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Canberra Airport's Submission on the Issues Paper for the Review of the National Airports Safeguarding Framework (NASF) Guideline C: *Managing the Risk of Wildlife Strikes in the Vicinity of Airports*

The Good Reason for an Effective Guideline C

Canberra Airport contends the effective mitigation of Bird Strike by the collaboration of all stakeholders is in the interest of Public Health and Safety resulting in a Social Dividend across the Broad Community and lower cost of aircraft operations.

Canberra Airport is committed and continues to support the intentions and purpose of the NASF. In terms of this Issues Paper, the following comments are provided:

Page 1 Last paragraph	"Implementation and enforcement of the guideline are out of scope for this review." This is the core problem as airports have no statutory enforcement power nor seek it. The Department of Infrastructure, Transport, Regional Development, Communications and the Arts (DITRDCA) protects the airspace around leased Federal airports under Part 12 of the *Airports Act 1996* and the *Airports (Protection of Airspace) Regulations 1996* to facilitate the safety, efficiency, and regularity of aircraft operations in the interest of the community.
Page 4	Canberra Airport does not agree that there is any ambiguity about responsibility between airports and planning authorities. Airports have DITRDCA and CASA enforcing/imposing an obligation on airports to reduce the risk of wildlife strikes with aircraft on airports. Off airport, the planning agencies have the clear power and airports only have an influencing role. The airport is disappointed DITRDCA and CASA do not exercise their powers, pursuant to the *Airports (Protection of Airspace) Regulations 1996*, to implement measures to robustly protect aircraft operations in the region from bird and wildlife threats and hazards off airports consistent with the intent of Guideline C.
Page 4 Paragraph 16	The statement above is again relevant in that DITRDCA and CASA should exercise their powers, pursuant to regulated airspace, to protect aircraft from bird and wildlife threats and hazards off airports.
Page 4 Paragraph 17	Canberra Airport agrees that: This review Issues Paper is an opportunity to consider whether the obligation should be clarified to apply equally to planning authorities off Airports.

Page 4 Paragraph 18	Canberra Airport agrees there is an: Opportunity to strengthen this opportunity from (can) to an obligation (should or shall).
Page 4 Paragraph 19	If this means that planning agencies should align their planning documentation with the Airport's Wildlife Hazard Management Plan (WHMP) then Canberra Airport is in agreement with this suggestion.
Page 5 Paragraph 20	Canberra Airport: ▪ Believes the 13km airport buffer zone should be extended to be consistent with the OLS perimeter. ▪ Would support improving links to Attachment 1 table. ▪ Asks the question - If the NASF is not implemented in the State/Territory planning tools and criteria, how do planners know what to do? Back to the core problem. ▪ Suggests that the NASF be a standing agenda item for future Canberra Airport Planning Co-ordination Forum (PCF) meetings, which is attended by senior officers of Commonwealth, NSW and ACT planning agencies.
Page 5 Paragraphs 21 and 22	Canberra Airport reiterates that airports do not have the power to enforce – only influence. Consulting will not resolve any problems unless planning agencies will participate and acknowledge that Best Practice Urban Planning includes NASF Guidelines. Reference to the Australian Airports Association Airport Practice Note 9: *Wildlife Hazard Management at Airports* would assist planning agencies to better understand why it is essential that they implement the NASF into their planning regimes. Copy attached.
Page 5 Paragraph 23	Canberra Airport has a bird strike reporting system and retains records; as does the ATSB. This system is outlined in the Bird and Wildlife Hazard Management Plan. The Airport suggests that this data should be shared with the land use planners by inviting the NCA, EPSDD, QPRC and NSW Planning to participate in meeting at least once a year with CASA, DITRDCA and the Airport.
Page 6 – Attachments – land uses, activity types and buffers	Canberra Airport offers the following: ▪ Most of the capital city airports have main runways over 3km long. This means the 3km circle is less than 1.5km outside of an airport. ▪ DITRDCA and CASA enforce/impose an obligation on airports to reduce the risk of wildlife strikes on airport. ▪ Guideline C should be more focussed about off airport bird and wildlife Management. ▪ In terms of risk specific to Canberra Airport, the outer distance is 13km or 7 nautical miles (nm) in the context of the main runway 17/35 extended centre line, from the Airport reference point, in the south reaches the southern housing perimeter of Jerrabomberra NSW and in the north, the ACT/NSW border, rural residential area north of the Federal Highway.

	▪ The 8km distance is 4.4nm. To the south this reaches Aldi adjacent to the ILS marker on the Poplars and to the north of the AFP campus in the Majura Valley. ▪ At circa 4nm from the touch down zone (TDZ), the aircraft are about 1,000 feet above ground level (AGL). ▪ A Tiger A320 on the ILS arrival flight path to Runway 35 hit and killed a Wedge-tailed Eagle at about 5nm from the TDZ - the Eagle was recovered from Lake Jerrabomberra (further detail and image provided below). ▪ Canberra Airport suggests that the buffers for 3km, 8km and 13km should be measured from the runway ends or at least the runway TDZ – or out to where the aircraft on arrival are not less than 1,500 feet AGL. ▪ For Canberra, with rising land out from all the runway ends, this may be more than 13km. ▪ Most importantly, the sensitive areas to protect are the STAR and SID flight path corridors for Runway 17/35 and the OLS splays for Runway 12/30.
Discussion Questions	Canberra Airport provides no further comments on Discussion Questions, 1, 3, 4, 5, 6, 7, 8, 10, 11, 12 and 13, other than what has already been stated above.
Page 5 Q2	The general thrust of landscaping for the purposes of Guideline C should have a focus on not attracting birds, including water birds.
Page 6 Q9	Canberra Airport has answered this question suggesting that the Airport buffers should be calculated from either the runway ends, or the runway TDZ.

As set out in the 2019 Implementation Review Report of October 2021, not much has happened in the context of NASF implementation ten years on. This is evidenced below where Canberra Airport recites the comments it offered in terms of Guideline C to the Draft National Airports Safeguarding Framework in a submission dated 15 March 2012. They suggest these comments are still relevant in 2022:

> *"Canberra Airport supports the key considerations for managing risk of wildlife strikes in the vicinity of airports.*
>
> *Canberra Airport makes the following comments:*
>
> 1. *We support the concept of the guidelines and some of the specific guidelines, especially the concept of collaboration of airports with government agencies and land managers. However, without legislative power, backing the airport and the guidelines it will be difficult to enforce when required. The need is for an overarching Legislative backing as part of State and Territory Planning Policies and the Local Planning instruments that require consultation with the airport in compliance with Guideline C.*
>
> 2. *13km Radius - without legislative backing the 13km radius is far too great an area for placing the liability on the airport if a strike or occurrence was to occur outside the current definition of "within the airport boundary". This also would require additional Airport resources to manage this increased area of responsibility and liability. We note that the 13km radius when overlaid onto Canberra Airport and region includes some of the defined specific high risk wildlife attractants, such as Googong Dam Lake, within the 13km radius and Lake Burley Griffin and the Molonglo River within the 8km zone.*

3. *Canberra Airport contends that the best practice model requires that Airservices Australia, CASA and the Airport be consulted by the Planning and Building Approval Authority. This can be readily achieved, as set out in Item 1 above, via State and Territory Planning Policies requiring local planning instruments to include this consultation regime in a harmonisation of town planning criteria across all States and Territories.*

4. *Key Considerations: paragraph 13 refers to "the appropriate authority shall take action" as recommended by the ICAO convention Annex 14 Clauses 9.4.3 and 9.4.4 and 9.4.5. Although this is a consideration, who is this authority? This needs to be clearly defined.*

5. *Paragraph 13 and others: Again some of the wording used in the guidelines such as "Airport **should** take immediate action to address bird hazards whenever detected". Without legislative backing what actions can be taken by an Airport to enforce action by a landowner within a 13km radius?*

6. *The specific high risk wildlife attractants noted in paragraph 15 do not include turf farms, fruit farms, showgrounds, rubbish tips and wetlands which are within the 8km radius as noted in Attachment 1, requiring mitigation. These should be aligned, as they are common activities in and around city and country airports.*

7. *Again under paragraph 22 we note that Airports "should negotiate". Without Legislative backing this is an onerous task to achieve. It is also not clear who would be responsible for the cost of ongoing action plans as listed in this item.*

8. *Paragraph 24 makes recommendations that need more clarity. These are as follows:*

   ***Wildlife Management Plans** - Who approves this? Who pays for this? Who is responsible if a wildlife strike occurs? Who owns it?*

   ***Performance Bonds** - who manages and administers this – Local Councils?*

   ***Authority for airport** - who issues this authority to inspect and monitor properties – Department of Infrastructure and Transport?*

9. *Paragraph 26 - Flying foxes are protected species and until this is reviewed, the safety benefits of wildlife management planning by airports and land use authorities is marginal given their protection.*

10. *Managing off-airport wildlife strike risk*

    (i) *Canberra Airport suggests that the existing consultation mechanisms of the Planning Coordination Forum and the Community Aviation Consultation Group are the best practice model to achieve paragraphs 21-23.*

    (ii) *Canberra Airport also suggests that a review and application of the Airport's declared prescribed airspace would assist the Secretary of the Department of Infrastructure and Transport with enforcement protocols, as required.*

11. *Further to Item 10 above, Canberra Airport contends that the risk of wildlife strike outside the Airport boundary is a shared risk mainly by Airservices Australia, who determine where the aircraft fly, the Airlines and others, including pilots, who own and/or operate the aircraft, and the Local Government authorities managing development, including vegetation, under the flight paths. The Airports have a significant interest in the safe and efficient operation of the Airport and the flight paths to and from the Airport. Canberra Airport contends therefore, that the final Guideline C should clarify the shared risk managers, as set out above, outside the Airport boundary."*

Some Examples of Bird Strike Impacts

Canberra Bird Strike – 16 September 2019

On 26 September 2019, an A320 was on final approach into Canberra Airport when it struck a large bird at about 1,500 feet AGL, causing extensive damage to the nose cone. DNA sample was taken of the strike. Through the Canberra Airport wildlife consultant, who is a member of the local Canberra bird group, a member of the group found a Wedge-tailed Eagle under the approach path for Runway 35 believed to have been struck by the A320. DNA evidence confirmed that a Wedge-tailed Eagle was the species struck. The aircraft was taken offline in Canberra for a few days while it was repaired.

Canberra Bird Strike

Airport VA B 737-800 hit two Black Swans on departure to Adelaide South of the Airport east of Fyshwick. One bird entered and destroyed the starboard jet engine – the port engine remained untouched. The other Swan was caught in the flaps and died. The pilot circled to use up fuel and to investigate what was working before thankfully a safe emergency landing at Canberra Airport.

16 September 2019 – A320 Damage caused by Bird Strike at Canberra Airport

International Bird Strike

On 15 January 2009, US Airways Captain Chesley "Sully" Sullenberger became an overnight hero when he and his crew ditched a commercial airliner (Airbus A320-214) into the freezing waters of New York's Hudson River after an unlucky encounter with a flock of geese. All 155 passengers and crew aboard survived. The geese destroyed both engines and it was a miracle no one died.

15 January 2009 – Airbus A320-214 in Hudson River following strike by flock of geese

Bird and Wildlife Strike Cost

Below are some studies on bird strike costs in 1999 and 2000. Although this data is aged, all current indicators suggest that bird and wildlife strikes have been increasing over the years (except for the last Covid impacted years).

The actual costs are difficult to calculate in Australia as no relevant studies are available.

It would be useful if an outcome from the Issues Paper is that the Australian Transport Safety Bureau (ATSB) undertakes a study with the assistance of the Bureau of Infrastructure and Transport Research Economics (BITRE) on the annual costs of bird and wildlife strikes in Australia.

Table 2 Estimated costs of birdstrike damage and delays to the world airline fleet in 1999 and 2000

	1999	**2000**
Total number strikes per 10,000 flights	16.2	19.2
Total cost per strike	US$ 42,947	US$ 33,020
Total cost per flight	US$ 69.7	US$ 62.2
Total cost to world commercial aviation	US$ 1.36 billion	US$ 1.21 billion

Source: August 2001: The Costs of Birdstrikes to Commercial Aviation – University of Nebraska-Lincoln – Bird Strike Committee – USA/Canada, Third Joint Annual Meeting, Calgary, AB

Military figures are more accurately tracked and they are:

- The US military suffers around US$33 million per year in damages.
- UK Air Force suffers around US$23 mil per year.

Canberra Airport would be happy to engage in any further discussion about the comments it has provided in this submission by contacting the writer.

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Enclosure:
Australian Airports Association Airport Practice Note 9: *Wildlife Hazard Management at Airports*

AUSTRALIAN
AIRPORTS
ASSOCIATION

WILDLIFE HAZARD MANAGEMENT AT AIRPORTS

AIRPORT PRACTICE NOTE 9

MARCH 2016

ABOUT THE AUSTRALIAN AIRPORTS ASSOCIATION

The Australian Airports Association (AAA) is the national industry voice for airports in Australia. The AAA represents the interests of more than 260 airports and aerodromes Australia wide – from local country community landing strips to major international gateway airports.

There are a further 130 corporate partners representing aviation stakeholders and organisations that provide goods and services to the airport sector. The AAA facilitates co-operation among all member airports and their many and varied partners in Australian aviation, whilst contributing to an air transport system that is safe, secure, environmentally responsible and efficient for the benefit of all Australians and visitors.

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The AAA is the leading advocate for appropriate national policy relating to airport activities and operates to ensure regular transport passengers, freight, and the community enjoy the full benefits of a progressive and sustainable airport industry.

These Airport Practice Notes are prepared on behalf of industry to promote 'best practice' across airport operations.

If you have any questions regarding this document please contact the AAA on 02 6230 1110.

This Airport Practice Note has been prepared on behalf of the AAA by:

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FOREWORD

The Australian Airports Association (AAA) commissioned preparation of this airport practice note to provide aerodrome operators with a comprehensive guide to wildlife hazard management in Australia to support a safe and sustainable airport industry. The airport practice note will assist aerodrome operators to manage the wildlife hazard at their aerodrome by providing them with a full overview and examination of the different aspects and considerations that are required when managing the risk of wildlife at aerodromes.

The AAA was encouraged to develop this document following the release of the Australian aviation wildlife strike statistics 2004 – 2013 document produced by the Australian Transport Safety Bureau (ATSB), which identified wildlife strikes as one of the biggest factors affecting the safe and efficient operation of aerodromes across the country. As a result of this report the AAA partnered with Avisure, in consultation with members, to produce a document that collates the relevant wildlife hazard management theories and practices available to industry.

The AAA believes that this airport practice note provides members with a comprehensive best practice overview to wildlife hazard management at Australian aerodromes. The AAA believes this document delivers a guide that will assist aerodrome operators to produce plans, programs and procedures to ensure they meet their regulatory compliance requirements along with helping them to reduce the risk of wildlife strikes at the aerodrome. The AAA believes that this document will be a very worthwhile and useful asset to aerodrome operators across Australia.

The AAA would like to acknowledge the contribution of Avisure in the development of this extensive project and members of the AAA wildlife working group for their contribution.

GLOSSARY

active management	The use of short-term management techniques such as distress calls, pyrotechnics, trapping and lethal control to disperse or remove wildlife.
airport services manual	Series of publications from the International Civil Aviation Organization that provide civil aviation recommendations and guidance.
airside	The movement area of the airport, adjacent terrain and buildings or portions thereof within the airport security fence line
anti-perching spikes	Rows of vertical spikes installed on structures, such as building ledges and light fittings, to prevent birds from perching.
aviation ecologist	Specialist ecologists in the field of wildlife hazard assessment, monitoring and management on airports.
bird watch condition report	Report that details strike hazard warnings (eg low, moderate, high severe) for aircrew, often accompanied with strike mitigation recommendations.
consequence	The outcome of an event expressed qualitatively or quantitatively, being a loss, injury, disadvantage or gain. There may be a range of possible outcomes associated with an event.
crepuscular	Appearing or active at dusk or dawn.
critical area	Areas within, or in close proximity to, the flight strip, approach and landing paths, and movement areas of an airport
dispersal	The act of harassing and scaring animals from aircraft movement areas, generally by using various noise and visual devices.
diurnal	Appearing or active during the daylight period.
En route supplement Australia	Australia's civil aviation Aeronautical Information Publication. Aeronautical Information Publications contain long term aeronautical information essential to air navigation in accordance with International Civil Aviation Organization Annex 15 (Aeronautical Information Services).
granivorous	Animals that feed on plant seeds.
habituation	The tendency for wildlife to become accustomed to a certain stimulus when repeatedly exposed to it.
hazard	A source of potential harm or a situation with potential to cause loss.
hazardous species	Those wildlife species that are assessed as very high, high, or moderate risk.
foraging	When animals search for and obtain food.
impact force	The force or shock applied over a short time period when two or more bodies collide. The effect depends on the relative velocity of the bodies to one another, as well as their respective masses.
landside	Landside areas include airport parking lots, public transportation, passenger pickup/drop-off areas, access roads, and terminal buildings.
lethal control	The removal of bird(s) or animal(s) from the population through the use of poisons, shooting, or other humane means.
loafing	When animals rest.
long grass management	Where airports control the height of airside grasslands as a means of deterring animals.
macropod	The marsupial family Macropodidae, which includes kangaroos, wallabies, tree-kangaroos, and pademelons.
multiple strike	A single wildlife strike event involving more than one animal. Wildlife species that flock, such as Galahs and Silver Gulls, are more likely to be involved in a multiple strike.

notice to airmen	A notice to alert aircrews of potential hazards along a flight route or at a location that could affect the safety of the flight.
off-airport hazard	Land uses and activities outside the airport's management jurisdiction that attract wildlife that contribute to wildlife strike risk (eg landfill, agriculture, water bodies etc).
passive management	The modification of habitat to render it less attractive to wildlife.
probability	The likelihood of a specific event or outcome, measured by the ratio of specific events or outcomes to the total number of possible events or outcomes.
putrescible waste	Food and organic waste generated by human activity.
pyrotechnics	Combustible projectiles launched from a shotgun, pistol or other device to frighten wildlife by producing noise, light or smoke.
recommended practices	Wildlife hazard management guidance material produced by the Australia Aviation Wildlife Hazard Group for the aviation industry to: » use the most suitable elements that are available from worldwide practice » capture the unique experiences and knowledge available from our industry » tailor practices to meet the conditions that are unique to Australia.
risk assessment	A quantitative or qualitative estimate of risk related to a recognised hazard.
risk mitigation	Actions applied to reduce the chance of a strike occurring.
risk profile	The determination and categorisation of an airport's strike risk. May be completed in terms of aircraft movements, airport operations, wildlife species densities and distributions, wildlife behaviour, and contributing factors such as climate and off-airport land uses.
roosting	When birds repeatedly return to a particular place in numbers to loaf or spend the night.
routine reportable incidents	A transport safety matter that has not had a serious outcome and does not require an immediate report but transport safety was affected or could have been affected. Under section 19 of the *Transport Safety Investigation Act 2003*, a responsible person who has knowledge of a routine reportable matter must report it within 72 hours with a written report to a nominated official (as per the Australian Transport Safety Bureau).
safety management system	Systematic approach to managing safety. Key elements include: organisational structures, accountabilities, policies and procedures.
separation-based dispersal	Maintaining separation between wildlife and aircraft in flight (any phase) in real time by clearing wildlife away from aircraft movement paths and advising aircraft so that they can remain clear of wildlife movement paths.
significant strike investigation	The process of investigating strikes that have resulted in serious aircraft damage, flight delay, human injury or fatality.
species information sheets	Airport practice note prepared by the Australian Airports Association to provide advice and guidance on management of hazardous wildlife species at Australian airports.
strike report	Report submitted to the Australian Transport Safety Bureau following a wildlife strike incident.
transiting	When birds fly from one place to another.
wildlife strike	Deemed to have occurred whenever: » a pilot reports a strike to the Australian Transport Safety Bureau » aircraft maintenance personnel find evidence of a bird or animal strike on an aircraft » personnel on the ground report seeing an aircraft strike one or more birds or animals » bird or animal remains are found on the airside pavement area, or within the runway strip, unless another reason for the bird or animals death can be established.

wildlife strike: confirmed	Deemed to have occurred whenever: » aircrew report that they *definitely* saw, heard or smelt a bird strike » bird or animal remains are found on the airside pavement area or within the runway strip, unless another reason for the bird or animal's death can be found » aircraft maintenance personnel find evidence of a bird or animal strike on an aircraft.
wildlife strike: near miss	Deemed to have occurred whenever a pilot takes evasive action to avoid birds or animals.
wildlife strike: on-aerodrome	Deemed to be any strike that occurs within the boundary fence of the aerodrome, or where this is uncertain, where it occurred below 500 ft on departure and 200 ft on arrival.
wildlife strike: suspected	Deemed to have occurred whenever a bird or animal strike has been suspected by aircrew or ground personnel but upon inspection no bird or animal carcass or remains are found, and there is no physical evidence on the aircraft of the strike having occurred.
wildlife strike: remote from aerodrome	Deemed to have occurred whenever a bird strike occurs more than 15 km from an aerodrome or more than 1000 ft above the elevation of the aerodrome.
wildlife strike: vicinity of aerodrome	Deemed to have occurred whenever a bird strike occurs outside the area defined as 'on aerodrome' but within an area of a 15 km radius from the aerodrome reference point or up to 1000 ft above the elevation of the aerodrome.
terrestrial animal	Land-dwelling animals.
wildlife count	Standardised and replicable procedure to count wildlife.
wildlife hazard assessment	An evaluation of an airport's wildlife hazards and their management. Often includes a compliance audit against civil aviation regulations, relevant aviation legislation, and/or international best practice standards, as well as a risk assessment to determine high and moderate risks.
wildlife hazard management plan	Documents an airports wildlife hazard management program that at least includes: » an overview of high and moderate risk species (determined via risk assessment) » descriptions of the roles and responsibilities of the wildlife control team and other stakeholders » goals and targets of the wildlife management program » procedures describing how to identify, manage and monitor wildlife hazards and implement specific elements of wildlife management programs » a process for reviewing and updating the wildlife hazard management plan.
wildlife hazard notifications	Notifications for aircrew that detail moderate to severe wildlife hazards, including strike mitigation recommendations. Extends on notice to airmen by providing more detail about the nature and management of the identified hazard.
wildlife patrol	Airside patrols usually conducted by wildlife control personnel to identify the presence of wildlife, with a particular emphasis on critical aircraft movement areas.

ABBREVIATIONS

AAWHG	Australian Aviation Wildlife Hazard Group
AC	Advisory Circular
AIP	Aeronautical Information Package
APN	airport practice note
ARP	Aerodrome Reference Point
ASRI	Airport Species Risk Index
ATC	air traffic control
ATIS	Automatic Terminal Information Service
ATSB	Australian Transport Safety Bureau
BAM	Bird Avoidance Model
BASH	bird aircraft strike hazard
BRDB	bird-ingestion rulemaking database
BWC	bird watch condition
CAMBA	China–Australia Migratory Bird Agreement
CASA	Civil Aviation Safety Authority
CFR	Code of Federal Regulations (US)
CTAF	common traffic advisory frequency
EPBC	*Environment Protection and Biodiversity Conservation Act 1999*
ERSA	en route supplement Australia
FOD	foreign object debris
IATA	International Air Transport Association
IBIS	Bird Strike Information Database
IBSC	International Bird Strike Committee
ICAO	International Civil Aviation Authority
IE	Average infringement rate
JAMBA	Japan–Australia Migratory Bird Agreement
JAR-E	Joint Aviation Regulations engines
KPI	key performance indicator
LAME	licenced aircraft maintenance engineer
MOS	Manual of Standards
NASF	National Airports Safeguarding Framework
nm	nautical miles
NOTAM	notice to airmen
PIC	pilot in command
PPE	personal protective equipment
	Republic of Korea–Australia Migratory Bird Agreement
SAP	species action plan
SMS	safety management system
SOP	standard operating procedure
SRI	Survey Risk Index
SSIR	significant strike investigating and reporting
UK	United Kingdom
USA	United States of America
WBA	World Birdstrike Association
WHA	wildlife hazard assessment
WHMP	wildlife hazard management plan
WHN	wildlife hazard notification
WMP	wildlife management plan

SECTION 1: BACKGROUND

Introduction

In Australia, wildlife striking aircraft is the most common aviation occurrence reported to the Australian Transport Safety Bureau (ATSB). Strike rates per 10 000 aircraft movements have shown an increasing trend since wildlife strike reporting became mandatory under the *Transport Safety Investigation Act 2003*. Increasing strike rates may cause concern among airport operators, suggesting that their management efforts are ineffective. However, improved strike reporting by operators allows the aviation industry to better understand the true strike rate. In response to wildlife hazards, airports often complete a wildlife hazard assessment (WHA), then develop and implement wildlife hazard management plans (WHMPs), which, when based on more accurate data, provide for more effective management.

Why are airports concerned about wildlife?

Wildlife is attracted to airport environs in response to the availability of food, water, shelter and the safety of a relatively predator-free environment. The presence of wildlife on and around an airport can lead to conflict in the form of aircraft strikes.

Between 2004 and 2013, 14 571 wildlife strike occurrences were reported to ATSB (ATSB 2014). The average strike rate for high capacity air transport was 7.4 strikes per 10 000 movements. Six wildlife incidents to high capacity air transport were considered serious.

The most struck species during that time were Black Kite, galah, bat[1], plover[2], kites[3], flying-fox[4], swallow[5], Nankeen Kestrel, and duck[6].

For general aviation, 1445 wildlife incidents were reported between 2004 and 2013 with an average strike rate of 0.3 strikes per 10 000 movements (ATSB 2014).

Wildlife strike consequences

The main factors determining the consequences of a wildlife strike are the number and size (body mass) of wildlife struck, the phase of flight when struck, the speed of the aircraft, the type of aircraft and the part of the aircraft hit. Generally, the larger the animal, the greater the damage. Large animals have the ability to destroy engines and windshields and cause significant damage to airframe components and leading edge devices. Strikes involving more than one animal (multiple strikes) can be serious, even with relatively small animals, potentially disabling engines and/or resulting in major accidents.

Impact-force, determined by the animal mass and impact speed, influences the consequences of a strike. There are other contributing factors such as impact angle, the size of the animal(s) and the speed of the aircraft that determine the impact force and therefore the likelihood of damage.

Globally, wildlife strikes cost the civil aviation industry US$1.2 billion per year (Allan 2000), with an average per strike cost estimated at US$36 000[7]. These figures are broad estimates and account for direct costs:

- delays
- cancellations
- cost of repairs, including labour, parts, transport costs, and aircraft downtime
- time spent on inspections, including baroscopic and forensic investigations
- resources spent to transport engineers to remote or regional airports to carry out inspections
- time spent rescheduling flights and passengers
- costs of accommodating passengers that have been rescheduled on other flights
- resources spent on follow up investigations for significant strike incidents
- aircraft write-offs.

1 Likely to include flying-foxes and micro-bats.
2 Likely to include Masked Lapwing and smaller plovers.
3 Likely to include kites (Black Kite, Whistling Kite, Brahminy Kite, Black-shouldered Kite) and other raptors.
4 Likely to include Grey-headed Flying-fox, Black Flying-fox, Spectacled Flying-fox, or Little Red Flying-fox.
5 'Swallow' is often used to describe any small insectivorous bird, including Fairy Martin, Tree Martin, Welcome Swallow, or Barn Swallow.
6 Likely to include Pacific Black Duck and Wood Duck.
7 Estimates of per strike costs include: US$39,705/strike (Allan 2000); US$67,000/strike (McCreary 2009); US$31,000/strike (FAA 2012); AUD$7,000 (Taylor 2007).

Ancillary strike costs, or indirect costs, are more difficult to source and quantify, but include: loss of customer loyalty; tainted safety record; negative corporate image; lower service quality and perceived value; poor industry reputation; liability costs and payouts; and changes to insurance premiums.

Litigation following significant strike incidents has resulted in judgements against the airport operator. Judgements are generally based on the airport operator not showing appropriate duty of care or not facilitating their wildlife management programs in accordance with regulations and documentation. Some examples include:

1. More than US$15 million settlement was paid out in 1985 for an incident at JFK Airport (New York, USA) in November 1975. An ONA DC10 struck a flock of gulls, and the judge ruled that ineffective bird hazard control was one of the contributors to the accident (Dolbeer 2006). The legal battle that ensued was complex, with ONA and the aircraft owner (Bank of America) suing, in various state and federal courts, the Federal Aviation Authority, the Port Authority or New York, the Port Authority of New Jersey, New York City, and several aerospace companies. Exact amounts paid by each party and their insurance companies is unknown.
2. TNT Air Cargo was awarded US$2 million compensation, following a strike with gulls at Genoa Airport (Genoa, Italy). Liability was assigned as: 50 per cent to the Ministry of Transport, 30 per cent to the private company operating the airport, and 20 per cent to the Port Authority (Battistoni, 2003).
3. A private jet owner, who struck a deer on take-off from Nashville International Airport (Nashville, USA), sued the Metropolitan Nashville Airport Authority for US$1.4 million. The lawsuit was won in trial court, but lost in the court of appeals because of the liability legislation that capped the government's liability for property damage to only US$50 000 (Dolbeer 2006).
4. The French Aviation Authority sued the Port Authorities of New York and New Jersey for the US$7 million damage bill after an Air France Concord struck Canada Geese while landing at JFK Airport (New York, USA). They settled out of court for US$5.3 million (Transport Canada 2004).

What can airports do about wildlife?

Using this practice note as a guide to manage wildlife, airports need to apply a WHMP that is consistent with their safety management system (SMS). The Civil Aviation Safety Authority (CASA) requires a WHMP to be developed as part of the aerodrome manual; where regular monitoring confirms existence of a bird or animal hazard to aircraft operations, or when CASA so directs. The management plan must be prepared by a suitably qualified person such as an ornithologist or a biologist. It should be based on a risk assessment that identifies the main hazards and systematically manages these, with appropriate monitoring and data collection to allow risks to be periodically reviewed.

Management approaches will include habitat management to reduce the overall attraction of the airport and its surrounds, and active controls. This usually involves providing training and equipment to airside operations staff to disperse or remove wildlife hazards. Engagement with stakeholders is also a critical element to ensure a truly integrated program.

Airport Practice Note Number 9 – Wildlife hazard management

There are a number of good guidance documents for airport operators that have been produced internationally or for particular countries such as Canada, United States of America (USA), and the United Kingdom (UK). The Australian Aviation Wildlife Hazard Group (AAWHG) has developed some guidance material including recommended practices and a WHMP template, but in Australia, we lack a comprehensive document that guides airport operators on wildlife management, relevant regulations, best practices and standards.

