Australian Government

Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY INVESTIGATION REPORT
Aviation Research and Analysis Report AR-2008-027
Final

An analysis of Australian birdstrike occurrences 2002 to 2006

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Figure 2: Aviation Safety Digest (1970), Department of Civil Aviation, Australia.

Abstract

This report analyses birdstrikes reported to the Australian Transport Safety Bureau between 2002 and 2006. In Australia, over the last five years, the number of birdstrike occurrences reported annually to the Australian Transport Safety Bureau (ATSB) has risen from approximately 750 in 2002 to 1,200 in 2006. The report includes bird and bat strikes that occurred in Australian territory involving VH- and overseas registered aircraft. It excludes strikes involving non VH-registered Australian aircraft and those involving VH-registered aircraft that occurred overseas. Birdstrikes were analysed by year, month, phase of flight, type of operation, record source, effect on flight, time, aircraft damage, injuries, the nature of occurrence reports, flight disruption, aircraft movements, aircraft size, ingestion, bird size, species, and location. Location data are presented for major aerodromes, General Aviation Airport Procedures aerodromes and regional aerodromes. The report tables birdstrikes and aircraft movements, as well as species struck and species causing damage.

Birdstrike reporting was found to have almost doubled over the reporting period. There have been three injuries, but no fatalities. Around seven per cent of birdstrike events resulted in damage, and double-engine ingestion was recorded for eight of 5103 birdstrike occurrences. Birdstrike events vary by location, and rates of birdstrike events at aerodromes are only indicators of the effectiveness of control measures.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an operationally independent multi-modal bureau within the Australian Government Department of Infrastructure, Transport, Regional Development and Local Government. ATSB investigations are independent of regulatory, operator or other external bodies.

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 enhance safety. To reduce safety-related risk, ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated.

It is not the object of an investigation to determine blame or liability. However, 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 proactively initiate safety action rather than release formal recommendations. However, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation, a recommendation may be issued either during or at the end of an investigation.

The ATSB has decided that when safety recommendations are issued, they will focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on the method of corrective action. As with equivalent overseas organisations, the ATSB has no power to implement its recommendations. It is a matter for the body to which an ATSB recommendation is directed (for example the relevant regulator in consultation with industry) to assess the costs and benefits of any particular means of addressing a safety issue.

About ATSB investigation reports: How investigation reports are organised and definitions of terms used in ATSB reports, such as safety factor, contributing safety factor and safety issue, are provided on the ATSB web site www.atsb.gov.au.

DEFINITIONS

- **Aerodrome birdstrike:** a birdstrike occurring within the boundary of an aerodrome. This includes all takeoff, landing, taxiing and stationary aircraft strikes. It also includes birdstrikes where a carcass was found on a runway or taxiway, but the aircraft striking the bird is not known.
- **Aircraft damage:** when an aircraft sustains either a scratch, crack, dent, bent, broken or non-functioning component or system as a result of a collision with a bird. An aircraft is also considered to have sustained damage when a responsible person states it was damaged, even in the absence of a description of the aircraft part damaged, or damage severity.
- **Aircraft movement:** a takeoff, landing or circuit.
- **Birdstrike:** a collision between an aircraft and bird or bat. A birdstrike is deemed to have occurred when a pilot reports a strike; evidence of a strike is found on or in the aircraft; a responsible person directly observes a strike; or remains are found on, or beside a runway and no other reason can be determined for the deceased animal.
- **Coastal aerodrome:** an aerodrome that lies within five kilometres of the Australian coastline.
- **Engine ingestion:** the entrance of a bird into the inlet of a turbine engine during the operation of an aircraft. A birdstrike was characterised as ingestion if the report stated ingestion occurred, or a description of damage to an engine part was given, indicating ingestion had occurred.
- **General Aviation Airport Procedures (GAAP):** is an aerodrome where the pilot has responsibility for maintaining separation during taxiing. The air traffic control tower has responsibility for separating aircraft in the air, using a combination of position reports and type of aircraft.
- **Major aerodrome:** an aerodrome that services **regular public transport** operations.
- **Multiple birdstrikes: birdstrike** events where multiple carcasses are found, or where the pilot or a responsible person reports that the aircraft was struck by more than one bird.
- **Near aerodrome birdstrike: a birdstrike** occurring when an aircraft is established on any leg of a circuit pattern, including final approach, or an aborted approach.
- **Non aerodrome birdstrike: a birdstrike** occurring away from an aerodrome. This includes during the descent, initial approach, intermediate approach, long straight in approach, climb to cruise, en route, normal cruise, normal descent and manoeuvring phases of flight.
- **Regular public transport:** refers to aircraft that transport passengers or cargo according to fixed schedules and arrival and departure points for monetary reward.
- **Risk:** the chance of something happening that will have an impact on safety.

ABBREVIATIONS

- **AAWHG** Australian Aviation Wildlife Hazard Group
- **AAGSC** Australian Aviation Ground Safety Council
- **AHAS** Avian Hazard Advisory System
- **ALA** Authorised landing area
- **ALARP** As low as reasonably possible
- **ATS** Air Traffic Services
- **ATSB** Australian Transport Safety Bureau
- **BASI** Bureau of Air Safety Investigation
- **BHIU** Bird Hazard Investigation Unit
- **BITRE** Bureau of Infrastructure, Transport and Regional Economics
- **CAA** United Kingdom Civil Aviation Authority
- **CASA** Civil Aviation Safety Authority
- **CSIRO** Commonwealth Scientific Industrial Research Organisation
- **DCA** Department of Civil Aviation
- **DDAAFS** Defence Directorate Aviation and Flying Safety
- **DNA** Deoxyribonucleic acid
- **FAA** United States Federal Aviation Administration
- **GA** General aviation
- **GAAP** General Aviation Airport Procedures
- **IBSC** International Bird Strike Committee
- **ICAO** International Civil Aviation Organisation
- **NABSAS** North American Birdstrikes Advisory System
- **RPT** Regular public transport
- **US** United States of America

EXECUTIVE SUMMARY

The Australian Transport Safety Bureau (ATSB) released a discussion paper in 2002 on birdstrikes in Australia between 1991 and 2001. In 2003, the ATSB, the Civil Aviation Safety Authority, and the Australian Aviation Ground Safety Council met and agreed that an industry consultative forum on bird and animal hazards to aircraft would meet an important need in aviation. This led to the formation of a forum, now known as the Australian Animal Wildlife Hazard Group (AAWHG). Part of the AAWHG mandate is to examine birdstrike research. The AAWHG requested that the ATSB prepare a report on bird hazards to assist in examining trends, developing risk assessment models, and priorities. This report has been prepared in response to that request.

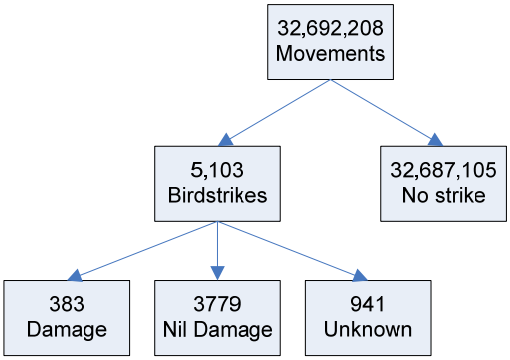
There has been an increase in the number of birdstrike occurrences reported to the ATSB. In Australia, over the last five years, the number of birdstrike occurrences reported annually to the Australian Transport Safety Bureau (ATSB) has risen from approximately 750 in 2002 to 1,200 in 2006. This investigation aims to examine the possible influences on and reasons for this increase and explore any areas of important or emerging risks related to birdstrike occurrences in Australia.

Many birdstrikes are reported to the ATSB more than once. Aerodrome ground staff were responsible for about 30 per cent of all birdstrike reports, Air Traffic Services (ATS) about 25 per cent, and flight crew and/or operators for just over 40 per cent of reports. Those proportions were also true for reports originating from major aerodromes and regional aerodromes. General Aviation Airport Procedures (GAAP) aerodromes had more reports from ATS and less from flight crew and/or operators, while the 'Other aerodromes' category had two-thirds of reports coming from flight crew and/or operators as a result of minimal ATS involvement at those locations.

Over the five year period 2002 to 2006, there were 5,103 reported birdstrikes; this equates to one birdstrike per 6,407 movements[1] (Figure 13). Damaging strikes were around 7.5 per cent (383 of 5,103) of all birdstrike occurrences, that is, one in 13 birdstrikes cause damage to the aircraft.

1 A movement is a takeoff, landing, or circuit. Therefore, the reported birdstrike rate per 10,000 movements would be almost double the rate per 10,000 sectors flown (commonly used overseas). Aircraft movements presented in this report are within an order of magnitude based on pooled data. They do not necessarily represent a precise figure. For the sake of consistency, and to represent the total number of birdstrikes, data presented in this report use aggregate estimates based on figures from the Bureau of Infrastructure, Transport, and Regional Economics and Airservices Australia.

Figure 1: Total movements and birdstrikes, 2002 to 2006



Importantly, birdstrike events resulting in two-engine ingestion that have the potential to lead to an accident, were even rarer at 0.15 of a percentage point (8 of 5103) between 2002 and 2006. All of the eight aircraft with a two-engine ingestion were able to maintain a safe altitude and subsequently land without further incident. Australia continues to maintain a record in which no fatal civil aviation accident has occurred due to a birdstrike.

In around four per cent of occurrences, pilots elected to perform a precautionary landing following a birdstrike, mostly returning to the departure point. There were two birdstrike related loss of control accidents between 2002 and 2006, both involving helicopters in general aviation (GA). These were serious accidents and one of the pilots sustained minor injuries.

Along with an increasing number of birdstrike occurrences, aircraft movements have also increased. Over the years 2002 to 2006, the rate of birdstrikes per 10,000 movements has increased from about one to two occurrences. However, the rate of damaging birdstrikes per 10,000 movements has remained steady since the 1980s. There are now more reports of non-damaging birdstrikes per aircraft movement when compared with 2002.

The probability of birdstrikes changes throughout the year, and is specific to locations (see the Appendices). The time of day birdstrikes are likely to occur follows the peak aircraft movement times of 06:00 to 10:00 and 15:00 to 21:00.

Two-thirds of birdstrikes involved regular public transport (RPT) operations, mostly from high capacity aircraft. Compared with general aviation, RPT operations were 16 times more likely to sustain a birdstrike. This is possibly related to aircraft size, speed and better RPT reporting. The rate of birdstrikes per 10,000 movements on RPT aircraft increased from 4.7 in 2002 to 6.7 by 2006.

Two-thirds of birdstrikes occurred during the landing and take-off phases of flight, with landings accounting for a slightly higher proportion than takeoffs. Most birdstrikes occurred at an aerodrome (81% of all birdstrikes), or near an aerodrome (14%). This is to be expected given the concentration of birds near the ground.

The birdstrike rate per 10,000 movements at GAAP aerodromes was considerably lower than the rate at major aerodromes and regional aerodromes in general. In addition, the GAAP aerodromes in each capital city all had a lower birdstrike rate than the major aerodromes in the same city. There was considerable variation between birdstrike rates at the various aerodromes. However, although the number of birdstrikes at a location informs industry to a degree about how well it is

controlling birds, location-specific bird populations and bird behaviours also significantly contribute to the number of birdstrikes at any location.

1 INTRODUCTION

1.1 Background to the report

Since the mid 1940s Australian birdstrike data have been systematically collected (Department of Civil Aviation, 1953) and used to address hazards posed to aircraft at aerodromes.[2] During the 1950s, 1960s and 1970s, the Australian Government provided significant funding to control bird hazards (Department of Civil Aviation, 1961; Department of Transport, 1976). Along with research and practice from overseas (Solman, 1973), this helped to focus the control of bird hazards from an Australian perspective.

Birdstrikes have traditionally been seen as a two-pronged problem; aircraft must be manufactured to reasonably withstand birdstrikes, and birds and aircraft must be appropriately separated (van Tets, et al. 1977; Department of Civil Aviation, 1978). In order to achieve these aims, the aviation industry has used a variety of controls to minimise the risks of birdstrikes upon aircraft. Industries outside of aviation such as horticulture and fishing, have realised significant financial benefits associated with controlling bird hazards (Bomford & Sinclair, 2002), but aviation has met with mixed success, and as yet, 'there is no 'silver bullet' for aerodrome bird control' (Harris & Davis, 1998).

In 2003, the ATSB released a birdstrike research report recommending the formation of an industry working group. This recommendation resulted in the formation of the Australian Aviation Wildlife Hazard Group (AAWHG). The AAWHG requested an updated report to assist in disseminating information on birdstrikes to industry, and to promote its research and advocacy activities. This report has been prepared in response to that request

1.2 Report objectives and scope

A primary objective of this report is to provide an update on birdstrikes to the AAWHG and industry. The scope of the report is to examine trends in birdstrike data over time including to:

- provide a brief historical overview of birdstrike organisations in government and industry;
- provide an overview of birdstrike accident and incident data collection in Australia;
- summarise some of the main birdstrike control measures available for use at aerodromes;
- describe the effect of birdstrikes upon aircraft operations;
- describe any important or emerging risks based on birdstrike data; and

2 National Archives of Australia: Department of Civil Aviation, 1961; Department of Civil Aviation, 1964; National Archives of Australia: Department of Civil Aviation, 1964; van Tets, 1966; National Archives of Australia: Department of Transport, 1976.

- review and analyse birdstrike data between 1 January 2002 and 31 December 2006 that is held by the ATSB.

2 WHY ARE BIRDSTRIKES A PROBLEM?

While birdstrikes occur frequently, only a small number of occurrences result in injuries to aircraft occupants or significant aircraft damage. Despite this, birdstrikes remain a perennial problem for both aircraft and aerodrome operators. Birdstrikes can be considered a source of potential harm to people, operations, equipment and processes.

2.1 Injuries and fatalities

The greatest source of concern associated with birdstrikes relates to injuries and loss of human life. According to Thorpe (2005), 47 fatal birdstrikes accidents have led to the loss of 242 lives world-wide since 1912. A breakdown of these occurrences shows that the events have occurred in the following types of aircraft:

- Airliners and executive jets - 174 fatalities in 12 fatal accidents
- Aeroplanes up to 5,700 kg – 58 fatalities in 29 fatal accidents
- Helicopters – 10 fatalities in six fatal accidents.

A recent Antonov freighter accident in Moscow on 29 July 2007, linked to a birdstrike, killed all seven crew (Kaminski-Morrow, 2007).

2.2 Birdstrikes and accidents

Birdstrikes in Australia and world-wide appear to be increasing. It is now believed that more than 50,000 birdstrikes occur on civil aviation aircraft each year. Overseas, a small number of birdstrikes lead to fatalities each year (United States Aviation Hazard Advisory System, 2007; Dolbeer, 2007). In Australia, over the last five years, the number of birdstrike occurrences reported annually to the Australian Transport Safety Bureau (ATSB) has risen from approximately 750 in 2002 to 1,200 in 2006.

One of the first documented birdstrikes in Australia occurred in 1934, and is found in the book *Flying Doctor* (Fenton, 1947). The author describes a collision between a hawk and his Gypsy Moth aircraft over Katherine in the Northern Territory. The collision made a football-size hole in the fabric of the top wing, which threatened to enlarge as the plane continued in flight. Fortunately, the pilot made a safe landing.

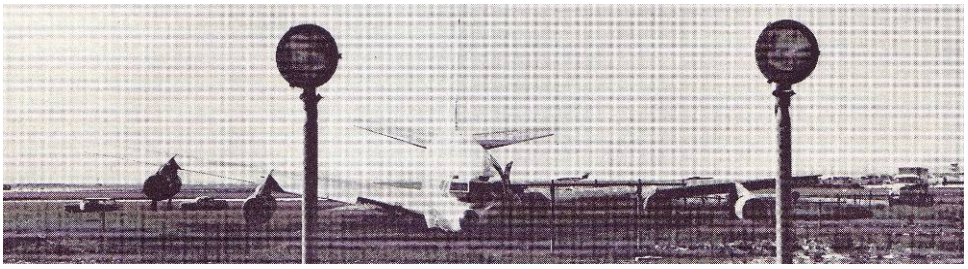
Over the years, there have been a number of prominent birdstrikes events in Australia, including the following.

- On 1 December 1969, a Boeing Co 707 aircraft, registered N892PA, struck a flock of seagulls during takeoff from Sydney Aerodrome, NSW. The pilot in command observed a power loss in the Number 2 engine and subsequently rejected the takeoff. The aircraft overran the runway and collided with the approach lighting installation, which caused the nose landing gear and port main landing gear to become detached. None of the 11 crew and 125 passengers received injuries (Figure 2).
- On 26 November 1977, a Piper PA-25-235 Pawnee aircraft, registered VH-SPB, was conducting aerial agricultural activities near Derrinallum in Victoria. As the pilot pulled the aircraft up in order to avoid trees, an eagle appeared to attack the

aircraft causing damage to the outer portion of the wing. The pilot sustained no injuries.

- On 5 July 1981, an Intermountain A-9A (also known as Callair) tug aircraft, registered VH-MPF, struck a kite (hawk) near Batchelor, NT, while towing a glider. The kite lodged in the 'V' formed by the leading edge wing and strut. The bird disturbed the flow of air over the aileron. Right rudder was applied but the aircraft continued to track left to the downwind leg of the aerodrome and then subsequently collided with terrain and was destroyed. The pilot sustained no injuries.
- On 24 November 1987, an amateur-built Osprey aircraft, registered VH-LII, struck a bird near Cape Liptrap, Vic. At 50 feet into the air after takeoff, a bird shattered the windshield and impaired the pilot's vision. The pilot was able to land the aircraft, but it subsequently caught fire. The fire was thought to have started when the bird ruptured a fuel line, spraying fuel onto a hot exhaust.
- On 17 May 1996, a De Havilland Dash 8, registered VH-JSI, was on descent to Broome Aerodrome, WA, when it struck an eagle passing 4,800 feet. The bird punctured the leading edge of the wing, near the root of the wing, causing damage to the spar, control assembly and electrical systems. Engine and landing gear instrumentation failed and the crew shut down the left engine, then carried out a low-level fly-past to confirm the position of the landing gear. The aircraft landed, but the pilot was not able to maintain directional control and it veered off the sealed runway.
- On 16 October 2001, a Cessna 172 Skyhawk, registered VH-MAI, was cruising at 4,500 feet, 22 km east of Nanango ALA, Qld, when it struck an eagle. The eagle penetrated the windscreen, hit the pilot's nose and tore off his headset. The pilot found the aircraft difficult to control and made a precautionary landing in a paddock. The aircraft touched down, stopped in a very short distance and was destroyed. The pilot was able to vacate the aircraft before it was destroyed but sustained a broken nose.

Figure 2: The Boeing Co 707, registered N892PA, after birdstrikes and runway overrun in 1969



2.3 Effect on operations

The effect of birdstrikes on aircraft operations is measured mainly in monetary terms. It is difficult to obtain an accurate estimate of the cost of birdstrikes for airline and aerodrome operations, let alone the cost of bird and animal hazard management. Recent reports show that, world-wide, birdstrike-related costs amount to $1.3 billion annually (Federal Aviation Administration, 2006; Defusco et al., 2005).

2.3.1 Airlines

Lost operating time from birdstrikes is thought to cost airlines millions of dollars. This cost is related to a number of components of flight operations including the cost of assessing if damage has occurred, repairing damaged aircraft, rescheduling, and staffing considerations. This is particularly true where passengers are accommodated at the expense of the airline and flight crew rosters are changed. Airlines incur other costs associated with the purchase and installation of bird collision avoidance systems, such as Pulselight®. This process takes the aircraft out of service for installation of the device. Some organisations may see this as an investment rather than a cost.

Qantas estimated the combined cost of aircraft inspections, repairs, cleaning and delays related to birdstrike events was $2.3 million in 2006. This included flight delays, crew alterations, rescheduling flights and accommodation, and injuries (Taylor, 2007).

Between 1993 and 1998, Ansett Australia estimated it spent in excess of $62 million on birdstrikes (Ansett Australia and Air New Zealand Flight Safety Magazine, 2000). One birdstrike incident involving a Boeing Co 737 at Norfolk Island in May 1996 cost $1.8 million. Ansett had to transport equipment and people to this remote location.

Aircraft damage

There is no easy method for determining birdstrike damage and cost, but it is generally agreed that aircraft damage from birdstrikes can be costly. Estimating the cost of damage usually requires data matching between large corporate databases. The following information provides some insight into the cost of damaging birdstrikes.

- For the years 1980 and 1981, airline operators made five separate jet engine changes (Department of Aviation, 1982 and Department of Aviation, 1983).
- In 1983, leading edge dent repair to three different aircraft cost $4,000, $2,920 and $2,447, while four separate birdstrikes involving engine ingestion cost between $44,000 and $150,000 each.
- In 1992, a British Aerospace BAe 146 struck a flock of Galahs on takeoff from Adelaide aerodrome. In an attempt to avoid the birds, the pilot over rotated the aircraft and struck the tail on the runway. Two engines ingested several birds each. The cost of airframe repair was around $90,000 and engine repair was approximately $230,000. This included engine removal, replacement of parts, and labour for the two engines. This did not include the cost of freighting spare engines from another Australian city. Airframe inspection and removal of bird debris cost over $2,000 (Bureau of Air Safety Investigation, 1992).
- Qantas estimated that a 1995 Airbus A300 birdstrike involving a 2 kg ibis at Gold Coast Aerodrome cost the company $8 million. This included engine replacement, downtime and schedule changes (Learmount, 2007).
- In 1997, a Qantas aircraft ingested an ibis at 2,500 feet, resulting in a cost of $6 million (Ibis Management Co-ordination Group, 1997). More recent analysis by Qantas showed that two birdstrikes in September and October of 2006 cost more than $180,000 and $125,000 respectively. Both events involved engine ingestion (Taylor, 2007).

Compared with other birdstrike data, the figures stated by Ansett appear to be at the high end. However, these may be a truer representation of the costs of birdstrikes. The challenge in describing cost is to separate engineering costs from other corporate costs. These figures demonstrate that detailed aircraft inspections and cleaning can cost between $3,000 and $5,000 dollars in today's terms. A bird ingestion that damages engine fan blades is likely to cost $40,000 and core damage may be at least $150,000 dollars. Engine replacement is likely to be in excess of $5 million. These data has not been adjusted for inflation and other market, but it is reasonable to assume that replacement part cost has risen over time.

2.3.2 Aerodromes

Disruption to aerodrome operations is not only inconvenient, but also costly to all concerned parties (Dolbeer, 2007). This cost relates to extra time managing rejected takeoffs, emergency or precautionary landings, and damage to the corporate image. Provisional estimates of the annual cost of detecting and deterring birds for one medium-sized Australian aerodrome are in the $30,000 to $50,000 range, while cost associated with larger Australian aerodromes is thought to be several hundred thousand dollars per annum. This cost includes staff, vehicles, detection and deterrence equipment, specialist expertise such as an ornithologist, and other fixed and variable costs, such as community and government consultations.

3 BIRDSTRIKES IN AUSTRALIA

3.1 Bird hazard oversight

Central Office on Bird Hazards

In 1976, the Department of Transport created a Central Office on Bird Hazards to Aircraft (the Office). Representatives from aerodrome engineering services, air safety investigation, environment and security, and regular public transport operators participated in central and regional committees to oversee priorities and control measures. In 1978, the birdstrike reporting system was updated. The Office was one of a handful of organisations in existence at the time who sent birdstrike data via computer tape to the International Civil Aviation Organization (ICAO), (Bureau of Air Safety Investigation, 1984).

Bird Hazard Investigation Unit

In 1980, the Bird Hazard Investigation Unit (BHIU) was created under the direction of ornithologist, Mr P.M. Davidson. A laboratory was completed in 1984 and used to identify bird remains and stomach contents. This information was used to direct control of food and water sources for birds at Australian aerodromes. The BHIU matched birdstrike data sent to the then Bureau of Air Safety Investigation (BASI)[3] with aerodrome bird population counts and laboratory data. They completed routine as well as ad-hoc reports at specific aerodromes. These comprehensive and valuable reports were resource intensive and took considerable time to prepare. In 1988, the BHIU became part of the Civil Aviation Authority (CAA).

Modern developments

The BHIU closed in 1991 following reorganisation and cost-cutting. Further systemic changes to the CAA led in 1995 to the formation of the Civil Aviation Safety Authority (CASA) and Airservices Australia. There was also the privatisation of aerodromes. As a result, many of the functions performed in relation to birdstrike reporting and risk management transferred to individual aerodrome owners. The reports by Pell and Jones (2002), Steele (2001) and Hutchinson (2001) are examples of work performed after centralised ownership of aerodromes ended. Subsequently, industry and government refocussed on birdstrikes and in 2003, the AAWHG was formed.

3.2 Birdstrikes research

Early publications

Australian birdstrike data has been systematically analysed since the 1940s. An article entitled ‘Who’s Air Space’ [sic] appeared in issue two of *Aviation Safety Digest* in 1953 (Department of Civil Aviation. 1953). This research analysed

3 The Bureau of Air Safety Investigation (BASI) became part of the newly formed multi-modal Australian Transport Safety Bureau (ATSB) on 1 July 1999.

birdstrikes between 1948 and 1953 by phase of flight, aircraft movements, aircraft damage and hours flown. In 1964, the Department of Civil Aviation (DCA) committed £50,000 over five years to study bird species struck by aircraft (Department of Civil Aviation, 1964). This research was performed by Commonwealth Scientific and Industrial Research Organisation (CSIRO) ornithologists, Drs van Tets and Trith. Along with Dr Lavery, they carefully analysed 985 bird carcasses between 1963 and 1971, examining the species struck, stomach contents and sources of attraction at Australian aerodromes. This led to the 1977 publication *Recognition of Aerodrome Bird Hazards* (van Tets et al., 1977). Amongst other things, this publication mapped where particular species had been struck in Australia, and tabled a list of birds struck.

A number of publications followed after this research including a study of orange runway lighting as a way of reducing birdstrike damage (van Tets et al., 1969), and a study on changes in habitat and avifauna at Sydney Aerodrome between 1964 and 1968. This 1969 report found the likelihood of a bird being killed was related to the cube root of their average numbers on the airfield. It concluded that bird numbers must be reduced by 80 per cent to produce a significant reduction in birdstrikes.

Australian Transport Safety Bureau publications

Three birdstrike reports have been produced by the ATSB (and its predecessor BASI) since the mid-1990s. The first titled *Reported Birdstrikes in Australia* (BASI, 1996) examined birdstrikes by location, aircraft damage and year for the period 1993 to 1996. With the exception of birdstrikes causing damage, data for the report is not held electronically by the ATSB. This paper included overseas birdstrike data involving Australian-registered (VH) aircraft.

In 2003, a second report (ATSB, 2003) titled *The Hazard Posed to Aircraft by Birds* studied birdstrikes by aircraft movements, aircraft damage, month and year, geographic region, time of the day, phase of flight, bird species, and impact physics. It also focused on birdstrike control measures and risk assessment at aerodromes. This area was targeted because of the high number of birdstrikes during landing and takeoff. Data were obtained from Directorate of Defence Aviation and Air Force Safety (DDAAFS) and presented for phase of flight, but not other study variables. Recommendations from the paper formed the basis of guidance material and the formation of an Australian industry birdstrike working group, the AAWHG.

As part of an ATSB-administered aviation grant program, which ran from 2003-04 to 2005-06, the ATSB funded a research project (Christidis, et al., 2006) titled the *Forensic Identification of Aviation Birdstrikes in Australia*. The paper, prepared by The Australian Museum, examined the utility of deoxyribonucleic acid (DNA) analysis for species identification. It established laboratory DNA as a means for correctly identifying Australian bird species. Two important findings were discovered in addition to DNA analysis. First, samples sent to the laboratory did not clearly match the top eight highest risk species from the 2003 birdstrikes report. This may be because the samples came largely from Queensland, which may limit extrapolation of this observation to other states or aerodromes. Second, the report concluded that errors in visually identifying species are likely to be high where the carcass is not intact. In this report, aerodrome staff sent samples of tissue and blood to a laboratory for species identification. Not all staff attempted to identify the species. Where species identity was attempted, only four of 11 birds were correctly identified. This suggests that accurate visual identification is extremely difficult. The small sample size (28) of this study may limit the findings, along with the fact that personnel often did not have much carcass left to identify the bird visually.

Department of Defence publications

The Department of Defence published one of the more comprehensive reports on birdstrikes in 1975. This Mechanical Engineering Report, authored by Pavia (1975), focused on birdstrikes and their damage, control and avoidance of birds around aerodromes, en route bird avoidance and control, and aircraft design to withstand damage from birdstrikes. The section on aircraft design covers structural considerations, transparencies (windows) and engines. The report combines civil and military birdstrike data to present a picture of hazards by type of aircraft, phase of flight, airfield location and conditions, seasonal effects, bird species and engine ingestion.

3.3 Role of the aviation industry

3.3.1 Aircraft manufacturers and airworthiness

Aircraft manufacturers have a responsibility to produce aircraft capable of withstanding birdstrikes. As early as 1965, the International Civil Aviation Organization (ICAO) requested member states report birdstrikes to its mandated airworthiness division so that airworthiness standards could be developed (Aviation Safety Digest, 1978). These data and experimental research have led to the airworthiness requirements now in place. Airframe, window and engine ingestion criteria must be met by all large modern aircraft. Some of these requirements have changed over time in response to data from birdstrike reports (Banilower & Goodall, 1992). More recently the US Federal Aviation Administration (FAA) aligned its engine ingestion criteria with the European requirements (Federal Aviation Administration, 2007). Boeing has recently revised the horizontal tail of the new Boeing Co 787 following the development of a small crack after simulating a large birdstrike (Emery Riddle Aeronautical University, 2007).

3.3.2 Aerodromes

Many reports and papers refer to the fact that the majority of birdstrikes occur either on or in the vicinity of an aerodrome (Australian Transport Safety Bureau, 2003; Department of Civil Aviation, 1978a; Milsom & Horton, 2005; Shaw, 2005). Here, control measures may be more easily implemented to reduce bird hazards than they can be when aircraft are en route between aerodromes (Ballantyne, 2005; Rao & Pinos, 2003). Under Part 139 of the Civil Aviation Safety Regulations, aerodrome operators must have in place procedures to control birds on or near aerodromes. Although they are not solely responsible for managing the risk of birdstrikes, aerodrome operators must assume a high level of responsibility for managing this risk. In 1990, the 190 member nations of ICAO adopted three recommended practices to control bird hazards at aerodromes (Annex 14 to the Convention on Civil International Aviation). Those recommendations were upgraded in 2003. The mandated practices are that authorities:

- assess the extent of the risk posed by birds on and in the vicinity of aerodromes;
- take necessary action to decrease the number of birds; and
- eliminate or prevent the establishment of any site in the vicinity of the aerodrome, which would attract birds and present a danger to aviation.

