate of birdstrikes each year at GAAP aerodromes (inside aerodrome confines only) per 10,000 movements

Aerodrome	2002	2003	2004	2005	2006	2007	2008	2009	Average
Archerfield	-	0.08	0.16	0.28	0.30	0.51	0.51	1.36	**0.40**
Bankstown	0.26	0.44	0.26	0.25	0.15	0.23	0.36	0.37	**0.29**
Camden	0.32	-	-	-	0.44	0.80	0.36	-	**0.24**
Jandakot	0.83	0.46	0.67	0.40	0.69	0.55	0.11	0.22	**0.49**
Moorabbin	0.28	0.30	0.44	0.45	0.21	0.29	0.31	0.45	**0.34**
Parafield	1.19	1.09	1.38	1.58	0.71	1.16	1.35	1.31	**1.22**

Figure 7: Average rate of birdstrikes for GAAP aerodromes (inside aerodrome confines only) per 10,000 movements from 2002 to 2009 and 2008 to 2009



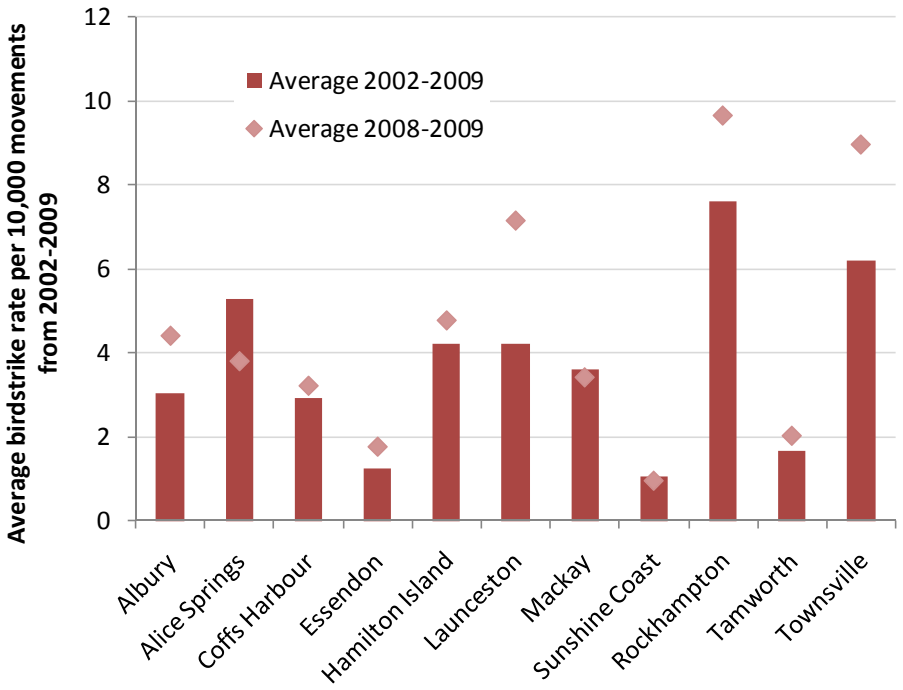
Towered regional aerodrome birdstrike rates generally fluctuate for each aerodrome, although most were generally increasing (Table 6). Rockhampton and Townsville have the highest average birdstrike rates for these aerodromes between 2002 and 2009, which is expected due to the tropical latitude of these aerodromes. Rockhampton also had the largest variation in strike rate between years, while Townsville's reported strike rate increased significantly over the period of study.

Table 6: Rate of birdstrikes each year at towered regional aerodromes (inside aerodrome confines only) per 10,000 movements

Aerodrome	2002	2003	2004	2005	2006	2007	2008	2009	Average
Albury	1.01	0.32	2.83	3.32	3.04	4.83	2.88	5.94	**3.02**
Alice Springs	9.35	3.84	4.49	5.22	5.98	5.90	2.29	5.32	**5.30**
Coffs Harbour	0.27	2.29	1.51	4.23	3.87	4.89	2.97	3.47	**2.94**
Essendon	0.73	0.47	0.84	1.36	2.03	1.12	1.52	2.02	**1.26**
Hamilton Island	1.27	1.40	3.70	6.02	6.19	5.44	4.94	4.61	**4.20**
Launceston	3.65	0.55	4.18	5.22	1.95	3.93	9.08	5.22	**4.22**
Mackay	3.48	2.11	7.08	4.32	3.12	1.95	2.41	4.43	**3.61**
Sunshine Coast	0.41	0.85	1.19	0.85	1.17	2.06	0.78	1.14	**1.06**
Rockhampton	3.43	10.74	7.36	6.98	8.01	5.09	9.46	9.84	**7.61**
Tamworth	1.27	2.26	1.08	0.88	1.66	1.99	2.65	1.41	**1.65**
Townsville	2.58	3.04	7.45	6.44	4.63	7.50	8.34	9.58	**6.20**

It can be seen in Figure 8 that in addition to Rockhampton and Townsville, Launceston has a significantly higher average birdstrike rate for the 2008-2009 period compared with the 8-year average. In contrast, Alice Springs has had lower birdstrike rate for 2008-2009.

Figure 8: Average rate of strikes for towered regional aerodromes (inside aerodrome confines only) per 10,000 movements from 2002 to 2009 and 2008 to 2009



Bird netting over ponds at Sydney Airport

6 SIGNIFICANT AUSTRALIAN BIRDSTRIKES

This chapter reviews birdstrikes that have been identified as posing a significant threat to aviation safety. Occurrences considered significant in this context are those involving ingestion of a bird, or birds, into a turbine engine (including turbofan, turbojet, turboprop and turboshaft engines), and occurrences involving aircraft damage and personal injuries as a result of birdstrikes.

6.1 Bird ingestions by aircraft engines

The majority of birdstrikes that resulted in engine ingestion occurred among high capacity air transport aircraft (84 per cent) (Table 7); these aircraft mainly operate using turbofan engines. Bird ingestion in these aircraft is related to the large frontal surface area of the engine air intake, and the very large suction produced by these engines, which draws air from an area much larger than the intake.

Engine ingestion makes up 11 per cent of all birdstrike occurrences (where the engine intake status was known) in high capacity air transport for the 8-year period. Only 5 per cent of low capacity strikes and 2 per cent of general aviation strikes involved engine ingestion.

Table 7: Number of birdstrikes by engine ingestion by operation type

Operation Type	Engine Ingestion	2002	2003	2004	2005	2006	2007	2008	2009	Total
High capacity air transport	1 Engine	43	34	66	61	65	74	73	67	**483**
	2 Engines	1	1	1	1	3	-	1	1	**9**
Low capacity air transport	1 Engine	2	8	7	4	8	14	20	6	**69**
	2 Engines	-	-	1	-	-	-	1	-	**2**
General aviation	1 Engine	-	2	1	4	-	3	5	-	**15**
Military	1 Engine	-	-	-	1	-	3	-	2	**6**
	2 Engines	-	-	-	-	-	-	1	-	**1**
Unknown	1 Engine	-	-	-	-	1	-	-	-	**1**
Total	**1 Engine**	**45**	**44**	**74**	**70**	**74**	**94**	**98**	**75**	**574**
	2 Engines	**1**	**1**	**2**	**1**	**3**	**-**	**3**	**1**	**12**

6.1.1 Birdstrike occurrences with engine ingestions

Single engine ingestions

The following are summaries of some more significant Australian occurrences involving aircraft with single engine bird ingestions during takeoff with turbofan and turboprop engines.

- Boeing 737 duck ingestion into turbofan engine

  During the take-off run, the aircraft struck a duck. During the initial climb, the crew detected high airframe vibration from the right engine and the aircraft was returned for a landing. After landing, significant fan blade damage was detected. (31 July 2009)

- SAAB 340 galah ingestion into turbo-prop engine

  During rotation, the aircraft struck a galah. The bird was ingested into the right engine, resulting in power loss and auto-coarsening of the propeller. The crew secured and shut down the engine, circled the aerodrome, and made a successful return landing with emergency services in attendance. (16 December 2007)

- Boeing K35 (military) pelican ingestion into turbofan engine

  During the landing, the aircraft struck a pelican which was ingested into the engine. The engine was shut down and the fire service was called as a precaution. An aircraft on final was sent around due to possible FOD [debris from the occurrence]. (20 June 2007)

Multiple engine ingestions

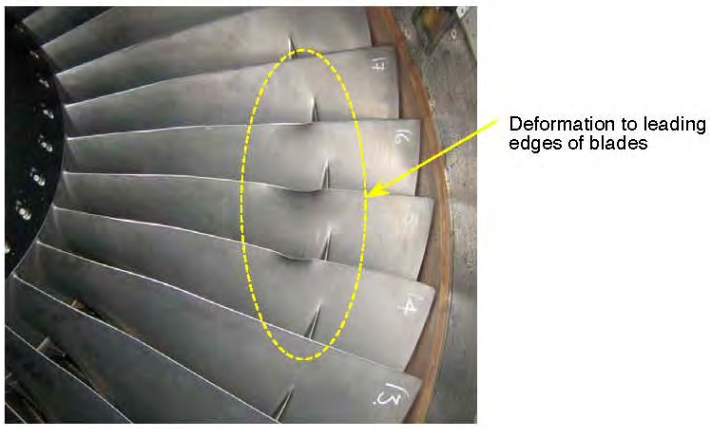
Table 7 above shows that multiple engine ingestions account for approximately 2 per cent of all bird engine ingestions. There have been a number of accidents around the world caused by the loss of thrust to more than one engine as a result of bird ingestion, such as the well known US Airways ditching into the Hudson River in January 2009.

The following are some examples of multiple engine bird ingestions that have occurred in Australia between 2002 and 2009:

- Boeing 767 multiple strikes with corellas resulting in engine damage (Figure 9)

  During rotation of the aircraft [at takeoff], the crew noticed a large flock of birds (estimated between 20 and 50 birds) converging with the aircraft's flight path. With no evasive manoeuvre available to the crew at this stage of flight, the aircraft encountered the flock and sustained multiple strikes on many parts of the aircraft. Immediately following the strikes, the crew checked the engine instruments and noticed that the left engine vibration indicator had risen to about 4.5 units. The crew reduced power on the left engine and that reduced the vibration levels. (3 October 2006)

Figure 9: Birdstrike damage to right engine fan blade on Boeing 767, 3 October 2006



- Boeing 777 ingestion of pacific gulls into both engines

  During short final approach to runway 16R, the aircraft struck several pacific gulls that impacted the wings and the engines. (25 July 2008)

- British Aerospace 'BAe 146' galahs ingested into two of four engines

  The pilot reported that during the landing roll, a flock of about ten galahs rose from left to right and four to five birds were ingested through the number-1 and 2 engines (both left wing engines). (7 March 2002)

6.2 Damage caused to aircraft by birdstrikes

Birdstrikes resulting in aircraft damage (including engine ingestions) present a significant hazard to aviation. Additionally, in cases where a birdstrike results in aircraft airframe or engine damage, a considerable cost can also be involved.[11]

6.2.1 Aircraft parts damaged from birdstrikes

There has been an increase in the number of damaging birdstrikes between 2002 and 2009 for all operation types. However, this is largely proportional to the increase in the number of total birdstrikes. Table 8 shows the highest number of damaging birdstrikes occurs in high capacity air transport. Birdstrikes causing damage to multiple parts were not common throughout the period.

Table 8: Number of birdstrikes by number of parts damaged by operation type

Operation Type	Number of Parts Damaged	2002	2003	2004	2005	2006	2007	2008	2009	Total
High capacity air transport	1	21	24	41	32	32	37	42	39	**268**
	2	-	-	1	-	-	1	-	1	**3**
Low capacity air transport	1	21	23	22	10	33	13	28	27	**177**
	2	-	-	-	-	-	1	2	3	**6**
	4	-	-	-	-	-	-	1	-	**1**
General aviation	1	19	19	22	18	21	18	28	37	**182**
	2	1	-	-	-	-	1	2	-	**4**
Military	1	-	-	-	2	2	3	2	3	**12**
Unknown	1	-	1	-	1	-	-	1	-	**3**

General aviation had the highest proportion of damaging birdstrikes, with almost 24 per cent of birdstrikes in general aviation causing damage, as shown in Figure 10. Given the lower rate of all reported birdstrikes in general aviation, this may be a result of this sector being less likely to report non-damaging birdstrike occurrences. It may also be contributed to by the smaller aircraft in general aviation relative to bird size.

[11] A brief review was conducted in the 2008 ATSB report *An analysis of Australian birdstrike occurrences, 2002 to 2006* (AR-2008-027), pp 5-6.

Figure 10: Proportion of damaging birdstrikes in each operation type

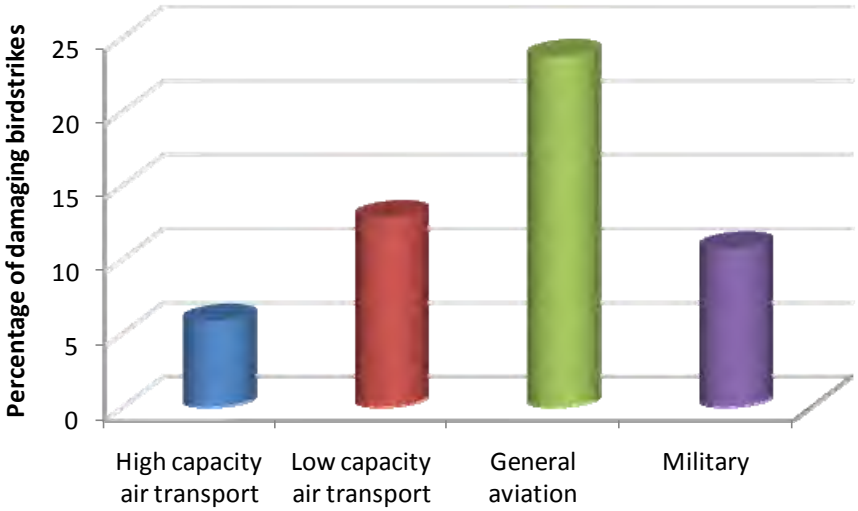


Table 9 shows that aeroplane wings and helicopter rotor blades are the most commonly damaged aircraft components across all operational types, particularly in general aviation, which had the highest number of these parts damaged. This may be due to the wing presenting the largest frontal surface area on an aircraft, and the relative speed of rotors in helicopters. Engines were the most frequently damaged component in high capacity air transport.

Table 9: Number of birdstrikes by part damaged by operation type

Operation Type	High capacity air transport	Low capacity air transport	General aviation	Military	Unknown	Total
Wing/Rotor	70	83	105	4	-	**262**
Engine	121	38	7	5	-	**171**
Nose	22	13	14	2	-	**51**
Windscreen	8	10	24	-	1	**43**
Landing gear	22	12	7	-	-	**41**
Propeller	6	18	10	-	1	**35**
Tail	11	7	9	1	-	**28**
Fuselage	4	8	10	-	1	**23**
Other	3	5	9	2	-	**19**
Lights	9	4	3	-	-	**16**

6.2.2 Birdstrikes resulting in serious damage

There were eight occurrences between 2002-2009 that resulted in serious damage[12] to the aircraft. Six of them were in general aviation, and two were in low capacity air transport. Five of the occurrences involved helicopters. Selections of these occurrences are described below:

- Fairchild Industries SA227 'Metro 23' strike with large bird

  While on descent through 3,000 ft, the aircraft struck a bird. Inspection revealed a large bird had impacted on the leading edge of the right horizontal stabiliser causing substantial damage. There was a hole in the leading edge and the stabiliser was bent backwards. (11 September 2002)

- Socata TB-10 'Tobago' strike with large bird on wing

  During the downwind leg of a circuit at night, the pilot felt a bump and the aircraft yawed left. The pilot landed the aircraft safely. Post flight inspection revealed a severe dent in the left wing resulting from an impact with a large bird. (12 May 2005)

- Robinson Helicopter R22 loss of power to main rotor after birdstrike

  The helicopter was being operated on a private photographic survey flight when the pilot reported hearing a loud bang, followed by increasing vibration and a loss of main rotor power. The pilot immediately initiated an autorotative descent and landing, during which control of the helicopter was lost and it rolled onto its side. There were no reported injuries. Upon examination of the helicopter at the accident site, the owner's representative reported damage to the tailrotor and drive assembly, with evidence of the tailrotor having struck a large bird. Damage to the tailrotor gearbox mountings and dislodgement of the clutch wheel drive belts was noted, however no indications of pre-existing mechanical failure within the clutch and main rotor drive assembly was observed. (7 August 2005)

- Robinson Helicopter R22 birdstrike with tailrotor on approach

  During the power on approach, a bird flew into the tailrotor. The pilot lost control of the helicopter and crashed into the river. The helicopter was destroyed. (7 March 2008)

6.3 Personal injuries resulting from birdstrikes

Only four of the 9,287 reported birdstrike occurrences between 2002 and 2009 resulted in injury. All of these occurred in general aviation, with one occurring each year between 2004 and 2007. Descriptions of the personal injury incidents and accident are listed below. All injuries received were minor.