This airport practice note is designed to fill that gap by consolidating relevant international and local information to provide an Australian context for wildlife hazard management at airports. It is structured to provide an understanding of regulations, and guidance for an airport through the process of identifying wildlife hazards, developing a WHMP, implementing a wildlife management program, and evaluating program effectiveness. However, each section can be read independently. References, further reading and appendices are provided at the back to assist further research where it is required.

CASE STUDY: First recorded fatal strike

Date/location:
3 April 1912 Long Beach, California (USA)

Aircraft/operator:
Calbraith Rogers

Phase/altitude:
Unknown

Damage:
Destroyed

Injuries/fatalities:
1 fatality

Species struck:
Gull

Description:
Following the completion of the first trans-American flight, aero-pioneer Cal Rodgers collided with a gull which became jammed in his aircraft control cables. He crashed at Long Beach California, was pinned under the wreckage and drowned.

Source: https://en.wikipedia.org/wiki/Calbraith_Perry_Rodgers

CASE STUDY: First fatal civil airline strike

Date/location:
4 October 1960, Boston International Airport, USA.

Aircraft/operator:
Lockheed Electra, Eastern Airlines

Phase/altitude:
Take-off, altitude unknown

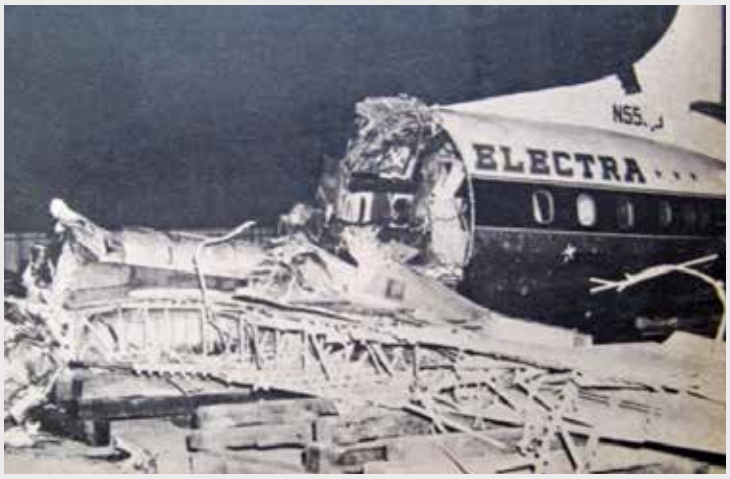
Damage:
Destroyed

Total on board: 72

Injuries/fatalities:
62 fatalities

Species struck:
Starlings

Description:
Eastern Airlines Flight 375, struck starlings (10 000 starlings) 20 seconds after take off. The birds struck three of four engines, lost power, stalled, then crashed into Boston Harbor. Resulted in more stringent Federal Aviation Administration guidelines for aircraft design and maintenance.



Source: https://en.wikipedia.org/wiki/Eastern_Air_Lines_Flight_375

CASE STUDY

Date/location:
11 April 2008, Evans Head (Australia)

Aircraft/operator:
F1-11, RAAF

Phase/altitude:
900m

Damage:
Nose, radome, engine

Total on board: 2

Injuries/fatalities:
Nil

Species struck:
Australian Pelican

Description:
While flying over a test bombing range a pelican struck the fiberglass nose and was sucked into an engine. Despite the damage, the aircraft was flown back to Amberley Air Base.

Source: www.news.com.au/national/f-111-almost-downed-by-a-pelican/story-e6frfkp9-1111116104156 and http://www.slideshare.net/lexl/f111-bird-strike

CASE STUDY

Date/location:
May 2015, Nevsehir (Turkey)

Aircraft/operator:
B737-800, Turkish Airlines

Phase/altitude:
Final approach, altitude unknown

Damage:
Nose, wings

Total on board:
Unknown

Injuries/fatalities:
Nil

Species struck:
Unknown (a flock of birds was reported)

Description:
The aircraft flew through a flock of birds during the final approach, impacted multiple birds, resulting in substantial damage. The occurrence aircraft was able to position back to Istanbul's Ataturk Airport about eight hours later and resumed service the following day.

Source: http://avherald.com/h?article=485d4116 and http://rt.com/news/255961-turkish-airlines-plane-bird/

CASE STUDY

Date/location:
16 July 2010, Kimberley Airport (South Africa).

Aircraft/operator:
DH8C, South African Express Airways

Phase/altitude: Landing, 0m AGL

Damage: Landing gear

Total on board: 44

Injuries/fatalities: Nil

Species struck: Aardvark

Description:
Struck an Aardvark (40–65 kg) on landing. The nose landing gear took a direct hit and collapsed, after a temporary loss of directional control, the runway centreline was regained and the aircraft brought to a stop. A 'MAYDAY' call was made by the aircraft commander during the deceleration. The investigation found wildlife access to the aerodrome was commonplace and the attempts at control inadequate.

Source: www.skybrary.aero/index.php/DH8C,_Kimberley_South_Africa,_2010_%28RE_BS%29

CASE STUDY

Date/location:
25 May 2008, Zaventem Airport (Brussels).

Aircraft/operator:
B747, Kalitta Air

Phase/altitude:
Take off run, 0m AGL

Damage: Destroyed

Total on board: Unknown

Injuries/fatalities: 5 minor injuries

Species struck: European Kestrel

Description:
Rejected take off after a European Kestrel strike, overrunning the runway, and the aircraft broke into three pieces. Incident investigation identified that 'the accident was caused by the decision to reject the take off 12 knots after passing V1 speed', with the following contributing factors:

- number three engine stalled after experiencing a bird strike.
- take off parameters had been computed using the full length of the runway, but aircraft lined up at the B1 intersection.
- the crew had limited situational awareness
- less than maximum use of deceleration devices
- a RESA does not conform to the ICAO recommendation for length.

Source: http://aircrewbuzz.blogspot.com.br/2009/07/final-report-issued-for-kalitta-air.html and http://www.skybrary.aero/index.php/B742,_Brussels_Belgium,_2008_(RE_BS_HF)

CASE STUDY

Date/location:
17 January 2009, Forrest City (USA)

Aircraft/operator:
Unknown helicopter, Baptist Med-Flight

Phase/altitude:
En route from Memphis to Little Rock, altitude unknown

Damage:
Various

Total on board:
Unknown

Injuries/fatalities:
1 minor injury

Species struck:
Unknown

Description:
Struck a flock of birds and made an emergency landing.

Source: www.flickr.com/photos/fireflyphotography/sets/72157612944812758/

CASE STUDY

Date/location:
2009, San Diego (USA)

Aircraft/operator:
High performance aerobatic aircraft

Phase/altitude:
Mid-race

Damage:
Horizontal stabiliser

Total on board:
1

Injuries/fatalities:
Nil

Species struck:
Pelican

Description:
During the first interval, pilot Hannes Arch hit a pelican which punctured a hole in the horizontal stabiliser shortly before the midway point. Arch was unable to level his wings properly through the next air gate. He finished the race, in third place, and landed safely.

Source: www.redbull.com/cs/Satellite/en_air/Video/Archs-Bird-Strike-In-San-Diego-2009-021238615428145

SECTION 2: THE REGULATORY ENVIRONMENT

There are a number of regulations, standards and guidelines for the assessment and management of activities that contribute to an airport's wildlife strike risk. An outline is presented here and further detail is provided in the appendices.

International legislation, practices and agreements

International Civil Aviation Organization

The International Civil Aviation Organization (ICAO) is a specialised United Nations agency that coordinates and regulates international civil aviation. As a signatory of the Convention on International Civil Aviation, Australia is required to maintain aviation rules that align with the requirements of the convention. This includes standards for wildlife hazard management at civilian airports in accordance with Annex 14, Volume 1 (Aerodrome Design and Operation), which establishes requirements for the management of collisions between wildlife and aircraft, and requires authorities to take actions to reduce the prevalence of wildlife-attracting sites in the vicinity of airports.

ICAO's Doc. 9137 - *Airport Services Manual* Part 3, *Wildlife Control and Reduction*, (2012) elaborates on the wildlife management responsibilities of airports, providing guidance on the development and implementation of effective airport wildlife management programs, while recognising that geographic location, climate, attractiveness of the site to wildlife and air traffic density are site specific and that programs should be developed accordingly. Doc. 9137 also includes recommendations on hazard review and habitat management, and identifies a recommended boundary for monitoring off-airport wildlife hazards and land uses (appendices A and B).

ICAO's regulations and standards inform CASA regulations and recommendations for wildlife management at airports, and are therefore relevant to the airport bird and bat strike risk assessment.

International Air Transport Association

The International Air Transport Association (IATA) provides little information regarding wildlife strikes, but does recommend the correct way to handle animal remains:

www.iata.org/whatwedo/safety/health/Documents/health-guidelines-bird-strike-2011.pdf

World Birdstrike Association

Superseding the International Bird Strike Committee (IBSC) in 2012, the World Birdstrike Association (WBA) aims to be the worldwide catalyst for improving flight safety by reducing the wildlife strike risk for aviation in a cost-effective way, considering the need for a sustainable environment. Its primary working document—inherited from the IBSC—is the Recommended Practices No.1: Standards for Aerodrome Bird/Wildlife Control (2006). These standards are recommended by ICAO.

http://worldbirdstrike.com/index.php/resources/publications/ibsc-best-practices-manual

International migratory bird agreements

1. Australia has signed three international treaties that aim to minimise impacts on major areas used by birds migrating between Australia and Asia:
2. Japan–Australia Migratory Bird Agreement (JAMBA)
3. China–Australia Migratory Bird Agreement (CAMBA)

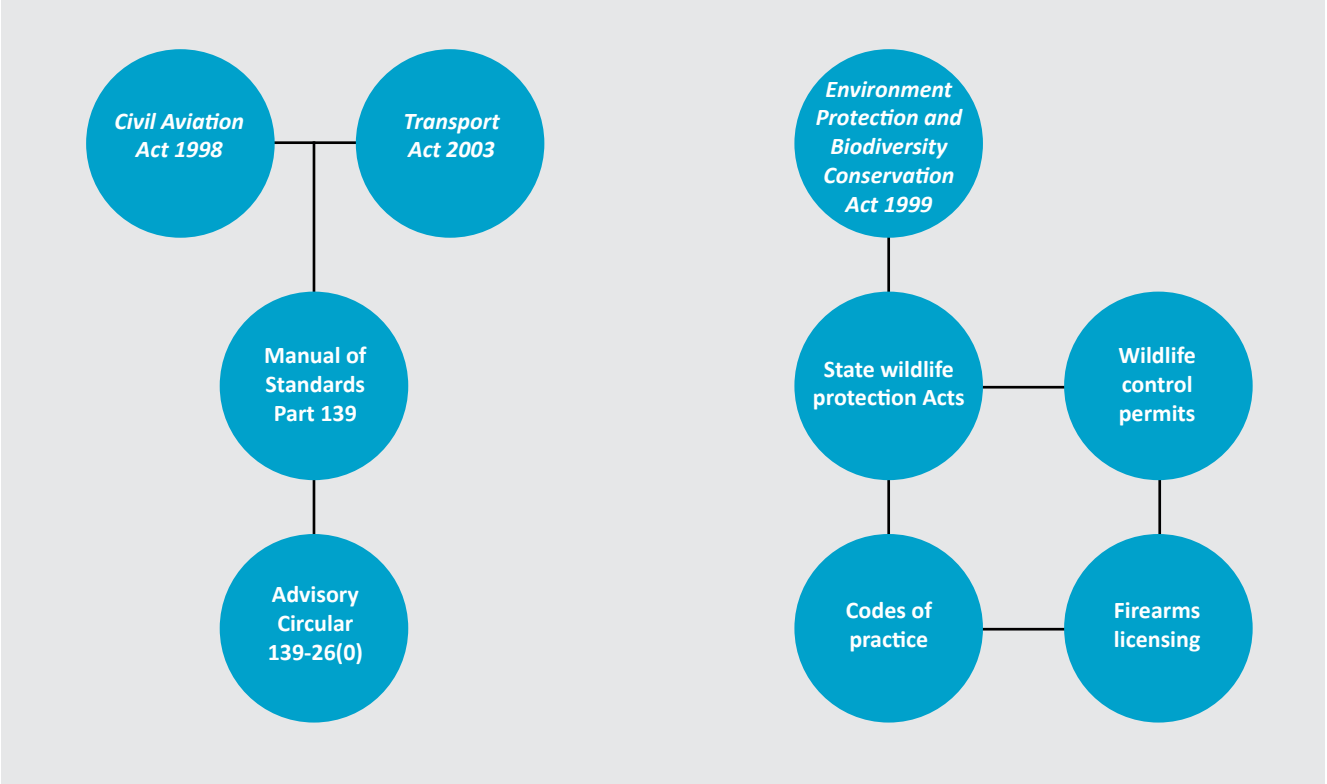
Republic of Korea–Australia Migratory Bird Agreement (ROKAMBA)).

Each treaty provides a list of birds protected under the agreements and this may have implications for species management on airports. Refer to Appendix C for bird lists under each agreement.

National legislation and guidelines

Managing wildlife on and around airports requires consideration of a suite of legislative and regulatory requirements. In addition to international obligations as a member state to ICAO, there are also national, state and territory requirements. Figure 1 and Table 1 summarise these requirements and recommendations.

Figure 1 Summary of key legislative and regulatory instruments for wildlife hazard management on Australian airports.



State and territory legislation and guidance

Management of wildlife at airports is also regulated under certain state and territory legislation and codes of practice (some codes of practice apply nationally). These mainly relate to the use of firearms, lasers, pyrotechnics and to the legal, humane and safe lethal control and disturbance of wildlife. They may also apply to the removal or destruction of eggs and nesting materials.

The clearing of vegetation or other habitat management practices that have potential to disturb native vegetation or habitat may also fall under these requirements (or under the EPBC Act if involving matters of national significance). For more details, refer to Appendix F.

Table 1 Australian regulation and legislation relevant to wildlife hazard management at airports.

Instrument	Oversight	Description	Link
Civil Aviation Act 1998	CASA	Establishes CASA functions in relation to civil aviation, with a particular emphasis on safety.	www.comlaw.gov.au/Series/C2004A03656
Civil Aviation Safety Regulations 1998	CASA	Details Commonwealth legislation regarding all aspects of civil aviation safety, and establishes the regulatory framework. Part 139 (Aerodromes) contains specific requirements for wildlife hazard management.	
Manual of Standards (MOS) Part 139 Aerodromes	CASA	Part 139 prescribes the aerodrome requirements. Sections relevant to wildlife hazard management focus on: bird hazard information for the Aeronautical Information Package (AIP) (5.1.3.24); drainage and drains in the runway strip (6.2.23.2); requirements for serviceability inspections (10.2.2.1, 10.2.7, 10.2.10.1, 12.1.3.2); Notice to Airmen (NOTAM) requirements for bird hazards (10.3.2.2, 10.3.6.1); reporting officer responsibilities (10.6.3.1, 10.6.4.1), animal hazard management requirements (10.14); and standing water on paved surfaces (10.15.4.2). Refer to Appendix D for details.	www.comlaw.gov.au/Details/F2014C01301
Advisory Circular (AC) 139–26(0) Wildlife Hazard Management at Aerodromes	CASA	The advisory circular is intended to provide recommendations and guidance for Part 139 compliance, by providing interpretative and explanatory material to assist aerodromes.	www.casa.gov.au/wcmswr/_assets/main/rules/1998casr/139/139c26.pdf
Transport Safety Investigation Act 2003	ATSB	Bird strikes are defined as reportable matters, of which written reports must be submitted within 72 hours.	www.comlaw.gov.au/Series/C2004A01102
Environment Protection and Biodiversity Conservation (EPBC) Act 1999	Commonwealth Department of the Environment	The EPBC Act provides the framework for the protection of the Australia's natural environment and its biodiversity and establishes processes that help to protect threatened species and ecological communities, and promote their recovery. Within the context of wildlife hazard management on airports, of principal consideration is the effect that management actions, such as dispersal and lethal control, may have on threatened species. The management of species listed as either critically endangered, endangered, vulnerable or conservation dependent under the Act, may require departmental approval and airports may need to consult the department for clarification. The EPBC Act also identifies species protected under the various international migratory bird agreements.	www.environment.gov.au/epbc
National Airports Safeguarding Framework Guideline C	Department of Infrastructure and Regional Development[8]	Aims to develop informed land use planning decisions to safeguard airports and their adjacent communities from wildlife hazards based on the international and national regulatory framework. See Appendix E.	https://infrastructure.gov.au/aviation/environmental/airport_safeguarding/nasf/nasf_principles_guidelines.aspx .

8 Formerly the Department of Infrastructure and Transport

SECTION 3: WILDLIFE HAZARD MANAGEMENT PLAN

Documentation

A wildlife hazard management plan (WHMP) documents an airport's wildlife hazard management program, but it sits within a greater framework of documents that includes:

1. Safety management plan.
2. Aerodrome manual – some aerodrome operators provide a summary of the WHMP in the aerodrome manual, with the detail provided in a separate document. Others provide the detail in the aerodrome manual itself.
3. Standard operating procedures (SOPs) – SOPs related to wildlife management usually sit within the WHMP.
4. Aerodrome emergency plan.
5. Airport master plan.
6. Airport environment plan/strategy.

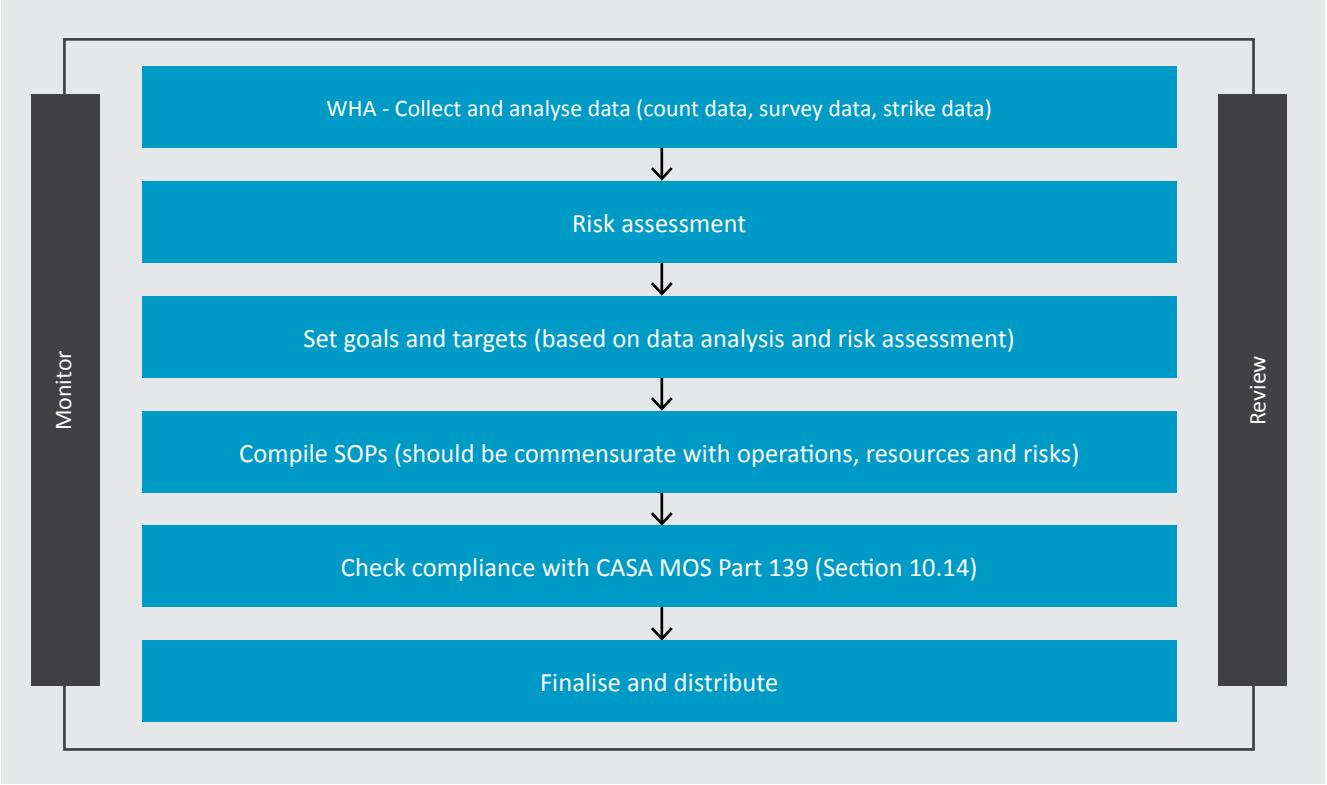
The WHMP must take into account other documents to ensure consistency.

Developing a WHMP

Although the CASA Manual of Standards directs airports to produce a WHMP where regular monitoring confirms the existence of a wildlife hazard to aircraft operations, or when CASA directs the airport to do so, developing and implementing a WHMP is also the most appropriate means of mitigating risk.

The suggested approach to developing a WHMP is summarised in Figure 2.The WHMP should be preceded by a WHA (Section 4) which includes a risk assessment (Section 5). The WHA is used to establish goals and targets and monitoring programs (Section 6) which are documented in the WHMP. The WHMP also details management actions (Section 7); the collation of strike reports (Section 8); hazards communication to stakeholders (Section 9); staff training (Section 10); and wildlife management program evaluation (Section 11).

Figure 2 Suggested approach to developing a WHMP.



Wildlife hazard management plan contents

The AAWHG has developed a template that provides suggested content for WHMPs (http://aawhg.org/publications-and-tools/) including:

1. A risk assessment (gathered via a WHA) that prioritises individual species risk and considers the number of wildlife incidents (including strikes).
2. Procedures for pilot notification that includes: NOTAMs in response to any significant increase or concentrations in wildlife both on and in the vicinity of the aerodrome; an En route supplement Australia (ERSA) entry that specifies the nature of the hazard including species, location, attraction, timing/duration.
3. Liaison and working relationships with land use planning authorities.[9]
4. On-airport wildlife attractants which provide food, water or shelter.[10]
5. Suitable harassment methods that include: Pre-emptive (passive) methods (appropriate fencing, removal of food and habitat, use of spikes, wires, nets, selection of low wildlife attracting plants, grass management, removal of waste, appropriate landscape techniques), and; active methods (scare tactics (horns, sirens, pyrotechnics), lures, dogs, distress calls, capture and lethal control. CASA recommends airports seek guidance from suitably qualified personnel and from suggested recommended practices and legislative requirements.
6. An ongoing strategy for wildlife hazard reduction.[11]

Roles and responsibilities

Clearly defined responsibilities encourage accountability by ensuring that all management elements are accounted for and job expectations are clear. Roles and responsibilities should be commensurate with airport operations, existing responsibilities, and the extent of the wildlife hazard management program, but may include:

- WHMP endorsement and authorisation
- liaising with aircraft operators, local government and other stakeholders (including land use planning authorities) to assist in identifying and managing wildlife issues
- reviewing and updating the WHMP
- counting, inspecting, assessing, removing, recording and reporting wildlife or potential attractions as described in the relevant sections of the WHMP
- ensuring that wildlife management personnel are trained and competent in the functions required for wildlife hazard management.

Depending on the nature and extent of stakeholder involvement, roles and responsibilities can also be extended to air traffic control, airlines, airport tenants, CASA, local government, state government, planning authorities, and off-airport land users.

Examples of roles and responsibilities are summarised in Table 2.

9 The MOS does not provide specific requirements, however it is recommended that airports: identify land use planning authorities; include planning authorities, and other off-airport stakeholders, in wildlife committee meetings, and; liaise closely with stakeholders when planning and executing hazard management treatments.

10 The MOS does not provide specific requirements, however it is recommended that airports: identify key attractants; map key attractants; manage, modify or remove the attractants; prioritise management based on risk; monitor regularly.

11 The MOS does not provide specific requirements, however it is recommended that airports: stage and prioritise management that incorporates new technologies such as radar; integrate a 'whole-of-industry' approach to management; develop measurable scorecards and KPIs; facilitate preventative risk assessments for all on, and the vicinity of, airport constructions and operations.

Table 2: Summary of WHMP roles and responsibilities

Stakeholder	responsibilities
Airport manager	Endorse the final version of the WHMP.
	Ensure the resources for implementing the WHMP are provided.
Airport safety manager	Oversee the implementation and review of the WHMP.
	Ensure operations staff are trained and competent in the functions required for wildlife hazard management, including wildlife count, identification, harassment, and reporting techniques.
	Ensure the WHMP and procedures are issued to relevant staff and applied where necessary.
	Ensure operations staff adhere to responsibilities listed in the WHMP.
	Liaise with aircraft operators, local government and other stakeholders to assist in identifying and managing wildlife issues at wildlife management meetings.
	Ensure relevant sections of the WHMP are reflected in the Aerodrome Operations Manual.
Airport planning and development	Ensure an appropriate mechanism exists for notification of development and land use changes with potential to attract hazardous wildlife populations in the vicinity of the airport.
Aerodrome reporting officers	Count, inspect, assess, remove, record and report wildlife or potential attractions as described in the relevant sections of the WHMP and SOPs.
	Use, store and maintain firearms as required by the airport's firearm policy.
	Accurately record management actions as described in the relevant sections of the WHMP and procedures.
Airport grounds maintenance	Ensure waste is disposed of appropriately and bins and other waste storage facilities are maintained with closed lids or other suitable covering.
	Maintain or modify grass, landscapes and ground conditions where required.
Air traffic control	Ensure compliance with procedures in the Manual of Air Traffic Services. Particular attention should be given to the notification of bird hazards and reporting strikes to operations staff.
	Provide a representative to attend wildlife committee meetings.
	Inform operations staff of any reported strikes, near misses or indications of heightened risk conditions.
Aircraft operators	Require air and ground crews to promptly inform operations staff of all bird and animal strikes or hazardous conditions.
	Require ground staff to relay evidence of strikes including damage, carcasses, feathers, or other material to operations for collection.
	Provide copies of strike records to airport management for cross referencing and data validation.
	Attend wildlife committee meetings.
Airport tenants	Ensure waste is disposed of appropriately and bins and other waste storage facilities are suitable for the level of waste generated and maintained with closed lids or other suitable covering. Ensure waste levels in surrounding areas are monitored and maintained.
	Promptly report observations of bird nesting in hangars to airport operations staff.
	Attend wildlife committee meetings.
Local government authorities and land managers in the vicinity of the airport	Consider the potential for the wildlife attraction when developing land use strategies
	Attend wildlife committee meetings.
Civil Aviation Safety Authority	Ensure audits are completed thoroughly and in accordance with the MOS (ie make sure the WHMPs comply with the MOS).
	Ensure all regulatory changes relevant to wildlife strike management are communicated to airport operators.
	Attend wildlife committee meetings.

Reviewing the WHMP

Reviews and updates are recommended to maintain currency, update risks and hazards, and monitor program progress against targets.

Annual reviews

The CASA MOS Part 139 requires a review of the WHMP as part of each technical inspection, and is supported where necessary with the assistance of a suitably qualified and experienced aviation ecologist. The annual review should:

- be based on performance indicators and assessment findings
- detail progress of the plan against the key performance indicators (KPIs)
- recommend management actions to further reduce the strike risk
- ensure compliance with all current legislation
- re-assess the risk to determine current high and moderate risk species
- ensure all procedures, roles, and responsibilities are current and relevant.

Although annual reporting is not a regulatory requirement, it can assist airports to evaluate the progression of their wildlife management programs and the efficacy of their WHMPs. These reports can consolidate information for program stakeholders and identify gaps and highlight changes in risk profiles that can influence management efforts. Annual reporting should:

- summarise the re-assessed species risks to highlight high and moderate risk species
- provide a review of the programs' progression against any KPIs, goals and targets that have been established
- summarise key initiatives and issues for the reporting period
- summarise intended actions for the following year.

Triggered reviews

CASA recommends a triggered review (ie at periods less than the standard review cycle) when:

- an aircraft experiences multiple wildlife strikes
- an aircraft experiences substantial damage following a wildlife strike
- an aircraft experiences an engine ingestion of wildlife, or
- wildlife is observed on the aerodrome in size or in numbers that are capable of causing the events described above.

CASE STUDY: Sydney Airport Wildlife Management Plan

Sydney Airport's wildlife management plan (WMP) sets clear objectives, performance indicators and procedures for the systematic management of the wildlife strike risk. The WMP, which is updated annually, is the guiding document for wildlife hazard management, however Sydney Airport also facilitates routine reporting throughout the year (monthly, quarterly, and half-yearly), to maintain an up-to-date understanding of risks and hazards. The focus of the WMP details how Sydney Airport identifies, manages, and monitors their wildlife risks, principally in the form of SOPs and species action plans (SAPs). SOPs relating to: strike reporting; wildlife counts; wildlife hazard surveillance; and wildlife dispersal, provide step-by-step instruction for the airport safety team, and the SAPs provide targeted management guidance for species assessed as high or moderate risk.

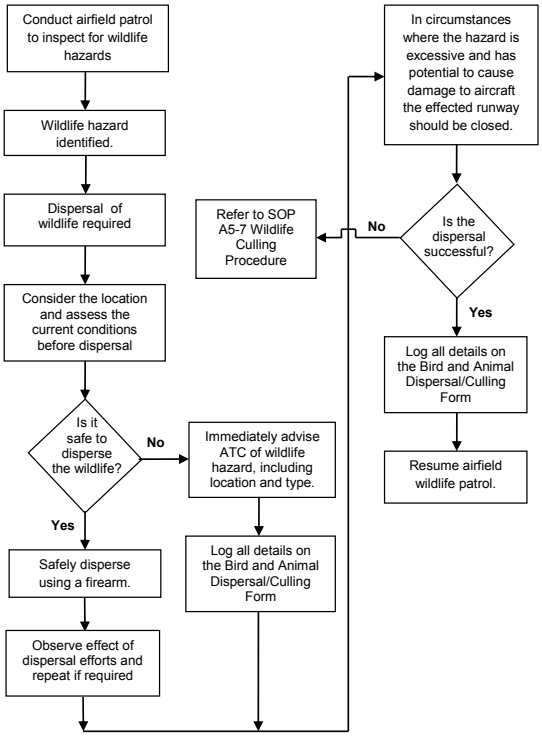
Other key elements included in the Sydney Airport WMP:

- a comprehensive list wildlife hazard management KPIs
- results of species and strike risk assessments
- an analysis of strike trends
- a description of roles and responsibilities, including those of external stakeholders
- a review of all land uses in the vicinity of the airport that are known to contribute to the strike risk
- a description of the Sydney Airport Wildlife Working Group's functions and responsibilities.

CASE STUDY: Sydney Airport – standard operating procedures

Key to managing wildlife hazards at Sydney Airport are the SOPs included in the Sydney Airport WMP. The SOPs provide airport safety personnel with a systematic and replicable approach to identifying, managing and monitoring hazards. For example, the Sydney Airport wildlife dispersal SOP provides instruction and guidance, as well as relevant forms and description for wildlife controllers.