This typically involves modifying aerodrome habitat, scaring and culling, and community and government liaison. Aerodrome operators around the world have found it difficult to comply with these standards (Dolbeer, 2007) and their own national regulations. However, unless an effective aerodrome bird risk management program is in effect, collisions between aircraft and birds are probably more likely to occur (Rao & Pino, 2003).

3.4 Aerodrome bird hazard control strategies

It is beyond the scope of this report to evaluate and outline all bird control strategies currently available either in Australia or overseas. Readers are referred to Harris and Davis (1998) and the International Bird Strike Committee website[4]. It would appear that no publication similar to that of Harris and Davis (1998) has been attempted in Australia, although there is some evidence that a similar approach was used during a review of Townsville Aerodrome during the period the Bird Hazard Investigation Unit (BHIU) was operating. This section outlines some of the control techniques and emerging technologies for birdstrike control.

There is a range of guidance material relating to the management of bird and animal strikes available including the publication *National Framework for Bird and Animal Management at Airports* (Australian Airports Association, 2006). The risk assessment model is semi quantitative and, among other things, includes bird population data, bird size, flocking characteristics, strike frequency or probability. A second framework publication compiled by the Australian Airports Association and the AAHWG also provides a guide to all aerodrome operators for developing aerodrome bird risk management programs. It is important to bear in mind that most publications available for examining the effectiveness of bird control techniques are subjective. There are very few comprehensive, well designed studies.[5] Bias[6] may play a large role in any data collected for the purposes of evaluating bird control methods, particularly where the work is not separate from commercial interests.

Aerodrome authorities can use a variety of conventional bird control techniques to minimise the hazards posed by birds. Basic bird hazard management principles are used to identify what attracts birds to aerodromes, and then manage the habitat to minimise or remove sources of attraction, and/or deny birds' access to it. Removal and dispersal tactics can then be used to remove any birds that remain (International Bird Strike Committee, 2006; Transport Canada, 2002; Cleary & Dolbeer, 2005).

Emerging technologies may assist aerodrome managers to avoid birdstrikes, but no single approach in isolation will completely eliminate the threat of birdstrikes. It appears that a dynamic and systemic approach to bird hazard management provides the best method for controlling birdstrikes.

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4 http://www.int-birdstrike.org

5 This is not suggesting that all studies must employ experimental methods, randomized controlled trials or case control studies. Rather, well designed quasi-experimentation using interrupted time-series, non-equivalent control group designs or even passive observation, provide a more comprehensive method of assessing the efficacy of control measures (Cook & Campbell, 1979).

6 Bias is defined as any error that occurs while collecting and interpreting data

3.4.1 Environment control

Birds are attracted to aerodromes because they are a source of food, water and shelter. Thus, conventional habitat controls are based on minimising these attraction sources (Dolbeer, 2007). Birds will continue to return to an aerodrome if they have easy access to food and water. Dispersal tactics are unlikely to work, where the food and water are easily accessed (International Bird Strike Committee, 2006).

The IBSC (2006) recommend the following habitat management methods:

- minimise potential nesting areas
- reduce the amount of water lying on the aerodrome grounds
- maintain the grass at a length which deters birds
- minimise available food, by changing the ground cover and mowing the grass at night, as many birds gather to catch insects disturbed by the mower.

Emerging environmental management technologies

A promising new development in environment management is endophyte infected grasses. Researchers from New Zealand have designed grass and fungus combinations that are less palatable to birds and insects. These grasses cause post digestion malaise in herbivorous birds, reduce insect populations living in the grasses, and have low seed production after mowing. In 2006, the New Zealand research team planted test plots of grasses at Christchurch International Airport. Early indications are that it produces positive results in reducing the number of birds at the aerodrome (Ballantyne, 2005; Pincock, 2006).

3.4.2 Scaring and dispersal

A number of conventional bird control techniques are used by aerodromes to disperse birds. Such dispersal techniques include:

- firing hand-held pyrotechnics
- playing recorded bird distress calls or artificial electronic 'harassment' sounds
- training dogs and birds of prey to scare off birds (see below)
- directing hand-held laser devices at birds.[7]

Portable bird deterrent devices are generally regarded as offering the best control, provided the staff involved are properly trained. Devices such as pyrotechnic pistols and vehicle mounted distress call generators produce an impression of a direct threat, which can be continually varied in time and location by the operator in a manner not available in static systems. In general, static bird scaring devices lose their effectiveness over time (International Bird Strike Committee, 2006).

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7 There is a certain sensitivity associated with use of lasers in proximity to aircraft (Flight Safety Australia, 2008) in light of a number of recent events where aircraft have been targeted by individuals using laser (Canberra Times, 2008). State and federal government bodies have, or are moving to regulate these devices more closely.

Dogs and falconry

The use of trained falcons and dogs can be effective in dispersing birds. Both are natural predators for many species of hazardous birds found on aerodromes. To effectively work, a considerable investment must be made in training the animals and their handlers. They are not effective at dispersing all hazardous birds or under all conditions (International Bird Strike Committee, 2006). It is also difficult to record their actions and monitor their functional efficiency with absolute certainty and therefore demonstrate an aerodrome operator's duty of care (Walker, 2005).

Laser and sonic devices

Although the use of laser is not new (Pavia, 1964), in recent years a number of advancements have been made in sonic and laser devices designed for scaring birds away from flight paths.

Automated sweeping green laser beams have been used to scare away birds during takeoff and landing; the TOM500, developed by Lord Ingénierie for the French Direction Générale de l'Aviation Civile, was tested at Montpellier Airport in France in 2004. After one year, the number of birdstrikes had decreased by 40 per cent and serious birdstrikes were eliminated according to Briot (2005). At this stage, birds are not becoming accustomed to the laser (AMEInfo, 2006). The system is useful during low-light conditions, but ineffective on sunny days and when birds are flying over the runway (Briot, 2005).

Scarecrow Bio-acoustic Systems Ltd, known as Ultima™, uses global positioning system technology to track local bird activity around aerodromes and then disperses flocks by mimicking distress calls of individual species. It also automatically logs the process and builds a database of local bird activity, thereby establishing proof of dispersal procedures completed (Learmount, 2007). Unfortunately, not all bird species respond to acoustic distress calls.

3.4.3 Culling and bird trapping

Culling and trapping can be used to control birds on aerodromes (Civil Aviation Authority, 2006). Generally, this is not the first type of control measure chosen by aerodromes. In Australia, native and migratory species are protected under the Environment Protection and Biodiversity Conservation Act (1999), and a permit is required to cull these birds. This process operates under state and territory law in Australia. Introduced species do not require a permit. There has been some success in trapping and relocating birds of some species.

3.4.4 Communication of bird information

Radar

Radar has been used to study bird migration patterns since the late 1960s (Solman, 1970). It has taken longer to formulate how this data can be used. Radar can provide real-time information to pilots on the location of birds and their direction of movement. In some places, localised advisories such as a Notice to Airmen (NOTAM) are being created using mobile avian radars, aerodrome surveillance radars, and other systems under research and development by various agencies

(DeFusco, et al., 2005; Shaw, 2005; Air Safety Week, 2006; Werfelman, 2007). However, the development of real-time predictive bird models is in its infancy. Beyond the aerodrome property, the ability to communicate useful, real-time warnings is limited (DeFusco, Hovan, Harper, & Heppard, 2005)

Integrated tools

A number of bird hazard control systems are combining different pieces of information to provide a picture of risk. The US Avian Hazard Advisory System (AHAS) has recently directed effort to reduce birdstrikes outside aerodrome boundaries. First designed and tested in 1998, AHAS is an online, near real-time, geographic information system used for birdstrike risk flight planning. AHAS evaluates birdstrikes risk by using next generation weather radar systems to monitor large-scale bird migration. The risk from migration and soaring bird activity is also determined by predictive models using weather data from the National Weather Service. Forecasts of bird activity beyond 24 hours are currently limited by the reliability of weather forecast model predictions (United States Avian Hazard Advisory System, 2007).

The FAA, Transport Canada and the US Air Force are progressing work on an integrated birdstrike database called the North American Birdstrikes Advisory System or NABSAS. The goal of this collaboration is to establish a national network of bird detection radars at aerodromes. Data held in a central repository will be analysed by staff who will issue advisory notices (Air Safety Week, 2006). The vision is to develop an advisory system for a variety of end-users that will provide accurate and near-real time information about bird hazards at North American aerodromes (Federal Aviation Administration, 2006).

3.4.5 Species and control options

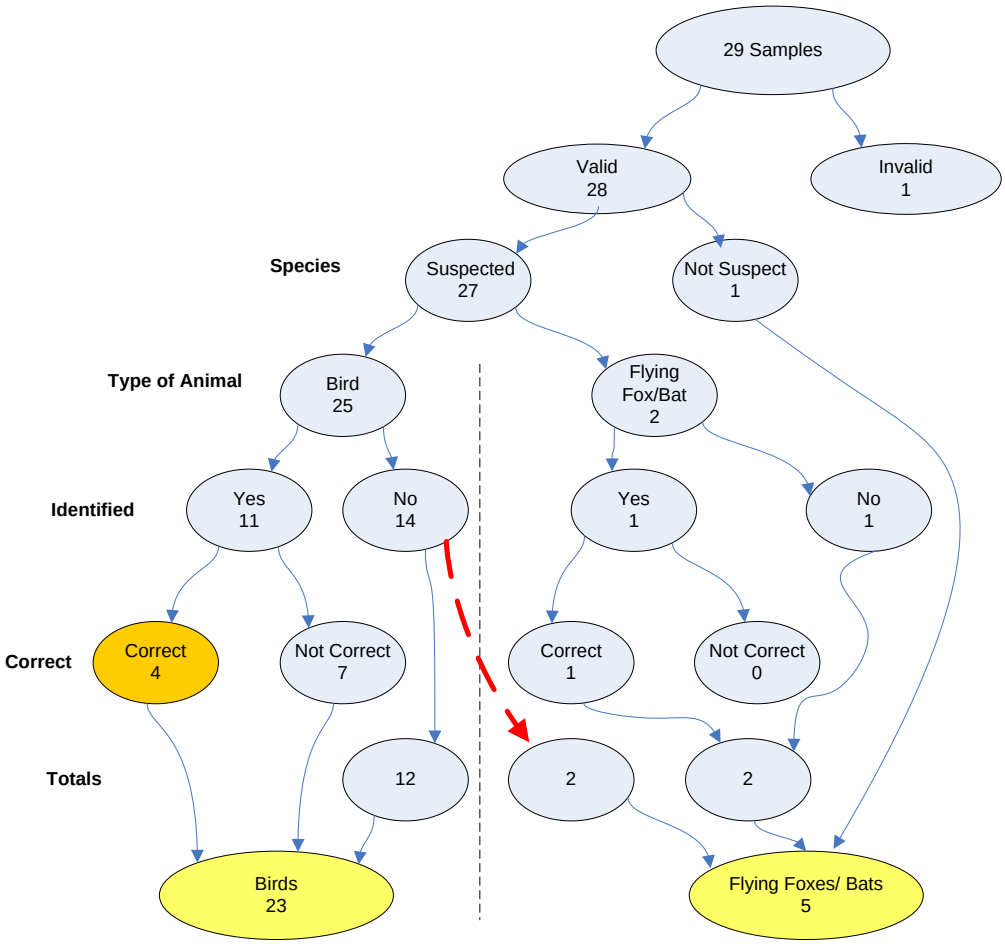
Personnel who perform aerodrome bird hazard management often hold the opinion that it is very important to identify the species involved in a birdstrike. This assumes that knowing the bird identity will enable operations personnel to control the bird species in question. It also assumes a clear link between control measures and specific species. This closer association between controls and specific species tends to be associated with larger aerodromes, which have larger aircraft movements and operating budgets. Aerodromes with limited resources can still manage bird hazards without a species-specific approach. This approach aims to minimise any species that can intrude on the path of an aircraft.

Visual species identification

There is some evidence from a human factors perspective that visual species identification is inaccurate. The time available for a pilot to see and identify a particular species of bird can be limited to a couple of seconds. Usually, a pilot's attention is focussed on avoiding a hazard, rather than upon identifying a particular species. Generally, it is perceived as a large or medium-size object. Aerodrome ground personnel are in a better position to examine a carcass than pilots. Where only part of the carcass remains after a birdstrike, an attempt to identity the species is likely to be erroneous. Although the sample size was small, Figure 3 shows the results of the previously cited paper funded by the ATSB on the DNA analysis of birds. This shows that four of 11 species were correctly identified, where an attempt to identify species was made. It is worth noting that no attempt was made to

identify species in 14 of the 25 birds. Species data held by the ATSB may not correctly attribute damage to a particular species.

Figure 3: Species identification by aerodrome operations staff and laboratory



DNA identification

Studies have confirmed that DNA from birds and bats can be used to correctly identify the species (Beikert & Ulbrich, 2006; Christidis et al., 2006). This process can be quite time-consuming, and potentially the window of opportunity for addressing a 'problem bird' may pass as the time taken to correctly identify the species increases. The other potential factor that must be considered is cost. It costs around $300 to process a sample at the Australian Museum. Neither industry nor government are likely to see this as value for money. Larger countries like the United States analyse bird remains at the Smithsonian Institute free-of-charge. However, much of the research conducted in the US is paid for by the Federal Aviation Administration and the United States Air Force. The US also has a much larger population and funding base upon which to carry out this type of research.

3.5 Changes in legal responsibilities

Aircraft operators and their insurers are increasingly the subject of legal action for cost recovery purposes at aerodromes where birdstrikes damage occurs (International Bird Strike Committee, 2006). Aerodrome authorities need to be aware that, as a result of the new ICAO standards in Annex 14, and local regulations, they now have a legal responsibility to protect aircraft from such risks.

Several aerodromes in other countries have been successfully sued as they have not been able to comprehensively demonstrate the existence of an effective bird risk management program (Dolbeer, 2006). One of the better known cases in the last 15 years occurred on 20 January 1995 at Le Bourget Airport in Paris. A Dassault Falcon jet, registered F-GHLN, had an uncontained engine failure occurred following the ingestion of a number of lapwings immediately after rotation. This ejected parts of the engine into the fuselage and a fire developed in the rear of the aircraft. The aircraft attempted to return for an emergency landing but collided with terrain at the threshold of the runway, killing 10 people and a dog on board (Bureau d'Enquêtes et d'Analyses, 2008). A subsequent inquiry found some aerodrome staff failed to perform routine bird-scaring before the accident. Subsequently, police laid manslaughter charges, but the outcome of the case is not known (Dolbeer, 2006).

Such matters illustrate that aerodromes must demonstrate they have a robust bird risk management program in place and that the effectiveness of the program is regularly assessed (International Bird Strike Committee, 2006). Aerodrome operators are likely to realise the long-term benefits from investing effort into managing birdstrikes (Cleary & Dolbeer, 2005; Shaw, 2005).

4 METHOD

4.1 Analyses

A search was performed of the ATSB's aviation safety database to identify all birdstrikes accidents and incidents (occurrences), including flying-fox strikes, within Australian territory between the period 1 January 2002 and 31 December 2006. This included aircraft with foreign aircraft registration (around 60 occurrences). The dataset excluded animal strikes and occurrences where a birdstrike was suspected, but no evidence of a strike was found. Some variables contain missing values; where there are missing values, an N or number value is used to describe the number of records used in tables and figures.

4.2 Data sources

Data were filtered using a combination of keyword text searches and coded data. The birdstrike dataset extracted from the ATSB's aviation safety database was combined with bird species data constructed with the assistance of the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and aircraft movement data provided by the Bureau of Infrastructure, Transport and Regional Economics (BITRE) and Airservices Australia.

4.2.1 Birdstrike reports

Aviation occurrence data, including birdstrikes, are collected under the authority of *Transport Safety Investigation Act, 2003* (TSI Act) and regulations. Prior to 2003, data were collected under Part 2A of the *Air Navigation Act 1920.* The ATSB database hold records of all aviation accidents and incidents reported to the ATSB by both Australian and foreign aircraft operators. These data combine all types of aircraft operations from high capacity RPT through to general aviation. Some Australian and foreign military aircraft data are held by the ATSB. Birdstrike occurrences in this dataset come mainly from aircraft on the Australian VH-register. Prior to 2007, the ATSB received military birdstrike data from Airservices Australia's Electronic Safety Incident Reports, but not as a matter of routine.[8]

Birdstrike data held by the ATSB is largely uncorroborated. In the majority of cases, a birdstrike notification does not lead to an investigation by the ATSB. This often results in incomplete data. For example, it may be known that a bird struck the nose of an aircraft but not known what damage was caused. An incident description may say that a bird was found lying on a runway, but it is not known what aircraft struck the bird, or whether any damage was sustained. Even when the aircraft is damaged, the extent or cost of that damage may be unknown. The limitations of the data will affect the accuracy of the results presented below.

8 The ATSB now receives data electronically from the Directorate of Defence Aviation and Air Force Safety.

Aircraft operational type data

For the five year period 2002 to 2006, between 13 and 25 per cent of birdstrike occurrences did not record the aircraft operation type. In a small number of cases, the aircraft was identified as a light aircraft. Therefore, some inferences could be made that the operation type was not RPT. However, the majority of occurrences with an unknown aircraft operation were at major aerodromes like Sydney. They did not record any aircraft details because a bird carcass was discovered on the runway but no aircraft associated with the event was identified. As the majority of movements at those places are RPT, it is highly likely that the RPT birdstrike rates would be higher than those presented in Table 5 below.

Time of day data

In 274 occurrence reports, an inspection of the runway found a bird carcass. This represents the time of the inspection, not necessarily the time of the birdstrike. These occurrences were removed from the analysis of birdstrikes times. They are instructive as they show a sample of times where inspections occur at aerodromes across Australia. Inspections occur in the early morning, midday and mid afternoon according to this limited sample.

Engine ingestion data

The number of occurrences involving engine ingestion may be different from the data presented below because occurrence reports do not always state whether ingestion occurred. However, this difference was minimised by the analysis of the reporter's text description of the birdstrike and aircraft damage descriptions. Birdstrikes that were described as involving engine ingestion for piston-engine aircraft were excluded.

Bird and bat species data

Due to the variety of common bird names used, the ATSB consulted the CSIRO in order to consistently order species data. The CSIRO provided advice on aggregating species with numerous common bird names to one name.

Birdstrike notifications do not always provide the ATSB with species information, and species data in this report is missing for roughly half of all birdstrikes.[9] It is important to note that the bird population of 'unknown' species is not necessarily made up of the same distributions of known species. In fact, it is likely that the 'unknown' bird population has a higher proportion of small or nocturnal birds or bats. This is because medium to large birds tend to be easier to identify (Department of Aviation, 1983).

4.2.2 Aircraft movements

The two main sources of movement data in Australia are collected by BITRE and Airservices Australia.

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9 For example, a bird may be struck, but no carcass is ever found, or an intact carcass does not exist after a strike. Sometimes the only evidence available is from damage or markings on an aircraft such as blood or feathers.

The BITRE collects aircraft movement data from both the major airlines and the general aviation (GA) industry. Airline operators provide data on scheduled regular public transport movements by date and location. Data pertaining to GA operations are collected through the *General Aviation Activity Survey*, which provides the number of hours flown and landings conducted each year (BTRE, 2006).

Airservices Australia collects movement data from 29 towered aerodromes, based on the Avdata scheme. This data covers major capital city aerodromes, General Aviation Airport Procedures (GAAP) aerodromes and some regional aerodromes. Movement data at smaller aerodromes and Authorised Landing Areas (ALA) is not collected. In order to calculate aircraft movements, the number of landings are doubled. Data in this paper uses a combination of aerodrome-specific and Australia-wide data.

5 RESULTS & DISCUSSION

5.1 Reporting trends

Birdstrikes account for between 12 per cent and 20 per cent of all events classified as occurrences[10] by the ATSB (Table 1). The proportion peaked in 2004, but has since declined. If data for the period 2002 to 2006 are aggregated, around 16 per cent of all recorded occurrences are related to birdstrikes.

Table 1: Birdstrikes as a proportion of all occurrences, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Birdstrikes	739	818	1,078	1,249	1,219	**5,103**
All occurrences[11]	6,014	5,017	5,315	6,873	7,608	**30,827**
% birdstrikes	12.3	16.3	20.3	18.1	16.0	**16.6**

Birdstrike reports are received from a number of different sources. Table 2 records the number of reports sent to the ATSB for the period 2002 to 2006. It is worth noting that the number of reports sent to the ATSB is greater than the number of birdstrikes. This is because more than one source[12] may send information on the same occurrence. This shows that birdstrikes where one report has been sent, as a proportion of the total number for that year, has decreased from approximately 80 per cent (592 of 739) to 62 per cent in 2006 (761 of 1219). As a proportion of all reports within years, events involving two or three reports have risen. In other words, the number of times when multiple reports have been submitted for the same birdstrike event, has risen.

Table 2: Number of birdstrikes by number of reports per occurrence, 2002 to 2006

	2002	2003	2004	2005	2006	Total
One	592	631	808	938	761	**3730**
Two	127	155	220	230	295	**1027**
Three	19	30	46	80	162	**337**
Four	1	2	4	1	1	**9**
Total	**739**	**818**	**1078**	**1249**	**1219**	**5103**

10 Separate bird strike reports sent to the ATSB are recorded as one occurrence.

11 This includes accidents, serious incidents and incidents, and excludes confidential aviation incident reports (CAIR) and technical analysis occurrences.

12 Section 2.5 of the Transport Safety Investigation Regulations describes personnel who are considered as 'responsible persons' for reporting any reportable matter to the ATSB, including aircraft crew and operators, ATS, ground handing crew and aerodrome staff.

Table 3: Number of birdstrike reports by source, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Ground staff	185	288	422	553	614	**2,062**
ATS	239	257	329	424	439	**1,688**
Operator	102	219	334	372	519	**1,546**
Flight crew	364	265	297	269	258	**1,453**
Military	1	2	1	2	6	**12**
Government	0	1	0	0	0	**1**
Public	0	0	0	0	1	**1**
Not known	16	7	19	22	4	**68**
Total	**907**	**1,039**	**1402**	**1,642**	**1,839**	**6,831**

The number of birdstrike reports submitted to the ATSB by aerodrome ground staff has risen over the 2002 to 2006 period (Table 3). In 2002, 20 per cent (185 of 907)[13] of reports were submitted by aerodrome ground staff. In 2006, about 33 per cent (614 of 1839) of reports were submitted by aerodrome ground staff. A similar growth has been observed in aircraft operator reports. In 2002, around 11 per cent (185 of 907) of occurrence reports were submitted to the ATSB from this group, while in 2006, 28 per cent (519 of 1839) of occurrences were submitted by aircraft operators. Reports sent by flight crew decreased from 40 per cent (364 of 907) to 14 per cent (258 of 1839) over the reporting period.[14]

Table 4 shows the number of birdstrike reports submitted to the ATSB from the various sources for birdstrikes that occurred at major aerodromes, GAAP and regional aerodromes, and at other locations[15]. This shows that aerodrome ground staff reports account for about 30 per cent of reports submitted to the ATSB at all locations. Reports from GAAP aerodromes were more likely to originate from Air Traffic Services (ATS) (40%) and less likely from flight crew and/or operators (30%) compared to major aerodromes and regional aerodromes. The 'Other aerodromes' category had 66 per cent of reports coming from flight crew and/or operators as a result of minimal ATS involvement at those locations.

13 There are more reports than occurrences.

14 The three trends were statistically significant (p<0.001) using a chi-square test for the linear trend.

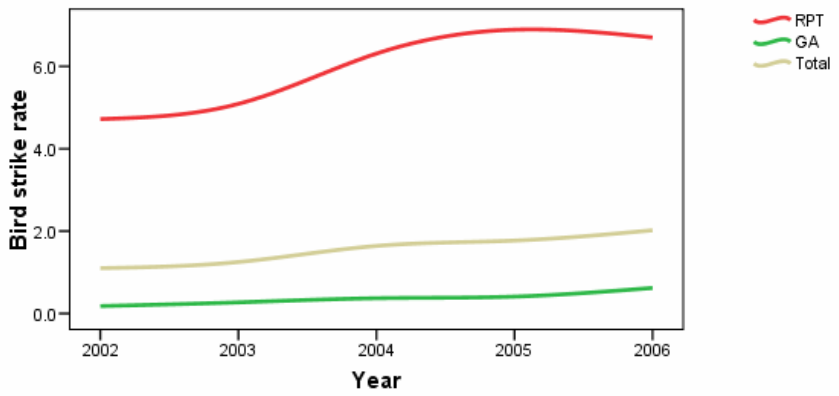
15 Includes aerodromes, authorised landing areas and unlicensed aerodromes located at mines, oil rigs, and on ships.

Table 4: Number of reports by sources, aggregated for 2002 to 2006

	Major aerodromes	GAAP aerodromes	Regional aerodromes	Other aerodromes	Total
Ground staff	1224	126	353	359	**2062**
ATS	1085	176	376	51	**1688**
Operator	1029	12	230	275	**1546**
Flight crew	537	121	220	575	**1453**
Military	1	0	8	3	**12**
Government	0	0	1	0	**1**
Public	0	0	0	1	**1**
Not known	36	4	12	16	**68**
Total	**3912**	**439**	**1200**	**1280**	**6831**

Figure 4 shows the Australian birdstrike rate between 2002 and 2006. This shows a small increase in the rate of birdstrikes from just over one per 10,000 aircraft movements to about two per 10,000 aircraft movements. Expressed as a relative risk, the increase from one to two birdstrikes per 10,000 movements represents a doubling of the birdstrike rate. However, the absolute risk increase is found by subtracting the number of birdstrikes per 10,000 movements in 2006 from those in 2002. The difference is one birdstrike per 10,000 movements. The absolute risk increase is therefore one birdstrike per 10,000 movements, which equates to a 0.01 per cent increase in birdstrike risk.

Figure 4: Australian birdstrike rate per 10,000 movements



To control for the confounding affects of aircraft movements on birdstrikes, Table 5 records the number of birdstrikes, aircraft movements, and rate of birdstrikes. This shows that aircraft movements have risen in the international and domestic sectors of the industry, but not in regional or general aviation (GA) [16]. The rate of

16 Regional aircraft movements are defined as those operations by airlines conducting Regular Public Transport (RPT) operations primarily servicing regional centres (Bureau of Transport and Regional Economics, 2006).

birdstrikes in RPT aircraft is significantly higher than in GA. The odds of an RPT aircraft having a birdstrike are 16:1[17] when compared with GA aircraft using relevant aircraft movements as a denominator. The higher rate of birdstrike in RPT operations compared to GA may be as a result of better reporting, aircraft speed and size, or a combination of these factors.

Table 5: Australian birdstrike rate by movement type, 2002 to 2006

		2002	2003	2004	2005	2006	Total
Number of birdstrikes	RPT	502	542	743	833	793	**3,413**
	GA	130	117	136	161	110	**654**
	Other	101	150	188	240	300	**979**
	Total	739	818	1,078	1,249	1,219	**5,103**
Movements (10,000)	International	10.6	10.9	13.0	13.4	13.1	**61.0**
	Domestic	44.4	47.6	55.7	58.1	57.6	**263.3**
	Regional	51.4	48.0	49.1	49.5	47.7	**245.6**
	GA	566.6	548.1	515.0	583.9	485.7	**2,699.3**
	Total	672.9	654.5	632.7	704.9	604.1	**3,269.2**
Birdstrike rate per 10,000 movements	RPT[18]	4.72	5.09	6.31	6.89	6.70	**5.99**
	GA	0.18	0.27	0.37	0.41	0.62	**0.36**
	Total	1.10	1.25	1.64	1.77	2.02	**1.56**

5.1.1 Discussion of reporting trends

It is likely that a number of factors have led to an increase in Australian birdstrike reports to the ATSB. Those factors include the establishment and operation of the Australian Animal Wildlife Hazard Group (AAWHG), changes in people and systems that submit reports to the ATSB, along with increases in aircraft movements.

Australian Animal Wildlife Hazard Group

The AAWHG was established in 2003. This group has consistently promoted birdstrike reporting and information dissemination through forums and regular meetings. A corresponding growth in the proportion of birdstrikes reported by aerodrome ground staff has been observed in this report. Aerodrome ground staff and aircraft operators are active members of the AAWHG.

Different sources of data

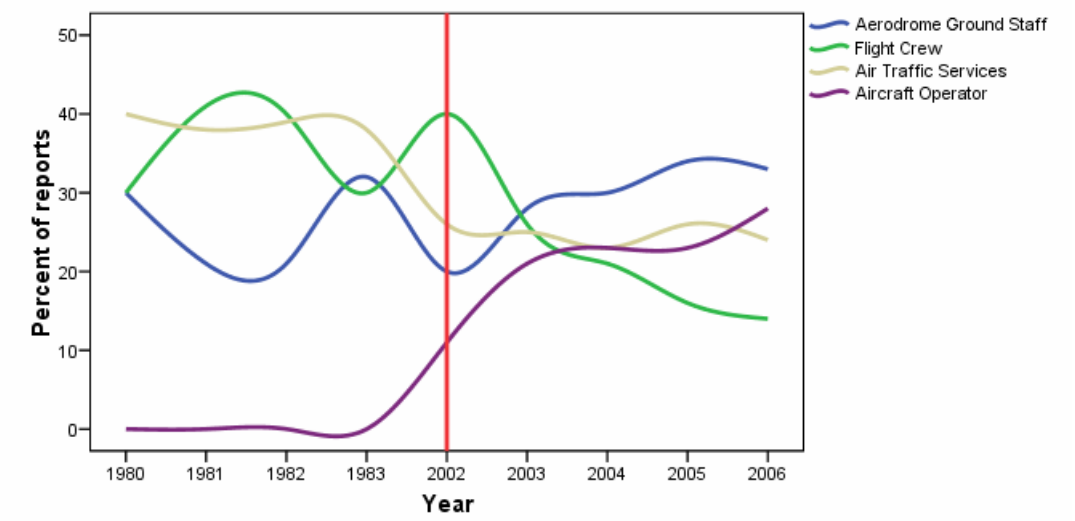
The decline in flight crew reports may be the result of flight crews no longer submitting reports to the ATSB directly, but rather via their company reporting system. Reports from ATS remained stable at about 25 per cent as a proportion of the total number within each year.

