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WILDLIFE HAZARD MANAGEMENT PLAN – RAAF BASE TINDAL

VENTIA

August 2021

Document Control Page

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Authorisation

This document forms the Wildlife Hazard Management Plan (WHMP) for RAAF Base Tindal (RBT).

This WHMP has been prepared in accordance with the *Defence Aviation Safety Regulation* (DASR) Operations for Aerodromes (OFA) and the *Civil Aviation Safety Regulations 1988* (Manual of Standards Part 139) to provide a framework to manage hazard to aircraft operations caused by the presence of wildlife on or near the aerodrome.

The Chief of Air Force has the overall responsibility for the technical and operational airworthiness of Defence aviation safety system, and the Estate and Infrastructure Group (E&IG) are responsible for coordinating this WHMP at RBT. The WHMP is authorised by the Base Manager (BM) and Senior Australian Defence Force Officer (SADFO).

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Revision History

Rev	Review Date	Review Type	Reviewed By
00	2018	Wildlife Hazard Management Plan	Avisure
01	2019	Wildlife Hazard Management Plan Complete Review - Draft	Biodiversity Australia
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List of Acronyms

ABCP:	Air Base Command Post
ACO:	Aerodrome Commanding Officer
ADF:	Australian Defence Force
ADO:	Australian Defence Organisation
ARP:	Aerodrome Reference Point
ASMS:	Aviation Safety Management System
ASR:	Aviation Safety Report
ATSB:	Australian Transport Safety Bureau
ATC:	Air Traffic Control
BAEO:	Base Airfield Engineering Officer
BASO:	Base Aviation Safety Officer
BM:	Base Manager
CASA:	Civil Aviation Safety Authority
CASR:	Civil Aviation Safety Regulations 1998
CTAF:	Common Traffic Advisory Frequency
DASA:	Defence Aviation Safety Authority
DASR:	Defence Aviation Safety Regulation
DELM:	Department of Environmental & Land Management
DFSB:	Defence Flight Safety Bureau
ECC:	Environmental Clearance Certificate
EMOS:	Estate Maintenance and Operations Services
ERSA:	En Route Supplement Australia
IBSC:	International Birdstrike Committee
ICAO:	International Civil Aviation Organisation
MOS:	Manual of Standards Part 139
NWHMS:	National Wildlife Hazard Management Strategy
OA:	Operational Area
OFA:	Operations for Aerodromes
SADFO:	Senior Australian Defence Force Officer
SME:	Subject Matter Expert
WHMP:	Wildlife Hazard Management Plan
WMO:	Wildlife Management Officer
YPTN:	RAAF Tindal (ICAO code)

Glossary

Active management:	The use of "on ground" management techniques aimed at discouraging wildlife from utilising the airfield. Visual, auditory and olfactory techniques may be used to actively manage wildlife. Where necessary, active management may involve euthanasia of wildlife where they may present an imminent risk to aircraft or operational safety.
Aerodrome/Airfield:	A defined area on land or water (including any buildings, installations, and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft.
Airside:	The movement area of the airport, as depicted in Figure 4.
Air Traffic Control:	Ground based control service provided by the RAAF or Air Services Australia.
Apron:	Portion of the airfield dedicated to the loading or unloading of passengers or freight, refuelling, parking or performing aircraft maintenance.
Culling:	The reduction of a wild animal population by selective lethal control.
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.
Incident:	An occurrence associated with the operation of an aircraft that may impact on the safety of operations. This does not include emergencies or disasters.
Landside:	Areas of the base not considered to be airside.
Manoeuvring area:	Airfield sections, excluding aprons, for the purpose of taxiing, take-off and landing of aircraft.
Movement area:	Airfield sections, including aprons, for the purpose of taxiing, take-off and landing of aircraft.
Migration:	When wildlife pass periodically from one region to another.
Nocturnal species:	A species which is most active during the night.
Operational area	Area within the Tindal perimeter fence. Including inside the wallaby fence

Passive management: The modification of habitat to render it less attractive to wildlife.

Risk: The chance of something happening that will have an impact upon objectives. Measured in terms of consequence and probability.

Runway: A defined area on the aerodrome specifically for the take-off and landing of aircraft.

Transit: When birds fly from one place to another.

Wildlife: Animals that may pose hazards to aircraft when struck. This includes birds, bats and mammals such as kangaroos, hares and dogs.

Wildlife count: Scheduled counts conducted by airport staff.

Wildlife strike: A "**reported wildlife strike**" is deemed to have occurred whenever:

1. a pilot reports a strike to the Defence Flight Safety Bureau (DFSB) or Australian Transport Safety Bureau (ATSB).
2. personnel report seeing an aircraft strike of one or more birds or animals.
3. aircraft maintenance personnel find evidence of a bird or animal strike on an aircraft.
4. bird or animal remains are found on the airside area, unless another reason for the bird or animal's death can be found.

A "**significant strike**" is deemed to have occurred when:

1. there is resulting damage to the aircraft.
2. there are impacts to flight plans (e.g. delays or diversions).

A "**confirmed wildlife strike**" is deemed to have occurred whenever:

1. aircrew report that they definitely saw, heard or smelled a strike.
2. aircraft maintenance personnel find evidence of a bird or animal strike on an aircraft.
3. wildlife 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.

A "**suspected wildlife strike**" is deemed to have occurred whenever a bird or animal strike is reported by aircrew or ground personnel but upon inspection:

1. no bird or animal carcass is found.
2. no physical evidence is detected on the aircraft.

A "**wildlife near miss**" is deemed to have occurred whenever a pilot takes evasive action to avoid birds or animals within or in the vicinity of an aerodrome.

An "**on-aerodrome wildlife strike**" is 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.

A "**bird strike in the vicinity of an aerodrome**" is deemed to have occurred whenever a bird strike occurs outside the area defined as "on aerodrome" but within an area of 15 kilometres radius from the aerodrome reference point (ARP) or up to 1000 ft above the elevation of the aerodrome.

A "**bird strike remote from the aerodrome**" is deemed to have occurred whenever a bird strike occurs more than 15 kilometres from an aerodrome or more than 1000 ft above the elevation of the aerodrome.

1. Introduction

1.1 Background

Biodiversity Australia Pty Ltd (Bio Aus) was commissioned by Ventia on behalf of the Australian Defence Organisation (ADO) to undertake a Wildlife Hazard Management Plan (WHMP) review for RAAF Base Tindal (RAAF Tindal). The purpose of this WHMP is to provide a management framework to best manage wildlife strike risk at RAAF Tindal. The function of this WHMP is to define the risk that wildlife pose to air traffic that utilise RAAF Tindal and to set objectives, performance indicators and procedures that contribute to the systematic management and reduction of that risk.

The ADO's National Wildlife Hazard Management Strategy (NWHMS) (ERM & Avisure, 2015) aims to reduce the risk associated with wildlife strike in Australian Defence Force (ADF) aviation. Applying Defence Aviation Safety Authority (DASA) vision "Capability first, Safety always". This WHMP has been prepared in accordance with Objective 8 of the NWHMS, which stipulates that a WHMP be prepared for all Defence airfields to ensure the approach to aviation safety adopted by DASA is aligned, where appropriate with Civil Aviation Safety Authority (CASA) and Australian Transport Safety Bureau (ATSB).

In addition, this WHMP aims to support the requirements of Appendix 1 to *Civil Aviation Safety Regulations* (CASR) *1998,* Part 139, subparagraph 139.095(a)(ii) in relation to the inclusion of procedures for bird and animal hazard management in the Aerodrome Manual. It also aims to support the requirements of the Manual of Standards (MOS) Part 139, Chapter 17, Sections 17.03 and 17.04 (made under the CASR) in relation to the preparation of a WHMP. This WHMP has also been developed in consideration of the International Civil Aviation Organisation (ICAO) recommendations and International Bird Strike Committee (IBSC) – Best Practice Standards.

The RAAF Tindal WHMP (Avisure, 2018) is currently the primary reference document for wildlife hazard management at RAAF Tindal. This WHMP review has been prepared as part of a recurring revision process (as detailed in Section 1.4), which builds upon the current plan to provide:

- An updated compliance assessment which considers the MOS 139 Chapter 17, which was updated in August 2020;
- An update of compliance with International Bird Strike Committee (IBSC) – Best Practice Standards;
- An updated wildlife risk assessment based on contemporary wildlife management data;
- An updated off-airport risk assessment including classification of sites as per the National Airport Safeguarding Framework guidelines;
- Provision of specific roles, responsibilities, and recommendations to help the WHMP achieve compliance with extant legislation, policies and guidelines;
- Promote improvement of competencies for specific roles and responsibilities through framework, guidance and recommendations;
- Identify wildlife hazards and key patterns for high to extreme risk species and identify appropriate rectification recommendations to minimise risk to aircraft operation and wildlife; and
- Ensure incorporation of wildlife hazard promotions incorporated to base by providing clear tools of governance for appropriate platforms and safety meetings.

1.2 Geographical Context

RAAF Tindal is located in the Northern Territory, approximately 15 km south of Katherine and 320 km south-east of Darwin (-14.521100, 132.378006) (Figure 1). It is accessed via the Stuart Highway. The base occupies an area of approximately 122 km^2, while the Tindal Aerodrome (YPTN) comprises an area of approximately 6 km^2. The airfield is predominantly used for military purposes, but civilian aircraft (including private aircraft, commercial air charters, and Air Medivac aircraft) also utilise the runway and airfield. A working agreement has been in place between Katherine Town Council and the Department of Defence (DoD) since the early 1990s. The Tindal Aerodrome also functions as the primary alternative aerodrome for Darwin International Airport, if for any reason it is unavailable.

Infrastructure within the base includes numerous aircraft and vehicle hangars, administrative and training buildings, mess buildings, workshops, fuel farms, air traffic control tower, ordinance loading areas, runways, and taxiways. The Katherine Tindal Civilian Airport also operates from YPTN.

A wallaby-proof fence separates the airfield from the administrative areas, workshops and fuel farms, and a security fence surrounds the Operational Area (OA) as a whole. Beyond this is the residential area, messes, and recreational areas for RAAF personnel at Tindal. A description of key attributes of the base is provided in Table 1 below.

The broader RAAF Tindal base also supports a high diversity of flora and fauna, including significant patches of native remnant and regrowth vegetation. The surrounding topography consists of karst landform, which is highly biodiverse and productive. Native bushland surrounds the OA, predominantly consisting of eucalypt woodland with a mix of melaleuca woodland. Managed grasslands surround the airfield, and depressions in the landscape of the airfield can allow for the pooling of water after heavy rainfall events. Natural surface water in the area is ephemeral. Four Mile Creek (also known as Tindal Creek) lies south-east of RAAF Tindal and passes south of the runway, crossing the Stuart Highway before entering the Katherine River. It has a catchment area of 173 km^2 but does not typically flow between May and November. An ephemeral swamp also exists on the southern boundary of the Base.

RAAF Base Tindal is also bordered by agricultural and rural residential land to the north, north-west and north-east and the persistent Four Mile Creek line to the south and south-east. A large limestone quarry (Holcim Australia) is situated close to the north-western border of the base.

Table 1. RAAF Base Tindal – attribute summary.

Attribute	Description
Airfield Location	Tindal, Northern Territory
ICAO Code	YPTN
Climate	Tropical savannah region with two distinct seasons: the wet season (October to end April) and the dry season (May to end September) Mean maximum temp: 34.0°C Mean minimum temp: 20.5°C Average annual rainfall: 1141 mm
Surrounding Land Use(s)	Agricultural properties Natural areas Residential, business and community use Mining Waste management
Operations	Defence and civilian aircraft operations Defence training exercises

Attribute	Description
Geography	Located inland, approximately 15 km south of Katherine and 320 km south-east of Darwin
Elevation	Approximately 135 m above sea level
Airfield Ownership	Department of Defence
Runways	RWY 14/32 Sealed (2,744 m)
Navigational Aids	Instrument Landing System (ILS) with Localiser (LOC) Glide Path Outer Marker (OM) Middle Marker (MM) Tactical Air Navigation (ACAN) VHF omnidirectional range (VOR) Distance Measuring Equipment (DME)
Communications	Common Traffic Advisory Frequency (CTAF) Tindal Approach (APP) Tindal Ground (SMCV) Tindal Ground (SMC) Tindal (ATIS) Tindal Delivery (ACD) Tindal Tower (TWR)

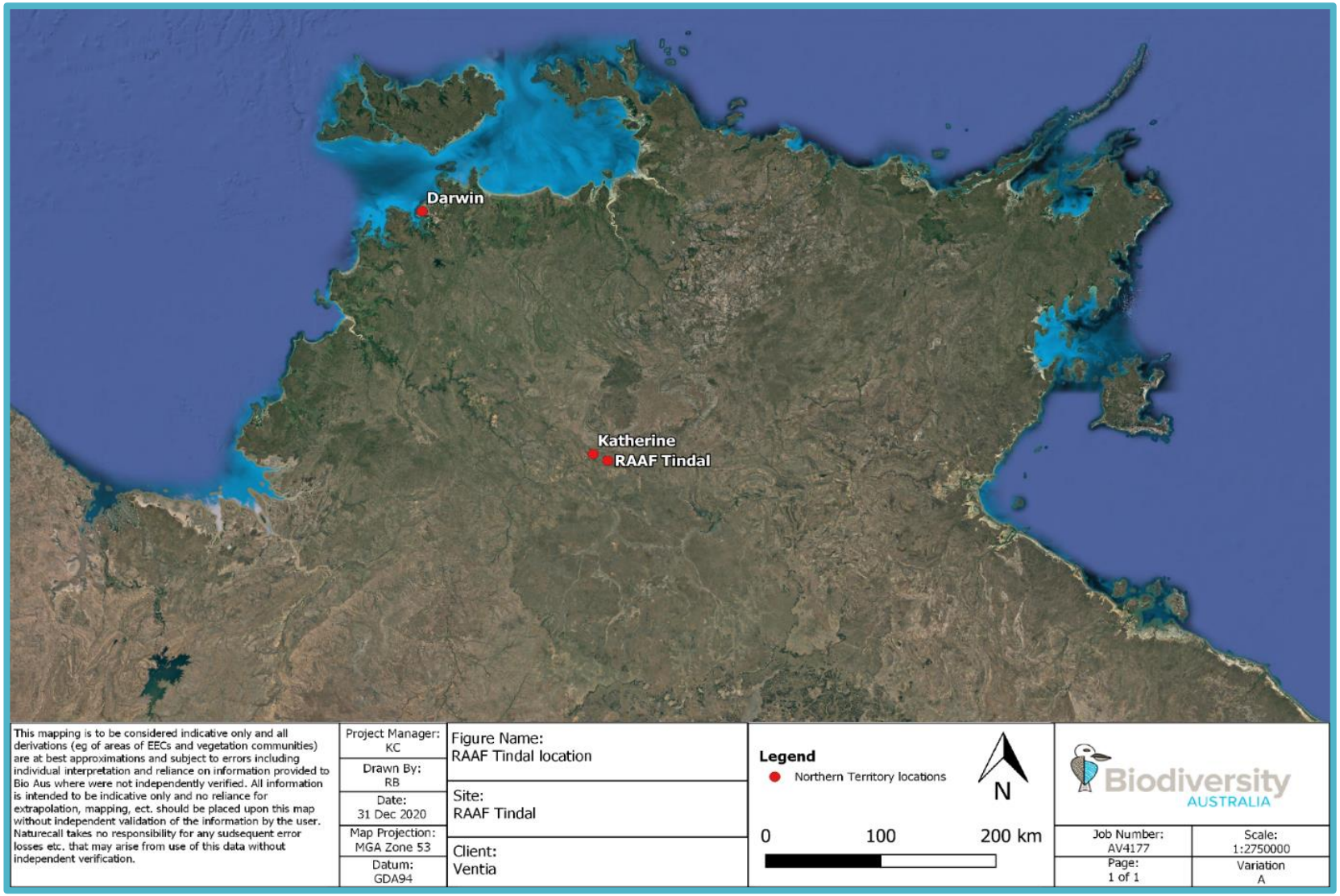


Figure 1. Location of RAAF Base Tindal

1.3 Goals and Objectives

The ADO is committed to ensuring the safety of aircraft using the RAAF Tindal airfield. Whilst the safety of aircraft at RAAF Tindal is paramount, it is not possible to prevent all wildlife strikes from occurring. This WHMP aims to reduce the overall risk (including both frequency and severity) of strikes by focusing management efforts on species and habitats that constitute significant risk to aircraft that operate at RAAF Tindal.

The specific objectives of this WHMP are listed below.

1. Define the risk posed by wildlife within and around the RAAF Tindal airfield.
2. Define management guidelines for extreme to high risk hazard score species and their habitats.
3. Ensure that adequate systems are in place to define roles, responsibilities, and procedures for managing wildlife risks at RAAF Tindal.
4. Define the methods by which wildlife hazards are managed at RAAF Tindal.
5. Develop performance goals and targets for management of wildlife risks and outline how these will be assessed and reviewed.
6. Fully consider all relevant aviation operational and environmental legislation, regulations, standards, and guidelines (Table 2).
7. Assess the efficacy of the current wildlife risk assessment tools in the context of the defence environment and provide recommendations to deliver a more contiguous risk assessment to that of the ASMS.

Table 2. Operational and environmental legislation, regulations, guidelines and standards relevant to the WHMP.

Legislative Instrument or Guideline	Description
Defence Regulations and Standards	
Defence Aviation Safety Regulation (DASR) – Safety Management System (SMS), Operations for Aerodromes (OFA) **OFA.10.A – Aerodrome Manual,** **OFA.40.A – Wildlife Hazard Management Plans,** **OFA.40.B – Aerodrome WHMP Requirements.**	OFA.10.A sets out the requirement for an aerodrome manual to be established for each certified or registered aerodrome, and details the purpose, broad content, personnel, and approval and review conditions. OFA.40.A requires the establishment of a WHMP for each certified aerodrome, in order to minimise the likelihood of bird/wildlife strikes. OFA.40.B states the necessity for the WHMP requirements of each registered aerodrome to be determined in order to control resources based on site-specific risk.

Legislative Instrument or Guideline	Description
Department of Defence – BONS Guideline – Management of Biosecurity and Overabundant Native Species Risks on the Defence Estate 2009 and the Biosecurity and Overabundant Natives Species (BONS) Management Program for Vertebrate Pests on Northern Territory Defence Estates (2018 – 2022)	The primary purpose of the BONS Guideline is to facilitate consistent and effective mitigation of Biosecurity and Overabundant Native Species risks, in line with Defence policy, across prevention, preparedness and emergency response, and ongoing management. The Guideline covers the entire Defence Estate and all Defence actions. The Guideline includes identification and assessment of risks and impacts, prevention of outbreaks, preparedness and response to outbreaks, ongoing management, and the preparation, use and evaluation of BONS plans. The guideline also gives way to the below pamphlets: Department of Defence – BONS pamphlet – Managing flying-foxes at Airfields 2009 Department of Defence – BONS pamphlet – Managing birds at Airfields 2009 The NT Vertebrate BONS Program 2018 – 2022 aligns and takes guidance from the National Planning Guidelines. It focuses on the vertebrate pests identified at each Defence site, including RAAF Tindal. Priority management actions for RAAF Tindal include targeting of nuisance animals via cage trapping or darting and a flying fox dispersal program in conjunction with WHMP actions.
National Wildlife Hazard Management Strategy (NWHMS) (ERM & Avisure, 2015)	The Strategy sets out the process and regulatory framework for creating, delivering and evaluating WHMPs for the DoD. It aims to minimise the risk to personnel and the cost and loss of capability associated with wildlife strike to ADF aircraft, with the primary purpose of ensuring airworthiness. Structural and regulatory frameworks, risk assessment processes, environmental and land use factors in strike risk, wildlife management measures, monitoring, auditing, and consultation are described and discussed in detail.
International Standards	
International Civil Aviation Organization (ICAO) Aerodrome Services Manual, Part 3	A manual intended to provide airport personnel with the information necessary to develop and implement an effective wildlife control program for their aerodrome, for the purpose of reducing the risk of wildlife strikes to aircraft. The manual includes organisational structures for programs, roles and responsibilities, risk assessment, site management, repellent techniques, best practices, program evaluation, and communication procedures.
International Civil Aviation Organization (ICAO) Airport Services Manual, Part 3 – Chapter 3	This chapter of the Manual describes the roles and responsibilities within a wildlife strike control program. It sets out the roles of the State civil aviation authority, airport operator, wildlife strike committee and wildlife strike control coordinator. It also discusses the importance of reporting.
International Civil Aviation Organization (ICAO) Annex 14 – Chapter 9 **Section 9.4 Wildlife Strike Hazard Reduction** **Section 9.10 Fencing**	This chapter of the Annex relates to aerodrome operational services, equipment, and installations. It requires the establishment of an aerodrome emergency plan to facilitate coordination of emergency response actions. Two sections of the chapter particularly relate to wildlife hazard management: Section 9.4 requires the assessment of wildlife strike risk, the collection and forwarding to International Civil Aviation Organization of wildlife strike reports, the adoption of measures to minimise the likelihood of strikes, and the management or removal of nearby attractant sites. Section 9.10 requires the provision of a fence or other suitable barrier to prevent the entry of animals large enough to be a hazard to aircraft.
Commonwealth Legislation and Guidelines	
***Civil Aviation Act* and *Civil Aviation Safety Regulations 1998* (CASR)**	The *Civil Aviation Safety Regulations 1998* (CASR) are made under the *Civil Aviation Act 1988* which govern aviation safety in Australia. The Regulation covers all aspects of aviation safety including but not limited to administrative processes, enforcement, airworthiness, licensing, aerodrome management, and training.

Legislative Instrument or Guideline	Description
Civil Aviation Safety Authority (CASA) – Manual of Standards – Part 139 - Aerodromes	The Manual of Standards (MOS) prescribes the requirements for aerodromes, including requirements for wildlife hazard management. Chapter 17 describes the requirements for wildlife hazard management at aerodromes. Advisory Circulars provide advice and guidance to explain particular regulatory requirements of a CASR Part. Advisory Circular 139-26(0) - Wildlife Hazard Management at Aerodromes - provides additional information to assist aerodromes in achieving compliance with the MOS Part 139.
Air Navigation Act 1920	The *Air Navigation Act 1920* gives effect to the Convention on International Civil Aviation (Chicago Convention). It provides for regulations to be made for the purpose of carrying out, and giving effect to, the Chicago Convention and international standards and recommended practices contained in any Annex to the Convention. As a contracting state to the Convention on International Civil Aviation Australia has international obligations regarding the regulation and management of aviation safety, including wildlife hazard management.
Transport Safety Investigation Act 2003	The *Transport Safety Investigation Act 2003* establishes the Australian Transport Safety Bureau (ATSB) as the 'no-blame' investigator of aviation accidents and incidents, including wildlife strikes, and aims to maintain and improve transport safety, by providing for the reporting of transport safety matters, independent investigations into transport accidents and other incidents, the making of safety action statements and recommendations, and the protection of certain kinds of safety information.
Airports Act 1996	The *Airports Act 1996* establishes the regulatory arrangements which apply to the airports formerly owned and operated on behalf of the Commonwealth by the Federal Airports Corporation, and Sydney West Airport. All leased federal airports (except for Tennant Creek and Mount Isa) are subject to a planning framework in the *Airports Act 1996* and are required to prepare a Master Plan that incorporates an Environment Strategy.
***Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)**	The *Environment Protection and Biodiversity Conservation Act 1999* is the key overarching Commonwealth legislation governing environment and heritage protection and biodiversity conservation. It covers environmental assessment and approvals, protects significant biodiversity, and integrates the management of important natural and cultural places. The Act may affect the management of certain species that present a risk at RAAF Base Tindal.
National Airport Safeguarding Framework (NASF)	The National Airports Safeguarding Framework is a national land use planning framework that aims to: improve community amenity by minimising aircraft noise-sensitive developments near airports; and improve safety outcomes by ensuring aviation safety requirements are recognised in land use planning decisions through guidelines being adopted by jurisdictions on various safety-related issues. The National Airport Safeguarding Framework – Guideline C provides guidelines to State/Territory and local government decision makers to manage the risk of collisions between wildlife and aircraft at or near airports where that risk may be increased by certain land-uses.
State Legislation	
Territory Parks and Wildlife Conservation Act 1967	The*Territory Parks and Wildlife Conservation Act 1967* provides the framework for the creation and management of protected areas in Northern Territory, including national parks, conservation parks, wilderness areas, international agreement areas, and world heritage areas. It also provides a detailed framework for the protection of native species and use of protected areas through Regulations under the Act. Under the *Territory Parks and Wildlife Conservation Act 1967* a licence, permit or authority is required to take, keep, and use many native plants and animals. A "Permit to interfere with protected wildlife" is the most appropriate type of permit for managing wildlife on aerodromes.
Animal protection Act 2018	The *Animal Protection Act 2018* covers the welfare of animals in the care of humans, as well as those in their natural environment. It takes over from the *Animal Welfare Act 1999*. The new act includes more clearly defined rights, roles and responsibilities for government, industry and the community. Tools contained in the Act include policies, processes, development approval systems, environmental authorities, statements of duty, protection orders, evaluations and audits, financial assurances, investigative powers, and reporting and enforcement provisions.

1.4 Governance

1.4.1 CASA tools of Governance

This WHMP forms one component of the Aviation Safety Management System (ASMS) at RAAF Base Tindal. It is not intended to be used as an overarching safety management framework for the entirety of the RAAF Base Tindal. The WHMP relates only to the management of wildlife on the RAAF Base Tindal airfield, and all wildlife species risk assessments contained within should be viewed as part of the overall wildlife strike risk at RAAF Base Tindal. The species risk assessment, risk rankings and recommendations contained in this WHMP must be considered in the context of other management plans that are in effect at RAAF Base Tindal.

The WHMP is subject to regular review in accordance with the requirements of the CASR Manual of Standards Part 17.04, subsection 4. The planning, implementation and review structure detailed in this document is provided in Figure 2 and summarised below.

1. Planning – includes the establishment of goals and objectives, hazard identification, assessment of wildlife-related risks, summary of key responsibilities and production of a WHMP to govern future management implementation.
2. Implementation – involves the execution of pre-defined roles and responsibilities, relevant training of personnel, on-ground wildlife management measures and targeted wildlife monitoring.
3. Review – involves annual reviews of the WHMP, biennial audits by external consultants, and major reviews every three years. These reviews will be targeted to improving the contents of the RAAF Tindal management plan and will allow for adaptive management practices to be utilised at the airfield. Recommended time frames for review and their legislative justifications are provided in Table 3.

Figure 2. Structure of the WHMP development and review process.

Table 3. Review structure for the WHMP for RAAF Tindal.

Review Stage	Frequency	Details	Responsibility
Initial WHMP preparation	Required for all certified aerodromes	Must be prepared by a suitably qualified person (e.g. ornithologist or wildlife biologist specialising in aviation management)	EMOS SME
Internal review	Annually	To be undertaken once every 12 months as part of the internal review process	BM
Biennial audit	Every second year	WHMP review to be undertaken by an external consultant every two years	EMOS SME
Major review	Every three years	A rewrite and re-issue of the RAAF Tindal WHMP will occur every three years to ensure current wildlife hazards are identified and mitigated in an adaptive manner. Major reviews may take the place of biennial audits in the years that they overlap.	EMOS SME
Circumstantial	If one of the following events occurs: • Multiple wildlife strikes to aircraft, • Substantial damage to aircraft,	A review of the wildlife hazard management plan should be undertaken if any of these events occur as per the CASA MOS Chapter 17, part 17.04.	BM EMOS SME

	• Ingestion of wildlife by aircraft, • Wildlife observed on the aerodrome in densities that could result in one of the above scenarios.		