4 PROCEDURE



WILDLIFE DISPERSAL

1 INTRODUCTION

1.1 SACL is responsible for reducing the potential risk to aircraft operations of birds and animals on the aerodrome and, within reason, the vicinity of the aerodrome. This is documented in the SACL Wildlife Management Plan (WMP).

1.2 Wildlife dispersal is an activity undertaken by appropriately trained and licensed Airport Operations Officers (AOO) to reduce the risk of bird and animal activity present to aircraft operations.

1.3 There are a number of methods available to AOO for the purpose of wildlife management. The purpose of this procedure is to ensure dispersal is carried out in a safe manner with respect to aircraft movements and the airport environment.

2 DETAILS

2.1 Responsibility

This procedure applies to AOO whom hold a Class A firearms licence and are tasked for this function.

Regular wildlife hazard surveillance (see SOP A5-5) of the airfield may reveal wildlife hazards that require dispersal. This hazard may be located on or near active runways, on or near the taxiway system, or in the immediate vicinity of the airport boundary.

Where assistance is required, Car 3 may liaise with Car 2 to arrange further resources to assist with dispersal efforts.

During periods of high bird activity it is possible that this will result in a reduced level of service to other areas of the airport.

2.2 Procedure

When a hazard is identified, careful consideration must be made as to how and when dispersal will be carried out. Factors such as the location of the wildlife hazard, runway in operation, location of aircraft when dispersal is required, prevailing wind conditions, where the AOO can position themselves and where the wildlife should ideally be dispersed to must all be considered prior to any dispersal. It must be remembered that any dispersal should be carried out to ensure a continued safe operating environment for aircraft operations.

Where a hazard cannot be effectively removed using dispersal techniques below, culling of hazardous wildlife should be considered (see SOP A5-7). Where this cannot be achieved ATC must be notified of the hazard/s and in extreme circumstances closure of the runway or runway direction if there is an immediate risk to aircraft operations.

Case study: Sydney Airport – standard operating procedures (continued)

Wildlife Management **10 May 2013** **A 5 – 6**

Attachment 5-6 A Airport Bird and Animal Dispersal/Culling Form

Bird and Animal Dispersal / Culling Form

Time	Time Spent	Grid	Species	Number	Number Culled	Control Method	Ammunition				Reason	Effect	Disposal		
							BF	Live	Dud	Pel			Bin	Freezer	Other*

Control method

A- Vehicle approaching
B- Lights
C- Sirens
D- Human activity
E- Birdfrite
F- Culling
G- Gas cannon
H- Acoustic
I- Air Rifle
J- Other (provide details)
K – Starters Pistol
L- Distress Caller

Reason for Dispersal/ Wildlife Activity

A- Flying / Moving across runway
B- Flying / Active in area
C- Feeding near runways
D- Feeding in area
E- Resting on / near runway
F- Resting in area
G- Nesting / Burrowing near runway
H- Nesting / Burrowing in area
I- Programmed culling
J- Other (provide details)

Effect?

A- All birds dispersed immediately
B- Most birds dispersed in 5 minutes
C- A few birds dispersed in 5 minutes
D- Most birds dispersed after 30 minutes
E- A few birds dispersed after 30 minutes
F- Birds did not disperse/ culling required
G- Bird dispersal required all day
H- Animal captured / culled
I- Animal dispersed from area

Cloud Amount

0 Oktas – Sky clear (Cavok)
1- 2 Oktas – Few
3- 4 Oktas - Scattered
5- 7 Oktas – Broken
8 Oktas - Overcast

Weather

AM **Time**:____ Rwy: ____ Wind: ___/___ Cloud amt: ____ Cloud base: ____ Visibility:____ Temp:____ QNH: ____ Rain (24hr): __ (mm) Tide **L/M/H**

PM Time ____ Rwy: ____ Wind: ___/___ Cloud amt: ____ Cloud base: ____ Visibility:____ Temp:____ QNH: ____ Rain (24hr): __ (mm) Tide **L/M/H**

Officer's Name _____ **Officer's Signature** _____ **Date** _____

Rabbit Counts to be undertaken Sunday, Tuesday and Thursday nights
Data to be entered into the Wildlife Management Database each night

Bat counts to be undertaken Monday, Wednesday and Friday nights
Amend 11- 26 September 2012

SECTION 4: WILDLIFE HAZARD ASSESSMENT

The strike risk is different at every airport and is influenced by the particular hazards present. Climate, altitude, latitude, the nature and extent of wildlife attractants on- and off-airport, season, aircraft operations and the efficacy of the wildlife management program all determine the risk. Airport operators should complete their own risk assessments to determine their unique risk profile, and provide rationale and direction for wildlife hazard management (see Section 9).

This section addresses hazards that are common to most airports and provides a starting point for an individual airport to start to establish context. Hazards present themselves either as habitats and activities that attract wildlife or as particular wildlife. Section 5 addresses the assessment of wildlife strike risk based on hazards present.

Habitats and activities

Airports are attractive to wildlife because they can satisfy the basic requirements for food, water and shelter. Some features that attract wildlife are common to many airports and are described below. For detail on monitoring and managing these hazards, refer to sections 5 and 6.

Drains

Airport drains can attract wildlife, particularly where water is slow moving or accumulates for extended periods. Drains with gentle slopes provide easy access to the water, particularly for long-legged waders (such as egrets, herons and ibis) that can find a suitable water depth to access food in the base of the drain, irrespective of how full it is. Steep-sided drains limit access for most birds, although some can still land directly on the water's surface (eg ducks, coots, grebes, pelicans, swans). Drain vegetation, such as reeds or surface plants, can exclude some birds but attract others. For example, the establishment of reeds may deter ducks and swans from landing on the surface, but in turn can create a refuge for other wildlife such as Purple Swamphen. Drain infrastructure, such as culverts, can provide refuge for wildlife, including terrestrial mammals when water is absent. Drain culverts also provide an ideal nesting site for Fairy Martins to construct their mud nests on the walls and roof.

Poorly drained areas

Areas that accumulate with water following rainfall, such as depressions, and soils that become waterlogged, often create serious short-term bird hazards. These areas provide temporary access to freshwater, and waterlogged soils forces invertebrates close to the surface, making them more accessible to foraging birds.

Many of Australia's aerodromes are located in low-lying coastal areas, which can exacerbate drainage issues, particularly in high rainfall areas where prolonged periods of pooled water persist when local water tables are saturated. Conversely, some low-lying coastal airports are situated on sandy soils that allow water to drain quickly, which can make it difficult to establish and maintain thick grass.

Wetlands

Wetlands can attract a range of birds including pelicans, swans, ducks, egrets, wading birds and others for drinking, feeding, resting and nesting. These may be ecologically important and disturbance of these areas may not be acceptable.

Retention/detention basins

Retention and detention basins can essentially act as artificial wetlands depending on many factors including: the vegetation within and surrounding the basin, period of inundation, size and structure. Wetland birds can therefore be attracted to such basins.

Grass

Grasslands usually occupy the largest surface area on airports. Grasslands provide opportunities to forage, loaf, and to establish nesting territories. In response to the low-predator pressure on airfields, airport grasslands are often the most attractive habitat, particularly when maintained at short lengths. Masked Lapwing, Little Corella, Galah, Australian Magpie, Australian White and Straw-necked Ibis, and Feral Pigeon are examples of bird species that are attracted to short grass. Various mammals including macropods, rabbits and hares are also attracted to short-grassed areas.

Grass height predominantly determines the type of wildlife utilising it, but the grass species itself can be important. For example, grasses that produce a high volume of seed attract granivorous animals such as parrots, pigeons and rodents. Airport grasslands often comprise of a number of grass and weed types, making it difficult to manage specific grass species, however new airports and existing airports that are restabilising grasslands, have the opportunity to select grass types that are less attractive.

The action of mowing can create a wildlife hazard, with birds following mowers to forage on the disturbed insects. This is particularly hazardous when mowing inside runway strips and adjacent to other aircraft movement areas.

Airside/landside landscaping

Airport landscaping aims to improve amenity, but the design and plant species selection can contribute to the wildlife attraction. For example, planting fig trees in landside areas can attract flying-foxes, creating a strike hazard particularly if the flying-foxes need to transit aircraft airspace to access the trees. Planting trees and shrubs in close proximity to areas of natural vegetation can promote a movement corridor for wildlife, as well as offering a refuge for large terrestrial animals such as macropods. Where landscaping provides a different habitat to that found in the local airport environment (eg water features in arid regions) a refuge can be created. In general, airside and landside landscaping provide wildlife with foraging, perching, nesting, and roosting opportunity.

Bushland/forested areas

Natural areas may attract wildlife. Flying-foxes and some birds may be attracted to feed, perch, roost or nest in native trees and shrubs, and similar to landscaped areas could cause wildlife movements through aircraft flight paths.

Waste management

The availability of putrescible waste (ie food and organic waste generated by human activity) can be a significant wildlife attraction on airports where waste receptacles and industrial bins provide access to wildlife. Scavenging birds such as Torresian Crows, Silver Gulls, Feral Pigeons and Australian White Ibis are of particular concern as they take advantage of overflowing bins, or bins that are accessible to birds (ie not enclosed or lidded). Rodents may also take advantage of available rubbish, in turn attracting raptors that forage on the rodents.

Airport infrastructure

Airport infrastructure such as buildings hangars, fencing, sealed pavement areas (ie runaways, taxiways, and aprons), roads, air traffic control towers, signs, navigational aids, lighting, and even the aircraft themselves, can provide a range of perching, roosting and nesting opportunities for wildlife. For example; building eaves provide nesting platforms for Fairy Martins; hangars provide shelter for roosting Common Starlings; apron light structures provide platforms for raptor nests; runways and taxiways provide safe loafing opportunity for Silver Gulls, particularly during inclement weather; gable markers, Precision Approach Path Indicator and '**T**'-Visual Approach Slope Indicator System structures provide diurnal shelter for rodents and other small mammals; and wasps or other insects may establish nests in the engines of disused aircraft.

Airside/landside developments

Apron and runway extensions, new taxiways, drainage works, and new building development temporarily disturb the airport environment and can elevate the wildlife hazard above normal levels. Exposed soils during earthworks attract birds to forage on the exposed invertebrates. Temporary water retention areas can attract wildlife, particularly ducks and other water birds. The establishment of temporary soil or material stockpiles can provide additional loafing and perching opportunities for birds. Construction material, such as pipes, can temporarily provide shelter and even nesting opportunity for some birds. Even contractors employed to do the work can inadvertently attract wildlife by not managing their food waste, by feeding the wildlife, and by not having the skills or knowledge to recognise potential or actual wildlife hazards within the strike risk context.

Wildlife hazards

The hazard presented by wildlife is determined by the size of the species, its strike frequency, the tendency for the species to flock, and whether the species predominantly occupies air-space or ground-space. For example, Black Kites are particularly hazardous because of their moderate body mass (585 g) and their aerial behaviour (eg foraging, thermalling) that often places them in aircraft flight paths. Conversely, galahs have a smaller body mass (307 g), but usually congregate in large flocks, increasing the chance of a multiple strike event. Based on total strikes, the ATSB identifies the following species as Australia's most hazardous:

1. Black Kite
2. galah
3. bat[12]
4. plover[13]
5. kites[14]
6. flying-fox[15]
7. swallow[16]
8. Nankeen Kestrel
9. duck[17]

In response, the Australian Airports Association (AAA) has prepared a series of species information fact sheets to assist airports in managing these particular species https://airports.asn.au/dev/uploads/others/Airport%20Practice%20Note%206%20-%20Managing%20Bird%20Strike%20Risk%20Species%20Information%20Sheets.pdf. Although airport wildlife management programs generally direct resources to managing high- and moderate-risk species, which is the principal benefit of risk assessments, management must also extend to high and moderate risk situations that may involve a low-risk species.

12 Likely to include a combination of flying-foxes and micro-bats.
13 Likely to include Masked Lapwing and other plovers.
14 Likely to include Black Kite, Whistling Kite, Brahminy Kite, Black-shouldered Kite, Letter-winged Kite and may include various other raptors.
15 Likely to include Grey-headed Flying-fox, Black Flying-fox, Spectacled Fluing-fox or Little Red Flying-fox.
16 'Swallow' is often used to describe any small insectivorous bird, and is likely to include Fairy Martin, Tree Martin, Welcome Swallow, or Barn Swallow.
17 Likely to include Pacific Black Duck Wood Duck and other ducks.

SECTION 5: WILDLIFE RISK ASSESSMENT

Risk assessments determine species risks, location risks, and time of day and seasonal risks (refer to Appendix G for risk definitions). Understanding these risks informs key elements of the WHMP and streamlines management actions. By targeting high and moderate risk species, locations, and times, airports can allocate resources to manage the most significant hazards rather than trying to manage all wildlife at all times and in all locations.

Assessing the wildlife strike risk, in accordance with the aerodrome's safety management system (SMS), allows appropriate targeting of resources to areas where best risk management can be achieved. There are two levels of risk assessment:

1. Comparing the overall risk of wildlife strike with other operational risks to ensure risk mitigation is at appropriate levels for each risk.
2. Detailed assessment of species, locations and other lead and lag indicators of the strike risk.

Assessing operational risks

Many airports have risk registers that itemise operational hazards such as foreign object debris (FOD), security breaches and wildlife strike, among many other operational hazards. For each hazard:

1. likelihood and consequence is estimated
2. risk is rated (as low, moderate or high)
3. existing mitigation measures and their impact on risk are considered
4. the residual risk is determined.

If the residual risk is unacceptable, further mitigation may be necessary.

Wildlife strike is the most frequently reported incident to ATSB (ATSB 2014). It is usually ranked as one of the highest operational risks at airports because it is one of the few incident types regularly reported that is primarily the responsibility of the aerodrome operator to manage and it is usually the most frequent source of aircraft damage. The likelihood of wildlife strike is therefore high or very high, and a damaging strike is moderately or highly probable. Catastrophic events such as hull loss (eg US Airways flight 1549 landing on the Hudson River – see case study) and/or fatalities involving wildlife strikes are however, very rare.

Airports must consider, at a broad level, each of their operational risks and how they compare. More detailed analysis of wildlife risks as described below will assist in this process.

Detailed wildlife risk assessments

As suggested in the Australia and New Zealand Standard 31000, Risk Management – Principals and Guidelines (Standards Australia, 2009), data collection is important in order to analyse and evaluate risk. Wildlife strike and count data provide the basis of analysis, although other information such as air traffic movements, environmental studies, on- and off-airport land use or activities (including those that may either increase or decrease the wildlife risk), off-airport hazard assessments, and stakeholder engagement (eg minutes from wildlife committee meetings), should also be collated.

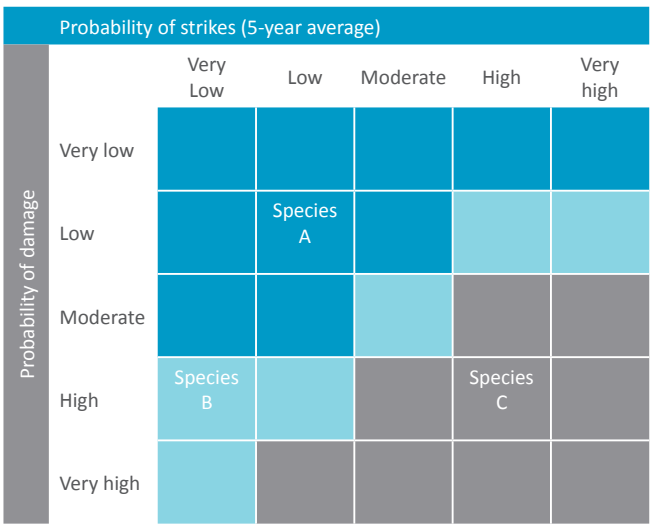
Available risk models are numerous (see references and further reading), including some that refer to off-airport wildlife attractions, and to new airport developments. Other models suggest using mass of wildlife struck to indicate risk, while others use damaging strike rates or strikes affecting planned flight. Solely assessing risk using strike rates per 10 000 aircraft movements (used by many airports) is not recommended because raw strike rates are very poor indicators of actual risk. Without further analysis, it is possible that an airport with an increasing strike rate actually has a decreasing risk and vice versa.

Below are three options for assessing wildlife risk that are used at Australian airports.

Strike risk assessment

This approach was developed by John Allan, the former Chair of the IBSC and is detailed in Allan (2006). Species identified in strike reports over the previous five-year period are categorised as high-, moderate- or low-risk, depending on their frequency of strike (likelihood) and their potential to cause damage (consequence).

Figure 3 Strike risk assessment matrix (Allan 2006).



Risks which fall into the green section are classified as 'low' and require no further action beyond current management. Brown is 'moderate' and requires a review of current management practices and options for additional action. Red is 'high' and requires immediate action to reduce the current risk. Allan (2006) suggests that the national strike database is used to categorise consequence based on the percentage of strikes to each species resulting in damage. Given the relatively small sample size, Australia has modified that and uses body mass for Australian airports. Tables 3 and 4 describe the probability and consequence scores.

Confirmed strikes that are recorded on-airport or in the vicinity should be included in the analysis. Species involved in multiple strikes (ie more than one animal struck in a single event) should increase one risk category, excluding very low consequence species such as Fairy Martins. For example, if a multiple strike species was assessed as moderate risk, it should be elevated one risk category to high risk.

Limitations

This measurement of risk is from the airport operator's perspective not the aircraft operator, because it assesses risk per period of time not risk per aircraft movement. It is therefore difficult to compare one airport with another unless they have similar aircraft operating in similar number of movements. Risk assessments based solely on historical strike data are limited, as they cannot easily accommodate real time changes in wildlife species composition or distribution. For instance, if a new bird attraction creates a new hazard, it will take some time for this to be expressed in the risk, hindering pre-emptive risk mitigation efforts by the aerodrome operator.

Survey risk assessment (Shaw, 2004)

Avisure has developed a model for determining risk categories using wildlife survey data. The survey data is used to assess factors which affect the likelihood of a strike (population size, position on airport, time spent in air and the species ability to avoid) and consequence factors (wildlife mass and group/flock size) for all species observed. The combination of these probability and consequence factors provide a numerical risk index, which when added together for all the observations of a particular species provide the Species Risk Index (SRI). The sum of all the SRIs provides an overall risk rating for the survey period called the Airport Species Risk Index (ASRI). This provides a real-time method of risk assessment as it is able to react to observed changes in airside wildlife assemblages and movement patterns. Table 3 outlines the risk rating for wildlife species according to calculated SRI, and the risk ranking of an airport.

The process intends to provide a transparent, logical and systematic approach to the identification and treatment of wildlife related risks at the airport. The risk assessment identifies high risk species, which allows suitable management practices to be targeted in areas where the maximum risk reduction may be achieved.

Table 3: Strike probability categories (Allan, 2006)

Probability level	Very low	Low	Moderate	High	Very high
Total strikes over 5 years	1	2 to 4	5 to 14	15 to 50	>50

Table 4: Strike consequence categories (Allan, 2006)

Consequence	Very low	Low	Moderate	High	Very high
Species mass (g)	<140	140 to 414	415 to 696	397 to 1407	>1408

Table 5: Survey Risk Index (SRI) and Airport Species Risk (ASRI) Index for determining risk categories based on survey data (Shaw, 2004).

SRI ranges used to rate risk for each species		ASRI ranges used to rate risk of an airport	
SRI	Risk rating	ASRI	Risk rating
>1000	Very high	>10,000	Very high
100 to 999.9	High	1 000 to 9 999.9	High
10 to 99.9	Moderate	100 to 999.9	Moderate
1 to 9.9	Low	10 to 99.9	Low
< 1	Very low	<10	Very low

Limitations

The assessment of nocturnal risk (ie risk arising from wildlife that are present and active at night) can be problematic because surveying at night is difficult. Spotlights and/or night vision equipment can assist, but wildlife is simply more difficult to detect at night. Accordingly, results from the nocturnal risk assessment cannot be compared with daytime assessments.

The survey risk assessment is probably the most frequently used at Australian airports, but requires the collection of survey data by professionals with strong ornithological expertise, as well as professional involvement for data processing. Therefore, it is difficult for airport operators to implement it themselves.

Bird risk assessment model for airports and aerodromes (Paton, 2010)

Adelaide Airport engaged David Paton (University of Adelaide) to develop a bird risk assessment model. The model scores each species for consequence factors (body mass, flocking behaviour, flight behaviour) to estimate the category from very low to extreme. The probability of strike is categorised from low to very high and is derived from quantitative or qualitative estimates of abundance factors (relative abundance, frequency of occurrence, area of occurrence) and strikes among other factors. Consequence and probability scores are then placed within a conventional risk matrix to estimate the risk from negligible to extreme for each of the species assessed.

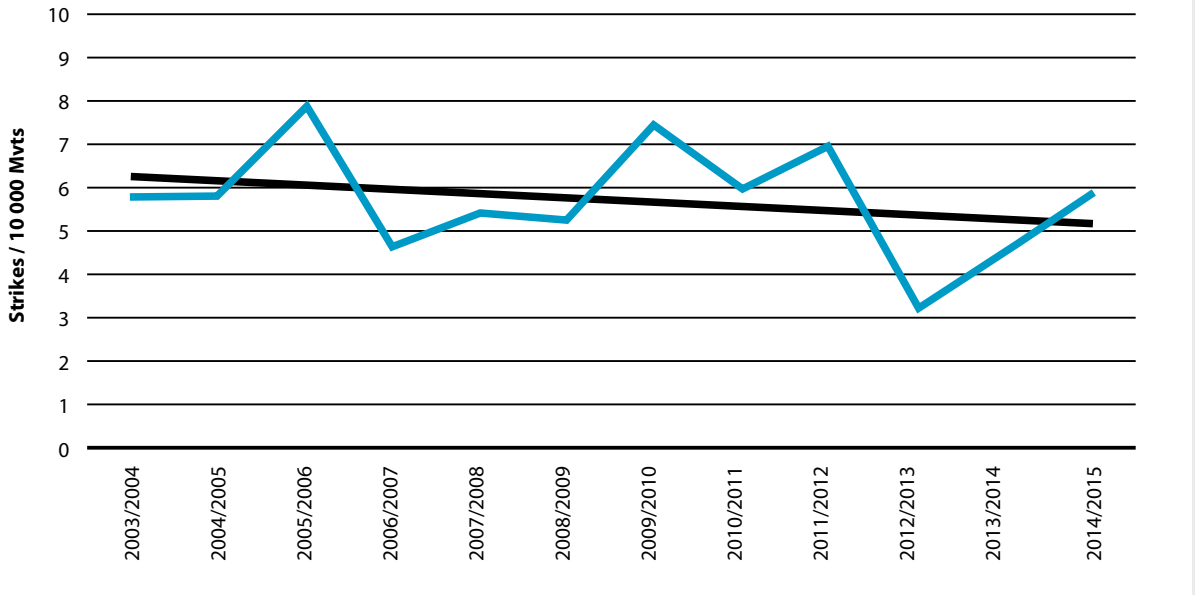
Limitations

The model can be subject to bias from the individual completing the evaluation. While some categories have a relatively fixed scoring system, others (particularly the qualitative data) are subjectively assessed based on the assessor's interpretation of the hazard. This lack of objectively may bias the results.

CASE STUDY

In 2007 Adelaide Airport, in conjunction with the University of Adelaide, developed a bird risk assessment model that allowed the airport to use more than 20 years of airside survey data to determine species risks. Identifying their most hazardous species in this way has allowed the airport to target and priorities the management of species that present the greatest strike risk, contributing to their decreasing strike rate (see figure below).

Adelaide Airport wildlife strike rate 2003–04 to 2014–15 (strike data source: ASTB; movement data source: Airservices Australia)



CASE STUDY

US Airways flight 1549 captured the attention of the global aviation industry on 15 January 2009 after the aircrew ditched the A320 in the Hudson River shortly after striking a flock of Canada Geese two minutes into their departure from LaGuardia Airport in New York. The aircraft suffered almost complete loss of thrust in both engines following the impact with the geese. Without the possibility of returning to LaGuardia, or making an emergency landing at near-by Teterboro Airport, the quick decision of the aircrew permitted a safe landing in the river rather than in the nearby neighbourhoods of Manhattan or Jersey City, where human fatality would have been inevitable. Of the 150 passengers and five crew on board, five people suffered serious injury.

According to the official investigation report released from the National Transportation Safety Board, contributing to the survivability of the accident was:

1. the decision-making of the flight crew members and their crew resource management during the accident sequence
2. the fortuitous use of an airplane that was equipped for an extended overwater flight, including the availability of the forward slide/rafts, even though it was not required to be so equipped
3. the performance of the cabin crewmembers while expediting the evacuation of the airplane, and
4. the proximity of the emergency responders to the accident site and their immediate and appropriate response to the accident.

The National Transportation Safety Board released a number safety recommendations following the investigation, including seven wildlife-specific recommendations:

Recommendation no.	Recommendation to	Recommendation detail
Safety Recommendation A-10-064	The Federal Aviation Administration	Modify the 14 Code of Federal Regulations 33.76(c) small and medium flocking bird certification test standard to require that the test be conducted using the lowest expected fan speed, instead of 100 per cent fan speed, for the minimum climb rate.
Safety Recommendation A-10-065	The Federal Aviation Administration	During the bird-ingestion rulemaking database (BRDB) working group's re-evaluation of the current engine bird-ingestion certification regulations, specifically re-evaluate the 14 Code of Federal Regulations (CFR) 33.76(d) large flocking bird certification test standards to determine whether they should: 1 apply to engines with an inlet area of less than 3 875 square inches 2 include a requirement for engine core ingestion. If the BRDB working group's re-evaluation determines that such requirements are needed, incorporate them into 14 CFR 33.76(d) and require that newly certificated engines be designed and tested to these requirements
Safety Recommendation A-10-075	The Federal Aviation Administration:	Require all 14 Code of Federal Regulations Part 139-certificated airports to conduct WHAs to proactively assess the likelihood of wildlife strikes, and, if the WHA indicates the need for a WHMP, require the airport to implement a WHMP into its airport certification manual.
Safety Recommendation A-10-076	The Federal Aviation Administration:	Work with the US Department of Agriculture to develop and implement innovative technologies that can be installed on aircraft that would reduce the likelihood of a bird strike
Safety Recommendation A-10-087	The United States Department of Agriculture	Develop and implement, in conjunction with the Federal Aviation Administration, innovative technologies that can be installed on aircraft that would reduce the likelihood of a bird strike.
Safety Recommendation A-10-088	The European Aviation Safety Agency	Modify the small and medium flocking bird certification test standard in Joint Aviation Regulations engines to require that the test be conducted using the lowest expected fan speed, instead of 100 per cent fan speed, for the minimum climb rate.
Safety Recommendation A-10-089	The European Aviation Safety Agency	During the BRDB working group's re-evaluation of the current engine bird-ingestion certification regulations, specifically reevaluate the Joint Aviation Regulations engines (JAR-E) large flocking bird certification test standards to determine whether they should: 1 apply to engines with an inlet area of less than 3 875 square inches, and 2 include a requirement for engine core ingestion. If the BRDB working group's re-evaluation determines that such requirements are needed, incorporate them into JAR-E and require that newly certificated engines be designed and tested to these requirements.

SECTION 6: MONITORING AND DETECTING WILDLIFE HAZARDS

Monitoring wildlife hazards is an essential component of wildlife management programs, and is a CASA requirement as per section 10.14.1.1 of the MOS Part 139 (refer Section 2). Wildlife monitoring aims to determine:

- species present, their numbers and flocking behaviour
- locations/habitats occupied
- resources utilised
- behaviour, with consideration to their activity relative to aircraft movements the times, seasons and climatic conditions that they respond to and how.
- When this monitoring is standardised and regular, the data can:
- inform wildlife managers of wildlife trends, particularly for high- and moderate-risk species
- provide baseline data to monitor the progress of wildlife management programs and specific management actions
- inform wildlife management decisions regarding where to target management resources and focus efforts, effectively streamlining management programs
- provide data for risk assessments to determine high and moderate risk species and locations.

On-airport monitoring

Airport safety personnel and/or wildlife professionals are usually charged with the responsibility of wildlife monitoring. Monitoring requirements should be detailed in standard operating procedures and training should be provided to personnel on monitoring protocols, species identification, and data collection.

Airport wildlife hazard monitoring programs should include, as a minimum, fence inspections, runway inspections, wildlife patrols, and bird counts (Table 6).

Table 6: Summary of on-airport wildlife hazard monitoring activities

Monitoring type	Objectives	Recommended procedure	Frequency
Fence Inspections	Early detection of hazards Locate actual or potential braches by terrestrial wildlife	Inspect the entire perimeter fence for evidence of deterioration or damage. Report any potential breach areas to the Airport Manager and arrange for immediate repair.	Daily
Runway inspections	Hazard detection Locate eggs and nests of birds Locate wildlife remains FOD detection	Inspect pavements, grassed areas, and flight paths for wildlife activity and search for eggs, nests and animal remains. Where hazardous wildlife activity is observed, immediately disperse as per dispersal procedure. If no activity is observed, log an entry in the daily log book to show the time of the inspection.	Commensurate with operations
Wildlife patrols	Hazard detection Locate eggs and nests of birds Locate wildlife remains FOD detection	Inspect the airside area for wildlife activity. Where hazardous wildlife activity is observed, immediately disperse as per dispersal procedure. If no activity is observed, log an entry in the daily log book to show the time of the patrol and the area patrolled.	Commensurate with operations
Wildlife counts	Long-term and standardised, data can inform wildlife management actions	Complete the count in accordance with the procedure that should detail route, observation points, designated sectors, count frequency, and count timing. Complete all data fields of the record sheet that should include, as a minimum: date; observer name; observation times; species; number; location; weather; special notes such as mowing activity or ponded water. Counts should occur across four time periods (morning, midday, afternoon, night) preferably on the same day.	Weekly (or commensurate with operations)

Wildlife detection technology

Although not yet widely used at Australian airports, the remote detection of real-time wildlife hazards using radar (and potentially infra-red camera), can provide information directly to the wildlife controller, aircrew and air traffic control about actual and predicted hazards. Mobile and stationary detection radar tracks wildlife flight paths, can alert airports of immediate or pending hazards, the location of the hazard relative to aircraft, estimated flock sizes and ground speed, and some devices can even provide enough resolution to resolve wing-beat frequency to identify wildlife type (eg a duck as opposed to a pelican whose wing beat frequencies are different).

Off-airport monitoring

Wildlife hazards in the vicinity of airport can vary widely, however anything that attracts, or has the potential to attract, wildlife can increase the strike risk. These land uses can include: landfills; sewage treatment works; sports fields; water treatment works; abattoirs; food processing plants; agriculture/farming; water bodies (natural and artificial); parks and gardens; and wildlife breeding grounds/colonies.