17 Confidence interval: 15.13<OR<17.47, p<0.001 (Mantel-Haenszel odds ratio).

18 Regular public transport combines international, domestic and regional movements.

The proportion of birdstrikes reported to the ATSB by pilots, ground staff and operators appears to have changed in the last 30 years. In 1980 and 1983, around 40 per cent of reports came from aerodrome ground staff, and in 1981, 50 per cent of reports came from pilots. In the earlier period between 1980 and 1983, birdstrike reporting appears to have been reliant upon individuals, rather than systems.

Figure 5: Per cent of birdstrike reports by source, 1980-1983 and 2002 to 2006



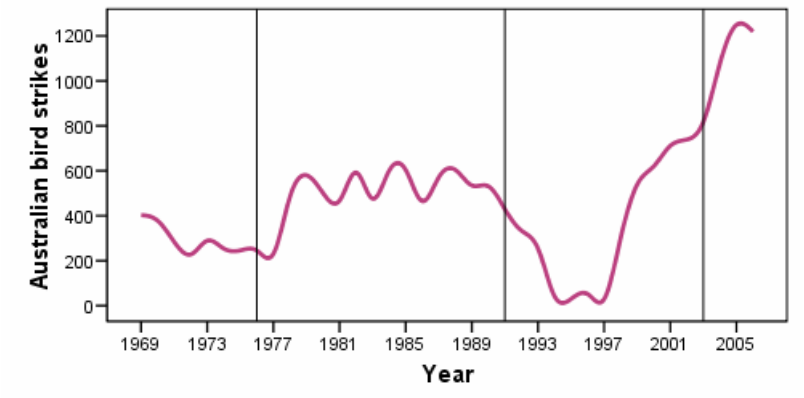
Sources of data for 1980 to 1983 were the Department of Aviation, Bird Hazard Investigation Unit Annual Reports.

A number of other influences may have led to an increase in reporting. These include the need of aerodrome operators and airlines to demonstrate commitment to quality and safety systems to their managers. Sending a report to the ATSB within the mandated reporting period may be used as evidence to senior managers of commitment to these processes.

5.1.2 Historical Australian reporting

To understand whether increases observed between 2002 and 2006 were atypical, or part of a broader trend of normal variability, birdstrike data held by the ATSB was examined back to 1969 (Figure 6). These data show significant reporting variability with changes based on perceptions of the importance of reporting, resources and legislation. The evidence for the increased reporting being responsible for the change in the number of birdstrikes recorded is likely, rather than a change in the actual number of birdstrikes.

Figure 6: Recorded Australian birdstrikes, 1969 to 2006



Note these data excluded overseas occurrences and non VH-registered Australian aircraft.

During the period when the Central Office on Bird Hazards and the Bird Hazard Investigation Unit operated, the number of reports increased. During the period 1993 to 1998, the then Bureau of Air Safety Investigation (BASI) only recorded strikes which resulted in damage in its electronic database. All other occurrences were filed, but not recorded. A count of all birdstrike reports for the period 1993 to 1998 showed that the total number fell as a result of the focus on occurrences causing damage.

A large study of bird hazards at Townsville aerodrome published by the Bird Hazard Investigation Unit (1990) found that the number of birdstrike reports doubled after an ornithologist campaigned to improve birdstrike reporting in 1978. This also raises the possibility that the number of recorded birdstrikes is influenced by reporting.

Damaging strikes and aircraft movements

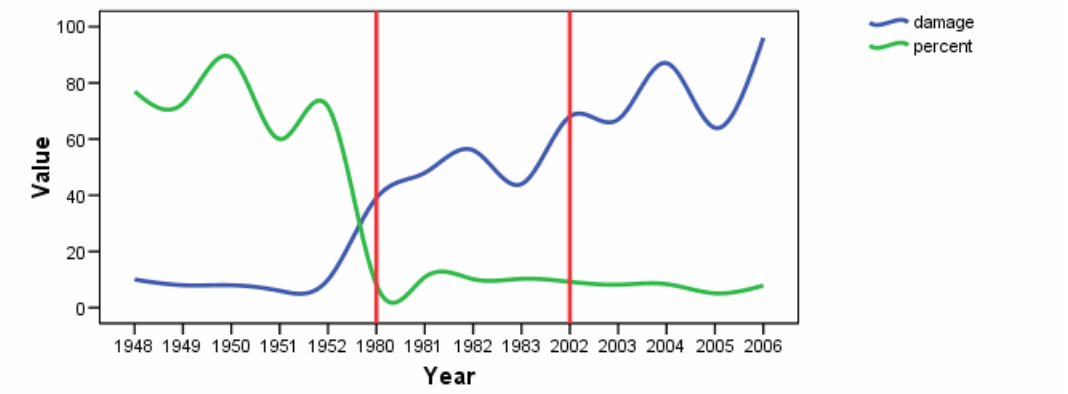
It could be expected that an increase in the number of birdstrikes will occur if there are more aircraft movements. There is some evidence that increases in aircraft movements are linked to the increase in reporting. The UK Civil Aviation Authority (2006) suggests that the two data sets should be examined in tandem; the proportion of serious to not serious occurrences, and aircraft movements. For ATSB birdstrike data, the marker of seriousness is aircraft damage. Therefore, an analysis of birdstrikes by damage reported is offered below.

Figure 7 records the number of damaging strikes recorded in Australia during three periods; 1948 to 1952, 1980 to 1983, and 2002 to 2006. The number of recorded birdstrikes during the period 1948 to 1952 was only small, but a high proportion of the occurrences resulted in damage. This may be due to airworthiness standards, and aircraft that, structurally, had less strength than modern aircraft. It is also possible that the threshold for reporting birdstrikes was limited largely to damaging strikes.

During the period 1980 to 1983, between eight and 10 per cent of birdstrikes resulted in damage. During the period 2002 to 2006, between seven and nine per cent of birdstrikes resulted in damage, as denoted by the green line in Figure 7. The number of damaging strikes, denoted by the blue line in Figure 7, has continued to rise, even though damaging strikes as a proportion of the total number of birdstrikes

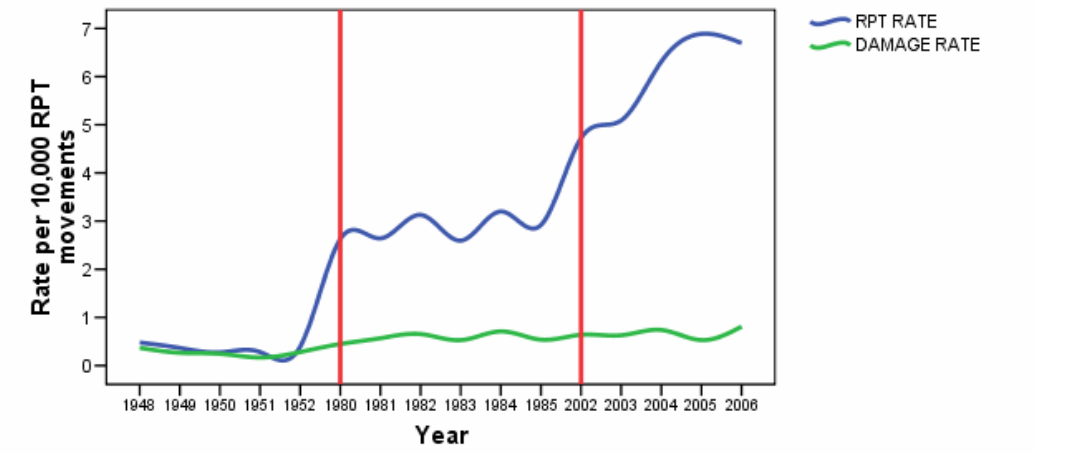
has remained roughly the same (green line).There was about 50 more damaging birdstrikes per year in 2006 compared with 1980.

Figure 7: Number of damaging birdstrikes, per cent of total reported birdstrikes resulting in damage by year, 1948-1952, 1980-1983,2002-2006[19]



The green line in Figure 8 shows that the rate of birdstrikes resulting in damage per aircraft movement has stayed roughly the same since around 1980. The total birdstrike rate, however, has been increasing since 2002 (blue line)[20]. This suggests that since 2002, there are more reports of non-damaging birdstrikes per aircraft movement than previously.

Figure 8: Rate of RPT birdstrikes and damaging birdstrikes per 10,000 movements, 1948-1952, 1980-1983, 2002-2006



The Transport Safety Investigation Act & Regulations

The TSI Act and regulations, which came into existence on 1 July 2003, explicitly required birdstrikes involving air transport operations to be notified to the ATSB. In

19 Vertical axis represents number of damaging birdstrikes (blue line) and damaging birdstrikes as a proportion of total birdstrikes. Data for earlier years was derived from Department of Civil Aviation (1953), Department of Aviation (1982, 1983, 1984, 1985).

20 Note that total aircraft movements data were not available for 1948-1952, and 1980-1983, therefore RPT movements are used as a proxy measure.

addition, all birdstrikes leading to a fatality or serious injury, regardless of aircraft operation type, are required to be notified to the ATSB. Birdstrikes involving aircraft operations other than air transport must only be sent to the ATSB where the event occurs at a licensed aerodrome. At least 66 per cent (3413 of 5103) of birdstrikes in this report come from air transport operations.

The effect of the TSI Act & Regulations cannot be discounted as an influence on reporting, but the evidence is indeterminate. Under the old Air Navigation Regulations (ANR), Parts 270 and 274, and subsequently Part 2A of the Air Navigation Act (ANA), the decision to report was based on the perception of safety risk. Perceptions of safety risk are somewhat subjective and open to interpretation (Standards Australia, 2004), and a birdstrike was not explicitly spelt out as a safety risk in the way that the TSI Act and Regulations prescribes the need to report; for example, bird or animal strike, is explicitly included in the reportable matters list, along with events such as runway incursions, ground proximity warnings and many other events.

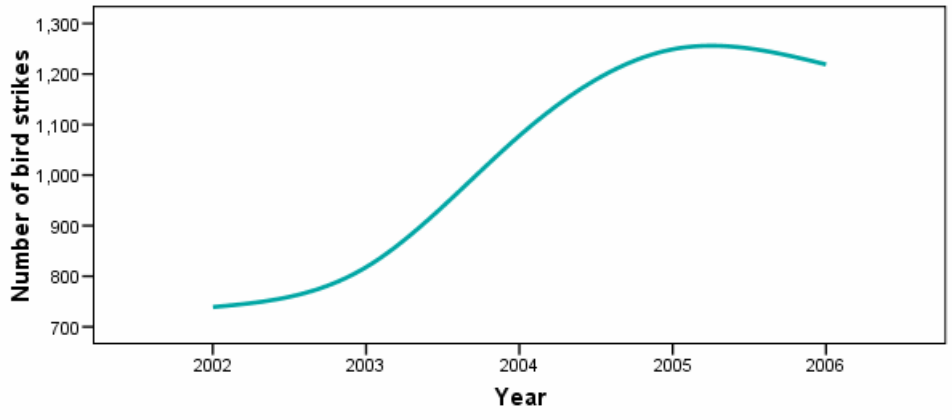
Although the TSI Act has wider powers than the former ANA had, it is difficult to draw a definitive link between greater powers and incident reporting. The evidence for the TSI Act and Regulations being responsible for the increase in reporting is indeterminate.

5.2 Temporal Factors

5.2.1 Year

Between 2002 and 2006, 5,103 birdstrike occurrences were reported to the ATSB. Over this period, the number of birdstrikes increased from 739 occurrences in 2002 to 1,219 in 2006, an increase of 65 per cent (Figure 9). The highest number of occurrences was 1,249 in 2005.

Figure 9: Number of Australian birdstrikes, 2002 to 2006

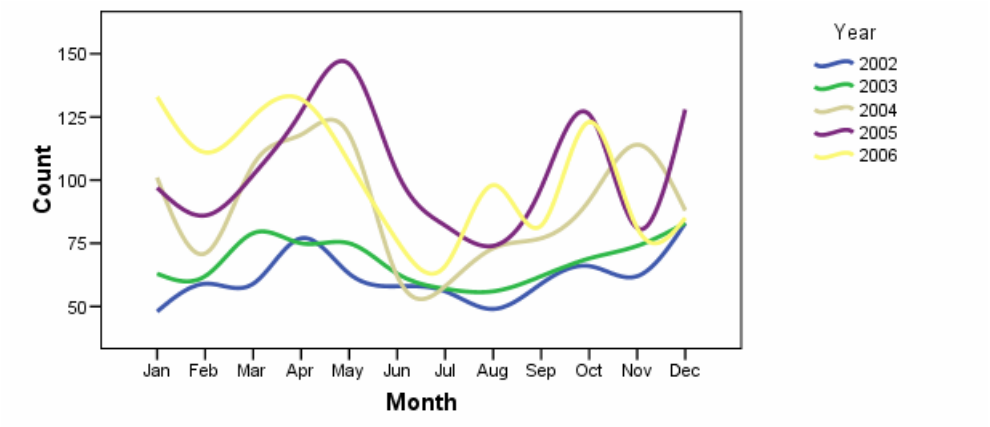


The ATSB investigated one birdstrike occurrence during this time period. In 2006, during the takeoff from Melbourne Airport, the crew of a Boeing Co 767-338 aircraft, registered VH-OGJ, noticed a large flock of birds (estimated between 20 and 50 birds) converging with the aircraft's flight path. With no evasive manoeuvre available to the crew, the aircraft encountered the flock and sustained multiple strikes on many parts of the aircraft (ATSB, 2007).

5.2.2 Month

The distribution of reported birdstrikes by month and year is roughly bimodal with peaks in March, April and May and then in the months, October, November, December and January (Figure 10). For 2002, 2003 and 2004, the basic bimodal pattern applies, even though a smaller number of occurrences were reported to the ATSB. The same scale (y or vertical axis scale) is used for all figures, and this has the effect of smoothing years with less reported occurrences. The distributions for 2002, 2005, and 2006 appear to peak slightly earlier in October then fall away in November, with a subsequent rise in December.

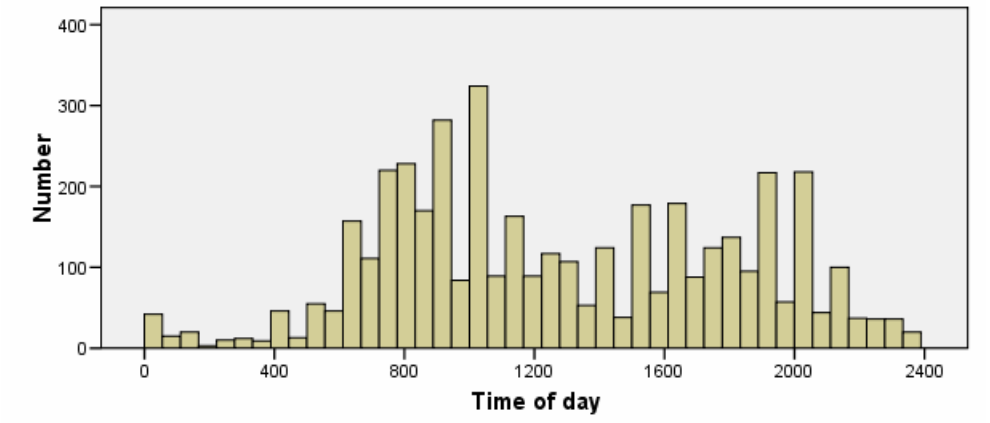
Figure 10: Australian birdstrikes by month, 2002 to 2006



5.2.3 Time of day

The relationship between birdstrikes and time of day is recorded in Figure 11. This shows that birdstrikes occurred most frequently during the busiest times of aircraft operation. The busiest times are between 06:00 and 10:00 in the morning and 15:00 and 21:00 in the afternoon and evening. About 16 per cent of occurrences did not record the time of birdstrikes. There were two different types of unknown time of strike; either the time was not known (568 of 5,103), or the time when the bird carcass was found was recorded, but not the time of the birdstrike (274 of 5,103). These were excluded from the time analysis.

Figure 11: Number of birdstrikes by time of day (N=4,261)



5.3 Operational factors

5.3.1 Type of operation

Table 6 and Table 7 record birdstrikes by the type of operation and year. RPT operations accounted for approximately two-thirds of birdstrikes recorded between 2002 and 2006. The number of GA birdstrikes has decreased with time, while the number of birdstrikes on other aircraft (including when the aircraft struck was unknown), has risen.

Table 6: Number of birdstrikes by type of operation, 2002 to 2006

	2002	2003	2004	2005	2006	Total
RPT	502	542	743	833	793	**3,413**
GA	132	117	136	161	110	**656**
Other[21]	99	150	188	240	300	**977**
Military	6	9	11	15	16	**57**
Total	**739**	**818**	**1,078**	**1,249**	**1,219**	**5,103**

Table 7: Per cent of birdstrikes by type of operation, 2002 to 2006

	2002	2003	2004	2005	2006	Total
RPT	67.9	66.3	68.9	66.7	65.1	**66.9**
GA	17.9	14.3	12.6	12.9	9.0	**12.9**
Other[21]	13.4	18.3	17.4	19.2	24.6	**19.1**
Military	0.8	1.1	1.0	1.2	1.3	**1.1**
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Some preliminary evidence by the Federal Aviation Administration (1991) indicates that gulls and pigeons do not recognise the threat of an oncoming aircraft until the aircraft is around 1,000 ft from where the bird is positioned. If an aircraft is half way through the take-off run, a bird then has up to five seconds to take action before being struck. If the aircraft is larger and/or faster, this may allow less time for a bird to avoid a collision. This may help explain why the majority of birdstrikes involved larger RPT aircraft rather than smaller and slower GA aircraft. Quieter aircraft may also present a problem for birds (Chilvers et al., 1997).

Smaller aircraft in this report are more susceptible to damage affecting flight controls, but the numbers are too small for statistical analyses. With the advent of even bigger aircraft, such as the Airbus A380, it will be interesting to see if the size of the aircraft enables birds to see aircraft sooner and take avoiding action. It is

21 This category is unknown aircraft. In around 270 of 977 occurrences, the type of aircraft was known, and the place of occurrence was generally at a GAAP or regional aerodrome. It is likely that these were some type of general aviation birdstrikes, but this could not be determined with certainty.

possible that the bigger surface area of aircraft will mean that it will strike more birds than smaller aircraft.

5.3.2 Phase of flight

Birdstrikes by phase of flight and year is recorded in Table 8 and Table 9. As expected, relatively few birdstrikes occur while the aircraft is stationary (standing) or taxiing. The largest number of birdstrikes occurred during the landing and take-off phases of flight, accounting for two-thirds of strikes over the five-year period. About 15 per cent of birdstrikes occurred during an unknown phase of flight, while around three per cent occurred during the cruise or when manoeuvring.

Table 8: Number of birdstrikes by phase of flight, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Standing	1	2	1	0	2	**6**
Taxiing	9	8	9	7	14	**47**
Takeoff	248	237	331	373	371	**1,560**
En route	24	19	20	28	17	**108**
Manoeuvring	4	4	9	6	5	**28**
Approach	131	115	156	174	158	**734**
Landing	237	317	393	449	466	**1,862**
Not known	85	116	159	212	186	**758**
Total	**739**	**818**	**1,078**	**1,249**	**1,219**	**5,103**

Table 9: Per cent of birdstrikes by phase of flight, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Standing	0.1	0.2	0.1	0.0	0.2	**0.1**
Taxiing	1.2	1.0	0.8	0.6	1.1	**0.9**
Takeoff	33.6	29.0	30.7	29.9	30.4	**30.6**
En route	3.2	2.3	1.9	2.2	1.4	**2.1**
Manoeuvring	0.5	0.5	0.8	0.5	0.4	**0.5**
Approach	17.7	14.1	14.5	13.9	13.0	**14.4**
Landing	32.1	38.8	36.5	35.9	38.2	**36.5**
Not known	11.5	14.2	14.7	17.0	15.3	**14.9**
Total	**100**	**100**	**100**	**100**	**100**	**100**

5.3.3 Effect on flight

In around four per cent of occurrences, pilots elected to perform a precautionary landing following a birdstrike. In most circumstances, this was a return to the departure point, but in a few circumstances, pilots diverted to a nearby landing area.

Table 10 shows that there were also eight engine shutdowns between 2002 and 2006, and two occurrences leading to loss of control, both of which were related to helicopters as follows:

- On 9 February, 2005, a Schweizer 269C-1[22], registered VH-WPF, was manoeuvring at an altitude of approximately 100 ft, about 60 nm from Charters Towers, Qld, performing cattle mustering operations. An eagle struck the tail rotor. This led to a loss of control, contact with trees and the helicopter rolled onto its left side. The pilot received minor injuries.
- On 7 August, 2005, a Robinson R22, registered VH-JDR, was operating at an altitude of 1,000 ft on a survey flight, near Adelaide River, NT. The pilot heard a loud bang, followed by increasing vibration and a loss of main rotor power. The pilot immediately initiated an autorotative descent, during which, control of the helicopter was lost, and it rolled onto its side. There was evidence of a large birdstrike on the tail rotor. Damage to the tail rotor gearbox mountings and dislodgement of the clutch wheel drive belts was noted, but there was no indication of pre-existing mechanical failure within the clutch and main rotor drive assembly. There were no reported injuries.

The data in Table 10 also shows that the vast majority of occurrences did not result in any effect on flight. These data do not take into account the effect upon operations such as delayed flights and the need for precautionary engineering inspections.

Table 10: Number of birdstrikes by effect on flight, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Precautionary landing	27	36	43	47	46	**199**
Rejected takeoff	22	21	22	21	38	**124**
Engine shutdown	0	4	2	1	1	**8**
Loss of control	0	0	0	2	0	**2**
Other[23]	1	0	0	1	1	**3**
None	629	672	918	1,057	1,048	**4,324**
Not known	60	85	93	120	85	**443**
Total	**739**	**818**	**1,078**	**1,249**	**1,219**	**5,103**

In most circumstances, flight disruption results from the actions of the flight crew in response to a potential rather than an actual threat. In larger RPT aircraft, flights usually continue to their intended destination despite striking a bird. Unless there is immediate evidence of damage, pilots do not generally return to the point of departure.

22 Also known as a Schweizer 300CBI.

23 The aircraft in these occurrences had not yet left the ground, but were returned for engineering inspection.

5.3.4 Aircraft damage

Table 11 records the frequency of aircraft damage by year and Table 12 records the per cent of occurrences involving damage by year. The latter shows that occurrences resulting in nil damage have dropped as a proportion of the total number of strikes in each year, by about 15 per cent. It also shows that occurrences where damage is unknown have risen from around seven per cent in 2002 to about 25 per cent in 2006.

Table 11: Number of birdstrikes by damage to aircraft, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Nil damage	617	607	828	896	831	**3,779**
Damaged	68	67	87	65	96	**383**
Not known	54	144	163	288	292	**941**
Total[24]	**739**	**818**	**1,078**	**1,249**	**1,219**	**5,103**

Table 12: Per cent of birdstrikes resulting in damage to aircraft, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Nil damage	83.5	74.2	76.8	71.7	68.2	74.1
Damaged	9.2	8.2	8.1	5.2	7.9	7.5
Not known	7.3	17.6	15.1	23.1	23.1	18.4
Total	**100**	**100**	**100**	**100**	**100**	**100**

Aircraft part struck and damaged

Table 13 records aircraft part struck and damaged. The most common part struck was the aircraft wing, accounting for 23 per cent (606 of 2693) of known parts struck. Of this, a quarter of occurrences resulted in damage. This was followed by the aircraft engine and fuselage, which accounted for 17 per cent and 15 per cent respectively. A large number of reports submitted to the ATSB indicated that the aircraft parts struck and damaged were not reported.

Generally, birdstrikes to the fuselage, landing gear, nose, propellers and windshield are associated with a lower per cent of damage, while strikes to empennage, engines, tail rotors and wings have a higher per cent of damage.

The proportion of occurrences where the part struck or damaged is not recorded is noteworthy. This occurs when an occurrence report does not include enough information about the event. The following example illustrates the level of information provided in about 50 per cent of birdstrike occurrence reports.

> Bird strikes on final runway [X], might have been a plover. ATC informed.

In some cases, a report will state that damage occurred, but not indicate the part that was damaged.

24 In some cases, more than one part was damaged among the 5,103 occurrences.

Table 13: Number of parts struck and damaged, 2002 to 2006

		2002	2003	2004	2005	2006	Total
Wing	Struck	87	62	111	120	205	**585**
	Damaged	25	20	31	22	44	**142**
Engine	Struck	63	61	108	100	123	**455**
	Damaged	13	15	29	16	24	**97**
Fuselage	Struck	102	51	73	80	92	**398**
	Damaged	1	8	6	3	5	**23**
Nose	Struck	52	56	72	71	95	**346**
	Damaged	4	6	9	6	4	**29**
Propeller	Struck	39	49	51	61	99	**299**
	Damaged	1	4	4	4	6	**19**
Windshield	Struck	55	45	51	65	82	**298**
	Damaged	11	4	3	7	8	**33**
Landing Gear	Struck	36	47	53	38	70	**244**
	Damaged	6	9	3	3	3	**24**
Empennage	Struck	5	3	2	7	7	**24**
	Damaged	2	1	2	3	7	**15**
Helicopter trans	Struck	0	0	0	1	0	**1**
	Damaged	0	0	0	0	0	**0**
Rotor	Struck	4	4	4	3	6	**21**
	Damaged	1	0	1	0	2	**4**
Tail Rotor	Struck	0	0	1	2	0	**3**
	Damaged	0	0	1	2	0	**3**
Other	Struck	10	0	5	1	3	**19**
	Damaged	3	0	2	0	1	**6**
Total	**Struck**	**453**	**378**	**531**	**549**	**782**	**2,693**
	Damaged[25]	**67**	**67**	**91**	**66**	**105**	**396**

5.3.5 Engine ingestion

Engine ingestion represents one of the most potentially serious outcomes associated with birdstrikes. As such, it is analysed in some detail in the following tables.

There were 296 occurrences involving engine ingestion (Table 14). The number occurring in each year is relatively small. Engine damage was recorded in 28 per

25 This number does not equal the total number damaged of 383 as some parts damaged were unknown, or multiple parts of an aircraft were damaged.

cent of cases. The majority of engine ingestions occurred to Boeing Co 737 aircraft (data not shown in the tables).

Table 14: Number of engine ingestions by damage, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Damage	8	15	27	13	19	**82**
Nil damage	30	27	38	45	38	**178**
Not known	3	4	5	9	15	**36**
Total	**41**	**46**	**70**	**67**	**72**	**296**

Data on the number of engines ingesting a bird are shown in Table 15. This shows that the ingestion of birds into two engines in the one event occurs at least once a year. This is a relatively rare event. No three or four engine ingestions have been submitted to the ATSB during the period 2002 to 2006.

Table 15: Engine ingestion by number of engines, 2002 to 2006

Number of engines	2002	2003	2004	2005	2006	Total
1	40	45	68	66	69	**288**
2	1	1	2	1	3	**8**
Total	**41**	**46**	**70**	**67**	**72**	**296**

A breakdown of damage by the number of engines ingested is shown in Table 16 and Table 17. Engine ingestion involved helicopters, turbo-prop and turbofan aircraft. The vast majority of ingestions occurred in twin-engine turbofan aircraft. Data presented in Table 16 mostly involve aircraft with more than one engine. Some of these occurrences involved four-engined aircraft such as the British Aerospace BAe 146. Around 27 per cent of single-engine ingestions involved some type of damage. This damage is difficult to categorise, but usually involved damage to fan blades that resulted in vibrations or some sort of degradation in engine performance.

Table 16: Number of bird ingestions involving only one engine by damage, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Damage	8	15	24	13	17	**77**
Nil damage	29	27	39	44	37	**176**
Not known	3	3	5	9	15	**35**
Total	**40**	**46**	**68**	**66**	**69**	**288**

Table 17: Number of bird ingestions involving two engines by damage, 2002 to 2006

	2002	2003	2004	2005	2006	**Total**
Damage	0	0	2	0	2	**4**
Nil damage	1	0	0	1	1	**3**
Not known	0	1	0	0	0	**1**
Total	**1**	**1**	**2**	**1**	**3**	**8**

A breakdown of two-engine ingestions (Table 18) shows that they involved RPT aircraft at a variety of locations across Australia, at different times of the day, involving different aircraft models, and during different months. In four of the eight occurrences, damage occurred. According to data reported to the ATSB, Galahs were responsible for three of the two-engine ingestions, while Martin (Swallow) or Gull were the species responsible for other ingestion events.

Table 18: Two-engine bird ingestions details, 2002 to 2006

Year	Damage	Location	Month	Model	Birds	Species
2002	No	Leinster	March	BAe 146	5	Galah
2003	Not known	Sydney	July	Boeing 737	3	Gull
2004	Yes	Adelaide	January	Boeing 737	2	Galah
2004	Yes	Burketown	November	Fairchild SA227	2	Not known
2005	No	Perth	February	Airbus A330	2	Not known
2006	No	Gold Coast	March	Airbus A320	3	Martin
2006	Yes	Adelaide	September	Boeing 737	4	Galah
2006	Yes	Melbourne	October	Boeing 767	8	Corella

These data show that engine ingestion is a relatively rare event. It is a low frequency, potentially high consequence problem. About 26 per cent (77 of 288) single-engine ingestions resulted in damage. Of the two-engine ingestion occurrences, damage occurred in four of eight events.