1.4.2 Defence Tools of Governance

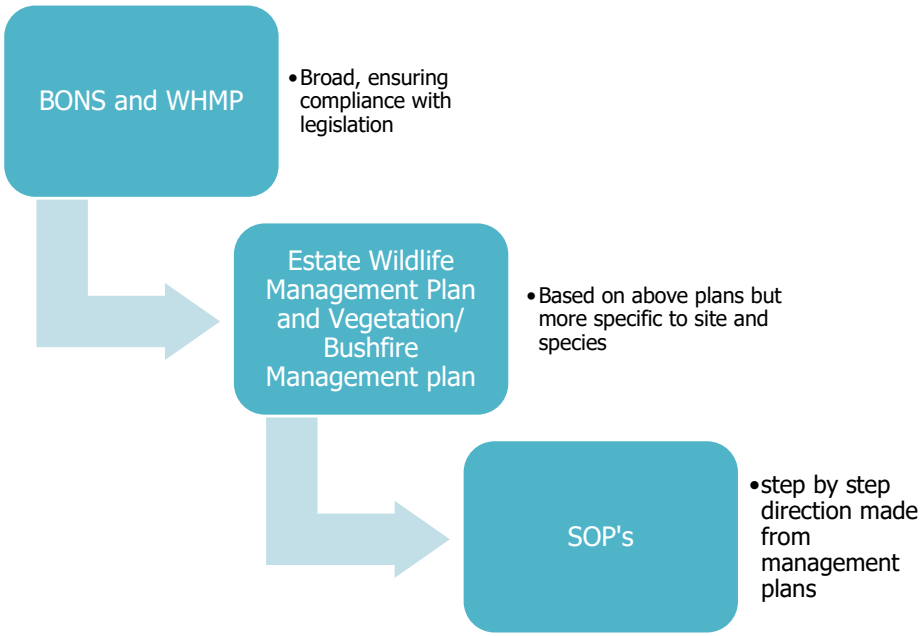
Base safety meetings and direct communication lines provide an essential platform to deliver accurate wildlife hazard information for incorporation into the defence tools of governance. For this to be delivered effectively, "wildlife strike risk" subject matter experts must be present at nominated defence stakeholder meeting to inform, educate and receive feedback.

Relevant meetings include; coordination meetings and risk review meetings to mitigate the capability, safety, financial and reputational risks associated with wildlife interactions with aircraft at RAAF Tindal.

It is important that correct and accurate information relating to wildlife hazard is provided to key personnel responsible for ASMS and/or similar. Having appropriately competent and knowledgeable personnel present at safety meetings is a key process to ensure that the hazards identified in this WHMP are communicated formally to stakeholders.

This plan is read in conjunction with further plans including Estate Wildlife Management Plans, Vegetation Management Plans and SOP's (Figure 3).

Figure 3: Framework of documents relating to Wildlife Hazard Mitigation



2. Assessing Wildlife Risks

This WHMP review utilises a three-step approach to assess and reduce the risk posed by wildlife to aircraft. A description of each step in this process is provided below:

1. Hazard Identification – identification of hazards by undertaking a broad assessment of the wildlife hazard profile at RAAF Tindal through completion of the below-listed actions:
    a. a desktop assessment (including review of documentation, strike data and aircraft movement data),
    b. airside wildlife surveys,
    c. off-airfield wildlife surveys.
2. Risk Assessment – preparation of a wildlife risk assessment using the Paton Risk Assessment method (Paton, 2010) informed by available information including wildlife behaviour, characteristics, occurrence and/or strikes for each species encountered on and around the airfield.
3. Wildlife Management Plan – preparation of a plan that dictates management of potentially hazardous wildlife including operational requirements and mitigations for each of the highest hazard ranked species.

2.1 Hazard Identification

2.1.1 Desktop Assessment

Databases and resources that were reviewed as part of the hazard identification process are listed in Table 5. Other documentation and data relating to wildlife hazard mitigation at RAAF Tindal that was reviewed included:

- Tindal Aerodrome, RAAF Base Tindal Wildlife Hazard Management Plan (Avisure, 2018),
- Draft RAAF Tindal – Wildlife Hazard Management Plan (Biodiversity Australia, 2019),
- Previous RAAF Tindal wildlife reports, including:
    - Weekly Situational reports,
    - Quarterly wildlife monitoring and harassment reports,
    - Wildlife audits, and
    - BONS management program reports for wild dogs and agile wallabies.

Table 4. Resources reviewed for the RAAF Tindal desktop assessment.

Resource	Description	Relevance
ATSB National Aviation Occurrence Database and internal strike reports (provided by Air Traffic Control)	Records of wildlife strikes reported internally or to the ATSB. Includes details of species identification (where known), occurrence category, flight phase and consequence.	Historical strike records over a 10-year period (within a 25 km radius of RAAF Tindal) provide empirical evidence of strike risks and are critical for formulating hazard ratings. Species known to have been previously struck are afforded additional consideration during surveys and site assessments.
Aircraft movement data	Internal records relating to the number of aircraft movements to and from the airfield.	Many WHMPs will standardise the number of wildlife strikes at an airport as "strikes per 10,000 movements" so that relative strike-rate can be compared over time and between aerodromes. As such, it is important to accurately quantify the number of aircraft movements and strikes at an aerodrome so that the efficacy of mitigation measures can be measured. In general, the more aircraft movements at an aerodrome the greater the chances of wildlife strike.
National Flying-fox Monitoring Viewer	A public portal presenting camp census data collected by the National Flying-fox Monitoring Program. It allows users to explore reported flying-fox camps and the numbers of each species counted over time.	Flying-foxes can present a significant strike hazard, and knowledge of camp locations (areas where flying-foxes congregate in large numbers), species and numbers provide essential information for assessing strike risk for aerodromes. Camps can be visited and observed during surveys if required.
Atlas of Living Australia	Australia's national biodiversity database, aggregating data from a range of institutions, based on specimens from natural history collections, field observations and surveys. Provides information about species presence and occurrence records.	Knowledge of the species present within a 25 km radius of RAAF Tindal enables a comprehensive assessment of the site and wildlife risks present.
Department of Environment and Natural Resources (N.T.) – Land, soil and vegetation mapping	Land, soil and vegetation information available in a range of formats including GIS data and pdf documents. Includes profiles and map unit descriptions of landforms, soil and vegetation, technical reports, and survey guidelines.	Vegetation near RAAF Tindal influences the species present near the aerodrome, and can act as attractants to high-risk species. Knowledge of the local vegetation groups enables a comprehensive assessment of the site and wildlife risks present.

2.1.2 Airside Wildlife Harassment and Surveys

Harassment of wildlife on the airfield at RAAF Tindal was conducted daily from Monday to Friday and as necessary during after-hours operations throughout 2020. Data from harassment events was systematically collected at the time of interaction to enable a comprehensive assessment of species posing a direct hazard to operations.

Wildlife surveys were also conducted airside at RAAF Tindal on a weekly basis throughout 2020 to inform a site-specific species list, account for seasonal variability, provide standardized data to allow, and assess potential risks posed by these species. All surveys were undertaken using the point-count method to assist in estimating the relative abundance of different wildlife species. All observers utilised binoculars and collected data pertaining to:

- Species present,
- Abundance of each species present,
- Activity of animals (e.g. foraging, loafing, transiting, etc.),
- Location of animals.

These methodologies present a number of limitations that may affect the WHMP review process, including that it:

- May be biased towards gregarious or non-cryptic species,
- May be biased towards diurnal species.

2.1.3 Off-airfield Wildlife Surveys

Anthropogenic structures and developments such as landfill sites, recycling facilities and water treatment facilities located in the vicinity of the airfield may provide habitat to various species which have adapted to thrive in urban environments. Many species, including masked lapwings, cockatoo species (including galahs and corellas), ibis, wallabies, and wild dogs benefit from modified habitats as they provide abundant sources of food and water. Resource-rich off-airfield sites may therefore contribute to larger than usual populations of certain species, which in turn increases the number of wildlife proximate to the airfield. This can increase the strike risk associated with certain species if their populations reside close to the airfield.

The seasonal variation of fauna populations in these habitats must also be considered, as population numbers or movement may increase during particular seasons or as a result of certain climatic processes. Flying-fox roosts close to the airfield also pose significant risk as ingress and egress of flying-foxes from their roosts at dawn and dusk increase hazard to aircraft.

Sites that may influence local wildlife populations or that constitute off-airfield hazards for RAAF Tindal were assessed as per the National Airport Safeguarding Framework (NASF, Appendix C). The NASF proposes that off-airport risks be classified at 3 km, 8 km and 13 km intervals from the Aerodrome Reference Point (ARP). These intervals align with ICAO guidelines, and are utilised by other international aviation regulators. The areas (shown in Figure 4) surrounding the airfield will be referred to as follows as per the NASF guidelines:

- 3 km radius surrounding the airfield.
- 8 km radius surrounding the airfield.
- 13 km radius surrounding the airfield.

Off-airfield sites that are known to present additional hazard to operations at RAAF Tindal were assessed monthly throughout 2020. Sites were surveyed using the point-count methodology described in Section 2.1.2. Surveyed sites included those identified during the desktop assessment, and those highlighted during stakeholder engagement sessions undertaken during review of the WHMP.

Each off-airfield site was assessed according to NASF Guideline C, Attachment 1 – Managing the Risk of Wildlife Strikes in the Vicinity of Airports (Appendix D). Sites known to present a higher risk than is reflected by this framework were elevated a risk category (e.g. reclassified from moderate to high), and vice-versa where appropriate.

2.2 Wildlife Risk Assessment

This WHMP uses the Bird Risk Assessment Model for Airports and Aerodromes to assess the probability and consequences of a strike event in relation to a bird species body mass, flocking characteristics, flight behaviour, and abundance on or near an airfield (Paton, 2010). The hazard associated with a wildlife strike is dependent on the body mass of the animal, flock density, and flight behaviour; as such, the consequence category of each species is calculated using a scoring system which places species in one of six categories of body mass, three categories of flocking behaviour and two categories of flight behaviour. The consequence ranking is the severity outcome of a strike relative to the other species present on the airport.

The likelihood category for each species estimates the probability of a species being involved in a strike. For the purposes of the risk assessment for wildlife at RAAF Tindal, relative abundance of surveyed species and number of harassments per species were used to determine the likelihood of strike associated with a particular species. Risk assessments for this WHMP were calculated using the 'probability x consequence' matrix as defined by the Paton Risk Assessment method (Table 5).

It is relevant to note that the results of this risk assessment must be viewed in the context of the broader RAAF Tindal ASMS, and that the hazard rankings of individual species should be interpreted relative to one another and not relative to other non-wildlife hazards present at RAAF Tindal. Bridging documentation which contextualise these wildlife specific risks into the broader base ASMS are essential.

Table 5. Risk assessment matrix for assessing the severity of bird hazards at airports (Paton, 2010).

Consequence of a strike	Probability/Likelihood of a strike			
	Very High	**High**	**Medium**	**Low**
Extreme	Extreme	Extreme	Very High	High
Very High	Very High	High	High	Medium
High	High	High	Medium	Medium
Medium	Medium	Medium	Low	Low
Low	Low	Low	Negligible	Negligible
Very Low	Negligible	Negligible	Negligible	Negligible

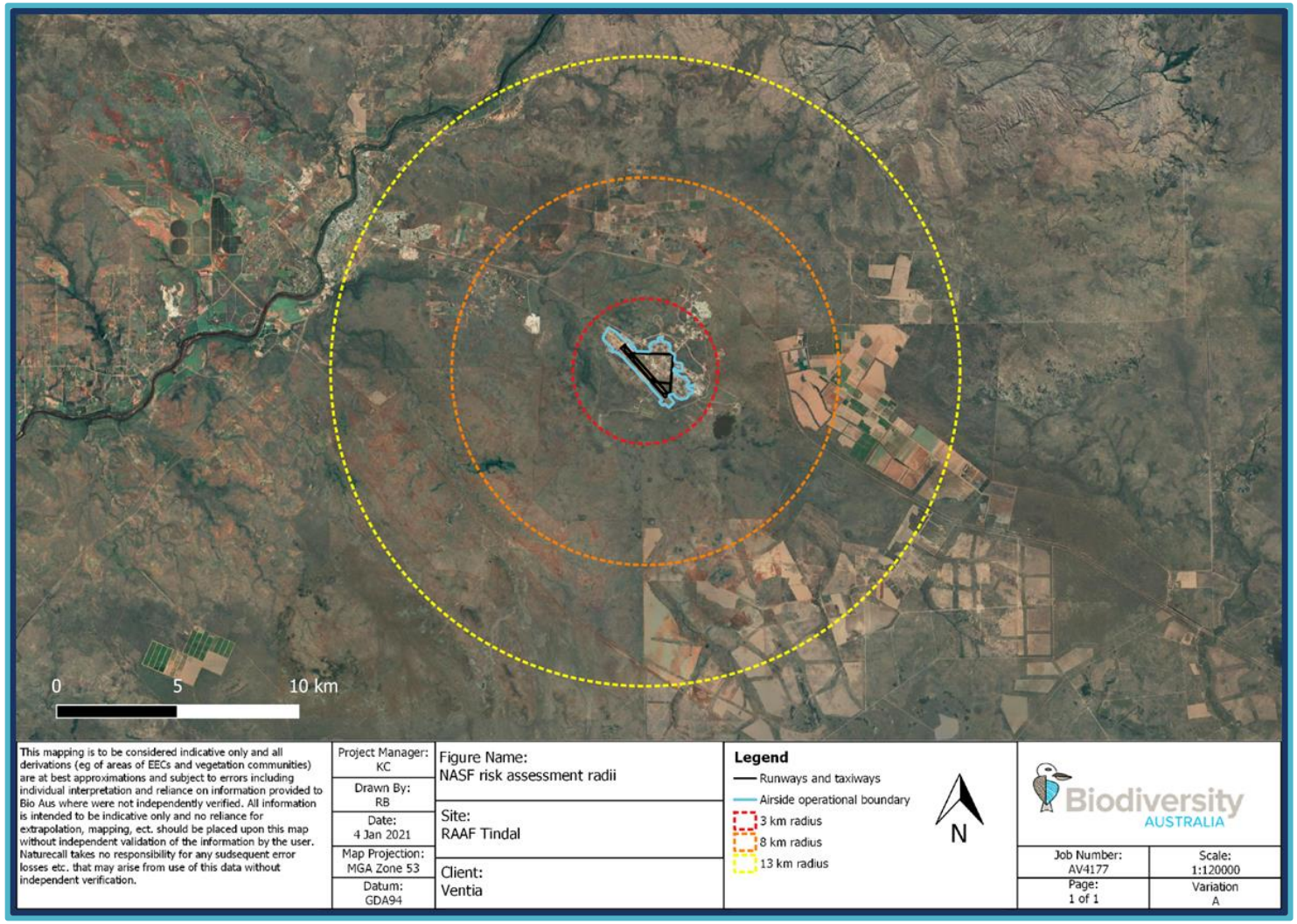


Figure 4. RAAF Tindal NASF assessment intervals at 3, 8 and 13 km.

3. Hazard Identification

3.1 Desktop Assessment

3.1.1 Strike Reports

From January 2013 to December 2020 a total of 102 confirmed wildlife strike occurrences have been recorded at RAAF Base Tindal (Table 6). The average strike rate per 10,000 movements for the WHMP review period (2019 and 2020) was 8.35. This number represents a 35% reduction from the average strike rate of 12.83 for the previous review period (2017 and 2018).

89.58% of ATSB recorded strikes (2013-2020) were from unidentified avian species, whilst the species identified as being involved in strikes included masked lapwing (also recorded as plover), Australian pratincole, eagle (unidentified species), magpie-lark, Australian bustard, and agile wallaby.

Bird strike numbers were highly variable from year to year, with 2017 recording the highest number of strikes and 2016 the lowest (Table 6). On average, the highest number of strikes have occurred at the end of the wet season, in April (1.6 strikes) and the lowest in September, with no strikes being recorded in this month (Figure 5).

In the previous review 2017 and 2018 review period strike data matches ATSB strike numbers. Strike data for this review has included ATSB, internal defence data and data recorded by the WMO. Strike numbers have been calculated on 'strike events' rather than birds struck as ATSB data not detailed enough to all this. The Data is utilised together and any clear duplicates between the platforms are rectified. A WMO was present for 2019 and 2020, actively recording all strikes when on site, including a carcass on taxiway alpha. Also, carcasses found on or in proximity to the runway were also reported as strikes.

Table 6. Aircraft movement and strike data RAAF Tindal 2013-2020 from ATSB and Defence records.

Year	Total Aircraft Movements	Total Recorded Wildlife Strikes	Strikes/10,000 Aircraft Movements
2013	10283	9	8.75
2014	12237	14	11.44
2015	11927	19	15.9
2016	10590	5	4.72
2017	13873	24	17.3
2018	15532	13	8.37
2019	12903	6	4.65
2020	9956	12	12.05

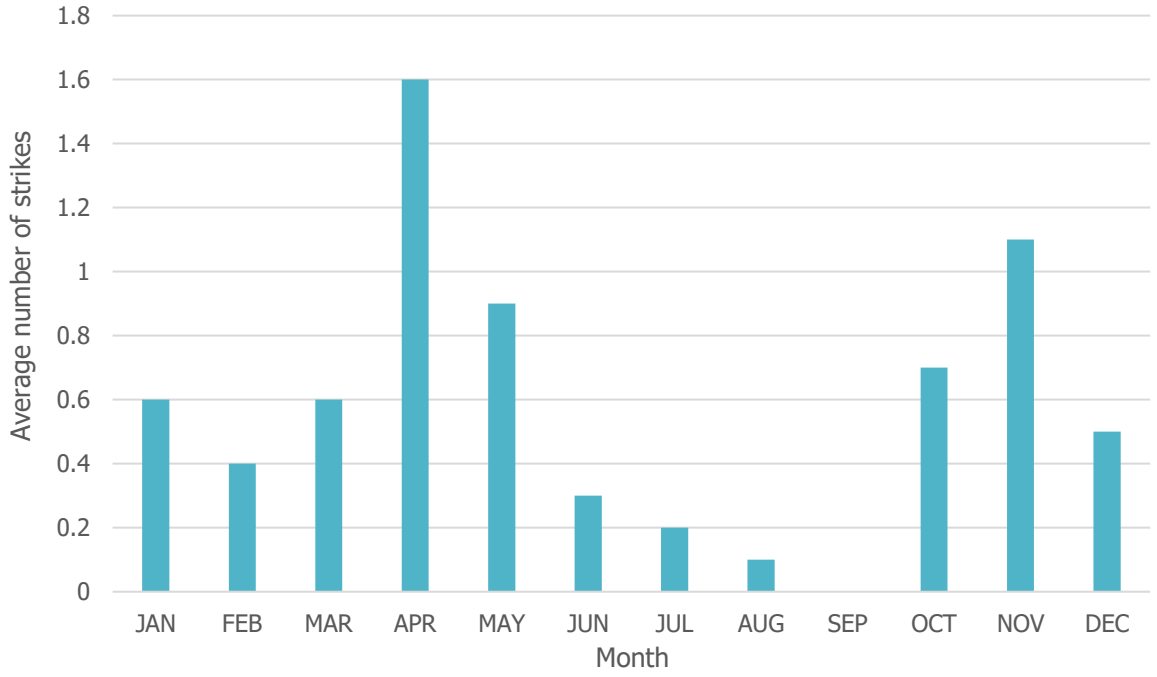


Figure 5. Average number of wildlife strikes per month at RAAF Tindal 2009-2020 from ATSB.

3.2 Airside Wildlife Harassment and Surveys

A number of habitat features at RAAF Base Tindal are known to attract wildlife and may therefore indirectly increase the risk of wildlife strike for aircraft utilising the airfield. These features include:

- Managed grassland,
- Airside landscape,
- Ancillary structures and buildings,
- Airside drainage, and
- Sealed pavement.

Wildlife attractants found on and around RAAF Base Tindal during airside wildlife surveys are listed and presented in Table 7. Each attractant provides varying conditions for a diversity of fauna species. The indicative locations of these airside attractants are presented in Figure 6. Numerous avifauna and terrestrial fauna have been observed utilising these attractants (Appendix F).

Table 8 describes the natural and anthropogenic events that may affect the presence, abundance and behaviour of wildlife at RAAF Tindal.

Table 7. RAAF Tindal airside wildlife attractants.

Habitat Type	Description	Potential as Wildlife Attractant
Buildings and ancillary infrastructure	Built environment surrounding the airfield and the nearby training grounds, including buildings, fences, lighting structures, and antennas.	Built structures may provide a perching apparatus for species on or near the airfield, including large-bodied raptors. Some species may utilise parts of the built environment as nesting sites.
Sealed pavement	Runways and other areas where the ground has been capped by concrete, tarmac, or other impervious materials. (Photo plate 1).	Sealed pavements and paved areas create thermal updrafts and provide conditions suitable for 'thermalling', particularly by raptors. Pooling of water after high rainfall events may also occur, providing drinking or bathing opportunities for wildlife.
Remnant vegetation (woodland and open forest)	Different vegetation communities supporting a range of flowering species, habitat features, and wildlife. (Photo plate 2).	Mature vegetation supports a number of habitat features that may support local wildlife populations and attract large-bodied predatory species.
Watercourses	Natural features that accumulate or channel water, such as lakes, ponds, and creeks. Can be seasonal and temporary or permanent.	Potential for water bodies, pooling water, and waterlogged areas to attract waterfowl.
Drainage	Depressions designed to collect and redirect water from the airfield after rain events.	Drainage depressions can attract wading birds and waterfowl and also provide water for terrestrial species such as kangaroos when they maintain water.
Airside grassland	Semi-maintained open grassland, providing foraging and shelter opportunities for birds or terrestrial animals. (Photo plate 4).	Potential to attract granivorous birds or large-bodied terrestrial herbivores utilising the area for foraging purposes.
Cleared areas	Cleared areas adjoining the airfield. (Photo plate 5).	Cleared areas with little to no vegetation may be attractive to ground-foraging birds and reptiles, which may in turn attract larger predatory species.
Rocky outcrops	Rock formations that appear above the surface and may support a range of fauna.	Rocky outcrops provide shelter for a variety of prey species, which may in turn attract larger predatory wildlife.
Sink holes	Lowering of ground levels resulting from seasonal changes in groundwater table usually due to heavy rain or drought	Sink holes provide habitat utilised by olive python, geckos, frogs and microbats. These species likely attract bird of prey spices and carnivorous birds to feed.

Photo Plate 1. Sealed pavement.

Photo Plate 2. Remnant vegetation adjacent to airfield.

Photo Plate 3. Wedge-tailed eagle perched in airside vegetation.

Photo Plate 4. Airside grassland.

Photo Plate 5. Cleared areas.

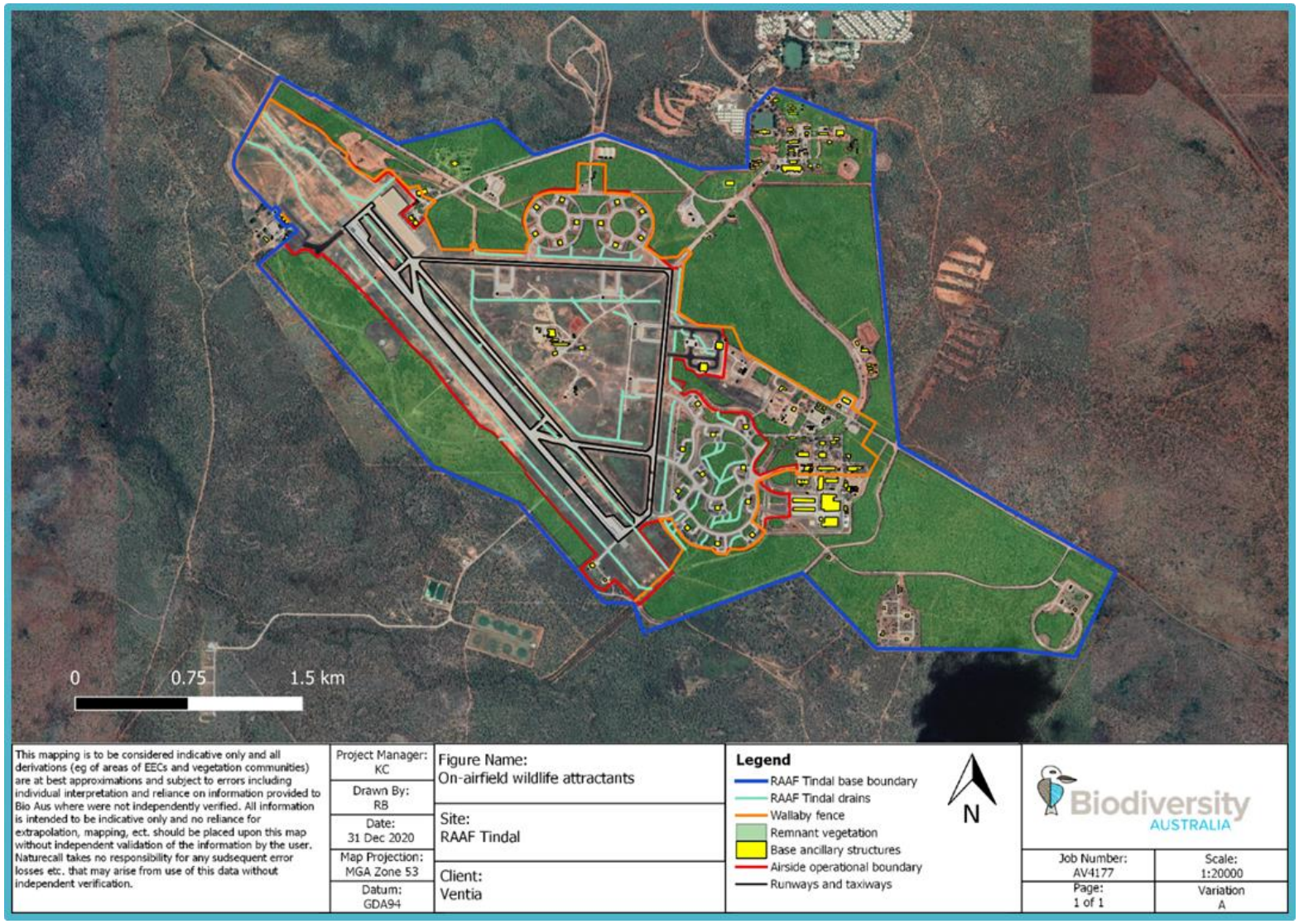


Figure 6. On-airfield wildlife attractants.

Table 8. Natural and anthropogenic events affecting the presence, behaviour, and abundance of wildlife around RAAF Tindal.

Event type	Description	Species attracted
Wet season	The wet season represents a time of high resource availability to many wildlife species and therefore a period of high abundance.	A greater abundance of bird species may be observed around RAAF Tindal during and just after the wet season, during which time average rainfall exceeds 200 mm per month (as compared to the dry season low of 0.7 mm per month) (Bureau of Meteorology, 2021). Species that may move into the area during the wet season include wading birds such as white-faced herons and magpie geese. An increase in the abundance of invertebrate species such as grasshoppers may also attract a number of other birds that feed on them such as black kites, Australian bustards, and pied butcherbirds. The flowering and fruiting of native trees and shrubs during and immediately after the wet season attract nectivorous and frugivorous birds such as red-winged parrots, red-collared lorikeets, and red-tailed black cockatoos. The seeding of grasses during or just after the wet season also acts as an attractant to ground seed feeders such as little corellas, cockatiels, and galahs. An increase in prey species following the wet season may also attract predatory species such as whistling kites, black kites, and wedge-tailed eagles.
Dry season	The dry season is characterised by a lengthy period of low rainfall and a reduction in resource availability.	The dry season will see a reduction in the presence of wading birds around RAAF Tindal, as the availability of water across the local land decreases. A number of bird species are also known to migrate from the south into the Northern Territory during the dry season including fairy martins, Pacific swifts and Australian pratincoles. These species may therefore be observed in the area more commonly during the dry season. Macropod species such as agile wallabies may also be attracted to the maintained grasslands within RAAF Base Tindal as a source of forage during the dry season.
Bushfire and controlled burns	Bushfires may occur more often during the dry season.	Fires attract a number of bird of prey species taking advantage of feeding opportunities presented by fleeing animals, and carrion availability following the fire. Species such as black kites and whistling kites that flock in large numbers with increased prey potential are most likely to be seen around RAAF Tindal following fire. Other raptor species such as wedge-tailed eagles, brown falcons, spotted harriers and nankeen kestrels are also likely to be attracted to the area for hunting opportunities following fire. Red-tailed black cockatoos are also attracted to recently burnt areas to feed on seeds and corms left lying open on the ground. Grass shoots emerging after a fire will also attract a number of wildlife species such as agile wallabies, Australian bustards and galahs.