- Aero Commander 500 broken windscreen by unknown bird impact

  The pilot reported to ATC [air traffic control] that his aircraft had struck a bird when 2 NM from touchdown and had sustained a broken windscreen in the collision. The pilot had also been slightly injured, however, the aircraft was landed without further incident. (11 February 2004)

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[12] Serious damage is defined in the Transport Safety Regulations 2003 as damage to an aircraft that: (i) significantly affects the structural integrity, performance or operational characteristics of the aircraft; and (ii) requires major repair or replacement of the affected component or components of the aircraft; or (b) destruction of the aircraft.

- Schweizer 269CB helicopter tailrotor struck by eagle

  During cattle mustering operations, the helicopter's tailrotor struck an eagle. The pilot lost control and the helicopter crashed into a heavily timbered area. The pilot received minor injuries but the helicopter was destroyed. (9 February 2005)

- Robinson R22 helicopter bubble canopy smashed by bush turkey

  During climb, the helicopter struck a bush turkey that impacted the perspex bubble. The bubble was smashed and the front of the helicopter was damaged. The main rotor was damaged by debris and the pilot received facial injuries from shards of perspex. (2 April 2006)

- Aero Commander 500 left windscreen destroyed by a tern

  While conducting a survey at 200 ft, the aircraft struck a bird that impacted and destroyed the left windscreen. The aircraft climbed to 1,000 ft before the pilot returned the aircraft to Broome where it landed safely. [The pilot was wearing a face shield, however, suffered minor facial scratches.] (28 June 2007)

6.4 Other significant birdstrike occurrences

The following are a selection of occurrences which have been identified as having the potential for a more severe outcome due to controllability issues encountered as a result of the birdstrike. An image is included under one occurrence to show an example of the potential damage to wings in general aviation from birdstrikes.

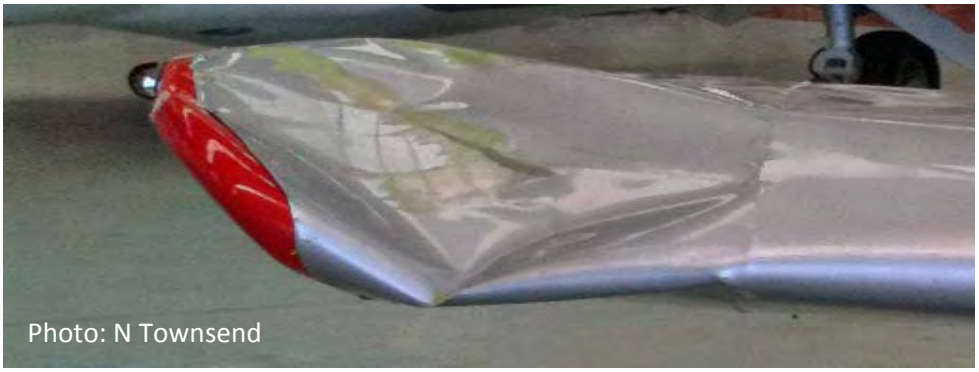
- Robinson Helicopter Co. R44 tailrotor strike with pelican at 800 ft

  Soon after takeoff at 800 ft, a pelican collided with the helicopter, impacting the cabin and tailrotor. The pilot conducted an autorotation due to severe vibrations and immediately landed the aircraft at Port Melbourne. (8 November 2007)

- Avions Pierre Robin R-2160 right wing leading edge strike with ibis

  On approach to the aerodrome, a flock of ibis was observed directly in front of the aircraft. The pilot manoeuvred to avoid the flock; however, one bird diverted from the flock and struck the outboard leading edge section of the right wing. Deformation of the upper wing skin and wing tip caused the aircraft to yaw right, and a slight aileron buffet. An uneventful landing was performed. The damage to the wing section is shown below. (19 December 2009)

Figure 11: Frontal image of R-2160 right leading edge tip following a birdstrike with an ibis, 19 December 2009



7 RECENT INTERNATIONAL BIRDSTRIKE ACCIDENTS

In recent years, there have been a number of accidents attributed to birdstrikes around the world. There have been no civilian aviation fatalities attributed to a birdstrike in Australia to date, although there have been a number of accidents; for example, in 1969, the pilot of a Boeing 707 performed a high speed rejected takeoff after ingesting seagulls. It over-ran Sydney airport flight strip and resulted in damage, but no serious injuries to the 11 crew and 125 passengers on board.

The following review of two recent international birdstrike accidents has been conducted to show the potential implications of birdstrike occurrences, and to present recommendations from these investigation reports relating to the reduction of the birdstrike risk hazards that are common threats internationally as well as domestically.

7.1 Airbus A320 ditching on the Hudson River

On 15 January 2009 at about 1525 local time, US Airways flight 1549 departed LaGuardia Airport, New York City en route to Charlotte, North Carolina with five crew and 150 passengers on board. Approximately 2 minutes into the flight after climbing through 2,700 ft, with an airspeed of about 220 kts[13], the first officer observed a flock of large birds (identified after the accident as Canadian migratory geese[14]). The aircraft struck multiple birds and subsequently lost almost all power in both engines. The pilots conducted a forced landing into the Hudson River. The ditching resulted in one crew member at the rear of the aircraft and four passengers sustaining serious injuries during the impact; however, all on board survived. [15]

An investigation by the US National Transportation Safety Board (NTSB) contained many findings and recommendations.[16] Findings covered issues such as deficiencies in procedures in the event of a dual engine failure, problems associated with ditching into water, the current airworthiness standards for bird ingestion into aircraft engines, and the adoption of new and emerging technologies for detecting or deterring birds in flight.

A summary of the conclusions and recommendations with respect to birdstrikes are listed below:

- There is a need for innovative technologies that can be installed on aircraft that would reduce the likelihood of a birdstrike (recommendations 15 and 26).
- Relevant regulations relating to bird ingestion into aircraft engines require review or change with respect to the following

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[13] Animation available at web address: http://www.ntsb.gov/Events/2010/Hudson-River-NY/AnimationDescription.htm (accessed 7 June 2010)

[14] The Canada migratory geese were identified by the Smithsonian Institute's Migratory Bird Center.

[15] NTSB Media Release 4 May 2010 "Crew Actions and Safety Equipment credited with saving lives in US Airways 1549 Hudson River Ditching, NTSB says". Web Address: http://www.ntsb.gov/Pressrel/2010/100504.html (accessed 14 May 2010).

[16] NTSB report available at web address: http://www.ntsb.gov/Publictn/2010/AAR1003.pdf (accessed 7 June 2010)

  - Small and medium flocking bird tests should be performed at the lowest expected fan speed for the minimum climb rate, rather than greater than or equal to 100% fan speed[17], which is stipulated in current requirements.
  - Review the current large flocking bird standard and determine whether this should apply to smaller engines[18], and whether it should include engine core ingestion.
- The recommendations also emphasise the importance of wildlife hazard assessments and plans at aerodromes.

7.2 Crash of Cessna 500 following collision with pelicans

On 4 March 2008 at about 1513 local time, a Cessna Citation 500 took off with five people on board from Wiley Post Airport in Oklahoma City en route to Mankato Regional Airport in Minnesota. Two minutes into the flight, while flying at an altitude of about 1,800 ft above ground level, eye witnesses reported that the aircraft rolled to the left and spiralled nose-down to the ground. A light coloured substance was observed trailing from the aircraft's left side, likely to be fuel. The steep descent commenced at about the same time the aircraft was observed on radar to intersect the flight track of numerous primary radar returns.[19] The aircraft was destroyed on impact, with all five occupants killed (two crew and three passengers).

The NTSB investigation[20] found that the Citation had impacted with one or more American white pelicans while the aircraft was travelling at a relative speed of about 200 kts. The right engine showed evidence that a bird ingestion had occurred and the engine was not producing thrust at the time the aircraft impacted the ground. However, the left engine was deemed to be operating normally through the accident sequence. The loss of power in the right engine was not considered to have caused the accident; it was determined that the probable cause of the accident was due to one or more pelicans impacting the left wing structure, resulting in damage sufficient to rupture a wing fuel tank and cause the loss of control of the aeroplane.

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17 NTSB Recommendations 3 and 27. This is to allow the largest possible amount of bird to enter the engine core.

18 Currently the large flocking bird ingestion standards (contained in Federal Airworthiness Regulation 33.76) only include engines with a face area above 3,875 square inches.

19 A standard aviation primary radar return gives position, but not altitude information, and were presumed to be large birds.

20 NTSB report AAR-09/05 Adopted July 28, 2009 located at Web address: http://www.ntsb.gov/publictn/2009/AAR0905.pdf (accessed 13 May 2010)

Figure 12: Aircraft wreckage showing tail section

Source: NTSB report AAR-09/05

The NTSB investigation report on this accident contained many findings and recommendations. With respect to birdstrikes, these findings suggest that:

- 'the current airframe certification standards for birdstrikes are insufficient[21]' due to them being derived from obsolete 'birdstrike and bird population data and trends' and also because they allow for lower levels of birdstrike protection for some structures (such as the wing) on the same aeroplane
- there was no wildlife risk assessment performed by Wiley Post Airport to determine if any mitigation strategy could have been implemented to reduce the risk of a collision with the pelicans
- precautionary operational strategies could be devised by pilots with the aid of reference charts showing airframe limitations from various sized birds and reliable information about the mass, numbers and activity of birds likely to be encountered at each aerodrome.

[21] Finding four of the NTSB report.

8 BIRD TYPES, NUMBERS STRUCK AND SIZE

8.1 Type of birds struck

8.1.1 Total birdstrikes by bird type

Table 10 shows the total number of birdstrikes for each bird type distributed by state. The table is in order of the most commonly struck bird types and includes all bird types with 40 or more birds struck nationally from 2002 to 2009. The full list of species is contained in Appendix C (Table 35).

Table 10: Birdstrikes by bird type by state 2002-2009

Bird Type	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Other	Total
Lapwing/Plover	12	92	110	124	24	110	30	95	-	**597**
Bat/Flying Fox	-	176	51	265	2	-	26	22	-	**542**
Galah	57	213	8	80	112	1	22	39	-	**532**
Kite	-	48	104	233	2	-	28	38	-	**453**
Magpie	20	78	1	60	77	3	88	26	-	**353**
Nankeen Kestrel	8	55	14	98	66	-	6	74	6	**327**
Swallow/Martin	7	35	22	171	17	8	11	28	-	**299**
Hawk	10	39	21	77	19	12	18	51	1	**248**
Magpie-lark	-	33	19	88	75	6	5	8	-	**234**
Silver Gull	1	71	1	12	59	22	42	23	-	**231**
Curlew/Sandpiper	-	2	79	101	1	-	-	3	1	**187**
Pratincole	-	-	143	9	-	-	-	-	-	**152**
Dove	-	30	4	28	47	-	22	11	1	**143**
House Sparrow	1	25	7	37	12	7	32	14	-	**135**
Duck	18	21	2	52	3	2	13	14	1	**126**
Pipit	4	41	4	10	-	4	41	18	-	**122**
Owl	-	14	12	20	5	-	12	23	-	**86**
Heron/Egret	-	10	2	53	-	-	5	7	8	**85**
Ibis	-	25	1	41	2	-	12	4	-	**85**
Crow/Raven	6	13	3	23	9	7	9	9	-	**79**
Eagle	-	11	6	26	-	1	3	21	-	**68**
Finch	-	3	8	8	-	20	1	5	1	**46**
Starling	-	12	2	7	9	11	4	1	-	**46**

The most common bird type struck was the lapwing/plover, and it was found in every Australian state and territory; however, this may be influenced by the broad species range included in this bird type (banded plover, black-fronted plover, dotterel, lapwing, masked lapwing, masked plover, oriental plover, pacific golden plover, plover, spur-winged plover). Figure 13 shows that the number of lapwing/plover average strikes in 2008-2009 was higher than the average for the whole 8-year period.

Masked Lapwing

The highest single bird species struck was the galah, making up a significant proportion of birdstrikes in New South Wales, the Australian Capital Territory and South Australia.

Galah

Three large bird types not included in the list below are the:

- Pelican, with 13 total strikes
- wedge-tailed eagle, with 15 total strikes
- Australian brush-turkey, with 26 total strikes.

While the number of total strikes involving these larger birds is relatively low, the potential for aircraft damage or injury from such strikes represents a significant risk to aviation safety (see Section 8.1.2 below).

Table 11shows the common bird types for 2008-2009, recording bird types with 30 or more strikes across Australia in the 2-year period. The 10 most common birds struck remained largely the same in 2008-2009 when compared with the 8-year period. However, the Pipit moved from the 16th most frequently struck bird to the 10th. In 2008-2009, the bat/flying fox and lapwing/plover bird types changed positions in order of most frequently struck bird type, as did the kite and galah. Most changes were due to a greater relative increase in birdstrikes for a particular bird type, rather than any bird types having a lower than average strike rate. That is, the strike rate of most bird types appears to be increasing at varying rates. It is probable that these data reflect increased strikes of these species rather than better bird identification and reporting, as the proportion of all birds struck each year that were not identified remained stable at about 40 per cent between 2003 and 2009.

Table 11: Recent birdstrikes by common bird types by state 2008-2009

Bird Type	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Other	Total
Lapwing/Plover	2	44	24	38	14	37	9	20	-	**188**
Bat/Flying Fox	-	58	19	97	-	-	4	5	-	**183**
Galah	15	67	2	25	33	1	7	5	-	**155**
Kite	-	15	32	67	-	-	5	21	-	**140**
Nankeen Kestrel	-	22	5	36	16	-	1	19	5	**104**
Magpie	6	29	-	20	20	-	19	8	-	**102**
Swallow/Martin	2	4	9	54	6	2	5	8	-	**90**
Magpie-lark	-	10	6	20	31	-	1	3	-	**71**
Hawk	2	14	1	17	3	5	2	11	-	**55**
Pipit	1	15	1	4	-	3	16	12	-	**52**
Dove	-	12	-	7	14	-	10	3	1	**47**
Silver Gull	-	9	-	1	8	5	10	13	-	**46**
House Sparrow	-	1	2	16	4	2	12	3	-	**40**
Curlew/Sandpiper	-	1	14	22	-	-	-	1	1	**39**
Duck	7	8	1	15	-	2	-	6	-	**39**
Heron/Egret	-	3	1	24	-	-	1	2	6	**37**
Pratincole	-	-	27	3	-	-	-	-	-	**30**

Little red flying fox

All bird types in the top 10 in 2008-2009 were either at or above the total average per year for the period of this study, as shown in Figure 13. Bat and flying-fox strikes were 20 strikes above their total period average for 2008-2009, with significant increases in Queensland and New South Wales.