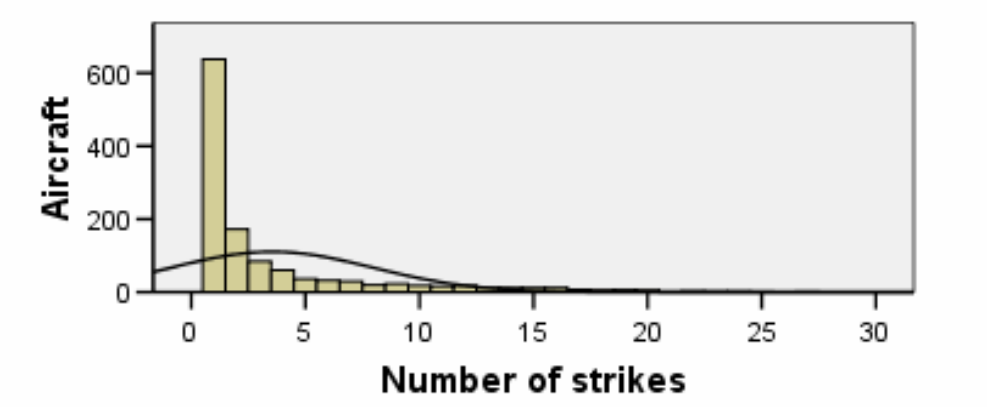
Approximately 60 per cent (169 of 296) of engine ingestions took place during approach and landing. This suggests that aircraft have greater exposure to the risk of birdstrikes resulting in engine ingestion during the approach and landing phases than during other phases of flight. Thirty per cent (30%) of ingestions take place during the take-off run.

Where an ingestion event does not result in an accident and the aircraft lands safely, a number of interesting questions can be raised as to whether the actions of pilots increase the risk associated with engine ingestion. Those actions have been the subject of a recent ATSB Investigation Report (Australian Transport Safety Bureau, 2007) involving two-engine ingestion. The investigation report provides some insight into the proportion of pilots who take active measures to clarify the extent of damage including carrying out precautionary landings or aborted takeoffs.

5.3.6 Number of aircraft at risk

It is important to understand that the 5,103 birdstrikes between 2002 and 2006 did not involve 5,103 aircraft. In 771 of 5,103 (15 per cent) occurrences, the registration of the aircraft was unknown. In the remaining 4,332 occurrences, 1,227 different aircraft were struck, that is, separate registrations. Of these 1,227 aircraft, 638 were struck on at least one occasion, while the remaining 588 were struck on more than one occasion. There were 133 aircraft that were struck on 10 or more different occasions over the period 2002 to 2006, while 14 aircraft were struck on 20 or more occasions. This distribution is skewed to the right (positively skewed), (Figure 12). One fact not comprehensively accounted for in these data is the change of aircraft registration over time. It is possible that a slightly larger number of aircraft were at risk of birdstrikes over the five-year period.

Figure 12: Number of birdstrikes per aircraft, 2002 to 2006



5.4 Injuries

Of the 5,103 birdstrike occurrences between 2002 and 2006, three resulted in injuries to the pilot. All injuries sustained were minor.

Occurrence 1

The pilot of an Aero Commander 500-S reported to air traffic control that the aircraft had struck a bird when 2 nautical miles from touchdown. The aircraft sustained a broken windscreen and the pilot received minor injuries. The type of bird and bird size was unknown.

Occurrence 2

While conducting cattle mustering operations, the tail rotor of the Schweizer 269CB helicopter struck an eagle. The pilot lost control and the helicopter crashed into a heavily wooded area. The pilot received minor injuries and the helicopter was substantially damaged.[26]

26 Refer to paragraph number 5.3.3 for more details.

Occurrence 3

During the climb, a Robinson R22 helicopter struck a bush turkey, which 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.

5.5 Location

Birdstrikes by major aerodromes, General Aviation Airport Procedures (GAAP) aerodromes and regional aerodromes, is found in the following section. A detailed analysis of all individual major aerodromes and GAAP aerodromes is provided in the appendices. There was considerable variation between birdstrike rates at the various aerodromes. However, although the number of birdstrikes at a location informs industry to a degree about how well it is controlling birds, location-specific bird populations and bird behaviours also significantly contribute to the number of birdstrikes at any location.

Birdstrikes occur at, or near aerodromes, as well as during aircraft cruise or manoeuvring. This report does not provide an analysis of cruise occurrences. Rather, birdstrikes are stratified according to aerodrome and near-aerodrome occurrences (Table 19). This enables aerodromes operators to clearly delineate occurrences directly within their scope of control. The near-aerodrome perspective provides aircraft operators with detail to encourage control of birds outside the direct area of the aerodrome.

It is worth noting that for some aerodromes, the proportion of damaging occurrences near aerodromes can be almost as great as those occurring on the aerodrome. The analysis of aerodrome birdstrikes uses aircraft movements as a denominator to produce a rate per 10,000 movements. No such data are readily available for near-aerodrome birdstrikes, so only the number of birdstrikes is reported. Around 80 per cent of birdstrikes occur at an aerodrome, and 14 per cent occur near an aerodrome (Table 19).

Table 19: Location of birdstrikes, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Aerodrome	567	668	867	1,020	1,010	**4,132**
Near aerodrome	125	106	147	166	154	**698**
En route	34	32	38	42	26	**172**
Not known	13	12	26	21	29	**101**
Total	**739**	**818**	**1,039**	**1,249**	**1,219**	**5,103**

Note that analyses are tabled for major, GAAP and regional aerodromes. Birdstrikes occurred at a wide variety of aerodromes, authorised landing areas (ALA) and unlicensed aerodromes. This included birdstrikes at mines, oil rigs, and on ships. It is beyond the scope of this report to table and comment on all of those strikes.

Table 20 shows the rate of birdstrikes at major aerodromes around Australia. The first observation to be made is that there is significant variation between years at each of those aerodromes. Secondly, these aerodromes may not be directly

comparable for a range of reasons. The rate of birdstrike reporting may represent a number of different variables; these include a positive reporting culture, changes to information technology systems, or a change in birdstrike risk at the relevant aerodrome.

Table 20: Birdstrike rate per 10,000 total movements, major aerodromes

	2002	2003	2004	2005	2006	Total
Darwin	8.41	8.19	11.59	13.47	7.92	**9.90**
Hobart	7.98	5.62	3.26	8.56	9.16	**6.93**
Cairns	2.74	4.38	5.40	7.11	3.95	**4.70**
Adelaide	2.89	3.54	5.71	5.70	5.10	**4.60**
Brisbane	3.83	4.43	3.91	4.01	3.94	**4.02**
Perth	1.52	3.29	4.35	3.64	4.11	**3.41**
Melbourne	2.05	1.89	3.08	3.21	3.67	**2.83**
Gold Coast	2.07	3.54	1.70	3.73	3.53	**2.80**
Canberra	1.04	0.57	2.18	3.88	5.25	**2.54**
Sydney	1.54	2.32	2.92	2.73	2.50	**2.43**

Table 21 records birdstrikes at GAAP aerodromes. This table shows that the birdstrike rate at GAAP aerodromes is less than the rate at major aerodromes in general. In addition, the GAAP aerodromes in each capital city all have a lower birdstrike rate than the major aerodromes in the same city. Table 22 shows that the birdstrike rate at regional aerodromes is more similar to that of major aerodromes.

Table 21: Birdstrike rate per 10,000 total movements, GAAP aerodromes

	2002	2003	2004	2005	2006	Total
Parafield	1.18	1.09	1.37	1.35	0.71	**1.12**
Jandakot	0.73	0.46	0.66	0.40	0.68	**0.59**
Moorabbin	0.27	0.29	0.43	0.45	0.21	**0.34**
Bankstown	0.23	0.43	0.21	0.25	0.15	**0.26**
Archerfield	0.00	0.07	0.16	0.28	0.30	**0.17**
Camden	0.32	0.00	0.00	0.00	0.43	**0.16**

Table 22: Birdstrike rate per 10,000 total movements, regional aerodromes

	2002	2003	2004	2005	2006	Total
Rockhampton	3.43	10.44	7.36	6.98	8.01	**7.25**
Alice Springs	8.96	3.84	4.49	5.22	5.55	**5.65**
Townsville	2.39	3.04	7.03	6.44	4.63	**4.60**
Mackay	2.95	2.11	7.08	4.32	3.12	**3.99**
Broome[27]	1.80	3.74	2.58	6.94	3.24	**3.69**
Hamilton Island	1.27	1.40	3.70	5.57	6.02	**3.62**
Williamtown[28]	1.79	1.83	0.88	2.00	9.68	**3.60**
Avalon[29]	1.19	1.00	0.89	7.79	3.22	**3.31**
Launceston	3.65	0.55	4.18	4.70	1.95	**3.01**
Coffs Harbour	0.27	2.29	1.51	3.87	4.23	**2.28**
Albury	1.01	0.32	2.83	3.32	3.04	**2.10**
Tamworth	1.27	2.15	1.08	0.88	1.66	**1.39**
Essendon	0.73	0.47	0.84	1.19	2.03	**1.03**

5.6 Environmental factors

5.6.1 Bird size

Table 23 shows the distribution of birdstrikes by bird size and year. Large and medium-sized birds are more frequently struck, but in a significant number of occurrences the bird size was unknown.

27 Data are estimated based on figures from Emery (2003) and Civil Aviation Safety Authority (2006). Linear interpolation is used to generate unknown values. Data were requested from Broome Airport in 2008 but not received.

28 Data were RPT movements into Williamtown (Newcastle Airport Limited, 2007). RPT movements account for approximately 20 per cent of movements (Australia, Senate 2002), and the remainder are military aircraft movements. All birdstrikes in this dataset occurred to VH-registered RPT aircraft.

29 Data are based on estimates provided by the Civil Aviation Safety Authority (2008).

Table 23: Number of birdstrikes by size, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Very large	6	7	6	11	8	**38**
Large	145	193	259	282	286	**1,165**
Medium	171	192	241	262	318	**1,184**
Small	61	116	126	149	142	**594**
Very small	4	11	12	15	17	**59**
Not known	355	301	438	535	452	**2,081**
Total	**742**	**820**	**1,082**	**1,254**	**1,223**	**5,121**[30]

5.6.2 Species

Table 24 records the number of bird species reported to the ATSB. This report shows that roughly 120 different bird and bat species have been struck by aircraft[31] in Australia during the period 2002 to 2006 at a variety of locations around Australia.

There were 5,121 records for 5,103 occurrences of birdstrikes. In a few instances, more than one species of bird was struck. Over the period 2002 to 2006, approximately 60 per cent of birdstrike reports sent to the ATSB contained bird species data. This increased from about 47 per cent in 2002 to 63 per cent in 2006. The increase in the proportion of reports sent to the ATSB with species data is statistically significant.[32]

Table 24: Number of birdstrike occurrences with bird species reported, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Species reported	389	523	647	721	774	**3,054**
Species not reported	353	297	435	533	449	**2,067**
Total	**742**	**820**	**1,082**	**1,254**	**1,223**	**5,121**

5.6.3 Bird size by species

It is worth noting that some bird families have a wide variety of bird sizes. Where the species is known, birds have been categorised according to their usual size. The ATSB occurrence reporting form gives an opportunity for those reporting a strike to record the bird size, even if they are unsure of the species. Initial analysis of this data showed wide variation in the sizes stated for the same types of birds. Therefore, the size of the bird was determined using names and sizes supplied by

30 In some cases, more than one bird species was involved in an occurrence.

31 There is no clear relationship between the number of birds and bats on an aerodrome, and the number struck (Pell & Jones, 2002; National Archives of Australia: Federal Airports Corporation, 1992)

32 Chi-square for linear trend 7.979, $p<0.01$.

the CSIRO. Bird, bat and flying-fox size is relative measurement, not an absolute measurement. For example birds with long tail feathers may not necessarily be heavier than

The following size range[33] was used to categorise common name bird families into sizes:

- very small: less than or equal to 15 cm;
- small: 15.1 to 25.0 cm;
- medium: 25.1 to 39.9 cm;
- large: 40 to 79.9 cm;
- very large: greater than or equal to 80 cm.

Data sent to the ATSB is often recorded at the common name family level. Table 25 shows the number of very large birds struck by aircraft across Australia by year. The number of birds in each family category is relatively small. The largest number of strikes for large birds was recorded in 2005.

Table 25: Number of birdstrikes for very large birds by common family name, 2002 to 2006

Family	2002	2003	2004	2005	2006	Total
Kites, Goshawks, Eagles, Harriers	2	1	2	2	2	**9**
Herons, Egrets, Bitterns	2	2	0	4	0	**8**
Pelicans, Shoebills	1	2	2	1	1	**7**
Cranes	0	0	2	3	1	**6**
Geese, Swans, Ducks	1	2	0	0	1	**4**
Bustards	0	0	0	0	2	**2**
Cassowaries and Emus	0	0	0	1	0	**1**
Frigatebirds	0	0	0	0	1	**1**
Total	**6**	**7**	**6**	**11**	**8**	**38**

33 Approximate body size.

Table 26 records the number of large birds by common family name and year. This shows that of the large birds, 37 per cent of the strikes involved kites, goshawks, eagles or harriers, 22 per cent were from the raven, crow, jay and magpie family and 14 per cent were from the gull, tern, skua and jaeger family. Curlews, ibises and spoonbills make up the next most frequently struck birds.

Table 26: Number of birdstrikes for large birds by common family name, 2002 to 2006

Family	2002	2003	2004	2005	2006	Total
Kites, Goshawks, Eagles, Harriers	58	67	79	103	123	**430**
Ravens, Crows, Jays and Magpies	31	40	70	53	59	**253**
Gulls, Terns, Skuas, Jaegers	19	35	34	46	27	**161**
Curlews	6	10	19	36	25	**96**
Geese, Swans, Ducks	10	11	17	17	15	**70**
Ibises, Spoonbills	4	10	15	13	10	**52**
Parrots and Cockatoos	8	4	7	6	7	**32**
Falcons	1	9	6	3	2	**21**
Herons, Egrets, Bitterns	3	0	4	2	8	**17**
Mound-builders	2	1	3	1	5	**12**
Cormorants and Shags	1	0	3	1	2	**7**
Rails, Crakes, Swamphens, Coots	1	4	0	0	2	**7**
Kingfishers, Kookaburras	0	1	1	0	1	**3**
Lapwings, Plovers, Dotterels	0	1	1	1	0	**3**
Barn and Grass Owls	1	0	0	0	0	**1**
Total	**145**	**193**	**259**	**282**	**286**	**1,165**

Table 27 records the number of medium-sized birds by common family name and year. This shows that lapwings, plovers and dotterels are most frequently struck, followed by parrots and cockatoos, then falcons. The proportion of parrots and cockatoos reported as striking aircraft each year has increased over time.

Table 27: Number of birdstrikes for medium birds and bats by common family name, 2002 to 2006

Family	2002	2003	2004	2005	2006	Total
Lapwings, Plovers, Dotterels	56	40	66	67	85	**314**
Parrots and Cockatoos	32	46	56	66	87	**287**
Falcons	30	33	37	30	58	**188**
Flying-Fox	21	35	29	16	30	**131**
Ravens, Crows, Jays and Magpies	8	11	26	51	18	**114**
Pigeons, Doves	10	9	15	16	19	**69**
Typical Owls	6	7	10	10	9	**42**
Gulls, Terns, Skuas, Jaegers	4	6	0	1	1	**12**
Curlews	1	3	0	1	4	**9**
Barn and Grass Owls	0	1	1	1	3	**6**
Kites, Goshawks, Eagles, Harriers	2	0	0	3	1	**6**
Flycatchers, True Thrushes	1	1	0	0	2	**4**
Kingfishers, Kookaburras	0	0	1	0	1	**2**
Total	**171**	**192**	**241**	**262**	**318**	**1,184**

Table 28 shows that swallows, martins, finches and bat species are the most frequently struck among small and very small birds.

Table 28: Number of birdstrikes for small and very small birds by common family name, 2002 to 2006

Family	2002	2003	2004	2005	2006	Total
Swallows, Martins	14	31	34	35	41	**155**
Microbats[34]	13	38	24	34	24	**133**
Passerine Finches	18	21	25	35	33	**132**
Pratincoles and Coursers	10	11	27	33	17	**98**
Starlings, Mynas	5	8	4	5	12	**34**
True Finches and Allies	1	2	2	8	8	**21**
Old World Larks	0	5	3	3	6	**17**
Lapwings, Plovers, Dotterels	0	3	5	3	5	**16**
Typical Swifts	1	1	4	4	5	**15**
Curlews, Sandpipers, Snipes, Godwits	3	3	5	2	0	**13**
Ravens, Crows, Jays and Magpies	0	1	1	2	2	**6**
Australo-Papuan Robins	0	0	2	0	2	**4**
Old World Flycatchers, True Thrushes	0	1	0	0	1	**2**
Bee-eaters	0	0	0	0	1	**1**
Fairy-wrens and Allies	0	0	1	0	0	**1**
Gulls, Terns, Skuas, Jaegers	0	1	0	0	0	**1**
Honeyeaters, Chats	0	1	0	0	0	**1**
Old World Warblers and Allies	0	0	0	0	1	**1**
Parrots and Cockatoos	0	0	0	0	1	**1**
Pigeons, Doves	0	0	1	0	0	**1**
Total	**65**	**127**	**138**	**164**	**159**	**653**

5.7 Summary of results

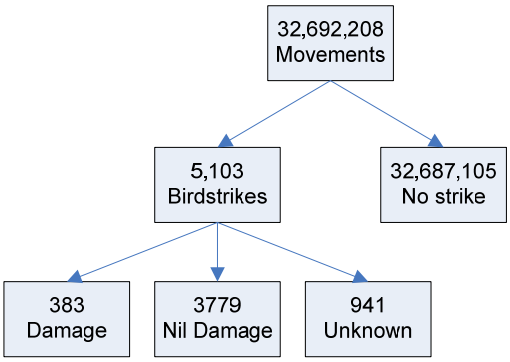
Clearly, there has been an increase in the number of birdstrike occurrences reported to the Australian Transport Safety Bureau (ATSB).

34 It is difficult to determine with precision the exact size of Bats in this category. Pilots, aerodrome ground staff and members of the public often do not make a distinction between Flying-Foxes and Bats. Flying-Foxes are much larger. It is possible that a proportion of the animals in this category are, in fact, Flying-Foxes.

Many birdstrikes are reported to the ATSB more than once. Aerodrome ground staff were responsible for about 30 per cent of all birdstrike reports, ATS about 25 per cent, and flight crew and/or operators for just over 40 per cent of reports. Those proportions were also true for reports originating from major aerodromes and regional aerodromes. GAAP aerodromes had more reports from ATS and less from flight crew and/or operators, while the 'Other aerodromes' category had two-thirds of reports coming from flight crew and/or operators as a result of minimal ATS involvement at those locations.

Over the period 2002 to 2006, there were 5,103 reported birdstrikes; this equates to one birdstrike per 6,407 movements[35] (Figure 13). Damaging strikes remain rare at around 7.5 per cent (383 of 5,103) of all birdstrike occurrences, that is, one in 13 birdstrikes cause damage to the aircraft.

Figure 13: Total movements and birdstrikes, 2002 to 2006



More importantly, birdstrike events resulting in two-engine ingestion that have the potential to lead to an accident, are even rarer at 0.15 per cent (8 of 5103) of birdstrike occurrences between 2002 and 2006. All of the eight aircraft with a two-engine ingestion were able to maintain a safe altitude and subsequently land without further incident. Australia continues to maintain a record in which no fatal accident has occurred due to a birdstrike.

In around four per cent of occurrences, pilots elected to perform a precautionary landing following a birdstrike, mostly returning to the departure point. There were two loss of control accidents between 2002 and 2006, both involving helicopters in general aviation (GA). Although these were serious accidents, only one of the pilots sustained injuries.

Along with an increasing number of birdstrike occurrences, aircraft movements have also increased. Over the years 2002 to 2006, the rate of birdstrikes per 10,000 movements has increased from about one to two occurrences. However, the rate of damaging birdstrikes per 10,000 movements has remained steady since the 1980's. Since 2002, there appears to be more reports of non-damaging birdstrikes per aircraft movement than previously.

35 A movement is a takeoff, landing, or circuit. Therefore, the reported birdstrike rate per 10,000 movements would be almost double as a rate per 10,000 sectors flown.

The probability of birdstrikes changes throughout the year, but is specific to locations (see the Appendices). The time of day birdstrikes are likely to occur follows the peak movement times 06:00 to 10:00 and 15:00 to 21:00.

Two-thirds of birdstrikes involved regular public transport (RPT) operations, mostly from high capacity aircraft. Compared to general aviation, RPT operations were 16 times more likely to sustain a birdstrike. The rate of birdstrikes per 10,000 movements on RPT aircraft has increased from 4.7 in 2002 to 6.7 by 2006.

Two-thirds of birdstrikes occurred during the landing and take-off phases of flight, with landings accounting for a slightly higher proportion than takeoffs. Most birdstrike occurrence recorded occurred at an aerodrome (81% of all birdstrikes), or near an aerodrome (14%).

The birdstrike rate at GAAP aerodromes was considerably lower than the rate at major aerodromes and regional aerodromes in general. In addition, the GAAP aerodromes in each capital city all had a lower birdstrike rate than the major aerodromes in the same city. There was considerable variation between birdstrike rates at the various aerodromes. However, although the number of birdstrikes at a location informs industry to a degree about how well it is controlling birds, location-specific bird populations and bird behaviours also significantly contribute to the number of birdstrikes at any location.

Large and medium-sized birds were more frequently struck, but in a significant number of occurrences the bird size was unknown.

6 FINDINGS

From the data presented in this paper, the following findings are made with respect to birdstrikes in Australia between the period 2002 and 2006.

- Birdstrike reporting has increased from just over 700 records in 2002 to around 1,200 records in 2006. This increase in reporting does not necessarily reflect an increase in the underlying risk of birdstrikes in Australia.
- Over the period 2002 to 2006, there were 5,103 reported birdstrikes; this was one birdstrike per 6,407 air traffic movements.
- Damaging birdstrikes were relatively rare, with 383 of 5,103 occurrences resulting in some type of damage.
- No fatal civil aviation birdstrikes accidents have occurred in Australia, but three pilots have sustained minor injuries.
- Since 2002, the total birdstrike rate per aircraft movement increased while the damaging birdstrike rate per aircraft movement remained fairly constant.
- Two-thirds of reported birdstrikes involved regular public transport (RPT) operations; and RPT operations were 16 times more likely to sustain a birdstrike compared with general aviation. This may reflect differences in reporting culture, or aircraft size and speed.
- Major aerodromes and regional aerodromes have a higher birdstrike rate than do General Aviation Airport Procedures (GAAP) aerodromes.
- Eight two-engine bird ingestions occurred, but only four of these involved known damage.
- Birdstrikes vary according to location; and birdstrike rates are indicators of the effectiveness of control measures, but cannot be taken in isolation as indicators of poor control techniques.

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8 APPENDIX I: MAJOR AERODROMES, 2002 TO 2006

8.1 Sydney aerodrome, NSW

Sydney aerodrome is a coastal aerodrome with human population centres in close proximity to its runways. It is situated in a crossover temperate, subtropical weather zone, and roughly 90 per cent of total aircraft movements are RPT.

Sydney aerodrome recorded a total of 395 at or near aerodrome birdstrikes for the period 2002 to 2006. There were 328 aerodrome birdstrikes recorded for 1,352 million aircraft movements (Figure 14). This yields an overall strike rate of 2.43 per 10,000 total movements. Of these birdstrikes, 20 (six per cent) resulted in aircraft damage. Figure 15 shows that total aircraft movements and RPT movements have risen by approximately 30,000 movements over the five-year period.

Figure 14: Aerodrome birdstrikes at Sydney aerodrome, 2002 to 2006

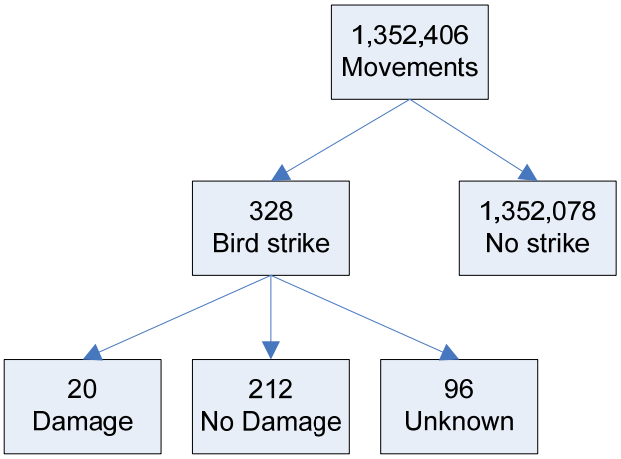
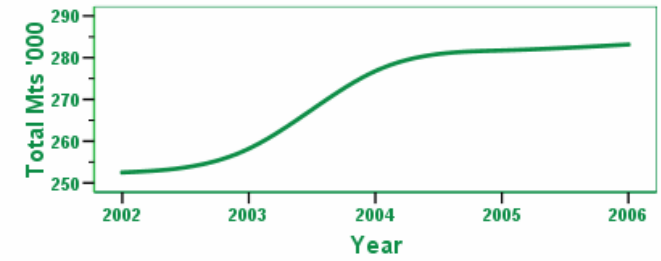
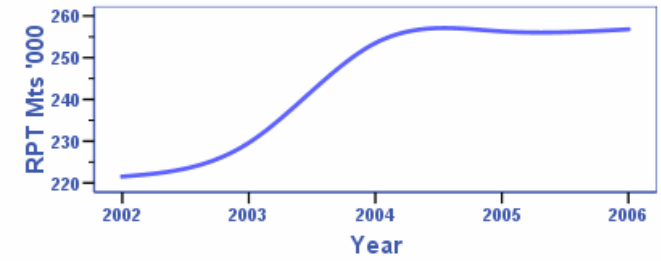


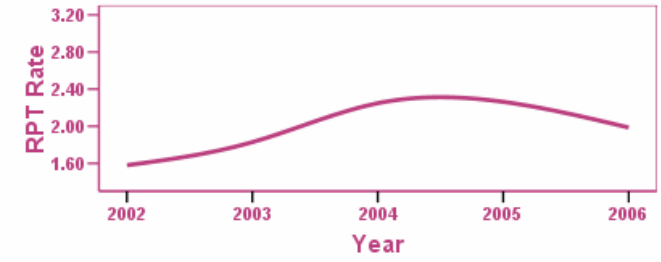
Figure 15: Sydney aerodrome, 2002 to 2006



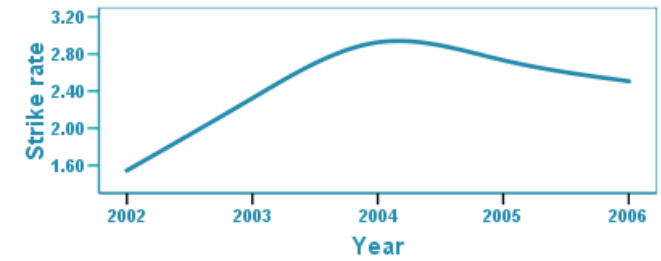
a. Total aircraft movements ('000)



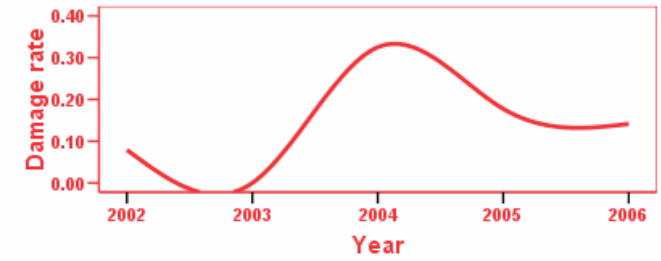
b. RPT aircraft movements ('000)



c. RPT birdstrike rate per 10,000 RPT aircraft movements



d. Birdstrike rate per 10,000 total aircraft movements



e. Damaging birdstrike rate per 10,000 total aircraft movements

Figure 16: Sydney aerodrome total birdstrike by month, 2002 to 2006

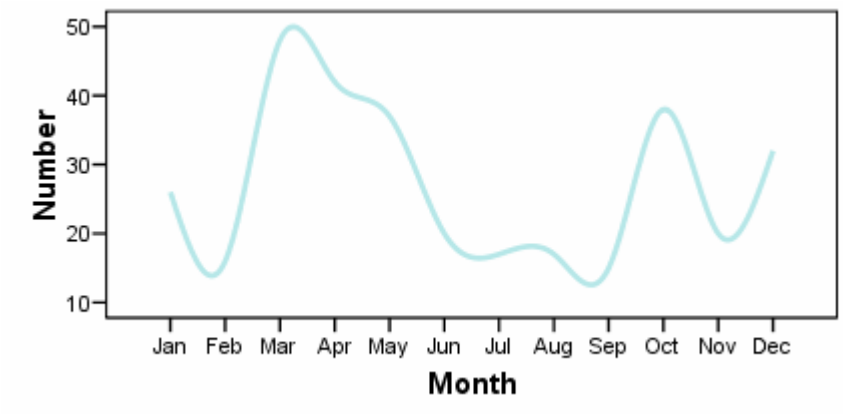


Figure 17: Sydney aerodrome birdstrike rate per 10,000 total aircraft movements by month and year, 2002 to 2006

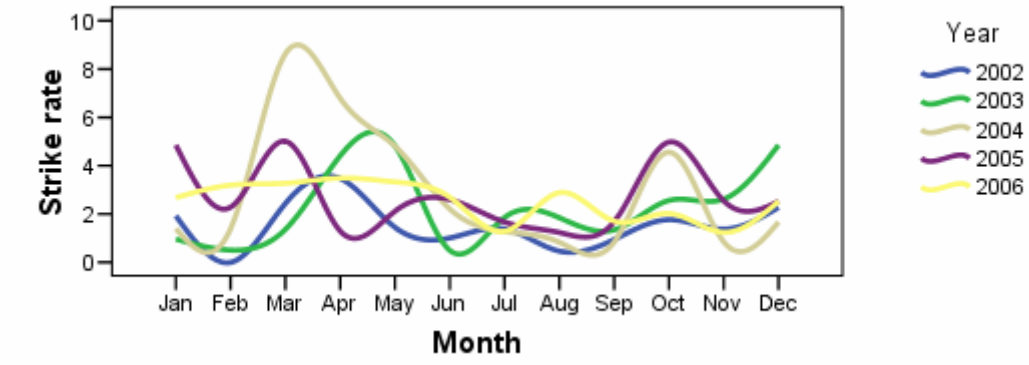


Table 29: Sydney aerodrome birdstrike by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Flying-Fox	2	5	15	11	12	**45**
Silver Gull	1	10	6	11	6	**34**
Nankeen Kestrel	5	4	2	7	5	**23**
Australasian Pipit	0	4	4	3	5	**16**
House Sparrow	3	2	2	3	4	**14**
Swallow	2	1	2	0	5	**10**
Rock Dove	0	1	4	1	0	**6**
Ibis	0	0	1	2	2	**5**
Common Starling	0	1	0	2	1	**4**
Australian Magpie	0	0	1	0	2	**3**
Hawk	1	1	0	1	0	**3**
Owl	1	2	0	0	0	**3**
Barn Owl	0	0	1	0	1	**2**
Welcome Swallow	0	2	0	0	0	**2**
Australian Raven	0	1	0	0	0	**1**
Cormorant	0	0	0	1	0	**1**
Eagle	0	0	1	0	0	**1**
Finch	0	0	0	0	1	**1**
Grey Goshawk	0	1	0	0	0	**1**
Lark	0	1	0	0	0	**1**
Magpie-lark	0	0	0	0	1	**1**
Pacific Golden Plover	0	1	0	0	0	**1**
Pacific Gull	0	0	0	0	1	**1**
Plover	0	1	0	0	0	**1**
Swamp Harrier	0	0	0	0	1	**1**
Wedge-tailed Eagle	0	0	1	0	0	**1**
Not known	24	22	41	35	24	**146**
Total	**39**	**60**	**81**	**77**	**71**	**328**

Table 30: Sydney aerodrome damaging birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Flying-Fox	0	0	1	0	1	**2**
Silver Gull	0	0	1	1	0	**2**
Ibis	0	0	0	0	1	**1**
Not known	2	0	7	4	2	**15**
Total	**2**	**0**	**9**	**5**	**4**	**20**

Table 31: Sydney near aerodrome birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Silver Gull	1	3	4	2	4	**14**
Flying-Fox	0	1	2	2	2	**7**
Australian Pelican	1	0	0	0	0	**1**
Australasian Pipit	0	0	1	0	0	**1**
Ibis	0	1	0	0	0	**1**
Magpie Goose	1	0	0	0	0	**1**
Rock Dove	0	0	0	0	1	**1**
Sulphur-crested Cockatoo	0	0	0	1	0	**1**
Not known	8	4	15	11	2	**40**
Total	**11**	**9**	**22**	**16**	**9**	**67**

Table 32: Sydney near aerodrome damaging birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Silver Gull	0	1	1	0	1	**3**
Flying-Fox	0	0	0	0	1	**1**
Sulphur-crested Cockatoo	0	0	0	1	0	**1**
Not known	3	0	2	1	0	**6**
Total	**3**	**1**	**3**	**2**	**2**	**11**

8.2 Melbourne aerodrome, Vic.

Melbourne aerodrome is situated approximately 20 km from the coast and sits on a large area of land, mainly surrounded by open fields to the north and west of the runways. The human population around the aerodrome has grown over a number of years, and includes housing within a 4 km radius. To the south and west are creeks and a gold course, and to the north west and north east is grey box woodland. The aerodrome is in a temperate weather zone and operates mainly RPT services (95 per cent).