Event type	Description	Species attracted
Invertebrate levels	Increased levels of invertebrates driven by rainfall - eggs hatch after rain events	High numbers of locus have been recorded in the Tindal area resulting in an increase of insectivorous species feeding on locus n runways and becoming difficult to disperse.
Grass cutting	Routine slashing of airfield grass	Slashing of grass provides opportunistic feeding for birds of prey including black kite. Often observed circling above slasher and eating remains on insects and even small mammalian species. Reluctance to disperse due to high foraging potential.

3.3 Off-airfield Wildlife Surveys

Fourteen off-airfield sites and/or habitat categories with the potential to increase risk at RAAF Tindal were identified through the desktop assessment and associated off-airfield wildlife surveys. Details regarding each of these sites have been presented in Table 9. Off-airfield hazard sites and flying-fox roosts identified within the locality of RAAF Tindal can be viewed in Figures 6 and 7 respectively.

Lying just outside the 13 km risk assessment radius, the Katherine Waste Management facility, Katherine Wastewater Stabilisation Ponds, Katherine Abattoir, Katherine Golf Course, and Katherine Sports Ovals are sites that should also be monitored seasonally for bird species that pose risk to aircraft. Although they are outside the maximum risk assessment radius from the ARP, these sites fall within 13 km of the western limit of the OA and represent a concentration of wildlife attractants.

These sites provide habitat and feeding grounds for many high-risk species including black kite, whistling kite, straw-necked ibis, little corella, red-tailed black-cockatoo, Torresian crow, and nankeen kestrel.

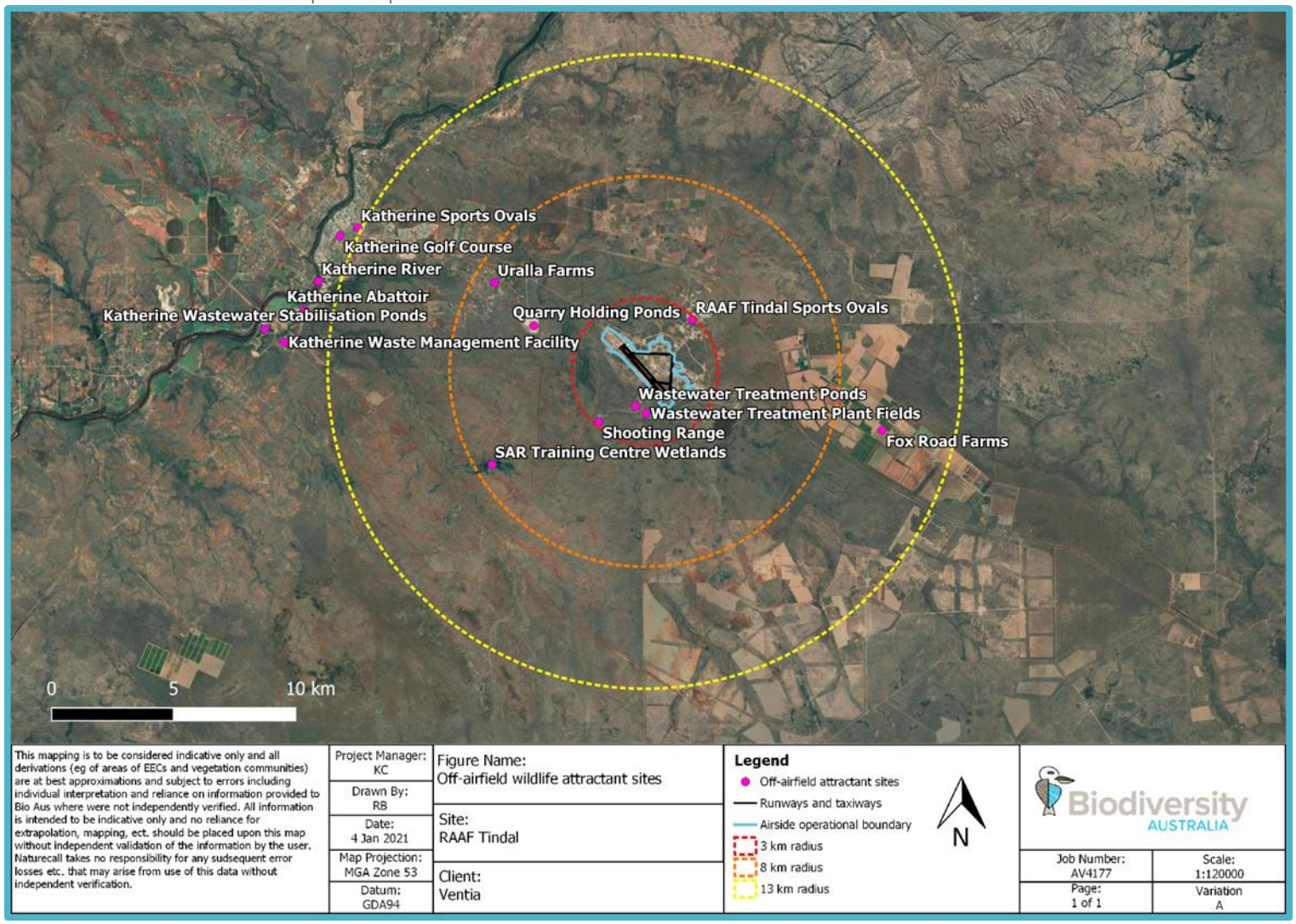


Figure 7. Off-airfield wildlife attractants.

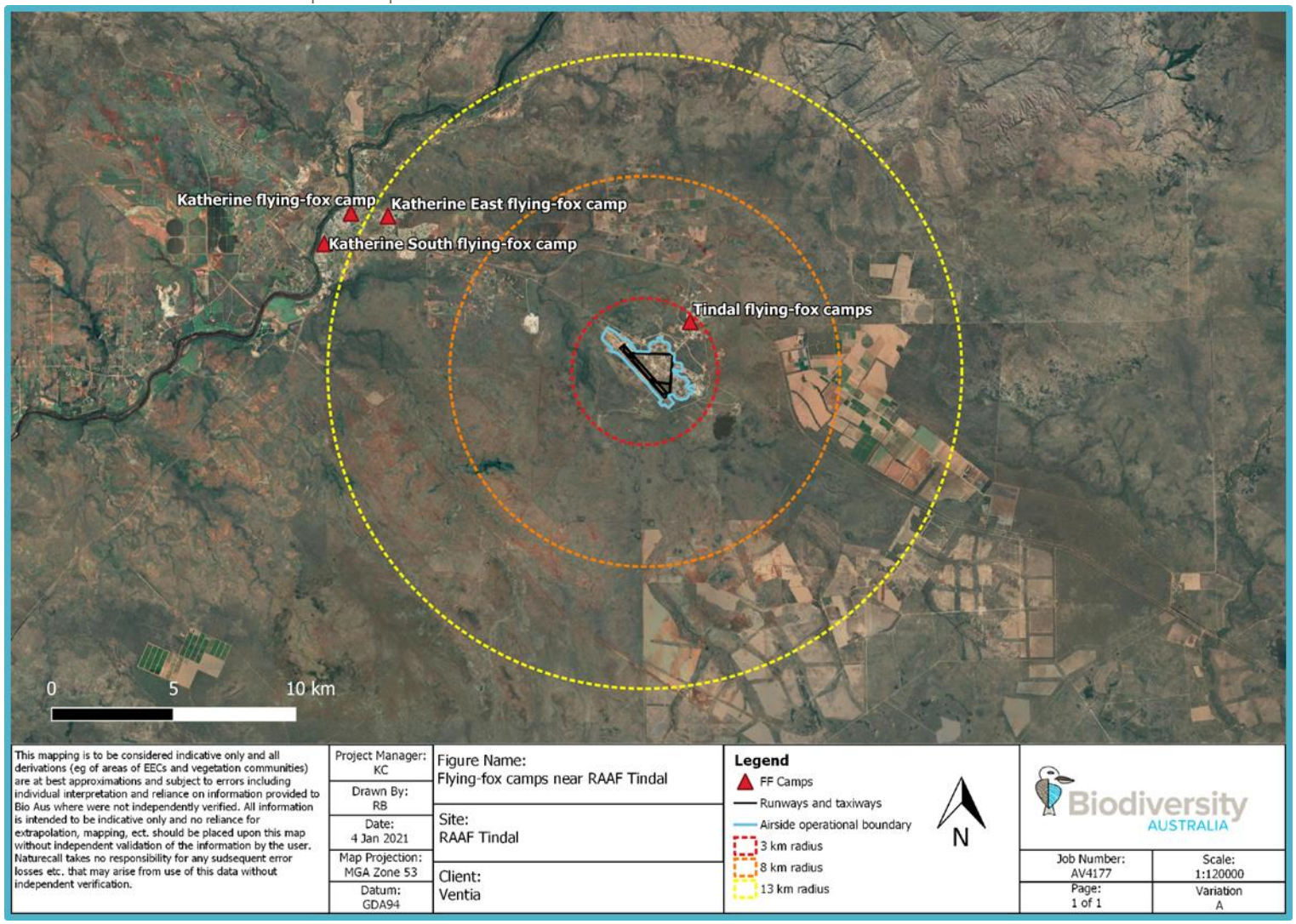


Figure 8. Flying-fox camps near RAAF Tindal.

Table 9. RAAF Tindal - off-airfield wildlife attractants and NASF risk rating.

Site Name	Distance from Airfield	NASF Land-use Category	NASF Risk	NASF Recommended Action for Existing Developments	Description	Indicative Fauna	
Wastewater Treatment Ponds	1.5 km	Sewage / wastewater treatment facility	Moderate	3 km radius - Mitigate 8 km radius - Monitor 13 km radius - Monitor	Fields attached to wastewater treatment ponds	• Red-tailed black-cockatoo • Black kite • Galah • European cattle • Magpie-lark	• Brolga • Masked lapwing • Agile wallaby • Black-faced woodswallow
Wastewater Treatment Plant Fields	1.7 km	Sewage / wastewater treatment facility	Moderate	3 km radius - Mitigate 8 km radius - Monitor 13 km radius - Monitor	Waste water treatment ponds	• Red-tailed black-cockatoo • Australasian grebe • Galah • Cattle egret	• Red-collared lorikeet • Black kite • Peaceful dove • Grey teal • Fairy martin
RAAF Tindal Sports Ovals	2.8 km	Sports facility	Moderate	3 km radius - Mitigate 8 km radius - Monitor 13 km radius - Monitor	Sports ground	• Grey-crowned babbler • Magpie-lark • Masked lapwing • Red-collared lorikeet • Straw-necked ibis	• Peaceful dove • Galah • Great bowerbird • Red-winged parrot • Agile wallaby • Apostlebird
Shooting Range	2.8 km	Sports facility	Moderate	3 km radius - Mitigate 8 km radius - Monitor 13 km radius - Monitor	Sports facility-Shooting Range (400m)	• Red-collared lorikeet • Red-tailed black-cockatoo • Grey-crowned babbler	• Peaceful dove • Masked woodswallow • Magpie-lark
Quarry Holding Ponds	4.9 km	Wildlife sanctuary /	High	3 km radius - Mitigate		Unable to be surveyed however, species likely to occur here include:	• Royal spoonbill • Cattle egret

Site Name	Distance from Airfield	NASF Land-use Category	NASF Risk	NASF Recommended Action for Existing Developments	Description	Indicative Fauna	
		conservation area - wetland		8 km radius - Mitigate 13 km radius - Monitor	Holding ponds within limestone quarry	• Whistling kite • Black kite • Banded stilt • Australasian grebe	• Plumed whistling-duck • White-faced heron
Uralla Farms	7.1 km	Agriculture	High	3 km radius - Mitigate 8 km radius - Mitigate 13 km radius – Monitor	Agricultural land including fruit trees	• Red-tailed black-cockatoo • Straw-necked ibis • Plumed whistling-duck • Magpie-lark • Red-collared lorikeet	• Agile wallaby • Crested pigeon • Grey-crowned babbler • Red-winged parrot • Galah
SAR Training Centre Wetlands	7.3 km	Wildlife sanctuary / conservation area - wetland	High	3 km radius - Mitigate 8 km radius - Mitigate 13 km radius - Monitor	Wetlands	Not surveyed in 2020, however species previously observed at this site include: • Brolga • Purple swamphen • Little red flying-fox	• White-faced heron • Black flying-fox • Blue-winged kookaburra
Fox Road Farms	10.0 km	Agriculture	High	3 km radius - Mitigate 8 km radius - Mitigate 13 km radius - Monitor	Agricultural land including fruit trees	• Red-tailed black-cockatoo • Straw-necked ibis • Galah • Red-collared lorikeet • Crested pigeon • Little corella	• Bar-shouldered dove • White-breasted woodswallow • Torresian crow • Magpie-lark • Black-faced woodswallow • Red-winged parrot

Site Name	Distance from Airfield	NASF Land-use Category	NASF Risk	NASF Recommended Action for Existing Developments	Description	Indicative Fauna	
Katherine Sports Ovals	13.1 km	Sports facility	Moderate	3 km radius - Mitigate 8 km radius - Monitor 13 km radius - Monitor	Sports ground	• Little corella • Red-collared lorikeet • Apostlebird • Australian wood duck • Masked lapwing • Magpie-lark • Black kite	• Magpie goose • Grey-crowned babbler • Straw-necked ibis • Black-faced woodswallow • Peaceful dove • White-breasted woodswallow
Katherine Golf Course	13.6 km	Golf course	Moderate	3 km radius - Mitigate 8 km radius - Monitor 13 km radius - Monitor	Golf course, including large grassed areas, trees and permanent water bodies	• Little corella • Plumed whistling-duck • Straw-necked ibis • Magpie goose • Red-collared lorikeet • Magpie-lark • Black-faced woodswallow	• Apostlebird • Black kite • Bar-shouldered dove • Great bowerbird • Rainbow bee-eater • Grey-crowned babbler
Katherine River	13.8 km	Wildlife sanctuary / conservation area - wetland	High	3 km radius - Mitigate 8 km radius - Mitigate 13 km radius - Monitor	Permanent watercourse with fringing vegetation	Not surveyed in 2020, however species previously observed at this site include: • Black kite	• Magpie-lark • Little corella • Red-tailed black-cockatoo • Galah • Little friarbird
Katherine Abattoir	14.1 km	Food processing plant	High	3 km radius - Mitigate 8 km radius - Mitigate 13 km radius - Monitor	Cattle processing facility	• Red-collared lorikeet • Straw-necked ibis • Whistling kite	• Black kite • Magpie-lark • Double-barred finch

Site Name	Distance from Airfield	NASF Land-use Category	NASF Risk	NASF Recommended Action for Existing Developments	Description	Indicative Fauna	
Katherine Waste Management Facility	14.8 km	Putrescible waste facility - landfill	High	3 km radius - Mitigate 8 km radius - Mitigate 13 km radius - Monitor	Waste processing facility	• Black kite • Torresian crow • Whistling kite • Cattle egret	• Red-collared lorikeet • Magpie goose • Straw-necked ibis
Katherine Wastewater Stabilisation Ponds	15.6 km	Sewage / wastewater treatment facility	Moderate	3 km radius - Mitigate 8 km radius - Monitor 13 km radius - Monitor	Open ponds	• Plumed whistling-duck • Ibis-straw-necked ibis • Magpie goose • Cattle egret • Red-collared lorikeet • Australian white ibis • Bar-shouldered dove • Black-fronted dotterel • Wood sandpiper	• Pied stilt • Black kite • Radjah shelduck • Masked lapwing • Pied heron • Whiskered tern • Double-barred finch • Royal spoonbill • Fairy martin • Common sandpiper

4. Wildlife Risk Assessment

An outline of the risk ranking associated with the species observed around RAAF Tindal as defined by the Bird Risk Assessment Model for Airports and Aerodromes (Paton, 2010) is presented within Table 10. There are a number of species present at RAAF Tindal that have not been involved in strikes over the past ten years, but may still present risk to aircraft and are regularly harassed by WMOs or observed during airside monitoring; for this reason, they have been included in the risk assessment.

Because the WHMP falls under the umbrella of the broader ASMS, the risk rankings below should be viewed relative to one another only. The collective wildlife hazard ranking (which encompasses all wildlife strike hazards) should align with the ASMS in the broader context of the defence operation. Measures to determine the resource allocation, prioritisation and management of competing hazards and risks at RAAF Base Tindal falls outside of the scope of this plan.

Forty-six species were included in the risk assessment for RAAF Tindal, with the following species assessed as carrying an extreme or very high risk to operations in either the wet or dry season:

- Agile wallaby,
- Australian bustard,
- Galah,
- Straw-necked ibis,
- Masked lapwing,
- Brolga,
- Flying-fox (black & little red),
- Magpie goose,
- Wild dog,
- Red-tailed black-cockatoo,
- Whistling kite,
- Pacific black duck, and
- Little corella.

An additional 12 species were assessed as a high risk to operations in either the wet or dry season:

- Australian pratincole,
- Black-breasted buzzard
- Black kite,
- Black-breasted buzzard
- Bush stone-curlew,
- Magpie-lark,
- Nankeen kestrel,
- Red-collared lorikeet,
- Sulphur-crested cockatoo,

- Torresian crow,
- Magpie-lark,
- Wedge-tailed eagle,
- Northern brown bandicoot,
- Pacific swift, and
- White-faced heron.

These species require both passive and active management to mitigate strike risk. Relevant mitigation techniques for each species have been described within Appendix A. These mitigations must be formally assessed in regular internal Wildlife Hazard Management Plan reviews for RAAF Tindal (see Section 1.4).

4.1 Limitations

The lack of positive identification for most species involved in strikes at RAAF Tindal prior to 2019 is considered to be a limitation to this wildlife risk assessment. Since 2019, species involved in wildlife strike events have been identified by the WMO (with the possibility of identification by DNA test should only partial animal remains be found). This is expected to increase the accuracy of future wildlife risk assessments. Prior to this, most species involved in wildlife strikes on ATSB were not identified to the species-level (i.e., genus or family level only) or were classified as bird or bat.

Table 10. Species risk assessment for RAAF Tindal.

Species Common Name	Scientific Name	Nocturnal or crepuscular*	Consequence				Likelihood					Wet Season Hazard Score	Dry Season Hazard Score
			Mass (g)	Mass Score	Flock Score	Flight / Movement Score	Consequence Score	Consequence Rank	Percentage of Total Harassments/Surveys (2020)	Likelihood Score – Wet Season	Likelihood Score – Dry Season		
Agile wallaby	*Macropus agilis*	✓	12000	32	2	2	128	EX	0.24%	**H**	**VH**	**EX**	**EX**
Australian bustard	*Ardeotis australis*		4500	16	2	2	64	EX	2.59%	**VH**	**VH**	**EX**	**EX**
Galah	*Eolophus roseicapilla*		330	8	4	2	64	EX	3.44%	**VH**	**VH**	**EX**	**EX**
Straw-necked ibis	*Threskiornis spinicollis*		1465	16	4	1	64	EX	5.12%	**VH**	**VH**	**EX**	**EX**
Masked lapwing	*Vanellus miles*	✓	360	8	2	2	32	VH	0.35%	**VH**	**M**	**EX**	**VH^**
Brolga	*Antigone rubicunda*		6700	32	1	2	64	EX	0.06%	**H**	**L**	**EX**	**H**
Flying-fox (black & little red)	*Pteropus alecto* & *Pteropus scapulatus*	✓	680	8	4	2	64	EX	0.67%	**VH**	**L**	**EX**	**H**
Magpie goose	*Anseranas semipalmata*		2800	16	4	1	64	EX	0.14%	**H**	**L**	**EX**	**H**
Dog	*Canis lupus familiaris or Canis lupus dingo*	✓	20000	32	1	2	64	EX	0.02%	**M**	**M**	**VH**	**VH**
Red-tailed black-cockatoo	*Calyptorhynchus banksii*		720	8	2	2	32	VH	3.54%	**VH**	**VH**	**VH**	**VH**
Whistling kite	*Haliastur sphenurus*		910	8	1	2	16	H	0.27%	**H**	**H**	**VH^**	**VH^**
Pacific black duck	*Anas superciliosa*	✓	1120	16	4	1	64	EX	0.02%	**M**	**L**	**VH**	**H**

Species Common Name	Scientific Name	Nocturnal or crepuscular#	Consequence				Likelihood					Wet Season Hazard Score	Dry Season Hazard Score
			Mass (g)	Mass Score	Flock Score	Flight / Movement Score	Consequence Score	Consequence Rank	Percentage of Total Harassments/Surveys (2020)	Likelihood Score – Wet Season	Likelihood Score – Dry Season		
Little corella	*Cacatua sanguinea*		560	8	4	1	32	VH	4.72%	**VH**	**L**	**VH**	**M**
Australian pratincole	*Stiltia isabella*	✓	65	4	2	1	8	M	9.36%	**VH**	**VH**	**H^**	**H^**
Black-breasted buzzard	*Hamirostra melanosternon*		1350	16	1	2	32	VH	0.11%	**VH**	**H**	**H**	**H**
Black kite	*Milvus migrans*		625	8	1	2	16	H	3.41%	**VH**	**VH**	**H**	**H**
Bush stone-curlew	*Burhinus grallarius*	✓	1200	16	2	1	32	VH	0.09%	**H**	**H**	**H**	**H**
Magpie-lark	*Grallina cyanoleuca*		90	4	2	2	16	H	4.07%	**VH**	**VH**	**H**	**H**
Nankeen kestrel	*Falco cenchroides*		185	4	2	2	16	H	0.14%	**H**	**H**	**H**	**H**
Red-collared lorikeet	*Trichoglossus rubritorquis*		125	4	4	1	16	H	0.74%	**VH**	**VH**	**H**	**H**
Sulphur-crested cockatoo	*Cacatua galerita*		790	8	2	2	32	VH	0.07%	**H**	**H**	**H**	**H**
Torresian crow	*Corvus orru*		550	8	2	1	16	H	0.19%	**H**	**H**	**H**	**H**
Wedge-tailed eagle	*Aquila audax*		3950	16	1	2	32	VH	0.16%	**H**	**H**	**H**	**H**
Northern brown bandicoot	*Isoodon macrourus*	✓	1200	16	1	1	16	H	0.05%	**H**	**M**	**H**	**M**
Pacific swift	*Apus pacificus*		40	2	4	2	16	H	0.57%	**VH**	**L**	**H**	**M**
White-faced heron	*Egretta novaehollandiae*		600	8	1	2	16	H	0.05%	**H**	**L**	**H**	**M**

Species Common Name	Scientific Name	Nocturnal or crepuscular#	Consequence				Likelihood					Wet Season Hazard Score	Dry Season Hazard Score
			Mass (g)	Mass Score	Flock Score	Flight / Movement Score	Consequence Score	Consequence Rank	Percentage of Total Harassments/Surveys (2020)	Likelihood Score – Wet Season	Likelihood Score – Dry Season		
Swamp harrier	*Circus approximans*		870	8	1	2	16	H	0.01%	**M**	**M**	**M**	**M**
Spotted harrier	*Circus assimilis*		670	8	1	2	16	H	0.02%	**M**	**M**	**M**	**M**
Australian magpie	*Gymnorhina tibicen*		330	8	2	1	16	H	0.01%	**L**	**M**	**M**	**M**
Great bowerbird	*Ptilonorhynchus nuchalis*		205	8	1	1	8	M	0.01%	**H**	**H**	**M**	**M**
Red-winged parrot	*Aprosmictus erythropterus*		140	4	2	1	8	M	0.14%	**H**	**VH**	**M**	**H**
Pied butcherbird	*Cracticus nigrogularis*		140	4	2	1	8	M	0.05%	**H**	**VH**	**M**	**M**
Cockatiel	*Nymphicus hollandicus*		95	4	2	1	8	M	0.82%	**VH**	**H**	**M**	**M**
Grey-crowned babbler	*Pomatostomus temporalis rubeculus*		80	4	4	4	64	EX	0.02%	**M**	**H**	**M~**	**M~**
Black-faced woodswallow	*Artamus cinereus*		40	2	2	2	8	M	0.28%	**H**	**VH**	**M**	**M**
Pheasant coucal	*Centropus phasianinus*		380	8	1	1	8	M	0.02%	**H**	**M**	**M**	**L**
Oriental pratincole	*Glareola maldivarum*		75	4	2	1	8	M	0.17%	**H**	**L**	**M**	**L**
Peregrine falcon	*Falco peregrinus*		890	8	1	1	8	M	0.1%	**M**	**M**	**L**	**L**
Brown falcon	*Falco berigora*		625	8	1	1	8	M	0.02%	**M**	**M**	**L**	**L**
Channel-billed cuckoo	*Scythrops novaehollandiae*		610	8	1	1	8	M	0.01%	**M**	**L**	**L**	**L**

Species Common Name	Scientific Name	Nocturnal or crepuscular#	Consequence				Likelihood					Wet Season Hazard Score	Dry Season Hazard Score
			Mass (g)	Mass Score	Flock Score	Flight / Movement Score	Consequence Score	Consequence Rank	Percentage of Total Harassments/Surveys (2020)	Likelihood Score – Wet Season	Likelihood Score – Dry Season		
Australian hobby	*Falco longipennis*		290	8	1	1	8	M	0.02%	**M**	**M**	**L**	**L**
Masked woodswallow	*Artamus personatus*		35	2	2	2	8	M	0.01%	**M**	**L**	**L**	**L**
Fairy martin	*Petrochelidon ariel*		11	1	2	2	4	L	1.61%	**VH**	**VH**	**L**	**L**
Black-faced cuckooshrike	*Coracina novaehollandiae*		115	4	1	1	4	L	0.03%	**H**	**H**	**L**	**L**
Australasian pipit	*Anthus novaeseelandiae*		32	2	1	1	2	VL	0.05%	**H**	**H**	**N**	**N**
Willie wagtail	*Rhipidura leucophrys*		20	1	1	1	1	VL	0.01%	**M**	**H**	**N**	**N**

Legend: EX = extreme, VH = very high, H = high, M = medium, L = low, VL = very low, N = negligible

^ Hazard score elevated due to strike history at RAAF Tindal.

~ Hazard score reduced due to species behaviour and habitat preferences.

There is an increased risk associated with this species during dusk and night time activities.

5. Wildlife Management Plan

This section details the measures that can be adopted to best manage the wildlife strike risk at RAAF Tindal. Units operating at RAAF Tindal have a responsibility to address wildlife hazards as soon as they are detected.

The policies and procedures are to be applied with respect of their purpose or intent and variances may be required from time to time. The flying units operating at RAAF Tindal may be authorised to amend or vary a policy or procedure as required and in response to situational changes.

Procedures are developed around an operational framework, including the three components listed below.

1. Detection
2. Hazard mitigation
3. Data management

5.1 Detection

5.1.1 Wildlife Identification and Monitoring

Identification and monitoring regimes enable the assessment of wildlife hazards on the airfield to inform aircrew of potential risks and subsequent wildlife harassment actions. Detection of wildlife hazards at RAAF Tindal should occur prior to aircraft movements when the airfield is in operation. Wildlife monitoring conducted by the Wildlife Management Officer (WMO) currently occurs on a weekly basis so that a reliable baseline of data is obtained prior to implementing wildlife hazard management strategies and long-term trends are captured.

Flying fox counts and perimeter fence inspections are also important for assessing risk. Procedures for on-airfield wildlife monitoring, flying-fox monitoring, fence inspections, and runway and flight strip inspections can be viewed in Appendix E.

5.1.2 Wildlife Safety Inspections

Air Traffic Control (ATC) can request additional wildlife safety inspections prior to aircraft activity during times of severe activity, or when wildlife is reported by a third party. A dedicated, suitably qualified WMO may assist with these surveys as required.

5.1.3 Wildlife Strike Data

Wildlife strike data, including species, location, time, and nature of strike must also be recorded into the wildlife management database as a mandatory requirement of Aviation Safety Report (ASR) reporting. If partial remains are found, identification of birds involved in strikes should be carried out by squadrons with the assistance of a WMO through the use of DNA testing kits, prior to the cleaning of aircraft. A full list of the roles and responsibilities required by the WHMP is provided in Appendix C.

Formal identification of birds involved in strikes is vital for informing wildlife risk assessments at RAAF Tindal. Procedures for wildlife strike reporting and the identification and handling of remains can be viewed in Appendix E.

5.1.4 Off-airfield Wildlife Monitoring

An SME should carry out bird surveys in surrounding areas and at nearby (within 13 km) sites identified as risk sites within this WHMP.