Figure 13: Average total birdstrikes per year from 2002-2009 versus 2008-2009 total birdstrikes by bird type

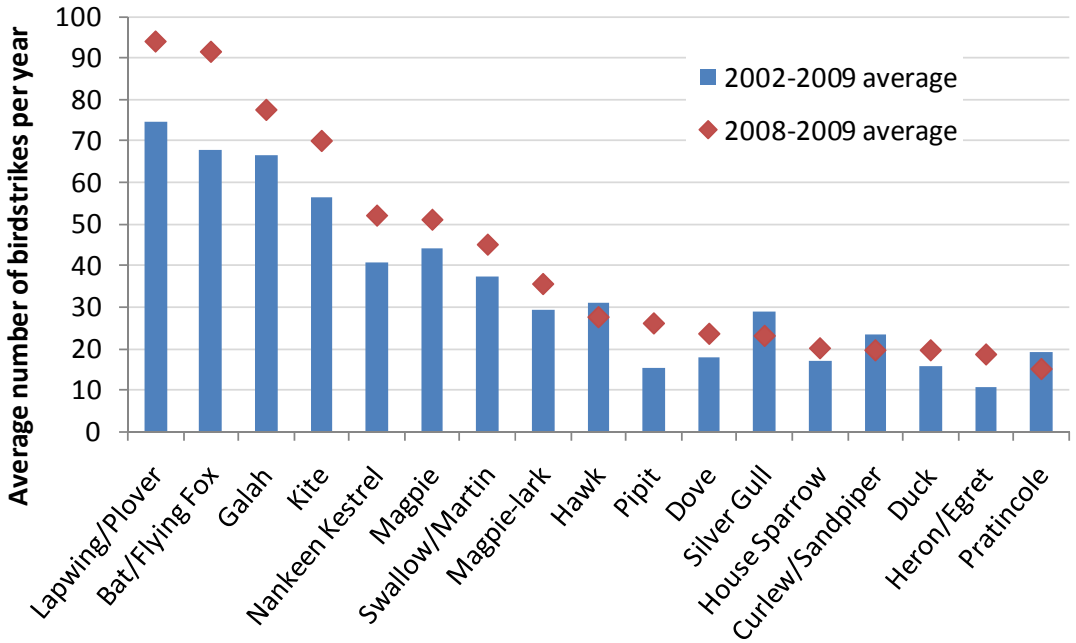
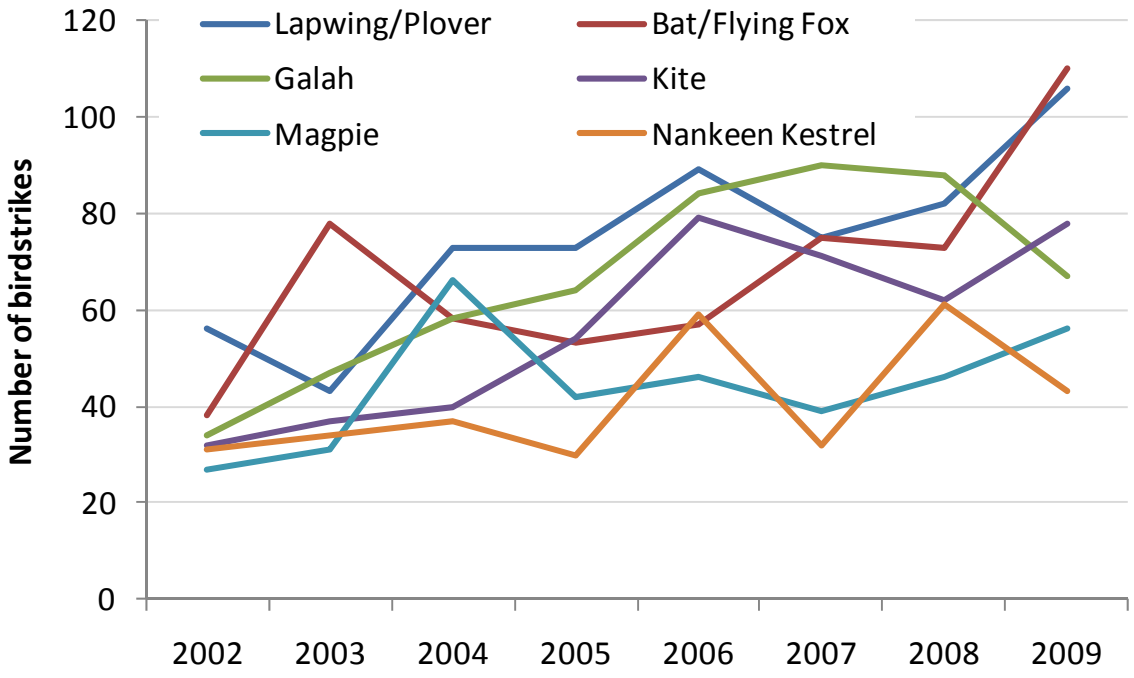


Figure 14 shows the six bird types struck most commonly from 2002-2009. Bats and flying foxes were greater than lapwings/plovers, and more kites were struck than galahs in 2009. A full list of species by year is included in Table 36 of Appendix C.

Australian Magpie

Figure 14: Number of birdstrikes for highest bird types struck by year



8.1.2 Damaging birdstrikes by bird type

Table 12 shows the total number of damaging birdstrikes by bird type, sorted in order of serious and minor damage. Galahs, bats/flying foxes and kites had the highest reported damaging strikes between 2002 and 2009.

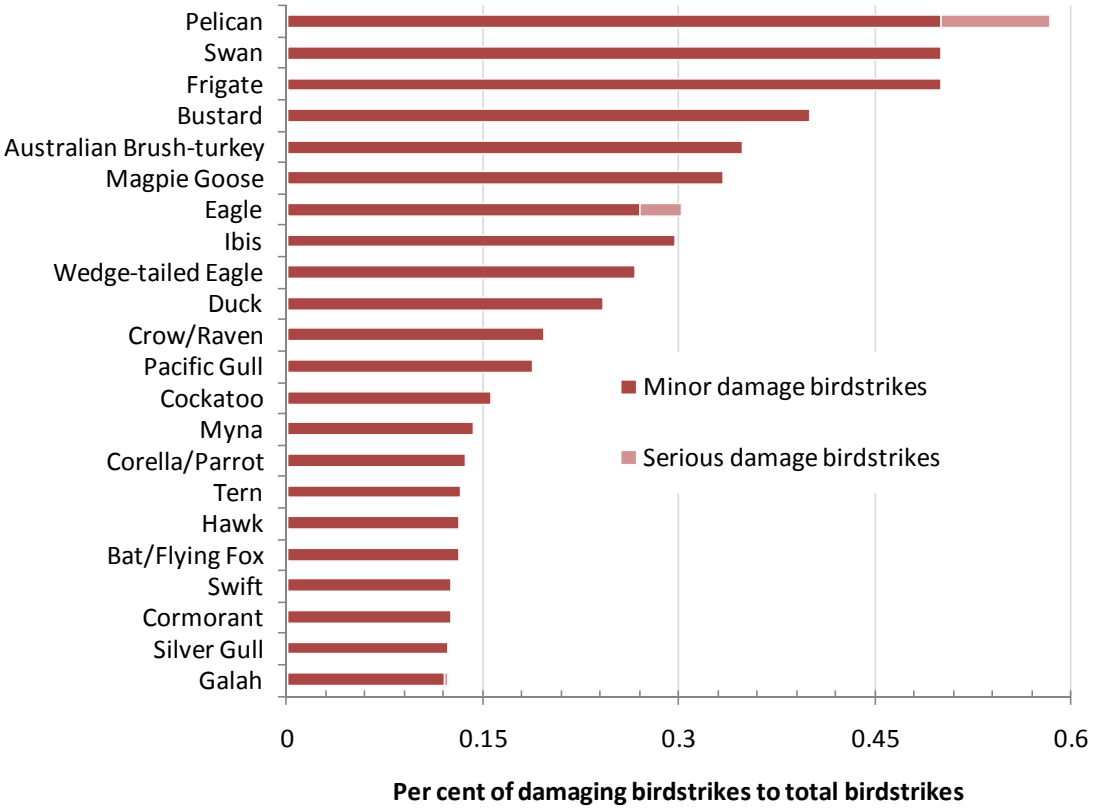
Black Kite

Table 12: Aircraft damage severity (where damage is known) by bird type

Bird Type	Serious damage	Minor damage	Nil damage
Eagle	2	17	44
Galah	1	47	342
Pelican	1	6	5
Bat/Flying Fox	-	47	311
Kite	-	33	264
Hawk	-	24	158
Duck	-	23	72
Silver Gull	-	21	149
Ibis	-	19	45
Lapwing/Plover	-	16	413
Magpie	-	11	242
Crow/Raven	-	10	41
Dove	-	8	77
Australian Brush-turkey	-	8	15
Curlew/Sandpiper	-	5	115
Heron/Egret	-	5	50
Cockatoo	-	5	27
Magpie-lark	-	4	146
Tern	-	4	26
Wedge-tailed Eagle	-	4	11
Nankeen Kestrel	-	3	191
Pratincole	-	3	93
Corella/Parrot	-	3	19
Pacific Gull	-	3	13
Magpie Goose	-	3	6
Swallow/Martin	-	2	225
Owl	-	2	53
Other	-	2	9
Swift	-	2	14
Bustard	-	2	3
Swan	-	2	2
House Sparrow	-	1	113
Pipit	-	1	63
Starling	-	1	36
Falcon	-	1	21
Cormorant	-	1	7
Myna	-	1	6
Frigate	-	1	1

Figure 15 shows the 11 bird types that have the highest proportion of damaging strikes compared with the total strikes reported. With the exception of the galah, which is included due to one serious damage strike, all bird types shown in Figure 15 had at least one damaging strike reported in every five strike occurrences. Pelicans had more than half of all strikes reported with damage occurring.

Figure 15: Per cent of birds struck to aircraft damage by bird type



Damaged aircraft from a pelican strike

8.1.3 Damaging birdstrikes by bird type and operation type

Strikes Causing Serious Damage

There were four birdstrikes causing serious damage between 2002 and 2009 where the bird type was known. One low capacity charter birdstrike caused serious damage which involved a Robinson R44 helicopter striking a pelican (described in section 6.4). There were no high capacity air transport birdstrikes resulting in serious damage.

Three birdstrikes resulting in serious damage occurred in general aviation; one from a flock of galahs and two from lone eagles. Two of these were from the tailrotor of a helicopter being impacted by birds (galahs and one eagle) resulting in loss of control.

Birds with the most reported damaging strikes for each operation type

The figures below show the top 10 bird types with the highest number of damaging birdstrikes reported for each operation type. There are many similar damaging bird types by operation type, however, each operation type has a distinct distribution. This probably reflects varying bird threats at specific locations used by the different operation types.

Figure 16: High capacity air transport damaging birdstrikes by bird type

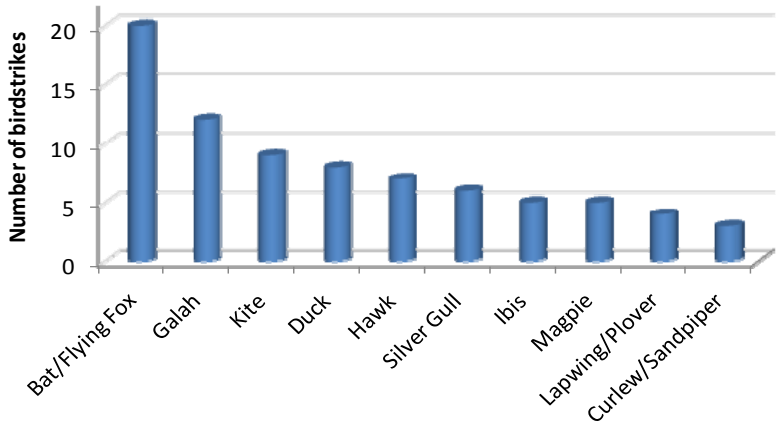


Figure 17: Low capacity air transport damaging birdstrikes by bird type

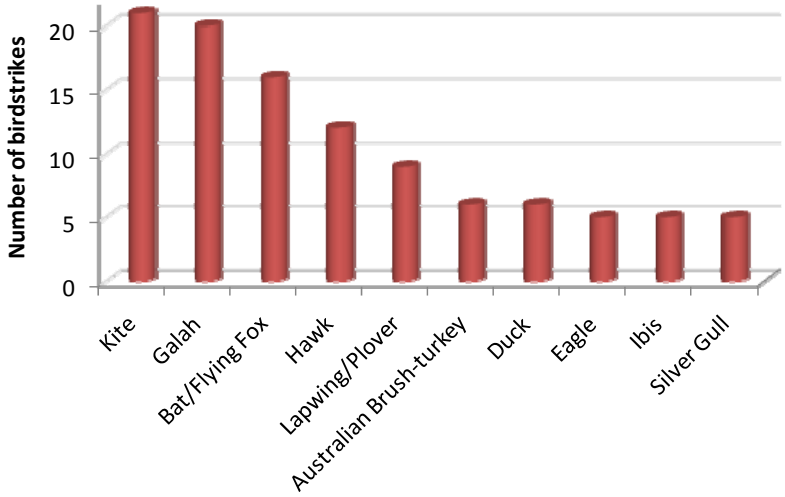
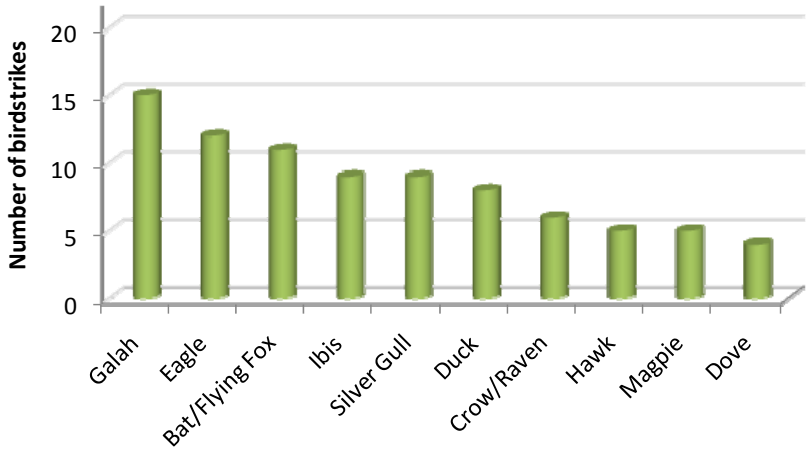


Figure 18: General aviation damaging birdstrikes by bird type



Wedge-tailed eagle

8.2 Multiple birds struck

A birdstrike occurrence with multiple birds being struck generally presents a greater hazard to aviation safety. For larger aircraft, one of the most hazardous scenarios is when multiple engine ingestions occur, as shown with the US Airways occurrence described in section 7.1, in particular with large birds.

Table 13 includes bird types where at least one birdstrike occurrence involved multiple birds being struck. Multiple galah strikes were the most common over the study period, with a multiple birdstrike occurring in more than 39 per cent of galah strikes. Galahs are known to have flocking tendencies, and these flocking tendencies may lead to a higher frequency of multiple birdstrikes. Medium to large-sized flocking water bird types, such as the magpie-goose, duck, and silver gull, had at least one in four birdstrike occurrences recorded with multiple strikes when considered collectively.