ICAO and the Australian Government via the National Airports Safeguarding Framework (Section 2) provide guidelines for land-use compatibility in the vicinity of airports, however site specific investigations are necessary to determine the extent of the wildlife hazard and how it contributes to an airport's strike risk. As such, the establishment of a monitoring program that is commensurate with the level of risk, will help airports to identify location and extent of the hazard.

Land-use beyond the airport perimeter fence can contribute significantly to the strike risk. Managing off-airport hazards is complicated by the lack of management and administrative jurisdiction by the airport authority. Wildlife hazards can be proactively identified within the planning framework for new airport developments, however existing airports often have to deal with antiquated land use planning and zoning decisions that may have resulted in the establishment of significant wildlife hazards close by. Monitoring and communication are the key tools available to airports to address off-airport hazardous sites.

Collecting data

Wildlife controllers are responsible for the collection of data from: wildlife counts; wildlife strikes; wildlife dispersals; and lethal control. Standard operating procedures for wildlife hazard management should not only provide task instruction and guidelines, but also data forms for data collection. Data fields included on the forms should capture all information relevant for each task (Table 8) and wildlife controllers provided training on task requirements and data collection.

To ensure data comparability (ie the ability to compare data over time), standardised data collection is essential. For example, data is not comparable if two wildlife controllers conduct bird counts in different ways, the data is meaningless, and resources were used for no apparent gain. The consequences for poor or inconsistent data collection may include:

- not being able to replicate methods or validate data
- distorting or biasing data in a way that provides false or misleading conclusions
- allocating resources to manage the wrong risks
- program managers making poor decisions that do not positively influence risk mitigation.

The compilation of effective procedures, and the provision of training, will ensure data collection methods are standardised and replicable.

Time spent recording data can be minimised by adopting codes or number references for wildlife and dispersal tools. Data sheetsw and associated procedures should include code descriptions to ensure consistent use by data collectors. Table 9 provides some examples.

Data integrity and quality is compromised if:

- there is uncertainty about the timing, methods, and responsibility of data collection
- data fields are only partially completed, or not at all
- data collection procedures offer only vague descriptions rather than of rigorous step-by-step instructions
- training, or retraining, staff members responsible for data collection is not provided
- there is no mechanism to document procedural changes in responses to modified data collection methods.

Storing data

Using simple electronic databases, such as Microsoft Excel or Access, arrange and manage data for ease of analysis. Databases should enable the user to filter or pivot on any particular data field, or combinations thereof. To facilitate data entry from paper datasheets into databases, data field sequence should mirror each other.

Table 7: Summary of off-airport wildlife hazard monitoring activities

Monitoring type	Objectives	Recommended procedure	Frequency
Wildlife counts	Long-term and standardised counts of hazardous sites within 13 km radius of the airport.	Complete the count in accordance with the procedure that should detail observation points, count frequency, and count timing. Complete all data fields of the record sheet that should include, as a minimum: date; observer name; observation times; species; number; location; and weather. Counts should occur across four time periods (morning, midday, afternoon, night) preferably on the same day.	Monthly (or commensurate with operations)
Development applications	Ensure wildlife-related issues are minimised.	Invite planning department authorities to wildlife committee meetings. Establish airport-specific NASF tool to assess development applications.	As required

Table 8: Recommended data fields for wildlife hazard management program data collection

Activity	Minimum recommended data fields	
Wildlife counts	Date	*Date of count*
	Observer	*Name of individual completing the count*
	Weather details	*Rainfall, cloud, wind speed and direction, tide*
	Time	*Time of each observation*
	Species	*Species name*
	Number	*The number observed in any one observation*
	Location observed	*Where on-airport (grid reference system recommended)*
	Behaviour observed	*What the animal was doing when observed (eg foraging, perching, transiting etc).*
	Habitat	*What habitat the animal was using when observed (eg grass, tree, building, fence pooled water, drain etc)*
Wildlife strikes	See Section 8	
Wildlife dispersals	Date	*Date of dispersal*
	Wildlife controller	*Name of individual completing the dispersal*
	Weather details	*Rainfall, cloud, wind speed and direction, tide*
	Species	*Species name*
	Number	*The number of species targeted*
	Location observed	*Where on-airport (grid reference system recommended)*
	Dispersal tool used	*Name of tool or method used*
	Distance dispersed	*How far the target animal moved in response to dispersal effort*
	Time of dispersal	*Time each dispersal effort started*
	Time spent dispersing	*Time spent on each dispersal effort*
	Overall effect	*Whether the hazard was dispersed*
Lethal control	Date	Date of lethal control
	Wildlife controller	Name of individual completing the lethal control
	Weather details	Rainfall, cloud, wind speed and direction, tide
	Time	Time of lethal control
	Species	Species name
	Number	Number controlled
	Location	Where on-airport (grid reference system recommended)
	Firearm	Firearm type used
	Ammunition	Quantity of ammunition used
	Reason	Justification for lethal control

Table 9: Example species and dispersal tool codes

Type	Name	Code Examples		
Wildlife names	Australian Magpie	AM	AuMa	AMAG
	Masked Lapwing	ML	MaLa	MLAP
	Black Kite	BK	BlKi	BKIT
	Silver Gull	SG	SiGu	SGUL
	Magpie Goose	MG	MaGo	MGOO
Wildlife dispersal tools	Pyrotechnics	01	PYRO	PY
	Vehicle	02	CAR	VE
	Stock whip	03	WHIP	SW
	Distress caller	04	CALL	DC
	Distress caller: ibis	04_I	CALL(I)	DC_Ib
	Distress caller: gull	04_G	CALL(G)	DC_Gu
	Falconry	05	FALC	FA

CASE STUDY: Litigation and the importance of regular patrols

An Air France A320 ingested a number of gulls in the right engine during take off causing the pilot to abort. The engine was destroyed. The gulls were determined to have been attracted to a dead hedgehog at the end of the runway. In its judgment, the court in Marseille ruled that the French government was responsible for keeping the runways clear of such perils and that its staff at the airport should have noticed 'such a large group of birds' in the path of the jet. It ordered the government to pay €850 000 to Air France over the incident, and €2.3 million to five insurance companies that had paid out after the accident[18]

CASE STUDY: Using data to know what works

Melbourne Airport has been trialling the use of standardised data to better quantify environmental risk factors, test the effectiveness of different management interventions, and develop management strategies to reduce predicted risk. An analysis of dispersal data allowed them to identify that in contrast to magpies, all dispersal techniques were effective in dispersing ibis, with vehicle approach with flashing lights and/or horn slightly more effective than other techniques. They also were able to determine that the application of insecticide influenced the Australian Magpie strike rate (ie strike rate reduced following applications).

CASE STUDY: Making wildlife management programs smarter

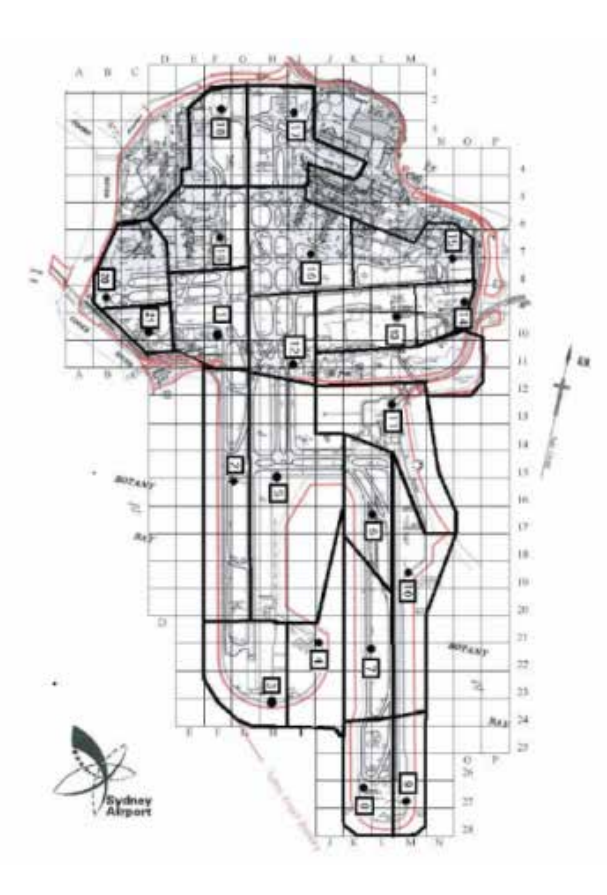
In 2007, Darwin Airport completed a gap analysis of its wildlife management program and identified key issues relating to the collection, understanding, quality and use of data, specifically: operations officers did not understand the importance of completing bird and animal counts; operations officers did not realise the high number of bird strikes compared to other years or other airport; data quality was lacking; and the system did not allocate resources on a risk basis. In response, the airport:

- set measurable objectives based on an analysis of strike data
- completed a quantitative risk assessment, using strike data, to determine management priorities (ie high and moderate risk species)
- provided training and species identification assistance to improve the quality of data collected
- established a new database (Bird and Animal Hazard Management System) for the collection, storage and analysis of all data relating to strikes, counts, and dispersal actions
- introduced regular reporting protocols that analysed and interpretive program data against targets.

12 Administrative Court of Marseille (2005) Group La Reunion Aerienne and other companies Air France #0005015-0102226. Republic of France www.birdstrike.it/birdstrike/file/images/file/2013.02_marseille.pdf

CASE STUDY: Sydney Airport makes counting birds easier

At almost 900 hectares, monitoring bird activity at Sydney Airport could be a laborious task, however the procedures developed by the airport for their bird control personnel provide clear direction to ensure standardised and replicable bird counts. The airport's WMP details count procedures that clearly show airfield count sectors and observations points, as well as providing a standardised count forms and species codes. On the ground, clear stopping points have been established for personnel conducting bird counts. Standardised counts such as these, allow the airport to directly compare data over weeks, months, and even years to identify bird density and distribution trends across the airfield.



Daily Bird and Fauna Count

	Grid Ref	Wildlife Species	Number	Wildlife Activity	Other Observations	Comments
Count Start						
Count End						

Additional Comments:

Images: http://aawhg.org/assets/forums/2008/08presentations/5hain.pdf

CASE STUDY: Where are the problems?

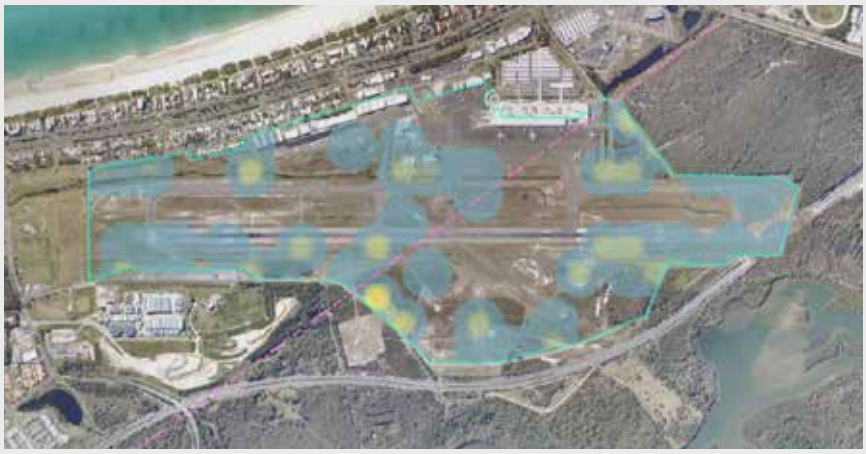
Using wildlife count and survey data to determine the density and distribution of wildlife on the airfield helps the airport to identify problem areas and species, allowing management to be more streamlined and targeted.

Example: Adelaide Airport

Adelaide Airport mapped the density and distribution of galahs on the airfield, and where able to determine that their distribution correlated with the distribution of Onion Grass (*Romulea rosea* var. *australis*), on which the galahs were foraging. The subsequent management of the Onion Grass has helped to better manage galahs on the airfield.

Example: Gold Coast Airport

Surveys completed at Gold Coast Airport enable the mapping of mass surveyed to identify those areas that support the highest risks. This allows the airport to streamline management efforts by targeting and prioritising specific locations.



SECTION 7: MANAGING WILDLIFE HAZARDS

Wildlife hazard management on airports is broadly defined into two categories: active management and passive management. Active management directly removes or reduces the number of wildlife. Passive management modifies habitats or other aspects of the environment to indirectly remove or reduce the number of wildlife. Each alone is inadequate to effectively mitigate the strike risk; however, when applied together, they can make significant contributions to risk mitigation.

Active management: dispersal

Dispersal aims to maintain separation between aircraft and wildlife by harassing wildlife from the airside area. Essentially, the wildlife controller acts as a predator. It is indeed possible to 'train' resident wildlife to respond in certain ways. Wildlife that is familiar with the management techniques applied at the airport, particularly if that approach is consistent irrespective of who is on duty, will learn to respond in a way that is predictable to the wildlife controller.

By understanding that response and being situationally aware about other vehicles and activities, and understanding aircraft movements at that time, the wildlife controller can carefully choose how to initiate a dispersal and when.

If a particular tool or approach is used exclusively and for a long period, habituation is likely to occur. This is when the wildlife becomes used to the tool, and does not associated a negative consequence with it. This can be overcome if the wildlife controller has access to an extensive dispersal 'tool-kit' that include a variety of tools and techniques (Table 10), and are used in a variety ways. The most effective dispersal programs are those that are site-specific and align with known hazardous species. It is highly recommended that airports first determine their wildlife issues, and then trial dispersal tools accordingly to determine what works best. Table 10 provides a general tool guidance, however depending on individual risks, some airports may find items in the 'Limited recommendations' column can be effective.

Table 10: Types of dispersal tools (* indicates recommendation from Sharing the Skies)[19]

Not recommended	Limited recommendation	Highly recommended
High-intensity sound*	Gas cannons*	Pyrotechnics*
Microwaves*	Phoenix Wailer ®*	Falconry*[20]
	AV-Alarm ®*	Distress and alarm calls*
Ultrasound*	Bird Gard AVA ®*	Shooting*
Aircraft hazing*	Bird Gard ABC ®*	Trapping and remote release*
Smoke*	Scarecrows*	Dogs*
Magnets*	Reflecting tape*	Stock whip
Lights*	Predator models*	Starter's pistol
Dyes*	Hawk kites and balloons*	
Aircraft engine noise*	Gull models*	
Infrasound*	Chemical repellents*	
Poisons*	Foam*	
Animal effigies	Predator calls*	
	Lure areas*	
	Surfactants and water spray*	
	Model aircraft*	
	Whistle	
	Paint ball gun	
	Lasers	

19 Table modified from Sharing the Skies, Transport Canada 2001. www.tc.gc.ca/civilaviation/aerodrome/wildlifecontrol/tp13549/menu.htm

20 Check relevant state legislation

Dispersal guidelines

1. Dispersal needs to be most intense at the end of the breeding season to discourage young wildlife from foraging at the airport. Young are easily deterred from airports provided they recognise the airport as an unattractive and threatening environment (note that different species breed at different times of the year).
2. Do not allow settling wildlife to feed in order to discourage regular visitation. It is easier and more effective to harass newcomers to the airport than birds that have established their territory on-site.
3. Concentrate dispersal activities for most species in the early morning and mid-afternoon, prior to peak feeding periods. Early morning harassment discourages visitors settling in for the day.
4. Identify time priorities. Knowing the times of day when birds are most active, such as early morning arrivals to the airfield, allows the controller to be proactive. Similarly, understanding the migratory pattern of regular visitors contributes to more proactive management that can anticipate high risk periods.
5. It may be necessary to continuously patrol and disperse during periods where aircraft movements are scheduled close together.
6. Identify the wildlife priorities in terms of species. Airports that complete risk assessments to identify high- and moderate-risk species assist the wildlife controller to identify the most important targets. Chasing a low risk species, such as an Australasian Pipit, uses time, money and resources with little risk mitigation gain.
7. Identify priority areas. Table 11 provides general recommendations on key locations for wildlife management. These recommendations should be modified to suit on airport operations, aircraft movement activity, and the distribution of high- and moderate-risk species.
8. Where wildlife identifies a particular vehicle as a risk and move to a different airside location, consider undertaking dispersal in a different type of vehicle (eg tractor).
9. The location of the wildlife controller should ensure that wildlife are encouraged to fly/move away from aircraft movement areas and not across them, unless there is some over-riding reason.
10. Select the most appropriate tool/technique for the situation. Not all birds and situations are the same. For example, what works for an individual ibis, may not work for a flock of ibis, or what is effective for gulls during wet stormy weather may not work when conditions are sunny and calm.

Table 11: General recommendations for wildlife management relative to on-airport aircraft manoeuvring areas.

Area	To be excluded	Times to be excluded
Runways, flight strips, undershoots	All wildlife	At all times
Adjacent flight strips (incl. taxiways and aprons)	High-risk species	At all times
	Moderate-risk species	At all times
	Low-risk species	Prior to RPTs
Remaining airside areas	High-risk species	At all times
	Moderate-risk species	Avoid making part of daily routine
	Low-risk species	Low numbers tolerated

Figure 4: High priority areas for wildlife hazard management on airports

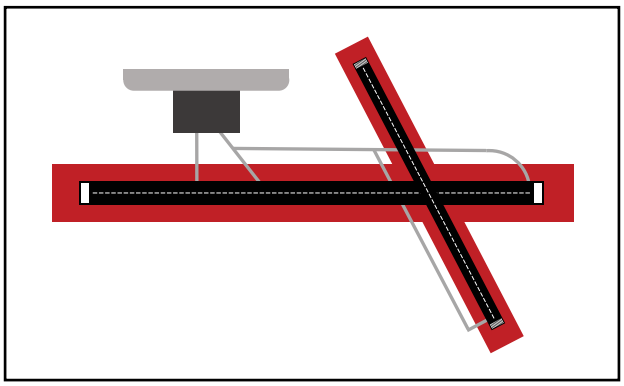


Figure 5: Moderate priority areas for wildlife hazard management on airports

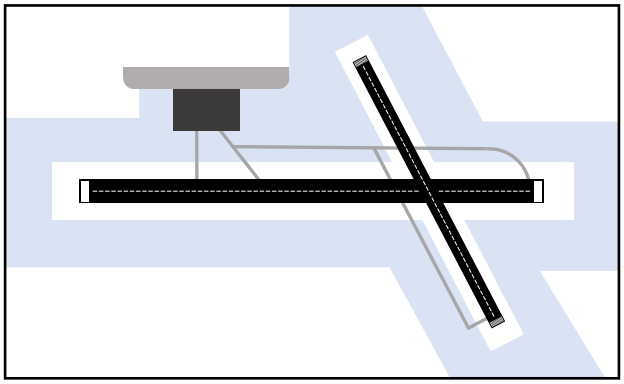
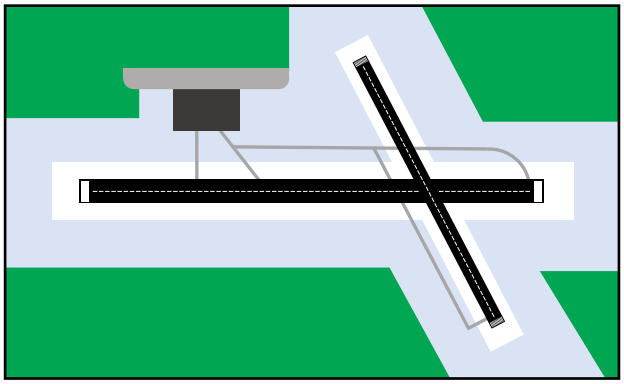


Figure 6: Low priority areas for wildlife hazard management on airports



Separation-based dispersal

Separation-based dispersal is maintaining separation between wildlife and aircraft in flight (any phase) in real time by clearing wildlife away from aircraft movement paths and advising aircraft so that they can remain clear of wildlife movement paths.

What is needed?

- Suitably trained and equipped wildlife team for dispersing wildlife away from airspace.
- The ability to detect wildlife movements through airspace in a timely fashion.
- The ability to assess those movements as likely or not to conflict with an aircraft in flight.
- The ability to communicate likely conflict to aircrew in a timely fashion.
- The ability of aircrew to quickly assess the information given to them and then decide on a course of action relevant to their operational imperatives.
- Positive coordination by air traffic control (if applicable).

For these elements to be implemented, it is important to provide training in wildlife hazard identification and risk assessment for air traffic controllers who also require the resources needed to be able to fully implement this function into routine operations at towered aerodromes. Air crew members are also encouraged to undertake wildlife hazard identification and risk assessment training to ensure that pilot initiated responses to avoidance do not significantly affect traffic flow.

Hazard detection is achieved either visually or by remote sensing technologies, and the core elements include:

- bird movement forecasts
- bird movement reports
- bird separation procedures
- bird collision avoidance systems.

Risk assessment requires observers to have a good understanding of aircraft performance, wildlife identification, wildlife behaviour, and dispersal procedures, including: coordinated engagement of air traffic control (ATC) (if applicable) and aircrew; and the development of new procedures and systems. It may also require the purchasing of new equipment and training for personnel; and the possibility of significant operational disruption during transitional phase.

Active management: lethal control

Lethal control is an important element of integrated wildlife management programs at airports. When applied sparingly, and as a last resort option, it can be used:

- to target high- and moderate-risk species
- in circumstances when there is a clear and present danger with strike event highly probable
- to reinforce non-lethal dispersal tools
- when other dispersal techniques are ineffective.

Lethal control is usually performed in Australia using firearms. Trapping and poisoning, or poisoning alone is sometimes also used.

Animal welfare is a critical element of lethal control. As such, wildlife controllers should be well-trained on firearm/poison usage, on species identification, and effective lethal control techniques and be well versed in any applicable codes of practice relevant to animal welfare (see Section 2).

Human welfare is an equally critical element, and wildlife controllers must not only ensure their personal safety, but also of the safety of others in the vicinity.

Permits for lethal control vary from state to state, and often restrict the number and type of animals allowed (see Section 2). Most state departments responsible for issuing permits will require evidence of an airport's wildlife management program that demonstrate an integrated approach.

Refer to appendices H and I for safety considerations for handling of biological remains, and recommended procedures for handling of biological remains.

Firearms safety

The safe use, transport, storage and maintenance of firearms is paramount, so too is training and licensing. Airports should develop their own firearms policy that, at least, include the following guidelines:

1. A gun shall not be fired in the direction of or in the vicinity of any aircraft. The location of the hazard in relation to any aircraft in the vicinity, whether landing, taking-off, taxiing, etc should be considered.
2. A strict watch is to be maintained for any personnel working in the vicinity, particularly people on foot whose clothing may blend in with the background.
3. Loaded guns should never be carried in the vehicle or fired from the vehicle.
4. Particular care to be taken when using a gun in the vicinity of any buildings, aerials, runway lights, windsocks, etc.
5. A strict watch must be kept for helicopter and fuel tanker traffic.
6. Never fire in the direction of any vehicle moving on the perimeter road or at any houses, vehicles, etc in the vicinity of the boundary fence.
7. When using pyrotechnic ammunition in dry, hot conditions, care must be taken to ensure that the spent cartridge casing (which has a tendency to smoulder) does not set off a grass fire.
8. Guns must be thoroughly cleaned and oiled daily, preferably as soon as practicable after use.
9. When not being carried in the wildlife controller's vehicle, guns and ammunition must be stored in a locked cupboard.
10. Wear ear and eye protection when discharging firearms.
11. Lethal control should target young inexperienced birds during and after the breeding season, as well as naive vagrants.
12. Lethal control should be applied sparingly to groups of birds, particularly territorial species such as lapwings as these birds can reduce the presence of other species.
13. Lethal control should adhere to animal welfare guidelines and codes of practice.

Active management: trapping and relocation

Dispersal, lethal control, or even nest removal, is not always effective. Some individuals can persist, or the target species is protected under state or commonwealth law. In these instances, trapping and relocating individuals can be effective, and requires the assistance and approval from local environment authorities.

In North America, raptors are often trapped and tagged at airports and relocated over 100 km away. Some airports choose to shoot the birds that return; others, like Vancouver Airport Canada, choose to leave and monitor the birds that return. These birds become experienced in manoeuvring around aircraft and establish territories which minimise the entry of other less-experienced birds into the territory.

Active management: egg and nest removal

Wildlife that establishes breeding and nesting territories on-airports can create a strike hazard. Birds defending their territories can become oblivious to aircraft traffic. Additionally, young hatchlings and juvenile birds tend to be inexperienced and lack awareness making them more prone to being struck. Removing nests can deter the establishment of breeding territories, as well as limiting local breeding success. Permits from environment authorities are required for native species, and nests cannot be removed if chicks are present. In this instance, nests can only be removed once chicks have fully fledged. Appropriate personal protective equipment (PPE) should be used (ie gloves, safety glasses, face masks) and care must be taken for aggressive territorial behaviour.

Passive management

Wildlife is attracted to the airport environment for food, shelter and water (see Section 3). Passive management, sometimes referred to as habitat management, aims to manipulate the availability of these resources to reduce the wildlife attraction. It is better to make the airport environment less attractive to wildlife in the first place, rather than rely solely on active management. It provides longer-term risk reduction than active management.

Passive management: grass

Grass height maintained at 200–300 mm is a viable method of deterring ground-foraging birds. Establishing and maintaining long grass on airports is site specific, and depends on soil type, grass species, climate and rainfall. It is recommended that airports:

1. Trial an area of long grass to determine if:
    - » the grass species is capable of growing to the required length
    - » the establishment of a dense sward is possible (patchy areas of exposed soils or sparse vegetation can offer a refuge to wildlife)
    - » visual access to navigational equipment and visual aids will be compromised
    - » mowing equipment is capable of cutting grass at longer lengths, and
    - » a different mix of hazardous wildlife species are attracted to the longer grass.
1. Regularly remove seed heads so as not to create an attraction to granivorous birds and animals.
2. Mow adjacent to aircraft movement areas at night to reduce the wildlife attraction.
3. If mower access to airside grasslands is restricted during the wet season due to waterlogged soils, consider a low cut just prior to the wet season.
4. Where long grass (ie 200–300 mm) is regularly maintained, assess the suitability of 'bottoming out' whereby grass is cut to 25 mm in order to remove dead growth and accumulated clippings from previous cuts. Bottoming out frequency depends on soil type and grass species.
5. Assess seed mixes designated for areas of grass reestablishment, excluding species that are known attractants.
6. Where applicable, apply fertilisers to encourage dense and consistent growth.

Alternative grass management options

Some soils do not allow for the establishment of dense grass swards, or support grass species that can grow to more than 200 mm. In these instances, other vegetation types can be considered. For example, airports located in coastal regions on sandy soils can encourage low heath to establish that has the same wildlife exclusion function as long grass.

Endophytic grasses have been developed (grasses bred with a specific fungus) which have shown a reduction in insects and birds feeding on them. Trials with these grasses are taking place in Australia's southern states. To date, there are no endophytic grasses available for warmer climates.

Passive management: drains and drainage

Removing water, or excluding access to water, contributes significantly to mitigation. It is recommended that airports:

1. Identify all areas of water availability (eg drains, retention/detention ponds, irrigation systems, ground depression that accumulate with water rainfall, areas prone to occasional or regular flooding, creeks, wetlands).
2. Drain and remove all unnecessary areas of water (ie those areas that do not provide hydrological function for the airside area).
3. Re-grade sealed areas that accumulate with water following rainfall.
4. Fill ground depressions that accumulate with water following rainfall.
5. Install netting, or a wire matrix, over permanent or semi-permanent water retention areas, such as ponds or drains, to exclude wildlife access.
6. Install floating devices on areas of permanent water.

7 Incorporate steep-sided concrete-lined drains into drain design.

8 Remove any islands that act as wildlife refuges.

9 Remove dense vegetation (eg reeds, macrophytes, bank vegetation) that act as a wildlife refuge or restrict visual access for wildlife controllers.

10 Install 'curtains' over drain culvert entries. Curtains should act to prevent wildlife access but not restrict water flow.

Passive management: landscaping

Airside and landside landscaping performs an important aesthetic role for airports, however when not carefully considered, can contribute to the wildlife strike risk. It is recommended that airports:

1 Review the suitability of plant species used in the airport's existing landscaping.

2 Assess plant species suitability for new landscaping design projects that are part of terminal and landside upgrade works.

3 Develop a landscaping policy that at least identifies plants species not to be used.

4 Do not use plants that produce attractive fruits (eg fig, lilipily, commercial fruit trees, palms).

5 Do not use plants that produce attractive flowers (eg eucalypt, melaleuca, grevillea).

6 When planting trees along access and other roads on the airport:

- » do not plant species that exceed 10 m when mature
- » do not plant more than five trees in any one group
- » the average interval between tree groups should not be less than 200 m
- » single trees should not be planted closer than 50 m to any other single tree or tree groups
- » trees should make up no more than five per cent of total tree/shrub plantings.

7 When planting shrubs

- » species should not to exceed 5 m mature height.
- » shrubs which produce nectar, fruits or seed should not be planted in groups of more than five per group and such groups shall not be planted closer than 50 m to specimens of the same species or groups of any species which may similarly attract birds or flying-fox at the same time of the year.

8 Avoid the use of sprinklers, especially during hot dry weather.

9 Regularly remove fruiting bodies of palms.

Passive management: built environment

Airports should aim to identify and regularly monitor the built environment to ensure that wildlife hazards are detected and managed. It is recommended that airports:

1 Remove disused and dilapidated buildings and aircraft.

2 Install exclusion devices, such as netting, to prevent wildlife access to building roof spaces, ledges, eaves, or other building structures that can support nesting, perching, or roosting birds.

3 Use automatic doors, or plastic strip curtains, to prevent wildlife access.

4 Install anti-perching spikes on lights, signs, navigational equipment and visual aids.

5 Remove all unnecessary posts, signs and poles.

6 Modify apron lighting enclosures to prevent nest establishment.

7 Turn off runway lights when not in use to reduce the insect attraction.

8 Ensure perimeter fencing adequately excludes terrestrial animals (eg macropods, cattle, dogs).

9 Regularly check perimeter fences to identify potential breaches.

10 Extend fence footing up to 30 cm into the ground to prohibit access by digging animals or alternatively, install a sub-surface concrete barrier.

11 Regularly monitor infrastructure for nests or roosts.

Passive management: waste management

Poor waste management can attract significant numbers of high risk species to an airport and its vicinity. It is recommended that airports:

1 Ensure industrial bin lids are closed at all times.

2 Ensure bin design restricts bird access.

3 Ensure the frequency of waste removal is commensurate with the volume of waste generated to avoid waste overflow.

4 Provide training and guidance material to tenants on waste management protocols.

CASE STUDY

20 January 1995. Paris, France: A Falcon business jet with 10 people on board struck a flock of lapwings during take-off. The aircraft crashed, killing all 10 people on board. The presiding judge declared that the airport staff failed to perform routine bird scaring, 'negligently failing to follow normal security procedures'. Three Paris Airport Authority staff were criminally charged with, but later found not guilty, of involuntary manslaughter.

www.birdstrike.it/birdstrike/file/images/file/2013.02_le_bourget.pdf

CASE STUDY: Where are the problems?