A total of 293 at or near aerodrome birdstrikes occurred at Melbourne aerodrome between 2002 and 2006. There were 240 aerodrome birdstrikes and 849,140 total movements (2.83 birdstrikes per 10,000 total aircraft movements). Aircraft damage occurred in 15 of 240 (six per cent) of birdstrikes.

From 2002, RPT and total aircraft movements have risen. This growth has since reached a plateau from 2004 onwards.

Figure 18: Aerodrome birdstrikes at Melbourne aerodrome, 2002 to 2006

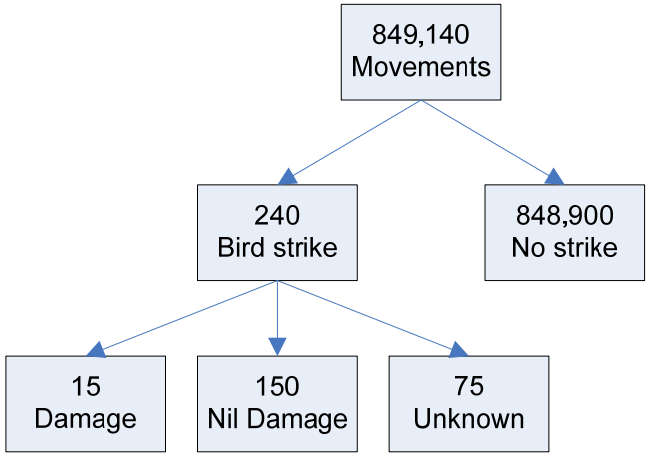
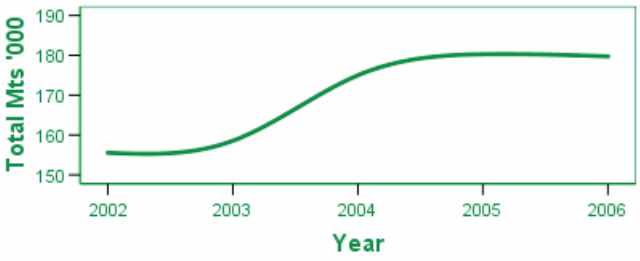
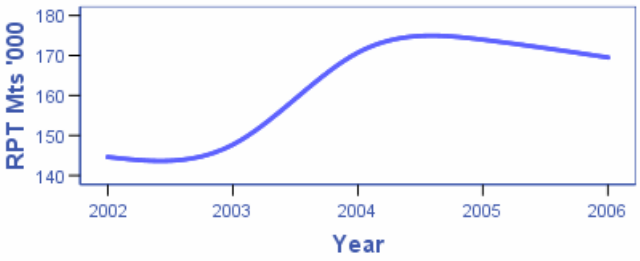


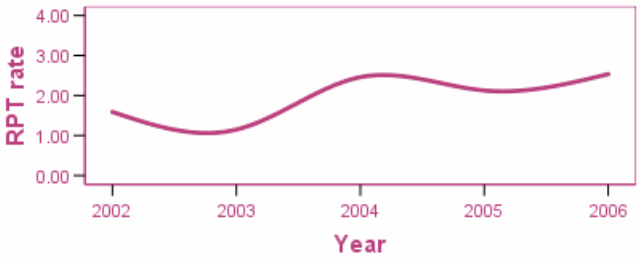
Figure 19: Melbourne aerodrome, 2002 to 2006



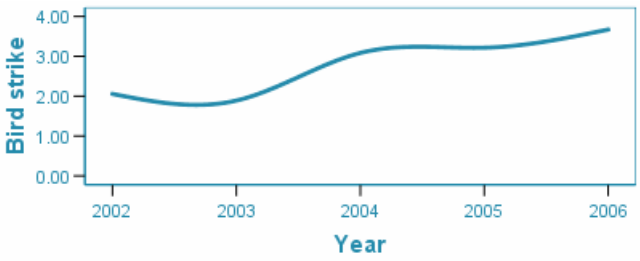
a. Total aircraft movements ('000)



b. RPT aircraft movements ('000)



c. RPT birdstrike rate per 10,000 RPT aircraft movements



d. Birdstrike rate per 10,000 total aircraft movements

e. Damaging birdstrike rate per 10,000 total aircraft movements

Figure 20: Melbourne aerodrome total birdstrikes by month, 2002 to 2006

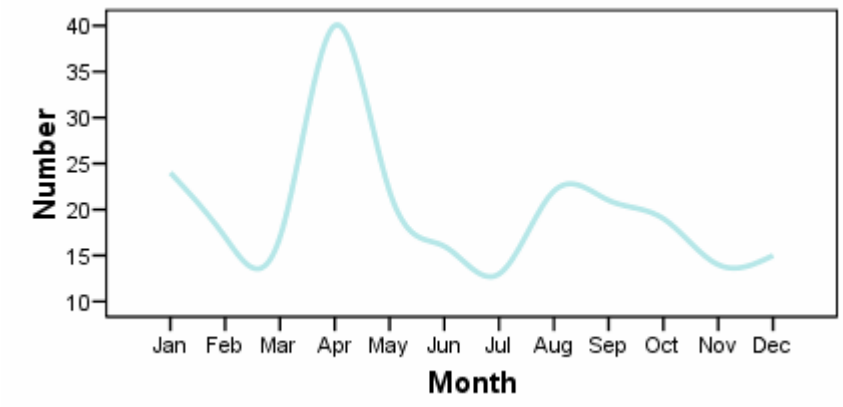


Figure 21: Melbourne aerodrome birdstrike rate per 10,000 total aircraft movements by month and year, 2002 to 2006

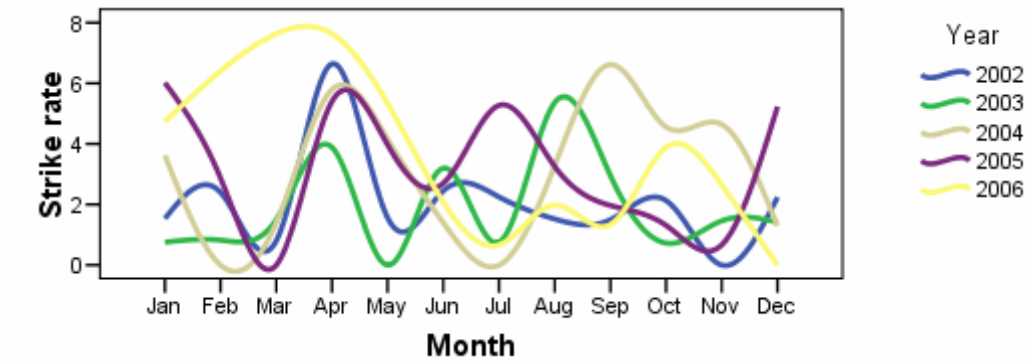


Table 33: Melbourne aerodrome birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Australian Magpie	5	3	16	12	12	**48**
Australasian Pipit	0	4	2	5	10	**21**
Flying-Fox	1	2	1	3	9	**16**
House Sparrow	2	2	5	6	1	**16**
Falcon	1	2	4	1	0	**8**
Hawk	3	0	1	1	3	**8**
Plover	1	1	1	3	0	**6**
Nankeen Kestrel	1	0	0	2	2	**5**
Swallow	0	1	0	1	3	**5**
Duck	0	1	1	2	0	**4**
Eurasian Skylark	0	0	1	1	1	**3**
Rock Dove	0	2	0	1	0	**3**
Barn Owl	0	0	0	0	2	**2**
Black Kite	0	0	0	0	2	**2**
Black-shouldered Kite	1	0	0	0	1	**2**
Brown Falcon	0	1	0	1	0	**2**
Owl	0	0	0	2	0	**2**
Peregrine Falcon	0	0	0	1	1	**2**
Raven	1	0	0	0	1	**2**
Australian Raven	0	0	1	0	0	**1**
Australian Wood Duck	0	0	0	1	0	**1**
Corella	0	0	0	0	1	**1**
Eagle	0	0	0	1	0	**1**
Common Blackbird	0	0	0	0	1	**1**
Grey-headed Flying-Fox	0	0	0	0	1	**1**
Heron	1	0	0	0	0	**1**
Lapwing	0	0	0	1	0	**1**
Masked Lapwing	0	0	0	1	0	**1**
Silver Gull	1	0	0	0	0	**1**
Welcome Swallow	0	1	0	0	0	**1**
Not known	14	10	21	12	16	**73**
Total[36]	**32**	**30**	**54**	**58**	**67**	**241**

36 More than one species struck in an occurrence.

Table 34: Melbourne aerodrome damaging birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Australian Magpie	0	0	3	0	0	**3**
Brown Falcon	0	0	0	1	0	**1**
Corella	0	0	0	0	1	**1**
Common Blackbird	0	0	0	0	1	**1**
Flying-Fox	0	0	1	0	0	**1**
Not known	1	0	5	2	0	**8**
Total	**1**	**0**	**9**	**3**	**2**	**15**

Table 35: Melbourne aerodrome near aerodrome birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Flying-Fox	0	0	1	0	2	**3**
Ibis	0	0	0	1	2	**3**
Owl	0	0	1	0	1	**2**
Australian Magpie	0	1	0	0	0	**1**
Black Kite	1	0	0	0	0	**1**
Eagle	0	0	0	0	1	**1**
Rock Dove	0	0	1	0	0	**1**
Not known	7	5	11	11	7	**41**
Total[37]	**8**	**6**	**14**	**12**	**13**	**53**

Table 36: Melbourne near aerodrome damaging birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Australian Magpie	0	0	3	0	0	3
Brown Falcon	0	0	0	1	0	1
Corella	0	0	0	0	1	1
Common Blackbird	0	0	0	0	1	1
Flying-Fox	0	0	1	0	0	1
Not known	1	0	5	2	0	8
Total	**1**	**0**	**9**	**3**	**2**	**15**

37 More than one species struck in an occurrence.

8.3 Adelaide aerodrome, SA

Adelaide aerodrome lies approximately 800 metres from the coast in a temperate weather zone. It is proximal to population centres, and around 66 per cent of total aircraft movements are RPT.

There were 265 birdstrikes at or near the aerodrome for 514,242 aircraft movements. Of these strikes, 237 occurred on the aerodrome (4.61 birdstrikes per 10,000 total aircraft movements), (Figure 22). One hundred and ninety-nine (199) of the strikes were involved RPT aircraft. Five aerodrome birdstrikes reported damage. Total movements at Adelaide aerodrome dropped in 2003 and peaked in 2005 with a subsequent fall in 2006.

Figure 22: Aerodrome birdstrikes for Adelaide aerodrome, 2002 to 2006

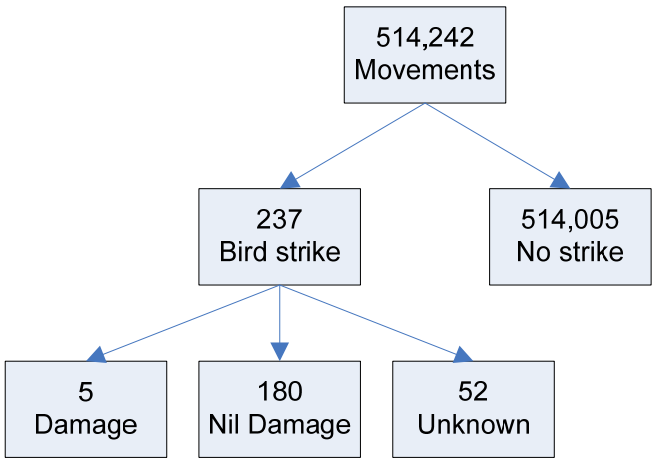
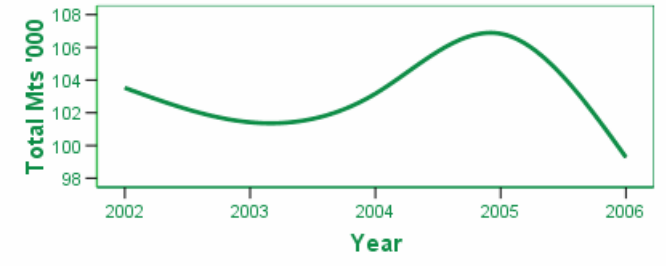
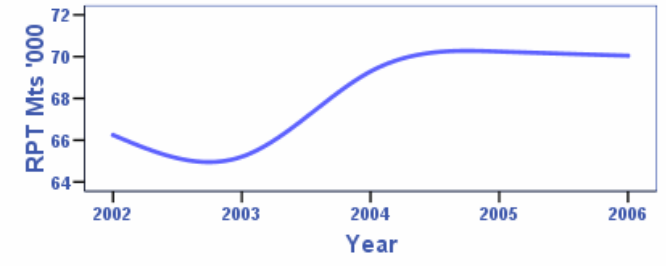


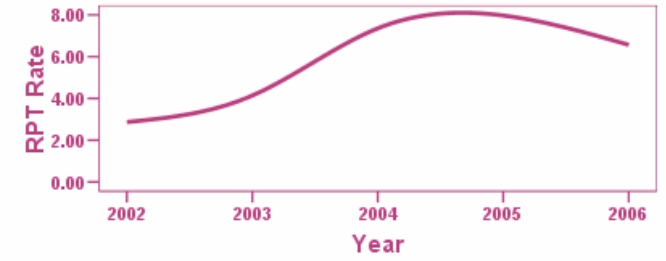
Figure 23: Adelaide aerodrome, 2002 to 2006



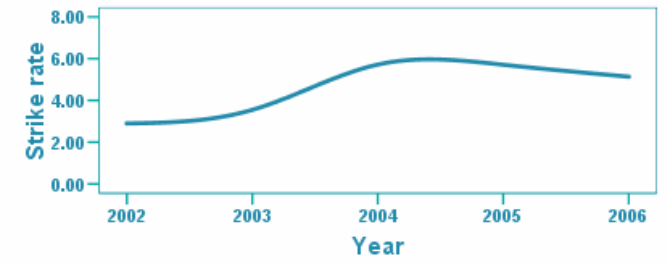
a. Total aircraft movements ('000)



b. RPT aircraft movements ('000)



c. RPT birdstrike rate per 10,000 RPT aircraft movements



d. Birdstrike rate per 10,000 total aircraft movements

e. Damaging birdstrike rate per 10,000 total aircraft movements

Figure 24: Adelaide aerodrome total birdstrikes by month, 2002 to 2006

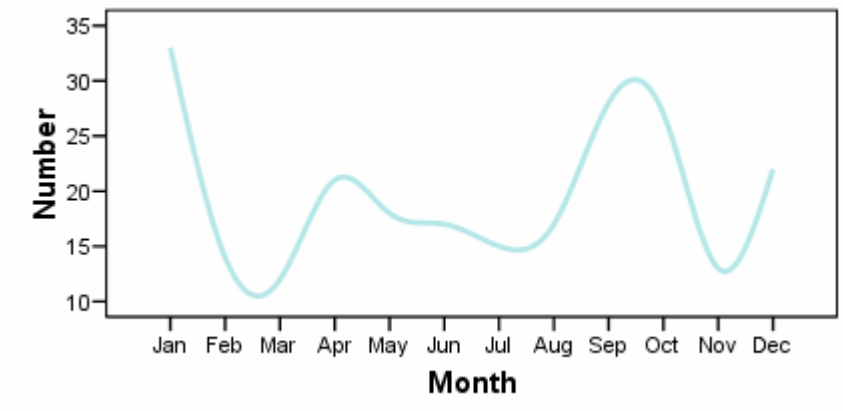


Figure 25: Adelaide aerodrome birdstrike rate per 10,000 total aircraft movements by month and year, 2002 to 2006

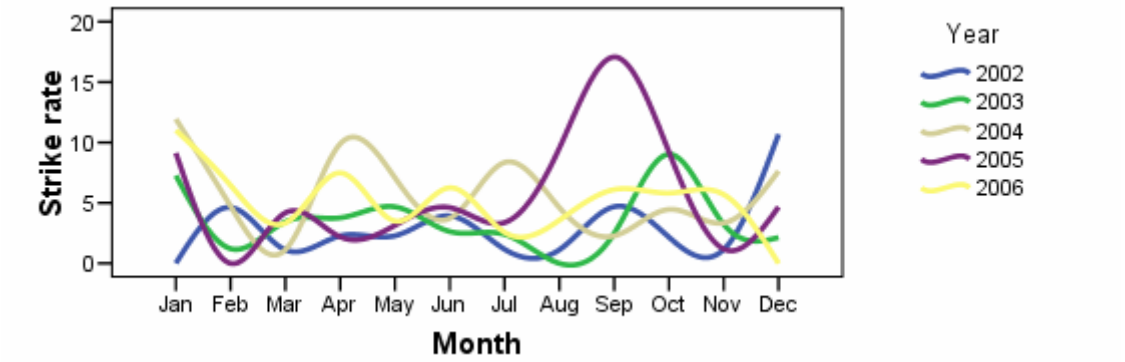


Table 37: Adelaide aerodrome birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Nankeen Kestrel	12	6	13	5	8	**44**
Galah	1	10	8	11	7	**37**
Silver Gull	1	2	5	13	4	**25**
Australian Magpie	3	2	6	5	4	**20**
Magpie-lark	0	2	6	4	2	**14**
Rock Dove	2	1	0	4	3	**10**
Swallow	0	2	5	1	1	**9**
Hawk	4	0	0	0	2	**6**
Common Starling	0	0	1	1	3	**5**
House Sparrow	1	2	1	0	0	**4**
Corella	0	0	1	0	1	**2**
Pacific Black Duck	1	0	0	0	1	**2**
Peregrine Falcon	0	2	0	0	0	**2**
Barn Owl	0	1	0	0	0	**1**
Crimson Rosella	0	0	0	1	0	**1**
Cuckoo-shrike	0	0	0	0	1	**1**
Duck	0	0	1	0	0	**1**
Common Blackbird	0	1	0	0	0	**1**
Eurasian Skylark	0	0	0	0	1	**1**
Falcon	0	0	1	0	0	**1**
Ibis	0	0	0	1	0	**1**
Lark	0	0	0	0	1	**1**
Owl	0	0	0	0	1	**1**
Pied Cormorant	0	0	0	0	1	**1**
Plover	0	0	0	1	0	**1**
Not known	5	5	11	14	10	**45**
Total	**30**	**36**	**59**	**61**	**51**	**237**

Table 38: Adelaide aerodrome damaging birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Galah	0	0	1	0	1	**2**
Pacific Black Duck	0	0	0	0	1	**1**
Silver Gull	0	0	1	0	0	**1**
Not known	0	0	1	0	0	**1**
Total	**0**	**0**	**3**	**0**	**2**	**5**

Table 39: Adelaide near aerodrome birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Rock Dove	0	1	1	0	1	**3**
Silver Gull	0	1	1	1	0	**3**
Nankeen Kestrel	1	0	0	0	0	**1**
Australian Magpie	0	0	1	0	0	**1**
Galah	0	1	0	0	0	**1**
House Sparrow	0	0	0	1	0	**1**
Not known	1	0	4	6	7	**18**
Total	**2**	**3**	**7**	**8**	**8**	**28**

No damaging birdstrikes were recorded near Adelaide aerodrome.

8.4 Perth aerodrome, WA

Perth aerodrome is approximately 20 km from the coast, with a river system approximately 5 km to the north-west of the aerodrome reference point. The aerodrome is surrounded by suburban population in a subtropical weather zone. It supports both RPT and GA aircraft, with approximately half of movements being RPT.

There were 184 near or at aerodrome birdstrikes for 483,574. Of these strikes, 165 were at the aerodrome, yielding an overall birdstrike rate of 3.41 per 10,000 total movements. Six of these strikes resulted in damage (about four per cent).

Total aircraft movements at Perth aerodrome rose until 2005 and then dipped a small amount. Movements for RPT operations have continued to increase since 2002, rising about 13,000 movements over the period 2002 to 2006.

Figure 26: Aerodrome birdstrikes for Perth aerodrome, 2002 to 2006

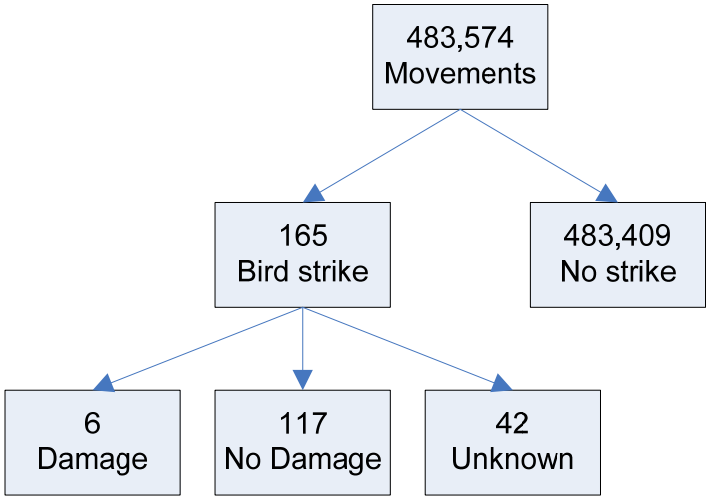
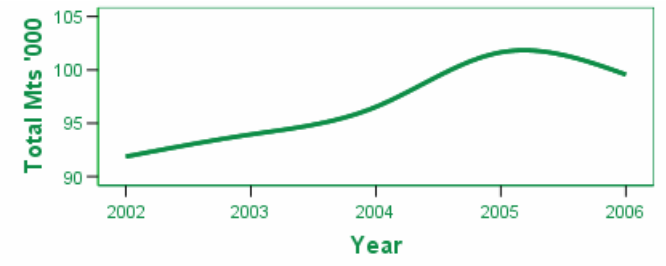
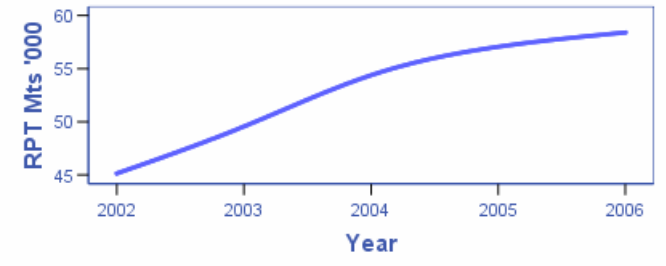


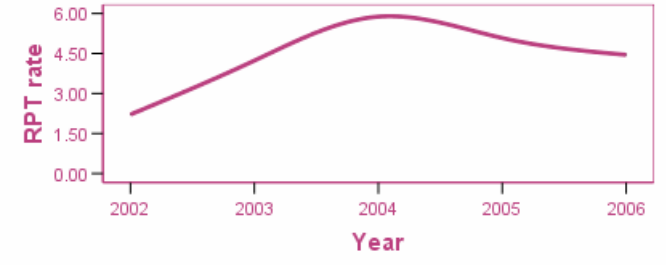
Figure 27: Perth aerodrome, 2002 to 2006



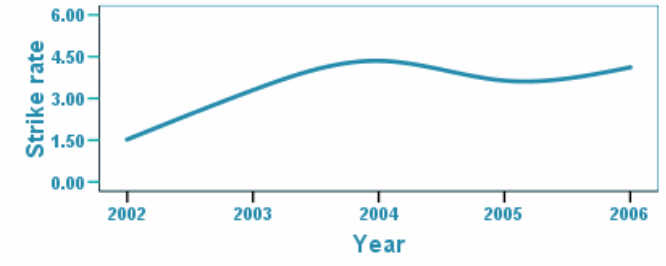
a. Total aircraft movements ('000)



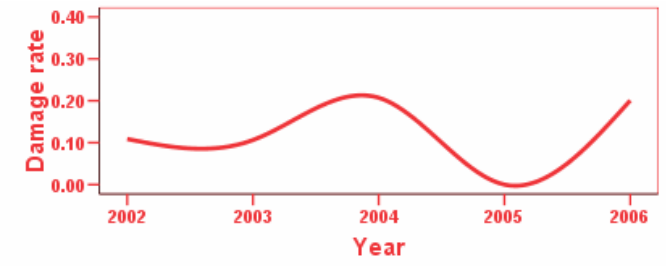
b. RPT aircraft movements ('000)



c. RPT birdstrike rate per 10,000 RPT aircraft movements



d. Birdstrike rate per 10,000 total aircraft movements



e. Damaging birdstrike rate per 10,000 total aircraft movements

Figure 28: Perth aerodrome total birdstrikes by month, 2002 to 2006

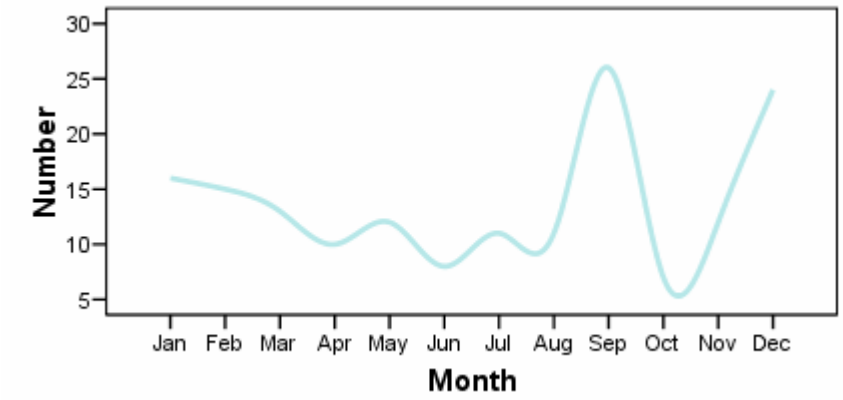


Figure 29: Perth aerodrome birdstrike rate per 10,000 total aircraft movements by month and year, 2002 to 2006

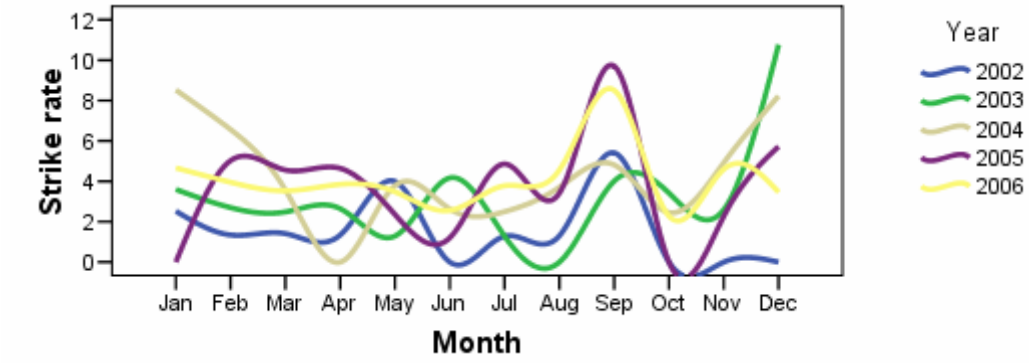


Table 40: Perth aerodrome birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Nankeen Kestrel	2	10	14	4	15	**45**
Galah	3	1	2	6	2	**14**
Owl	0	2	3	0	3	**8**
Swallow	0	1	2	2	3	**8**
Australian Magpie	0	1	2	1	1	**5**
Duck	1	1	1	1	0	**4**
Crow	0	0	1	2	0	**3**
House Sparrow	1	0	0	2	0	**3**
Flying-Fox	0	2	0	0	0	**2**
Plover	1	0	0	0	1	**2**
Australasian Pipit	0	0	0	1	0	**1**
Barn Owl	0	0	0	1	0	**1**
Crane	0	0	1	0	0	**1**
Dove	0	0	1	0	0	**1**
Hawk	0	1	0	0	0	**1**
Masked Owl	1	0	0	0	0	**1**
Rock Dove	1	0	0	0	0	**1**
Tree Martin	0	1	0	0	0	**1**
Wagtail	0	0	1	0	0	**1**
Wedge-tailed Eagle	0	0	0	1	0	**1**
White-faced Heron	0	0	1	0	0	**1**
Woodswallow	0	0	0	0	1	**1**
Not known	4	11	14	16	15	**60**
Total[38]	**14**	**31**	**43**	**37**	**41**	**166**

Table 41: Perth aerodrome damaging birdstrikes species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Galah	1	0	2	0	1	4
Not known	0	1	0	0	1	2
Total	**1**	**1**	**2**	**0**	**2**	**6**

38 More than one species struck in an occurrence.

Table 42: Perth aerodrome near aerodrome birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Bush Stone-curlew	0	0	0	0	1	**1**
Crow	0	0	1	0	0	**1**
Eagle	0	1	0	0	0	**1**
Swallow	0	0	0	0	1	**1**
Not known	1	4	2	1	7	**15**
Total	**1**	**5**	**3**	**1**	**9**	**19**

Table 43: Perth aerodrome near aerodrome damaging birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Not known	0	0	0	0	1	**1**
Total	**0**	**0**	**0**	**0**	**1**	**1**

8.5 Brisbane aerodrome, Qld.

Brisbane aerodrome is a coastal aerodrome with the main runway approximately 1.5 km from the coastline. To the east lies a river system, and to the south and west are populated areas. Brisbane has a subtropical weather pattern, with about 80 per cent of aircraft movements involving RPT aircraft.