This will help identify trends in local population dynamics and will assist in informing management decisions for wildlife hazards. New developments in the area also have the potential to attract and maintain wildlife populations. As these develop, they should be integrated into the off-airfield monitoring program and incorporated into this WHMP. A procedure for the monitoring of off-airfield wildlife is provided in appendix E.

5.1.5 Analysis of Wildlife Management and Survey Data

Wildlife data must be analysed on a quarterly basis to inform future wildlife risk assessments at RAAF Tindal and to gauge the effectiveness of management strategies. This includes regular analysis of monitoring data and data related to strikes, near-misses or other incidents. All data should be provided in a quarterly report that summarises the following information:

- Species managed by the WMO during operations at RAAF Base Tindal;
- Quantity and relative abundance of each species managed during operations at RAAF Base Tindal;
- Results of off-airfield wildlife monitoring and analysis of trends; and
- Species and quantity involved in wildlife strike events and near misses.

Regular analysis and review of wildlife management and survey data will allow wildlife and land managers to make proactive evidence-based decisions regarding future wildlife management at RAAF Base Tindal.

5.2 Hazard mitigation

5.2.1 Passive Management

Passive management acts to reduce the attractiveness of the airfield to wildlife by reducing the amount of water, food and shelter available.

Passive (or habitat) management includes the implementation of careful grass and landscaping management procedures including species selection, control of undesirable vegetation maintenance of drainage and the removal of dead birds and animals. Procedures for the passive management of wildlife at RAAF Tindal should be developed in coordination the EMOS, who oversee land management.

Passive management in an airfield setting also requires that the following actions be taken:

- Landscaping and grass management – maintenance of airside grass between 150 and 300 mm. Removal of wildlife attracting vegetation within the airfield, or within close proximity of the airfield.
- Removal of roosting or nesting sites - through trimming or removal of trees or unnecessary signage airside.
- Lighting control - where possible, lighting near the runway should be turned off between flights to reduce the number of insects attracted by lights, which may in turn attract nocturnal insectivorous bird and mammal species.

- Bird and bat deterrent devices - these may be installed on ancillary infrastructure to deter birds and bats from approaching or nesting around the airfield.
- Airfield perimeter fence – may be installed to prevent ingress of wildlife onto the airfield.
- Management of airfield construction works – prior to exercises, carefully manage grounds disturbed by construction works on and surrounding the airfield to ensure that they are not attracting wildlife.
- Land-use planning - all proposed land use changes within RAAF Tindal and surrounds with potential to increase the risk of bird strike should be scrutinised appropriately.
- Off-airfield hazard management – recurring discourse with local stakeholders and land managers can assist in ensuring that local bird populations are monitored and mitigated accordingly.

5.2.2 Active Management

Active management includes wildlife harassment, culling, nest removal or any management measures used to proactively or reactively remove wildlife from the airfield. The intensity, frequency and methods used in active management are determined by wildlife hazard levels and aircraft movements. Active management aims to reduce the immediate and ongoing risk posed by wildlife to aircraft by deterring or removing animals from the vicinity of the runways and surrounding airfield.

The aim of active management programs is to continually disrupt flocking behaviour at feeding and/or roosting sites so as to discourage future use of these areas by wildlife. Where animals cannot be effectively managed by passive management measures such as habitat modification or exclusion, active management must occur to minimise risk. Recurring wildlife harassment is the most effective and immediate active management strategy for wildlife risk management on an airfield. A qualified WMO should conduct wildlife harassment at RAAF Tindal during operational hours using a variety of methods. Methods that may be used include vehicle horns, stock whips, gas guns and pyrotechnic charges. Lethal control is only a last resort and the hierarchy of non-lethal control escalates prior to lethal control being considered.

Procedures for wildlife harassment can be viewed in Appendix E.

5.3 Data Management

Wildlife survey and harassment data should be collected by wildlife management officers or units operating at RAAF Tindal into a universal database that allows for easy and quick collection of data. At present, all data is collected by WMOs using QuickTapSurvey. This database must be carefully managed, maintained and subject to quarterly review. Wildlife data should be rigorously analysed on a quarterly basis to inform site-specific risk assessments and to determine the effectiveness of management strategies. It is the responsibility of the WMO, base fire, or anyone utilising RAAF Tindal to report confirmed wildlife strikes, suspected strikes or near-misses as they occur.

6. Recommendations

Surveys, data and document reviews, stakeholder feedback and wildlife risk assessments have delivered a comprehensive understanding of the wildlife risks present at RAAF Tindal. Species with an extreme hazard rank at RAAF Tindal include the agile wallaby, straw-necked ibis, and Australian bustard. Other species, such as the pacific black duck and wild dog, have a very high hazard ranking but an extreme consequence ranking in the event of a strike – these species also require careful monitoring and management.

A reference table including specific recommendations to streamline compliance of wildlife hazard management operations at RAAF Tindal with relevant legislative instruments has been provided in Table 11.

Table 11. Summary of recommendations and key performance indicators for improving wildlife management at RAAF Tindal.

Key Performance Indicators	Objective	Responsibility
Development of National Defence Risk Assessment Matrix.	The current risk assessment matrix utilised in WHMP's is solely for the identification of ranking hazard relative to species identified on site. Incorporating second layer of assessment in conjunction with the wildlife hazard ranking. This will allow incorporation of current mitigation methods and flight times and altitudes to be factored in. Similar or incorporated into the ASMS framework. DFSB (ADF) risk assessment matrix should be considered for comparison.	DELM
DNA analysis of species involved in wildlife strikes.	It is standard practice for unidentified species to be identified by a DNA test. A high proportion (89.58%) of strikes recorded at RAAF Tindal are from unidentified bird species. By increasing the number of species identified, through DNA analysis, wildlife hazard management can be more reliably tailored to suit the highest risk species, thus reducing the risk to aircraft posed by these species. DNA testing utilises kits provided by Australian Museum and sent back for testing as required. It is only required to be utilised when the carcass/remains are completely unidentifiable. Partial body remails can usually be identified by WMO. If a carcass is encountered by defence staff while WMO off duty remains should be moved to freezer located at the fire station for identification by WMO	All Stakeholders WMO
Increased presence of Wildlife Management Officers to cover all military aircraft movements. **Note: A WMO must be present on site for all activities involving F35s, including landings, touch and go's and flybys.**	An increased number of flights at RAAF Tindal at varying hours means increased risk of wildlife strike events, and an increased requirement for wildlife harassment on base. Further, animals become habituated to human movements and patterns, and can learn that certain times of day are "safe" to utilise habitat at RAAF Tindal. Increasing presence on site can help prevent habitation from occurring. Increased presence of WMOs during the wet season, when local wildlife abundance is high may also be advisable to reduce the risk of strike at this time. Presence of the WMO during dusk and nocturnal hours should also be considered as these times correspond to high movements of agile wallaby and flying foxes. The introduction of F35s into the RAAF over the next year comes with the condition (2 – M22) that all airfields interacting with this aircraft require a WMO onsite to monitor and document bird and bat movements and to perform wildlife dispersal techniques where necessary. This is in accordance with the Civil Aviation Safety Regulation (CASR) – Manual of Standards (MOS) Part 139 – Aerodromes Section 10.14 and the Bird and Animal Hazard Management, Defence Safety Manual, National Parks and Wildlife Act No. 80 (1972) and supporting documentation.	EMOS SME

Key Performance Indicators	Objective	Responsibility
Approve use of pyrotechnics airside for increased harassment on extreme risk species.	Using a variety of methods is vital to ensuring the continued effectiveness and sustainable management of airside wildlife. Pyrotechnics are extremely effective as they provide both negative auditory and sensory stimuli for wildlife. Pyrotechnics should only be used by suitably trained personnel.	BM BASO SME
Streamlined structure and approval process for management of wildlife in circumstances that present an imminent risk to aircraft safety.	Occasionally, an animal may not die following wildlife strike. This most commonly occurs with larger wildlife. In this instance, it is most humane that euthanasia be conducted as soon as possible to mitigate animal welfare concerns and to avoid future incidents. The approval process for such circumstances should be streamlined so that such situations can be managed as quickly as possible.	BM EMOS
Establish a Wildlife Working Group at RAAF Tindal.	Establishing a formal wildlife working group at RAAF Tindal will enable the identification and coordinated management of key local issues surrounding wildlife. Such issues include the presence, abundance and movement of flying foxes and the presence and abundance of high risk feral mammal and bird species. This Wildlife Working Group should include representatives from RAAF Tindal, Parks and Wildlife (N.T.), Katherine Town Council and other relevant local stakeholders and landholders, and meetings of this group should occur ideally quarterly. Local strike risk may be reduced through the establishment of this group, by improving relationships and increasing engagement with local stakeholders and through promoting activities that lead to a reduction in local wildlife hazards At a minimum a routine formalised communication plan and inclusion of escalation of issues plan should be developed.	BASO SME
Incorporation of wildlife hazard objectives in the vegetation management plan for RAAF Tindal.	Incorporation of wildlife passive mitigation methods and consideration from a wildlife hazard perspective to the vegetation management plan. This will allow for succinct documentation throughout defence including grass management procedure and landscaping procedure. A vegetation management plan should also outline acceptable landscaping principles for the base including type of species permissible for planting and management plans for existing species. At present, there are a number of remnant vegetation patches, including flowering eucalypt species and rubber bush, in very close proximity to the YPTN runways - these are high risk attractants to birds. Large patches of unmown grass, and weeds may also be found near the mid and south-eastern sections of the runway. Such hazards must be removed to reduce the risk of wildlife strike at YPTN.	BM
Repair and maintain airside fencing at the RAAF Tindal base.	Data indicate that terrestrial fauna such as agile wallaby and wild dog pose a significant hazard to aircraft operations at YPTN. Fencing design should be updated to encompass the entire airfield perimeter to exclude terrestrial species.	EMOS
Maintaining bird spikes on airfield signage and infrastructure.	Bird spikes are an effective bird deterrent as they create a physical barrier that prevents perching behaviour. However, through normal deterioration, unmaintained areas may be identified and utilised by birds. Ensuring the correct bird spike specifications are utilised will maintain success of this deterrent.	EMOS

Key Performance Indicators	Objective	Responsibility
Cap animal carcass pits.	A wildlife carcass pit located approximately 3km from the RAAF Tindal airfield is currently open, and thus remains attractive to high-risk species such as black and whistling kite, wedge-tailed eagle, and wild dog. Capping the pit after each new carcass is placed within will help to reduce this risk.	EMOS
Carefully control fire management regimes.	Fire management regimes are important for both land and conservation management. Controlled burning is undertaken in habitats surrounding the airfield. Prescribed burns around RAAF Tindal must be timed appropriately, so as not to encourage wildlife (e.g. raptors, wild dogs, parrots) to the area of the airfield around times of high aircraft activity. Some flexibility in burn times may be required.	EMOS
Control grass mowing regimes.	Ensuring that mowing of grass is timed to precede grass seeding and dispersal is a key method by which the attractiveness of the airfield to granivorous bird species and rodents, potential prey for high-risk species, can be reduced. Grass mowing should also be undertaken outside of scheduled flight times, as mowing attracts a number of high risk species (including black kite and nankeen kestrel) due to the displacement of ground-dwelling fauna. Airside grasses should be mowed to and consistently maintained at approximately 150 – 300mm. This will reduce the attractiveness of the airfield to grassland bird species such as Australian bustard, corella and ibis.	EMOS
Improve knowledge of wildlife risks within squadrons through ongoing education programs.	Educating squadrons about wildlife risks and hazard reduction at RAAF Tindal will improve awareness and thus reduce risk. Education programs should also be extended to include foreign forces (e.g. Singapore, U.S.A), as their knowledge of Australian wildlife may be limited. Briefing pilots of mitigations to decreased likelihood of bird strike including, reducing taxiing speed and reducing speed on landing as quickly as possible to reduce risk of pratincole strike. E.g. aircraft requested to taxi on Sierra to avoid spooking birds from alpha back to the runway. Educating squadrons about the use of DNA testing kits prior to cleaning aircraft will also improve the proportion and accuracy of species strike identification in the future. This could also be undertaken by the WMO directly if appropriate communication lines are established.	BASO SME
Multistakeholder wildlife strike register.	To increase efficiency when reporting wildlife strikes, it would be useful to incorporate a wildlife strike register that all stakeholders would be able to add to including ATC, Base Fire or any other stakeholders/squadrons that may identify a strike. SME will consolidate register to include strikes discovered and ability to update when species identified. Training and promotion of register at stakeholder meetings would also be required to ensure effectiveness.	BM EMOS SME

Key Performance Indicators	Objective	Responsibility
Development of Defence/site specific SOP's	Generalised Standard Operating Procedures are currently attached to the WHMP. Developing site specific SOP's incorporate the areas of responsibility within the procedures and additional details relating to the site. Additional SOP's to be developed for repeatability including DNA sampling, wildlife surveys including a site specific wildlife survey form, Standard approach for species management Grass management, and Landscaping Grass management and landscaping to be developed in conjunction with review of the vegetation management plan.	BM EMOS SME

7. Resources

7.1 Articles, Books and Reports

Allan, J. O. (2006). A heuristic risk assessment technique for birdstrike management at airports. Risk Analysis, 26 (3), 723-729.

Avisure. (2016). *RAAF Tindal – Draft Wildlife Hazard Management Plan*.

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Paton, D. C. (2010). Bird risk assessment model for airports and aerodromes: Revision 3. Adelaide, SA: Australian Aviation Wildlife Hazard Group.

Stirrat, S.C. (2000). The ecology and management of the agile wallaby, Macropus agilis, Doctor of Philosophy Thesis, Northern Territory University.

The Western Australian Museum (1966), List of Northern Territory Birds. Ride, W.D.I., and Neumann, A (eds), Perth, Western Australia.

Vardon, M.J., Brocklehurst, P.S., Woinarski, J.C.Z., Cunningham, R.B., Donnely, C.F., and Tidemann, C.R. (2001), Seasonal habitat use by flying-foxes, *Pteropus alecto* and *P. scapulatus* (Megachiroptera), in monsoonal Australia, *Journal of Zoology London,* 253, pp. 523 – 535.

Woinarski, J.C.Z., Williams, R.J., Price, O., and Rankmore, B. 2005, Landscapes without boundaries: wildlife and their environments in northern Australia, *Wildlife Research*, 32, pp. 377 – 388.

7.2 Databases

Avibase – the world bird database. Available at https://avibase.bsc-eoc.org

ATSB National Aviation Occurrence Database. Available at https://www.atsb.gov.au/avdata/naod/

7.3 Document Templates

Australian Aviation Wildlife Hazard Group. (2011). Wildlife hazard management plan template. Sydney, NSW: Australian Aviation Wildlife Hazard Group.

7.4 Fact Sheets

Australian Transport Safety Bureau. (2018). Airport Practice Note 6: Managing bird strike risk: Species information sheets. West Burleigh, QLD: Avisure.

7.5 Guidelines and Policies

Department of Defence. (2009). Management of biosecurity and overabundant native species risks on the Defence estate: National planning guidelines. Australian Government.

Department of Infrastructure and Regional Development. (2012). National Airports Safeguarding Framework: Guideline C – Managing the risk of wildlife strikes in the vicinity of airports. Australian Government.

7.6 Websites

BirdLife Australia. (n.d). BirdLife: Find a bird. Available at http://www.birdlife.org.au/

Bureau of Meteorology (2021) 'Average annual, seasonal and monthly rainfall.' Available at http://www.bom.gov.au/climate/averages/tables/cw_014932.shtml

The Cornell Lab of Ornithology. (n.d.) eBird. Available at https://ebird.org/home

Appendix A Species Management Plans

Passive management strategy should be ongoing and all maintenance work and infrastructure upgrades to take into account wildlife hazard to improve compliance gradually and continually with the MOS 139 standards. Active management is triggered when species is detected airside prior to or between air force movements.

Species management plans, including species profiles, passive and active management strategies, and site-specific recommendations, have been prepared for all species found to have an "Extreme" or "Very High" hazard ranking at RAAF Tindal. Species management plans are provided on the following pages for the below-listed species:

- agile wallaby,
- Australian bustard,
- galah,
- straw-necked ibis,
- masked lapwing,
- brolga,
- flying-fox (black & little red),
- magpie goose,
- wild dog,
- red-tailed black-cockatoo,
- whistling kite,
- pacific black duck, and
- little corella.

Recommendations for "High" risk species have been summarised in Table A-1.

Agile Wallaby

(Macropus agilis)

Hazard Ranking: Extreme (Dry), Extreme (Wet)

Average Weight: 12,000 g

Flocking Tendency: Travels and feeds in mobs of five to ten animals.

Preferred Habitat: Modified, open grasslands.

Breeding Season: Year-round.

Diet: Herbivorous. Grazes on shrubs and grasses; may also feed on some varieties of fruit and dig for shoots.

Image source: www.animalia.bio

Site Utilisation: Attracted to grasslands adjacent to airstrips for grazing, particularly if open woodlands nearby offer shade and shelter. Accessible water sources will encourage agile wallabies to remain in the area.

Activity Variation: Most active at dawn and dusk. Agile wallabies will rest and graze in the shade, if available, during the hottest part of the day. A reduction in food availability during the dry season will lead to this species foraging for longer in the evenings and travelling longer distances to forage. New green shoots emerging from recently burnt areas will attract wallabies.

Strike Risk & Consequence: Male agile wallabies can weigh up to 27 kg. Due to its large body size this species has the potential to cause significant aircraft damage if struck. The tendency of the species to gather and move in groups increases the risk of a multiple strike. The speed and direction of their movement is unpredictable, again increasing the risk of a strike if they are present near the airfield during operations.

Passive Management:

Exclude access to the airfield with fencing.

Ensure minimal pooling of water or waterlogged areas (by filling depressions and increasing slope of drainage sides to 4:1).

Exclude access to standing water sources near the airfield with fencing.

Active Management:

Wallabies may behave erratically following harassment. Harassment should be conducted well before airfield operations are due to commence.

Harassment is best carried out in a very controlled manner to prevent myopathy in target animals.

Slow approach from a vehicle with horn, siren and starter pistol is likely to be the most effective approach. On-foot harassment is not recommended.

Undertake population control (using either translocation or lethal control) where required.

Recommendations:

Maintain fencing to prevent wallaby access to the airfield.

Review airfield drainage and reduce waterbodies around the airfield.

Monitor wallabies and their movements, including regular formal population surveys to inform management decisions.

Implement the RAAF Tindal Wallaby Management Plan.

Be aware of the increased risk of this species at dusk if nocturnal flights are scheduled.

Australian Bustard

(Ardeotis australis)

Hazard Ranking: Extreme (Dry), Extreme (Wet)

Average Weight: 4,500 g

Flocking Tendency: Usually solitary or in groups of up to four individuals, but may congregate in larger numbers when prey availability is high.

Preferred Habitat: Dry plains, grasslands and open woodland.

Breeding Season: October to December.

Diet: Omnivorous: eats seeds and insects to small vertebrates, with a particular preference for grasshoppers.

Image source: www.ebird.org

Site Utilisation: Forages in areas with low or sparse vegetation, including grasslands surrounding airfields. It tends to avoid densely vegetated areas.

Activity Variation: Active during the day. This is a nomadic species, and its presence and activity will increase in response to prey availability. Numbers are likely to increase in periods of high rainfall and plagues of mice or locusts. Recently burnt areas may also attract bustards in large numbers due to increased insect prey, which is drawn to new growth.

Strike Risk & Consequence: Average weight for this species is 4.5 kg but males can weigh up to 14 kg. Due to its large body size this species has the potential to cause significant aircraft damage if struck. When larger groups congregate in response to food availability the risk of a multiple strike increases.

This species rarely flies but when it does its flight is strong and can place the bird in the path of an aircraft relatively quickly.

Passive Management:

Maintain grass heights between 200 and 300 mm and manage flowering weed species.

Mowing should be timed to ensure grass seed heads are regularly removed.

Manage prey species (e.g. grasshoppers, mice) to reduce airfield attractants.

Active Management:

Immediate harassment (e.g. before flocks congregate) will assist in mitigating imminent strike risks.

Harassment methods proven effective for this species include pyrotechnics (short- and long-range), stock whips, on-foot approach, portable distress callers, sirens, lights, starter pistols, and vehicular approach.

Recommendations:

Maintain mowed grass at 200 to 300 mm.

Initiate harassment activities prior to aircraft movements if bustards are present around the airfield.

Control pest species that act as attractants for bustards and other predators (e.g. mice).

Galah

(Eolophus roseicapillus)

Hazard Ranking: Extreme (Wet), Extreme (Dry)

Weight: 330 g

Flocking Tendency: Flocks and feeds in large groups. Likely to be observed in high numbers when present around the airfield. Flocks may be in excess of 1000 individuals.

Preferred Habitat: Timbered and grassed habitats, usually near water.

Breeding Season: February to July.

Diet: Ground seeds, such as grass seeds.

Image source: www.ebird.org

Site Utilisation: Attracted to seeded areas, often found in un-mowed grasslands and near shallow waterbodies. This leads to them feeding in large numbers close to airstrips.

Activity Variation: Most active in the morning and late afternoon. In hot weather they will spend much of the day amongst vegetation. Nomadic, and will relocate in search of food and water. Abundance of this species may increase at the end of the wet season, with increasing seed availability. This species may also be attracted to drains or pooling water for drinking. Recently burnt areas may also act as an attractant to this species through the increased availability of burnt and opened seeds.

Strike Risk & Consequence: This species' flocking behaviour and relatively large body size create the potential for multiple strikes and significant damage to aircraft.

Passive Management:

Maintain grass heights between 150 and 300 mm, and manage flowering weed species.

Time mowing to ensure grass seed heads are regularly removed.

Review drainage to ensure minimal pooling of water or waterlogged areas (by filling depressions and increasing slope of drainage sides to 4:1).

Active Management:

Immediate harassment (i.e. before flocks congregate) will assist in mitigating imminent strike risks.

Harassment methods proven effective for this species include pyrotechnics (short- and long-range), stock whips, on-foot approach, portable distress callers, sirens, lights, starter pistols, and vehicular approach.

Recommendations:

Maintain mowed grass at 150 to 300 mm, without seed heads.

Review airfield drainage and reduce waterbodies around the airfield.

Initiate harassment activities prior to aircraft movements if large numbers of galahs are present.

Straw-necked Ibis

(Threskiornis spinicollis)

Hazard Ranking: Extreme

Weight: 1560 g

Flocking Tendency: Flocks and feeds in large groups. Flocks maintain 'V' formation in flight. Will settle in flocks to forage. Flocks often perch conspicuously in dead trees.

Preferred Habitat: Grasslands, with a preference for cultivated and irrigated pastures, and terrestrial wetlands.

Breeding Season: August to January

Diet: Insects, molluscs, crustaceans, frogs, fish; consumes anthropogenic waste.

Image source: www.ebird.org

Site Utilisation: Commonly seen around anthropogenic sites and modified grasslands, including airfield habitats. Will utilise anthropogenic food sources such as rubbish bins, although not to the extent that Australian white ibis do.

Activity Variation: Active during the day. Particularly attracted to grasslands after mowing or rain, or where grass is sparse, as prey access and availability are greater at these times. This species is nomadic and the individuals in the local population will be constantly changing.

Strike Risk & Consequence: This species' flocking behaviour and relatively large body size create the potential for multiple strikes and significant damage to aircraft.

Passive Management:

- Maintain grass heights between 150 and 300 mm.
- Reduce mowing frequency or mow at night to reduce prey availability.
- Limit access to food by keeping bins closed and emptied regularly.
- Ensure minimal pooling of water or waterlogged areas (by filling depressions and increasing slope of drainage sides to 4:1).

Active Management:

- Harassment methods proven effective for this species include Pyrotechnics (short- and long-range), stock whips, on-foot approach, portable distress callers, sirens, lights, starter pistols, and vehicular approach.
- Discourage breeding behaviour and nesting via removal of eggs and nests.

Recommendations:

- Maintain mowed grass at 150 to 300 mm.
- Reduce mowing frequency or mow at night.
- Remove food sources on site (e.g. regular removal of rubbish and anthropogenic food sources).
- Review airfield drainage and reduce waterbodies around the airfield.
- Increase harassment effort following periods of high rainfall, when invertebrates and other prey are likely to be more accessible to ibis.

Masked Lapwing

(Vanellus miles)

Hazard Ranking: Extreme (Wet), Very High (Dry)

Average Weight: 360 g

Flocking Tendency: Usually found in pairs or small family groups.

Preferred Habitat: Inhabits marshes, mudflats, beaches and grasslands. Frequently found in suburban areas.

Breeding Season: July to November.

Diet: Primarily insectivorous.

Image source: www.ebird.org

Site Utilisation: Ground-dwelling species that forages in grasslands surrounding airfields. Will nest on the ground in modified grasslands.

Activity Variation: Most active in the mornings and late afternoons, but often also active at night. May be particularly territorial, especially during breeding times. Will rise and fly in circles or directly towards intruders, including humans.

Strike Risk & Consequence: Seven incidents involving masked lapwings have occurred within 25 km of YSWG in the ten years preceding this review.

This species' territorial behaviour and relatively large body size create the potential for frequent strikes, multiple strikes and damage to aircraft.

Passive Management:

Maintain grass heights between 150 and 300 mm to reduce lapwings' ability to detect predators and deter nesting.

Active Management:

Harassment methods proven effective for this species include pyrotechnics (short- and long-range), lights, stock whips and vehicles.

Discourage breeding behaviour and nesting via removal of eggs and nests as early as possible.

Likely to be difficult to disperse due to defensive behaviour and strong territoriality.

Recommendations:

Maintain mowed grass at 150 to 300 mm.

Monitor and actively manage local populations (trapping and relocation of stubborn individuals as necessary).

Monitor the grasslands surrounding the airfield for nests and remove nests and eggs.

Be aware of the increased risk of this species at dusk and night time if nocturnal flights are scheduled.

Brolga

(Grus rubicunda)

Hazard Ranking: Extreme (Wet), High (Dry)

Average Weight: 6,700 g

Flocking Tendency: Usually in pairs or small groups but outside the breeding season may form flocks of up to 100 birds.

Preferred Habitat: Open wetlands, grassy plains, coastal mudflats and irrigated croplands.

Breeding Season: February to May.

Diet: Omnivorous, primarily feeding on tubers with some insects, molluscs, amphibians and small mammals also taken.

Image source: www.ebird.org

Site Utilisation: Attracted to grasslands and waterways in the vicinity of RAAF Tindal.

Activity Variation: Active during the day. Particularly attracted to grasslands after rain. This species is relatively sedentary and rarely migrates far when sufficient resources are available.

Strike Risk & Consequence: This species' flocking behaviour and large body size create the potential for multiple strikes and significant damage to aircraft.

Passive Management:

Ensure minimal pooling of water or waterlogged areas (by filling depressions and increasing slope of drainage sides to 4:1).

Active Management:

Harassment methods likely to be effective for this species include pyrotechnics (short- and long-range), stock whips, on-foot approach, portable distress callers, sirens, lights, starter pistols, and vehicular approach.

Discourage breeding behaviour and nesting via removal of eggs and nests.

Recommendations:

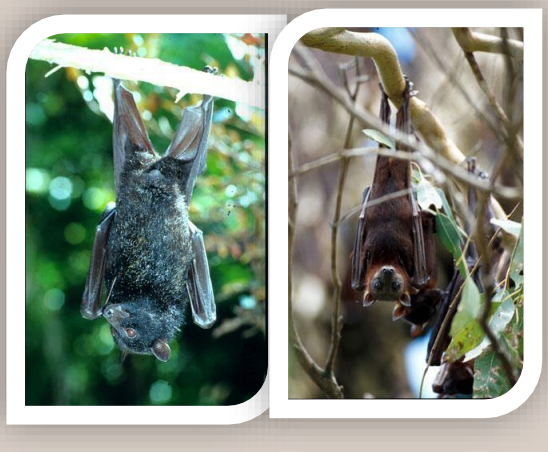
Review airfield drainage and reduce waterbodies around the airfield.

Increase harassment effort following periods of high rainfall.

`Black Flying-fox *(Pteropus alecto)*

Little Red Flying-fox (*Pteropus scapulatus*)

Hazard Ranking: Extreme (Wet), High (Dry)



Weight: 550 – 1500 g

Flocking Tendency: Tends to transit or forage in large groups at dawn and dusk.

Preferred Habitat: Forests and woodlands, remnant urban tree pockets.