Fairy Martins, a small insectivorous bird widely distributed throughout Australia, often use drains on airports to establish their mud nests that they attach to the ceiling and sides of drain culverts. Although a single Fairy Martin, at 11 g, presents a relatively low strike risk, their tendency to flock often results in multiple strike incidents whereby more than one individual is struck. Many airports, such as Mackay and Gold Coast in the examples below, have installed simple exclusionary devices to inhibit culvert access.

Mackay Airport. Photo © Avisure

Gold Coast Airport. Photo © Avsiure

CASE STUDY: Anti-perching

Anti-perching spikes and netting can be used by airports to inhibit perching by bird species on ledges and other structures around the airport.

© Avisure

© Avsiure

CASE STUDY: Netting installation

Brisbane Airport identified a key water attractant along its secondary runway. The area attracted large numbers of water birds including cormorants which contributed to increased strike risk. To address this risk, the airport installed a net to exclude access.

Brisbane Airport. Photo © BAC

CASE STUDY: Fencing and wallabies at Proserpine

The cattle fencing encircling the cross runway at Whitsunday Coast Airport permitted wallaby access to the airfield, with the wallaby risk ranging from moderate to high over several consecutive years. In 2010, Whitsunday Coast Regional Council decided to the close the cross runway and installed an appropriate fence commensurate with the rest of the airfield perimeter fence, effectively excluding all terrestrial mammals, including the problematic wallaby. Considerable cost savings were also made by installing approximately 300 m of fencing, as opposed to more the 2.5 km of fencing required if the cross runway had remained open.

(Left) Perimeter fence around the cross runway (photo © Avisure). (Right) Fence installed following the cross runway closure (photo © Avisure)

CASE STUDY: Drain modification

The primary drain running through Sunshine Coast Airport supported the greatest density of birds on the airport, including high risk species such Pacific Black Duck and White-faced Heron. To reduce the bird attraction, significant modifications were made including steepening the sides, narrowing the width, removing the aquatic vegetation, and installing a concrete invert. Birds that previously accessed the drains via the vegetated banks were no longer able to access the water, effectively reducing attraction. To overcome the cost-prohibitive nature of such works, Sunshine Coast Airport committed to completing small sections each year.

(Left) Main drain prior to modifications (photo © Avisure). (Right) Main drain after modifications (photo © Avisure)

CASE STUDY: Natural revegetation

The short-grassed areas of Sunshine Coast Airport supported high numbers of Straw-necked Ibis, Australian White Ibis, Australian Magpie and Masked Lapwings, contributing to a significant strike risk. Unable to grow dense swards of grass on the sandy, low-nutrient soils, the airport successfully trialed revegetating the naturally occurring Wallum Heath vegetation in some airside areas. The establishment of the heath excluded the aforementioned high-risk species, in the same way long grass does, and encouraged low-risk species such as honeyeaters. In addition, the heath provided the opportunity for the establishment of a small population of the Eastern Ground Parrot *Pezoporus wallicus* which is listed as vulnerable, endangered or threatened under various legislation in Queensland, New South Wales, Victoria, and Western Australia.

(Left) Airside vegetation when mowed short (photo © Avisure). (Right) Airside vegetation when the naturally occurring heath vegetation is permitted to grow (photo © Avisure)

CASE STUDY: Wildlife relocation

In July 2006, a Dash 8 struck, and killed, two adult brolgas at Townsville Airport, orphaning a single juvenile brolga that had remained airside following the incident. Given the high potential strike risk of leaving the juvenile brolga airside, and the unsuitability for lethal control, the airport coordinated with the Queensland Parks and Wildlife Service to capture and release the brolga in a suitable habitat remote from the airport. The brolga was safely released in Cromarty Wetlands, more than 30 km from the airport.

(Left) Main drain prior to modifications (photo © Avisure). (Right) Main drain after modifications (photo © Avisure)

CASE STUDY

Many Australian palm trees produce fruits that are very attractive to birds and flying-foxes. To reduce this attraction, Darwin Airport included a palm management policy in its wildlife hazard management plan that required the regular removal of fruits from the palms planted along the airport road and other landside areas.

CASE STUDY

In 2010, Gold Coast Airport engaged wildlife strike management and dog training specialists to recruit and train a dog for airside wildlife dispersal. Of particular concern at that time were Pacific Black Ducks, Australian White Ibis and various other large bird species such as egrets and herons. In order to mitigate any possible risks associated with using a dog airside, the airport completed a thorough risk assessment covering all aspects from dog selection to training to operation. Selection and training commenced in August 2010, and by March 2011, the dog (called Joe) and his handler were operating airside. Joe's success was quickly obvious, with target bird numbers in critical areas reduced within the first year, as well as a 75 per cent reduction in the use of pyrotechnics by wildlife control personnel.

© Avisure

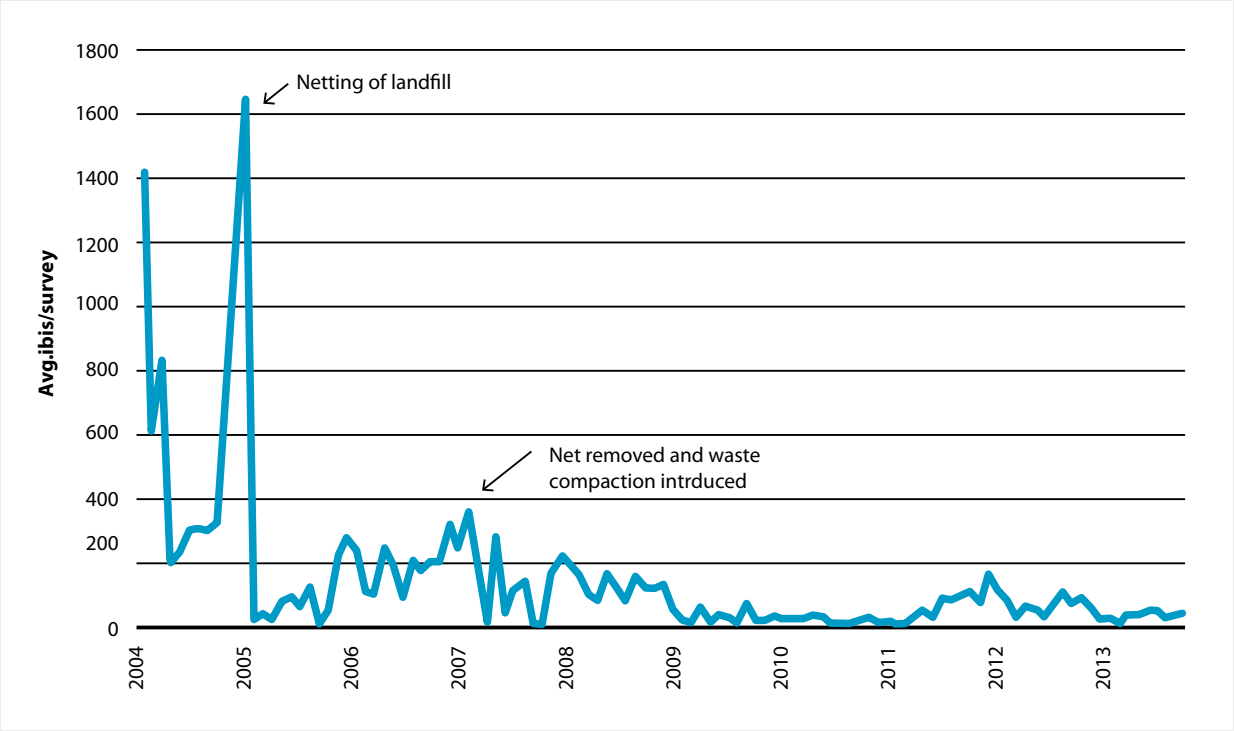
© Avsiure

CASE STUDY: Gulls and the tuna industry in Port Lincoln

Port Lincoln Airport experiences a seasonal influx of Silver Gulls (up to 1400 in a day) between July and September. On occasions, airport safety staff have spent up to five hours a day dispersing the gulls. The high gull population in the Port Lincoln area is linked to the Blue Fin Tuna farming industry which undertakes daily feeding of the farm tuna. It is this feeding activity that attracts the gulls. In winter, the tuna are harvested and sold, and it is during this time the feeding stops and the gulls relocate to other forage sites in the region, including the airport. At this time, rainfall is high which creates attractive waterlogged soils for the gulls to access worms and other invertebrates.

CASE STUDY: Managing the off-airport hazard

Located less than 500 m southwest of Ballina Airport, Ballina Landfill is the most significant wildlife hazard for aircraft operating at the airport, particularly the risk associated with Australia White Ibis. In 2005, netting was installed over the active waste cells. While ibis (and other bird) numbers decreased, the zero target was not achieved due to operational problems such as an ineffective door and holes in the net that provided bird access, with ibis numbers gradually increasing within 12 months after the installation of the net. Between March 2007 and April 2013, waste at Ballina Landfill was baled (compacted) and placed in the landfill. The bales were tightly compacted to reduce the accessibility of waste to birds and to maximise the life of the landfill. However, the attraction was still relatively high during baling and transporting. Ibis numbers fluctuated during this baling period, regularly exceeding the target number. In April 2013, baling was replaced by the establishment of a transfer station in lieu of the landfill. Although the waste transfer method still provides foraging opportunities for ibis due to spillage of putrescible waste and uncovered transfer bins, overall numbers are significantly lower than pre-management numbers in 2004. This outcome was only possible due to the cooperative effort between the airport and the landfill.



Source: Ballina Landfill Bird Management Plan 2013 (prepared by Avisure).

CASE STUDY: Carrion and kites at Karumba

In 2014, a wildlife hazard assessment at Karumba Airport identified Black Kites, and other raptors, as high strike risk. One of the raptor attractants identified was the presence of carrion (remains of animals ie 'roadkill') on roads and roadsides in close proximity to the airfield. Following the development of a wildlife hazard management plan in 2015, the airport committed to regular inspections of the roads adjacent to the airport, and the removal of any carrion located during these inspections.

CASE STUDY: Predicting the flying-fox risk at Cairns Airport

In March 2007, in cooperation with CSIRO and Avisure, Cairns Airport commenced a flying-fox monitoring and management project in response to the high risk presented by flying-foxes on, and in the vicinity, of the airport. The project aimed to:

1. identify the flying-fox strike risk at Cairns Airport
2. examine the dynamics of flying-fox camps located in the Cairns region over time
3. define the resource attractants for flying-foxes within and outside Cairns Airport
4. identify flying-fox and aircraft conflict in terms of height and time
5. develop management options for reducing the risk of flying-fox strikes at Cairns Airport.

Key outcomes of the project included:

- An understanding of flying-fox risks in terms of time of day, time of year, altitudes, and in response to vegetation fruiting/flowering, allowing risk periods to be predictive.
- An identification of the local flying-fox camps contributing to the airport strike risk.
- The establishment of a flying-fox monitoring procedure.
- The use of the Automatic Terminal Information Service (ATIS), NOTAMs, and bird watch condition reporting to communicate peak risks to airlines and ATC.
- The positive action by airlines in response to hazard warnings.
- During high risk dusk periods, the encouragement of airlines to undertake full length departures; delay take-off; carry extra fuel in case of delayed landing (ie 'go-arounds' until flying-foxes have completed dusk transits of the airport).
- The removal of known attractants from Cairns Airport land (airside and landside).
- The implementation of a standard procedure for reviewing plant species lists proposed for any landscaping works.
- Ongoing liaison with local authorities to remain informed of any changes to local flying-fox camps (ie camp abandonment or new camp establishment) via Queensland Parks and Wildlife Service representative at Cairns Airport Bird and Wildlife Committee meetings.

Source: Cairns Airport Flying-fox Program, Final Report 2009 (prepared by Avisure)

CASE STUDY: Rescheduling flights to avoid risks at Ballina Airport

The flying-fox hazard was assessed as very high at Ballina Airport, and a subsequent investigation identified key risk periods associated with known transit patterns over the airfield at different times of the year (see following table):

Month	Risk period (UTC)	Month	Risk period (UTC)
January	09:00 – 09:45	July	07:15 – 08:00
February	08:45 – 09:30*	August	07:30 – 08:15
March	08:15 – 09:00*	September	07:45 – 08:30
April	07:30 – 08:15*	October	08:00 – 08:45
May	07:15 – 08:00*	November	08:30 – 09:15
June	07:00 – 07:45	December	09:00 – 09:45

In response, the airport developed and implemented flying-fox monitoring and hazard notification procedures. But more importantly, because the risk periods extended over short time periods of approximately 45 minute intervals, REX airline was able to modify its night flight schedule to avoid the known risk. It is understood that this was the first time an Australian airline and airport have worked cooperatively to reschedule flight times to avoid high risk periods associated with wildlife.

Source: Ballina Airport Flying-fox Risk to Airport Report 2012 (prepared by Avisure)

SECTION 8: STRIKE REPORTING

Wildlife strikes are classed as routine reportable incidents under the Transport Safety Investigation Regulations 2003 (Section 2) and must be reported to the ATSB within 72 hours of occurring. Any strike that results in serious injury or death, and/or serious damage to aircraft or other property must be immediately reported to the ATSB.

Completing strike reports

Airports are notified of strikes via aircrew, ATC, ground crew or engineers, or following the discovery of an animal carcass during runway inspections.

Standard operating procedures included in the WHMP should provide step-by-step instruction for reporting strikes, handling wildlife carcasses and remains, and submitting strike reports to the ATSB.

In Australia strikes are defined as either confirmed, suspected or as a near miss.

Strikes are further categorised by location. These categories are important to inform risk managers where to focus management and mitigation efforts.

Figure 7: Wildlife strike type, as defined by the Australian Aviation Wildlife Hazard Group (Wildlife Hazard Management Plan template) 2010.

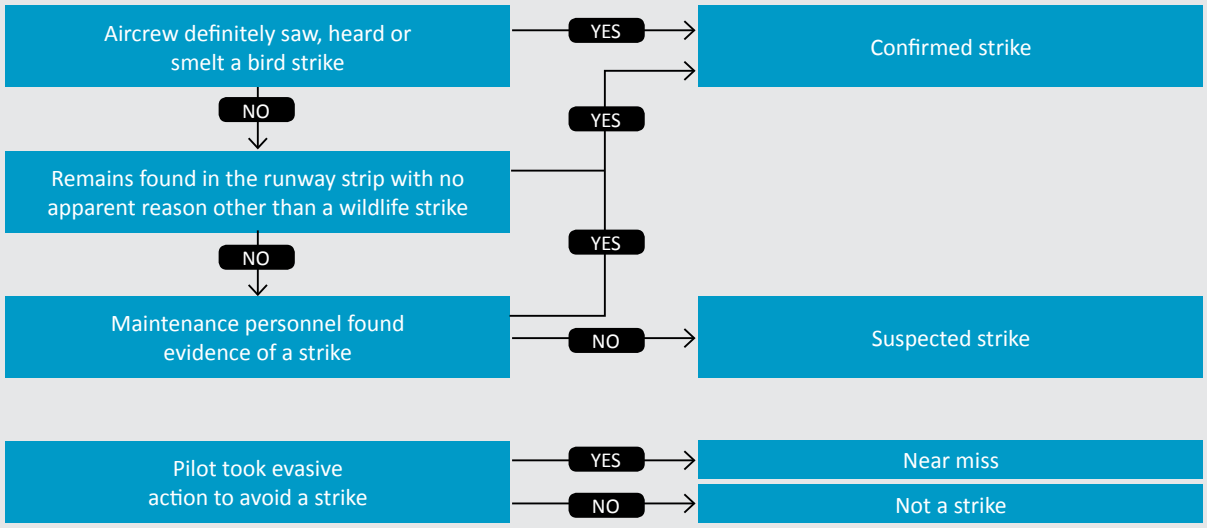
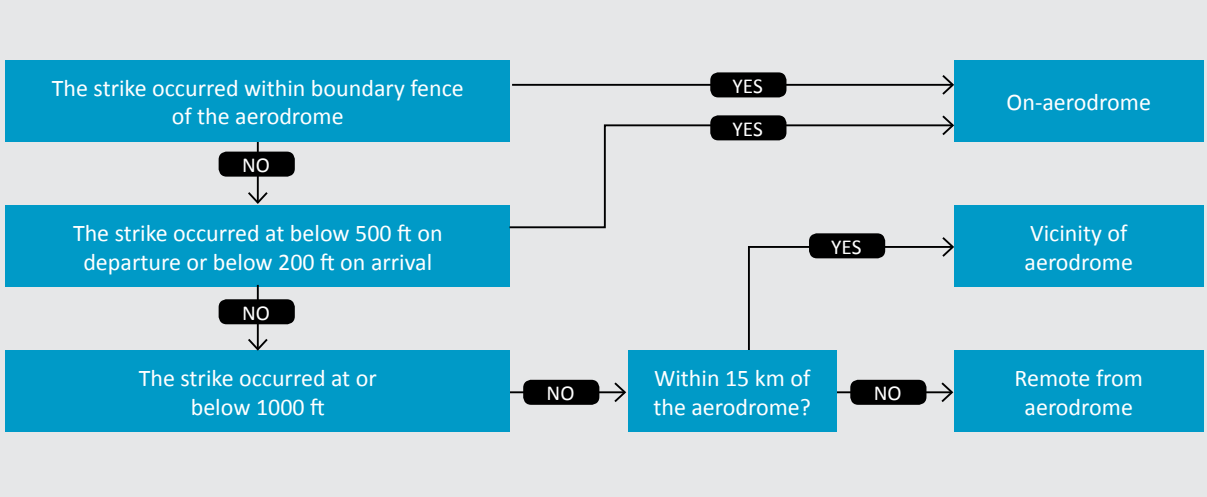


Figure 8: Wildlife strike location, as defined by the Australian Aviation Wildlife Hazard Group (Wildlife Hazard Management Plan template) 2010.



Species identification

Accurate species identification informs risk assessments which enables effective hazard management. Struck wildlife should always be identified as close to species level as possible. Table 12 summarises methods of identification. Attachments H and I provide safety guidelines and recommended procedures for handling animals and animal remains.

Submitting strike forms

Strikes are submitted to ATSB by:

Aviation accident or incident notification report
Online: www.atsb.gov.au/mandatory/asair-form.aspx
Download: www.atsb.gov.au/media/4458108/AAIN-form.pdf

E: atsbasir@atsb.com.au **P:** 1800 011 034
F: 02 6274 6434

Post: ATSB Notifications Reply Paid 967,
PO Box 967, Civic Square, ACT 2608

The ATSB's strike report form is for all aviation accidents and incidents, and as such contains data fields that are not relevant to wildlife strikes. The ATSB accepts non-ATSB forms. See Appendix J for an example form.

Common strike report errors

Poor strike reporting may result in airports not being able to validate data resulting in a misinterpretation of actual strike risks. Inadequate reporting may distort or bias data in a way that provides false or misleading conclusions, which can lead to ineffective resource allocation to manage hazards, and poor decision-making by program managers to positively influence risk mitigation.

Table 12: Methods of species identification and relevant requirements.

Identification method	Requirements
Visual: On-site by airport personnel.	Bird identification training. Bird field guides, or similar.
Visual: On-site by ornithologist.	Bird identification training. Bird field guides, or similar. Carcass storage facilities (eg freezer).
Visual: Remotely by ornithologist from photographs.	Bird identification training. Bird field guides, or similar. Photographs of strike remains whereby the images: » clarify colouration by placing remains on a contrasting background » are of various angles and distances » show scale to determine animal size.
Forensic: DNA analysis* *DNA analysis can be performed on all biological material, including blood smears located on aircraft.	Designated laboratory equipped to analyse samples (eg Australian Museum). Training on sample collection, storage and transport. See appendices H and I.
Forensic: Feather analysis.	Designated laboratory equipped to analyse samples (eg Australian Museum). Training on sample collection, storage and transport. See appendices H and I.
Post-mortem: Whole carcass	Designated facility equipped to perform post mortems (eg veterinary surgeries, zoos etc). Training on carcass collection, storage and transport. See appendices H and I.

Table 13: Common errors in wildlife strikes reports and recommendations to improve reporting.

Error	Problem	Recommendation
Omissions of known details.	Failure to include all known details resulting in incomplete records.	Note all details relevant to the strike. For example, instead of 'A runway inspection was completed', use 'Runway XX/XY inspection complete, no carcass found'.
Leaving fields blank when details are unknown.	Blank fields imply details were not collected by the reporter.	Where details are unknown, record fields as such. For example, when recording aircraft type for a carcass found in the flight strip with no reports from aircrew, report aircraft type as 'unknown' rather than leaving blank.
Incorrect date/time/weather when details are unknown.	Strike reporters often use time and/or weather details current at the time of completing the strike report, when in fact the strike time and weather details from may be unknown.	Where details are unknown, record fields as such. For example, when recording time of strike for a flying-fox carcass found during morning inspections, record the time as 'unknown', rather than using the time of carcass discovery.
Incorrect strike type/location.	Inconsistent or incorrect reporting of strike types (eg confirmed or suspected) or strike location (eg on or off airport) results in incorrect analysis of strikes.	Provide training to all individuals responsible for reporting strikes. Ensure reporting procedures clearly define strike types and locations.
Non-specific species identification.	Reporting the species struck as 'small brown bird', 'hawk' or 'duck' rather than the actual species has significant implications for hazard management (ie without knowing the species, specific management cannot be applied).	Wherever possible, identify species via: 1 carcass identification 2 DNA analysis 3 feather analysis.

Significant strike investigating and reporting (SSIR)

SSIR is a detailed analysis of wildlife strikes that attempts to answer the question of why that aircraft and animal occupied the same space at the same time. Although not a regulatory requirement, determining the exact sequence of events can reduce the chances of recurrence, offset aerodrome liability, reduce aircraft operator costs, and contribute to managing environmental issues relevant to the wider community.

SSIR may be trigged by:

- a strike causing a serious incident, accident, delay or aircraft damage
- a strike, or series of strikes, involving an unusual species for the region
- a strike during an unusual wildlife or ecological phenomenon
- any strike incident considered unusual in nature, timing, location or frequency, or
- a serious accident or incident where wildlife strike needs to be ruled in or out as a contributing factor.

CASE STUDY: Significant strike report

On 1 October 2013, an inspection of a recently arrived China Southern A330 at Brisbane Airport identified a bird strike in one of the engines which had caused damage to one of the fan blades. Crew members thought they had smelt something shortly after departure form Gangzhou Airport in China, however a strike at that time was not confirmed. Brisbane Airport personnel collected a sample of the strike remains from the engines and submitted it the Australian Museum for DNA analysis. The analysis returned positive identification for Black-crowned Night Heron (Nycticorax nyticorax) which is commonly found throughout Asia and other are regions, but not in Australia. The DNA analysis alone was enough to determine that the strike did not occur on arrival at Brisbane Airport.

SECTION 9: COMMUNICATING WILDLIFE HAZARDS

Aircrew personnel rely on airport operator vigilance to communicate information that may compromise flight safety, including the presence of wildlife hazards. Effective hazard communication informs pilot decision-making, but only when it is succinct, yet detailed enough to allow an appropriate practical and operational response. Providing aircrew with a 'bird hazard exists' warning is neither explanatory nor useful, and does not equip aircrew with sufficient information to avoid a strike.

En route supplement Australia (ERSA)

Where the presence of wildlife is assessed as constituting an ongoing hazard to aircraft, Section 10.14.1.6 of the MOS Part 139, requires the aerodrome operator to notify the Aeronautical Information Service in writing, to include an appropriate warning notice in the ERSA. Section 10.3.5 provides guidance for making changes to the AIP. ERSA entries must include sufficient information to provide the reader with nature of the wildlife hazard, including species, period of concentrating, location and flight path.

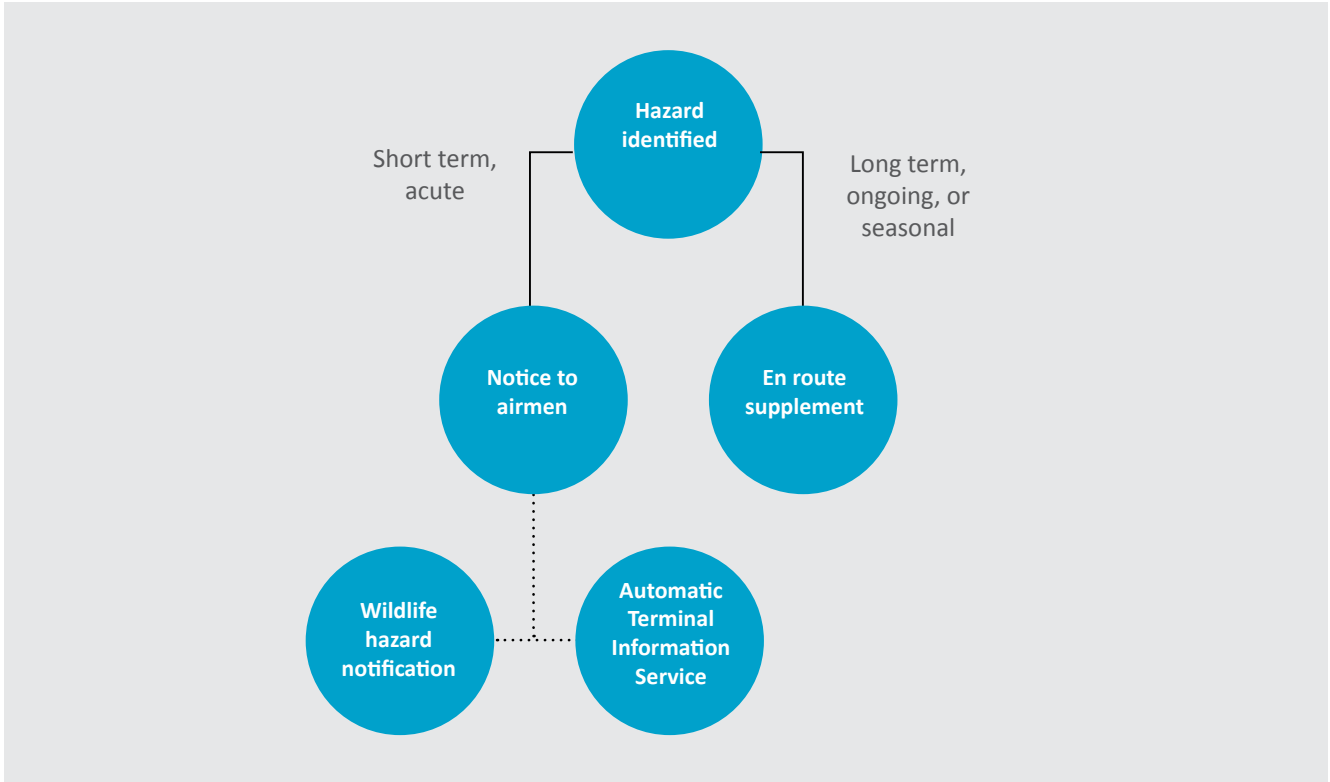
Notice to airmen (NOTAM)

Where a wildlife hazard is assessed as acute, of short-term or seasonal nature, Section 10.14.1.7 of the MOS Part 139, directs airports to release a NOTAM. Section 10.3 directs airport on how to initiate a NOTAM, with Section 10.3.6 requiring airports to provide specific information on the nature of the wildlife hazard, including species, period of concentration, location and flight path. In addition, Section 10.5 provides examples of NOTAMs and abbreviations.

Automatic Terminal Information Service (ATIS)

The continuous broadcast of key information, such as weather and active runways, can be updated by the air traffic controller to communicate significant and acute wildlife hazards.

Figure 9 Wildlife hazard communication options



Wildlife hazard notifications

Although not required within Australia's aviation regulatory framework, and not widely adopted throughout Australia, some Australian airports use wildlife hazard notifications (WHNs) to communicate wildlife hazards to airlines and other industry stakeholders. Based on the concept of bird watch condition BWC reporting created by the Bird Aircraft Strike Hazard (BASH) team of the United States Air Force, WHNs inform the recipient of: the airport strike hazard level (low, moderate, high, or severe); the nature of the hazard including species, location, time, duration height; what the airport is doing to mitigate the risk, and; recommendations for aircrew to minimise the chance of a strike. The latter two elements, which provide important strike mitigation information, are what differentiate from an ERSA entry or a NOTAM.

Direct communications

In the case of immediate hazards on the airfield that are presenting a potentially serious risk to arriving and departing aircraft airport personnel should communicate directly to aircrew via ATC at towered aerodromes, or via common traffic advisory frequency (CTAF) on non-towered aerodromes. Information communicated should include the location and nature of the hazard including species, and recommendations for aircrew to minimise the chance of a strike. For the latter, recommendations may include delaying take-off or landing until wildlife control personnel can mitigate the hazard.

CASE STUDY

On 13 November 1996 at Pula International Airport, Pula, Croatia, Croatian Airlines B737-200 struck a gull on take off for Pula Airport. The engine was destroyed and the pilot aborted take off. The airline insurer billed the airport for the engine replacement (US$1.4 m), however the airport refused payment and litigation ensued. Final finding for the plaintiff after many appeals was that the airport was liable. The airport argued they had a permanent NOTAM stating 'bird hazard exists'. The judge argued that the permanent NOTAM acknowledged the hazard but did not exempt the operator from mitigating against it. The judge further argued that the operator was the more duty bound to ensure all reasonable actions are taken to mitigate it.

http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1136&context=icwdm_usdanwrc

CASE STUDY

Airports often include a wildlife hazard warning in the ERSA, however the information provided is typically 'bird hazard exists' or similarly empty information. Providing a more informative warning assists aircrew to better understand the hazard and be better informed to mitigate against a strike. For example:

Alice Springs: www.airservicesaustralia.com/aip/current/ersa/FAC_YBAS_28-May-2015.pdf

Animal and bird hazard exists. Bird hazard reduced on very hot summer days with increased bird hazard May-Aug daily and in months after increased average rainfall. Occasional feral animals present and seasonal influx of migratory birds. Animal hazard managed to minimal risk during daily airport business HRS.

Emerald: www.airservicesaustralia.com/aip/current/ersa/FAC_YEML_28-May-2015.pdf

Bird hazard exists. Pilots to particularly check for soaring black kites prior to landing and TKOF. Flying fox HN activity, transiting AD FM North to South across RWY 06/24. Fruit bat activity occurs throughout the year. ARO monitors during dusk and alert over CTAF, if observed.