Brisbane aerodrome recorded 393 at or near aerodrome birdstrikes for 773,096 movements. Of these occurrences, 311 aerodrome birdstrikes occurred between 2002 and 2006. This gives an overall strike rate of 4.02 birdstrikes per 10,000 total aircraft movements. In total, 11 of 311 (four per cent) birdstrikes caused aircraft damage.

Figure 30: Aerodrome birdstrikes for Brisbane aerodrome, 2002 to 2006

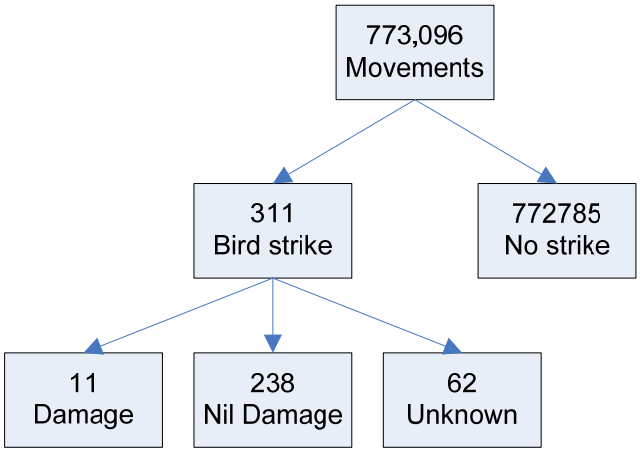
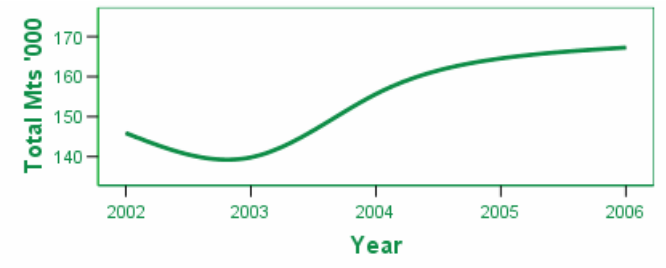
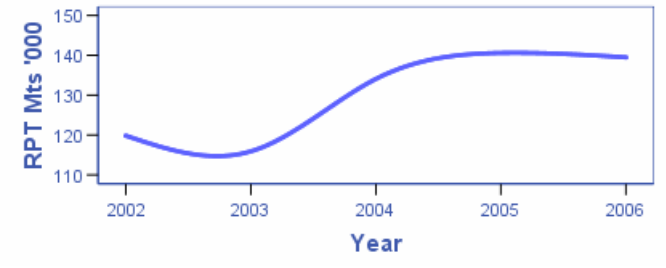


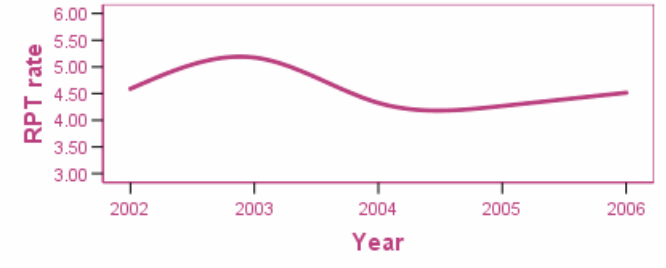
Figure 31: Brisbane aerodrome, 2002 to 2006



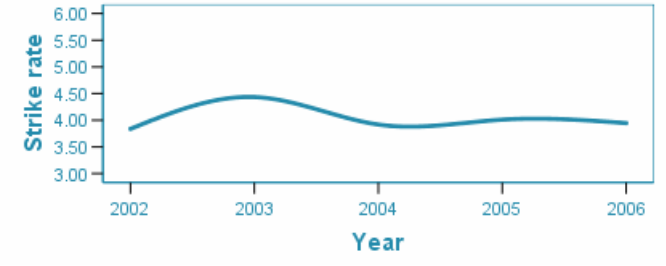
a. Total aircraft movements ('000)



b. RPT aircraft movements ('000)



c. RPT birdstrike rate per 10,000 RPT aircraft movements



d. Birdstrike rate per 10,000 total aircraft movements

e. Damaging birdstrike rate per 10,000 total aircraft movements

Figure 32: Brisbane aerodrome total birdstrikes by month, 2002 to 2006

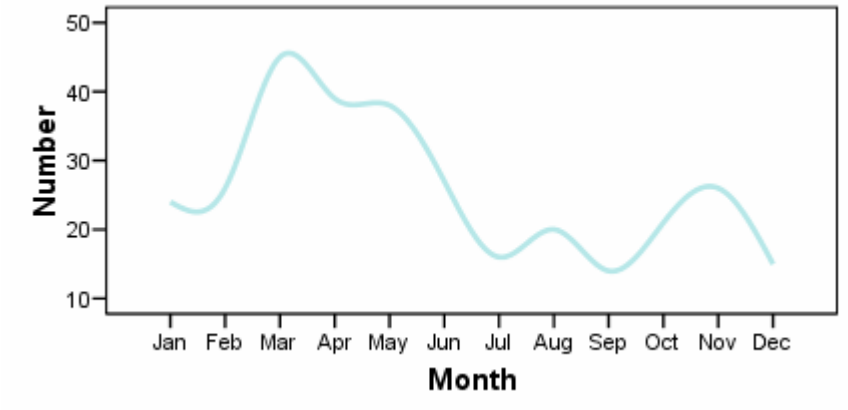


Figure 33: Brisbane aerodrome birdstrike rate per 10,000 total aircraft movements by month and year, 2002 to 2006

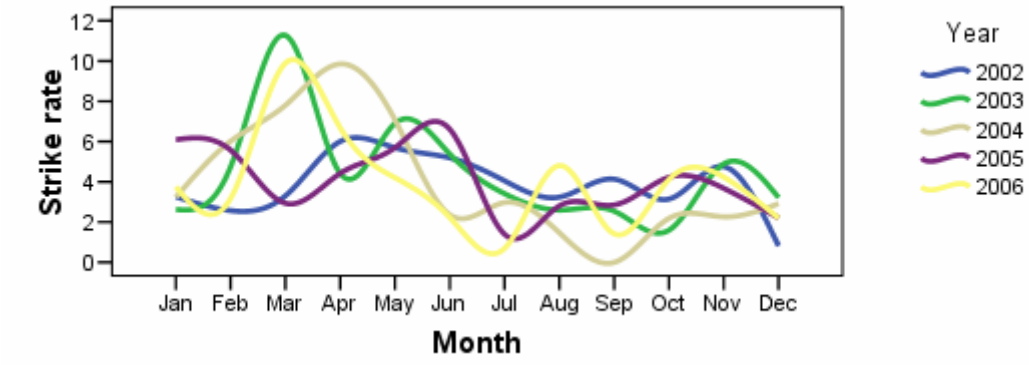


Table 44: Brisbane aerodrome damaging aerodrome birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Nankeen Kestrel	3	6	4	3	8	**24**
Flying-Fox	2	7	6	3	5	**23**
Ibis	1	2	5	2	2	**12**
Plover	3	1	2	2	3	**11**
Swallow	2	3	1	2	3	**11**
Hawk	1	1	1	2	1	**6**
House Sparrow	0	2	0	2	1	**5**
Black Kite	0	0	1	1	1	**3**
Duck	0	1	0	2	0	**3**
Common Starling	0	1	0	0	2	**3**
Australian Magpie	1	0	0	1	0	**2**
Brahminy Kite	1	1	0	0	0	**2**
Crow	0	1	1	0	0	**2**
Eagle	0	0	2	0	0	**2**
Egret	0	0	1	0	1	**2**
Heron	1	0	0	1	0	**2**
Magpie-lark	0	0	0	2	0	**2**
Owl	0	0	0	2	0	**2**
Tern	0	2	0	0	0	**2**
Cattle Egret	0	0	1	0	0	**1**
Cormorant	0	0	1	0	0	**1**
Falcon	0	1	0	0	0	**1**
Galah	1	0	0	0	0	**1**
Masked Lapwing	0	0	0	0	1	**1**
Silver Gull	1	0	0	0	0	**1**
Swift	0	0	0	1	0	**1**
Whistling Kite	0	0	1	0	0	**1**
White-faced Heron	1	0	0	0	0	**1**
Woodswallow	0	1	0	0	0	**1**
Not known	38	32	34	40	38	**182**
Total	**56**	**62**	**61**	**66**	**66**	**311**

Table 45: Brisbane aerodrome damaging aerodrome birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Falcon	0	1	0	0	0	**1**
Flying-Fox	0	0	1	0	0	**1**
Ibis	0	0	1	0	0	**1**
Plover	0	0	0	0	1	**1**
Tern	0	1	0	0	0	**1**
Not known	0	2	2	1	1	**6**
Total	**0**	**4**	**4**	**1**	**2**	**11**

Table 46: Brisbane aerodrome near aerodrome birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Flying-Fox	2	4	3	0	1	**10**
Hawk	1	0	0	2	0	**3**
Ibis	0	1	0	1	0	**2**
Nankeen Kestrel	1	0	0	0	0	**1**
Owl	0	0	0	1	0	**1**
Swallow	0	0	0	0	1	**1**
Swift	0	0	1	0	0	**1**
Not known	10	10	19	11	13	**63**
Total	**14**	**15**	**23**	**15**	**15**	**82**

Table 47: Brisbane aerodrome near aerodrome damaging birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Hawk	0	0	0	1	0	**1**
Not known	0	0	2	1	0	**3**
Total	**0**	**0**	**2**	**2**	**0**	**4**

8.6 Cairns aerodrome, Qld.

Cairns aerodrome is a coastal aerodrome with the main runway about 850 metres from the coast. Regular public transport movements account for around 45 per cent of the total aircraft movements. Cairns has a tropical weather pattern with populated areas to south and west, and more sparsely populated areas to the north.

There were 320 at or near aerodrome birdstrikes for 510,344 aircraft movements at Cairns Aerodrome. Only 240 of these strikes were on the aerodrome, yielding an overall strike rate of 4.70 birdstrikes per 10,000 movements between 2002 and 2006. Damaging birdstrikes occurred in 14 of 240 occurrences (six per cent)..

Total and RPT aircraft movements at Cairns aerodrome reached the bottom of a trough in 2003. Since this time, total movements have increased steadily, while RPT movements have reached a plateau.

Figure 34: Aerodrome birdstrikes for Cairns aerodrome, 2002 to 2006

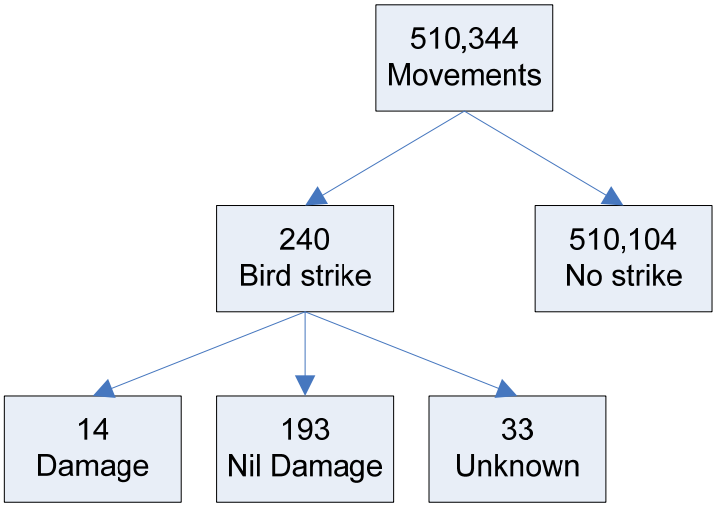
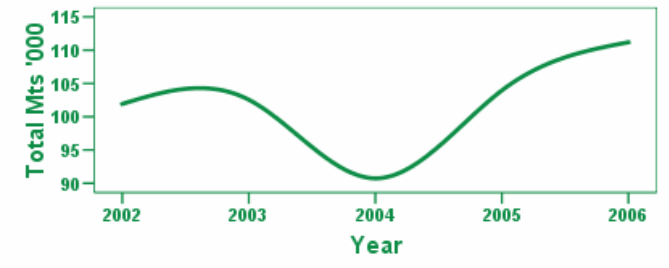
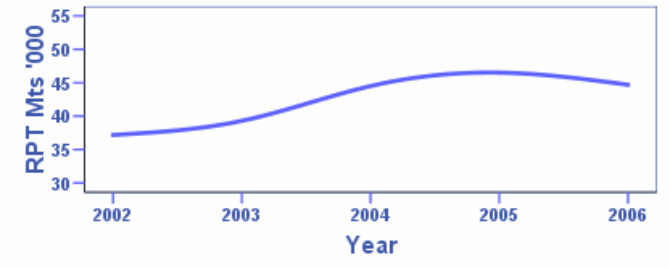


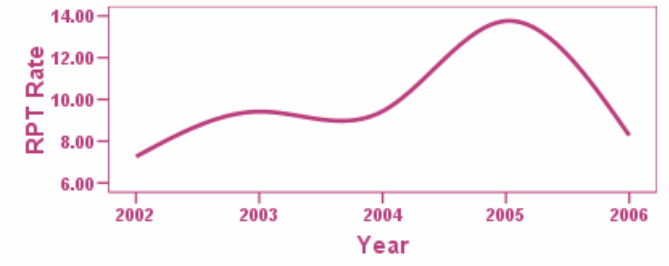
Figure 35: Cairns aerodrome, 2002 to 2006



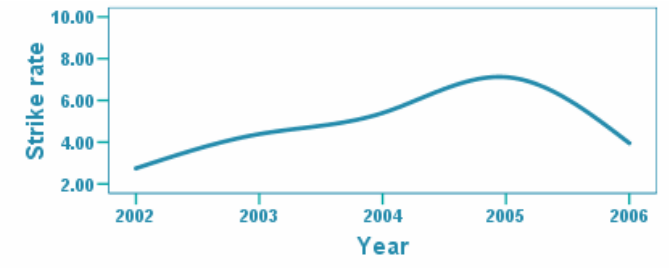
a. Total aircraft movements ('000)



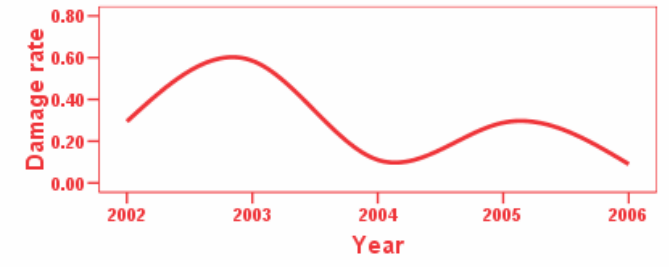
b. RPT aircraft movements ('000)



c. RPT birdstrike rate per 10,000 RPT aircraft movements



d. Birdstrike rate per 10,000 total aircraft movements



e. Damaging birdstrike rate per 10,000 total aircraft movements

Figure 36: Cairns aerodrome total birdstrikes by month, 2002 to 2006

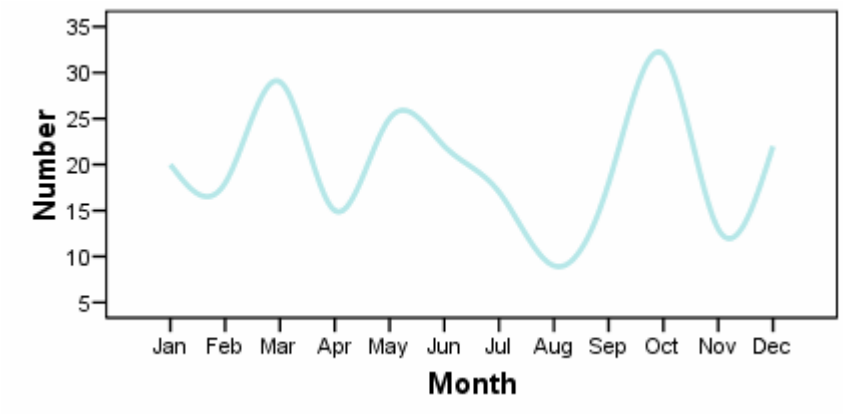


Figure 37: Cairns aerodrome birdstrike rate per 10,000 total aircraft movements by month and year, 2002 to 2006

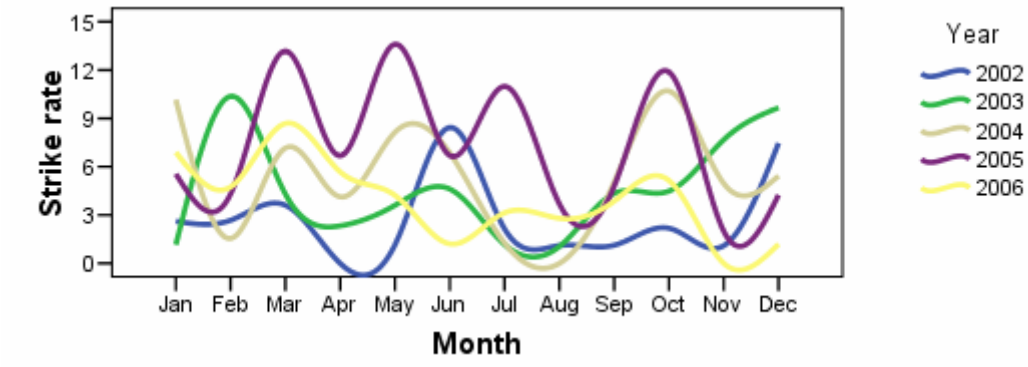


Table 48: Cairns aerodrome birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Flying-Fox	3	6	2	4	3	**18**
Black Kite	3	0	3	3	1	**10**
Bush Stone-curlew	0	0	0	8	2	**10**
Swallow	0	2	0	4	2	**8**
Curlew	2	2	0	2	0	**6**
House Sparrow	0	1	2	1	2	**6**
Magpie-lark	1	0	0	4	0	**5**
Nankeen Kestrel	0	1	0	2	1	**4**
Common Myna	0	2	1	0	1	**4**
Masked Lapwing	1	0	1	1	0	**3**
Caspian Plover	0	1	1	0	0	**2**
Duck	0	1	1	0	0	**2**
Fairy Martin	0	0	2	0	0	**2**
Ibis	2	0	0	0	0	**2**
Pacific Black Duck	0	0	1	0	1	**2**
Plover	1	0	1	0	0	**2**
Tern	0	0	0	1	1	**2**
Australasian Shoveler	0	0	1	0	0	**1**
Dove	0	0	0	0	1	**1**
Eagle	0	0	0	1	0	**1**
Flycatcher	0	1	0	0	0	**1**
Hawk	0	1	0	0	0	**1**
Heron	0	0	0	1	0	**1**
Miner	0	1	0	0	0	**1**
Owl	0	0	0	1	0	**1**
Parrot	0	0	0	1	0	**1**
Peregrine Falcon	0	0	1	0	0	**1**
Rock Dove	0	0	1	0	0	**1**
Sandpiper	0	0	0	1	0	**1**
Silver Gull	0	0	1	0	0	**1**
Sulphur-crested Cockatoo	0	0	0	0	1	**1**
Welcome Swallow	0	0	1	0	0	**1**
Whistling Kite	0	0	1	0	0	**1**
White-faced Heron	1	0	0	0	0	**1**
Not known	14	26	28	39	28	**135**
Total	**28**	**45**	**49**	**74**	**44**	**140**

Table 49: Cairns aerodrome damaging birdstrikes species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Flying-Fox	0	1	0	1	0	**2**
Common Myna	0	1	0	0	0	**1**
Duck	0	1	0	0	0	**1**
Parrot	0	0	0	1	0	**1**
Whistling Kite	0	0	1	0	0	**1**
White-faced Heron	1	0	0	0	0	**1**
Not known	2	3	0	1	1	**7**
Total	**3**	**6**	**1**	**3**	**1**	**14**

Table 50: Cairns aerodrome near aerodrome birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Flying-Fox	1	4	2	4	1	**12**
Nankeen Kestrel	1	0	0	0	1	**2**
Owl	1	0	0	1	0	**2**
Swallow	1	0	0	0	1	**2**
Australian Magpie	0	0	1	0	0	**1**
Brahminy Kite	1	0	0	0	0	**1**
Bush Stone-curlew	0	0	0	1	0	**1**
Curlew	0	0	0	1	0	**1**
Duck	0	0	1	0	0	**1**
Eagle	0	0	0	1	0	**1**
House Sparrow	0	1	0	0	0	**1**
Silver Gull	0	1	0	0	0	**1**
Swift	0	1	0	0	0	**1**
Not known	6	9	8	20	10	**53**
Total	**11**	**16**	**12**	**28**	**13**	**80**

Table 51: Cairns aerodrome near aerodrome damaging birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Brahminy Kite	1	0	0	0	0	**1**
Flying-Fox	0	0	1	0	0	**1**
Not known	1	0	0	0	1	**2**
Total	**2**	**0**	**1**	**0**	**1**	**4**

8.7 Canberra aerodrome, ACT

Canberra is an inland aerodrome, approximately 120 km from the coast. A small river and a number of farms lie to the south and west, and to the north there are open fields. A large business park is parallel with the southern end of the runway, with a shopping centre on the very edge of the aerodrome. A waste disposal centre is located approximately 1 km to the south east. Canberra has a temperate weather pattern and around 45 per cent of the movements are RPT.

Canberra aerodrome had 121 reported at or near aerodrome birdstrikes for the period 2002 to 2006. There were 104 aerodrome birdstrikes per 410,228 movements, giving a total birdstrike rate of 2.54 per 10,000 total movements. There were eight damaging aerodrome birdstrikes, which occurred in eight per cent of birdstrikes.

Total aircraft movements at Canberra aerodrome were at a peak in 2003, dipped during 2004 and 2005, and then began an upward trend in 2006. Movements for RPT operations rose to a peak in 2004 then returned to approximately the same level as 2002. Overall, birdstrike rates have risen in a linear trend for RPT strikes and total movements, despite the fall in movements. At the same time, damaging birdstrikes have risen from around 1.5 per in 100,000 movements to around 8 in 100,000 movements.

Figure 38: Aerodrome birdstrikes at Canberra aerodrome, 2002 to 2006

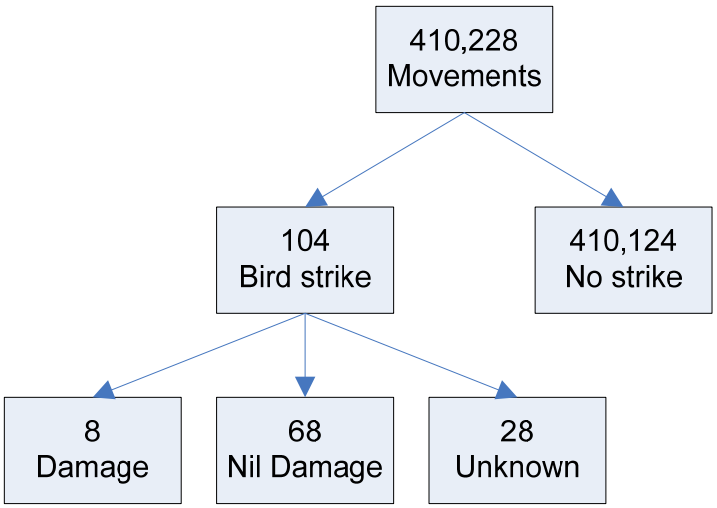
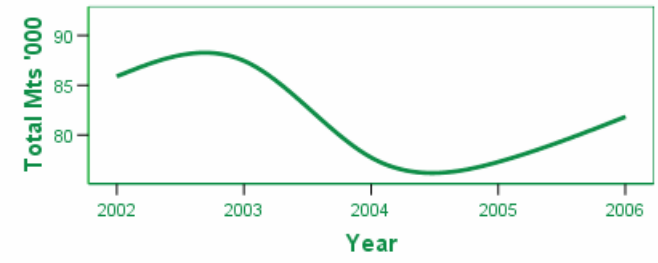
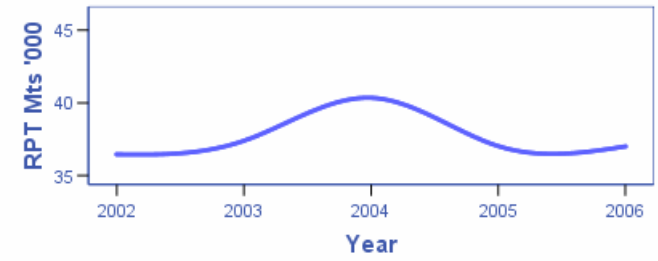


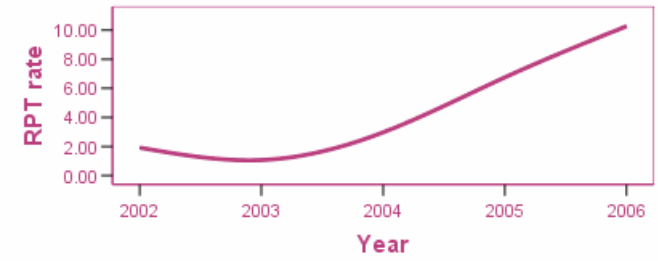
Figure 39: Canberra aerodrome, 2002 to 2006



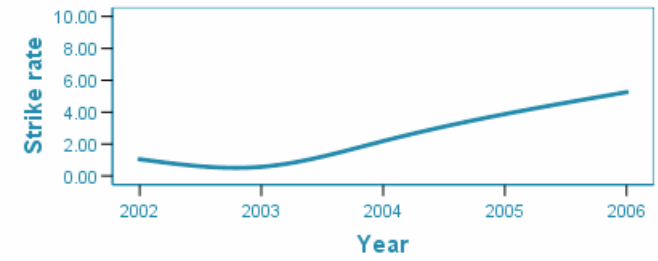
a. Total aircraft movements ('000)



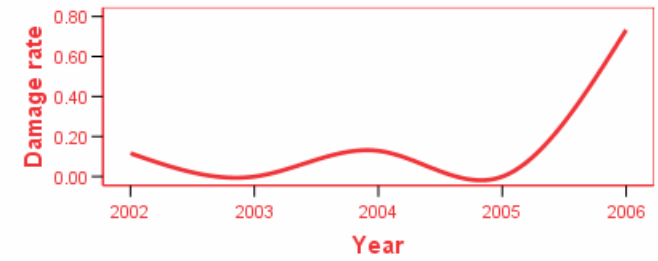
b. RPT aircraft movements ('000)



c. RPT birdstrike rate per 10,000 RPT aircraft movements



d. Birdstrike rate per 10,000 total aircraft movements



e. Damaging birdstrike rate per 10,000 total aircraft movements

Figure 40: Canberra aerodrome total birdstrikes by month, 2002 to 2006

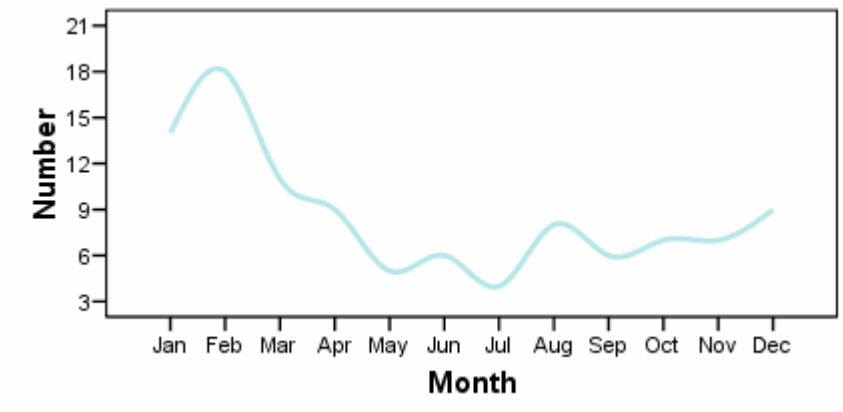


Figure 41: Canberra aerodrome birdstrike rate per 10,000 total aircraft movements by month and year, 2002 to 2006

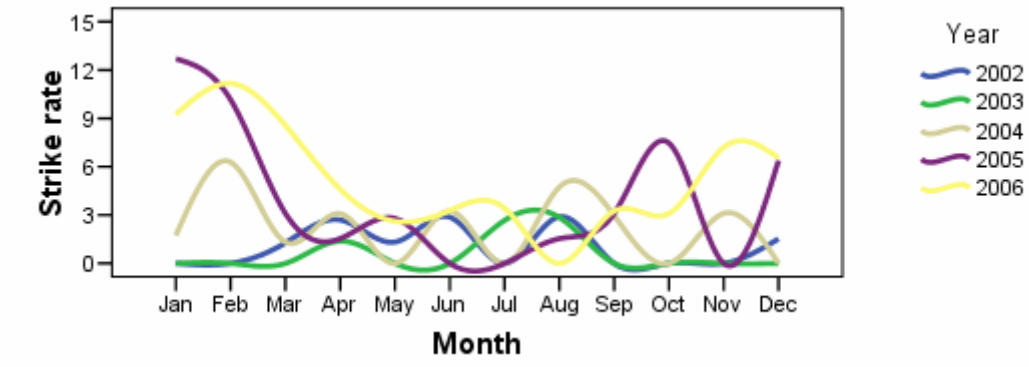


Table 52: Canberra aerodrome birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Galah	3	0	0	10	10	**23**
Australian Magpie	1	1	5	3	3	**13**
Nankeen Kestrel	0	0	0	1	6	**7**
Plover	0	0	1	2	4	**7**
Duck	1	1	0	1	2	**5**
Hawk	0	0	0	1	3	**4**
Brown Goshawk	0	0	2	1	0	**3**
Crow	0	0	0	2	1	**3**
Swallow	0	0	1	1	1	**3**
Australasian Pipit	0	0	0	1	1	**2**
Raven	0	0	0	1	1	**2**
Welcome Swallow	0	0	2	0	0	**2**
Australasian Hobby	0	0	0	1	0	**1**
Australian Wood Duck	0	0	0	0	1	**1**
Black Swan	0	0	0	0	1	**1**
Flying-Fox	0	0	1	0	0	**1**
Pacific Black Duck	0	0	1	0	0	**1**
Robin	0	0	1	0	0	**1**
Not known	4	3	3	5	9	**24**
Total	**9**	**5**	**17**	**30**	**43**	**104**

Table 53: Canberra aerodrome damaging birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Nankeen Kestrel	0	0	0	0	1	**1**
Duck	0	0	0	0	1	**1**
Flying-Fox	0	0	1	0	0	**1**
Galah	0	0	0	0	1	**1**
Not known	1	0	0	0	3	**4**
Total	**1**	**0**	**1**	**0**	**6**	**8**

Table 54: Canberra aerodrome near aerodrome birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Galah	0	1	0	0	0	**1**
Plover	0	0	1	0	0	**1**
Not known	2	3	2	5	3	**15**
Total	**2**	**4**	**3**	**5**	**3**	**17**

Table 55: Canberra aerodrome near aerodrome damaging birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Not known	0	1	0	0	0	**1**
Total	**0**	**1**	**0**	**0**	**0**	**1**

8.8 Darwin aerodrome, NT

Darwin aerodrome is a coastal aerodrome, which lies roughly in the middle of a peninsula with the coastline being approximately 3 km from the runway. To the south and north are populated areas, and the weather is tropical. Darwin aerodrome is operated as a joint civilian and military facility, with military movements accounting for about eight per cent of total aircraft movements and RPT for around 22 per cent.