Breeding Season: Varies with species and extends over several months from birth; black flying-foxes give birth in spring, little red flying-foxes give birth in autumn.

Diet: Tree blossoms, nectar, fleshy fruit.

Image source: www.des.qld.gov.au

Site Utilisation: Flying-foxes may establish camps in large trees near airfields. Transit routes can bring large groups of flying-foxes into proximity with airfields even when camps are some distance away, as they can travel 20 to 50 km each night to feed. Active flying-fox camps are present within 3 km of the RAAF Tindal airfield, and animals from these camps are likely to transit over YPTN airspace at dawn and dusk.

Activity Variation: Flying-foxes are active from dusk to dawn, departing the camp at dusk and feeding all night before returning to the camp before dawn. Local numbers will fluctuate annually and seasonally depending on food availability. Direction of flight is subject to seasonal changes in food availability.

Strike Risk & Consequence: These species' grouping behaviour and large body size create the potential for multiple strikes and significant damage to aircraft.

Passive Management:

Manage and reduce flowering tree species near the airfield.

Monitor transit paths and communicate potential hazards to aircraft operators.

Ongoing monitoring of known roost sites is recommended.

Active Management:

Harassment must be carefully timed and managed. If required, relocation of a large camp in close proximity of the airfield should be carefully planned by an external SME to maximise effectiveness and avoid negative animal welfare consequences.

Recommendations:

Targeted monitoring of flying-fox roosts in proximity to RAAF Tindal.

Limit aircraft movements at dusk and dawn when flying-fox are present, wherever possible.

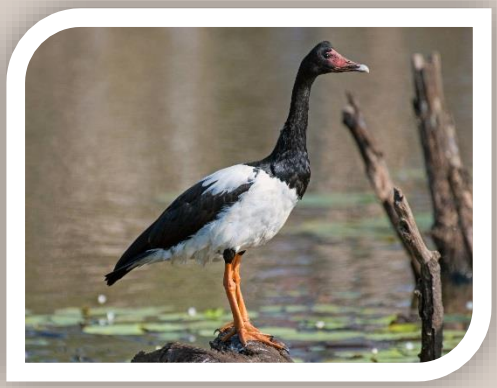
Implement the RAAF Tindal Flying-fox Management Plan.

Be aware of the increased risk of this species at dusk and night time if nocturnal flights are scheduled.

Magpie Goose

(Anseranas semipalmata)

Hazard Ranking: Extreme (Wet), High (Dry)



Average Weight: 2,800 g

Flocking Tendency: Usually in pairs or small groups but can form flocks numbering in the thousands.

Preferred Habitat: Freshwater swamps and wetlands, inundated grassland and dry grassland.

Breeding Season: February to April.

Diet: A specialised feeder on aquatic vegetation and tubers. *Oryza* spp. (wild rice), *Paspalum* spp., *Panicum* spp. and *Eleocharis* spp. (spike-rush) form the bulk of its diet.

Image source: www.ebird.org

Site Utilisation: Attracted to grasslands and waterways in the vicinity of RAAF Tindal where its preferred food species grow.

Activity Variation: Active during the day. Particularly attracted to grasslands after rain. This species is relatively sedentary and rarely migrates far when sufficient resources are available.

Strike Risk & Consequence: This species' flocking behaviour and relatively large body size create the potential for multiple strikes and significant damage to aircraft.

Passive Management:

Ensure minimal pooling of water or waterlogged areas (by filling depressions and increasing slope of drainage sides to 4:1).

Active Management:

Harassment methods likely to be effective for this species include pyrotechnics (short- and long-range), stock whips, on-foot approach, portable distress callers, sirens, lights, starter pistols, and vehicular approach.

Discourage breeding behaviour and nesting via removal of eggs and nests.

Recommendations:

Review airfield drainage and reduce waterbodies around the airfield.

Increase harassment effort following periods of high rainfall.

Wild dog

(Canis lupus familiaris or Canis lupus dingo)

Hazard Ranking: High

Average Weight: 12,000 – 17,400 g

Grouping Tendency: Often form social groups (packs) of three to 12 members, but may also hunt singly or in pairs. Females begin breeding in their second year and may breed up to twice per year with litter sizes of up to 11 cubs. Pack size may depend on local resource availability.

Preferred Habitat: Flexible habitat requirements limited more by food availability than by habitat restrictions.

Breeding Season: May breed year-round but generally April to June.

Diet: Opportunistic hunters and scavengers, feeding on reptiles, small birds and mammals and also feeding opportunistically on carrion.

Image source: www.animalia.bio

Site Utilisation: Wild dogs have flexible habitat requirements and seem to be attracted to areas with increased food availability, rather than preferred habitat. For this reason, wild dogs reach their highest densities in areas where food availability is high, including around human settlements, and areas where prey are abundant.

Activity Variation: Wild dogs tend to be more active during the breeding season (autumn months). Wild dogs are known to exhibit diurnal, crepuscular and nocturnal activity patterns.

Strike Risk and Consequence: This species' grouping behaviour and large body size create the potential for significant damage to aircraft.

Passive Management:

- Exclude access to the airfield with fencing.
- Reduce availability of food scraps during military training exercises through the provision of fully covered and secured waste bins.
- Reduce food availability through the immediate removal of carrion.

Active Management:

- Slow approach from a vehicle with horn, siren and starter pistol is likely to be the most effective approach. On-foot harassment is not recommended.
- Implementation of a continual vertebrate pest management control program.

Recommendations:

- Erect fencing to prevent wild dog access to the airfield and nearby water sources.
- Reduce availability of food scraps during military training exercises through the provision of fully covered and secured waste bins.

Red-tailed black cockatoo

(Calyptorhynchus banksii)

Hazard Ranking: High

Weight: 720 g

Flocking Tendency: Often forms large flocks, although may also occur in pairs and trios.

Preferred Habitat: Eucalyptus forests or woodlands and often in adjacent areas of woodlands or shrublands, especially if they have experienced fire recently.

Breeding Season: March to September.

Diet: Predominantly grass seeds and seeds extracted from the hard seed pods of eucalyptus, casuarina and banksia. Occasionally feed on insect larvae.

Image source: www.birdlife.org.au

Site Utilisation: Red-tailed black cockatoos are attracted to sites with high seed availability. Recently burnt areas are also strong attractants for this species as there is improved access to open seeds. Woodland areas surround the Samuel Hill Airfield provide a considerable food source for this species. Typically nest in tree hollows. May forage on the ground.

Activity Variation: Present throughout the woodlands of SWBTA. Red-tailed Black-Cockatoos are described as dispersive, meaning that they move away from where they were born to where they breed and that they may breed in separate locations. They also appear to move around in response to seasonal food availability. Flocks of this species are often seen flying high, returning from feeding areas to roosts in large trees along the banks of rivers or streams.

Strike Risk & Consequence: The grouping behaviour and large body size of this species creates the potential for multiple strikes and significant damage to aircraft

Passive Management:

- Recently burnt areas may attract large numbers of this species as they provide easy access to cracked and opened seeds. Schedule controlled burns well outside of planned military training exercises.
- Monitor movements at dawn and dusk (when this species is most often in transit) to determine high-risk timeframes.
- Maintain regularly mowed grass to 150 – 300mm to discourage ground foraging.

Active Management:

- If observed feeding near the airfield, harassment methods likely to be effective for this species include pyrotechnics (short- and long-range), stock whips, on-foot approach, portable distress callers, sirens, lights, starter pistols, and vehicular approach.

Recommendations:

- Maintain regularly mowed grass to 150 to 300 mm to discourage ground foraging.
- Monitor local populations seasonally
- Initiation of harassment activities prior to aircraft movements if large numbers of red-tailed black cockatoo are present.

Whistling Kite

(Haliastur sphenurus)

Hazard Ranking: Very High

Weight: 910g

Flocking Tendency: May form large flocks, particularly where food is abundant.

Preferred Habitat: Prefers open or partially wooded areas, and often observed near agricultural lands and landfill.

Breeding Season: May breed year-round but typically February to May.

Diet: Opportunistic scavengers and hunters, feeding on carrion, small birds, rodents, insects and frogs.

Image source: www.ebird.org

Site Utilisation: Grasslands surrounding airfields can provide a reliable source of easily detected prey. Hot air rising from paved surfaces enables thermalling.

Activity Variation: Active during the day. Attracted to sites with increased prey availability. Attracted to fires and may will follow lawnmowers to target prey species disturbed by mowing. Numbers may dramatically increase when food is abundant.

Strike Risk & Consequence: Raptors such as whistling kites carry the potential for strikes due to their presence and hunting behaviour around airfields. Their position as apex predators also makes them less likely to move away from approaching aircraft.

Passive Management:

- Manage prey species populations such as insects and rodents on and airfields.
- Maintain grass heights between 150 and 300 mm to reduce prey detection.
- Reduce mowing frequency or mow at night to reduce prey detection.

Active Management:

- As apex predators, raptors are less aware of or concerned about nearby threats than are prey species. This may make them difficult to disperse.
- Most effective would be use of long-range pyrotechnics coupled with persistent negative audio and visual cues (e.g; presence of vehicle coupled with pyrotechnics).
- Other methods include stock whips, on-foot approach and vehicular approach.

Recommendations:

- Maintain mowed grass at 150 to 300 mm.
- Mow grass at night where possible.

Pacific Black Duck

(Anas superciliosa)

Hazard Ranking: Very High (Wet), High (Dry)

Average Weight: 1120 g

Flocking Tendency: Usually seen in pairs or small flocks. Often seen with other species.

Preferred Habitat: Freshwater intertidal areas.

Breeding Season: No defined breeding season.

Diet: Mainly vegetarian, feeding on seeds of aquatic plants. This diet is supplemented with small crustaceans, molluscs and aquatic insects.

Image source: www.ebird.org

Site Utilisation: Most likely to be transiting overhead to and from feeding or roosting sites. Food is occasionally sought on land in damp grassy areas.

Activity Variation: Typically feed in the early morning and late in the day. Active during the day. Particularly attracted to grasslands after mowing or rain, or where grass is sparse, as prey access and availability are greater at these times. Usually seen in pairs or small flocks. Readily mixes with other ducks in the wild.

Strike Risk & Consequence: This species' flocking behaviour and relatively large body size create the potential for multiple strikes and significant damage to aircraft.

Passive Management:

Maintain grass heights between 150 and 300 mm to reduce lapwings' ability to detect predators and deter nesting.

Active Management:

Harassment methods proven effective for this species include pyrotechnics (short- and long-range), lights, stock whips and vehicles.

Discourage breeding behaviour and nesting via removal of eggs and nests as early as possible.

Likely to be difficult to disperse due to defensive behaviour and strong territoriality.

Recommendations:

Maintain mowed grass at 150 to 300 mm.

Monitor and actively manage local populations (trapping and relocation of stubborn individuals as necessary).

Monitor the grasslands surrounding the airfield for nests and remove nests and eggs.

Little Corella

(Cacatua sanguinea)

Hazard Ranking: Very High (Wet), High (Dry)

Weight: 500 g

Flocking Tendency: Flocks and feeds in large groups.

Preferred Habitat: Sites with seeding grasses, particularly along waterways. Thrive in agricultural and urban settings

Breeding Season: April to August.

Diet: Seeds, especially grass seeds.

Image source: www.ebird.org

Site Utilisation: Attracted to seeded areas, often found in un-mowed grasslands and near shallow waterbodies. This leads to them feeding in large numbers close to airstrips.

Activity Variation: Most active in the morning and late afternoon. In hot weather they will spend much of the day amongst vegetation. Nomadic, and will relocate in search of food and water. Abundance of this species may increase at the end of the wet season, with increasing seed availability. This species may also be attracted to drains or pooling water for drinking. Recently burnt areas may also act as an attractant to this species through the increased availability of burnt and opened seeds.

Strike Risk & Consequence: This species' flocking behaviour and relatively large body size create the potential for multiple strikes and significant damage to aircraft.

Passive Management:

Maintain grass heights between 150 and 300 mm and manage flowering weed species.

Time mowing to ensure grass seed heads are regularly removed.

Review drainage to ensure minimal pooling of water or waterlogged areas (by filling depressions and increasing slope of drainage sides to 4:1).

Active Management:

Immediate harassment (i.e. before flocks congregate) will assist in mitigating imminent strike risks.

Harassment methods proven effective for this species include pyrotechnics (short- and long-range), stock whips, on-foot approach, portable distress callers, sirens, lights, starter pistols, and vehicular approach.

Recommendations:

Maintain mowed grass at 150 to 300 mm, without seed heads.

Review airfield drainage and reduce waterbodies around the airfield.

Initiate harassment activities prior to aircraft movements if large numbers of corellas are present.

A-1 High risk species and management recommendations

Table A-2: High risk species information.

Species	Description	Habitat	Management Actions
Australian pratincole (*Stiltia isabella*) Image source: www.ebird.com 	Medium sized shorebird (60g) They feed on insect and spiders, hunting on ground or from in the air. They gather in flocks to migrate and can be seen in high numbers at RAAF Tindal. Can breed in any month after suitable rainfall and nests in small hollows in bare ground. **Risk Rating: High**	Found in a variety of habitats close to water including inland and wooden plains, grassland and stony ground areas with sparse vegetation including airfields.	**Passive Management:** Maintain grass height between 150 and 300mm. **Active Management:** Species not easily dispersed and habituate to human presence. On foot approach to move bird but likely not very far. Pyrotechnics would be effectively used in early morning prior to settling in for the day.
Black-breasted buzzard (*Hamirostra melanosternon*) Image source: www.ebird.com 	A large soaring raptor (1330g) They feed on small mammals, birds, lizards and carrion. They glide low and fast and snack prey from the air, on the ground or in trees Eggs laid August to October, breeding likely stimulated by plentiful food source and rain. **Risk Rating: High**	Found in a variety of habitats including semi arid to arid, open country, lightly timbered plains and tree lined waterways in inland Australia.	**Passive Management**: Manage prey species (rodents) which may lure raptors to the site. Remove all carrion on site and within adjacent areas. Monitor transit paths and communicate hazards to airlines and aircraft operators. Reduce raptor perching locations on site by removing dead trees, reducing unnecessary structures, and installing bird spikes. Maintain grass heights between 150 and 300 mm to limit prey detection. Mow grass at night to conceal movement of disturbed prey species. **Active Management:** Harass with pyrotechnics (short- and long-range), lights, stock whips, on-foot and vehicular approach.

Black kite (*Milvus migrans*) Image source: www.ebird.org 	Medium-sized (to 750 g) bird of prey. An opportunistic hunter that is more likely to scavenge than some other raptors. Often observed soaring and gliding in thermals (as created above runways) in search of food. May form large flocks, especially during grasshopper plagues. Breeds from March to August. **Risk Rating: High**	Found in a variety of habitats from timbered watercourses to open plains. Common in urban areas. Will utilise and congregate at anthropogenic food sources such as landfills.	**Passive Management:** Manage prey species (rodents) which may lure raptors to the site. Remove all carrion on site and within adjacent areas. Monitor transit paths and communicate hazards to airlines and aircraft operators. Reduce raptor perching locations on site by removing dead trees, reducing unnecessary structures, and installing bird spikes. Maintain grass heights between 150 and 300 mm to limit prey detection. Mow grass at night to conceal movement of disturbed prey species. **Active Management:** Harass with pyrotechnics (short- and long-range), lights, stock whips, on-foot and vehicular approach.
Bush stone-curlew (*Burhinus grallarius*) Image source: www.ebird.org 	Is a tall medium bodied shorebird (670g) Mainly nocturnal ground dwelling bird. Feeds on insects, molluscs, small lizards and small mammals and seeds. Breeding occurs in the second half of the year from August–January. **Risk Rating: High**	Open grassland areas and commonly found in parks at night when reduced human activity.	**Passive Management:** Maintain grass heights at 150-300mm and manage prey insect populations on or near the airfield. **Active Management:** easily dispersed on foot or with lights and vehicle.

Magpie-lark (*Grallina cyanoleuca*) Image source: www.ebird.org 	Small (95 g) predominantly ground-dwelling bird. Feeds on insects, larvae, earthworms, freshwater invertebrates, and seeds. Migrates seasonally, moving north in winter and south in summer. Breeding pairs maintain a territory but immatures and non-breeders form roving flocks. Construct nests out of mud on the branches of trees. Breeds from August to December. **Risk Rating: High**	Found in almost all habitats other than rainforests and deserts. Familiar in urban settings.	**Passive Management:** Maintain grass heights between 150 and 300 mm to limit prey detection. Manage prey insect populations on and near airfields. Remove accessible water sources on and near the airfield, including fixing dripping taps and managing pooling water, to reduce mud available for nesting. **Active Management:** Harass with on-foot approach, vehicular approach, siren, horn, pool noodles, lights, starter pistols, and stock whips.
Nankeen kestrel (*Falco cenchroides*) Image source: www.ebird.org 	Small raptor (bird of prey) (170g). Commonly seen in airport habitats. Preys on insects, small reptiles, mammals, and birds. Hunts by observing from perched areas in preparation. Mated pairs are semi monogamous and raise one brood per year. This species is highly adapted to airport environments and may occur in high densities. **Risk Rating: High**	Prefers lightly wooded areas and open agricultural regions.	**Passive Management:** Removal of unused ancillary infrastructure to prevent perching. Provision of deterrents on preferring perching sites. **Active Management:** Persistent negative audio and visual cues. Persistent on foot and/or vehicular approach may also suffice.

Red-collard lorikeet (*Trichoglossus rubritorquis*) Image source: www.ebird.org 	Small to medium-sized bird (125 g). Usually seen in loud and fast-moving flocks or in communal roosts at dusk. Easily identified by their bright plumage. Red-collard lorikeet is a sub species of the rainbow lorikeet, also similar to the scaly-breasted lorikeet, which is entirely green and yellow. **Risk Rating: High**	Found in a wide range of habitats, including rainforest, woodland and urban areas with trees and vegetation. Typically forage on the flowers of shrubs or trees, but sometimes small insects.	**Passive Management**: Selection of airfield landscape species to avoid flowering species. **Active Management**: use of a negative auditory stimulus at known feeding and roosting sites in the vicinity of the airfield. Most likely to be seen transiting overhead.
Sulfur-crested cockatoo (*Cacatua galerita*) Image source: www.ebird.org 	Large parrot (780g) usually in large flocks foraging on the ground and perched in trees. All white with a bright yellow crest. Similar looking to the little corella but much larger and has retractile crest. **Risk Rating: High**	Variety of woodland habitats watercourses, parks, and human developed areas. Nesting is preferred in hollows of eucalyptus trees.	**Passive Management:** ensuring reduced roosting trees in the close vicinity of the aerodromes. **Passive Management:** use of a negative auditory stimulus at known feeding and roosting sites in the vicinity of the airfield. Most likely to be seen transiting overhead.

Torresian crow (*Corvus orru*) Image source: www.birdlife.org.au 	Can form flocks of up to 20 unpaired individuals that share common roost sites. Feeds on grain, fruit, insects and other invertebrates, eggs, anthropogenic food sources and carrion. **Risk Rating: High**	Open forests and woodlands, taller scrublands and dry areas. Also found around farms, in croplands and urban areas. Found in transitional zones (e.g. ecotones). Requires tall trees for nesting.	**Passive Management:** Reduce breeding habitat on site (monitor airside trees for nests, nest removal). Careful waste management will reduce foraging opportunities for this species, as will the immediate removal of carrion from site. Installation of anti-perching spikes may also be considered as management options **Active Management:** Use long-range pyrotechnics coupled with persistent negative audio and visual cues. On foot and/or vehicular approach may also suffice.
Wedge-tailed eagle (*Aquila audax*) Image source: www.nationalparks.nsw.gov.au 	Largest bird of prey (raptor) in Australia (2800 – 3500g). Tends to fly solitarily or in pairs. Breeds year-round. Feeds on live prey such as wallabies, kangaroos, rabbits, hare, birds, lizards, and mammals but also consumes carrion. **Risk Rating: High**	Found from sea level to alpine regions, but prefers woodland and forested land and open country, generally avoiding rainforest and coastal heaths. Wedge-tailed Eagles build their nest in a prominent location with a good view of the surrounding countryside. It may be built in either a living or dead tree, but usually the tallest one in the territory.	**Passive Management:** Manage prey species such as small mammals and birds, which may lure eagles to the airfield. Remove all carrion attractants from near the airfield to a distant location. Monitor transit paths (time of day/year, height of transit) and communicate hazards to aircraft operators. **Active Management:** Use long-range pyrotechnics coupled with persistent negative audio and visual cues. On foot and/or vehicular approach may also suffice.

Northern brown bandicoot (*Isoodon macrourus*) Image source: www.australianwildlife.org 	Ground dwelling marsupial (3.1kg), diet consist of insects, small vertebrates, plant matter and fungi. Breeding occurs all year round. **Risk Rating: High**	Habitats include grassland, heath and eucalyptus forest. Nest in small burrows in the ground.	**Passive Management:** have mesh or concrete under fence to ensure bandicoot cannot fit under fence. **Active Management:** trapping and relocating off the airfield. Inspecting runways at night prior to aircraft movements to ensure clear, disperse with on foot or vehicular approach and lights.
Pacific swift (*Apus pacificus*) Image source: www.ebird.org 	Small agile bird (43g) flying in flocks and feel aerially in smally insects. Similar looking to swallows, however, duller in colour. **Risk Rating: High**	Nests in sheltered locations including rock crevices and roofs of houses.	**Passive Management:** net areas on hanger and infrastructure where potential nesting sites. Management insect populations on airport. **Active Management:** not easily dispersed, pyrotechnics sometimes work for a short period.

White-faced heron (*Egretta novaehollandiae*) Image source: www.australianbushbirds.info 	Often seen flocking with several different egret species. Colonial breeder that nests and breeds in large groups, but also often observed in solitary pairs. Typically breed between October – December, but may breed outside of this time depending on rainfall. Feeds on fish, molluscs, amphibians, aquatic insects, small reptiles, crustaceans. **Risk Rating: High**	Shallow water, particularly when flowing, including damp grasslands.	**Passive Management:** Reduce wading habitat and pooling water on site (increase slope of drainage sides to 4:1, install netting). Remove suitable nesting locations airside if they should be identified. Continually monitor neighbouring roost sites near the airfield. **Active Management:** Remove eggs from nesting sites near the airfield. On-foot and vehicular approach may disperse this species.

Appendix B Compliance Assessment

The following review checklists summarise the requirements for competency in each area of wildlife management at RAAF Tindal and identify whether compliance has been achieved. The introduction of F35s into the RAAF over the next year comes with the condition (2 – M22) that all airfields interacting with this aircraft require a WMO onsite to monitor and document bird and bat movements and to perform wildlife dispersal techniques where necessary.

CASA MOS 139 Part 17 Compliance

Legislative Requirement or Competency	Related Tasks or Procedures	Responsibility	Timeframe	Compliance	Comments
CASA MOS Part 17.01 - Detection, monitoring and observation					
(1) The aerodrome operator must monitor and record at least the following: a) The presence and behaviour of wildlife on the aerodrome; b) Wildlife activity that is visible i. in the vicinity of the aerodrome; or ii. from the aerodrome; Note: For aerodromes with considerable wildlife hazards, a dedicated wildlife inspection, including wildlife counts, is recommended.	On-airfield Wildlife Monitoring Procedure	WMO	As required – ongoing.	☐ N/A ☐ Non-compliant ■ Compliant	Ventia has contracted Biodiversity to provide a WMO service for the RAAF Tindal airfield, collecting data including species, behaviour, attractants, and location.
(2) The aerodrome operator, in consultation with the local planning authority, must attempt to monitor sites within 13 km of the aerodrome reference point that attract wildlife.	Off-airfield Wildlife Monitoring Procedure	WMO SME	Quarterly.	☐ N/A ☐ Non-compliant ■ Compliant	Off-airport sites (Table 9) within 13km of the aerodrome are monitored monthly by duty WMO.
(3) The aerodrome operator must attempt to monitor any reported wildlife aircraft strike events at, or in the vicinity of, the aerodrome.	Wildlife Strike Reporting Procedure	WMO	After strikes or near misses occur.	☐ N/A ☐ Non-compliant ■ Compliant	WMO records all reported wildlife strikes while on duty. Other wildlife strike records are maintained by the ATC.
		17 SQN	After strikes or near misses occur.		

Legislative Requirement or Competency	Related Tasks or Procedures	Responsibility	Timeframe	Compliance	Comments
CASA MOS Part 17.02 - Wildlife hazard assessment and trigger criteria					
(1) Any detected wildlife hazard must be assessed for its potential risk to aircraft operations.	-	BM SADFO	Biennially	☐ N/A ■ Non-compliant ☐ Compliant	Wildlife hazards have been assessed and ranked in the order of risk (based on surveys, harassment data and strike history). Recommendations have been made for a more robust risk assessment to align with aerodrome requirements.
(2) If the aerodrome operator has a safety management system, or a risk management plan, mentioned in Chapter 25 or 26 respectively, the assessment must be conducted in accordance with the system or the plan.	-	BM SADFO	-	☐ N/A ■ Non-compliant ☐ Compliant	It is recommended that an audit of the plan's compliance with other safety management systems be undertaken. Efforts should be made to streamline compliance during future WHMP reviews.
(3) When conducting a wildlife hazard assessment, available data from the following must be considered: a) wildlife observations; b) reported aircraft strike events;	Wildlife Strike Reporting Procedure On-airfield Wildlife Monitoring Procedure	BM	Annually (during internal review)	☐ N/A ☐ Non-compliant ■ Compliant	The wildlife hazard assessment contained herein incorporated data from wildlife observations,

Legislative Requirement or Competency	Related Tasks or Procedures	Responsibility	Timeframe	Compliance	Comments
c) reported aircraft near miss events. Note: If multiple wildlife hazards are identified, CASA recommends that wildlife species be ranked in their order of risk.	Wildlife Dispersal and Harassment Procedure	SME	Biennially (during external WHMP review)		harassments, surveys, wildlife strike and near miss events.
CASA MOS Part 17.03 - Wildlife hazard management plan triggers					
(1) For an aerodrome that, in the course of a financial year, has: a) 50,000 or more air transport passenger movements; or b) 100,000 or more aircraft movements; the aerodrome operator must prepare and implement a wildlife hazard management plan.	-	-	-	■ N/A □ Non-compliant □ Compliant	RAAF Tindal has fewer than 50,000 aircraft movements per annum.
(2) The plan must be prepared and implemented not later than 6 months after: a) for paragraph (1) (a) — the date of publication, by the Department, of the air transport passenger movement numbers indicating that, for the first time under this MOS, there have been 50 000 or more air transport passenger movements for the aerodrome for the financial year; or b) for paragraph (1) (b) — the date the aerodrome operator becomes aware of information indicating that, for the first time under this MOS, there have been 100 000 or more aircraft movements at the aerodrome in the course of the financial year.	-	-	-	■ N/A □ Non-compliant □ Compliant	RAAF Tindal has fewer than 50,000 aircraft movements per annum.
(3) If paragraph (2) (a) or (2) (b): a) applied to an aerodrome operator; and b) subsequently ceased to apply to the operator; and c) subsequently would have applied to the operator again if such application were deemed to be for the first time under this MOS;	-	-	-	■ N/A □ Non-compliant □ Compliant	Paragraph (2) (a) or (2) (b) does not apply as RAAF Tindal has fewer than 50,000 aircraft movements per annum.

Legislative Requirement or Competency	Related Tasks or Procedures	Responsibility	Timeframe	Compliance	Comments
then the paragraph applies to the operator as if it were for the first time under this MOS.					
(4) Subsection (1) does not apply if: a) for aerodromes without scheduled international operations — wildlife hazard assessment demonstrates, using statistical and other data, that the wildlife hazard risk is low; and b) CASA, in writing, approves the assessment subject to conditions (if any). Note: For an aerodrome to which subsection (1) does not apply, but which has a high wildlife hazard management risk, CASA recommends the development of a wildlife hazard management plan.	This plan	EMOS	Ongoing	☐ N/A ☐ Non-compliant ■ Compliant	Subsection 1 does not apply, although this WHMP is in place as RAAF Tindal has a high wildlife hazard management risk.
(5) CASA may direct an aerodrome operator in writing to prepare and implement a wildlife hazard management plan if CASA considers that this is necessary in the interests of aviation safety. Note: For CASA directions see regulation 11.245 of CASR. If required in the interests of aviation safety, CASA may revoke an approval given under paragraph (4) (b) and issue a direction under this subsection.	-	-	-	■ N/A ☐ Non-compliant ☐ Compliant	Does not apply.
(6) A wildlife hazard management plan must be included in, or referenced in, the aerodrome manual.	Aerodrome Manual	ACO	As required	☐ N/A ☐ Non-compliant ■ Compliant	Aerodrome manual will require updating to include reference of the most recent document (this WHMP).
CASA MOS Part 17.04 - Preparation of a wildlife hazard management plan					
(1) A wildlife hazard management plan must be prepared in consultation with a suitably qualified or experienced person, for example: a) an ornithologist, zoologist, biologist, ecologist; or	This plan	EMOS SME	As required	☐ N/A ☐ Non-compliant ■ Compliant	This plan.