Table 13: Number of birds struck by bird type 2002-2009

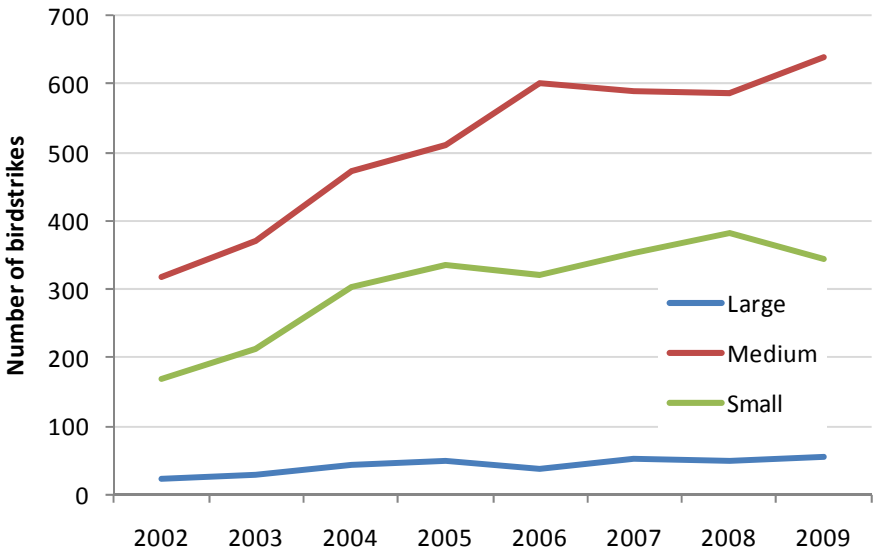
Bird type	Greater than 10	Between 2 and 10	Single bird
Galah	14	195	323
Silver Gull	4	52	174
Corella/Parrot	3	7	20
Lapwing/Plover	1	93	503
Bat/Flying Fox	1	50	491
Swallow/Martin	1	32	266
Dove	1	25	117
Magpie	1	21	330
Curlew/Sandpiper	1	20	166
Finch	1	12	33
Magpie Goose	1	2	7
Tern	1	1	34
Duck	-	37	89
Kite	-	29	424
Pratincole	-	20	132
Magpie-lark	-	19	215
Nankeen Kestrel	-	15	312
Hawk	-	11	237
Cockatoo	-	10	29
Swift	-	10	14
Pacific Gull	-	9	12
House Sparrow	-	8	127
Ibis	-	8	77
Pipit	-	7	115
Heron/Egret	-	7	78
Owl	-	4	82
Starling	-	4	42
Crow/Raven	-	3	76
Eagle	-	2	66
Skylark	-	2	19
Robin	-	2	6
Falcon	-	1	31
Australian Brush-turkey	-	1	25
Wren	-	1	1

8.3 Size of birds struck

8.3.1 Total birdstrikes by bird size

Table 14 on page 41 shows that medium-sized birds were struck the most often in every operation type, followed by small birds. There was a general increase in strikes of all sizes, however, Figure 19 shows that there does not appear to be any significant change in the proportion of the sizes of birds struck between 2002 and 2009.

Figure 19: Number of birdstrikes by bird size



General aviation has a slightly elevated proportion of large birds struck, with about 9 per cent of birds struck being large, compared with less than 6 per cent for all other operation types. This was a result of the considerable number of large bird birdstrikes reported in 2009 for general aviation.

Galahs

Table 14: Number of birdstrikes by bird size and operation type

Operation Type	Bird Size	2002	2003	2004	2005	2006	2007	2008	2009	Total
High capacity air transport	Large	11	12	16	23	14	25	31	23	**155**
	Medium	143	145	217	232	250	238	240	266	**1,731**
	Small	98	114	179	189	200	208	255	211	**1,454**
	Unknown	148	143	184	240	180	176	236	310	**1,617**
Low capacity air transport	Large	7	6	12	12	10	13	9	8	**77**
	Medium	78	89	97	90	130	120	125	142	**871**
	Small	31	39	47	47	19	48	55	52	**338**
	Unknown	47	33	38	55	40	33	26	55	**327**
General aviation	Large	5	5	8	9	7	6	5	19	**64**
	Medium	40	47	42	59	44	68	89	87	**476**
	Small	18	18	28	29	22	27	31	35	**208**
	Unknown	33	22	19	27	18	29	33	41	**222**
Military	Large	-	-	-	1	-	2	1	-	**4**
	Medium	1	3	5	3	6	14	4	11	**47**
	Small	4	2	2	3	4	5	2	5	**27**
	Unknown	1	4	4	8	6	10	3	10	**46**
Unknown	Large	1	6	7	3	7	5	3	5	**37**
	Medium	56	86	113	126	172	149	128	132	**962**
	Small	17	40	47	68	75	64	39	41	**391**
	Unknown	41	19	19	54	30	21	25	24	**233**

Figure 20 shows the percentage of birds struck by bird size in each state and territory (where size was known). This is generally correlated with particular bird types struck that are common to each state[22], as can be seen in Table 10 on page 29. The number of birdstrikes for all sizes of birds has increased over time in each state and territory.

Table 37 in Appendix C lists the number of birds struck by size in each state and territory.

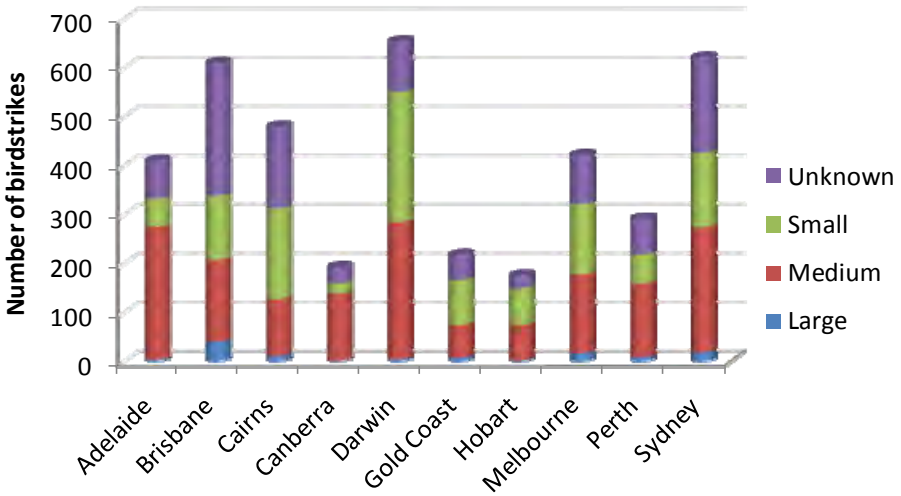
[22] Some bird types may include several species of significantly different sizes, for example bats and flying foxes, however there is a similar size trend for the majority of bird types.

Figure 20 shows that about 40 per cent of birdstrikes in Tasmania and Queensland and about 48 per cent in the Northern Territory involved small birds.

Figure 20: Percentage of birds struck by size for each state (2002-2009)

For the major airports, Figure 21 shows that although Darwin has more birdstrikes than other major aerodromes, it has a similar number of medium-sized bird strikes to Adelaide and Sydney. This is because Darwin has a higher proportion of strikes with small birds. Similarly, the majority of birdstrikes in Cairns, the Gold Coast, and Hobart are with small size birds.

Figure 21: Birdstrikes at major airports (aerodrome confines only) by bird size (2002-2009)



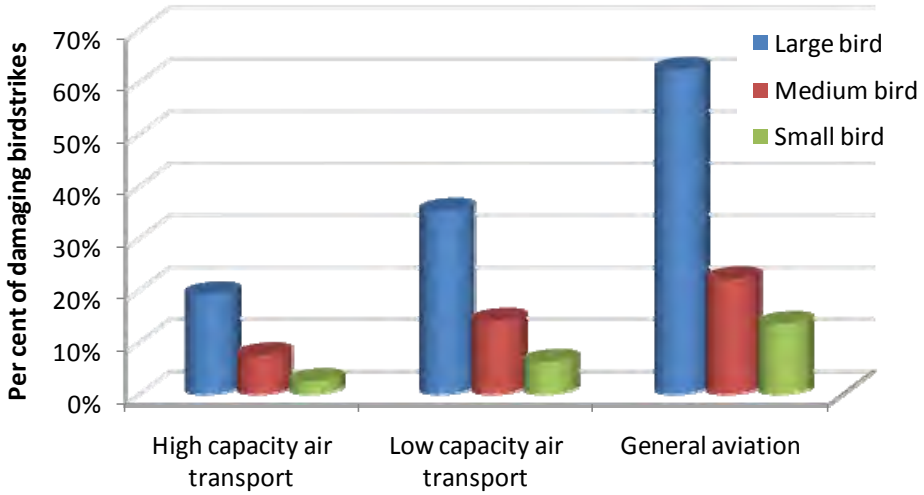
8.3.2 Damaging birdstrikes by bird size and operation type

Table 15 shows that the larger the bird size, the more likely there will be aircraft damage for all operation types. In addition, Figure 22 shows that as bird size increases, general aviation aircraft are more susceptible to damage than low capacity aircraft, which in turn, are more susceptible than high capacity aircraft.

Table 15: Bird size by aircraft damage and operation type

Operation Type	Aircraft Damage	Large bird	Medium bird	Small bird
High capacity air transport	Serious	-	-	-
	Minor	22	99	29
	Nil	93	1237	1154
Low capacity air transport	Serious	2	-	-
	Minor	23	109	19
	Nil	46	666	289
General aviation	Serious	4	1	-
	Minor	34	90	25
	Nil	23	322	161
Military	Serious	-	-	-
	Minor	3	3	2
	Nil	1	28	18

Figure 22: Per cent of damaging birdstrikes for each bird size



9 TERRESTRIAL ANIMAL STRIKES

The event of an aircraft striking a ground-based animal is not common in data reported to the ATSB, however, there is a relatively high possibility of aircraft damage when compared with birdstrikes.

9.1 Total animals struck

The total number of animal strikes fluctuates each year, but animal strikes are generally increasing. High capacity air transport had the highest average with 11.5 animal strikes per year, with general aviation having the second highest average, with 9.3 animal strikes per year.

Table 16: Number of animal strikes per year by operation type

Operation Type	2002	2003	2004	2005	2006	2007	2008	2009	Average
High capacity air transport	8	2	17	13	13	13	14	12	**11.5**
Low capacity air transport	3	12	5	4	10	10	6	9	**7.4**
General aviation	7	14	6	11	5	12	6	13	**9.3**
Military	1	-	-	-	1	-	1	-	**0.4**
Unknown	-	-	5	3	5	6	7	6	**4.0**
Total	**19**	**28**	**33**	**31**	**34**	**41**	**34**	**40**	**32.5**

Figure 23 shows the average number of animal strikes each year from 2002 to 2009 and the recent average from 2008 to 2009. High capacity air transport had the only significant change in 2008-2009 when compared with the 8-year average; however, the 8-year average is low for high capacity air transport due to the relatively small number of reported animal strikes in 2002 and 2003, as shown in Table 16. Removing 2003 from the 8-year average, high capacity air transport animal strikes are close to the average for 2008 to 2009. This differs from the general increase in reported birdstrikes recorded in Chapter 3.

Figure 23: Average animal strikes per year

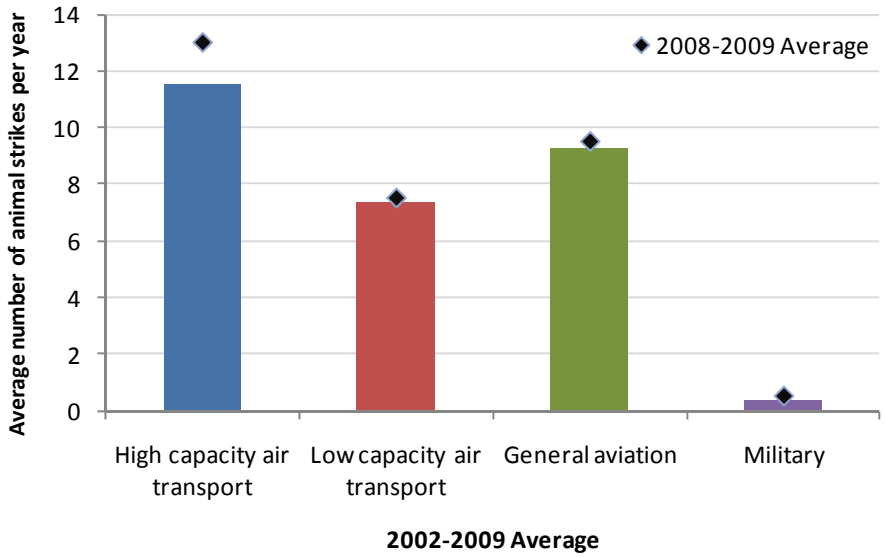


Table 17 shows that Queensland, followed by New South Wales had the highest rate of animal strikes over the assessed period. Hare/rabbit strikes were the most common animal struck, with kangaroos, wallabies and foxes/dogs making up the top four.

Table 17: Animal strikes by animal type and state (2002-2009)

Animal type	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Total
Hare/Rabbit	2	15	-	18	16	11	18	2	**82**
Kangaroo	-	17	8	17	3	1	1	11	**58**
Wallaby	-	6	11	13	1	-	-	3	**34**
Fox/Dog	2	5	3	7	7	-	4	3	**31**
Livestock	-	1	-	4	-	-	1	3	**9**
Lizard/snake	-	1	2	3	-	-	-	3	**9**
Goanna/Monitor	-	-	4	2	-	-	-	2	**8**
Echidna	-	-	-	3	-	3	-	-	**6**
Turtle	-	2	-	2	-	-	-	-	**4**
Emu	-	-	-	-	-	-	-	1	**1**
Other	-	1	4	6	-	3	1	-	**15**
Total	**4**	**48**	**32**	**75**	**27**	**18**	**25**	**28**	**257**

Table 18 shows the number of animal strikes by state in 2008-2009, which is similar in distribution to the animal strikes for the 8-year period. However, more strikes with unusual animals were reported. Three out of four turtle strikes reported for the entire period occurred in 2008-2009, as well as three out of six echidna strikes.

Table 18: Recent animal strikes by animal type and state (2008-2009)

Animal type	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Total
Hare/Rabbit	-	6	-	8	8	2	1	-	**25**
Kangaroo	-	2	2	4	-	-	-	3	**11**
Fox/Dog	-	1	1	3	1	-	2	1	**9**
Wallaby	-	1	2	4	-	-	-	2	**9**
Lizard/snake	-	-	1	3	-	-	-	1	**5**
Turtle	-	1	-	2	-	-	-	-	**3**
Echidna	-	-	-	2	-	1	-	-	**3**
Goanna/Monitor	-	-	-	1	-	-	-	2	**3**
Livestock	-	-	-	-	-	-	1	-	**1**
Other	-	-	1	2	-	1	-	-	**4**
Total	**-**	**11**	**7**	**29**	**9**	**4**	**4**	**9**	**73**

9.2 Aircraft damage from animal strikes

9.2.1 Damage from animal types

Animal strikes can cause a relatively large amount of damage due to the size and mass of many of the animals involved in strikes.

The highest number of damaging strikes reported was from kangaroos, with 31 out of 52 strikes reported causing damage (where the damage status was reported).

There were nine livestock strikes reported for the period between 2002 and 2009, and every occurrence resulted in damage as shown in the table below. Livestock strikes that occur away from licensed aerodromes and in general aviation aircraft are only reportable to the ATSB when they result in aircraft damage or injury, so it is possible that there have been some livestock occurrences not resulting in aircraft damage which have not been reported to the ATSB.

Table 19: Aircraft damage from animal strikes (where damage is known) by animal type

Animal type	Serious	Minor	Nil	Total
Kangaroo	2	29	21	**52**
Wallaby	2	7	18	**27**
Livestock[23]	6	3	-	**9**
Fox/Dog	1	2	15	**18**
Hare/Rabbit	-	2	59	**61**
Echidna	-	1	1	**2**

There were 11 animal strikes resulting in serious damage. Of note, all of the six serious damage livestock strikes occurred in general aviation. Half of these livestock serious damage occurrences were a result of mustering activities away from aerodromes and landing sites, while the other serious damage livestock occurrences were related to aircraft flying into aerodromes which may not have a distinct separation from the surrounding environment, such as landing in paddocks.