Darwin aerodrome had 404 at or near aerodrome birdstrikes for the period 2002 to 2006. There were 386 aerodrome birdstrikes for 389,978 total aircraft movements (9.90 birdstrikes per 10,000 total movements). In addition, there were 19 damaging birdstrikes, which accounted for five per cent of birdstrikes.

Total aircraft movements at Darwin aerodrome reached a trough in 2003 and have continued to rise above the 2002 level. A small drop in RPT movements at Darwin aerodrome has been observed, however, this data is reasonably stable. The overall strike rate has remained static, but the damaging strike rate has varied over time, being as low as 4 in 100,000 movements and as high as 9 in 100,000 movements.

Figure 42: Aerodrome birdstrikes at Darwin aerodrome, 2002 to 2006

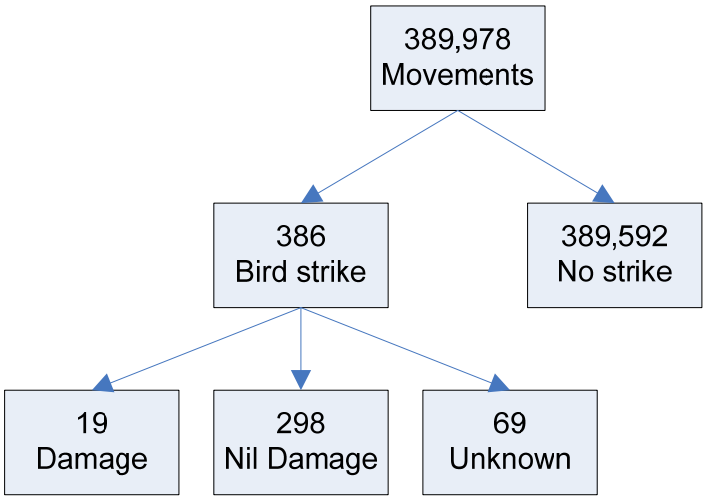
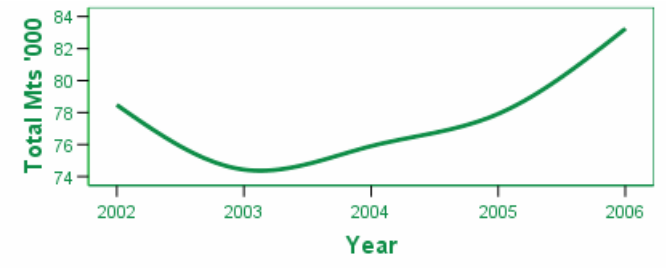
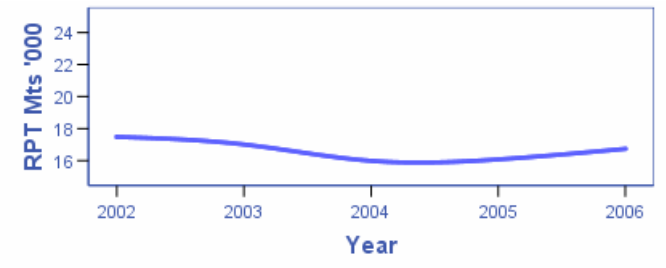


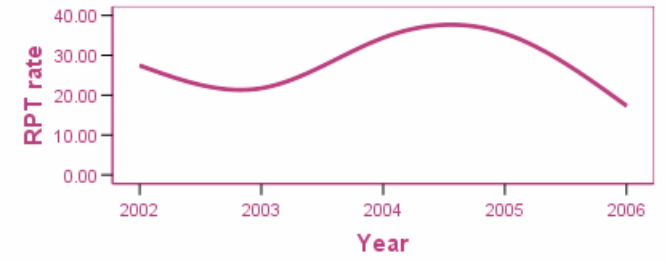
Figure 43: Darwin aerodrome, 2002 to 2006



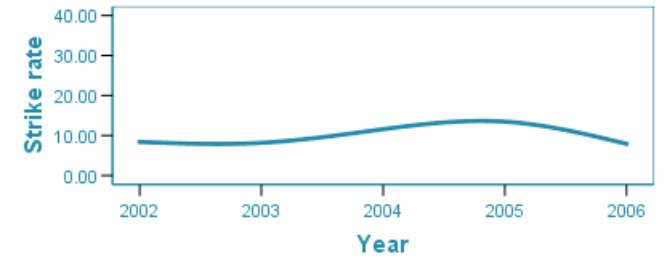
a. Total aircraft movements ('000)



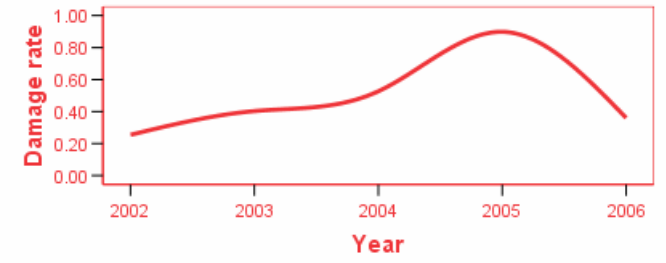
b. RPT aircraft movements ('000)



c. RPT birdstrike rate per 10,000 RPT aircraft movements



d. Birdstrike rate per 10,000 total aircraft movements



e. Damaging birdstrike rate per 10,000 total aircraft movements

Figure 44: Darwin aerodrome total birdstrikes by month, 2002 to 2006

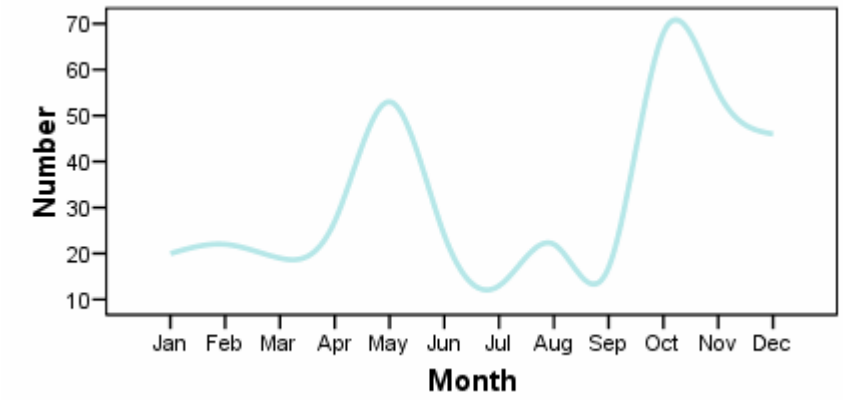


Figure 45: Darwin aerodrome birdstrike rate per 10,000 total aircraft movements by month and year, 2002 to 2006

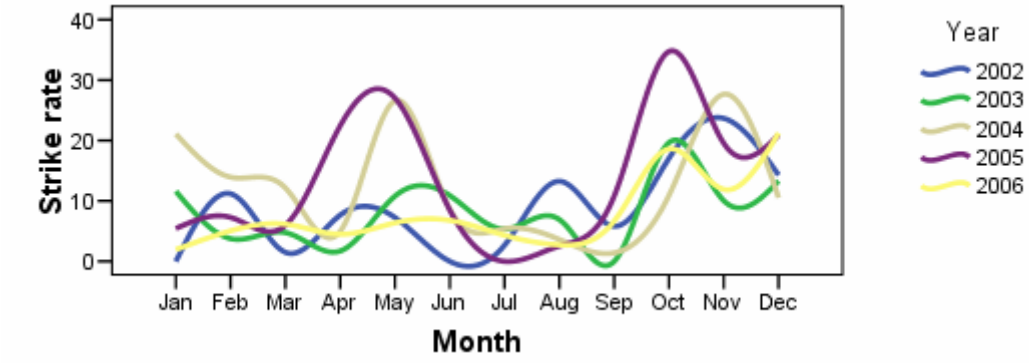


Table 56: Darwin aerodrome birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Australian Pratincole	10	11	24	30	10	**85**
Plover	11	9	13	4	2	**39**
Black Kite	4	5	4	14	9	**36**
Masked Lapwing	3	5	2	9	5	**24**
Curlew	4	5	4	7	2	**22**
Flying-Fox	7	7	1	3	0	**18**
Bush Stone-curlew	0	1	5	1	8	**15**
Whistling Kite	0	0	4	4	2	**10**
Little Curlew	1	3	0	1	4	**9**
Magpie-lark	2	1	0	4	0	**7**
Nankeen Kestrel	1	0	1	1	3	**6**
Owl	1	2	1	1	1	**6**
Hawk	0	0	2	0	3	**5**
Oriental Plover	0	0	1	1	2	**4**
Corella	1	0	0	1	0	**2**
Common Starling	0	1	0	1	0	**2**
Australasian Pipit	0	0	0	0	1	**1**
Eagle	0	1	0	0	0	**1**
Eastern Curlew	0	0	1	0	0	**1**
Galah	0	0	1	0	0	**1**
Gull	0	0	1	0	0	**1**
Nankeen Night Heron	0	0	0	0	1	**1**
Peaceful Dove	0	0	1	0	0	**1**
Rufous Songlark	0	0	0	0	1	**1**
Sanderling	0	0	1	0	0	**1**
Not known	21	12	21	25	14	**93**
Total[39]	**66**	**63**	**88**	**107**	**68**	**392**

39 More than one species struck.

Table 57: Darwin aerodrome damaging birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Australian Pratincole	0	0	1	2	0	**3**
Black Kite	0	1	0	2	0	**3**
Curlew	0	0	1	1	0	**2**
Bush Stone-curlew	0	0	0	0	1	**1**
Eagle	0	1	0	0	0	**1**
Flying-Fox	1	0	0	0	0	**1**
Hawk	0	0	1	0	0	**1**
Not known	1	1	1	2	2	**7**
Total	**2**	**3**	**4**	**7**	**3**	**19**

Table 58: Darwin aerodrome near aerodrome birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Flying-Fox	1	0	0	1	0	**2**
Australian Pratincole	0	0	0	1	0	**1**
Not known	3	2	2	6	2	**15**
Total	**4**	**2**	**2**	**8**	**2**	**18**

Table 59: Darwin aerodrome near aerodrome damaging birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Flying-Fox	1	0	0	0	0	**1**
Not known	0	1	0	0	0	**1**
Total	**1**	**1**	**0**	**0**	**0**	**2**

8.9 Gold Coast aerodrome, Qld.

The Gold Coast aerodrome (previously referred to as Coolangatta) is approximately 600 metres from the coast. It is subtropical in weather pattern and has the ocean to the east and swampy mangroves to the west. Populated areas are found particularly to the north and south, and the Pacific Highway abuts the eastern side of the aerodrome. A substantial number of helicopter movements occur at this aerodrome accounting for about 25 per cent of total movements. Regular public transport makes up around 30 per cent of total aircraft movements.

There were 123 at or near aerodrome birdstrikes for the period 2002 to 2006. Of these, 98 occurred on the aerodrome. With 421,802 movements, this yields a birdstrike rate of 2.8 per 10,000 movements. Over the five-year period, only one damaging birdstrikes occurred (0.8 per cent), which equates to 0.024 damaging strikes per 10,000 total aircraft movements.

Figure 46: Aerodrome birdstrikes for Gold Coast aerodrome, 2002 to 2006

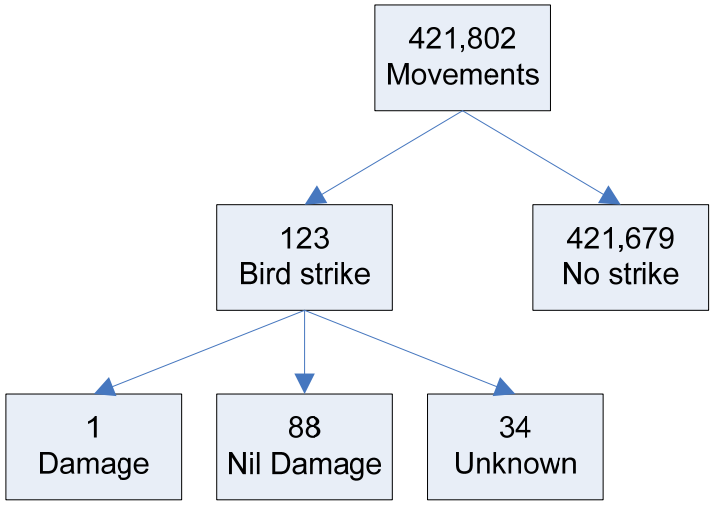
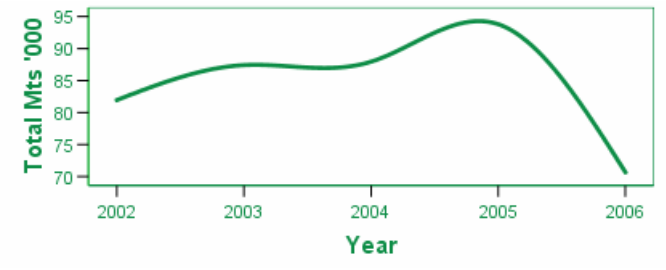
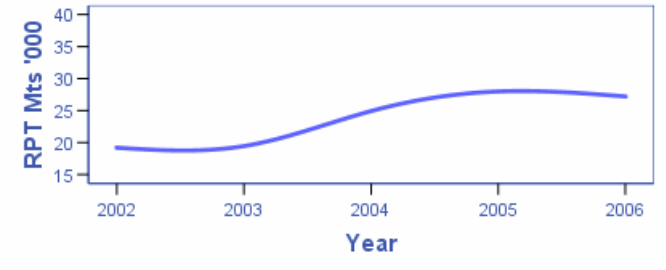


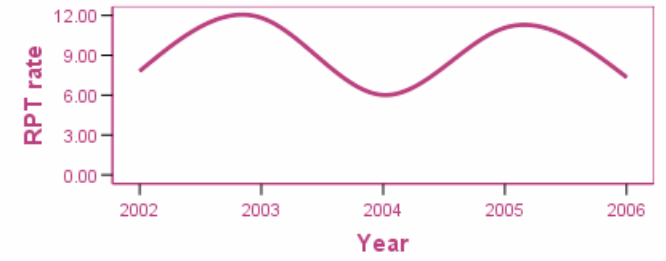
Figure 47: Gold Coast aerodrome, 2002 to 2006



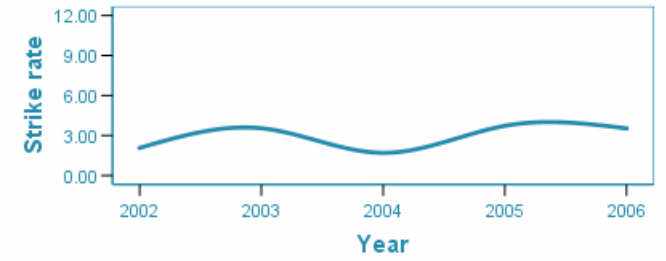
a. Total aircraft movements ('000)



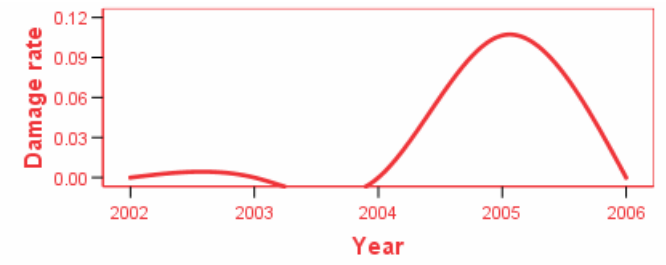
b. RPT aircraft movements ('000)



c. RPT birdstrike rate per 10,000 RPT aircraft movements



d. Birdstrike rate per 10,000 total aircraft movements



e. Damaging birdstrike rate per 10,000 total aircraft movements

Figure 48: Gold Coast aerodrome total birdstrikes by month, 2002 to 2006

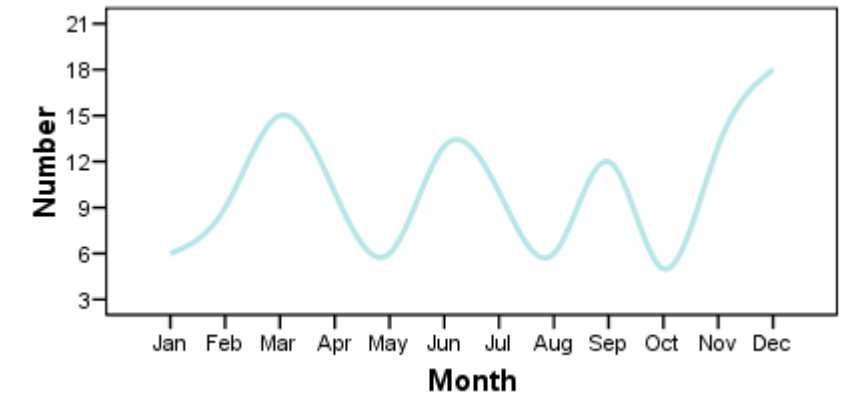


Figure 49: Gold Coast aerodrome total birdstrike by month, 2002 to 2006

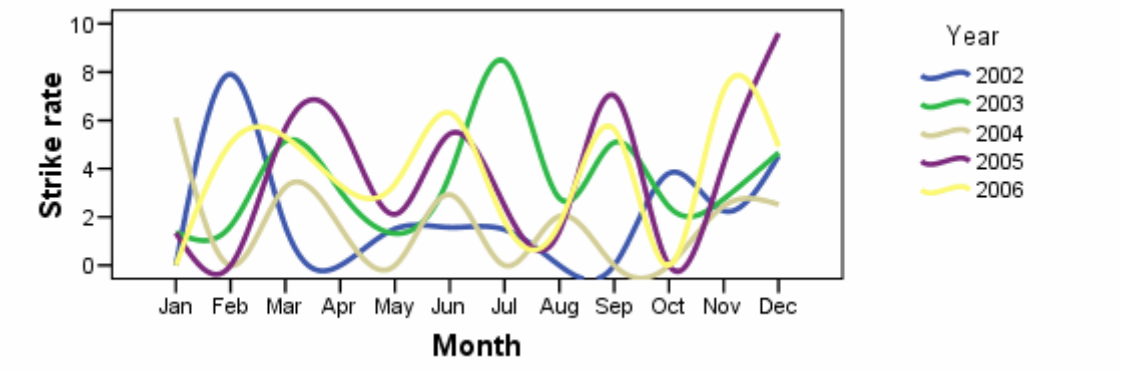


Table 60: Gold Coast aerodrome birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Flying-Fox	1	6	1	5	3	**16**
Fairy Martin	3	4	1	4	2	**14**
Martin	0	3	2	2	2	**9**
Duck	1	1	1	1	3	**7**
Swallow	2	2	3	0	0	**7**
Crow	2	0	0	2	0	**4**
Nankeen Kestrel	0	1	0	0	1	**2**
Australian Magpie	0	1	0	1	0	**2**
Egret	0	0	0	0	2	**2**
Galah	0	0	1	1	0	**2**
Pacific Black Duck	2	0	0	0	0	**2**
Purple Swamphen	0	1	0	0	1	**2**
Swift	0	0	1	0	1	**2**
Australasian Pipit	1	0	0	0	0	**1**
Bar-shouldered Dove	0	0	0	0	1	**1**
Barn Swallow	0	1	0	0	0	**1**
Cormorant	0	0	1	0	0	**1**
Dove	0	0	0	0	1	**1**
Eagle	0	0	1	0	0	**1**
House Sparrow	1	0	0	0	0	**1**
Osprey	0	0	0	0	1	**1**
Plover	0	0	0	0	1	**1**
Silver Gull	0	0	0	0	1	**1**
Welcome Swallow	0	0	0	1	0	**1**
Willie Wagtail	0	0	0	1	0	**1**
Not known	5	11	4	17	5	**42**
Total[40]	**18**	**31**	**16**	**35**	**25**	**125**

Table 61: Gold Coast aerodrome birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Flying-Fox	0	0	0	1	0	**1**
Total	**0**	**0**	**0**	**1**	**0**	**1**

40 More than one species struck.

Table 62: Gold Coast aerodrome near aerodrome birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Flying-Fox	0	0	1	0	1	**2**
Nankeen Kestrel	1	0	0	0	0	**1**
Brahminy Kite	0	0	0	0	1	**1**
Fairy Martin	0	0	0	1	0	**1**
Ibis	0	0	0	0	1	**1**
Silver Gull	0	0	0	1	0	**1**
Not known	3	4	7	5	8	**27**
Total	**4**	**4**	**8**	**7**	**11**	**34**

Table 63: Gold Coast aerodrome near aerodrome damaging birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Brahminy Kite	0	0	0	0	1	**1**
Total	**0**	**0**	**0**	**0**	**1**	**1**

8.10 Hobart aerodrome, Tas.

Hobart aerodrome is a coastal aerodrome located approximately 700 metres from the coast (Frederick Henry Bay). It is surrounded by water on three sides within a 1.5 km radius of the runway. The aerodrome abuts a golf course to the south west, and to the west is mainly small acreages and a light industrial complex. A pine tree plantation lies to the north east. A small town (Seven Mile Beach) lies to the south of the aerodrome. Weather in Hobart is temperate and about 50 per cent of total aircraft movements are RPT.

There were 108 at or near aerodrome birdstrikes at Hobart aerodrome. Of these, 97 occurred on the aerodrome for 140,054 aircraft movements between 2002 and 2006. This yields an overall strike rate of 6.93 per 10,000 total aircraft movements. There is no clear trend up or down in the reported number of birdstrikes over time. Damaging strikes occurred in four of 95 strikes (four per cent).

Figure 50: Aerodrome birdstrikes for Hobart aerodrome, 2002 to 2006

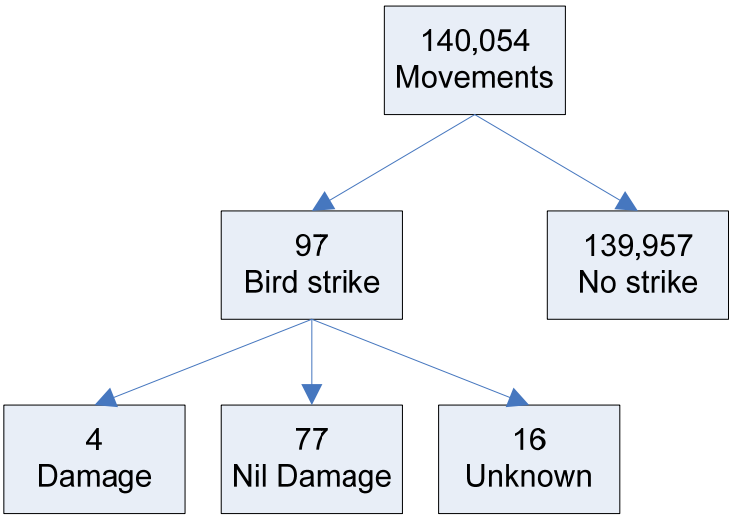
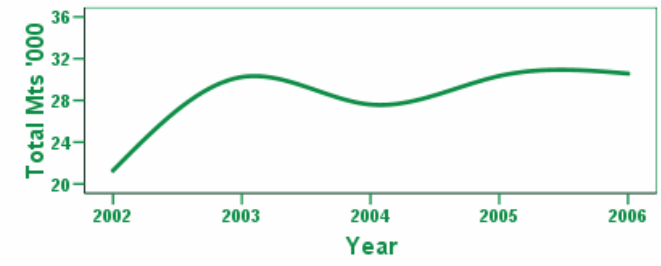
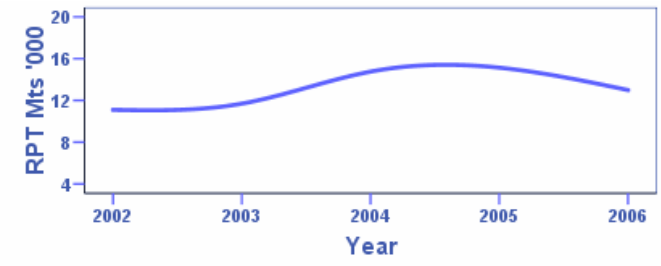


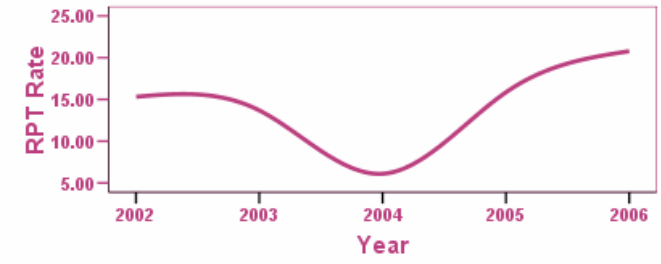
Figure 51: Hobart aerodrome, 2002 to 2006



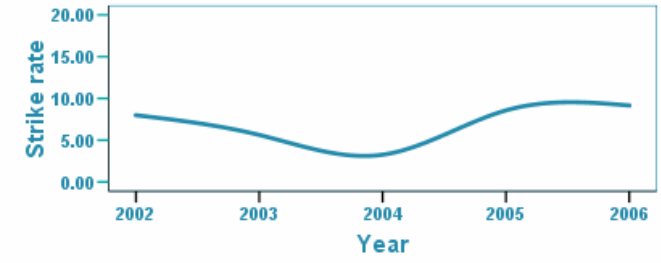
a. Total aircraft movements ('000)



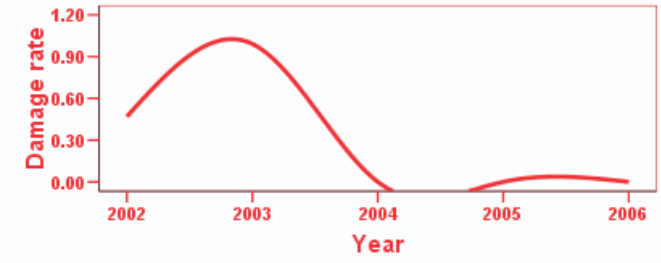
b. RPT aircraft movements ('000)



c. RPT birdstrike rate per 10,000 RPT aircraft movements



d. Birdstrike rate per 10,000 total aircraft movements



e. Damaging birdstrike rate per 10,000 total aircraft movements

Figure 52: Hobart aerodrome birdstrikes total by month, 2002 to 2006

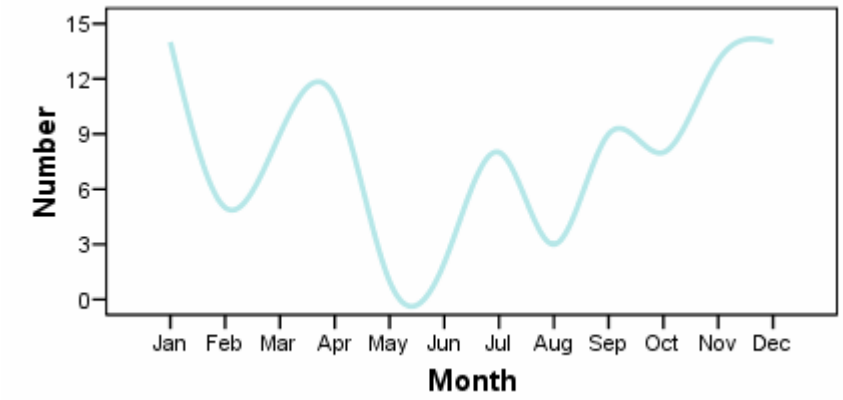


Figure 53: Hobart aerodrome birdstrike rate per 10,000 total aircraft movements by month and year, 2002 to 2006

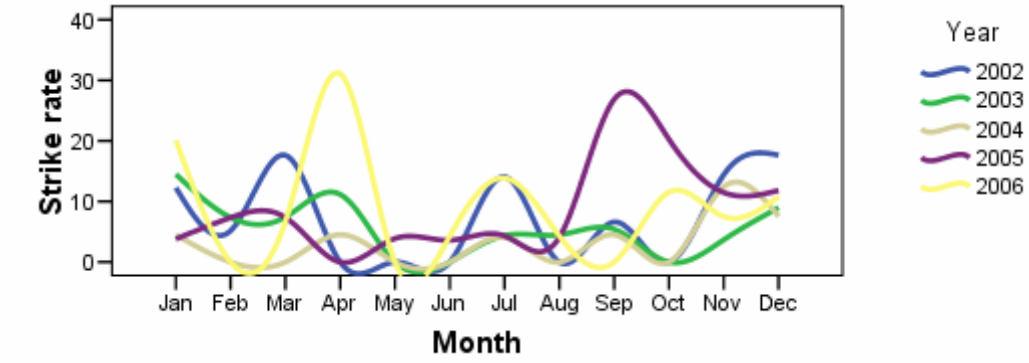


Table 64: Hobart aerodrome birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Plover	2	0	2	11	2	**17**
Silver Gull	3	0	1	3	0	**7**
Common Starling	1	3	0	1	2	**7**
Finch	1	1	0	1	3	**6**
Pacific Gull	1	3	0	2	0	**6**
Lark	0	2	0	1	1	**4**
Tasmanian Native-hen	0	3	0	0	1	**4**
Barn Swallow	1	0	1	0	1	**3**
Dotterel	0	0	0	0	3	**3**
European Goldfinch	0	0	0	1	2	**3**
House Sparrow	0	0	1	0	2	**3**
Eurasian Skylark	0	1	0	0	1	**2**
Hawk	1	0	1	0	0	**2**
Swallow	1	0	0	0	1	**2**
Australian Magpie	0	0	0	1	0	**1**
Gull	0	0	0	1	0	**1**
Masked Lapwing	1	0	0	0	0	**1**
Robin	0	0	0	0	1	**1**
Swamp Harrier	0	0	1	0	0	**1**
Not known	5	4	2	4	8	**23**
Total	**17**	**17**	**9**	**26**	**28**	**97**

Table 65: Hobart damaging aerodrome birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Masked Lapwing	1	0	0	0	0	**1**
Common Starling	0	1	0	0	0	**1**
Not known	0	2	0	0	0	**2**
Total	**1**	**3**	**0**	**0**	**0**	**4**

Table 66: Hobart aerodrome near aerodrome birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Pacific Gull	0	1	1	0	0	**2**
Hawk	1	0	0	0	0	**1**
Not known	2	1	1	2	2	**8**
Total	**3**	**2**	**2**	**2**	**2**	**11**

Table 67: Hobart aerodrome near aerodrome damaging birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Pacific Gull	0	1	1	0	0	**2**
Total	**0**	**1**	**1**	**0**	**0**	**2**

9 APPENDIX II: GAAP AERODROMES BIRDSTRIKES, 2002 TO 2006

The following section details birdstrikes at General Aviation Airport Procedures (GAAP) aerodromes.