Legislative Requirement or Competency	Related Tasks or Procedures	Responsibility	Timeframe	Compliance	Comments
b) a person with demonstrated expertise in the management of wildlife hazards to aviation.					
(2) The wildlife hazard management plan must at least: a) identify the key aerodrome or contracted personnel and define their responsibilities or functions in the plan; and b) identify sources and locations of wildlife attraction: i. on the aerodrome; and ii. in the vicinity of the aerodrome; iii. which are likely to cause wildlife to transit the take-off, approach and transitional surfaces; and c) set out the procedures for the following in relation to wildlife hazards: i. detection; ii. monitoring; iii. risk assessment and analysis; iv. reporting to pilots through the AIP, NOTAM and ATC (if applicable); v. mitigation, including passive and active strategies; and d) specify the liaison arrangements for local planning authorities within a radius of at least 13 km from the aerodrome reference point; e) set out the aerodrome operator's strategy for wildlife hazard reduction; and f) include records of the qualifications and experience of key personnel identified in the plan.	This plan	EMOS SME	Not applicable	☐ N/A ■ Non-compliant ☐ Compliant	Roles and responsibilities are identified in this table and summarised in Appendix C. Sources and locations of wildlife attraction on and in the vicinity of the aerodrome are defined in Section 3 of this plan. Procedures for detection, monitoring, reporting to pilots, passive and active mitigation strategies and provided in Appendix E. Paton risk assessment methods are included in appendix G Recommendations have been made for a more robust risk assessment to align with aerodrome requirements Sites within 13km radius surrounding RAAF Tindal are monitored monthly.

Legislative Requirement or Competency	Related Tasks or Procedures	Responsibility	Timeframe	Compliance	Comments
					Records of the qualifications for experience of key personnel identified in the plan should be provided in subsequent reviews of this plan. Criteria for the WMO are provided herein.
(3) The aerodrome operator must: a) implement the wildlife hazard management plan; and b) keep the plan under continuous review.	This plan	BM EMOS WMO SME	Ongoing	☐ N/A ☐ Non-compliant ■ Compliant	Ventia has contracted Biodiversity to review and implement the WHMP.
(4) For subsection (3), a review of the wildlife hazard management plan must be conducted in each of the following circumstances: a) if an aircraft experiences multiple wildlife strikes; b) if an aircraft experiences substantial damage following any wildlife strike; c) if an aircraft experiences an engine ingestion of wildlife; d) if the ongoing presence of wildlife is observed on the aerodrome in size or in numbers reasonably capable of causing an event mentioned in paragraph (a), (b) or (c); e) at least every 12 months, but if during a period of 12 months the plan was reviewed under paragraph (a), (b), (c) or (d), at least every 12 months after that review.	This plan	EMOS SME	As required	☐ N/A ☐ Non-compliant ■ Compliant	This review has been prepared as part of the RAAF Tindal WHMP review process. This plan outlines the specifications for WHMP review.
CASA MOS Part 17.05 - Wildlife Hazard Reporting					

Legislative Requirement or Competency	Related Tasks or Procedures	Responsibility	Timeframe	Compliance	Comments
(1) If the presence of wildlife is assessed as constituting an ongoing hazard to aircraft, the aerodrome operator must advise the AIS provider in writing to include an appropriate warning notice in the AIP-ERSA in accordance with Chapter 5 of this MOS. Note: Reports to the Australian Transport Safety Bureau following a wildlife strike event are also required in accordance with the Transport Safety Investigation Regulations 2003.	Wildlife Dispersal and Harassment Procedure	BASO EMOS WMO	As required	☐ N/A ☐ Non-compliant ■ Compliant	At this time of review a warning notice of an animal & bird hazard is present in the En Route Supplement Australia (ERSA).
(2) Without affecting subsection (1), if a wildlife hazard is assessed as being: a) at a higher risk than usual; and b) of a short-term or seasonal nature; i. then the aerodrome operator must ensure that a timely NOTAM warning of the hazard is given to pilots using the aerodrome. Note: See CASA Advisory Circular (AC) 139.C-16: Wildlife Hazard Management at aerodromes, as existing from time to time and freely available on the CASA website, for details on what information CASA recommends should be included in the NOTAM.	Wildlife Dispersal and Harassment Procedure	ATC ABCP WMO BASO/BAEO	As required	☐ N/A ☐ Non-compliant ■ Compliant	The duty WMO has ABCP's phone number to notify of high-risk or short-term bird hazards. NOTAMs are issued as required.
(3) Without affecting subsection (1) or (2), if a wildlife hazard is assessed as being a serious and imminent threat to aviation safety at an aerodrome, the aerodrome operator must ensure that pilots using the aerodrome are directly advised on CTAF or UNICOM.	Wildlife Dispersal and Harassment Procedure Runway and Flight Strip Inspection Procedure	ATC BM EMOS WMO	As required	☐ N/A ☐ Non-compliant ■ Compliant	While the WMO is on duty he or she can notify pilots of hazards on CTAF. WMO notifies ATC when active.
CASA MOS Part 17.06 - Wildlife Hazard Mitigation					

Legislative Requirement or Competency	Related Tasks or Procedures	Responsibility	Timeframe	Compliance	Comments
The aerodrome operator must implement controls to mitigate wildlife hazard risks within the boundary of the aerodrome. Note 1: For the management of hazards outside of the aerodrome boundary, see subsection 17.01 (2) and paragraph 17.04 (2) (d). Note 2: For the management of hazards from land-based wildlife CASA recommends continuous fencing around the aerodrome boundary, or otherwise containing the movement area.	This plan Fence Inspection Procedure	BM EMOS SME	Ongoing	☐ N/A ☐ Non-compliant ■ Compliant	Wildlife hazard mitigation measures are undertaken by the WMO.
CASA MOS Part 17.07 - Training					
(1) Wildlife hazard monitoring and reporting personnel must be trained to competently do the following: a) conduct wildlife observations and identify high-risk species; b) assess wildlife populations and describe their behaviour; c) record information; d) collect any remains of a wildlife strike on the aerodrome; e) attempt to facilitate the identification of: i. any wildlife involved in a strike event; and ii. any resulting damage to an aircraft; f) report the outcomes of observation, monitoring and strike collection activities. Note: To perform their roles properly, CASA recommends that monitoring personnel have access to wildlife identification materials and equipment such as a field guides, identification books, scopes or binoculars, active management tools, carcass handling tools, identification kits and relevant PPE.	Compliance with comprehensive specific criteria for Wildlife Management Officer	EMOS WMO All operational staff	Ongoing	☐ N/A ☐ Non-compliant ■ Compliant	All Operational staff are encouraged to report wildlife strikes to the WMO. Place remains in carcass freezer located at fire station. The duty WMO, with the support of Biodiversity Australia management team, is dedicated to airfield wildlife hazard mitigation at RAAF Tindal. The WMO is responsible for assessing and monitoring wildlife populations at RAAF Tindal, and the Biodiversity Australia management team is responsible for providing regular reports summarising data relating to wildlife activity and behaviour.

Legislative Requirement or Competency	Related Tasks or Procedures	Responsibility	Timeframe	Compliance	Comments
(2) Personnel engaged in wildlife hazard mitigation must be trained to competently: a) engage in active wildlife management without causing a hazard to aviation safety; and b) assess the effectiveness of any mitigation measures that are taken.	Compliance with comprehensive specific criteria for Wildlife Management Officer	EMOS WMO	Ongoing	☐ N/A ☐ Non-compliant ■ Compliant	The duty WMO, with the support of Biodiversity Australia management team, is dedicated to airfield wildlife hazard mitigation at RAAF Tindal.
(3) The aerodrome operator must create training records for its monitoring and reporting personnel to show compliance with subsections (1) and (2). Each record must be kept in safe custody for a period of at least 3 years after the record was created.	-	EMOS SME	Ongoing	☐ N/A ☐ Non-compliant ■ Compliant	Currently Biodiversity Australia contracted WMO's are specifically trained to comply with subsections (1) & (2).
Additional Compliance Elements					
All permits for bird and animal management activities held and kept valid (includes permits for bird nest removal or destruction animal breeding place (e.g. Egg destruction and habitat removal).	-	EMOS SME WMO	Renew as per permit requirements	☐ N/A ■ Non-compliant ☐ Compliant	Current permits for RAAF required to be signed off.
Agenda of safety meetings to cover wildlife issues and management actions.	-	BM EMOS WMO	Biennial	■ N/A ☐ Non-compliant ☐ Compliant	Biodiversity Australia is included in safety meetings to ensure wildlife issues and management actions are covered in meetings.
Perimeter fence inspections.	-	WMO	Ongoing	☐ N/A ☐ Non-compliant ■ Compliant	Duty WMO conducts fence inspections daily as operations allow.
Vegetation management - identification and modification where possible of vegetation that attracts significant birds/wildlife as specified in plan.	-	EMOS WMO	Ongoing	☐ N/A ■ Non-compliant ☐ Compliant	Current vegetation on base requires management. Duty WMO identifies areas requiring vegetation management.

Legislative Requirement or Competency	Related Tasks or Procedures	Responsibility	Timeframe	Compliance	Comments
Ponded water and drainage - areas of ponded water to be filled as required to reduce bird hazard as specified in plan.	-	EMOS WMO	Ongoing	☐ N/A ■ Non-compliant ☐ Compliant	Current drainage requires management. Duty WMO identifies areas of ponded water.
Waste management - ensure waste on aerodrome land is disposed of effectively to reduce bird attraction.	-	WMO and/or EMOS	Ongoing	☐ N/A ☐ Non-compliant ■ Compliant	Compliant, although carcass pit requires management to minimise wildlife attraction.

Compliance with International Bird Strike Committee (IBSC) – Best Practice Standards

IBSC Standard (2006)	Compliance	Comments
Standard 1 A named member of the senior management team at the airport should be responsible for the implementation of the bird control programme, including both habitat management and active bird control.	☐ N/A ☐ Non-compliant ■ Compliant	Biodiversity has been contracted by Venita to implement the airfield wildlife control program. Passive management strategies are organised through Ventia.
Standard 2 An airport should undertake a review of the features on its property that attract hazardous birds/wildlife. The precise nature of the resource that they are attracted to should be identified and a management plan developed to eliminate or reduce the quantity of that resource, or to deny birds access to it as far as is practicable. Where necessary, support from a professional bird/wildlife strike prevention specialist should be sought. Documentary evidence of this process, its implementation and outcomes should be kept.	☐ N/A ☐ Non-compliant ■ Compliant	This WHMP consists of a review of features on and surrounding the airfield that may attract hazardous birds and/or wildlife.
Standard 3 A properly trained and equipped bird/wildlife controller should be present on the airfield for at least 15 minutes prior to any aircraft departure or arrival. Thus, if aircraft are landing or taking of at intervals of less than 15 minutes there should be a continuous presence on the airfield throughout daylight hours. The controller should not be required to undertake any duties other than bird control during this time. Note that for aerodromes with infrequent aircraft movements, 15 minutes may not be long enough to disperse all hazardous birds/wildlife from the vicinity of the runway. In this case the controller should be deployed sufficiently in advance of the aircraft movement to allow full dispersal to be achieved. At night, active runways and taxiways should be checked for the presence of birds/wildlife at regular intervals and the dispersal action taken as needed.	☐ N/A ☐ Non-compliant ■ Compliant	The duty WMO undertakes wildlife dispersal before aircraft departures and arrivals. Active management occurs throughout the day, and at night when required.
Standard 4 Bird control staff should be equipped with bird deterrent devices appropriate to the bird species encountered, the numbers of birds present, and to the area that they need to control. Staff should have access to appropriate devices for removal of birds/wildlife, such as firearms or traps, or the means of calling on expert support to supply these techniques at short notice. All staff should receive proper training in the use of bird control devices.	☐ N/A ☐ Non-compliant ■ Compliant	WMOs have appropriate equipment.
Standard 5 Airport bird/wildlife controllers should record the following at least every 30 minutes (if air traffic is sufficiently infrequent that bird patrols are more than 30 minutes apart, an entry should be made for each patrol carried out).	☐ N/A ☐ Non-compliant ■ Compliant	Duty WMO records each harassment and monitoring event.

IBSC Standard (2006)	Compliance	Comments
areas of the airport patrolled, numbers, location and species of birds/wildlife seen, action taken to disperse the birds/wildlife, results of the action. More general information such as the name of the bird controller on duty, time on and off duty, weather conditions etc should be recorded at the start of a duty period.		
Standard 6 Bird/wildlife incidents should be defined in three categories: Confirmed strikes - Any reported collision between a bird or other wildlife and an aircraft for which evidence in the form of a carcass, remains or damage to the aircraft is found. Any bird/wildlife found dead on an airfield where there is no other obvious cause of death (e.g. struck by a car, flew into a window etc.). Unconfirmed strikes - Any reported collision between a bird or other wildlife and an aircraft for which no physical evidence is found. Serious incidents - Incidents where the presence of birds/wildlife on or around the airfield has any effect on a flight whether or not evidence of a strike can be found.	☐ N/A ☐ Non-compliant ■ Compliant	Duty WMO records strikes in the specified categories.
Standard 7 Airports should establish a mechanism to ensure that they are informed of all bird/wildlife strikes reported on or near their property. The total number of bird strikes should never be used as a measure of risk or of the performance of the bird control measures at an airport. Airports should ensure that the identification of the species involved in bird strikes is as complete as possible. Airports should record all bird strikes and include, as far as they are able, the data required for the standard ICAO reporting form. National Regulators should collate bird strike data and submit this to ICAO annually.	☐ N/A ☐ Non-compliant ■ Compliant	All strikes that occur are reported to ATC and followed up by either the duty WMO or 17 SQN who record the strike.
Standard 8 Airports should conduct a formal risk assessment of their bird strike situation and use the results to help target their bird management measures and to monitor their effectiveness. Risk assessments should be updated at regular intervals, preferably annually.	☐ N/A ☐ Non-compliant ■ Compliant	This WHMP includes a formal risk assessment used to help target bird management measures carried out by the duty WMO. Risk assessments are reviewed regularly.
Standard 9 Airports should conduct an inventory of bird attracting sites within the ICAO defined 13km bird circle, paying particular attention to sites close to the airfield and the approach and departure corridors. A basic risk assessment should be carried out to determine whether the movement patterns of birds/wildlife attracted to	☐ N/A ☐ Non-compliant ■ Compliant	This WHMP has identified features surrounding the airfield that may attract hazardous birds and/or wildlife. The WMO conducts monthly off-airport

IBSC Standard (2006)	Compliance	Comments
these sites means that they cause, or may cause, a risk to air traffic. If this is the case, options for bird management at the site(s) concerned should be developed and a more detailed risk assessment performed to determine if it is possible and/or cost effective to implement management processes at the site(s) concerned. This process should be repeated annually to identify new sites or changes in the risk levels produced by existing sites. Where national laws permit, airports, or airport authorities, should seek to have an input into planning decisions and land use practices within the 13km bird circle for any development that may attract significant numbers of hazardous birds/wildlife. Such developments should be subjected to a similar risk assessment process as described above and changes sought, or the proposal opposed, if a significant increase in bird strike risk is likely to result.		surveys and records changes in risk levels produced by existing sites and identifies new sites.

Compliance with NWHMS Strategy Wildlife Hazard Management Plan Criteria

Legislative Requirement or Competency	Relevant Section	Compliance	Comments
Review of wildlife strike data and trends.	Section 4	☐ N/A ☐ Non-compliant ■ Compliant	Included in the WHMP.
Compile procedures and control methodologies for reducing wildlife strike incidences.	Appendix E	☐ N/A ☐ Non-compliant ■ Compliant	Included in this WHMP.
Define roles and responsibilities.	Appendix C	☐ N/A ☐ Non-compliant ■ Compliant	Included in this WHMP.
Assess the risk using industry-endorsed, semi quantitative methodologies.	Section 4	☐ N/A ☐ Non-compliant ■ Compliant	Included in this WHMP.
Identify key legislative requirements relevant to the WHMP.	Section 1	☐ N/A ☐ Non-compliant ■ Compliant	Included in this WHMP.
Identify risk management gaps (e.g. training, equipment, resourcing).	Section 6	☐ N/A ☐ Non-compliant ■ Compliant	Included in this WHMP.
Document specific action plans for high and moderate risk species.	Appendix A	☐ N/A ☐ Non-compliant ■ Compliant	Included in this WHMP.
Recommend and define ongoing sound monitoring protocol with key performance indicators (objectives and targets) to evaluate program effectiveness.	Appendix A	☐ N/A ☐ Non-compliant ■ Compliant	Included in this WHMP.

Legislative Requirement or Competency	Relevant Section	Compliance	Comments
Include a list of wildlife species and their contributing factors (flight paths, feeding, breeding, seasonal fluctuations) that are considered hazardous.	Section 4	☐ N/A ☐ Non-compliant ■ Compliant	Included in this WHMP.
Map key habitat and hazards.	Section 3	☐ N/A ☐ Non-compliant ■ Compliant	Included in this WHMP.
Audit compliance results of wildlife management practices against international (International Bird Strike Committee – Best Practice Standards) and national (CASA MOS 139 – Section 10).	Appendix B	☐ N/A ☐ Non-compliant ■ Compliant	Included in this WHMP.

Compliance with comprehensive specific criteria for Wildlife Management Officer (WMO)

Specific criteria for WMO	Compliance	Comments or Recommendations
Qualifications		
Tertiary education relating to wildlife biology or environmental science (e.g. bachelor, diploma or certification in conservation, Natural resources management, ecology, wildlife biology or environmental science).	☐ N/A ☐ Non-compliant ■ Compliant	Adequate field experience acceptable but qualification preferred.
Work Experience		
300 hours minimum airside active wildlife dispersal, species identification and data collection training supervised by experienced WMO.	☐ N/A ☐ Non-compliant ■ Compliant	Training prior to commencing solo.
Access to and understanding of state, national and international legislation and permits relating to aviation and wildlife management.	☐ N/A ☐ Non-compliant ■ Compliant	Including updating permits as required.
If operating firearms, competency must be proven at shooting range and in airfield setting, including maintenance and storage education.	☐ N/A ☐ Non-compliant ■ Compliant	Including documenting in internal log book
Licences, permits and certifications		
Wildlife hazard management training by organisation that specialise in wildlife management in the aviation sector.	☐ N/A ☐ Non-compliant ■ Compliant	
Accreditation in vertebrate pest management.	☐ N/A ☐ Non-compliant ■ Compliant	Internal training

Specific criteria for WMO	Compliance	Comments or Recommendations
Aerodrome Report Officer and Works Safety Officer accreditation.	☐ N/A ☐ Non-compliant ■ Compliant	Australian Airports Association ARO and WSO certification.
CASA Aviation Reference number.	☐ N/A ☐ Non-compliant ■ Compliant	Required to acquire CASA certified A-ROC.
Aeronautical - Radio Operator Certificate (A-ROC).	☐ N/A ☐ Non-compliant ■ Compliant	Including CASA certification.
Firearm safety course and occupational licence mandatory for use of firearms airside – Class A & B.	☐ N/A ☐ Non-compliant ■ Compliant	Additional Class H preferred.
Certified to operate under animal welfare permits including clear criminal history.	☐ N/A ☐ Non-compliant ■ Compliant	No past convictions.
Department of Defence security clearance and pass.	☐ N/A ☐ Non-compliant ■ Compliant	Including after-hours access.
Airside access pass level 3.	☐ N/A ☐ Non-compliant ■ Compliant	Including after-hours access.
4x4 wheel drive accreditation.	☐ N/A ☐ Non-compliant ■ Compliant	

Appendix C Roles and Responsibilities

Task	Responsibility	Frequency
WHMP Preparation and Auditing		
Preparation of WHMP in consultation with a suitably qualified or experience person (ornithologist, wildlife biologist, or person with demonstrated expertise in the management of wildlife hazards to aviation) in accordance with the MOS Part 139 and the IBSC standards.	EMOS SME	Completed in 2018.
Annual internal review of WHMP.	EMOS BM SADFO	Annually.
Biennial external review of WHMP.	EMOS and SME	Biennially.
Circumstantial review of the WHMP.	BM SADFO	As required.
	EMOS and SME	If SME input is required in circumstantial review.
Risk-assessment of on-airfield wildlife hazards using wildlife observations, reported strike vents or near miss events.	EMOS and SME	Biennially (during external WHMP review).
Identification of sources and locations of wildlife attraction on and in the vicinity of the aerodrome.	SME	Reviewed biennially.
Audit of compliance of WHMP with other defence safety management systems.	BM SADFO	Annually or as required.
Retain copies of all relevant permits and ensure the currency.	EMOS and SME	Renew as per permit requirements.
WHMP Compliance		
Review of the WHMP to ensure compliance with other ADF safety management systems.	BM	Annually.
Review of the WHMP to ensure compliance with the aerodrome manual.	BM	Annually.
Monitor compliance with conditions of the relevant Environmental Compliance Certificate (ECC), Damage Mitigation Permit and vegetation removal permits.	SME	Ongoing.

Task	Responsibility	Frequency
Review relevant contracts to ensure that service delivery is in accordance with the WHMP.	EMOS	Ongoing.
Monitoring and Recording of Wildlife		
Monitoring and recording of wildlife on the aerodrome and in the vicinity (13 km) of the aerodrome.	SME	As required or quarterly.
Post-monitoring or wildlife following aircraft strike events.	SME	After strikes or near misses occur.
	17 SQN	After strikes or near misses occur.
Wildlife Hazard Management Plan Implementation		
Oversee the overall implementation of the WHMP.	BM	Ongoing.
	EMOS	Ongoing.
	SME	Ongoing.
Facilitate provision of resources to implement the WHMP.	BM	Ongoing.
	EMOS	Ongoing.
Facilitate provision of training, relating to WHMP, of all the units that will use the airfield.	EMOS and SME	Prior to and throughout all periods of airfield use.
Active wildlife management and/or harassment.	SME	Prior to planned aircraft movements and/or prior to training exercises.
Strike Reporting.	All operational units	As required.
Near-miss reporting.	All operational units	As required.

Task	Responsibility	Frequency
Post-strike inspection and/or investigation.	SME	After strike occurs.
Implement the Land Management Plan and associated sub-plans, inclusive of passive habitat measures for the areas on and in the vicinity of the airfield.	EMOS and SME	Ongoing.
Ensure that airfield wildlife hazard management is given due consideration prior to, during and following controlled burns.	EMOS and SME	As required.
Responsible for ensuring wildlife hazards are communicated in ERSAs and NOTAMs if necessary.	BASO/BAEO	As required.
Support communicating wildlife hazards to all units utilising the airfield.	EMOS	As required.

Appendix D National Airport Safeguarding Framework

National Airport Safeguarding Framework Guideline C, Attachment 1 to Wildlife Strike Guidelines

Land Use	Wildlife Attraction Risk	Actions for Existing Developments			Actions for Proposed Developments/ Changes to Existing Developments		
		3 km radius	8 km radius	13 km radius	3 km radius	8 km radius	13 km radius
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							

Land Use	Wildlife Attraction Risk	Actions for Existing Developments			Actions for Proposed Developments/ Changes to Existing Developments		
		3 km radius	8 km radius	13 km radius	3 km radius	8 km radius	13 km radius
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

Land Use	Wildlife Attraction Risk	Actions for Existing Developments			Actions for Proposed Developments/ Changes to Existing Developments		
		3 km radius	8 km radius	13 km radius	3 km radius	8 km radius	13 km radius
Cinemas	Very Low	Monitor	No Action	No Action	Monitor	No Action	No Action
Warehouse (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
Sewage / wastewater treatment facility	Moderate	Mitigate	Monitor	Monitor	Mitigate	Mitigate	Monitor
Potable water treatment facility	Low	Monitor	Monitor	No Action	Monitor	Monitor	No Action

Appendix E Wildlife Operations Procedures

1. Wildlife Count Procedure

Objective:	To provide data for the identification of trends and the development of targeted hazard management
Responsibility:	WMO
Frequency:	Weekly
Equipment:	Vehicle Binoculars
	Wildlife Count Form Wildlife Count Area Map
	Bird identification field guide

Procedures:

1. Wildlife counts always follow the same route.
2. The survey route includes 14 wildlife survey points (Figure E.1).
3. At each of the survey points, the vehicle is stopped and the entire sector is scanned using binoculars for a duration of exactly five minutes.
4. Record all data electronically, with Information recorded including:
    - date
    - name of observer
    - time of commencement and completion of the count
    - weather conditions
    - species and number observed
    - area recorded (including birds transiting the airfield)
    - special notes such as mowing or ponded water that may cause additional attractions.

Birds observed whilst driving between survey points are also recorded, particularly where the area between two survey points is too large to view from a single point.

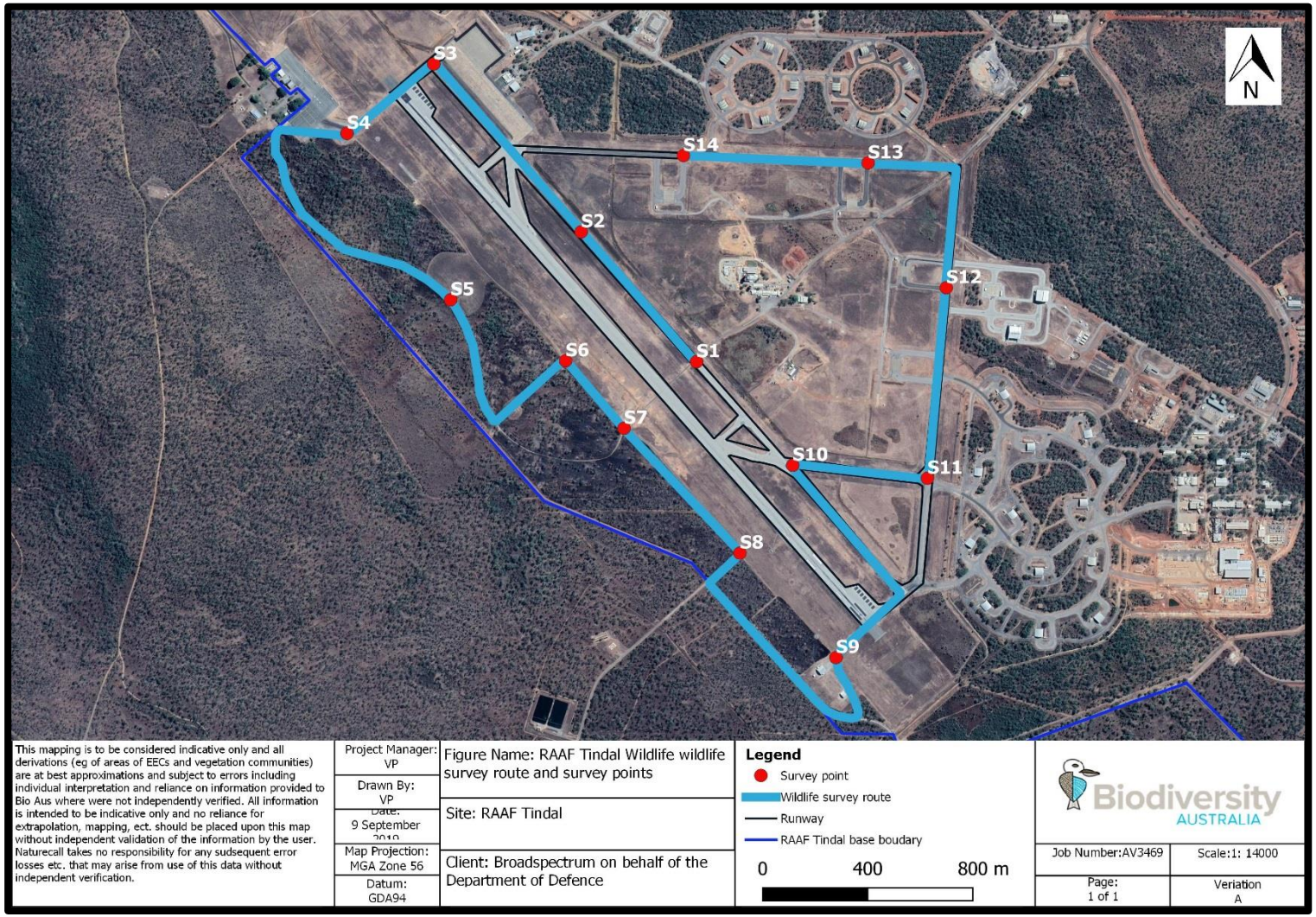


Figure E.1: RAAF Tindal wildlife monitoring route and survey points

2. Flying - fox Count Procedure

Objective:	To provide data for the identification of trends and the development of flying-fox hazard management
Responsibility:	WMO
Frequency:	Weekly
	Daily during periods of high flying-fox activity
Equipment:	Vehicle, binoculars
	Flying-fox Count Form

Procedures:

1. Observer is in position airside at least 25 minutes prior to last light.

2. During high flying-fox activity, the observer commences monitoring at least an hour before sunset.

3. In overcast/low ambient light conditions flying-foxes may depart camps earlier than normal, therefore the timing of monitoring will be adjusted accordingly.