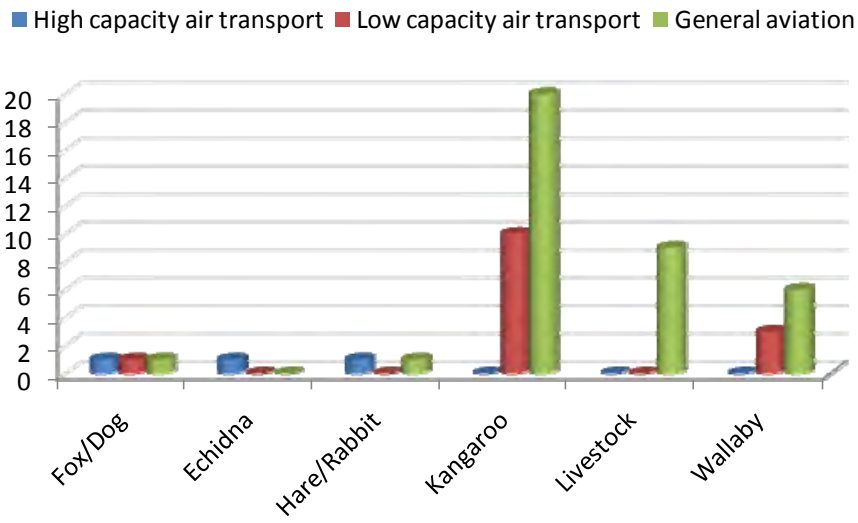
General aviation aircraft landing at licensed aerodromes mostly struck kangaroos, wallabies and small animals such as hares and rabbits capable of getting past aerodrome fences. Kangaroos and wallabies were also struck at Aircraft Landing Areas (ALAs) [24] as were larger animals such as cattle, horses and sheep.

Figure 24 shows aircraft animal related damage occurred mainly in general aviation, making up almost half of all reported damaging occurrences; however, low capacity air transport aircraft had damaging strikes of an average of at least one kangaroo or wallaby each year. More than half of all strikes in general aviation were from kangaroos.

[23] Serious damage was caused by a collision with two horses.

[24] Aircraft landing areas are unlicensed aerodromes that have been determined as suitable for landing, however may not meet the full requirements for a licensed aerodrome.

Figure 24: 2002-2009 Aircraft damage by animal type and operation type



9.2.2 Aircraft components damaged in animal strikes

The table below shows that the aircraft landing gear (including landing gear components) and propellers were damaged the most in animal strikes. These occurred mainly in general aviation followed by low capacity air transport categories.

Table 20: Number of animal strikes by part damaged and operation type (2002-2009)

Operation Type	Parts Damaged	Animal Strikes
High capacity air transport	Landing gear	1
	Other	2
Low capacity air transport	Propeller	8
	Landing gear	6
	Engine	2
	Wing	2
	Fuselage	1
	Lights	1
General aviation	Landing gear	15
	Propeller	15
	Wing/Rotor	6
	Engine	4
	Tail	3
	Fuselage	2

9.2.3 Significant animal strikes

The following are descriptions of typical animal strike occurrences where serious damage to the aircraft occurred, including some where minor injuries occurred. There were no serious injuries attributed to animal strikes in the period of review. Three of the 11 occurrences involved helicopter mustering of cattle.

- Robinson R22 cattle strike with tailrotor

  The helicopter was carrying out mustering operations when the tailrotor struck livestock. The tailrotor separated from the aircraft and the pilot lost control. The aircraft rotated twice before coming to rest on its side. The helicopter was destroyed but the pilot (sole occupant) received only minor injuries. (8 December 2004)

- Beech Aircraft Corp 200 King Air wallaby strike with nosewheel

  During the landing flare at Dirranbandi, a wallaby entered the runway. The pilot was unable to avoid the animal and the wallaby impacted heavily on the nosewheel. The pilot applied power and conducted a go-around. The pilot received an unsafe landing gear indication and elected to return to the departure aerodrome. He advised ATS of the anticipated collapse of the nose landing gear on arrival. The aircraft landed at Brisbane on runway 32 and the nose gear collapsed during the landing roll. Emergency services were in attendance. (7 June 2002)

- Airparts NZ Ltd. FU-24 Fletcher collision with cattle on takeoff

  The aircraft was taking off from an upward-sloping agricultural strip. When the aircraft reached the crest, the pilot sighted cattle running across the strip about 50 metres ahead. The pilot closed the throttle and applied maximum braking but the aircraft was still travelling at about 40 knots when it struck three animals. The pilot was not injured but the aircraft sustained substantial damage. The strip was about 500 metres in length, the first 150 metres being level then rising about 1 metre to a crest over the next 50 metres before dropping 5 metres over the remaining 250 metres. The pilot later stated that he had sighted the cattle in a position south of the strip and 200 metres beyond the its end, before the aircraft was loaded. (15 February 2005)

- Piper Aircraft Corp PA-31 Navajo collision with kangaroo on landing

  During the landing roll on runway 08, the aircraft struck a kangaroo that impacted the nosewheel leg causing it to detach from the aircraft. The pilot held the nose up for as long as possible until the aircraft came to rest on the nose. The propellers were at idle thrust at the point of impact with the ground. Engineering inspection revealed minor damage to the trailing edge of the left flap and a dent on the lower section of the cabin door, thought to be from the impact with the nose wheel or the kangaroo. (10 December 2007)

10 BIRDSTRIKE SURVEY

This chapter tables the results of survey of aerodrome operators across Australia with a view to providing a snapshot of the types of measures being used to control birdstrikes. Details regarding the survey methods are outlined in Section 2.3.

Survey responses were received from 11 high movement, eight low movement, and five GAAP aerodromes. Of these, 18 aerodromes were from temperate areas, and six were from tropical areas. Sixty per cent of responses were from certified aerodromes and 40 per cent were from registered aerodromes.[25]

Table 21: Aerodrome types used in birdstrike survey

Latitude	High Movement	Low movement	GAAP
Temperate	Gold Coast	Williamtown	Parafield
	Adelaide	Tamworth	Bankstown
	Sydney	Coffs Harbour	Moorabbin
	Canberra	Alice Springs	Archerfield
	Melbourne	Launceston	Camden
	Brisbane		
	Perth		
	Essendon		
Tropical	Cairns	Hamilton Island	
	Darwin	Broome	
	Townsville	Mackay	

10.1 Strategies used

Habitat modification

The frequency that habitat modification was used across all aerodromes surveyed is recorded in Table 22. This shows that grass height, and growing specific plants or grass was used more regularly than other strategies. Removal of grass, use of herbicides, and tree pruning and removal took place less regularly. The most commonly used habitat modification strategy at any frequency was tall grass (64 per cent of all aerodromes). This was followed by tree pruning at 60 per cent and short grass at 56 per cent.

[25] Classified according to the Civil Aviation Safety Authority Manual of Standards Part 139-Aerodromes.

Table 22: Per cent of aerodromes performing habitat modification

Habitat	Not used	Daily	Weekly	Fortnightly	Monthly	Quarterly	Biannually	Annually
Tall grass	36	36	4	4	20	-	-	-
Short grass	44	24	16	4	12	-	-	-
Grass removal	64	4	4	4	12	8	-	4
Herbicide	48	-	-	-	16	12	16	8
Tree removal	52	-	-	-	-	-	-	48
Tree pruning	40	-	-	-	-	4	12	44
Grow specific plants/grass	52	12	4	-	8	-	-	24
Other	76	12	-	-	4	4	-	4

Tall grass was more likely to be used as a birdstrike management strategy at low movement aerodromes than high movement or GAAP aerodrome. General aviation aerodrome procedures aerodromes were more likely to use short grass as a strategy than high and low movement aerodromes. About a third of low movement aerodromes used short grass, and about half of high movement aerodromes used a short grass strategy. High movement and GAAP aerodromes use tree removal as a birdstrike control strategy more frequently than low movement aerodromes.

In relation to climate, no significant differences were observed between temperate and tropical climates in relation to tall grass, but more tropical aerodromes use short grass as a birdstrike control strategy than temperate aerodromes. There is little use of grass removal in tropical aerodromes. For herbicide usage, GAAP aerodromes tended to use this strategy more than high and low movement aerodromes.

There were two types of responses in the *other* category; additional strategies not outlined in the closed-response choices, and the clarification of responses about the nature of habitat modifications. Additional strategies included:

- water drainage
- mowing at night to eliminate bird attraction
- mowing at irregular intervals to make the grass habitat less predictable for birds
- waste management.

Clarified habitat strategies discussed:

- use of a landscape master plan
- discouraging ground birds by keeping aerodrome grass at between 200 and 300 mm in height
- control of broad leaf weeds and removal of fruit bearing trees
- turning off runway lights when they are not in use, to minimise insects, which in turn, minimises birds.

About 30 per cent of aerodrome survey respondents used a combination of short and tall grass. From the survey data, it was not possible to tell whether short grass was used in combination with long grass at different parts of the aerodrome, or whether, at different times of the year, the grass length varies, to control problem species associated with changes in the season.

Auditory repellents

The percentage of aerodrome respondents using auditory deterrents is recorded in Table 23, which shows that auditory deterrents are largely used on a daily or weekly basis. Most respondents use a car horn (96 per cent) and shotguns (88 percent) as an auditory deterrent, while a smaller, but significant number use pyrotechnics (76 per cent). Aircraft engine noise, predator calls, and distress and alarm calls are less commonly used. No respondent reported using flares.

Table 23: Per cent of aerodromes using auditory deterrents

Auditory	Not used	Daily	Weekly	Fortnightly	Monthly	Quarterly	Biannually	Annually
Distress and alarm calls	56	32	12	-	-	-	-	-
Pyrotechnics	24	48	24	4	-	-	-	-
Shotguns	12	52	24	4	4	4	-	-
Car Horns	4	68	20	-	4	-	4	-
Flares	100	-	-	-	-	-	-	-
Calls of Predators	88	-	4	-	8	-	-	-
Aircraft Engine Noise	72	28	-	-	-	-	-	-
Other	68	24	8	-	-	-	-	-

Low movement aerodromes were most likely to use auditory distress and alarm calls daily or weekly when compared with high movement aerodromes, and distress and alarm calls were not used by GAAP aerodromes. Aerodrome survey respondents in temperate climates were more likely to use distress and alarm calls. All tropical climate survey respondents used pyrotechnics, whereas only 70 per cent of temperate climate aerodrome respondents used pyrotechnics. In relation to use of pyrotechnics and aerodrome type, pyrotechnics were more often used by high and low capacity movement aerodromes, when compared with GAAP aerodromes. Although most aerodromes use shotguns, those not using shotguns were from temperate climates and from low movement and GAAP aerodromes.

No significant differences in use of car horns were found on the basis of climate, or type of aerodrome, although GAAP aerodromes tended to use the horn less regularly than low and high movement aerodromes. Only low movement aerodromes used predator calls. High movement aerodromes are more likely to use aircraft engine noise as a birdstrike control strategy than GAAP or low movement aerodromes.

In relation to auditory deterrents fitting the *other* category, some respondents use:

- sirens and wailers
- starter pistols
- vehicle personal amplification systems
- gas cannons
- hand clapping.

For responses which clarified the nature of auditory deterrents, some people wrote about combinations of deterrents such as shotgun and gas cannon, while others referred specifically to the effectiveness of helicopter noise as a deterrent.

About 75 per cent of all respondents used a combination of car horn, shotgun, and pyrotechnics.

Visual and chemical deterrents

Visual deterrents are the least frequently used bird deterrent method among survey respondents, and chemical deterrents (tactile repellents such as sticky substances or paste) are not used. Where visual deterrents are used, 24 per cent used lights, 20 per cent used *other* strategies, while 4 per cent used reflectors and reflecting tape. In terms of regularity, reflectors and lights were used daily.

About 30 per cent of survey respondents from high and low movement aerodromes used lights as a visual repellent, but this strategy was not used by GAAP aerodromes. Fifty per cent of tropical aerodromes used lights as a visual repellent, while only 16 per cent of temperate aerodromes used lights as a visual repellent.

About 20 per cent of respondents recorded an *other* response. These included:

- safety and wildlife vehicles
- arm waving
- decoy birds and human effigies (wildlife officer)
- trained birds of prey.

Tactile deterrents

About 50 per cent of survey respondents used bird spikes as a tactile deterrent, while 8 per cent used sticky substances. One aerodrome reported it placed traffic cones on top of non-directional beacon aerials to stop crows nesting. About 10 per cent of GAAP and 10 per cent of low movement aerodromes used bird spikes, compared with high movement aerodromes, where about 80 per cent had bird spikes. Bird spikes were more common in tropical aerodromes than in temperate ones.

Exclusion Methods

About 30 per cent of survey respondents used some form of physical barrier, such as netting or fencing on a daily basis. Overhead wires and exclusion foam[26] were used by about 4 per cent of respondents respectively. Respondents to the open-ended question for exclusion methods referred to:

- sealing buildings
- hoods on apron flood lights to prevent perching, nesting and roosting.

In relation to differences between types of aerodromes, none of the GAAP aerodrome survey respondents used any type of physical barrier, overhead wires, or foam, but two GAAP aerodromes did use other exclusion methods, such as sealing buildings or putting netting under structures. Only one low movement aerodrome used physical barriers. In essence, physical barriers were largely used by high movement aerodromes, and by aerodromes in temperate rather than tropical climates.

[26] Generally used as a filler for holes and crevices in buildings.

Bird removal methods

In 84 per cent of responses, some form of bird removal by shooting was used (Table 24). In about half of these responses, this was a daily occurrence, and the remaining half were dispersed between weekly, monthly and quarterly. Although trapping was performed daily by 4 per cent of respondents, more respondents chose this as an annual strategy.

Table 24: Per cent of aerodromes using bird removal methods

Removal	Not used	Daily	Weekly	Fortnightly	Monthly	Quarterly	Biannually	Annually
Poisoning/baits	88	-	-	-	4	4	-	4
Shooting	16	48	20	-	4	12	-	-
Trapping	80	4	-	4	-	-	-	12
Other	88	8	-	-	-	-	4	-

Other methods for removal included egg and nest removal. Trapping and poisoning are not used by GAAP aerodromes.

Other strategies

Responses to the *other* strategies part of the survey covered a range of strategies and system-related issues. These included:

- use of ornithologists
- bird count and watch condition reports
- trapping of feral dogs and cats
- management plans, including those covering mowing, vegetation, staking and targeting particular times of the year for egg and nest removal
- bird and wildlife operations officers.

The last point about wildlife officers relates to the fact that not all aerodromes employ a full-time bird and wildlife officer. Responsibilities for bird and animal management are often shared with safety and environment management.

10.2 Effectiveness of strategies

Respondents were given the opportunity to describe their strategies in words, and how effective they have been in controlling bird hazards at their aerodrome. Twenty-four of the 25 survey respondents provided an answer to this question. In general, what is clear from these comments is that strategies that work at one aerodrome do not always work at another. Answers provided represent a range of input, process, output, and outcome measures. The three common themes were related to:

- management plans
- primary and secondary tactics
- grass and its length.

These themes are now explored.

Management plans and data

Several respondents wrote about using, or developing birdstrike management plans, including the use of specialist consultants where necessary, and seasonal versus daily activities. The type of aerodrome influenced the type of management plan, and how it was implemented at the aerodrome.

Seasonal strategies included bait poisoning, dead tree removal, and use of insecticides and herbicides to address problem plants. One survey respondent wrote that weather influenced how they carried out their birdstrike management plan.