9.1 Archerfield aerodrome, Qld.

Archerfield aerodrome is situated about 22 km from the coast in suburban Brisbane. Archerfield weather is subtropical and it mainly serves the general aviation community with a small number of helicopter movements each year. It is the main flying training aerodrome for the broader Brisbane population. The aerodrome is surrounded by industrial facilities to the north, east and south. To the south east and west are populated suburban areas, and to the west is a golf course.

During the period 2002 to 2006, there were 16 at or near aerodrome strikes, with 11 birdstrikes occurring at the aerodrome for 663,844 movements. This yields a rate of 0.17 birdstrikes per 10,000 total movements. Three damaging strikes were recorded for the period under observation. All occurrences reported for Archerfield contained information on the damage status of the aircraft.

Figure 54: Aerodrome birdstrikes for Archerfield aerodrome, 2002 to 2006

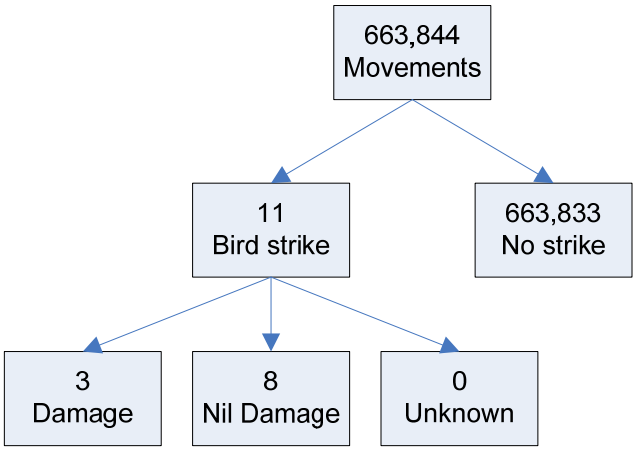


Table 68: Archerfield aerodrome birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Australian Magpie	0	0	0	1	1	**2**
Flying-Fox	0	0	1	0	1	**2**
Crow	0	0	0	1	0	**1**
Ibis	0	0	0	0	1	**1**
Plover	0	0	0	1	0	**1**
Not known	0	1	1	1	1	**4**
Total	**0**	**1**	**2**	**4**	**4**	**11**

Table 69: Archerfield aerodrome damaging birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Flying-Fox	0	0	1	0	1	**2**
Not known	0	0	0	1	0	**1**
Total	**0**	**0**	**1**	**1**	**1**	**3**

Table 70: Archerfield near aerodrome birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Not known	1	0	0	1	3	5
Total	1	0	0	1	3	5

Table 71: Archerfield near aerodrome damaging birdstrikes by species and year, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Not known	1	0	0	1	3	5
Total	1	0	0	1	3	5

9.2 Bankstown aerodrome, NSW

Bankstown aerodrome is the main training, charter and maintenance hub for Sydney. It is about 22 km from the coast and is surrounded by suburban population and industrial facilities. In addition, a river abuts the western border of the aerodrome. Bankstown has a temperate/sub tropical weather pattern, and accommodates a range of aircraft including helicopters and mid-sized aircraft between 7 and 136 tonnes. The majority of aircraft movements are amongst aircraft weighing less than 7 tonnes.

There were 59 near or at aerodrome birdstrikes at Bankstown aerodrome. Thirty-eight birdstrikes occurred for 1,474 million total aircraft movements between 2002 and 2006, giving a strike rate of 0.26 per 10,000 total aircraft movements. Damaging birdstrikes occurred in four of 38 (11 per cent) strikes at a rate of 0.03 per 10,000 total movements, or 2.7 per million total movements.

Figure 55: Aerodrome birdstrikes at Bankstown aerodrome, 2002 to 2006

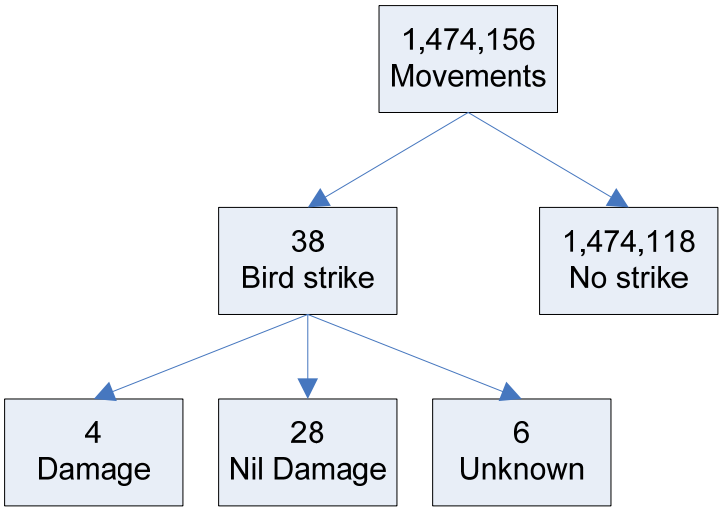


Table 72: Bankstown aerodrome birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Australian Magpie	1	2	1	2	1	**7**
Galah	0	3	2	1	0	**6**
Flying-Fox	1	1	0	0	1	**3**
Crow	0	2	0	0	0	**2**
Nankeen Kestrel	0	0	0	1	0	**1**
Duck	0	1	0	0	0	**1**
Ibis	0	1	0	0	0	**1**
Magpie-lark	0	0	0	0	1	**1**
Parrot	1	0	0	0	0	**1**
Plover	1	0	0	0	0	**1**
Rock Dove	0	0	1	0	0	**1**
Sulphur-crested Cockatoo	0	0	1	0	0	**1**
Swallow	0	1	0	0	0	**1**
Not known	4	2	0	3	2	**11**
Total	**8**	**13**	**5**	**7**	**5**	**38**

Table 73: Bankstown aerodrome damaging birdstrikes species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Flying-Fox	1	0	0	0	1	**2**
Ibis	0	1	0	0	0	**1**
Not known	1	0	0	0	0	**1**
Total	**2**	**1**	**0**	**0**	**1**	**4**

Table 74: Bankstown aerodrome near aerodrome birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Rock Dove	1	1	0	0	0	**2**
Australian Magpie	0	0	1	0	0	**1**
Duck	0	0	0	1	0	**1**
Flying-Fox	1	0	0	0	0	**1**
Hawk	0	0	0	1	0	**1**
House Sparrow	1	0	0	0	0	**1**
Sulphur-crested Cockatoo	1	0	0	0	0	**1**
Not known	5	0	4	2	2	**13**
Total	**9**	**1**	**5**	**4**	**2**	**21**

Table 75: Bankstown aerodrome near aerodrome damaging birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Australian Magpie	0	0	1	0	0	**1**
Rock Dove	0	1	0	0	0	**1**
Not known	1	0	1	0	0	**2**
Total	**2**	**1**	**0**	**0**	**1**	**4**

9.3 Camden aerodrome, NSW

Camden aerodrome is situated about 35 km from the coast in a semi rural setting. During World War II, it housed squadrons of aircraft and in the early 1980's it adopted GAAP status. It sits on a right sweeping river curve, and the township of Camden lies 1.5 km to the south east. To the west and south west are populated areas, to the north west are farms, and to the north east is an industrial area. Weather at Camden is temperate. Aircraft movements in 2006 are half what they were in 2002.

There were five at or near aerodrome birdstrikes at Camden, with three aerodrome birdstrikes for 192,206 total aircraft movements, yielding a birdstrike rate of 0.16 per 10,000 movements. None of these birdstrikes resulted in aircraft damage. Damage status was recorded for all strikes.

Figure 56: Aerodrome birdstrikes at Camden aerodrome, 2002 to 2006

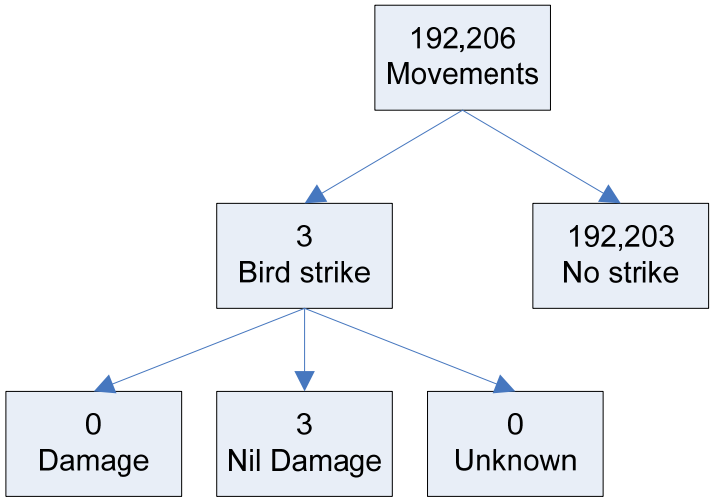


Table 76: Camden aerodrome birdstrikes species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Australian Magpie	1	0	0	0	0	**1**
Not known	1	0	0	0	1	**2**
Total	**2**	**0**	**0**	**0**	**1**	**3**

Table 77: Camden aerodrome near aerodrome birdstrikes species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Not known	1	0	1	0	1	**2**
Total	**1**	**0**	**1**	**0**	**1**	**2**

9.4 Jandakot aerodrome, WA

Jandakot aerodrome is located about 10 km from the coast in suburban Perth. It has the highest number of aircraft movements at any Australian aerodrome. Since 2002, aircraft movements have increased by almost 100,000 movements to 407,148 in 2006. Helicopters account for around six per cent (23,224 of 407,148) of movements and the weather is subtropical. To the south and north east of the aerodrome are industrial areas, while to the south west are small acreages. Populated areas are found in a 3 km radius from the runway.

Jandakot aerodrome had 109 near and aerodrome birdstrikes between 2002 and 2006. There were 102 aerodrome birdstrikes for 1,732 million movements over the five year period, yielding a rate of 0.59 birdstrikes per 10,000 movements. There were a total of six (of 102) damaging strikes or 0.03 damaging strikes per 10,000 total movements. Damaging strikes were not evenly dispersed over the period of study.

Figure 57: Aerodrome birdstrikes at Jandakot aerodrome, 2002 to 2006

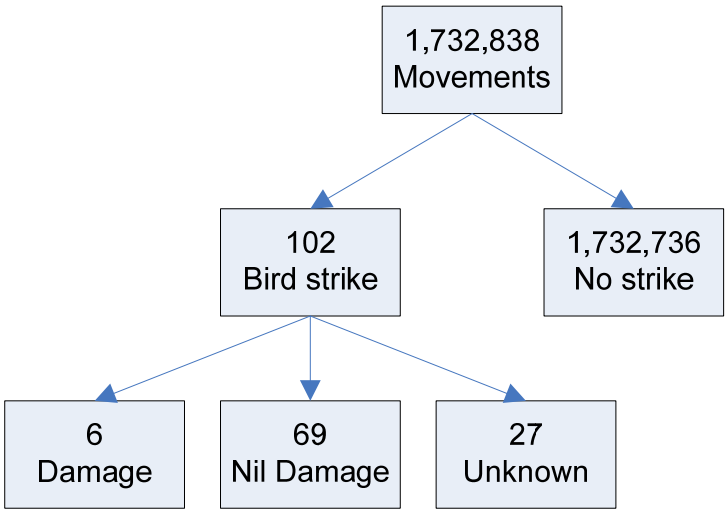


Table 78: Jandakot aerodrome birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Plover	11	2	10	5	11	**39**
Australian Magpie	1	2	1	1	3	**8**
Eagle	0	1	1	0	0	**2**
Robin	0	0	1	0	1	**2**
Swallow	0	0	0	0	2	**2**
Crow	0	1	0	0	0	**1**
Flying-Fox	0	0	1	0	0	**1**
Galah	1	0	0	0	0	**1**
Hawk	0	0	1	0	0	**1**
Ibis	0	1	0	0	0	**1**
Owl	0	0	0	0	1	**1**
Sulphur-crested Cockatoo	1	0	0	0	0	**1**
White-tail Black Cockatoo	0	1	0	0	0	**1**
Not known	9	7	6	9	10	**41**
Total	**23**	**15**	**21**	**15**	**28**	**102**

Table 79: Jandakot aerodrome damaging birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Eagle	0	1	1	0	0	**2**
Crow	0	1	0	0	0	**1**
Ibis	0	1	0	0	0	**1**
White-tail Black Cockatoo	0	1	0	0	0	**1**
Not known	0	1	0	0	0	**1**
Total	**0**	**5**	**1**	**0**	**0**	**6**

Table 80: Jandakot aerodrome near aerodrome birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Australian Pelican	0	0	1	0	0	**1**
Eagle	1	0	0	0	0	**1**
Hawk	0	1	0	0	0	**1**
Wedge-tailed Eagle	0	1	0	0	0	**1**
Not known	0	0	1	1	1	**31**
Total	**1**	**2**	**2**	**1**	**1**	**7**

Table 81: Jandakot aerodrome near aerodrome damaging birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Eagle	1	0	0	0	0	**1**
Hawk	0	1	0	0	0	**1**
Not known	0	0	0	0	0	**1**
Total	**1**	**1**	**1**	**0**	**0**	**3**

9.5 Moorabbin aerodrome, Vic.

Moorabbin aerodrome is coastal aerodrome situated in the eastern suburbs of Melbourne in a temperate weather zone. It is surrounded by industrial facilities to the south and east, suburban populations to the west and a golf course and industrial facility to the north. There has been some fluctuation in total aircraft movements over the period 2002 to 2006. Annual movements were around 250,000 in 2002, but subsequently dropped to around 230,000 movements in 2004. They rose to around 265,000 in 2005 and have subsequently fallen again in 2006 to roughly 236,000. When movement data for the period 2002 to 2006 are combined, around 15 per cent of movements are helicopters. According to Airservices Australia, it has seen the occasional large jet aircraft.

Moorabbin aerodrome had a total of 47 aerodrome and near aerodrome birdstrikes between 2002 and 2006. Of these birdstrikes, 41 occurred on the aerodrome for 1,218,826 movements. This yields an overall birdstrike rate of 0.34 per 10,000 total movements. Six strikes resulted in damage, which is roughly 15 per cent of birdstrikes. There were 6 near aerodrome birdstrikes, and 2 of these resulted in damage.

Figure 58: Aerodrome birdstrikes at Moorabbin aerodrome, 2002 to 2006

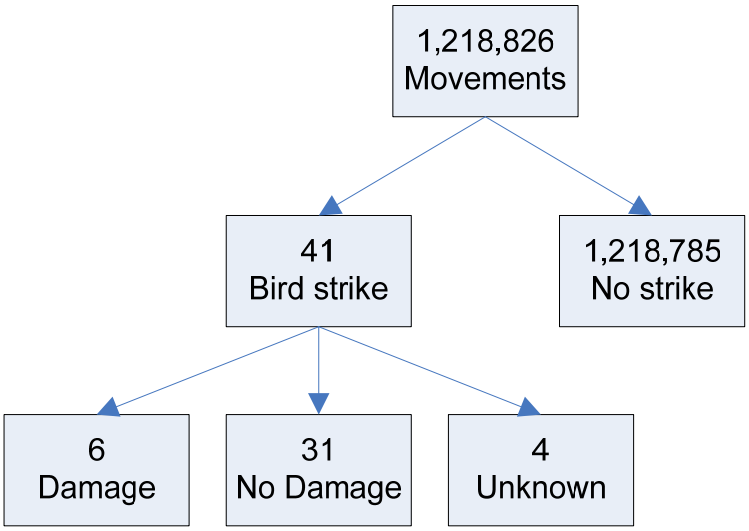


Table 82: Moorabbin aerodrome birdstrikes species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Silver Gull	1	2	3	5	3	**14**
Australian Magpie	0	0	4	0	0	**4**
Pacific Gull	2	1	1	0	0	**4**
Ibis	0	0	1	0	1	**2**
Galah	1	0	0	0	0	**1**
House Sparrow	0	1	0	0	0	**1**
Rock Dove	0	0	0	1	0	**1**
Not known	3	3	1	6	1	**14**
Total	7	7	10	12	5	**41**

Table 83: Moorabbin aerodrome damaging birdstrikes species by year, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Silver Gull	1	0	1	1	2	5
Ibis	0	0	0	0	1	1
Total	1	0	1	1	3	**6**

Table 84: Moorabbin near aerodrome birdstrikes species by year, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Ibis	0	0	1	0	0	1
Not known	1	0	0	0	0	1
Total	1	0	1	0	0	**2**

No near aerodrome damaging birdstrikes were recorded for Moorabbin.

9.6 Parafield aerodrome, SA

Parafield aerodrome is found in suburban Adelaide and is about 13 km from the coast. It is surrounded by populated areas and the weather is temperate. Total aircraft movements have increased over the period 2002 to 2006 by around 60,000, with a proportionate increase in helicopter movements occurring. Helicopter movements make up around three per cent of total aircraft movements.

Over the period 2002 to 2006 there were 90 aerodrome birdstrikes for 803,536 movements, with a strike rate of 1.12 per 10,000 movements. Two damaging strikes occurred, accounting for around two per cent of total birdstrikes.

Figure 59: Aerodrome birdstrikes at Parafield aerodrome, 2002 to 2006

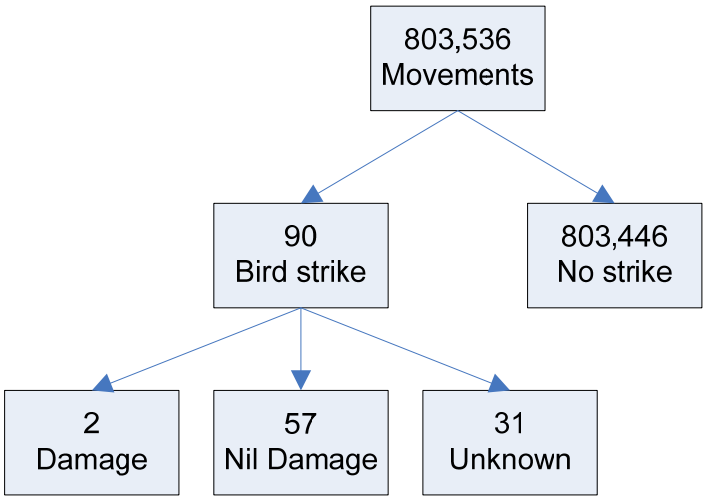


Table 85: Parafield aerodrome birdstrikes species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Australian Magpie	1	2	6	5	1	**15**
Magpie-lark	1	3	5	2	4	**15**
Silver Gull	3	4	3	1	0	**11**
Rock Dove	0	2	1	5	2	**10**
Galah	1	0	1	0	3	**5**
Hawk	2	0	1	0	0	**3**
Black Kite	0	1	0	0	0	**1**
Crested Pigeon	0	0	1	0	0	**1**
Cuckoo-shrike	1	0	0	0	0	**1**
Grey Goshawk	0	0	0	0	1	**1**
Common Starling	1	0	0	0	0	**1**
Tern	1	0	0	0	0	**1**
Whiskered Tern	1	0	0	0	0	**1**
Not known	5	2	2	11	4	**24**
Total	**17**	**14**	**20**	**24**	**15**	**90**

Table 86: Parafield aerodrome damaging birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Rock Dove	0	0	0	0	1	**1**
Not known	1	0	0	0	0	**1**
Total	**1**	**0**	**0**	**0**	**1**	**2**

Table 87: Parafield aerodrome near aerodrome birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Flying-Fox	0	0	0	0	1	**1**
Rock Dove	1	0	0	0	0	**1**
Not known	3	2	0	6	0	**11**
Total	**4**	**2**	**0**	**6**	**1**	**13**

Table 88: Parafield aerodrome near aerodrome damaging birdstrikes by species, 2002 to 2006

	2002	2003	2004	2005	2006	Total
Not known	0	0	0	2	0	**2**
Total	**0**	**0**	**0**	**2**	**0**	**2**

10 APPENDIX III: BIRD SPECIES BY TOTAL BIRDSTRIKES, 2002 TO 2006

Below is a list of all bird species that were recorded as being involved in a bird or bat strike anywhere in Australia between 2002 and 2006. Species are listed in alphabetical order. If the full common name of the species was provided to the ATSB, the name is recorded at that level; for example, Grey-headed Flying-Fox. Many reports recorded a loosely applied common name; for example, Flying-Fox. This can refer to many species. Rather than guess which species was struck, these names are recorded at common name level below. It may be necessary to combine various categories to gain a complete picture of the number struck. For example, it may be that all Curlews are Bush Stone-curlews.

Name	2002	2003	2004	2005	2006	Total
Apostlebird	1	1	0	0	0	**2**
Australasian Pipit	1	8	7	11	19	**46**
Australasian Shoveler	0	0	1	0	0	**1**
Australian Brush-turkey	2	1	3	1	5	**12**
Australian Bustard	0	0	0	0	2	**2**
Australian Hobby	0	0	0	1	0	**1**
Australian Magpie	26	31	66	41	46	**210**
Australian Pelican	1	2	2	1	1	**7**
Australian Pratincole	10	11	27	33	17	**98**
Australian Raven	0	1	1	0	0	**2**
Australian Wood Duck	1	1	0	2	2	**6**
Baird's Sandpiper	1	0	0	0	0	**1**
Banded Stilt	0	0	1	0	0	**1**
Barn Owl		1	1	1	3	**6**
Barn Swallow	1	1	1	0	1	**4**
Bar-shouldered Dove	0	0	0	0	2	**2**
Black Kite	25	37	32	48	75	**217**
Black Swan	0	0	0	0	1	**1**
Black Tern	0	1	0	0	0	**1**
Black-shouldered Kite	2	0	0	0	1	**3**
Blue-winged Kookaburra	0	0	0	0	1	**1**
Brahminy Kite	2	2	1	0	1	**6**
Brolga	0	0	0	0	1	**1**
Brown Falcon	0	2	0	1	0	**3**
Brown Goshawk	0	0	3	2	1	**6**

Name	2002	2003	2004	2005	2006	Total
Budgerigar	0	0	0	0	1	**1**
Bush Stone-curlew	0	1	5	10	17	**33**
Caspian Plover	0	1	1	0	0	**2**
Cattle Egret	0	0	1	0	1	**2**
Collared Sparrowhawk	0	0	0	3	0	**3**
Common Blackbird	0	1	0	0	2	**3**
Common Goldfinch	0	0	0	1	2	**3**
Common Myna	1	2	1	0	1	**5**
Common Starling	4	6	3	5	11	**29**
Corella	2	0	1	2	3	**8**
Cormorant	1	0	3	1	1	**6**
Crane	0	0	2	3	0	**5**
Crested Pigeon	1	0	2	0	0	**3**
Crimson Rosella	0	0	0	1	0	**1**
Crow	3	8	3	10	10	**34**
Cuckoo	0	0	0	1	0	**1**
Cuckoo-shrike	1	0	0	0	1	**2**
Curlew	6	9	13	26	8	**62**
Dotterel	0	1	2	2	3	**8**
Dove	1	0	1	1	4	**7**
Duck	6	9	13	14	10	**52**
Eagle	3	7	10	10	4	**34**
Eastern Curlew	0	0	1	0	0	**1**
Egret	0	0	2	1	3	**6**
Emu	0	0	0	1	0	**1**
Eurasian Skylark	0	1	1	1	4	**7**
Fairy Martin	3	4	3	5	2	**17**
Falcon	1	5	5	1	1	**13**
Finch	1	2	2	7	6	**18**
Flycatcher	0	1	0	0	1	**2**
Flying-Fox	36	77	56	52	56	**277**
Fork-tailed Swift	0	0	0	0	2	**2**
Frigatebird	0	0	0	0	1	**1**
Galah	34	46	58	63	85	**286**
Grey Goshawk	0	1	0	0	1	**2**

Name	2002	2003	2004	2005	2006	Total
Grey-headed Flying-Fox	0	0	0	0	1	**1**
Gull	0	0	1	3	1	**5**
Hawk	26	19	25	37	34	**141**
Heron	2	2	0	4	0	**8**
Horsfield's Bushlark	0	0	0	1	0	**1**
House Sparrow	17	13	17	24	12	**83**
Ibis	4	10	15	13	10	**52**
Kingfisher	0	0	1	0	0	**1**
Kookaburra	0	1	1	0	1	**3**
Lapwing	0	0	1	2	0	**3**
Lark	0	4	2	1	2	**9**
Little Curlew	1	3	0	1	4	**9**
Little Eagle	0	1	0	0	0	**1**
Magpie Goose	1	2	0	0	0	**3**
Magpie-lark	7	10	26	51	18	**112**
Major Mitchell's Cockatoo	0	0	0	0	1	**1**
Martin	0	3	2	3	2	**10**
Masked Lapwing	6	7	6	13	9	**41**
Masked Owl	1	0	0	0	0	**1**
Miner	0	1	0	0	0	**1**
Nankeen Kestrel	30	33	37	29	58	**187**
Nankeen Night Heron	1	0	0	0	2	**3**
Oriental Plover	0	0	1	1	2	**4**
Osprey	0	0	0	0	1	**1**
Owl	6	7	10	10	9	**42**
Oystercatcher	0	1	0	0	0	**1**
Pacific Black Duck	3	1	3	1	2	**10**
Pacific Golden Plover	0	1	0	0	0	**1**
Pacific Gull	3	5	2	2	1	**13**
Parrot	1	1	0	2	0	**4**
Peaceful Dove	0	0	1	0	0	**1**
Peregrine Falcon	0	2	1	1	1	**5**
Pied Cormorant	0	0	0	0	1	**1**
Pied Oystercatcher	0	0	0	1	0	**1**
Pink-eared Duck	0	0	0	0	1	**1**

Name	2002	2003	2004	2005	2006	Total
Plover	50	33	59	52	76	**270**
Purple Swamphen	1	1	0	0	1	**3**
Rainbow Bee-eater	0	0	0	0	1	**1**
Raven	1	0	0	1	2	**4**
Red-capped Plover	0	0	1	0	0	**1**
Robin	0	0	2	0	2	**4**
Rock Dove	8	9	12	15	12	**56**
Rufous Songlark	0	0	0	0	1	**1**
Sanderling	0	0	2	0	0	**2**
Sandpiper	2	3	3	2	0	**10**
Silver Gull	16	30	31	41	25	**143**
Spotted Harrier	0	0	0	0	1	**1**
Sulphur-crested Cockatoo	3	2	4	4	5	**18**
Swallow	10	18	25	26	35	**114**
Swamp Harrier	0	0	1	0	1	**2**
Swift	1	1	4	4	2	**12**
Tasmanian Native-hen	0	3	0	0	1	**4**
Tern	3	6	0	1	1	**11**
Thrush	1	0	0	0	0	**1**
Tree Martin	0	1	0	0	1	**2**
Turtle-dove	0	0	0	0	1	**1**
Wagtail	0	0	1	0	0	**1**
Wedge-tailed Eagle	2	1	2	2	2	**9**
Welcome Swallow	0	4	3	1	0	**8**
Whiskered Tern	1	0	0	0	0	**1**
Whistling Kite	2	0	7	6	4	**19**
White-breasted Woodswallow	0	0	1	0	0	**1**
White-faced Heron	2	0	1	1	2	**6**
White-tailed Black Cockatoo	0	1	0	0	0	**1**
White-throated Needletail	0	0	0	0	1	**1**
Willie Wagtail	0	0	0	2	1	**3**
Woodswallow	0	1	0	0	1	**2**
Wren	0	0	1	0	0	**1**
Zebra Finch	0	0	0	0	2	**2**

Name	2002	2003	2004	2005	2006	Total
Not reported	353	297	435	533	449	**2067**