Perth: www.airservicesaustralia.com/aip/current/ersa/FAC_YPPH_28-May-2015.pdf

Bird hazard exists as follows:

a Galah & Corella present in large flocks DRG Spring.

b Straw-necked ibis in large flocks overflying airfield DRG Winter & Spring.

c Nankeen kestrels present in RWY strip areas year round peaking in the Spring & Summer.

d Pacific black duck and Australian wood duck present DRG Spring & Summer with peak activity DRG Summer.

Irrespective of the seasonal information provided, Perth Airport will publish a NOTAM where an acute hazards exists.

CASE STUDY

In response to serious hazards associated with flying-foxes, Cairns Airport provides BWC reports to airlines. BWC reports define the risk and provide recommendations to airlines to mitigate against a strike.

CAIRNS AIRPORT
BIRD WATCH REPORT 2012/07

Condition: SEVERE – Flying Fox

Issue date: 14 April 2012 Review date: 20 April 2012

Legend
Bird Watch condition SEVERE.
Heavy concentration of birds on or immediately above the active runway or other specific locations that represent an immediate hazard to safe flying operations (>100 FF in a 10 min period).

Bird Watch condition MODERATE. Concentrations of birds observed in locations that represent a probable hazard to safe flying operations (>50 and <100 in a 10min period).

Bird Watch condition LOW. Above normal bird activity on and above the airfield with a low probability of hazard.

Bird Watch ALERT. Weather, time of day and seasonal conditions which make an influx of birds onto the airfield likely.

Location:
Large concentrations of Flying Fox (FF) have been sighted north east of the airport heading in a south westerly direction crossing the northern approach to Rwy 15/33 in an area from north of the Barron River to Twy B2 (see attached flight path map). There has also been some activity in the southern approach as FF coming from the direction of the Cairns CBD head to the western side of the airport. The FF at the north were observed at heights up to 50 ft and at the south at heights between 50 and 200 ft.

Time of Day:
(All times local): The fly outs are currently occurring between 1810 and 1845 hrs but depending on cloud cover and weather conditions the peak times can vary by 30 minutes either side of these times. Peak fly out periods are normally 15-20 minutes in duration. Any time between dusk and dawn there maybe isolated Flying Foxes in the vicinity of the airport and in the approaches.

Number of Birds / Wildlife:
A "Severe" Bird Watch condition was in place between 2 and 8 April '12 as a result of Melaleuca flowering in the Cairns area. Numbers up 3,400 were observed in a 30 minute period. Last night large numbers were again observed and a "severe" bird watch condition has been triggered. See table below for indicative numbers.

Cairns Airport – Flying Fox Count

Times	13 Apr	14 Apr	15 Apr				
1800-1810	-						
1810-1820	500						
1820-1830	350						
1830-1840	400						
1840-1850	18						
1850-1900	-						
TOTAL	1368						

Species Identification, Behaviour and Attractants

Identification:
Spectacled Flying Fox (*P. conspicillatus*).
Large blackish body and head fur. Black wings (not transparent in flight). Pale yellow collar and eye fur ('spectacles'). Wing beat slow, willowing. Weight: 500g - 1kg, Wingspan: up to 1.5m.

Behaviour:
The FF coming from the north east have returned, and are crossing the close in northern approach to Rwy 15. Rwy 15 landings during the peak fly out period will significantly increase the strike risk. Some FF are coming from a colony in the city are therefore flying within the southern approach. This means that full length departures Rwy 15 will minimise the strike risk.
There have not been any Flying Fox strikes since 3 Feb '12.
There was a non-damaging strike (unknown species) on a DH8 on 4 Apr '12 Landing Rwy 15 @ 2048 hrs local.

Attractants:
The main attractants for this fly out are not known. All flying-fox feed on fruit and nectar of various native and introduced tree species. Cairns Airport does not offer roosting habitat for FF, bird strike risk is associated with FF transiting across the airport and approaches from adjacent colonies heading to rainforest and other feeding areas.

Bird/wildlife management strategies implemented:

- Airport Safety Officers are monitoring the Flying Fox movements and reporting the presence, numbers, direction and approx flying height via Air Traffic Control to all arr and dep aircraft.
- A Notam covering the presence of Flying Foxes has been issued.
- A hazard report will be placed on the ATIS.
- Airline operators requested to advise aircrews by INTAM
- Cairns Airport Pty Ltd Apron Coordinators will provide fly out / fly in advice to airline movement control 30 mins prior to expected peak time, at the commencement of the peak period, and at the end of the peak period.
- Should mass fly outs continue to occur, Airline operators will be requested to review their operating schedules during the peak fly in / fly out period.
- Pilots may be requested to delay their arrival or departure on advice from the Airport Safety Officer / ATC in the peak fly out / fly in period.
- Should significant numbers of Flying Fox be reported crossing the southern approach only, pilots may be requested to use full length departures when RWY 15 is operational to avoid Flying Fox activity.
- If Rwy 15 is the duty runway, then aircraft may be requested to delay their landing until after the peak fly out.

NOTAM to be issued.

INCREASED FLYING FOX (BATS) HAZARD EXISTS
SEVERE BIRD WATCH CONDITION ACTIVATED BATS OBSERVED
CROSSING THE SOUTHERN APPROACH EAST TO WEST BTN BARRON
RV AND TWY BRAVO 2 UP TO 50 FT AGL AND IN THE SOUTHERN
APPROACH UP TO 200FT AGL. OBSERVATIONS OF UP TO 1,500
BATS IN A 20 MIN PERIOD.
FROM 04 140800 TO 04 200900 EST
EARLY 0800/2000

Prepared By:
Paul Lamont
Manager Operations

Contact Details:
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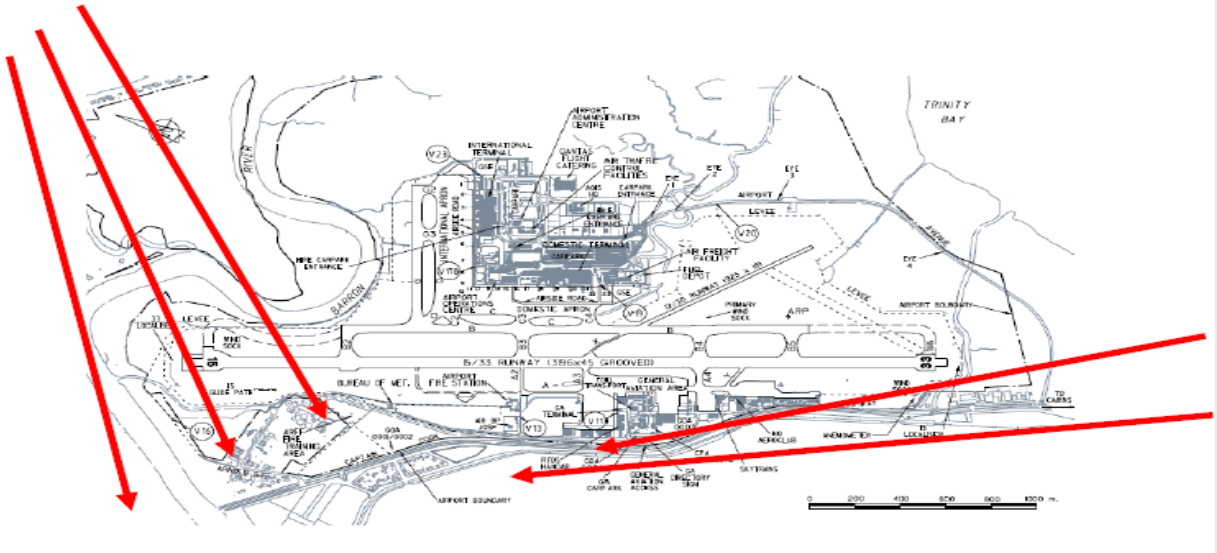
Email: paul.lamont@cairnsairport.com.au



SECTION 10: TRAINING

The CASA MOS Part 139, requires that personnel charged with reporting functions (eg airport safety officers), that include wildlife hazards, be adequately trained and experienced. The AC 139–26 also recommends that those personnel who are responsible for monitoring and managing wildlife hazards should be appropriately trained, and in the latter, qualified.

Although the regulatory framework in Australia only mentions airport operations personnel (ie safety staff), other facets of the aviation industry receive considerable benefits from the provision of wildlife strike management training, including but not limited to: flight crews; ground crews; and biologists and ornithological consultants.

Who should receive training?

The level of training should be commensurate with responsibilities, and the training framework should differentiate these responsibilities as well as linking the similarities.

Airport safety personnel

The CASA MOS Part 139 requires adequate training be provided for personnel that are charged with the responsibility of wildlife hazard management. The AAWHG recommend training is provided in at least the following areas:

1. Wildlife hazard management definitions, concepts, principles and legal context.
2. Risk assessment and risk management.
3. Wildlife observation and identification (including off-aerodrome hazards).
4. Strike remains collection.
5. Wildlife hazard and strike reporting.
6. Mitigation measures (both active and passive).
7. Data and document management.

http://aawhg.org/assets/Recommended-Practices/Suite-5/RP-5.1-Training-and-competency-Aerodrome-final.pdf

Flight crew

Flight crew receive little, if no, training on strike prevention, hazard identification, or strike investigation and reporting. Despite the current global model for wildlife hazard management placing almost the entire responsibility on the airport operator, flight crews are in a unique and important position to contribute to strike risk mitigation programs

The AAWHG recommend training is provided in at least the following areas for initial training programs:

1. Roles, responsibilities and legal framework for wildlife hazard management.
2. History and current status of wildlife strikes.
3. Wildlife identification and behaviour.
4. Factors affecting the probability of wildlife collision with aircraft.
5. Factors affecting the consequence of wildlife collision with aircraft.
6. Detecting, assessing and analysing wildlife strike risk.
7. Mitigating the wildlife strike risk.
8. Communications and reporting.

http://aawhg.org/assets/Recommended-Practices/Suite-5/RP-5-2-Training-and-competency-Flight-crew-working-final.pdf

Ground crew

Despite a lack of regulatory requirement for ground crew personnel training, their role in the detection and reporting of strikes is important. As people responsible for aircraft inspections, they are uniquely positioned to identify a strike, even in the absence of flight crew confirmation.

Training should at least include:

1. roles, responsibilities and legal framework for wildlife hazard management
2. aircraft assessment and strike detection
3. the safe handling of biological remains
4. communications and reporting.

Biologists

Wildlife biologists, ornithologists, aviation ecologists etc, are often contracted by airports to help assess wildlife hazards, develop management programs, conduct risk assessment, deliver training, and in some instances, facilitate wildlife dispersal programs.

Biologist training should aim to equip them with the skills and knowledge to safely operate airside so that operations are not compromised. Biologists working on wildlife strike management programs, should be experienced in:

1. monitoring wildlife
2. identifying wildlife hazards
3. communicating wildlife hazards
4. managing wildlife hazards (including dispersal)
5. risk assessments
6. auditing wildlife hazard management programs
7. developing procedures, plans, policies for wildlife hazard management
8. contributing to and/or facilitating stakeholder liaison
9. data management and analysis.

In addition, biologists working in the aviation arena should be trained and tested in:

1. aeronautical radio operator proficiency and use
2. excellent ornithology expertise and wildlife identification
3. airside driving ability/authorisation.
4. airside familiarisation: airport layout, signs, markers, navigation aids, etc
5. firearms for dispersal and lethal control activities
6. trained in wildlife dispersal tools and techniques
7. authorised/competent for direct communication with ATC to communicate hazards and provide immediate risk mitigation advice
8. regulatory/legislative knowledge
9. able to assess and manage wildlife hazards
10. aircraft recognition and basic airport operations.

Trainers

Trainers should be experienced in managing wildlife hazards at airports, including a demonstrated understanding of airport operations.

Competency assessment

Skills and knowledge should be tested to ensure competency, which should be evaluated only by people experienced and qualified in the field of wildlife strike management on airports. Assessment can assume many forms, but should, ideally, combine testing theoretical knowledge with practical application of skills.

Demonstrating a theoretical and practical understanding of how to identify, mitigate and monitor wildlife risks on airports is imperative.

Refresher training

Although there are no regulatory requirements for refresher training, annual training is recommended, and should coincide with annual risk assessments and annual management plan reviews.

SECTION 11: EVALUATING WILDLIFE HAZARD MANAGEMENT PROGRAMS

Section 10.14.1.5 of the CASA MOS Part 139 requires that a WHMP '… must be reviewed for effectiveness, on a regular basis, at least as part of each technical inspection'. The CASA Advisory Circular 139–26(0) reinforces the concept of continuous review and improvement to ensure that management programs and plans correspond with actual wildlife hazard. Program evaluations measure the efficacy of a program to determine if it is commensurate with risks, and if management actions are contributing to strike risk mitigation. Program evaluations:

- validate management actions
- determine realisations of goals, targets and KPIs
- identify areas for improvement
- identify gaps (eg training, resourcing, management)
- re-assess risks
- evaluate the value of particular tools, techniques and technologies
- improve program efficiency
- ensure legislative and regulatory compliance
- inform decision-making and strategic planning
- allow for better resource use, with fewer fiscal surprises
- provide greater transparency in decision making
- identify management opportunities
- increased knowledge and understanding of risk exposures
- provide for proactive, rather than reactive, risk mitigation
- improve preparedness for external review (eg CASA surveillance events)
- program progress.

Furthermore, program evaluation demonstrates to stakeholders and authorities a commitment to providing safe operations, and satisfies the requirement of continual improvement as part of the aerodrome SMS framework.

Elements of program evaluations

Structured evaluations allow for a systematic review that is replicable, robust, and objective (Table 14).

Program scorecards

Scorecards provide airport operators with a quick summary of program progress, and is reliant on the collection and analysis of data (see sections 5 and 6). Program managers can use scorecards to identify basic trends and highlight issues requiring attention.

Using data

How data is used depends on the questions being asked. Program managers generally want to know whether the effort to manage hazards is having an actual positive impact on the strike rate (ie the strike rate is reducing). Measuring program progress informs decisions on where to focus attention and resources.

Data analysis types are numerous, and may include:

- Strikes per 10 000 aircraft movements.
- Confirmed/on-airport strikes per 10 000 aircraft movements.
- Damaging strikes per 10 000 aircraft movements.
- Mass struck per 10 000 aircraft movements.
- Strikes affecting planned flight per 10 000 aircraft movements.
- Critical area infringement rate per hour by species.
- Proportion of lethal controls against dispersal attempts.
- Dispersal effort against strike rate.
- Grass height against average number of birds observed per count.

Never assess risk purely based on the total number of strikes, or on strikes per 10 000 aircraft movements. In Figure 10, the airport identified a risk associated with an increased number of strikes in 2004 (chart on left); a management program was implemented and subsequently the total number of strikes was reduced. However, when looking at what was struck via mass leading up to the 2004 peak rather than total strikes, it was evident there had been a higher risk in previous years when total strikes was significantly less than 2004 (chart on right). Red dots indicate damaging strikes.

Table 14 Key elements of wildlife hazard management program evaluations

Element	What to look at	Benefits and outcomes
Regulations	CASA MOS Part 139 IBSC best practice standards	1 Determines compliance against the CASA MOS Part 139. Management can target efforts to rectify non-compliances. 2 Assesses the program against international best practice standards.
Program data	See Section 8	1 Determines species strike risk profiles and if management efforts are targeting the right species. 2 Maps densities and distribution of hazardous species across the airfield and identifies if management efforts are hitting the target. 3 Assesses trends in strike rates and species struck, and how management effort is influencing these trends. 4 Assesses dispersal effort against actual dispersal impact, and the effectiveness of individual dispersal tools.
Risk assessment	See Section 10	1 Identifies up-to-date list of high- and moderate-risk species, risk times and risk locations. Management effort can then be adapted to target the highest risks. 2 Allows for an analysis of species risk and how, or if, the management program is reducing risk.
Management actions	Procedures Policies	1 Determines the applicability of procedures and if they reflect actual on-the-ground work. 2 Assess the validity and currency of polices and if they reflect the actual views and actions of the airport.
Program targets	Goals KPIs Triggers	1 Reviews the goal and KPI achievement (or progress). 2 Assesses the suitability of goals and KPIs and the need to update and modify to reflect actual on-the-ground risks. 3 Reviews any management triggers for hazardous species or scenarios.

Table 15 Wildlife hazard management program progress scorecard

Measure	2009–10	2010–11	2011–12	2012–13	2013–14	Target 2014–15
Total strikes	8	5	4	4	6	4
Damaging strikes	1	0	0	0	0	0
Strikes affecting flight	1	1	1	0	1	0
Strikes/10 000 movements	4.8	2.8	2.8	2	3.6	2.5
Ranking at Australian airports	15	17	11	10	6	10
Total mass struck (g)	1765	2341	2446	1500	2130	1500
Average mass struck (g)	252	390	489	380	426	300
Very high risk species	0	1	0	0	0	0
High risk species	4	4	4	2	4	2
Moderate risk species	13	14	15	13	13	10
Airport Species Risk Index (ASRI)	953	2130	695	650	1432	750
Average infringement rate (IE)	14	18	8.3	8	13	10

Figure 10 Example showing why total strikes is not an effective risk indicator

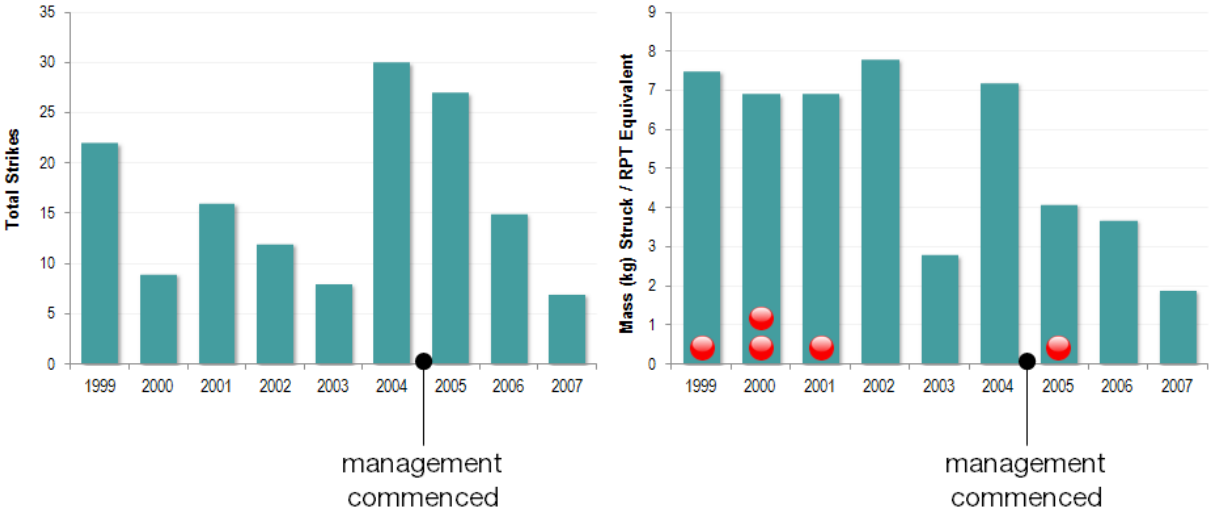
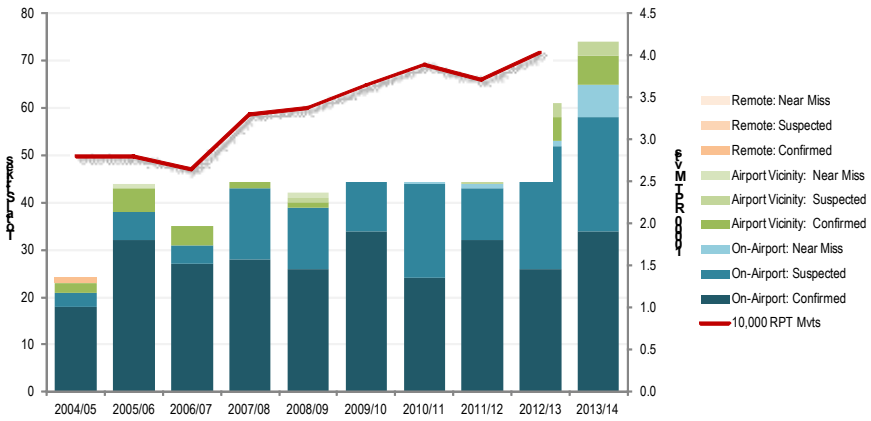
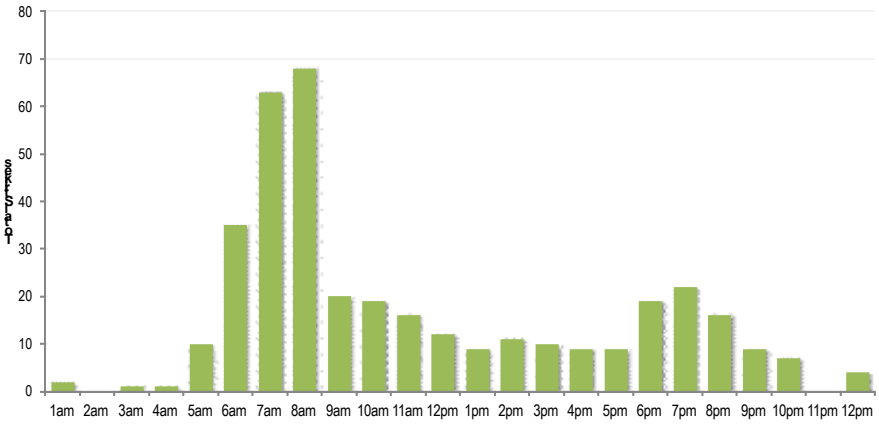
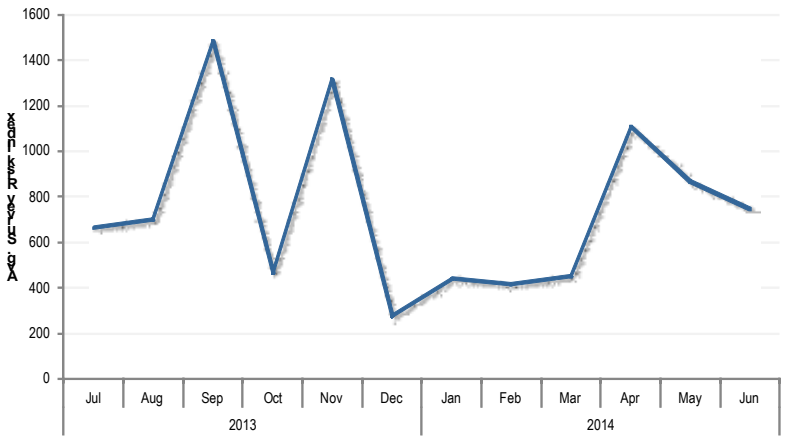
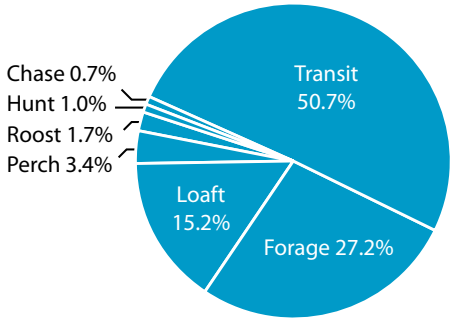


Table 16 More examples of data analysis

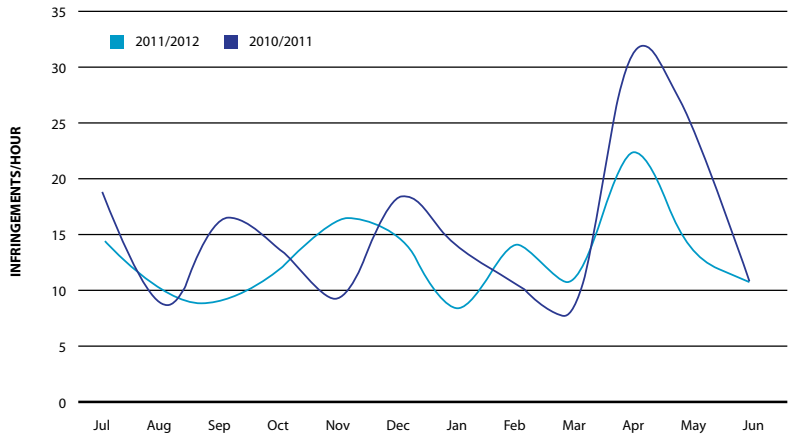
	Despite increasing movement, on-airport confirmed strikes remain relatively consistent. Increasing number of suspected strikes since 2007–08 may reflect more robust reporting protocols.
	Strike peaks may reflect increased bird activity, and/or aircraft movement peaks. Either way, management should focus efforts at peak times.



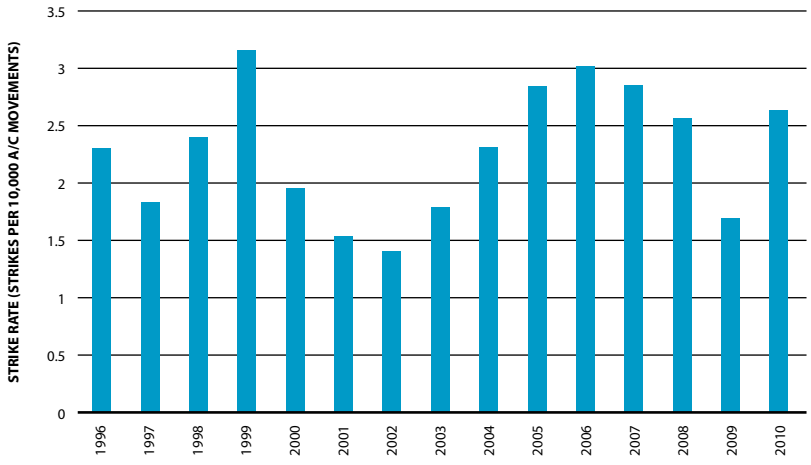
High September and November survey risks may reflect migratory bird activity, climatic influences or off-airport influences.



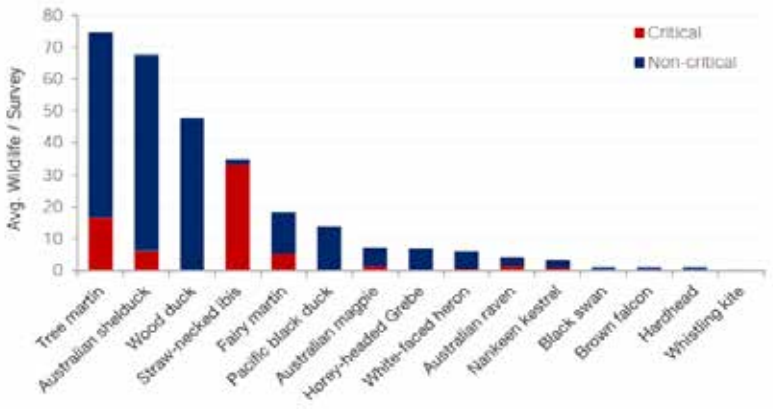
Knowing what the wildlife are doing airside can help to target passive management efforts.



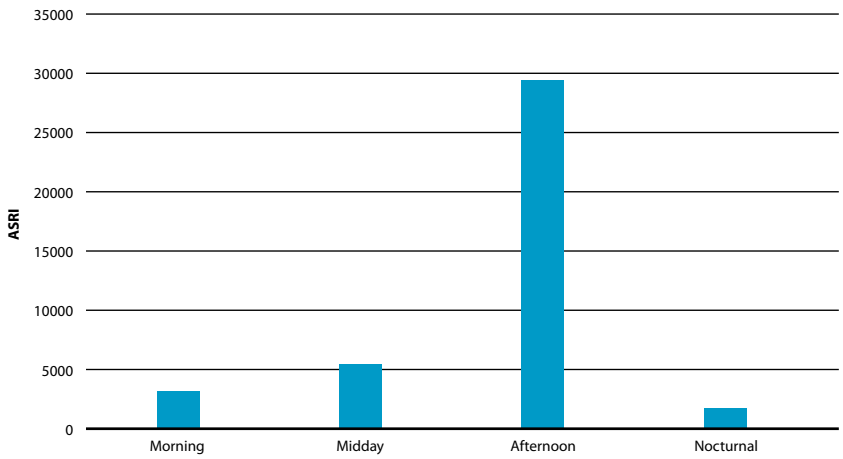
Wildlife infringing aircraft movement areas present a higher strike risk than wildlife perching on the perimeter fence. Understanding infringement rates for all, or individual, species can help target management. Infringement rates can also help measure management efforts (eg fewer birds in critical areas may reflect effective management).



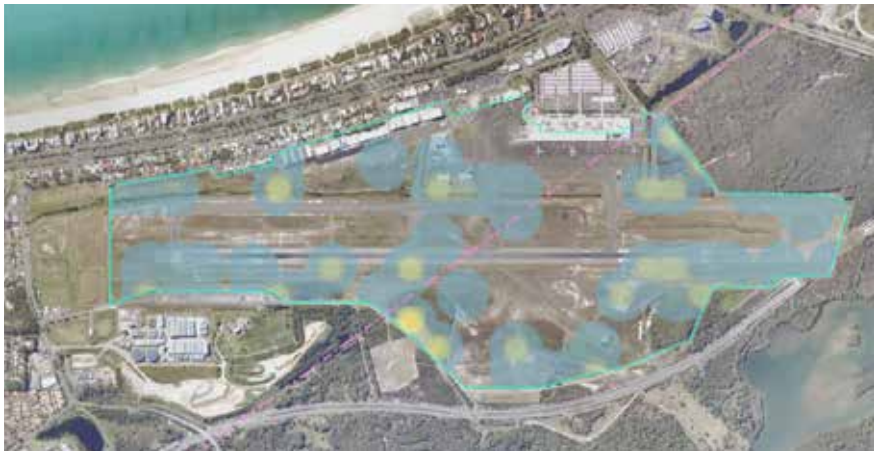
Monitoring strike rates rather than total strikes is more meaningful, and better reflects operational risk.



Monitoring species activity in and out of critical areas helps to direct management efforts.



A high afternoon survey risk may indicate hazardous bird activity such as pigeon flocks transiting critical zones to arrive at roosts, galah flocks arriving to forage on airside grasses before retiring to nearby forested areas to roost, mobs of foraging kangaroos, and so on.



Mapping hazards helps to identify areas requiring attention.

SECTION 12: WILDLIFE HAZARD MANAGEMENT AS AN INTEGRATED APPROACH

Managing wildlife strikes is problematic because flying animals operate in an open system and collision between wildlife and aircraft is a dynamic and seemingly unpredictable event. The complexity of the issue has led to its categorisation as 'too hard' or 'too easy'. The 'too hard' supporters believe that wildlife strike is an irrelevant and essentially insoluble problem, which leads to an attitude of neglect that tends to de-power cooperative management efforts. The 'too easy' supporters promote the rationale that since 90 per cent of strikes occur in the vicinity of aerodromes it is therefore an aerodrome problem. This proximity argument was and remains a convenient misdirection; by implication it assigns responsibility for a complex dynamic airspace problem solely to aerodrome operators and tacitly exonerates the remainder of the industry from contributing to a solution.