4. Record all flying-foxes observed in 15 minute intervals, include an estimate of:

    a. Airfield sector(s) over which flying-foxes transit.

    b. Number of flying-foxes. Depending on fly-out density, use tally counters to count flying-foxes in 10s, 100s or 1000s.

    c. Approximate height.

    d. Direction of flight.

5. Conclude monitoring once no flying-foxes have been observed for a ten-minute period.

6. Report all significant flying-fox activity to the BASO.

7. Issue a NOTAM if required.

3. Fence Inspection Procedure

Objective:	To detect holes in fences which could allow breaches by terrestrial fauna
Responsibility:	WMO
Frequency:	Weekly
Equipment:	Vehicle

For the purposes of maintaining airfield security, perimeter fence inspections are conducted weekly to ensure there are no holes to permit unauthorised entry of people into airside locations. This inspection also plays an important role in determining potential areas for breaches by macropods and other animals.

Procedures

1. Inspect the entire perimeter fence for evidence of deterioration or damage.
2. Report any potential breach areas to the Coordinator and arrange for immediate repair.

4. Runway and Flight Strip Procedure

Objectives:
1. To detect wildlife that may pose a hazard to aircraft
2. To locate eggs and nests of birds
3. To locate wildlife remains

Responsibility: WMO

Frequency: As frequently as possible, with emphasis on periods of high aircraft activity and high bird activity. Before each period of aircraft movement.

Equipment: Vehicle
Binoculars
Radio equipment to communicate with pilots
Dispersal equipment (if required)

Procedures:

1. Inspect pavements, grassed areas, and flight paths for bird activity and search for eggs, nests and animal remains.

2. Where hazardous bird/wildlife activity is observed, immediately proceed with the wildlife dispersal procedure.

3. Where a serious hazard remains despite all efforts, refer the matter to the BASO.

4. If no activity observed log an entry in the daily log book to show the time of the inspection and areas patrolled.

5. Wildlife Strike Reporting Procedure

Objective: To accurately record all possible information on bird and other wildlife strikes.

Responsibility: First person who notices strike, squadrons

Frequency: As required, within 72 hours of strike

Equipment: Vehicle, Wildlife Strike Form

Strike reports are integral to identify the risks posed by birds and other wildlife to aircraft. It is essential that all possible sources of information are investigated and details accurately recorded. Any carcass located on sealed areas or within the gable markers are considered as strikes, unless another cause of death are considered more probable.

Procedures:

1. Immediately report wildlife strike to the BASO
2. Enter aviation safety report into Sentinel
3. Test strike area with a DNA test kit, for analysis of involved species
4. All to be completed within 72 hours of strike

6. Identification and Handling of Remains

Objectives:	To safely collect, store and analyse wildlife remains.	
Responsibility:	First person who finds remains	
Frequency:	As required	
Equipment:	Vehicle Tweezer Re-sealable bags Labels Hand wash	Disinfectant Freezer Gloves Reference book

For determining trends in strikes at RAAF Tindal, it is essential to identify the species involved. In order to accurately assess both the cause of death and identification of the species, carcass retrieval is required. This information ultimately aids in better wildlife management on airport.

Procedures:

1. Locate remains.
2. Follow the procedures below for each type of remains found.
3. If an ornithologist or wildlife consultant is engaged, ensure all remains are stored for regular analysis.
4. Report all strikes, as per the Wildlife Strike Reporting Procedure.

6.1 Whole Carcasses (collect sample for professional identification)

1. Depending on size of sample - use disposable gloves, thick gloves or a pair of tongs to collect remains from runway, ground, aircraft etc. and seal carcass in plastic bag (taking care not to contaminate the outside of the bag).
2. Remove gloves and dispose, wash hands.
3. Disinfect tongs and tweezers.
4. Fill out strike form and place inside a separate sealed plastic bag with the carcass.
5. Freeze in designated bird carcass freezer for analysis by consultant at a later date.
6. Follow Wildlife Strike Reporting Procedure.

6.2 Feathers and fragments (collect sample for professional identification)

1. Use disposable gloves.
2. If single feathers, or with small amounts of flesh attached, place in re-sealable bag.
3. Remove gloves and dispose, wash hands.
4. Fill out strike form with all details and staple to bag.
5. Freeze in designated bird carcass freezer for analysis by consultant at a later date.
6. Follow Wildlife Strike Reporting Procedure.

6.3 Blood and fleshy remains (collect sample for DNA analysis)

1. Use disposable gloves.
2. If dry, dip sterile swab stick in sterile water (small container) and swab over the smear.
3. If wet, swab with dry sterile swab stick.
4. Place swab in sterile tube and recap.
5. Remove gloves and dispose, wash hands.
6. Fill out label on side of tube with details: tag number, aircraft, flight no., suspected species, and elapsed time since strike).
7. Place sterile tube in freezer.
8. Follow Wildlife Strike Reporting Procedure. Record on bird strike report form that DNA testing is required.

6.4 Moist and Fleshy Remains (collect sample for DNA analysis)

1. Use disposable gloves.

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

3. Remove gloves and dispose, wash hands.

4. Fill out label on side of bag with details: tag number, aircraft, flight no., suspected species, and elapsed time since strike).

5. Post to Australia Museum

6. Follow Wildlife Strike Reporting Procedure. Record on bird strike report form that DNA testing is required.

7. Notify the Coordinator that a sample has been taken and requires processing at the Australian Museum.

Note: Be very careful not to touch remains with anything other than Medi-swab or sample container – to ensure sterile conditions

7. Landscaping Policy

General:

Landscaping planning and implementation must consider and address the risk of attracting wildlife to the vicinity of the airfield.

Elements to consider include:

- Plant species
- Height of plants
- Potential for plants to provide roosting, nesting and feeding opportunities
- The presence of flowers
- The presence of fruits and seeds
- Lawn type and height
- Potential insect attractants

Principles:

In order to minimise bird populations within the RAAF Tindal base the following landscaping principles will be applied:

1. Landscaping and beautification should be kept to the minimum required to improve aesthetic amenity. Increased landscaping and supplementary irrigation will increase wildlife attraction.

2. In selecting plant species for landscaping, care should be taken to limit species known to attract wildlife (e.g. fruiting species). While all trees and shrubs may attract birds for perching, nesting, roosting or shelter, some plant species are more attractive than others.
3. The larger the plant (such as a tree or large shrub), the greater the food, shelter, perching or nesting opportunities for birds. Small to medium trees and small to medium shrubs are therefore less likely to attract birds than large ones. To reduce the number and size of birds attracted to airfield garden areas shrubs rather than trees should be planted.

4. The location of plantings in relation to areas of natural vegetation or other landscaped areas and the position of aircraft manoeuvring areas will affect the likelihood of birds or flying-fox flying through aircraft flight paths. Islands of trees, shrubs and irrigated lawns surrounded by large areas of grass are particularly attractive to birds which can use the island of landscaping as a base from which to forage.

5. The suitability of plant species used in the airfields existing landscaping should be reviewed on an ongoing basis, as should the plant species and design of all new landscape projects. In preparing and reviewing landscape designs it is important to take account of the relationship between the landscaped area and other natural and human-made habitats

on and around RAAF Tindal.

7.1 Species Selection:

Careful selection of plant species is essential to minimising birds and flying-foxes risk at RAAF Tindal.

Trees and shrubs which bear edible berries, fruits, seeds or nuts, or flower profusely, are likely to be particularly attractive to birds and flying-foxes. Some plants such as *Melaleuca* and *Ficus* species are known to attract flying-foxes. Other fruiting trees, such as mangoes and paw-paws, will not be planted.

Where such species already exist at the airport they should be replaced by a more suitable species, or fruits and flowers removed as soon as they set.

Some plants attract birds because of their structure and size rather than as a food source.

7.2 Design Specifications

Around the entire RAAF Tindal base, and particularly within and in close proximity to the airside boundary, the following design specifications may be used, in combination with suitable plant species, to minimise the attractiveness of landscaping to birds and flying-foxes.

Definitions:

Regardless of botanical or other definitions of 'tree' 'shrub' and 'ground cover', for the purpose of this guideline the following definitions apply:

- **Tree:** any plant which attains a mature height of greater than 5m.
- **Shrub:** any plant which attains a mature height between 300m and 5m.
- **Ground Cover:** any plant other than grass which attains a mature height less than 300mm.

Trees and Shrubs:

The landscaping layout may influence the number and types of birds attracted. Clumps of trees and shrubs provide more shelter and more concentrated feeding areas than individual or small groups of plants.

Tree species required for shade will be carefully chosen and individual trees planted well apart rather than in groups so as to minimise the likelihood of their use as roosts.

The following conditions will be applied to tree planting along access and other roads on the base:

1. Maximum mature height of any tree: 10m.
2. No more than 5 trees planted in any one group.
3. Average interval between tree groups not less than 200m.
4. Minimum interval between tree groups should be 100m.
5. Single trees should not be planted closer than 50m to any other single tree or tree groups.

The following conditions will be applied to all shrub plantings:

1. Shrubs not to exceed 5m mature height.
2. Shrubs which produce nectar, fruits or seed (e.g. *Banksia, Grevillea, Hakea*) will not be planted in groups of more than 5 per group and such groups shall not be planted closer than 50m 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.

Ground Cover:

In general, low prostrate ground cover plant species attract few birds; however, profusely fruiting or seeding species should be avoided. Extensive use of wide variety of ground cover species would, therefore, be unlikely to increase the bird strike risk. Extensive use of ground cover species rather than grasses would be likely to minimise ongoing maintenance costs. Grasses and pasture legumes can attract flocks of seed-eating birds such as galah and spinifex pigeon, and plants which seed abundantly should be avoided for rough grass or soil stabilisation areas. Green lawns are attractive to many birds which feed on soil invertebrates and flying insects. Well-watered lawns provide an excellent environment for soil invertebrates and insects which may be found on the ground or flying above the lawn. This relatively rich food source attracts birds such as magpie larks, lapwings and kestrels. Grass and weed seeds may attract pigeon, cockatoos and parrots. Sprinklers and dripping taps may also attract large numbers of birds, especially during hot dry weather. Irrigated lawns should therefore be limited to small areas.

Drainage Ditches:

Drains should be regularly inspected and maintained to discourage wading birds and vegetation growth. Vegetation is managed as frequently as required to maintain drainage flow.

Maintenance:

Landscaped areas will be regularly inspected (including at night and dawn and dusk) to ensure they are not attracting birds or bats. Remedial action should be taken as soon as a landscaped

area is found to be attracting significant numbers of birds or bats that may pose a hazard to aircraft.

Lopping and pruning to alter the structure of trees and shrubs can reduce the availability of food and perches and make the plants unsuitable for roosting or nesting. It can, however, be difficult if not impossible, to lop or prune some species of trees such as palms to the extent necessary to prevent birds from roosting or nesting. In such cases, the only effective way of suitably reducing risk may be to remove the trees. For this reason, use palms sparingly, or not at all, in airport landscaping. There are many other trees which may be used and which can be modified as necessary without removal. Regular pruning and lopping of trees and shrubs in the airport's landscaping can improve their health and vigor and also prevent the establishment of communal roosts and nesting colonies.

8. Grass Management Procedure

Objective: To effectively manage airside grassland to reduce bird attraction.

Responsibility: EMOS Contractor – Broadspectrum

Frequency: As required

Equipment: Grass Slasher

Long grass maintained at 300mm can be effective at reducing populations of grassland bird species such as plovers, corellas and ibis. The reduced attraction is due to their inability to successfully locate food and the insecurity of lower predator detection due to the obscured view caused by long grass. Seed heads must be removed regularly so as not to attract granivorous bird species or rodents.

Procedure:

1. Mowing heights should be gradually increased in stages to increase grass heights. Grass should be cut at 100mm. Subsequent cuts should be made higher in 50mm increments towards 300mm.

2. Increased vigilance during mowing operations is required to order to manage any immediate hazards (e.g. Black Kites following mowers).

3. After the long grass has established, areas inside the flight strip should be cut at 200mm and allowed to grow to a maximum height of 300mm to avoid obstruction of signs and markers.

9. Wildlife Dispersal and Harassment Procedure

Objective:	To remove immediate wildlife hazards from the airport.
Responsibility:	WMO
Frequency:	As required
	Monday to Friday 8am to 4.30 pm
	Monday to Friday before 9am and after 5pm and weekends - when a hazard has been identified or aircraft movements change.
Equipment:	Stock whip, starters pistol, car siren, suitable firearm and pyrotechnics

Dispersal of wildlife hazards is an integral aspect of active management as areas on the airport will remain attractive to some species and early detection and immediate removal of hazards is essential to effective management of risks.

Detection is achieved during bird counts (Wildlife Count Procedure) and runway and flight strip inspections (Runway and Flight Strip Inspection Procedure).

WMOs should be present on the airfield and equipped to manage wildlife hazards, as required, during scheduled counts and inspections, as well as carrying out general and routine daily surveillance.

The following details are recorded by WMOs:

- Time
- Areas of the airport patrolled
- Species of wildlife seen
- Numbers
- Location
- Action taken to disperse the wildlife
- Results of the action.

Guidelines:

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 airfields providing they recognise the airfield as an unattractive and threatening environment (note that different species breed at different times of the year). To discourage regular

visitation, do not allow wildlife to settle and feed. It is easier and more effective to harass newcomers to the airport than birds that have established their territory on-site.

1. Concentrate dispersal activities for most species in the early morning and mid-afternoon, prior to peak feeding periods. Early morning harassment is effective for discouraging birds settling in for the day.

2. It may be necessary to continuously patrol and disperse during periods where aircraft movements are scheduled closely together.

3. Where wildlife identify a particular vehicle as a risk and move to a different airside location, consider undertaking dispersal in a different type of vehicle.

Procedures:

1. Identify wildlife requiring dispersal.

2. Position yourself between the runways and the wildlife to ensure dispersal is away from aircraft manoeuvring areas.

3. Choose the most appropriate equipment for the task

4. Check that no aircraft activity is due in the very near future.

5. Activate equipment.

6. Determine effectiveness.

7. Continue until hazard is successfully removed.

8. Record details on wildlife harassment Form.

9. If the hazard cannot be mitigated to an acceptable level, communicate details of the hazard to pilots via NOTAM

10. Where a serious hazard remains refer to Wildlife Culling Procedure.

Equipment and Safety Guidelines: Harassment and Dispersal

There are a number of options available for undertaking dispersal and all will be used at various times to limit the likelihood of birds habituating to any one option.

Vehicle siren lights and horn can be used to herd and disperse birds. Arm wave and stock whips are other inexpensive and sometimes effective means of dispersing flocks of some species of birds. The arm wave requires the officer to stand on high ground or a vehicle and flap both arms slowly at around 1 beat per second. Flocks respond as if to a predator, and disperse. A well-used stock whip lets off a sound similar to that of a firearm and is an effective tool for dispersing some species.

Pyrotechnics (i.e. Bird Frite ®) are a very useful tool for dispersal. To reduce the chance of habituation, use as few shots as possible to achieve the required effect and ensure the cartridge explodes as close to the wildlife as possible. Firearms are also provided to WMOs for the purpose of harassing, dispersing, and when necessary, culling of wildlife (Firearms Policy). Under no circumstances will they be used for any other purpose.

Care is taken when harassing birds and in particular the WMOs will observe the following:

1. The location of the hazard in relation to any aircraft in the vicinity, whether landing, taking-off, taxiing, etc. A gun shall not be fired in the direction of or in the vicinity of any aircraft.

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. Never carry a loaded gun in the vehicle or fire 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 pyrotechnics 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 after use.

9. When not being carried in the WMOs vehicle, guns and ammunition must be stored in a locked cupboard (Firearms Policy).

10. Wear ear and eye protection when discharging firearms

Appendix F May to July 2020 – Delegated Airside and Landside Survey Results

Airside and landside surveys are conducted once weekly during period of no military aircraft movement. That is a snapshot of species abundance and does not include evening or nocturnal species as survey completed during WMO regular hours. This is a general survey not specifically identify numbers of an individual species, cryptic and nocturnal species including wallabies and fox's may be present in higher numbers than shown. Specific Wallaby surveys are conducted Ad hoc during breaks in traffic during night flights or during planned wallaby surveys. It is also noted no bustards were recorded in the airside and landside surveys. Harassments indicate around 1-4 Bustards were present Airside each day although were either dispersed or moved during Airside surveys. In the Quarterly reports all data including harassment data, airside and landside surveys and ad hoc surveys. Survey locations provided below.

Species recorded on-site during landside and airside surveys from May to July 2020.

Common name	Scientific name	Number observed landside	Number observed airside	Total
Aves				
Galah	*Eolophus roseicapilla*	268	124	392
Red-tailed black-cockatoo	*Calyptorhynchus banksii*	110	138	248
Magpie-lark	*Grallina cyanoleuca*	62	147	209
Pied butcherbird	*Cracticus nigrogularis*	98	34	132
Red-winged parrot	*Aprosmictus erythropterus*	69	8	77
Bar-shouldered dove	*Geopelia humeralis*	55	5	60
Red-collared lorikeet	*Trichoglossus rubritorquis*	51	6	57
Striated pardalote	*Pardalotus striatus*	45	10	55
Black-faced woodswallow	*Artamus cinereus*	18	27	45
Australian pratincole	*Stiltia isabella*	0	42	42
Apostlebird	*Struthidea cinerea*	37	0	37
Brown honeyeater	*Lichmera indistincta*	37	0	37
Blue-faced honeyeater	*Entomyzon cyanotis*	30	0	30
Black kite	*Milvus migrans*	15	8	23
Rufous whistler	*Pachycephala rufiventris*	22	1	23
Rainbow bee-eater	*Merops ornatus*	14	1	15
Little friarbird	*Philemon citreogularis*	14	0	14
Whistling kite	*Haliastur sphenurus*	11	2	13
Torresian crow	*Corvus orru*	9	2	11
Willie wagtail	*Rhipidura leucophrys*	8	3	11
Grey-crowned babbler	*Pomatostomus temporalis*	9	0	9
Yellow-tinted honeyeater	*Ptilotula flavescens*	8	0	8
Straw-necked ibis	*Threskiornis spinicollis*	0	8	8
White-throated honeyeater	*Melithreptus albogularis*	7	0	7

Common name	Scientific name	Number observed landside	Number observed airside	Total
Great bowerbird	*Ptilonorhynchus nuchalis*	4	1	5
White-gaped honeyeater	*Stomiopera unicolor*	5	0	5
Nankeen kestrel	*Falco cenchroides*	0	5	5
Black-faced cuckooshrike	*Coracina novaehollandiae*	2	1	3
Sulphur-crested cockatoo	*Cacatua galerita*	3	0	3
Crested pigeon	*Ocyphaps lophotes*	2	1	3
Common bronzewing	*Phaps chalcoptera*	3	0	3
Lemon-bellied flycatcher	*Microeca flavigaster*	3	0	3
Mistletoebird	*Dicaeum hirundinaceum*	3	0	3
White-bellied cuckooshrike	*Coracina papuensis*	3	0	3
White-throated gerygone	*Gerygone olivacea*	3	0	3
White-winged triller	*Lalage tricolor*	0	3	3
Fairy martin	*Petrochelidon ariel*	2	0	2
Peaceful dove	*Geopelia striata*	2	0	2
Olive-backed oriole	*Oriolus sagittatus*	2	0	2
Diamond dove	*Geopelia cuneata*	2	0	2
Yellow-throated miner	*Manorina flavigula*	2	0	2
Northern rosella	*Platycercus venustus*	2	0	2
White-breasted woodswallow	*Artamus leucorynchus*	0	2	2
Paperbark flycatcher	*Myiagra nana*	2	0	2
Brown goshawk	*Accipiter fasciatus*	1	0	1
Australasian figbird	*Sphecotheres vieilloti*	1	0	1
Grey fantail	*Rhipidura albiscapa*	1	0	1
Pheasant coucal	*Centropus phasianinus*	1	0	1
Spotted harrier	*Circus assimilis*	0	1	1
Red-backed fairy-wren	*Malurus melanocephalus*	0	1	1
Helmeted friarbird	*Philemon buceroides*	1	0	1
Yellow oriole	*Icterus nigrogularis*	1	0	1
Black tailed tree creeper	*Climacteris melanurus*	1	0	1
Mammals				
Agile wallaby	*Macropus agilis*	1	4	5

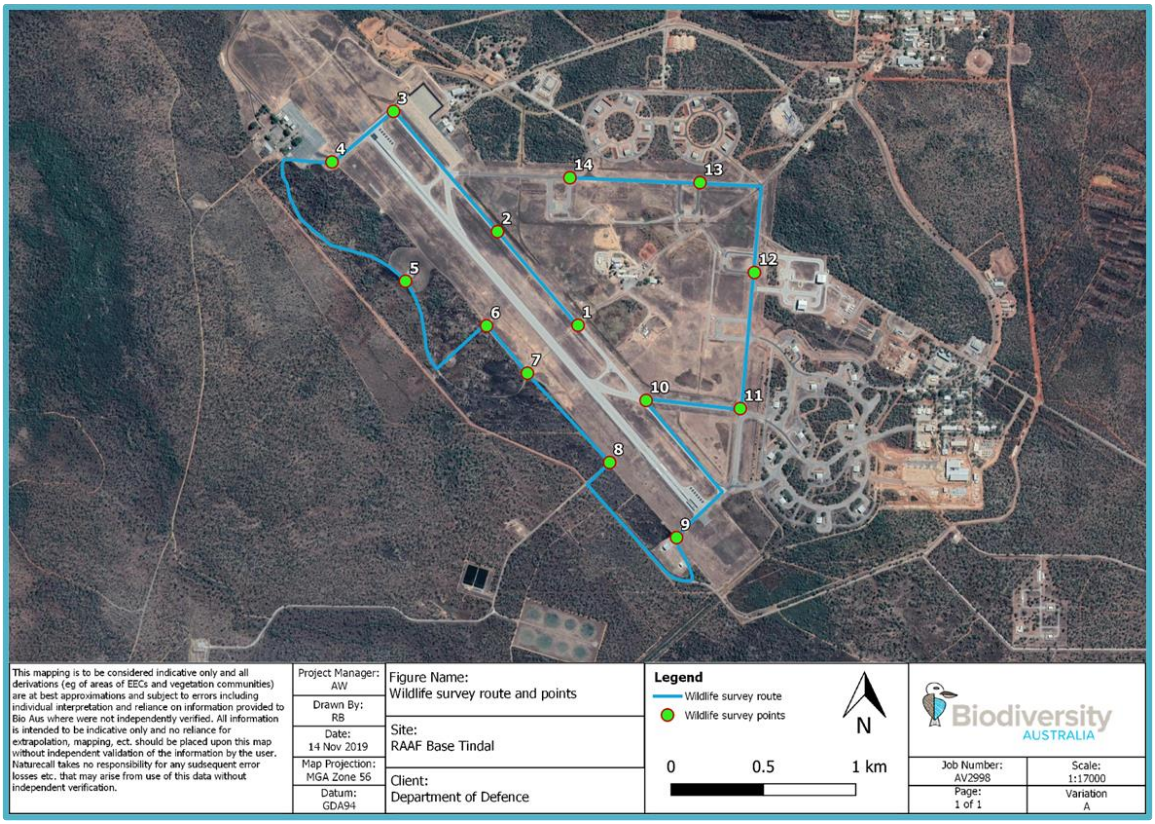


Figure F-1: Biodiversity Australia airside wildlife surveys

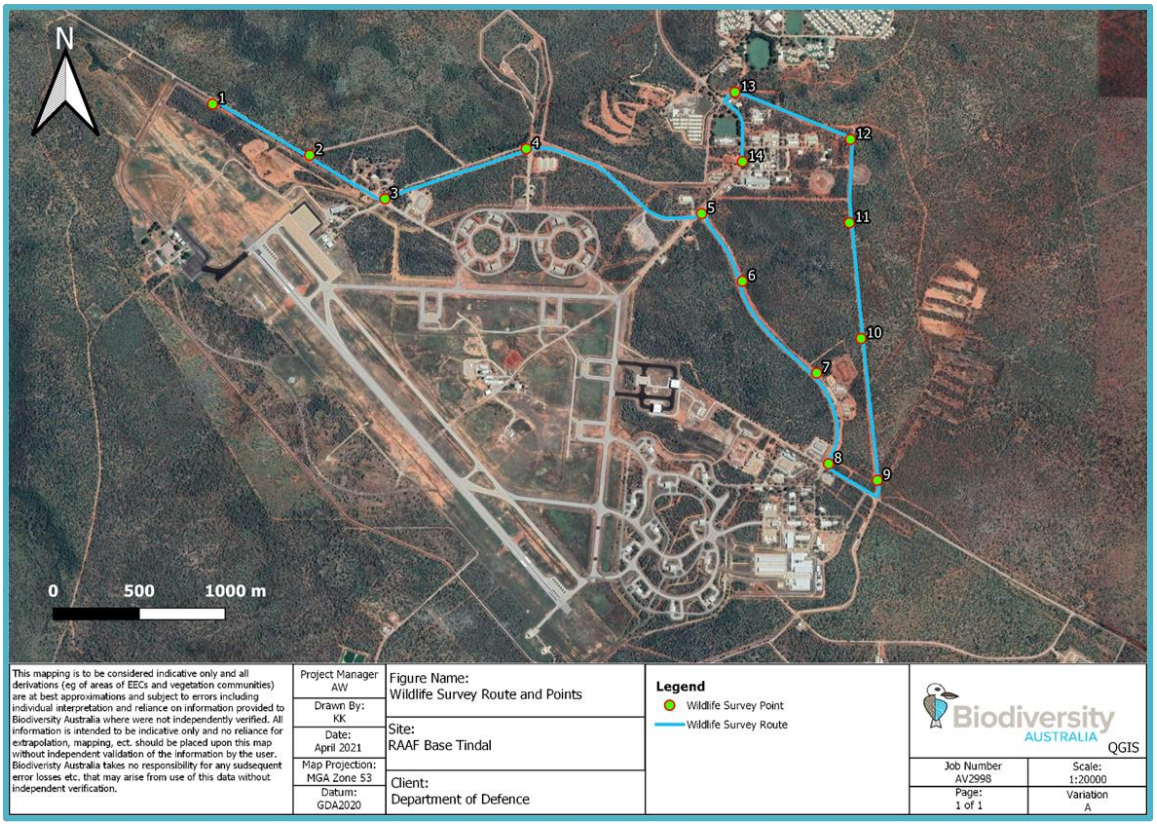


Figure F-2: Biodiversity Australia Landside wildlife surveys.

Appendix G Paton Risk Assessment

Bird Risk Assessment Model for Airports and Aerodromes

David C. Paton
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Revision 3
March 2010

Background

This risk assessment model has been prepared by Associate Professor David C. Paton, School of Earth and Biological Sciences, The University of Adelaide under contract to Adelaide Airport Ltd.