A number of respondents referred to data collection and key performance indicators. Key performance indicators cited were:

- confirmed bird/bat strike rate
- number of damaging strikes
- bird numbers airside.

For some respondents, key performance indicator data was tabled in a monthly report, and considered side-by-side with current strategies. Some respondents referred to the quality of the data, particularly in relation to bird species. Training in identifying birds and wildlife was cited in one response, and the use of deoxyribonucleic acid (DNA) testing for all bird strikes was cited in another response. Quite a number of respondents referred to high risk species, although they did not state how high risk species were identified.

Tactics

A number of respondents made reference to their tactics for managing bird and animal hazards.

Many respondents referred to having a *constant presence* on the airfield, or actively harassing birds and wildlife. Some respondents made specific reference to the need for daily harassment. Primary strategies included:

- scaring and sirens
- non-lethal Bird Frite® pyrotechnic cartridges and gas cannons.

Secondary strategies included use of live rounds from a shotgun as a deterrent near the birds, or culling. Some survey respondents started with Bird Frite rather than scaring or sirens.

In relation to culling, a number of respondents stated that this was not their first choice, but was used to address risks associated with juvenile birds.

Bins, rubbish and drainage

A number of respondents referred to rubbish, and rubbish bins and receptacles on the aerodrome, or in close proximity to, the aerodrome. They made the observation that a simple strategy of keeping bin lids closed appeared to assist in controlling birds. A couple of respondents referred to water drainage as a successful birdstrike control strategy.

Grass

Most of the respondents who made reference to grass suggested that long grass was a strategy that worked in their environment. Some made reference to operational issues associated with long grass. Some respondents also mentioned regular mowing of grass, to keep it at a consistent length. At least one respondent said that the nature of their aerodrome meant that grass length was irrelevant.

Equipment trials

One survey respondent referred to a trial of laser equipment as a bird control strategy, which they stated was not useful in their context. The particular species or group of birds they were targeting was not outlined.

10.3 New or planned strategy changes

Nineteen of 25 survey respondents answered the question detailing any new or additional bird and animal control strategies planned in the next 12 months. The responses covered a range of strategic and practical measures to control birds and bats/flying foxes. Practical measures included:

- covering open drains near runways
- increasing the hours safety officers are present at the aerodrome to cover all daylight hours
- using bird distress call megaphones
- using a trained dog to deter and move birds on
- wallaby trapping
- analysis of animal droppings
- use of pitfall traps.

A number of respondents referred to research and trials, including collaborations with academic institutions. In some circumstances specific birds and animals were being targeted for research and these included flying foxes, ibis, and nankeen kestrels. For flying foxes and ibis, the research plans to develop a model of movements to, and/or across, the aerodromes in question. For nankeen kestrels, there is a planned program of capture and release, to reduce the need for lethal measures. Other survey respondents were looking to build a better profile of birds at their aerodrome, and the off-airport hazards that are contributing to aerodrome birdstrikes. Some aerodrome operators are looking to introduce different vegetation around the aerodrome to better control certain species. Finally, better use of existing data sources, such as strike history, and electronic in-the-field computer systems were also cited as possibilities.

10.4 Management for specific species

Survey participants responded to a question about whether their aerodrome has any particular bird or bat/flying fox that needs constant control. Of the 25 aerodromes in the survey, 19 provided a response to this question. The data were divided according to whether the aerodrome was tropical or temperate. Dividing the data this way shows that there are some species common to both temperate and tropical climates. The data is tabled by species and climate, in the following categories:

- temperate and tropical aerodromes
- tropical aerodromes only
- temperate aerodromes only.

It is of note that some species below were considered to be a high risk of birdstrike due to flocking (galahs) or hovering behaviour (Nankeen kestrel). However, others (Magpie) were considered to have a low aircraft birdstrike risk despite being common.

Table 25: Species needing constant control at temperate and tropical aerodromes

Species	Number of aerodromes	Species specific control measures used
Lapwings/Plovers	6	long grass, nest removal, culling long grass policy Shooting for any plovers attempting to colonise the airport shooting
Black Kite	5	culling 'Bird Frite' harassment control of insect attractants.
Flying-Fox	5	routine monitoring (on and off airport), hazards are communicated via Air Traffic Control and NOTAM 18 month study to identify attractants, flight patterns, seasonal trends, colony demographics, impact to aircraft flight paths developed specific action plans for mass fly out events, enlisted airline support to avoid flying in periods of high risk, developed Bird Watch Condition Report process.

Cont.

Species	Number of aerodromes	Species specific control measures used
Australian Magpie	4	Vehicle horn 'Bird Frite' insecticide spray to reduce worm numbers culling of young Grass height control harassment
Ibis	4	Vehicle horn 'Bird Frite' drainage to reduce pondage Shooting is frequent to ensure birds do not become complacent. Off-site egg & nest removal at nearby nesting sites has been effective in reducing overall abundance of this species on airport.
Corella/Little Corella	3	observations and communications with the tower and aircraft spraying for Erodium to high risk areas which is a known food source for these species in season
Nankeen Kestrel	3	Difficult to herd via vehicle. Numbers currently controlled via shooting A capture & release program will be trialled Trapping and relocation.
Silver gull	3	Vehicle horn 'Bird Frite' watched for specifically when inclement weather occurs

Table 26: Species needing constant control at temperate aerodromes

Species	Number of aerodromes	Species specific control measures used
Galah	5	harassment modification of weed types through control of broad leaf weeds sprayed areas with known attractants (bulbs) culling trialling different vegetation types that cover the bare sandy soils spraying for Erodium to high risk areas which is a known food source for these species in season
Ducks	3	Culling Cannon netting

Cont.

Species	Number of aerodromes	Species specific control measures used
Rock dove	2	covering of soil stock piles spray and hydro mulch areas netting spikes
Cattle egret	1	Mowing schedules have been modified to ensure key movement areas are not slashed during high aircraft movement times runway strips are only mown at night
Common starling	1	cover bins, reduce food straps airside
Forest raven	1	distress callers Long grass
Little raven	1	long grass strategy
other bats	1	Not outlined
Pacific Gull	1	Not outlined
Pelican	1	Not outlined

Table 27: Species needing constant control at tropical aerodromes

Species	Number of aerodromes	Species specific control measures used
Magpie goose	2	Not outlined
Australian Pratincole	1	Not outlined
Bush-stone curlew	1	Not outlined
Goshawk	1	Vehicle horn ‘Birdfrite’
Little Curlew	1	Not outlined
Nankeen Night Heron	1	Not outline
Pipit	1	Vehicle horn ‘Birdfrite’
Tern	1	Vehicle horn ‘Birdfrite’

APPENDIX A: SPECIES IN TYPES

Table 28: Bird types by common and species names as reported (2002-2009)

Bird type	Name	Count
Australian Brush-turkey	Bush Turkey	20
	Brush Turkey	6
Bat/Flying Fox	bat	257
	fruit bat	164
	flying fox	115
	micro bat	5
	mouse-eared bat	1
Bustard	Bustard	3
	Australian Bustard	2
Cockatoo	Cockatoo	33
	Black Cockatoo	3
	Sulphur crested cockatoo	2
	White Cockatoo	1
Cormorant	Cormorant	9
	Pied Cormorant	1
Crow/Raven	Crow	60
	Raven	11
	Butcherbird	4
	Currawong	2
	Apostlebird	2
Cuckoo	Cuckoo-Shrike	4
	Cuckoo	1
Curlew/Sandpiper	Curlew	83
	Bush Stone-curlew	70
	Sandpiper	17
	Little curlew	14
	Whimbrel	1
	Eastern Curlew	1
	Bush Thick-knee	1
Dove	Pigeon	116
	Dove	17
	Rock Dove	7
	Turtle Dove	2
	Peaceful Dove	1

Bird type	Name	Count
Duck	Duck	92
	Wood Duck	16
	Pacific Black Duck	15
	Black Duck	3
Eagle	Eagle (not wedgetail)	52
	Sea eagle	8
	Brahminy Kite	6
	Little eagle	2
Falcon	Falcon	22
	Peregrine Falcon	5
	Brown falcon	4
	Australian Hobby	1
Finch	Finch	34
	Zebra Finch	7
	Goldfinch	5
Frigate	Frigate	3
Galah	Galah	532
Hawk	Hawk	214
	Chicken hawk	9
	Sparrowhawk	8
	Goshawk	8
	Swamp Harrier	4
	Osprey	2
	Collared Sparrowhawk	2
	Spotted Harrier	1
Hen	Swamphen	6
	Native Hen	5
	Tasmanian Native-hen	4
Heron/Egret	Egret	19
	Nankeen Night Heron	17
	Heron	14
	Cattle egret	12
	White-faced Heron	11
	Crane	9
	Brolga	2
	Jabiru	1
House Sparrow	Sparrow	133
	House Sparrow	2

Bird type	Name	Count
Ibis	Ibis	80
	White Ibis	3
	Straw-necked Ibis	2
Kingfisher/Kookaburra	Kookaburra	4
	Kingfisher	1
Kite	Kite	149
	Kite-Hawk	127
	Black Kite	125
	Whistling Kite	41
	Black-shouldered Kite	8
	Fork-tailed Kite	3
Lapwing/Plover	Plover	478
	Masked Lapwing	49
	Spur-winged Plover	19
	Oriental Plover	17
	Dotterel	17
	Masked Plover	10
	Lapwing	5
	Pacific Golden Plover	1
	Banded Plover	1
Magpie	Magpie	349
	Australian Magpie	4
Magpie Goose	Magpie Goose	9
	Goose	1
Magpie-lark	Magpie-lark	134
	Peewee	56
	Mudlark	23
	Lark	18
	Murray Magpie	3
Myna	Myna	9
Nankeen Kestrel	Kestrel	261
	Nankeen Kestrel	47
	Australian Kestrel	19
Owl	Owl	68
	Barn owl	17
	Masked owl	1
Oystercatcher	Pied Oystercatcher	2
	Oystercatcher	1
Pacific Gull	Pacific Gull	21

Bird type	Name	Count
Parrot	Corella	11
	Rainbow Lorikeet	7
	Parrot	7
	Little Corella	4
	Crimson Rosella	1
Pelican	Pelican	13
Pipit	Richard`s Pipit	71
	Pipit	49
	Australasian Pipit	2
Pratincole	Pratincole	102
	Australian Pratincole	39
	Australian Courser	8
	Swallow-plover	3
Robin	Robin	8
Silver Gull	Seagull	169
	Silver Gull	52
	Gull	10
Skylark	Skylark	21
Starling	Starling	42
	Common Starling	4
Swallow/Martin	Swallow	186
	Fairy Martin	37
	Martin	28
	Welcome Swallow	22
	Wood swallow	13
	Black-faced Wood Swallow	8
	Barn Swallow	5
Swan	Swan	4
Swift	Swift	19
	Spine tailed swift	3
	Fork-tailed Swift	2
Tern	Tern	28
	Crested Tern	4
	Little Tern	2
	Whiskered tern	1
	Black Tern	1
Thrush	Thrush	1
Wagtail	Willie wagtail	4
	Wagtail	3

Bird type	Name	Count
Wedge-tailed Eagle	Wedge-tailed Eagle	15
Wren	Wren	2
Other	Blackbird	3
	Darter	3
	Flycatcher	2
	Grey tailed tattler	2
	Banded stilt	1
	Bittern, brown	1
	Budgerigar	1
	Buff banded rail	1
	Common greenshank	1
	Dusky moorhen	1
	Partridge	1
	Petrel	1
	Rainbow bee-eater	1
	Snipe	1
	Unknown - sea bird	1
	Wader	1

Table 29: Animal types by common and species names as reported (2002-2009)

Animals Type	Name	Count
Fox/Dog	Fox	24
	Dingo	4
	dog	3
Echidna	Echidna	6
Goanna/Monitor	Goanna	6
	Monitor	2
Hare/Rabbit	Rabbit	46
	Hare	36
Kangaroo	Kangaroo	58
Emu	Emu	1
Livestock	Cattle	4
	Cow	2
	Sheep	2
	horse	1
Lizard/snake	snake	2
	lizard	7
Turtle	Turtle	4
Wallaby	Wallaby	34
Other	Bandicoot	3
	Cat	2
	Possum	2
	Potoroo	1
	Mouse	1
	Pig	1
	Toad	1
	Rat	1
	Wombat	1
	Frog/Toad	1
	Cane Toad	1

APPENDIX B: WILDLIFE SURVEY

Submit by Email | Print Form

ATSB Report Reference: AR-2009-064

Australian Government
Australian Transport Safety Bureau

Birdstrike Mitigation and Hazard Survey

The Australian Transport Safety Bureau (ATSB) is currently preparing a report on birdstrikes within Australia. As part of this, we would like to report on the types of bird and bat / flying fox mitigation strategies employed by aerodromes around Australia. Your input will help to provide a better picture of what sort of bird and bat / flying fox hazard control strategies are being used in Australia.

Information provided to the ATSB is held in strict confidence. All data received will be entered into a database and analysed in groups, and no individual results will be reported. Completing and returning the attached survey will indicate your informed consent to participate in this research.

Please contact the ATSB Aviation Research on 02 6274 7563 or aviation.research@atsb.gov.au if you have any questions about this survey.

Instructions for completing this survey

This survey can be completed and returned in 4 different ways.

1. Electronic Completion using email button: Fill in all relevant fields and select an option in each row of circular check boxes. Once complete, click the "Submit by Email" button located at the top of this page or at the end of the survey. This will open a new email with the survey attached. Select the send email option in your email program, and this will return the survey to the ATSB. Note: If a new email does not open upon clicking "Submit by Email", please consider using option 2 below.

2. Electronic Completion by saving and manually attaching to an email: Fill in all relevant fields and select an option in each row of circular check boxes. Once complete, click the "Save" button. Save the document to a known location, such as the "Desktop" or "My Documents" folders. Open a new message in your email program and select the attach option, followed by browse for file. Find where the saved file is located, click on the file, and select the attach file option. Send this form to aviation.research@atsb.gov.au

3. Electronic Completion and Submission by Mail: Fill in all relevant fields and select an option in each row of circular check boxes on your computer. Select the "Print Form" button located at the top of this page or at the end of the survey and print the completed form. Send the printed form to the following address (no postage stamp required if you are in Australia):

Research Investigations and Data Analysis
Australian Transport Safety Bureau

Reply Paid 967
Civic Square ACT 2608

4. Print and Complete by Hand with Submission by Mail: Select the "Print Form" button located at the top of this page, and print the blank form. Fill in all relevant fields and select an option in each row of circular check boxes by hand. Send the completed form to the address listed in option 3 above.

Survey Commences on the Next Page

Page 1 of 5

Australian Government
Australian Transport Safety Bureau

1. Please record the full name of your aerodrome: _____

2. Is your aerodrome: ○ Registered ○ Certified ○ Unlicensed

3. Please record the bird and bat / flying fox strike mitigation strategies used at your aerodrome on average in the past 12 months by indicating how often these activities are conducted. For strategies that are not used select the "Strategy Not Used" circle. For mitigation strategies which are permanantly in place, such as physical barriers, please select "Daily".