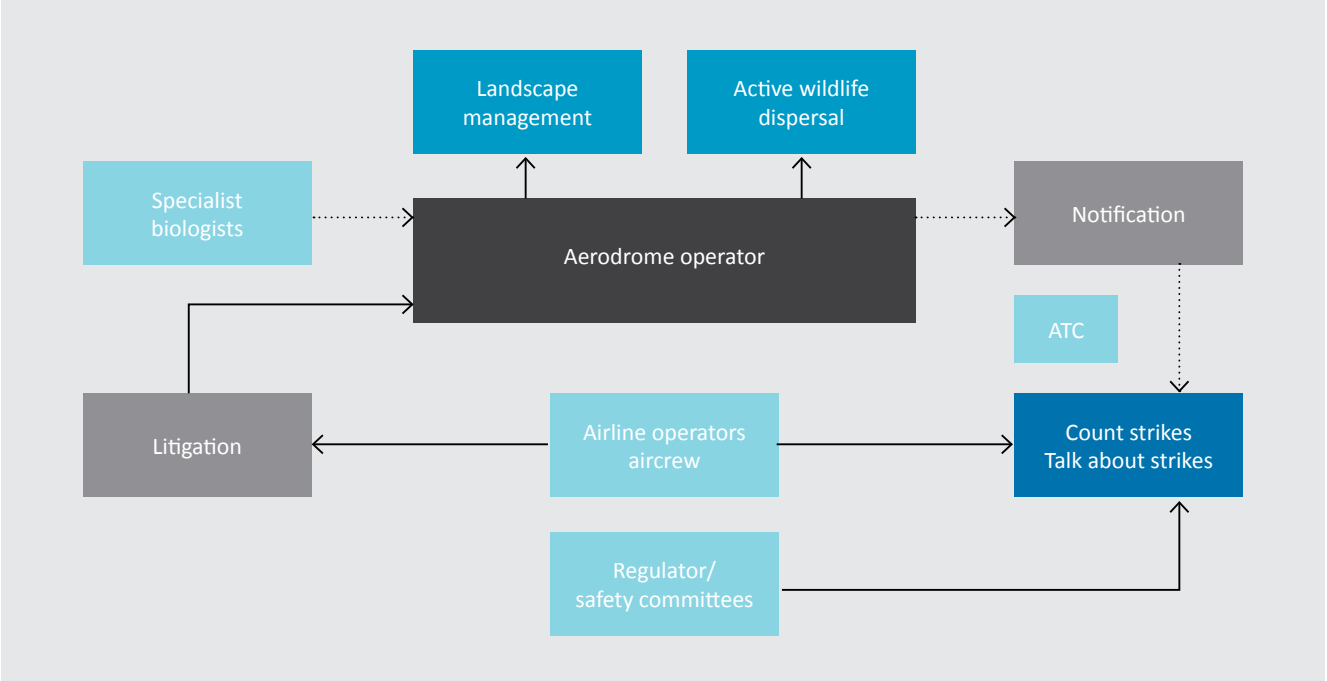
As a result of these two categorisations, the default management approach is airport-centric and in most countries today the expectation is almost entirely on aerodrome operators to prevent wildlife strike. The aim of this traditional approach is to prevent collision between wildlife and aircraft by attempting to create a wildlife exclusion bubble around airports. Sections 3 through 11 are focused on how airports can most suitably address wildlife hazards using the traditional 'exclusion bubble' approach.

In this section we examine some of the limitations of the airport-centric approach and some of the inequity associated with the expectation that aerodrome operators should be solely responsible for managing wildlife strikes. We propose an alternative, more integrated approach to wildlife strike management in the aviation industry.

Airport-centric wildlife management approach

Figure 11 summarises the components of the traditional airport-centric wildlife management approach. Most of the expertise necessary to understand the biological component of wildlife strike risk and mitigation resides with specialist biologists. Risk mitigation actions are the responsibility of airport operators and include landscape management, active wildlife dispersal and rudimentary hazard notification by NOTAM. ATC, aircrew and airline operators have no formal responsibilities and very little active input in this system other than occasionally trying to recover strike damage costs from airports. Notification of wildlife hazard by NOTAM is often ineffective. NOTAMs that include precise information about expected wildlife hazards may help with flight planning. However, if they are unsupported by regular reports providing real time hazard updates, they cannot inform of dynamic changes in threat status and cannot provide aircrew with any meaningful information about immediate wildlife threats.

Figure 11 Airport-centric wildlife management approach



Limitations of airport-centric model

There are several limitations to the airport centric approach. Firstly, it is an indirect and static approach to a dynamic problem. Rather than keeping wildlife away from aerodromes, management should be primarily aimed at keeping wildlife and aircraft separated during both the planning and execution phases of flight. To do this effectively, it is necessary to understand and manage the flight paths of both the wildlife and the aircraft.

Secondly, the current wildlife management approach is based on ecologically and operationally flawed premises. The concept that managing a small area within an airport boundary can significantly reduce the rate at which wildlife will infringe the airspace and conflict with aircraft may apply in select circumstances but it is exceptional rather than generally applicable.

Thirdly, the traditional airport-centric approach does not conform to the requirements of an integrated aviation safety management system. Most of the biological skills and knowledge required to understand wildlife movements and thereby reduce the prevalence of wildlife in the airspace, resides with external ornithologists and ecologists who assist airport management to assess and control the site strike risk. Some of this knowledge and understanding may filter through to on-ground staff responsible for airside wildlife management but very little reaches any other industry sector.

Finally, a concerning limitation of the current airport centric approach in civil aviation is that it is inherently adversarial. There is an increasing trend for airlines to litigate against aerodrome operators in an attempt to recoup strike damage costs to their aircraft and in some cases these attempts have been successful (Dale 2006; Dolbeer 2006; Battistoni 2009).

While there is no doubt that contemporary aerodrome wildlife management is both necessary and useful, truly effective wildlife collision avoidance can only be managed at an integrated operational level by applying the same conceptual models used to mitigate other dynamic hazards such as traffic separation and weather avoidance. This in turn implies that the operational sectors that hold authority over aircraft flight paths need to positively engage in strike mitigation.

Integrated wildlife management approach

A more balanced and adaptive approach to wildlife hazard management in aviation can be achieved by reassigning responsibility for certain tasks to industry sectors that have the expertise and authority to manage those tasks. Collision avoidance, irrespective of whether the collision hazard is traffic, terrain or thunderstorm is a primary responsibility of pilot in command (PIC) in conjunction with air traffic services because only these elements have the authority to alter the course of a flight to avoid collisions. The same basic chain of command needs to be applied to wildlife hazard management. Wildlife hazard management systems will become more effective when the detection, assessment and notification process for wildlife threats is nested across different spatial and time scales and the information is continually provided to aircrew so that they can make considered flight collision avoidance decisions. This prescription does not negate the role of aerodromes in contributing towards wildlife hazard management but adds critical dynamic management components that are currently lacking in the airport-centric model. Probably the best comparative model for an integrated approach to wildlife hazard management is one that parallels the current aviation weather hazard management system. This is an effective wildlife collision avoidance model for a number of reasons:

1. It is a responsive model able to deal with sudden dynamic changes in threat status.
2. It is an approach that does not subvert the command authority of PIC and confers a balance between authority and responsibility.
3. It is a proven approach for effectively managing other environmental hazards like weather avoidance.
4. This approach has already been used for wildlife hazard management in aviation and proved effective in some aviation operations (Flysafe, 2015). It remains to be tested, adapted and embedded for use with high movement rate passenger transport operations.

The central process in this model is a constantly updated Bird Avoidance Model (BAM) that is derived by a cross-disciplinary team of operational, biological and environmental specialists (Figure 12). The BAM provides WHM forecasts and real time situation reports that are relayed to aircrew for flight planning and flight execution. Aerodrome operators remain responsible for on-airport landscape modification, but in this model, airside wildlife dispersal is a dynamic collision avoidance process that requires real-time communications and is thus managed directly by ATC. ATC and aircrew receive formal training, as stipulated by the regulator, in wildlife recognition and risk assessment analogous to their current training in meteorology. Thus both ATC and aircrew are continually engaged with hazard risk assessment and are then able to make considered operational decisions in response to the real-time hazard level. The potential responsibilities of the various industry sectors in this integrated WHM model are listed and summarised in Table 17.

Figure 12 Integrated wildlife management approach

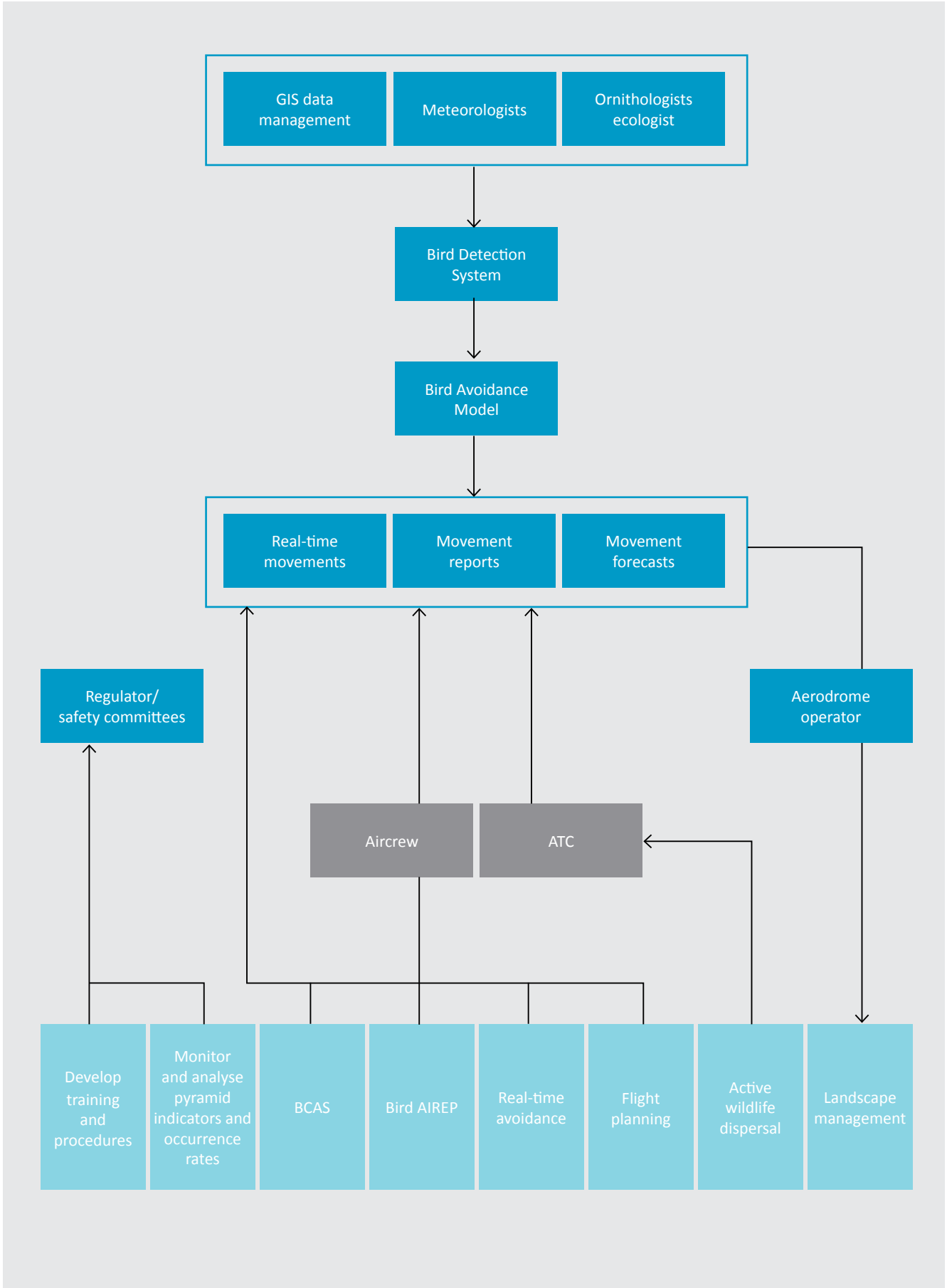


Table 17 Summary of the main responsibilities of various industry sectors in an integrated wildlife hazard management system.

Element and authority	Potential responsibilities
Aircrew Ultimate and final authority over the flight path of the aircraft both in planning and execution of flight. Authorised to use the airspace for the purpose of flight.	1 Provide the leadership, role model, responsibility and driving force to enable effective wildlife collision avoidance procedures to be integrated into operations. 2 Know and understand the major wildlife risks to air navigation within relevant flight sector areas. 3 Know and understand the methods of reducing the likelihood of aircraft-wildlife collision. 4 Asses BAM forecast and report information for flight planning and fuel carriage. 5 Assess ATIS and wildlife hazard actual information prior to take-off approach and landing. 6 Call for active hazard assessment and dispersal by ground wildlife controllers prior to take-off, approach, and landing as required. 7 Assess all available wildlife information and avoid high-risk wildlife hazards where practical to do so. 8 Provide regular wildlife situational report for integration into the BAM and for mitigation by other elements in the system.
Air traffic control Delegated authority over the flight path of aircraft in some circumstances. Authorised to manage and co-ordinate activities in the airspace.	1 Provide the role model, responsibility and driving force to enable effective wildlife collision avoidance procedures to be integrated into operations. 2 Know and understand the major wildlife risks to air navigation within your active flight area. 3 Know and understand the methods of reducing the likelihood of aircraft-wildlife collision in order to effectively direct ground personnel or advise aircrew accordingly. 4 Asses BAM forecast and report information for prioritisation and notification. 5 Manage ATIS wildlife hazard level notifications. 6 Actively manage real-time airside dispersal of wildlife hazards by automated or manual on-ground controllers. 7 Relay dynamic wildlife hazard status between ground controllers and aircrew. 8 Liaise with local government and local wildlife authorities to monitor and assess the wildlife infringement rate in the airspace encompassing the standard approach sector (10 nm from the aerodrome). 9 Obtain local land use restrictions where necessary to reduce the airspace infringement rate. 10 Assess airside real-time hazards and notification by visual means where feasible. 11 Provide real-time hazard warnings and avoidance advice based on remote sensing hazard detection when available. 12 Purchase, maintain and operate remote sensing devices that can detect, quantify, and assess wildlife collision risk within terminal airspace. 13 Provide detection data from remote sensing devices for incorporation into the BAM.
Aerodrome Authority over the land and static environment within the aerodrome boundary.	1 Monitor and maintain airside boundary fence to ensure exclusion of terrestrial wildlife that pose a threat to aircraft operations. 2 Monitor and maintain all areas owned or controlled by the aerodrome for wildlife activity that is potentially conflicting with air navigation. 3 Monitor and maintain all areas owned or controlled by the aerodrome for wildlife activity that is potentially detrimental to essential air navigation facilities such as radio navigation aids, windsocks and lighting. 4 Modify the habitat and landscape of areas under the aerodromes control that are attractive to wildlife so that they do not attract high-risk wildlife. 5 Provide adequate functional exclusion measures to reduce the likelihood of airside incursion by domestic species in transit. 6 Ensure clear lines of communication so that ATC, aircraft operators and aircrew are aware of the status of aerodrome wildlife hazards. 7 Communicate and collaborate with ATC, local landholders and local government in efforts to reduce the terminal airspace wildlife infringement rate.
Aircraft operator Authority over tasking, operating and maintaining aircraft.	1 Provision of SOP for assessment of wildlife hazard risk, avoiding wildlife collisions and for investigating incidents. 2 Liaison with airspace managers and environmental specialists to ensure that risks notifications are communicated to aircrew. 3 Provision of wildlife hazard incident cost data and monitoring of damage and adverse effect on flight costs as a means of determining overall management effect. 4 Provision of SOP and biohazard guidelines for licenced aircraft maintenance engineer (LAME) investigations of strike damage.

Civil Aviation Safety Authority Authority over the limitations and conditions of aircraft and aerodrome operators and operations. Ensuring safe operations, ensuring the standards and expertise of professionals involved with aircraft operations. Investigating incidents and accidents to ensure prevention.	1	Provisions of guidelines and legislative instruments, which clearly outline the roles and responsibilities of various industry sectors in managing wildlife strike risk.
	2	Provision of guidelines on the operational requirements that may be used to mitigate wildlife collision.
	3	Define the requirements for wildlife hazard risk management training for aircrew, ATC, LAME, airside wildlife controllers and aerodrome operations personnel.
	4	Define, oversee and implement a workable wildlife hazard notification and reporting system.
	5	Define, oversee and implement a consistent and balanced wildlife incident investigation process.
	6	Define, oversee and implement a credible incident monitoring and analytical system.
Australian Transport Safety Bureau	1	Collate and analyse national strike report statistics.
	2	Design and implement integrated strike investigation procedures.
Airside security Authority to prevent actions or occurrences that could compromise the safety of personnel or aircraft in the airside area. This work may be conducted by aerodrome operator staff or by an outside contractor.	1	Monitor and advise on the integrity of the airside boundary fence.
	2	Liaise with airside wildlife controllers on the status of animal and human movements on airport land.
	3	Share resources and information from various remote sensing devices used for both human and wildlife detection.
Bureau of Meteorology	1	Provide long-term and short-term forecast information crucial to developing BAM.
	2	Assist with wildlife hazard status notification.
Local government	1	Provide zoning support to limit or modify wildlife attracting enterprises within 10 nm of aerodromes.
State and territory government	1	State and territory environmental and wildlife agencies should monitor and advise on regional local wildlife congregations that may prejudice air navigation and should develop and implement regional management programs to protect both the wildlife and aircraft.

Managing wildlife to prevent collision with aircraft is a complex airspace problem. It also requires managing aircraft to prevent collision with wildlife. Ultimately, PIC is responsible for managing an aircraft's collision risk irrespective of what the hazard is. Airports cannot effectively manage strike risk in isolation. Effective strike reduction in aviation will depend on engagement by aircrew and airspace managers with a coordinated and dynamic approach similar to the current system used for weather hazard management.

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APPENDICES

Appendix A: ICAO and off-airport hazards

Within the context of wildlife hazards, ICAO defines the airport vicinity into two radial distances from the aerodrome reference point (ARP); Area A being 3km, and Area B being 8km. These distances have been based in the known activity of birds, in general, aligned with standard aircraft flight paths around airports. Within these distances, ICAO provides land-use guidelines for acceptable and unacceptable land uses, as shown in Table 18.

ICAO also indicate that the placement of food waste landfills within 13km of and aerodrome is of concern.

Furthermore, the International Bird Strike Committee's best practice standards (2006) recommend the establishment of a 13 km circle from the ARP, within which an inventory of wildlife hazards should be established, and risk assessments completed to determine the level of contribution to the strike risk.

Table 18 ICAO Land Use Guidelines for the Avoidance of Bird Hazards (Source: ICAO Doc 9184, Appendix 2)

Land use	Area A	Area B	Land use	Area A	Area B
Agriculture			Commercial*		
Landscape nurseries*	YES	YES	Offices	YES	YES
Tree farming*	YES	YES	Retail sales	YES	YES
Stock farming*	YES	YES	Hotels and motels	YES	YES
Dairy farming*	YES	YES	Restaurants	YES	YES
Sod farming	NO	YES	Parking lots	YES	YES
piggeries	NO	YES	Indoor theatres	YES	YES
Fruit tree farming	NO	YES	Warehouses	YES	YES
			Shopping centres	YES	YES
Wildlife Sanctuaries			Service stations	YES	YES
Bird sanctuaries	NO	NO	Cemeteries	YES	YES
Game reserves	NO	NO	Drive-in restaurants	NO	YES
			Food-processing plants	NO	YES
Recreational					
Golf courses*	YES	YES	Municipal utilities		
Parks*	YES	YES	Water treatment	YES	YES
Playgrounds*	YES	YES	Non-food garbage landfill	YES	YES
Athletic fields*	YES	YES	Food garbage disposal	NO	NO
Riding fields*	YES	YES			
Tennis, lawn bowling*	YES	YES			
Picnic and campgrounds	YES	YES			
Riding academies	NO	YES			
Racetracks	NO	YES			
Fair grounds	NO	YES			

Source: ICAO Doc 9184 (originally sources from Transport Canada Land use in the Vicinity of Airport

* These are general guidelines for planning and land-use zoning only. The avoidance of bird hazards during airport operations is another subject that can involve special controls to keep land free from food and shelter for birds

Requirements summary for managing off-airport hazards

Table 19 Summary of Australian regulatory and legislative requirements and recommendations for managing off-airport wildlife hazards.

CASA MOS Part 139. Section 10.6.4 Monitoring activities outside aerodrome	The reporting function must also include monitoring activities outside but in the vicinity of the aerodrome which may result in hazards to aircraft operations. This includes land planning and use which may attract birds.
Environmental Planning and Assessment Act 1979[10] Section 117(2) (NSW only)	Development near licenced aerodromes. Objectives: 1 The objectives of this direction are: a to ensure the effective and safe operation of aerodromes b to ensure that their operation is not compromised by development that constitutes an obstruction, hazard or potential hazard to aircraft flying in the vicinity.
ICAO Annex 14. Chapter 9; Section 9.5.3 Bird hazard reduction	When a bird strike hazard is identified at an aerodrome, the appropriate authority shall take action to decrease the number of birds constituting a potential hazard to aircraft operations by adopting measures for discouraging their presence on, or in the vicinity of, an aerodrome.
ICAO Annex 14. Chapter 9; Section 9.4.4 Bird hazard reduction	The appropriate authority shall take action to eliminate or prevent the establishment of garbage disposal dumps or any such other source attracting bird activity on, or in the vicinity of, an aerodrome, unless an appropriate aeronautical study indicates that they are unlikely to create conditions conducive to a bird hazard problem.
ICAO Doc 9137 2012. Section 4.7.3	For any new off-airfield developments being proposed that may attract birds or flight lines across the airport, it is important that the airport operator be consulted and involved in the planning process to ensure that its interests are represented.
CASA AC 139:26 2011. Section 9.4.1	The monitoring of wildlife in the vicinity of the aerodrome should cover any obvious concentrations of wildlife and/or sources of wildlife attraction (ie habitat, migratory routes, feeding and breeding areas etc.) which contribute to the risk at the aerodrome.
CASA AC 139:26 2011. Section 6.1.1	For wildlife hazards in the aerodrome vicinity which contribute to the risk but are outside the control of the aerodrome operator (ie on land located outside the aerodrome boundary), it is expected that the aerodrome operator will: » advise the relevant land owner(s) or controlling authority of both the nature of the wildlife hazard and the resultant impact on the aerodrome » work with the relevant land owner(s) or controlling authority to manage the wildlife hazard.
	Compile inventory of bird attracting features within 13 km of the airport. Assess the risk of bird attracting features within 13 km of the airport. Contribute to land use planning decisions within 13 km of the airport.

APPENDIX B: ICAO ANNEX 14 – WILDLIFE HAZARD MANAGEMENT REQUIREMENTS

ICAO Annex 14, Chapter 9, Section 9.5 (Bird Hazard Reductions) requires the establishment of national procedures for recording and reporting strikes, and well as procedures for collecting information pertaining to birds on and around the airfield that create a potential or actual hazard. It further requires that action is taken to decrease the number of birds and associated hazards by developing actions to discourage birds utilising the airport and areas within the vicinity. The establishment of waste management facilities, or any other land use activity that may attract birds, should be prevented or eliminated unless an appropriate study deems that they will not create a wildlife attraction and contribute to the strike risk. Finally, Annex 14 notes that airport operators' concerns regarding off-airport developments that may attract birds and other wildlife should be given due consideration.

The most relevant sections include:

- 9.5.1. The bird strike hazard on, or in the vicinity of, an aerodrome shall be assessed through:
  - i the establishment of a national procedure for recording and reporting bird strikes to aircraft, and
  - ii the collection of information from aircraft operators, airport personnel, etc. on the presence of birds on or around the aerodrome constituting a potential hazard to aircraft operations.
- 9.5.2. Recommendation. – Bird strike reports should be collected and forwarded to ICAO for inclusion in the ICAO Bird Strike Information System (IBIS) database.
- 9.5.3. When a bird strike hazard is identified at an aerodrome, the appropriate authority shall take action to decrease the number of birds constituting a potential hazard to aircraft operations by adopting measures for discouraging their presence on, or in the vicinity of, an aerodrome.
- 9.5.4. The appropriate authority shall take action to eliminate or prevent the establishment of garbage disposal dumps or any such other source attracting bird activity on, or in the vicinity of, an aerodrome, unless an appropriate aeronautical study indicates that they are unlikely to create conditions conducive to a bird hazard problem.

ICAO Doc. 9137 *Airport Services Manual*: Part 3 '*Wildlife Control and Reduction*' provides airport personnel with the necessary information to build and implement effective wildlife hazard management programs. Key elements include: establishing of a national committee; roles and responsibilities; program organisation; the role of aircraft operators; risk assessment; strike assessment; habitat management and modification; active harassment and dispersal techniques; international best practice; land use around airports; program evaluation; and, emerging technologies. Although generic in nature due to the broad international audience, it reiterates the importance of developing site specific programs that are congruent with local hazards, and operations.

ICAO Doc. 9184 *Airport Services Manual*: Part 2 '*Land Use and Environmental Control*' provides airport personnel with guidance on land use planning within the vicinity of aerodromes, and the need for good planning and control measures. It focuses on how the airport impacts on its surroundings, and vice versa, with regard to people, flora, fauna, the atmosphere, water courses, air quality, soil pollution, rural areas, and the environment in general. It frequently discusses the significance of how some land use in the vicinity of airports, such as landfills, can influence an airports strike risk profile. Appendix 2, Land-use Guidelines for the Avoidance of Bird Hazards, is particularly useful, however it does remind readers that … 'Any land use that had the potential to attract birds in the airport vicinity should be subject of a study to determine the likelihood of bird strikes to aircraft using the airport'.

APPENDIX C: MIGRATORY BIRD AGREEMENTS

Japan-Australia Migratory Bird Agreement (JAMBA)

Common name	Scientific name
Arctic Skua	*Stercorarius parasiticus*
Asiatic Common Tern	*Sterna hirundo*
Baird's Sandpiper	*Calidris bairdii*
Barn Swallow	*Hirundo rustica*
Bar-tailed Godwit	*Limosa lapponica*
Black-naped Tern	*Sterna sumatrana*
Black-tailed Godwit	*Limosa limosa*
Bridled Tern	*Sterna anaethetus*
Broad-billed Sandpiper	*Limicola falcinellus*
Brown Booby	*Sula leucogaster*
Buff-breasted Sandpiper	*Tryngites subruficollis*
Cattle Egret	*Bubulcus ibis*
Common Sandpiper	*Tringa hypoleucos*
Crested Tern	*Sterna bergii*
Curlew Sandpiper	*Calidris ferruginea*
Eastern Curlew	*Numenius madagascariensis*
Eastern Golden Plover	*Pluvialis dominica*
Fleshy-footed Shearwater	*Puffinus carneipes*
Fork-tailed Swift	*Apus pacificus*
Garganey Teal	*Anas querquedula*
Great Knot	*Calidris tenuirostris*
Greater Frigate-bird	*Fregata minor*
Greenshank	*Tringa nebularia*
Grey Plover	*Pluvialis squatarola*
Grey-tailed Tattler	*Tringa brevipes*
Japanese Snipe	*Gallinago hardwickii*
Knot	*Calidris canutus*
Large Sand-dotterel	*Charadrius leschenaultii*
Leach's Storm-petrel	*Oceanodroma leucorhoa*
Lesser Frigate-bird	*Fregata ariel*
Little Greenshank	*Tringa stagnatilis*
Little Tern	*Sterna albifrons*
Little Whimbrel	*Numenius minutus*
Long-toed Stint	*Calidris minutilla (including Calidris subminuta)*
Masked Booby	*Sula dactylatra*
Mongolian Sand-dotterel	*Charadrius mongolus*
Noddy	*Anous stolidus*
Oriental Cuckoo	*Cuculus saturatus*
Oriental Dotterel	*Charadrius asiaticus*
Oriental Pratincole	*Glareola pratincola*
Pectoral Sandpiper	*Calidris melanotos*
Pin-tailed Snipe	*Gallinago megala*
Pomarine Skua	*Stercorarius pomarinus*
Red-footed Booby	*Sula sula*
Red-necked Phalarope	*Phalaropus lobatus*
Red-necked Stint	*Calidris ruficollis*
Ringed Plover	*Charadrius hiaticula*

Ruff (Reeve)	*Philomachus pugnax*
Sanderling	*Crocethia alba*
Sharp-tailed Sandpiper	*Calidris acuminata*
Short-tailed Shearwater	*Puffinus tenuirostris*
Sooty Shearwater	*Puffinus griseus*
South-polar Skua	*Stercorarius skua*
Spine-tailed Swift	*Chaetura caudacuta*
Streaked Shearwater	*Calonectris leucomelas*
Terek Sandpiper	*Xenus cinereus*
Turnstone	*Arenaria interpres*
Wandering Tattler	*Tringa incana*
Wedge-tailed Shearwater	*Puffinus pacificus*
Whimbrel	*Numenius phaeopus*
White Egret	*Egretta alba*
White-tailed Tropic-bird	*Phaethon lepturus*
White-winged Black Tern	*Chlidonias leucoptera*
Wilson's Storm-petrel	*Oceanites oceanicus*
Wood Sandpiper	*Tringa glareola*
Yellow Wagtail	*Motacilla flava*

China-Australia Migratory Bird Agreement (CAMBA)

Common name	Scientific name
Andrew's Frigatebird	*Fregata andrewsi*
Arctic Willow Warbler	*Phylloscopus borealis*
Asian Dowitcher	*Limnodromus semipalmatus*
Barn Swallow	*Hirundo rustica*
Bar-tailed Godwit	*Limosa lapponica*
Black Tern	*Chlidonias niger*
Black-naped Tern	*Sterna sumatrana*
Black-tailed Godwit	*Limosa limosa*
Bridled Tern	*Sterna anaethetus*
Broad-billed Sandpiper	*Limicola falcinellus*
Brown Booby	*Sula leucogaster*
Caspian Plover	*Charadrius asiaticus*
Caspian Tern	*Hydropogne tschegrava (Hydroprogne caspia)*
Cattle Egret	*Bubulcus ibis*
Common Noddy	*Anous stolidus*
Common Sandpiper	*Tringa hypoleucos*
Common Tern	*Sterna hirundo*
Corncrake	*Crex crex*
Curlew Sandpiper	*Calidris ferruginea*
Dunlin	*Calidris alpina*
Eastern Curlew	*Numenius madagascariensis*
Eastern Reef Egret	*Egretta sacra*
Eurasian Curlew	*Numenius arquata*
Fork-tailed Swift	*Apus pacificus*
Garganey	*Anas querquedula*
Glossy Ibis	*Plegadis falcinellus*
Great Egret	*Egretta alba*
Great Frigatebird	*Fregata minor*
Great Knot	*Calidris tenuirostris*