It aims to assist individual airports and aerodromes to assess the relative risk of aviation strike posed by bird species and provides a framework to underpin bird and wildlife management plans, as required in Appendix 1 to *Civil Aviation Safety Regulations 1998* subparagraph 139.095(a)(ii).

Section 10.14 of the Manual of Standards (MOS) 139 requires an airport where a bird hazard has been identified to have a bird and wildlife management plan. This plan, including any risk assessment, should be prepared by a suitably qualified person such as an ornithologist or biologist. Whilst this model has been prepared by an ornithologist, risk assessments developed for specific airports or aerodromes can nonetheless benefit from specialist input.

Template Revision History

Revision number	Revision date	Title	Prepared by
1	July 2008	A Generic Risk Assessment Tool for Ranking Bird Hazards at Individual Airports	The University of Adelaide
2	May 2009	Bird Risk Assessment Model for Airports and Aerodromes	Adelaide Airport Ltd
3	March 2010	Bird Risk Assessment Model for Airports and Aerodromes	Adelaide Airport Ltd

Acknowledgments

The University of Adelaide and Adelaide Airport Ltd acknowledge aerodrome operators and members of the Australian Aviation Wildlife Hazard Group for their input and feedback on drafts.

Disclaimer

This Bird Risk Assessment Model for Airports and Aerodromes proposes a methodology for assessing the relative risk posed to aviation of bird species at an individual aerodrome. The model can be used by aerodrome operators as a framework to underpin a bird or wildlife hazard management plan.

Airport and aerodrome operators are advised to use the methodology detailed in this document, and analyse the results, at their own risk. No responsibility is accepted by the author and publishing parties for those who may use or rely on whole or any part of this model.

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Introduction

The purpose of this document is to outline a simple risk assessment model for assessing bird hazards at individual airports and aerodromes. This tool should allow airport and aerodrome operators to rank species and then focus their bird hazard reduction programs on those species presenting the greatest risk. The risk assessment involves assessing the probability of an event and the consequences when such an event happens. Incidents that have a high probability and or high consequences are regarded as being more hazardous than those with lower probabilities of occurrence and low consequences (Table 1).

The intention with this risk assessment model is to allow operators to identify the more hazardous species at their aerodrome and not to compare bird hazards between aerodromes. As such it is designed to aid and focus bird hazard reduction programs on the most hazardous species for that aerodrome. A more sophisticated approach would be required to compare bird hazards between aerodromes including information on amount of aircraft traffic, and the size, speeds and types of aircraft *et cetera* that use the airport.

The approach taken in the risk assessment is to assume that each aerodrome needs to identify those species that represent the greatest risk, irrespective of the absolute value of that risk. The philosophy behind this approach is two-fold. First, every aerodrome should be maintaining a targeted bird hazard management program irrespective of the number of strikes that might take place since there will always be some, albeit potentially very low risk of a strike. Second, in terms of meeting obligations to provide a safe operating environment, failing to have an effective and targeted management program may be regarded as negligent.

The likely consequences of a bird strike involving particular species of birds are related to the bird's body mass, their flocking behaviour and flight behaviour, while the probability of a strike are likely to be related to the abundances of different bird species on or near an aerodrome. In many cases some measure of the likely probability of a bird strike involving a particular species can be taken directly from strike statistics. However the probability of a strike on any one aircraft movement is remote and so strike data may not provide the best estimate of the likelihood of a strike. Furthermore using strike data is a reactive approach in that species are only identified as a risk after they have been involved in one or more strikes.

Both quantitative and qualitative measures of abundances and strikes are used to rank probabilities of a species being involved in a strike at a particular airport since airports differ in the quality and quantity of information that they hold. In this way the tool is designed to take into account different levels of knowledge and available statistics for different airports.

The aim of this document is to provide guidelines and procedures for ranking species of birds on the likely severity (*consequence*) of those species being involved in a strike and the likelihood (*probability*) of those species being involved in a strike (Table 1).

Table 1. A simple probability x consequence matrix for assessing the severity of bird hazards at airports.

Consequence	**Probability**			
	Very High	**High**	**Medium**	**Low**
Extreme	extreme	extreme	very high	high
Very high	very high	high	high	medium
High	high	high	medium	medium
Medium	medium	medium	low	low
Low	low	low	negligible	negligible
Very low	negligible	negligible	negligible	negligible

Consequence of a Bird Strike

The consequences of a strike historically have been assessed in two ways (Paton 2007). One method uses information on the size and behaviour of birds to assess the likely consequences with larger species. Large species, species with a propensity to flock and species with slow and meandering flight generating greater consequences and higher severity scores, all other things being equal. A second method uses the proportion of recorded strikes involving a species that cause significant damage to aircraft or disruption to air services to measure likely consequences (Allan 2000, 2006; Allan *et al.* 2003; Barras & Wright 2002; Zakrajsek & Bissobette 2005). These methods of assessment, however, provide similar rankings for species, but there are some important differences.

From an airline's perspective there are two consequences that eventuate from bird hazards: (1) damage to the aircraft if a bird is struck; and (2) disruption to aircraft movements caused by delays. Both have economic and social costs, direct or indirect. Indirect impacts are those where aircraft movements are disrupted even without a strike, for example when pilots decide to delay take-off until a hazardous species has been dispersed.

The damage caused to an aircraft by a bird in a strike will depend on the body mass of the bird (determines the force of the impact) and flock density (and hence the number of birds that may be struck in the one incident). In developing a simple tool for the consequences of a strike, a simple scoring system is used to place birds into one of:

- six categories of body mass (Table 2),
- three categories of flocking behaviour (Table 3), and
- two categories of flight behaviour (Table 4).

These are then combined (the scores for three criteria are multiplied) to provide a consequence score (Table 5). The flight behaviour of birds (Table 4) is included in the consequences score because species that fly slowly, have meandering flight paths or change direction erratically (part of their anti-predator behaviour) will take longer to clear airspace used by aircraft. The consequence in this case is largely economic, in that such species will lead to longer delays if the birds have to be dispersed before aircraft movements resume. In considering the relative importance of the different criteria, larger body masses are disproportionately weighted in this scoring system.

Table 2. Simple ranking and scoring system for body masses of birds that may be involved in a bird strike.

Body Mass	Examples	Body Mass Score
< 20 g	Welcome Swallow	1
21-50 g	House Sparrow; Skylark	2
51-200g	Common Starling, Magpie-Lark, Nankeen Kestrel	4
201-1000g	Domestic Pigeon, Galah, Silver Gull, Australian Magpie, Masked Lapwing, small ducks	8
1-5 kg	White Ibis, Straw-necked Ibis, large duck	16
>5kg	Australian Pelican, Cape Barren Goose	32

Table 3. A simple ranking system to account for different flocking behaviours for bird species

Flock Size	Examples	Flock Score
Usually solitary or widely spaced	Nankeen Kestrel, Skylark,	1
Often in loose flocks	Australian Magpie, Little Raven, Magpie-Lark, Welcome Swallow, Silver Gull	2
Often in tight flock	House Sparrow, Galah, Little Corella, lorikeets, ducks, ibis,	4

Table 4. Flight behaviours of selected species of birds

Flight Behaviour	Examples	Flight Score
Rapid direct	Little Raven, Australian Magpie, ducks, ibis	1
Slow, meandering, erratic, hovering, manoeuvrable	Nankeen Kestrel, Galah, Common Starling, swallows, Magpie-Lark, Silver Gull, Australian Pelican, Masked Lapwing	2

Table 5. Categories of consequences based on consequence scores

Consequence Category	Consequence Score*
Extreme	64-128
Very high	32
High	16
Medium	8
Low	4
Very low	1-2

*** = body mass score x flock score x flight score**

Probability of a Bird Strike

Two methods have been used to estimate the probability of a species being involved in a strike (Paton 2007). One method uses the abundances of a species at an airport; the more abundant species being more likely to be involved in a strike. For some species there is a clear relationship between abundance and numbers of strikes but for others the relationship is sometimes poor, and is affected by the ecology and behaviour of individual species. For example, a species that occurs in a flock may be less likely to have individual birds intruding into airspace compared to a solitary species having the same numbers of birds spread widely across the airport. So, the widely spaced species may be more likely to be struck but the flocking species if struck has more serious consequences, all other things being equal. Other differences in ecology (e.g. food preferences, use of different parts of an airport) will also influence the probability of a species being struck. In many cases this ecological information is lacking.

Since many aerodromes do not have good data or estimates of bird abundances an alternative has been used; the numbers of historical strikes (Allan 2000; Allan *et al.* 2003). In some cases these historical strikes are considered at the level of the aerodrome and measure the risk to the aerodrome or airport operator as opposed the flying passenger (Allan 2006). In others the strikes are assessed on a per aircraft movement basis (Barras & Wright 2002).

The probability of a bird strike on any one single flight, however, is remote. For example, at Adelaide and Parafield Airports there is less than one strike per 1,000 aircraft movements; and this rate is typical of many airports (Blokpoel 1976; Allan *et al.* 2003; Barras & Wright 2002). Assessments of the probability of a strike involving different bird species based on historical records of strikes involving that species might, by chance, fail to identify a potentially hazardous bird species until that species has been involved in not just one strike but several strikes, and at least one strike of consequence. The method is also not sensitive to changes in the avifauna at an airport and will fail to detect new hazards in a timely fashion to implement remedial actions. Some care is also required in using bird strike statistics in that a proportion of the reported bird strikes (as much as 10%) may fail to give the species involved or fail to identify the species correctly and so strike data are not perfect. Importantly using strike rate statistics alone is a reactionary approach while incorporating measures of abundance provides a proactive approach since they allow changes in risks to be detected and actions taken to address these before a significant strike event occurs.

When information on the abundances of birds *and* numbers of strikes involving a species is known then considering both of these provides a potentially more robust assessment. For the purposes of this risk assessment, the aim is to have a system that allows airport operators to identify the top 10 or so bird species that have a very high probability of being involved in a strike relative to other species of birds that are present at that airport, and not to derive an absolute percentage.

A generic tool for assessing the relative probability of a strike for an airport also needs to be able to account for the different qualities and types of information that may be available for an airport. Some airports will have large amounts of quantitative data others may have little background data.

For example, many smaller aerodromes may lack systematic counts of birds and so have limited quantitative data for scoring abundance, yet they may have some qualitative or observational data that allows them to rank species in terms of their relative abundances. A range of quantitative or qualitative criteria are listed in Table 6 and the intention is that any one or more of these can be used to rank species with respect to the probability of them being involved in a strike at an airport. The aim in this ranking system is to identify the species with the highest probability of being involved in a bird strike at a particular aerodrome and not to provide an absolute scoring system. As this is a relative measure of risks of a strike the listing of species into different categories (very high, high, medium and low) should aim to have 5-10 bird species falling into each of the two highest categories.

In using the criteria outlined in Table 6, a conservative or precautionary approach should be used and if species are ranked highly under one criteria and not another then the higher ranking criteria should be used to rank the species.

The following sections provide some discussion around the criteria listed in Table 6.

Data Used to Assess Probability

Where quantitative data exist the *relative abundance*, frequency of occurrence and or area of occurrence could be used to assist in ranking species. Relative abundance is straight forward in that it is simply the percentage of the total birds counted on the airport that is accounted for by that species, and those species accounting for >1% of all birds are given a “very high” rank. Two other criteria are also given.

The *frequency of occurrence* is simply a measure of the per cent of surveys or days that the species was detected on the airport, while the *area of occurrence* considers how widely dispersed a species is over an airport. Species which are more frequently present on an airport and/or widely dispersed over an airport are likely to be struck more frequently than those that are present only on some occasions or use only part of the airport *per se*. The likelihood that airports would have data in these two categories and not some measure of abundance is probably unlikely at present, but the purpose in identifying these as potential criteria to use in the future may aid airports to review their monitoring programs to allow opportunities to use these criteria as well. For example some of the difficulties of counting birds systematically over an airport may be overcome in the future by simply recording the presence of a species on different parts of the airport on a regular basis and using the frequency that the species is present.

A qualitative assessment of abundance and distribution could also be conducted. In Table 6, qualitative terms (many, most, some, few, occasional, etc) are used rather than quantitative values to categorize species. Up to four categories based around abundance, frequency of presence, widespread distribution and/or presence near runways. The latter could also be based on quantitative data if available, and assumes that species that aggregate near runways and flight paths are more likely to be involved in strikes.

No definition of the terms “many, most, often, some, few, occasional” are provided in part to allow aerodromes and airport operatores some flexibility in how these are defined. These terms are intended to be used in a relative sense rather than absolute sense. Where qualitative scoring is all that is possible ranking of bird species across the categories should result in 5-10 species in each of the highest two categories (i.e. very high, high, see Table 6). If on first attempt this qualitative approach does not provide such a result then the qualitative terms need to be adjusted to provide such an outcome.

A similar set of quantitative and qualitative criteria are proposed to allow species to be categorized based on knowledge of their involvement in strikes (Table 6). For the case of bird strikes, the highest category for a relative contribution to bird strikes is set at a higher percentage, in part reflecting the smaller total numbers of strikes (cf numbers of birds counted) and because with rare events some species may have elevated strike rates due to chance alone.

Table 6. Different methods of ranking species on the probability of those species being involved in a bird strike at a particular airport

Criteria	Very High	High	Medium	Low
Abundance				
Quantitative				
(a) relative abundance (% of total birds counted)	> 1	> 0.1	> 0.01	< 0.01
(b) frequency of occurrence (% surveys species scored)	> 75	50-75	25-50	< 25
(c) area of occurrence (% airport land used)	> 75	50-75	25-50	< 25
Qualitative				
(a) abundance	many	some	few	occasional
(b) frequency of occurrence	most	some	few	occasional
(c) area of occupation	most	some	few	occasional
(d) seen close to runways	often	some	occasionally	rarely
Bird Strikes				
Quantitative				
(a) relative frequency (% all strikes at airport)	> 5	1-5	0.1-1	< 0.1
Qualitative				
(a) apparent frequency	often	some	occasional	rare/none

Other Factors Influencing Probability

The above assessment of the relative likelihoods of species being involved in a bird strike is largely based on abundances or frequencies of events. Some species are rarely detected on airports but nevertheless are involved in strikes and these and other species are disproportionately involved in strikes relative to their abundance. Such species are often nocturnally active or have slow, erratic and or meandering flights. Where this information is known such species should be allocated to the next higher category of likelihood (Table 7). Similarly where information is available to suggest a species is increasing in abundance or the rate at which that species is involved in strikes (cf other species) is increasing, the species should be allocated to the next higher category. Similarly if abundances are known to be declining and or the involvement of that species in strikes is also declining then such species could be allocated to the next lower category. This allows some adjustment of the ranking system based on ecological information for individual species which is currently rarely taken into consideration.

In the above assessments, individual species may be ranked by a number of different criteria and if species are allocated to different categories based on the different criteria then the highest ranking criteria should take precedence. This is precautionary approach in that more species should fall into higher categories.

The end result of this process should lead to a suite of 10-20 species of birds being given high or very high scores for likelihood or probability of being involved in a strike. If fewer than 10 species have been identified in these two categories by this process then the assessment of likelihood of strikes should be repeated but with lower thresholds separating the different

categories. These can then be combined with the consequences rank in the risk assessment table to determine the species that the airport should focus their management programs on (see Table 1).

Table 7. Additional factors to consider when ranking species on the likelihood of that species being involved in a strike. Where this is likely to increase risks the species should be allocated to the next higher category, and where this is likely to reduce risks to next lower category.

Other Bird Behaviours	Species Displays Attribute	Change in Category
Slow, erratic flight behaviour	yes	+ 1
Nocturnal flight activity	yes	+ 1
Trend of increasing abundance	yes	+ 1
Trend of decreasing abundance	yes	- 1
Trend of increasing strikes	yes	+ 1
Trend of decreasing strikes	yes	- 1

Timeframes

Throughout this assessment process no consideration has been given to the time lines over which an assessment of risk is conducted. However the above assessment process can be based on specific periods of the year (seasons) or over longer periods as the case may require.

Summary

The bird risk assessment model outlined in the above sections is aimed at providing airport and aerodromes operators with a simple method of documenting a risk assessment process for bird hazards at their facility. It uses information on the likely consequences and probabilities of strikes involving different species of birds at an airport or aerodrome and is aimed at helping operators identify the major bird hazards and to focus management on those species.

Once the risk assessment table (Table 1) is populated with bird species, decisions about the species on which the operator should focus future management will still be required. Species that fit in the extreme or very high categories (ie. top left-hand corner of the table) should be given priority.

The intention with this risk assessment is to define the species of greatest risk and *not* to determine the relative risks to aviation *between* different airports. The intent with this approach is that each and every airport and aerodrome will be able to rank species of birds and have a suite of species that are considered the most hazardous, irrespective of whether it experiences many or only a few if any strikes.

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Appendix 1
Bird Species Scores

Appendix 1: Bird Species Scores

Common Name	Scientific Name	Mass (g)	Mass Score	Flock Score	Flight Score	Hazard Score	Hazard Rank	Notes
Australian Bustard (M)	Ardeotis australis	6,900	32	1	1	32	vh	
Australasian Grebe	Tachybaptus novaehollandiae	220	8	1	1	8	l	rarely flies
Australasian Pipit	Anthyus novaeseelandiae	32	2	1	1	2	vl	
Australian Hobby (F)	Falco longipennis	290	8	1	1	8	m	
Australian Magpie	Gymnohina tibicen	330	8	2	1	16	h	
Australian Pelican	Pelecanus conspicillatus	5,500	32	2	1	64	ex	
Australian Pratincole	Stiltia isabella	65	4	2	1	8	m	
Australian White Ibis (M)	Threskiornis molucca	2,000	16	4	1	64	ex	
Australian Wood Duck	Chenonetta jubata	810	8	4	1	32	vh	
Baillon's Crake	Porzana pusilla	29	2	1	1	2	vl	
Banded Lapwing	Vanellus tricolor	185	4	2	1	8	m	
Barking Owl (F)	Ninox connivens	583	8	1	2	16	h	
Barn Owl	Tyto alba	355	8	1	1	8	m	
Black Falcon (F)	Falco subniger	850	8	1	1	8	m	
Black Kite (F)	Milvus migrans	625	8	1	2	16	h	
Black Swan (M)	Cygnus atratus	6,270	32	4	1	128	ex	
Black-faced Cuckoo-shrike	Coracina novaehollandiae	115	4	1	1	4	l	
Black-fronted (Dotterel) Plover	Elseyornis melanops	32	2	1	1	2	vl	
Black-shouldered Kite (F)	Elanus axillaris	290	8	1	2	16	h	
Black-tailed Native-hen (M)	Gallinula ventralis	410	8	4	1	32	h	rarely flies
Black-winged Stilt (M)	Himantopus himantopus	170	4	2	2	16	h	
Bourke's Parrot	Neopsephotus bourkii	42	2	2	1	4	l	
Brolga (M)	Grus rubicundus	6,700	32	1	2	64	ex	
Brown Falcon (F)	Falco berigora	625	8	1	1	8	m	
Brown Goshawk (F)	Accipiter fasciatus	570	8	1	1	8	m	
Brown Songlark (M)	Cincloramphus cruralis	74	4	1	1	4	l	
Budgerigar	Melopsittacus undulatus	26	2	4	1	8	m	
Cape Barren Goose	Cereopsis novaehollandiae	5,000	32	2	1	64	ex	
Caspian Tern	Sterna caspia	575	8	1	2	16	h	
Chestnut Teal (M)	Anas castanea	680	8	4	1	32	vh	
Clamorous Reed-Warbler	Acrocephalus australis	19	1	1	1	1	vl	
Cockatiel	Nymphicus hollandicus	94	4	2	1	8	m	
Collared Sparrowhawk (F)	Accipiter cirrhocephalus	220	8	1	2	16	h	
Common Blackbird	Turdus merula	92	4	1	1	4	l	
Common Starling	Sturnus vulgaris	80	4	4	1	16	h	
Crested Pigeon	Ocyphaps lophotes	205	8	1	1	8	m	
Crested Tern (M)	Sterna bergii	305	8	1	1	8	m	
Crimson Rosella	Platycercus elegans	135	4	2	1	8	m	
Curlew Sandpiper	Calidris ferruginea	57	4	4	2	32	h	
Darter	Anhinga melanogaster	1775	16	1	1	16	h	
Domestic Fowl (M)	Gallus gallus	1420	16	2	1	32	h	rarely flies
Domestic Pigeon (see Rock Dove)								
Dusky Moorhen (M)	Gallinula tenebrosa	570	8	1	1	8	l	rarely flies
Emu (F)	Dromaius novaehollandiae	37,500	32	2	1	64	ex	does not fly
Elegant Parrot	Neophema elegans	44	2	1	1	2	vl	
Eurasian Coot	Fulica atra	530	8	2	1	16	m	rarely flies
European Goldfinch	Carduelis carduelis	14	1	2	1	2	vl	
European Greenfinch	Carduelis chloris	27	2	2	1	4	l	
Fairy Martin	Hirundo ariel	11	1	2	2	4	l	
Flame Robin	Petroica phoenicea	13	1	1	1	1	vl	
Galah	Eolophus roseicapillus	330	8	4	2	64	ex	
Great Cormorant (M)	Phalacrocorax carbo	2400	16	2	1	32	vh	
Great Egret (M)	Ardea alba	970	8	1	1	8	m	
Grey Fantail	Rhipidura fuliginosa	8	1	1	2	2	vl	
Grey Teal (M)	Anas gracilis	500	8	4	1	32	vh	
Hardhead (M)	Aythya australis	900	8	4	1	32	vh	
Hoary-headed Grebe (M)	Poliocephalus poliocephalus	258	8	1	1	8	l	rarely flies
Horsfield's Bronze-cuckoo	Chrysococcyx basalis	23	2	1	1	2	vl	
House Sparrow	Passer domesticus	29	2	4	1	8	m	
Latham's Snipe	Gallinago hardwickii	190	4	2	1	8	m	
Laughing Kookaburra (F)	Dacelo novaeguineae	350	8	1	1	8	m	
Little Black Cormorant (M)	Phalacrocorax sulcirostris	1,100	16	4	1	64	ex	
Little Button-quail (F)	Turnix velox	54	4	1	1	4	l	
Little Corella (M)	Cacatua samguinea	560	8	4	1	32	vh	

Common Name	Scientific Name	Mass (g)	Mass Score	Flock Score	Flight Score	Hazard Score	Hazard Rank	Notes
Little Eagle (F)	Hieraaetus morphnoides	1030	16	1	2	32	vh	
Little Egret	Ardea garzetta	330	8	1	2	16	h	
Little Grassbird	Megalurus gramineus	13	1	1	1	1	vl	
Little Pied Cormorant (M)	Phalacrocorax melanoleucos	800	8	2	1	16	h	
Little Raven	Corvus mellori	530	8	2	1	16	h	
Little Tern	Sterna albifrons	54	4	1	1	4	l	
Little Wattlebird (M)	Anthochaera chrysoptera	75	4	1	1	4	l	
Long-billed Corella (M)	Cacatua tenuirostris	590	8	4	2	64	ex	
Magpie Goose (M)	Anseranas semipalmata	2,800	16	4	1	64	ex	
Magpie-lark (M)	Grallina cyanoleuca	92	4	2	2	16	h	
Mallard (M)	Anas platyrhynchus	1,735	16	4	1	64	ex	
Masked Lapwing	Vanellus miles	360	8	2	2	32	vh	
Musk Lorikeet	Glossopsitta concinna	76	4	2	1	8	m	
Nankeen Kestrel (F)	Falco cenchroides	185	4	1	2	8	m	
Nankeen Night Heron	Nycticorax calendonicus	800	8	1	2	16	h	
New Holland Honeyeater (M)	Phylidonyris novaehollandiae	22	2	1	1	2	vl	
Noisy Miner (M)	Manorina melanocephala	65	4	1	1	4	l	
Osprey (F)	Pandion haliaetus	1,500	16	1	2	32	vh	
Pacific Black Duck (M)	Anas superciliosua	1,120	16	4	1	64	ex	
Pacific Black Duck/Mallard Hybrid	Anas sp.	~1400	16	4	1	64	ex	
Pacific Golden Plover	Pluvialis fulva	150	4	4	1	16	h	
Pacific Heron (see White-necked Heron)								
Pallid Cuckoo	Cuculus pallidus	88	4	1	1	4	l	
Peregrine Falcon (F)	Falco peregrinus	890	8	1	1	8	m	
Pied Cormorant (M)	Phalacrocorax varius	1950	16	2	1	32	vh	
Pink-eared Duck (M)	Malacorhynchus membranaceus	410	8	4	1	32	vh	
Purple Swamphen (M)	Porphyrio porphyrio	1090	16	1	1	16	l	rarely flies
Purple-crowned Lorikeet	Glossopsitta porphyrocephala	45	2	2	1	4	l	
Rainbow Lorikeet	Trichoglossus haematodus	125	4	2	1	8	m	
Red Wattlebird (M)	Anthochaera carunculata	114	4	2	1	8	m	
Red-capped Plover	Charadrius rufficapillus	38	2	2	1	4	l	
Red-kneed Dotterel	Erythrogonys cinctus	53	4	1	1	4	l	
Red-necked Stint	Calidris ruficollis	27	2	4	2	16	l	
Richard's Pipit (see Australasian Pipit)		26	2	1	1	2	vl	
Rock Dove	Columba livia	310	8	4	2	64	ex	
Royal Spoonbill (M)	Platalea regia	1,885	16	2	1	32	vh	
Rufous Songlark (M)	Cincloramphus mathewsi	35	2	1	1	2	vl	
Sanderling	Calidris alba	60	4	4	2	32	vh	
Sharp-tailed Sandpiper (M)	Calidris acuminata	75	4	4	2	32	vh	
Short-tailed Shearwater	Puffinus tenuirostris	550	8	2	1	16	l	only likely near breeding colonies
Silver Gull (M)	Larus novaehollandiae	325	8	4	2	64	ex	
Silvereye	Zosterops lateralis	11	1	2	1	2	vl	
Singing Honeyeater (M)	Lichenostomus virescens	28	2	1	1	2	vl	
Skylark	Alauda arvensis	38	2	1	2	4	l	
Southern Boobook (F)	Ninox novaeseelandiae	300	8	1	1	8	m	
Spotless Crake (M)	Porzana tabuensis	45	2	1	1	2	vl	rarely flies
Spotted Harrier (F)	Circus assimilis	670	8	1	2	16	h	
Spotted Turtle-dove	Steptopelia chinensis	160	4	1	1	4	l	
Straw-necked Ibis (M)	Threskiornis spinicollis	1,465	16	4	1	64	ex	
Stubble Quail (F)	Coturnix pectoralis	105	4	1	1	4	l	
Sulphur-crested Cockatoo	Cacatua galerita	790	8	2	2	32	vh	
Superb Fairy-wren	Malurus cyaneus	10	1	2	1	2	vl	
Swamp Harrier (F)	Circus approximans	870	8	1	2	16	h	
Tree Martin	Hirundo nigricans	15	1	2	2	4	l	
Wedge-tailed Eagle (F)	Aquila audax	3,950	16	1	2	32	vh	
Welcome Swallow	Hirundo neoxena	15	1	2	2	4	l	
Whiskered Tern (M)	Chlidonias hybridus	90	4	2	2	16	h	
Whistling Kite (F)	Haliastur sphenurus	910	8	1	2	16	h	
White-bellied Sea-Eagle (F)	Haliaeetus leucogaster	3,200	16	1	2	32	vh	
White-browed Woodswallow	Artamus superciliosus	35	2	2	2	8	m	
White-faced Heron (M)	Ardea novaehollandiae	600	8	1	2	16	h	
White-fronted Chat	Epthianura albifrons	13	1	2	1	2	vl	
White-necked Heron	Ardea pacifica	880	8	1	2	16	h	
White-plumed Honeyeater (M)	Lichenostomus penicillatus	20	1	1	1	1	vl	
White-winged Fairy-wren	Malurus leucopterus	8	1	2	1	2	vl	
Willie Wagtail	Rhipidura leucophrys	20	1	1	1	1	vl	
Yellow-billed Spoonbill	Platalea flavipes	1,820	16	2	1	32	vh	
Yellow-rumped Thornbill	Acanthiza chrysorrhoa	9	1	2	1	2	vl	
Yellow-tailed Black-cockatoo	Calyptorhynchus funereus	700	8	2	2	32	vh	