Description of Strategy	Frequency of Activity							
Habitat Modification	Strategy Not Used	Daily	Weekly	Fortnightly	Monthly	Quarterly	Every 6 Months	Annually
Tall Grass	○	○	○	○	○	○	○	○
Short Grass	○	○	○	○	○	○	○	○
Grass Removal	○	○	○	○	○	○	○	○
Herbicide Spray	○	○	○	○	○	○	○	○
Tree Removal	○	○	○	○	○	○	○	○
Tree Pruning	○	○	○	○	○	○	○	○
Growing Specific Plant / Grass Species	○	○	○	○	○	○	○	○
Other, please describe: _____	○	○	○	○	○	○	○	○

Auditory Deterrents	Strategy Not Used	Daily	Weekly	Fortnightly	Monthly	Quarterly	Every 6 Months	Annually
Distress and Alarm Calls	○	○	○	○	○	○	○	○
Pyrotechnics	○	○	○	○	○	○	○	○
Shotguns	○	○	○	○	○	○	○	○
Car Horns	○	○	○	○	○	○	○	○
Flares	○	○	○	○	○	○	○	○
Calls of Predators	○	○	○	○	○	○	○	○
Aircraft Engine Noise	○	○	○	○	○	○	○	○
Other, please describe: _____	○	○	○	○	○	○	○	○

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Description of Strategy	Frequency of Activity							
Visual Repellents	Strategy Not Used	Daily	Weekly	Fortnightly	Monthly	Quarterly	Every 6 Months	Annually
Reflectors and Reflecting Tape	○	○	○	○	○	○	○	○
Predator Models	○	○	○	○	○	○	○	○
Lights	○	○	○	○	○	○	○	○
Dyes	○	○	○	○	○	○	○	○
Smoke	○	○	○	○	○	○	○	○
Other, please describe:								
	○	○	○	○	○	○	○	○

Chemical Repellents	Strategy Not Used	Daily	Weekly	Fortnightly	Monthly	Quarterly	Every 6 Months	Annually
Taste Aversives	○	○	○	○	○	○	○	○
Other, please describe:								
	○	○	○	○	○	○	○	○

Tactile Repellents	Strategy Not Used	Daily	Weekly	Fortnightly	Monthly	Quarterly	Every 6 Months	Annually
Sticky Substances	○	○	○	○	○	○	○	○
Bird Spikes	○	○	○	○	○	○	○	○
Other, please describe:								
	○	○	○	○	○	○	○	○

Exclusion Methods	Strategy Not Used	Daily	Weekly	Fortnightly	Monthly	Quarterly	Every 6 Months	Annually
Physical Barriers	○	○	○	○	○	○	○	○
Overhead Wires	○	○	○	○	○	○	○	○
Foam	○	○	○	○	○	○	○	○
Other, please describe:								
	○	○	○	○	○	○	○	○

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Description of Strategy	Frequency of Activity							
Removal Methods	Strategy Not Used	Daily	Weekly	Fortnightly	Monthly	Quarterly	Every 6 Months	Annually
Poisoning	○	○	○	○	○	○	○	○
Shooting	○	○	○	○	○	○	○	○
Trapping Birds	○	○	○	○	○	○	○	○
Other, please describe:								
	○	○	○	○	○	○	○	○

Other (Please list strategies used not listed above)	Daily	Weekly	Fortnightly	Monthly	Quarterly	Every 6 Months	Annually
	○	○	○	○	○	○	○
	○	○	○	○	○	○	○
	○	○	○	○	○	○	○

4. Please briefly describe your strategies and how effective they have been in controlling bird and bat / flying fox hazards at your aerodrome.

5. Is your aerodrome planning to replace or introduce additional bird and bat / flying fox mitigation strategies in the next 12 months? ○ Yes ○ No

Please provide a comment:

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6. Does your aerodrome have any particular species of birds or bats / flying foxes that need constant control? ○ Yes ○ No

If Yes, please provide comment on the particular species, and the relevant control measures:

7. In relation to bird and bat / flying fox management, does your aerodrome engage and communicate with local industries, councils, community consultation groups or state government? ○ Yes ○ No

Please provide a comment.

Thank you for participating in this survey.

Submit by Email | Print Form

Please forward the complete survey to:

aviation.research@atsb.gov.au

or by post to

Research Investigations and Data Analysis
Australian Transport Safety Bureau

Reply Paid 967
Civic Square ACT 2608

APPENDIX C: ADDITIONAL BIRDSTRIKE DATA

Table 30: Number of birdstrikes at major aerodromes summed across all operation types

Airport	Aerodrome Proximity	2002	2003	2004	2005	2006	2007	2008	2009	Total
Adelaide	Aerodrome confines	32	36	60	62	54	49	45	74	**412**
	5 to 15 km	3	3	6	8	7	1	-	3	**31**
	>15 km	1	-	2	2	1	-	-	-	**6**
	Unknown	1	1	5	-	1	6	3	4	**21**
Brisbane	Aerodrome confines	64	62	62	68	67	73	113	103	**612**
	5 to 15 km	11	15	23	15	14	4	2	1	**85**
	>15 km	2	2	4	1	1	-	-	-	**10**
	Unknown	2	1	-	1	5	4	8	14	**35**
Cairns	Aerodrome confines	29	46	50	78	46	86	80	69	**484**
	5 to 15 km	12	16	11	26	11	5	3	2	**86**
	>15 km	1	1	-	3	3	-	2	-	**10**
	Unknown	-	3	3	3	5	12	22	2	**50**
Canberra	Aerodrome confines	9	5	18	30	44	37	30	21	**194**
	5 to 15 km	2	4	2	5	3	1	-	2	**19**
	>15 km	-	-	-	2	1	-	1	-	**4**
	Unknown	-	-	1	-	-	1	1	2	**5**
Darwin	Aerodrome confines	68	61	89	108	66	73	77	112	**654**
	5 to 15 km	4	2	2	8	2	1	-	1	**20**
	>15 km	2	4	4	3	1	-	1	4	**19**
	Unknown	-	1	4	3	1	3	10	6	**28**
Gold Coast	Aerodrome confines	19	31	15	35	27	31	30	32	**220**
	5 to 15 km	4	4	8	7	9	-	-	-	**32**
	>15 km	-	1	1	-	-	-	-	-	**2**
	Unknown	-	1	-	-	-	-	1	-	**2**
Hobart	Aerodrome confines	17	17	10	28	28	35	22	21	**178**
	5 to 15 km	3	2	1	1	2	1	1	-	**11**
	Unknown	-	-	-	-	-	1	2	1	**4**
Melbourne	Aerodrome confines	37	30	54	61	70	36	76	62	**426**
	5 to 15 km	7	6	14	11	11	6	3	2	**60**
	>15 km	-	3	1	3	-	-	1	-	**8**
	Unknown	1	-	5	4	6	5	10	9	**40**
Perth	Aerodrome confines	15	32	42	39	42	37	46	40	**293**
	5 to 15 km	1	5	3	1	9	1	2	2	**24**
	>15 km	1	-	1	-	1	-	1	-	**4**
	Unknown	1	2	1	2	2	4	4	-	**16**

Cont.

Airport	Aerodrome Proximity	2002	2003	2004	2005	2006	2007	2008	2009	Total
Sydney	Aerodrome confines	42	60	84	83	73	87	85	112	**626**
	5 to 15 km	10	9	19	17	9	5	-	1	**70**
	>15 km	2	3	1	1	3	-	-	-	**10**
	Unknown	7	5	6	3	3	12	12	12	**60**

Table 31: Number of birdstrikes at GAAP aerodromes summed across all operation types

Airport	Airport Proximity	2002	2003	2004	2005	2006	2007	2008	2009	Total
Archerfield	Aerodrome confines	-	1	2	4	4	6	7	18	**42**
	5 to 15 km	1	-	-	1	3	1	-	-	**6**
	>15 km	-	-	1	1	1	-	-	-	**3**
Bankstown	Aerodrome confines	9	13	6	7	5	8	13	13	**74**
	5 to 15 km	8	1	5	4	2	1	1	1	**23**
	>15 km	-	-	-	-	1	-	-	-	**1**
	Unknown	-	-	-	-	-	1	-	-	**1**
Camden	Aerodrome confines	2	-	-	-	1	1	1	-	**5**
	5 to 15 km	1	-	1	-	-	-	-	-	**2**
	>15 km	-	-	-	1	-	-	-	-	**1**
Jandakot	Aerodrome confines	26	15	21	15	28	21	4	8	**138**
	5 to 15 km	1	2	2	1	1	-	1	-	**8**
	>15 km	-	1	2	-	-	-	1	1	**5**
Moorabbin	Aerodrome confines	7	7	10	12	5	9	11	14	**75**
	5 to 15 km	1	-	1	-	2	1	-	2	**7**
	>15 km	-	-	-	-	-	-	-	1	**1**
	Unknown	1	-	-	-	-	1	-	-	**2**
Parafield	Aerodrome confines	17	14	20	28	15	27	32	32	**185**
	5 to 15 km	4	2	-	5	1	-	-	-	**12**
	>15 km	-	-	-	-	1	-	-	-	**1**
	Unknown	1	-	-	-	-	-	-	-	**1**

Table 32: Number of birdstrikes at towered regional aerodromes summed across all operation types

Aerodrome	Aerodrome Proximity	2002	2003	2004	2005	2006	2007	2008	2009	Total
Albury	Aerodrome confines	3	1	9	10	9	15	9	17	**73**
	5 to 15 km	3	1	1	-	1	-	-	-	**6**
	Unknown	-	-	-	-	-	-	2	-	**2**
Alice Springs	Aerodrome confines	24	10	10	11	14	14	6	12	**101**
	5 to 15 km	1	-	-	-	-	1	-	-	**2**
	>15 km	1	-	-	1	-	-	-	-	**2**
	Unknown	2	1	1	1	1	-	-	2	**8**
Avalon	Aerodrome confines	1	2	1	12	5	7	8	19	**55**
	5 to 15 km	2	-	-	3	-	1	-	-	**6**
	Unknown	-	-	-	-	-	-	-	1	**1**
Coffs Harbour	Aerodrome confines	1	7	4	12	10	14	9	10	**67**
	5 to 15 km	3	-	1	2	-	-	-	-	**6**
	>15 km	-	-	1	-	-	-	-	-	**1**
Essendon	Aerodrome confines	5	3	5	8	12	6	8	11	**58**
	5 to 15 km	-	-	1	-	1	-	1	-	**3**
	Unknown	-	-	-	-	-	1	-	-	**1**
Hamilton Island	Aerodrome confines	2	2	5	9	10	9	6	5	**48**
	Unknown	-	-	-	-	-	1	-	-	**1**
Launceston	Aerodrome confines	7	1	8	10	4	8	19	10	**67**
	5 to 15 km	1	-	1	1	1	-	-	-	**4**
	Unknown	1	-	-	-	-	-	1	1	**3**
Mackay	Aerodrome confines	13	8	32	22	16	10	12	23	**136**
	5 to 15 km	3	-	-	1	1	-	-	-	**5**
	>15 km	-	1	-	-	-	-	-	-	**1**
	Unknown	-	-	-	1	-	1	-	2	**4**
Sunshine Coast	Aerodrome confines	3	5	7	7	9	18	7	9	**65**
	5 to 15 km	4	-	1	-	1	1	-	-	**7**
	>15 km	-	-	-	1	-	-	-	-	**1**
Rockhampton	Aerodrome confines	12	36	30	32	37	21	37	41	**246**
	5 to 15 km	2	4	3	1	1	-	1	-	**12**
	>15 km	-	2	1	-	1	-	-	1	**5**
	Unknown	-	-	-	1	1	2	-	-	**4**
Tamworth	Aerodrome confines	12	21	11	9	17	17	23	12	**122**
	5 to 15 km	1	1	2	1	2	1	-	-	**8**
	>15 km	2	2	2	-	-	-	-	-	**6**
	Unknown	-	1	-	-	-	-	-	-	**1**

Cont.

Aerodrome	Aerodrome Proximity	2002	2003	2004	2005	2006	2007	2008	2009	Total
Townsville	Aerodrome confines	14	16	35	31	26	45	44	50	**261**
	5 to 15 km	4	7	6	5	6	2	-	2	**32**
	>15 km	-	-	-	1	1	1	-	-	**3**
	Unknown	-	-	1	-	3	2	3	1	**10**
Williamtown	Aerodrome confines	2	2	1	3	15	20	17	22	**82**
	5 to 15 km	1	-	-	1	5	-	1	1	**9**
	>15 km	-	-	1	1	-	1	-	-	**3**

Table 33: Number of damaging (serious and minor) strikes at aerodromes, departing and on approach (including >15 km) by operation type

Airport	Operation Type	2002	2003	2004	2005	2006	2007	2008	2009
Adelaide	High capacity air transport	-	-	2	-	1	1	1	4
	Low capacity air transport	-	-	1	-	1	-	-	2
	General aviation	-	-	-	1	-	-	-	-
	Military	-	-	-	1	-	-	-	-
Albury	High capacity air transport	-	-	1	-	-	-	-	-
	Low capacity air transport	-	-	-	-	1	2	1	1
	General aviation	1	-	-	-	-	-	-	-
Alice Springs	High capacity air transport	1	-	1	-	-	-	-	-
	Low capacity air transport	1	1	-	-	1	-	-	-
	General aviation	-	-	-	-	-	1	-	-
Archerfield	General aviation	1	-	1	3	2	-	1	5
Avalon	High capacity air transport	1	-	-	-	-	-	-	2
	General aviation	-	-	-	-	1	-	-	-
Bankstown	Low capacity air transport	1	-	-	-	1	1	-	-
	General aviation	1	2	3	-	-	-	1	2
	Military	-	-	-	-	-	-	1	-
Brisbane	High capacity air transport	-	4	5	3	2	4	3	4
	Low capacity air transport	-	-	-	-	-	-	1	-
	General aviation	-	-	1	-	-	-	-	-
	Military	-	-	-	-	-	1	-	-
Cairns	High capacity air transport	3	5	1	3	-	8	4	3
	Low capacity air transport	1	1	1	-	-	-	-	1
	General aviation	1	-	-	-	-	-	1	-
	Military	-	-	-	-	1	-	-	-
	unknown	1	-	-	-	-	-	-	-
Camden	General aviation	-	-	-	-	-	-	1	-
Canberra	High capacity air transport	1	1	1	-	4	2	3	3
	Low capacity air transport	-	-	-	-	1	-	-	-
	General aviation	-	-	-	-	2	-	-	-
Coffs Harbour	Low capacity air transport	1	-	-	-	-	-	-	-
	General aviation	1	-	-	-	-	-	-	-
Darwin	High capacity air transport	2	2	2	6	1	-	3	4
	Low capacity air transport	2	1	1	1	1	1	2	2
	General aviation	1	1	-	1	-	-	-	1
	Military	-	-	1	-	1	1	-	-

Cont.

Airport	Operation Type	2002	2003	2004	2005	2006	2007	2008	2009
Essendon	Low capacity air transport	-	-	-	-	3	-	-	1
	General aviation	-	-	-	-	-	1	2	-
Gold Coast	High capacity air transport	-	-	-	1	-	2	2	-
	General aviation	-	-	-	-	1	-	-	-
Hamilton Island	High capacity air transport	-	-	-	-	-	-	-	1
Hobart	High capacity air transport	-	4	-	-	-	2	-	2
	Low capacity air transport	-	-	1	-	-	-	-	-
Jandakot	General aviation	1	5	2	-	-	-	2	1
Launceston	High capacity air transport	2	-	-	-	-	1	2	-
	General aviation	-	-	-	-	-	-	1	-
Mackay	High capacity air transport	-	-	-	-	1	-	1	1
	Low capacity air transport	1	-	-	-	-	-	-	-
	General aviation	-	-	-	-	-	-	1	-
Sunshine Coast	High capacity air transport	-	-	-	-	-	-	-	1
	Low capacity air transport	-	-	1	-	-	-	-	-
	General aviation	1	-	-	-	2	-	-	-
Melbourne	High capacity air transport	2	-	13	3	3	2	4	2
	Low capacity air transport	1	1	-	-	-	-	-	1
Moorabbin	Low capacity air transport	-	-	-	-	2	-	-	-
	General aviation	2	-	1	1	1	2	-	4
Other	High capacity air transport	-	-	3	3	2	4	6	2
	Low capacity air transport	13	15	10	8	24	17	24	20
	General aviation	6	8	6	9	15	15	16	24
	Military	-	-	-	-	-	1	1	3
	unknown	-	-	-	-	-	-	1	-
Parafield	General aviation	1	-	-	1	2	2	4	1
	unknown	-	-	-	1	-	-	-	-
Perth	High capacity air transport	1	2	2	-	3	3	-	1
	General aviation	1	-	-	-	-	-	-	-
Rockhampton	High capacity air transport	-	1	-	-	3	1	1	2
	Low capacity air transport	1	-	-	-	-	-	-	1
	General aviation	-	1	1	-	-	-	-	2
	Military	-	-	-	-	-	1	-	-
Sydney	High capacity air transport	6	2	12	7	6	8	5	5
	Low capacity air transport	-	-	2	-	-	1	-	2
Tamworth	High capacity air transport	-	-	-	-	1	-	-	-
	Low capacity air transport	-	2	-	1	-	-	-	-
	General aviation	1	3	2	1	-	-	1	-

Cont.

