From: [redacted]
Sent: Friday, 5 October 2018 10:54 AM
To: Ives, Kieran
Cc: Rutledge, Geoffrey
Subject: Re: bird review [SEC=UNCLASSIFIED]
Attachments: pages 3&21.pdf

No problem, the two pages (in colour) are attached.

Best,

[redacted]

On Fri, Oct 5, 2018 at 10:45 AM Ives, Kieran <Kieran.Ives@act.gov.au> wrote:

> Thanks [redacted] – Both for providing a copy of the study and understanding our email server's limitations.
>
> As discussed, would it be possible to receive a high resolution and colour version of pages 3 and 21.
>
> Thanks again
>
> Kieran
>
> Kieran Ives | Executive Officer to Deputy Directors-General
>
> Environment, Planning and Sustainable Development Directorate | ACT Government
>
> Phone: (02) 6205 9095 | Email: kieran.ives@act.gov.au
>
> Level 3 Dame Pattie Menzies House, 16 Challis Street, Dickson, ACT | GPO Box 158, Canberra 2601
>
> **From:** [redacted]
> **Sent:** Thursday, 4 October 2018 5:18 PM
> **To:** Ives, Kieran <Kieran.Ives@act.gov.au>; Rutledge, Geoffrey <Geoffrey.Rutledge@act.gov.au>
> **Subject:** Fwd: bird review

commercial in confidence

Kieran / Geoff,

My apologies about the first file being too large, please see the original email message below, and a smaller file attached.

Best,

---------- Forwarded message ---------
From: 
Date: Thu, Oct 4, 2018 at 10:48 AM
Subject: bird review
To: <Kieran.Ives@act.gov.au>, <Geoffrey.Rutledge@act.gov.au>
Cc: 

commercial in confidence

Good morning Kieran and Geoff,

Please find attached the fauna study conducted by NGH Environmental. Our apologies for the delay in getting this to you. If you have any questions, please don't hesitate to reach out.

Best,

--

Wing

Public Policy, Australia

x.company/wing/australia

--

Wing
Public Policy, Australia
x.company/wing/australia

Project Wing Fauna Study

DRONE OPERATIONS IN CANBERRA (FINAL REPORT)

OCTOBER 2018

ngh environmental

www.nghenvironmental.com.au

CONTENTS

EXECUTIVE SUMMARY iii

1 INTRODUCTION 1

1.1 PROJECT BACKGROUND AND UNDERSTANDING 1

1.2 STUDY OBJECTIVE 1

1.3 STUDY SCOPE 2

1.4 STUDY AREA AND SITE CONTEXT 2

2 METHODS 4

2.1 LITERATURE AND DATABASE REVIEW 4

2.2 THREATENED OR SIGNIFICANT SPECIES 4

3 DESKTOP ASSESSMENT FINDINGS 5

3.1 A REVIEW OF DRONE AND WILDLIFE INTERACTION 5

3.1.1 Drones disturbing wildlife 5

3.1.2 Attacks on drones 7

3.1.3 Collisions with drones 7

3.1.4 Habitat displacement or alienation 7

3.1.5 Summary of key risk factors 8

3.2 A REVIEW OF PROJECT WING RISK PARAMETERS 8

3.3 REVIEW OF WILDLIFE IN THE OPERATION AREA 10

3.3.1 Types of animals most likely to be disturbed 10

3.3.2 Threatened and listed migratory species 12

3.3.3 Common species 13

4 SUMMARY OF POTENTIAL RISKS 16

4.1 ANALYSIS SUMMARY 16

4.2 POTENTIAL FOR A SIGNIFICANT IMPACT 18

4.3 POTENTIAL RISK AREAS 19

5 MEASURES TO MINIMISE IMPACTS TO WILDLIFE 22

5.1 PRINCIPLES FOR INTERACTIONS BETWEEN DRONES AND WILDLIFE 22

5.2 RECOMMENDATIONS FOR PROJECT WING 22

5.2.1 Operational management measures 22

5.2.2 Response to identified risk 23

5.2.3 Consultation (proposed) 25

5.2.4 Project Wing – expansion into new areas 26

6 CONCLUSION 27

7 REFERENCES 28

APPENDIX A THREATENED AND MIGRATORY SPECIES DATABASE SEARCHES ..... A-I

APPENDIX B THREATENED AND MIGRATORY SPECIES RECORDS IN THE OPERATIONS AREA ..... B-I

TABLES

Table 3-1 Review of project parameters in relation to risk factors 8

Table 3-2 Threatened or migratory species that may be disturbed by drones and the likelihood of habituation 14