Great Reed-Warbler	*Acrocephalus arundinaceus*
Greater Striated Swallow	*Hirundo striolata*
Greenshank	*Tringa nebularia*
Grey Phalarope	*Phaloropus fulicarius*
Grey Plover	*Pluvialis squatarola*
Grey Wagtail	*Motacilla cinerea*
Grey-tailed Tattler	*Tringa incana (Tringa brevipes)*
Large Sand-Plover	*Charadrius leschenaultii*
Latham's Snipe	*Capella hardwickii (Gallinago hardwickii)*
Leach's Storm-Petrel	*Oceanodroma leucorhoa*
Least Frigatebird	*Fregata ariel*
Lesser Crested Tern	*Thalasseus bengalensis (Sterna bengalensis)*
Lesser Golden Plover	*Pluvialis dominica*
Little Curlew	*Numenius borealis (Numenius minutus)*
Little Ringed Plover	*Charadrius dubius*
Little Tern	*Sterna albifrons*
Long-toed Stint	*Calidris subminuta*
Marsh Sandpiper	*Tringa stagnatilis*
Mongolian Plover	*Charadrius mongolus*
Northern Shoveler	*Anas clypeata*
Oriental Cuckoo	*Cuculus saturatus*
Oriental Pratincole	*Glareola maldivarum*
Painted Snipe	*Rostratula benghalensis*
Pheasant-tailed Jacana	*Hydrophasianus chirurgus*
Pin-tailed Snipe	*Capella stenura (Gallinago stenura)*
Pomarine Jaeger	*Stercorarius pomarinus*
Red Knot	*Calidris canutus*
Red-footed Booby	*Sula sula*
Red-legged Crake	*Rallina fasciata*
Red-necked Phalarope	*Phalaropus lobatus*
Red-necked Stint	*Calidris ruficollis*
Redshank	*Tringa totanus*
Ringed Plover	*Charadrius hiaticula*
Ruddy Turnstone	*Arenaria interpres*
Ruff	*Philomachus pugnax*
Sanderling	*Crocethia alba (Calidris alba)*
Sarus Crane	*Grus antigone*
Sharp-tailed Sandpiper	*Calidris acuminata*
Sooty Shearwater	*Puffinus griseus*
Streaked Shearwater	*Calonectris leucomelas*
Swinhoe's Snipe	*Capella megala (Gallinago megala)*
Terek Sandpiper	*Xenus cinereus (Tringa terek)*
Whimbrel	*Numenius phaeopus*
White Wagtail	*Motacilla alba*
White-bellied Sea-Eagle	*Haliaeetus leucogaster*
White-tailed Tropicbird	*Phaethon lepturus*
White-throated Needletail	*Hirundapus caudacutus*
White-winged Tern	*Chlidonias leucoptera*
Wood Sandpiper	*Tringa glareola*
Yellow Bittern	*Ixobrychus sinensis*
Yellow Wagtail	*Motacilla flava*
Yellow-headed Wagtail	*Motacilla citreola*

Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA)

Common name	Scientific name
Asian Dowitcher	*Limnodromus semipalmatus*
Australian Curlew (Eastern Curlew)	*Numenius madagascariensis*
Bar-tailed Godwit	*Limosa lapponica*
Black-tailed Godwit	*Limosa limosa*
Broad-billed Sandpiper	*Limicola falcinellus*
Brown Booby	*Sula leucogaster*
Buff-breasted Sandpiper	*Tryngites subruficollis*
Common Ringed Plover (Ringed Plover)	*Charadrius hiaticula*
Common Sandpiper	*Tringa hypoleucos (Acetitis hypoleucos)*
Common Tern	*Sterna hirundo*
Curlew Sandpiper	*Calidris ferruginea*
Dunlin	*Calidris alpina*
Garganey	*Anas querquedula*
Great Knot	*Calidris tenuirostris*
Great Reed Warbler (Oriental Reed- Warbler)	*Acrocephalus arundinaceus (Acrocephalus orientalis)*
Greater Sand Plover	*Charadrius leschenaultii*
Greenshank (Common Greenshank)	*Tringa nebularia*
Grey (Black-bellied) Plover (Grey Plover)	*Pluvialis squatarola*
Grey Wagtail	*Motacilla cinerea*
Grey-tailed Tattler	*Tringa brevipes (Heteroscelus brevipes)*
House Swallow(Barn Swallow)	*Hirundo rustica*
Latham's Snipe	*Gallinago hardwickii*
Lesser Frigate Bird	*Fregata ariel*
Little Curlew	*Numenius minutus*
Little Ringed Plover	*Charadrius dubius*
Little Stint	*Calidris minuta*
Little Tern	*Sterna albifrons*
Long-toed Stint	*Calidris minutilla(subminuta) (Calidris subminuta)*
Marsh Sandpiper	*Tringa stagnatilis*
Masked Booby	*Sula dactylatra*
Mongolian Plover (Lesser Sand Plover)	*Charadrius mongolus*
Oriental Cuckoo	*Cuculus saturatus*
Oriental Plover	*Charadrius veredus*
Oriental Pratincole	*Glareola maldivarum*
Pacific Golden Plover	*Pluvialis fulva*
Pale-footed Shearwater (Flesh-footed Shearwater)	*Puffinus carneipes*
Parasitic Jaeger (Arctic Jaeger)	*Stercorarius parasiticus*
Pectoral Sandpiper	*Calidris melanotos*
Pintail Snipe (Pin-tailed Snipe)	*Gallinago stenura*
Red Knot	*Calidris canutus*
Red-necked (Northern) Phalarope	*Phalaropus lobatus*
Red-necked Stint	*Calidris ruficollis*
Red-rumped Swallow	*Hirundo daurica*

Redshank (Common Redshank)	*Tringa totanus*
Ruff	*Philomachus pugnax*
Sanderling	*Crocethia alba (Calidris alba)*
Sharp-tailed Sandpiper	*Calidris aeuminata*
Shoveler (Northern Shoveler)	*Anas clypeata*
Slender-billed Shearwater (Short-tailed Shearwater)	*Puffinus tenuirostris*
Streaked Shearwater	*Calonectris leucomelas*
Swinhoe's Snipe	*Gallinago megala*
Terek Sandpiper	*Xenus cinereus*
Turnstone (Ruddy Turnstone)	*Arenaria interpres*
Whimbrel	*Numenius phaeopus*
White-rumped Swift (Fork-tailed Swift)	*Apus pacificus*
White-throated Needle-tailed Swift	*Chaetura caudacuta (Hirundapus caudacutus)*
White-winged Black Tern	*Sterna leucoptera (Chlidonias leucopterus)*
Wood Sandpiper	*Tringa glareola*
Yellow Wagtail	*Motacilla flava*

APPENDIX D: CASA MOS PART 139 – WILDLIFE HAZARD MANAGEMENT REQUIREMENTS

Chapter 5: Aerodrome Information for AIP

Section 5.1.3 Standards for Determining Aerodrome Information

Section 5.1.3.24 Additional Information. Significant local data may include the following

a Animal or bird hazard

Chapter 6: Physical Characteristics

Section 6.2.23 Surface of Graded Area of Runway Strip

Section 6.2.23.2 Effective drainage in the graded area must be provided to avoid water ponding and thus attracting birds. Open drains must not be constructed in the graded portion of a runway strip.

Chapter 10: Operating Standards for Certified Aerodromes

Section 10.2 Inspecting and Reporting Aerodrome Serviceability

Section 10.2.2 Significant Objects

Section 10.2.2.1. Any significant object found in the course of the inspection, including aircraft parts which may have fallen from the aircraft, or the remains of birds which may have been struck by an aircraft, must be reported immediately to Air Traffic Control, where appropriate, and to the Australian Transport Safety Bureau (ATSB).

Section 10.2.7 Birds and Animals on, or in the Vicinity of, the Movement Area

Section 10.2.7.1. The inspection must include:

a the condition of aerodrome fencing, particularly in critical areas;

b climatic or seasonal considerations, such as the presence of birds at certain times of the year, or related to the depth of water in drainage ponding areas;

c possible shelter provided by aerodrome infrastructure such as buildings, equipment and gable markers;

d bird hazard mitigating procedures incorporated in the environmental management procedures for the aerodrome;

e ff-airport attractors like animal sale yards, picnic areas, aeration facilities and waste disposal or landfill areas, and

f use of harassment procedures where appropriate.

Section 10.2.10 Aerodrome Fencing

Section 10.2.10.1. The inspection must check for damaged fences, open gates and signs of attempted entry by either animals or humans.

Section 10.3 Initiating a NOTAM

Section 10.3.2 Changes Reported to Australian NOTAM Office

Section 10.3.2.2. The following occurrence must be reported to the Australian NOTAM office:

e a significant increase in, or concentration of birds or animals on or in the vicinity of the aerodrome

Section 10.3.6 Bird or Animal Hazard Warning

Section 10.3.6.1. At aerodromes where a standing caution is included in ERSA for a bird or animal hazard, NOTAM must only be initiated where there is a significant increase of birds or animals. The NOTAM must provide specific information on species, period of concentration, likely location and flight path.

Section 10.6 Appointment of Reporting Officers

Section 10.6.3 What to Report

Section 10.6.3.1. Aerodrome operators must advise the Australian NOTAM Office of the following occurrences:

e a significant increase in, or concentration of birds or animals on or near the aerodrome which is a danger to aircraft

Section 10.6.4 Monitoring Activities Outside Aerodrome

Section 10.6.4.1. The reporting function must also include monitoring activities outside but in the vicinity of the aerodrome which may result in hazards to aircraft operations. This includes:

b land planning and use which may attract birds

Section 10.14: Bird and Animal Hazard Management

10.14.1 Introduction

10.14.1.1 The aerodrome operator must monitor and record, on a regular basis, the presence of birds or animals on or in the vicinity of the aerodrome. Monitoring personnel must be suitably trained for this purpose.

10.14.1.2 Where regular monitoring confirms existence of a bird or animal hazard to aircraft operations, or when CASA so directs, the aerodrome operator must produce a bird or animal hazard management plan, which would be included as part of the Aerodrome Manual.

10.14.1.3 The management plan must be prepared by a suitably qualified person such as an ornithologist or a biologist, etc.

10.14.1.4 The management plan must address:

a hazard assessment, including monitoring action and analysis;

b pilot notification;

c liaison and working relationships with land use planning authorities;

d on-airport bird and animal attractors which provide food, water or shelter;

e suitable harassment methods; and

f an ongoing strategy for bird and animal hazard reduction, including provision of appropriate fencing.

10.14.1.5 The bird and animal hazard management plan must be reviewed for effectiveness, on a regular basis, at least as part of each technical inspection.

10.14.1.6 Where the presence of birds or animals is assessed as constituting an ongoing hazard to aircraft, the aerodrome operator must notify the AIS in writing, to include an appropriate warning notice in the ERSA.

10.14.1.7 Where a bird or animal hazard is assessed as acute, of short term or seasonal nature, additional warning must be given to pilots by NOTAM.

Section 10.15: Pavement Maintenance

10.15.4 Surface Irregularities

10.15.4.2 Paved runway surfaces should be maintained so that standing water is neither formed nor retained. Birdbath depressions should be repaired at the earliest opportunity.

Chapter 12: Operating Standards for Registered Aerodromes

Section 12.1.3 Aerodrome Serviceability Inspections

Section 12.1.3.2 The checklist must encompass at least the following areas:

e Animal or bird activities on and in the vicinity of the aerodrome

APPENDIX E: NATIONAL AIRPORTS SAFEGUARDING FRAMEWORK

Part 139 of the Civil Aviation Safety Regulations 1998 regulates wildlife hazard management on Australian airports, but does not address off-airport wildlife hazards in the same way. In response to this gap, the then-Department of Infrastructure and Regional Development in May 2012 released the National Airports Safeguarding Framework (NASF) that aims to develop informed land use planning protocols to safeguard airports and their surrounding communities.

Guideline C of the framework, Managing the Risk of Wildlife Strikes in the Vicinity of Airports, provides land users and planners with guidelines to manage wildlife hazards within the ICAO defined radial distances from airports of 3 km, 8 km, and 13 km. Allocating risk categories to incompatible land uses (very low to high), the framework recommends actions for existing and proposed developments that are categorised as incompatible, requiring mitigation, requiring monitoring, or does not require any action. The framework emphasises the need for site-specific assessments, as well as encouraging a coordinated approach between airport operators and land use planning authorities.

Table 20: National Airports Safeguarding Framework, Guideline C Attachment 1 (Wildlife Attraction Risk and Actions by Land Use)

Land use	Wildlife attraction risk	Actions for existing developments			Actions for proposed developments/ Changes to existing developments		
		3km radius (Area A)	8km radius (Area B)	13km radius (Area C)	3km radius (Area A)	8km radius (Area B)	13km radius (Area C)
Agriculture							
Turf farm	High	Mitigate	Mitigate	Monitor	Incompatible	Mitigate	Monitor
Piggery	High	Mitigate	Mitigate	Monitor	Incompatible	Mitigate	Monitor
Fruit tree farm	High	Mitigate	Mitigate	Monitor	Incompatible	Mitigate	Monitor
Fish processing/packing plant	High	Mitigate	Mitigate	Monitor	Incompatible	Mitigate	Monitor
Cattle/dairy farm	Moderate	Mitigate	Monitor	Monitor	Mitigate	Mitigate	Monitor
Poultry farm	Moderate	Mitigate	Monitor	Monitor	Mitigate	Mitigate	Monitor
Forestry	Low	Monitor	Monitor	No Action	Monitor	Monitor	No Action
Plant nursery	Low	Monitor	Monitor	No Action	Monitor	Monitor	No Action
Conservation							
Wildlife sanctuary/conservation area – wetland	High	Mitigate	Mitigate	Monitor	Incompatible	Mitigate	Monitor
Wildlife sanctuary/conservation area – dryland	Moderate	Mitigate	Monitor	Monitor	Mitigate	Mitigate	Monitor
Recreation							
Showground	High	Mitigate	Mitigate	Monitor	Incompatible	Mitigate	Monitor
Racetrack/horse riding school	Moderate	Mitigate	Monitor	Monitor	Mitigate	Mitigate	Monitor
Golf course	Moderate	Mitigate	Monitor	Monitor	Mitigate	Mitigate	Monitor
Sports facility (tennis, bowls, etc)	Moderate	Mitigate	Monitor	Monitor	Mitigate	Mitigate	Monitor
Park/playground	Moderate	Mitigate	Monitor	Monitor	Mitigate	Mitigate	Monitor
Picnic/camping ground	Moderate	Mitigate	Monitor	Monitor	Mitigate	Mitigate	Monitor
Commercial							
Food processing plant	High	Mitigate	Mitigate	Monitor	Incompatible	Mitigate	Monitor
Warehouse (food storage)	Low	Monitor	Monitor	No Action	Monitor	Monitor	No Action
Fast food/drive-in/outdoor restaurant	Low	Monitor	Monitor	No Action	Monitor	Monitor	No Action
Shopping centre	Low	Monitor	Monitor	No Action	Monitor	Monitor	No Action
Office building	Very low	Monitor	No Action	No Action	Monitor	No Action	No Action
Hotel/motel	Very low	Monitor	No Action	No Action	Monitor	No Action	No Action
Car park	Very low	Monitor	No Action	No Action	Monitor	No Action	No Action
Cinemas	Very low	Monitor	No Action	No Action	Monitor	No Action	No Action
Warehousing (non-food storage)	Very low	Monitor	No Action	No Action	Monitor	No Action	No Action
Petrol station	Very low	Monitor	No Action	No Action	Monitor	No Action	No Action
Utilities							
Food/organic waste facility	High	Mitigate	Mitigate	Monitor	Incompatible	Mitigate	Monitor
Putrescible waste facility – landfill	High	Mitigate	Mitigate	Monitor	Incompatible	Mitigate	Monitor
Putrescible waste facility – transfer station	High	Mitigate	Mitigate	Monitor	Incompatible	Mitigate	Monitor
Non-putrescible waste facility – landfill	Moderate	Mitigate	Monitor	Monitor	Mitigate	Mitigate	Monitor
Non-putrescible waste facility – transfer station	Moderate	Mitigate	Monitor	Monitor	Mitigate	Mitigate	Monitor
Sewerage/wastewater treatment facility	Moderate	Mitigate	Monitor	Monitor	Mitigate	Mitigate	Monitor
Potable water treatment facility	Low	Monitor	Monitor	No Action	Monitor	Monitor	No Action

Source: https://infrastructure.gov.au/aviation/environmental/airport_safeguarding/nasf/nasf_principles_guidelines.aspx .

APPENDIX F: RELEVANT STATE AND TERRITORY LEGISLATION

Wildlife protection Acts

All native Australian wildlife are protected under various state and territory legislation.

Table 21: State and territory legislation pertaining to the protection of native fauna in Australia

State	Act	Authority	Link
Australian Capital Territory	*Nature Conservation Act 2014*	Environment ACT	www.environment.act.gov.au/
New South Wales	*Threatened Species Conservation Act 1995*	Office of Environment and Heritage	www.environment.nsw.gov.au/
Northern Territory	*Territory Parks and Wildlife Conservation Act 2000*	Parks and Wildlife Commission NT	www.parksandwildlife.nt.gov.au/
Queensland	*Nature Conservation Act 1992*	Department of Environment and Heritage Protection	www.ehp.qld.gov.au/
South Australia	*National Parks and Wildlife Act 1972*	Department of Environment, Water and Natural Resources	www.environment.sa.gov.au/Home
Tasmania	*Threatened Species Protection Act 1995*	Department of Primary Industries, Parks, Water and Environment	http://dpipwe.tas.gov.au/
Victoria	*Flora and Fauna Guarantee Act 1988*	Department of Environment and Primary Industries	www.depi.vic.gov.au/home
Western Australia	*Wildlife Conservation Act 1950*	Department of Parks and Wildlife	www.dpaw.wa.gov.au/

Firearms Licences and permits

State and territory laws regulate the ownership, possession and use of firearms in Australia. State and territory police departments are responsible.

Table 22: Firearms legislation and licensing in Australia

State	Act	Link
Australian Capital Territory	*Firearms Act 1996*, *Prohibited Weapons Act 1996*, and associated regulations	www.police.act.gov.au/crime-and-safety/firearms/licence-information
New South Wales	*Firearms Act 1996*, *Weapons Prohibition Act 1998*, and associated regulations	www.police.nsw.gov.au/services/firearms
Northern Territory	Firearms Act and associated regulations	www.pfes.nt.gov.au/Police/Firearms-Weapons.aspx
Queensland	*Weapons Act 1990* and associated regulations	www.police.qld.gov.au/programs/weaponsLicensing/default.htm
South Australia	*Firearms Act 1977* and associated regulations	www.police.sa.gov.au/services-and-events/firearms-and-weapons
Tasmania	*Firearms Act 1996* and associated regulations	www.police.tas.gov.au/services-online/firearms/
Victoria	*Firearms Act 1996*, *Control of Weapons Act 1990*, and associated regulations	www.police.vic.gov.au/content.asp?Document_ID=34098
Western Australia	*Firearms Act 1973* and associated regulations	www.police.wa.gov.au/Ourservices/PoliceLicensingServices/Firearms/tabid/1802/Default.aspx

Permits for lethal control

The aforementioned state and territory legislation for wildlife protection determine the permit requirements to control wildlife lethally as part of integrated airport wildlife management programs.

Table 23: Permit requirements and legislation for lethal control of wildlife

State	Permit name	Issuing authority	Link
Australian Capital Territory	Scientific Licence	ACT Government: Territory and Municipal Services	www.tams.act.gov.au/parks-recreation/plants_and_animals/animal_licensing
New South Wales	General Licence	Office of Environment and Heritage	www.environment.nsw.gov.au/wildlifelicences/index.htm
Northern Territory	Permit to Take or Interfere with Wildlife	Parks and Wildlife Commission NT	http://parksandwildlife.nt.gov.au/permits/wildlife#.VZammflViko
Queensland	Damage Mitigation Permit	Department of Environment and Heritage Protection	www.ehp.qld.gov.au/licences-permits/plants-animals/native_animal_management.html
South Australia	Permit to Destroy Wildlife	Department of Environment, Water and Natural Resources	http://www.environment.sa.gov.au/licences-and-permits/Animals_in_the_wild_permits
Tasmania	Permit to Take Protected Wildlife	Department of Primary Industries, Parks, Water and Environment	http://dpipwe.tas.gov.au/conservation/publications-forms-and-permits/forms-and-permits/taking-native-fauna-(non-scientific)
Victoria	Authority to Control Wildlife	Department of Environment and Primary Industries	www.depi.vic.gov.au/environment-and-wildlife/wildlife/wildlife-management
Western Australia	Application for a licence to take fauna for education of public purposes (fauna relocation and/or education)	Department of Parks and Wildlife	www.dpaw.wa.gov.au/plants-and-animals/licences-and-permits/134-fauna-licences?showall=&start=2

Codes of practice

Codes of practice and other recommended guidelines exist for various aspects of wildlife hazard management, such as lethal control, handling wildlife, etc.

Table 24: Codes of practice pertaining to lethal control of wildlife, removal and handling in Australia

State	Code name	Authority	Link
Australian Capital Territory	Animal Welfare Standards- Code of Practice	ACT Government	www.legislation.act.gov.au/a/1992-45/di.asp
Commonwealth	National codes of practices (commercial and non-Commercial) for the human shooting of kangaroos and wallabies	Department of the Environment	www.environment.gov.au/biodiversity/wildlife-trade/publications/national-codes-practice-humane-shooting-kangaroos-and-wallabies
	Model codes of practice and standard operating procedures for the humane capture, handling or destruction of feral animals in Australia	Department of the Environment	www.environment.gov.au/biodiversity/invasive-species/publications/model-codes-practice-feral-animals
New South Wales	Codes of practice for key pest species	Department of Primary Industries	www.dpi.nsw.gov.au/agriculture/pests-weeds/vertebrate-pests/publications/model-codes-of-practice
Northern Territory	National Code of Practice for the Humane Shooting of Kangaroos and Wallabies for Non-Commercial Purposes	Department of Primary Industries and Fisheries	www.animalwelfare.nt.gov.au/national_standards_and_guidelines
Queensland	Refers to the model codes of practice and standard operating procedures for the humane capture, handling or destruction of feral animals in Australia (Commonwealth Department of the Environment)		

South Australia	Code of practice for the humane destruction of birds by shooting in South Australia Code of practice for the humane destruction of flocking birds by trapping and carbon dioxide narcosis in South Australia National Code of practice for the humane destruction of kangaroos and wallabies for non-commercial purposes	Department of Environment, Water and Natural Resources	www.environment.sa.gov.au/managing-natural-resources/plants-and-animals/Animal_welfare/Codes_of_practice/Codes_of_practice_for_the_humane_destruction_of_wildlife
Tasmania	Wildlife management codes of practice and SOPs for Tasmania are covered by individual species'game hunting requirements which cover hunters and land managers who destroy feral animals and native wildlife under the Taking of Native Fauna Permit. Department of Primary Industries Parks Water and Environment Tasmaniapoints to the Invasive Animal CRC's PestSmart Toolkit information and guidance on best-practice invasive animal management on several key vertebrate pest species that can be relevant to aviation wildlife management Below are a few specific SOPs and codes of practice published byDPIPWE Tasmania: » Animal Welfare Standard for Shooting Wallabies in Tasmania » Code of Practice for the field shooting of brushtail possums in Tasmania » Code of Practice for the hunting of wild fallow deer in Tasmania » Code of Practice for the hunting of ducks in Tasmania » PestSmart: » GEN003: SOP Trapping using soft net traps » GEN001: SOP Methods of euthanasia » BIR002: SOP Trapping of Pest Birds » BIR001: SOP Shooting of pest birds » Model code of practice for the humane control of foxes » FOX003: SOP Ground Shooting of Foxes » National model code of practice for the humane control of wild dogs 2012. » DOG003: SOP Ground shooting of wild dogs » Model code of practice for the humane control of feral cats 2012 » CAT001: SOP Ground shooting of Feral Cats » Model code of practice for the humane control of feral pigs » PIG003:SOP Ground shooting of Feral Pigs » Model code of practice for the humane control of feral goats » GOA001: SOP Ground shooting of feral goats » Model code of practice for the humane control of rabbits » RAB009:SOP Ground shooting of rabbits » RAB004:SOP Ground baiting of rabbits with pindone » RAB005:SOP Diffusion fumigation of rabbit warrens » RAB006:SOP Rabbit Warren destruction by ripping » RAB002:SOP Ground baiting of rabbits with 1080 » HAR001:SOP Ground shooting of hares » DEE001:SOP Ground shooting of feral deer	Department of Primary Industries Parks Water and Environment	http://dpipwe.tas.gov.au/search?k=Shooting www.pestsmart.org.au/
Victoria	Model codes of practice and standard operating procedures for humane vertebrate pest control	Department of Environment and Primary Industries	www.depi.vic.gov.au/agriculture-and-food/animal-health-and-welfare/animal-welfare/humane-vertebrate-pest-control
Western Australia	Standard Operating Procedure Humane Killing of Animals Under Field Conditions In Wildlife Management	Department of Parks and Wildlife	www.dpaw.wa.gov.au/images/documents/plants-animals/monitoring/sop/SOP15.1_HumaneKillingOfAnimals_VR1.0_20131206.pdf

APPENDIX G: RISK MANAGEMENT DEFINITIONS

(SOURCE: AS/NZS 4360:1990 RISK MANAGEMENT)

Hazard	A source of potential harm or a situation with a potential to cause loss.
Risk	The chance of something happening that will have an impact (either positive or adverse) on objectives and is measured in terms of the probability (or likelihood) of an event and its consequences.
Likelihood	A qualitative description of probability or frequency.
Consequence	The outcome of an event expressed qualitatively or quantitatively, being a loss, injury, disadvantage or gain. There may be a range of possible outcomes associated with an event.

APPENDIX H: SAFETY CONSIDERATIONS FOR HANDLING OF BIOLOGICAL REMAINS

Dead animals may carry diseases harmful to humans.

Wear gloves and if necessary, disposable coveralls when handling carcasses or biological materials. Avoid direct skin contact with biological materials and avoid contaminating your normal work clothing. Ensure that the outside of sample bags, vehicles and freezers are not contaminated. Wear a mask and eye protection if there is a risk of body fluids or organic material misting into the atmosphere. Wash hands thoroughly when you are done.

If an animal is sick or injured, it may be necessary to humanely destroy the animal then process the carcass according to the procedures outlined in Appendix I. Seek veterinary advice if required and regularly liaise with local wildlife authorities to ensure your species knowledge and euthanasia competency is adequate. Regular competency checks will help avoid unnecessary euthanasia of an endangered species or delayed euthanasia leading to inhumane treatment.

APPENDIX I: RECOMMENDED PROCEDURES FOR HANDLING OF BIOLOGICAL REMAINS

General procedures:

» Wear PPE to collect remains.

» Remove gloves and dispose, wash hands.

» Disinfect tongs.

» Check reference book to confirm identification and/or seek expert ornithological advice.

» Complete strike form.

» Place strike form inside outer bag.

» Follow specific procedures for each type of remains (below).

Procedures: Processing whole carcasses

Seal carcass in double plastic bag (do not contaminate the outside of either bag).

Procedures: Processing blood smears (for DNA analysis)

» Collect sample based on DNA Kit instructions.

» Fill out label on side of tube with details (aircraft, flight number, suspected species, and time of strike).

» Record on the strike report form that a sample has been taken for DNA testing to confirm species.

» Advise airport manager (or similar) that sample has been taken on order to arrange transfer to Australian Museum.

NOTE: Do not touch swab tip with anything other than the sample to be collected. Contamination will lead to inconclusive results.

Procedures: Processing moist/fleshy remains (for DNA analysis):

» Collect sample based on DNA Kit instructions.

» Wrap remains in a clean medi-swab and place in clip-lock bag.

» Fill out sample label with details (aircraft, flight number, suspected species, and time of strike).

» Advise airport manager (or similar) that sample has been taken in order to arrange transfer to Australian Museum.

NOTE: Do not allow the remains to touch anything except the medi-swab. Contamination will lead to inconclusive results.

Procedures: Processing feathers (for analysis):

If single feathers, or with small amounts of flesh attached, place in clip-lock bag.

Fill out sample label with details (aircraft, flight number, suspected species, and time of strike).

Advise airport manager (or similar) that sample has been taken in order to arrange transfer to Australian Museum.

APPENDIX J: EXAMPLE STRIKE REPORT FORM (SAMPLE ONLY)

Wildlife Strike Report Form

Date of Occurence:	Aerodrome:
Time of Occurence:	Last Departure Point or Destination:
Pilot in Command:	Runway Used:
Squadron:	Position on runway (ch):
Aircraft Registration:	Light Conditions:
Aircraft Make/Model:	Grid Reference:

Weather information at time of strike:

		Yes	
Wind direction (°):			General description of weather
Wind speed (kts):	Clear		
Cloud height (ft):	Fog		
Cloud amount (/8):	Rain		

Strike: Confirmed ☐ Unconfirmed ☐ Near miss ☐

Location: On-airfield ☐ Vicinity ☐ Remote ☐

Phase of flight: Descent ☐ Approach ☐ Short finals ☐ Landing roll ☐ Taxi ☐ Take-off run ☐ Rotation ☐ Climb ☐

Effect on flight: None ☐ Rejected Take-off ☐ Missed Approach ☐ Precautionary Landing ☐

Parts Struck: Radome ☐ Windshield ☐ Nose ☐ Engine ☐ Propeller ☐ Wing ☐ Fuselage ☐ Landing Gear ☐ Tail ☐ Lights ☐

Other (specify) ☐

Wildlife species: ☐

Number of animals struck: ☐

Number of animals found: ☐

Blood smear only ☐ (sample DNA for ID)

Feathers only ☐ (collect feathers for ID)

Carcass: Disposed ☐ (take photos of all carcasses) Retained (freezer) ☐

Species ID checked ☐

Damage: Yes No (Take photographs of all damage)

Description of damage: ☐

Speed at time of impact: ☐

Height at time of impact: ☐

Costs: ☐

Aircraft downtime: ☐

Missions lost/cancelled: ☐

Missions delayed ☐

Information sources: ATC ☐ Pilot ☐ Aircraft Maintenance ☐ Other ☐

Wildlife control measures in place at the time of the strike: ☐

Additional description, information or suggestions: ☐

Name: ☐ Date and Time: ☐

In lieu of ATSB Accident or Incident Notification Form

Australian Airports Association
Unit 2/4 Brindabella Circuit | Canberra Airport ACT 2609

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