Airport	Operation Type	2002	2003	2004	2005	2006	2007	2008	2009
Townsville	High capacity air transport	1	1	-	3	4	2	2	1
	Low capacity air transport	-	-	1	-	-	-	-	-
	General aviation	-	1	-	-	-	1	-	1
Williamtown	High capacity air transport	-	-	-	-	1	1	1	1
	Low capacity air transport	1	-	-	-	-	1	1	-
	General aviation	-	-	1	-	-	1	1	-
	Military	-	-	-	-	-	1	-	-

Table 34: Aircraft damage birdstrikes (minor and serious damage) by bird type and operation type by location

Airport	Bird type	High capacity air transport	Low capacity air transport	General aviation
Adelaide	Duck	-	1	-
	Galah	3	1	-
	Magpie	1	-	-
	Magpie-lark	1	-	-
	Silver Gull	-	1	-
Albury	Dove	-	1	-
	Duck	1	-	-
	Galah	-	1	-
	Hawk	-	1	-
	Lapwing/Plover	-	1	-
	Magpie-lark	-	1	-
Alice Springs	Kite	1	1	-
	Lapwing/Plover	1	1	-
Archerfield	Bat/Flying Fox	-	-	3
	Duck	-	-	1
	Ibis	-	-	1
Avalon	Magpie	1	-	-
Bankstown	Bat/Flying Fox	-	2	1
	Dove	-	-	1
	Duck	-	-	-
	Ibis	-	-	1
	Magpie	-	-	1

Cont.

Airport	Bird type	High capacity air transport	Low capacity air transport	General aviation
Brisbane	Bat/Flying Fox	1	-	-
	Hawk	1	-	-
	Heron/Egret	-	1	-
	Ibis	4	-	-
	Lapwing/Plover	1	-	-
	Pelican	-	-	-
	Tern	1	-	-
Cairns	Bat/Flying Fox	1	2	-
	Duck	-	1	1
	Eagle	1	-	-
	Heron/Egret	-	1	-
	Kite	2	-	-
	Myna	1	-	-
	Nankeen Kestrel	1	-	-
	Corella/Parrot	2	-	-
	Swallow/Martin	1	-	-
Canberra	Bat/Flying Fox	1	-	-
	Crow/Raven	1	-	-
	Duck	3	-	-
	Galah	3	-	-
	Nankeen Kestrel	1	-	-
Coffs Harbour	Crow/Raven	-	-	1
Darwin	Bat/Flying Fox	1	2	-
	Curlew/Sandpiper	2	1	-
	Duck	1	-	-
	Eagle	-	-	1
	Hawk	1	-	1
	Kite	3	4	-
	Pratincole	1	-	1
Essendon	Dove	-	1	-
	Duck	-	2	-
	Silver Gull	-	1	1
Gold Coast	Bat/Flying Fox	2	-	-
	Duck	1	-	-
	Eagle	-	-	1
Hamilton Island	Crow/Raven	1	-	-

Cont.

Airport	Bird type	High capacity air transport	Low capacity air transport	General aviation
Hobart	Lapwing/Plover	1	-	-
	Pacific Gull	1	1	-
	Starling	1	-	-
Jandakot	Crow/Raven	-	-	1
	Eagle	-	-	5
	Hawk	-	-	1
	Ibis	-	-	1
Launceston	Duck	-	-	1
	Lapwing/Plover	1	-	-
	Swan	1	-	-
Mackay	Bat/Flying Fox	1	-	-
	Curlew/Sandpiper	1	-	-
	House Sparrow	1	-	-
Sunshine Coast	Duck	-	-	1
Melbourne	Bat/Flying Fox	2	-	-
	Ibis	-	1	-
	Kite	1	-	-
	Magpie	3	-	-
	Owl	2	-	-
Moorabbin	Crow/Raven	-	-	1
	Duck	-	-	1
	Ibis	-	1	1
	Silver Gull	-	1	4

Cont.

Airport	Bird type	High capacity air transport	Low capacity air transport	General aviation
Other	Australian Brush-turkey	1	6	1
	Bat/Flying Fox	2	8	6
	Bustard	-	1	-
	Cockatoo	-	3	1
	Crow/Raven	-	2	3
	Curlew/Sandpiper	-	-	1
	Dove	-	2	1
	Duck	1	2	3
	Eagle	-	5	4
	Falcon	-	1	-
	Frigate	-	-	1
	Galah	2	18	12
	Hawk	3	10	3
	Heron/Egret	-	1	-
	Ibis	-	2	4
	Kite	2	15	2
	Lapwing/Plover	-	7	3
	Magpie	-	1	2
	Magpie Goose	-	-	1
	Pacific Gull	-	1	-
	Pelican	-	1	2
	Pipit	1	-	-
	Silver Gull	-	2	4
	Swallow/Martin	-	-	1
	Swan	-	-	1
	Swift	-	-	2
	Tern	-	1	2
	Wedge-tailed Eagle	-	2	1
Parafield	Dove	-	-	2
	Galah	-	-	3
	Magpie	-	-	1
	Pelican	-	-	1
Perth	Galah	4	-	-
	Nankeen Kestrel	1	-	-

Cont.

Airport	Bird type	High capacity air transport	Low capacity air transport	General aviation
Rockhampton	Bat/Flying Fox	-	1	-
	Hawk	2	1	-
	Kite	-	-	1
	Corella/Parrot	1	-	-
	Wedge-tailed Eagle	-	-	1
Sydney	Bat/Flying Fox	5	1	-
	Cockatoo	1	-	-
	Cormorant	-	1	-
	Ibis	1	-	-
	Pelican	-	1	-
	Silver Gull	6	-	-
Tamworth	Eagle	-	-	1
	Ibis	-	1	1
	Kite	-	1	-
	Magpie	-	-	1
	Magpie-lark	1	-	1
Townsville	Bat/Flying Fox	3	-	-
	Bustard	1	-	-
	Duck	1	-	-
	Heron/Egret	2	-	-
	Magpie Goose	-	-	2
Williamtown	Bat/Flying Fox	1	-	1

Table 35: Complete birdstrikes by bird type by state 2002-2009

Bird Type	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Other	Total
Lapwing/Plover	12	92	110	124	24	110	30	95	-	**597**
Bat/Flying Fox	-	176	51	265	2	-	26	22	-	**542**
Galah	57	213	8	80	112	1	22	39	-	**532**
Kite	-	48	104	233	2	-	28	38	-	**453**
Magpie	20	78	1	60	77	3	88	26	-	**353**
Nankeen Kestrel	8	55	14	98	66	-	6	74	6	**327**
Swallow/Martin	7	35	22	171	17	8	11	28	-	**299**
Hawk	10	39	21	77	19	12	18	51	1	**248**
Magpie-lark	-	33	19	88	75	6	5	8	-	**234**
Silver Gull	1	71	1	12	59	22	42	23	-	**231**
Curlew/Sandpiper	-	2	79	101	1	-	-	3	1	**187**

Cont.

Bird Type	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Other	Total
Pratincole	-	-	143	9	-	-	-	-	-	**152**
Dove	-	30	4	28	47	-	22	11	1	**143**
House Sparrow	1	25	7	37	12	7	32	14	-	**135**
Duck	18	21	2	52	3	2	13	14	1	**126**
Pipit	4	41	4	10	-	4	41	18	-	**122**
Owl	-	14	12	20	5	-	12	23	-	**86**
Heron/Egret	-	10	2	53	-	-	5	7	8	**85**
Ibis	-	25	1	41	2	-	12	4	-	**85**
Crow/Raven	6	13	3	23	9	7	9	9	-	**79**
Eagle	-	11	6	26	-	1	3	21	-	**68**
Finch	-	3	8	8	-	20	1	5	1	**46**
Starling	-	12	2	7	9	11	4	1	-	**46**
Cockatoo	1	13	3	10	2	-	1	9	-	**39**
Tern	-	6	1	10	2	-	3	14	-	**36**
Falcon	1	5	3	2	3	1	15	2	-	**32**
Corella/Parrot	-	5	9	9	4	-	1	2	-	**30**
Australian Brush-turkey	-	-	7	10	-	-	-	9	-	**26**
Swift	-	8	-	12	-	-	1	3	-	**24**
Pacific Gull	-	2	-	-	-	11	8	-	-	**21**
Skylark	-	-	-	-	2	13	6	-	-	**21**
Hen	-	1	-	6	-	8	-	-	-	**15**
Wedge-tailed Eagle	-	4	-	3	2	-	-	6	-	**15**
Pelican	-	4	1	4	1	-	1	2	-	**13**
Cormorant	-	5	-	3	1	-	1	-	-	**10**
Magpie Goose	-	1	2	6	1	-	-	-	-	**10**
Myna	-	2	-	5	-	-	-	2	-	**9**
Robin	1	-	-	-	-	1	-	6	-	**8**
Wagtail	-	-	3	2	-	-	-	2	-	**7**
Bustard	-	-	1	4	-	-	-	-	-	**5**
Cuckoo	-	-	-	3	2	-	-	-	-	**5**
Kingfisher/Kookaburra	-	1	2	2	-	-	-	-	-	**5**
Swan	1	1	-	-	-	1	1	-	-	**4**
Frigate	-	-	1	1	-	-	-	-	1	**3**
Oystercatcher	-	-	-	-	-	3	-	-	-	**3**
Wren	-	-	-	1	-	1	-	-	-	**2**
Thrush	-	-	-	-	-	-	1	-	-	**1**

Table 36: Number of birdstrikes by bird types 2002-2009 (ordered by average difference between 2002-2005 and 2006-2009)

Bird Type	2002	2003	2004	2005	2006	2007	2008	2009	Total
Kite	32	37	40	54	79	71	62	78	**453**
Galah	34	47	58	64	84	90	88	67	**532**
Lapwing/Plover	56	43	73	73	89	75	82	106	**597**
Bat/Flying Fox	38	78	58	53	57	75	73	110	**542**
Swallow/Martin	14	32	35	35	41	52	37	53	**299**
Pipit	2	8	7	11	19	23	35	17	**122**
Nankeen Kestrel	31	34	37	30	59	32	61	43	**327**
Heron/Egret	5	2	6	9	9	17	17	20	**85**
Dove	11	9	16	16	21	23	24	23	**143**
Magpie	27	31	66	42	46	39	46	56	**353**
Finch	1	2	2	8	10	8	4	11	**46**
Crow/Raven	5	10	4	11	13	11	7	18	**79**
Duck	10	11	17	17	15	17	24	15	**126**
Skylark	-	1	1	1	5	3	6	4	**21**
Magpie-lark	8	14	27	61	21	32	41	30	**234**
Owl	7	8	11	11	13	11	14	11	**86**
Tern	4	7	-	1	1	11	5	7	**36**
Australian Brush-turkey	2	1	3	1	6	8	2	3	**26**
Hawk	26	20	29	44	39	35	23	32	**248**
Starling	4	6	3	5	9	6	7	6	**46**
Corella/Parrot	3	1	1	5	2	5	3	10	**30**
Cockatoo	4	3	4	4	6	8	4	6	**39**
Curlew/Sandpiper	10	16	24	40	29	29	18	21	**187**
Hen	1	4	-	-	2	6	-	2	**15**
Bustard	-	-	-	-	2	1	1	1	**5**
Magpie Goose	1	2	-	-	-	2	-	5	**10**
Robin	-	-	2	-	2	4	-	-	**8**
Swan	-	-	-	-	1	2	-	1	**4**
Frigate	-	-	-	-	1	-	1	1	**3**
Swift	2	1	4	4	6	6	1	-	**24**
Ibis	4	10	15	13	11	11	9	12	**85**
Other	5	4	5	6	8	4	4	5	**41**
Wedge-tailed Eagle	2	1	2	2	2	1	3	2	**15**
Wagtail	-	-	1	2	1	1	1	1	**7**
Cuckoo	1	-	-	1	1	2	-	-	**5**
Cormorant	1	-	3	1	2	-	1	2	**10**
Wren	-	-	1	-	-	1	-	-	**2**

Cont.

Bird Type	2002	2003	2004	2005	2006	2007	2008	2009	Total
Pelican	2	2	2	1	1	3	1	1	**13**
Myna	1	3	1	-	1	1	2	-	**9**
Kingfisher/Kookaburra	-	1	2	-	2	-	-	-	**5**
Oystercatcher	-	1	-	1	-	1	-	-	**3**
Thrush	1	-	-	-	-	-	-	-	**1**
Pacific Gull	3	5	2	2	1	-	4	4	**21**
Eagle	5	12	11	10	5	9	10	6	**68**
Falcon	2	9	6	4	2	2	5	2	**32**
House Sparrow	19	13	17	24	12	10	28	12	**135**
Pratincole	11	11	27	35	17	21	15	15	**152**
Silver Gull	18	31	32	46	28	30	17	29	**231**

Table 37: Number of birdstrikes by bird size and state

State	Bird Size	2002	2003	2004	2005	2006	2007	2008	2009
ACT	Large	-	-	-	-	1	-	-	-
	Medium	6	3	10	24	32	30	19	18
	Small	1	3	4	3	6	3	6	1
	Unknown	4	3	6	6	9	5	6	6
NSW	Large	6	5	11	8	2	10	11	7
	Medium	55	83	97	87	115	140	153	142
	Small	30	39	43	47	44	60	53	54
	Unknown	62	41	61	76	66	62	58	101
NT	Large	3	4	1	5	2	4	1	6
	Medium	42	42	42	51	60	45	44	70
	Small	35	33	56	70	39	58	52	51
	Unknown	41	17	25	34	13	11	26	42
QLD	Large	10	14	17	21	21	24	22	26
	Medium	89	120	137	160	176	181	182	166
	Small	52	83	117	121	114	126	152	125
	Unknown	81	92	100	150	98	102	135	160
SA	Large	-	1	1	2	2	1	-	1
	Medium	48	47	71	66	61	59	59	74
	Small	11	9	21	13	16	15	21	22
	Unknown	17	8	19	38	20	23	18	45
TAS	Large	-	-	1	1	-	1	2	1
	Medium	13	11	13	29	12	31	26	30
	Small	11	12	9	12	18	23	17	16
	Unknown	12	7	4	12	11	9	14	6
VIC	Large	2	2	-	5	5	5	6	5
	Medium	30	21	53	52	70	33	39	59
	Small	10	17	20	40	31	23	37	31
	Unknown	27	22	30	34	26	28	45	47
WA	Large	3	3	12	6	5	5	7	9
	Medium	35	43	51	39	75	68	58	72
	Small	18	17	33	30	50	42	43	43
	Unknown	25	31	19	34	31	29	19	32
Other	Large	-	-	-	-	-	1	-	-
	Medium	-	-	-	2	1	2	6	7
	Small	-	-	-	-	2	2	1	1
	Unknown	1	-	-	-	-	-	2	1

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