Table 3-3 Common birds and bats that may be disturbed by drones, and the likelihood of habituation 15

Table 5-1 Best practice principles for drones and wildlife 22

Table 5-2 Summary of response to a suspected or confirmed impact to wildlife 25

Table 5-3 Proposed consultation 25

FIGURES

Figure 1-1 Operations base (blue plane icon) and current test area (green shading). Image provided by client. 3

Figure 3-1 General shape of Project Wing aircraft is similar to that of a fixed-wing drone, with the addition of struts to carry hover props. Image provided by client. 9

Figure 4-1 Project Wing - potential risk areas for fauna 21

EXECUTIVE SUMMARY

Project Wing is a drone delivery project being undertaken by X (formerly Google [x]), in the Australian Capital Territory. The trial drone (i.e. unmanned aerial vehicle) delivery operation was recently commenced (2017) from a base at Rowland Rees Crescent, Greenway, Canberra. The (trial) service to date has involved home delivery of items such as medications, takeaway food and other small goods.

The objective of this report is to enable better understand the current and potential impacts of the drone delivery operation on native fauna (primarily birds) in order to recommend management measures which will minimise harm to wildlife. This has been achieved through a literature review, including use of available online databases to obtain information on known interactions between drones and avifauna, as well as to identify potential significant species known to occur in the operations area that may be particularly at risk from the project.

This report also considers potential requirements for further targeted research (i.e. field-based monitoring surveys) and suggests potential matters that could be discussed in consultation with relevant government agencies, or other organisations, such as local universities or specialist interest groups.

Drones have been found to impact certain wildlife types, including mammals and birds. The literature reviewed for this report pointed to four main issues associated with drone and native wildlife interaction, including disturbance leading to behavioural change, attacks on drones or direct collisions that could injure or kill fauna, and potential habitat alienation.

Key risk factors which increase the likelihood for wildlife impacts include:

- the angle of drone approach
- flight altitude
- flight speed
- flight volume/frequency
- resemblance of drones to raptors
- flights during breeding season
- potential (aggressive) territorial behaviour of certain species.

Project Wing parameters were considered against these risk factors, with consideration of the ecological characteristics/traits of both threatened and common (native) species that are known to occur in the operations area to identify whether any particular species or groups of animals may be potentially at risk from the project.

In undertaking this review, it was found that Project Wing has the potential to affect native fauna, particularly threatened migratory birds and resident raptors, however the level of impact is not considered likely to be significant[1].

The risk of impacts to fauna is mitigated by the following Project Wing parameters:

- flights largely expected within the ACT urban footprint
- limited flights anticipated over intact (remnant) vegetation
- direct flight path from pick-up to drop-off

[1] Note that Assessments of Significance in accordance with the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* Significant Impact Criteria have not been undertaken given the lack of field data for the Canberra project to support a detailed impact assessment against the relevant criteria.

- drone flights at relatively high speed (120 km/hr) with limited 'hovering' that might encourage raptor attack
- drones as quiet or quieter than average motor vehicle.

These conclusions are supported by anecdotal results of the trial operations to date, with almost 4,000 flights successfully completed in the ACT and surrounds and no reported failures or other problems (that could potentially be attributed to an interaction with birds).

The literature review also substantiated current practices and recommended additional approaches to minimise potential impacts to wildlife. The likelihood of disturbance or negative interactions (e.g. collisions) can be reduced by continuing to implement the following:

1. Limited flying over sensitive areas, with flights over Murumbidgee Corridor to remain within 100 m of nature reserve/urban interface (i.e. edge)
2. Vary flight height if necessary
3. Avoid using 'fast climb' flight features
4. Fly light coloured drones.

Additional recommendations include:

5. Develop a fauna incident procedure, incorporating a responsive fauna monitoring program
6. If expanding operations into new geographic areas, conduct a desktop review of site specific ecological values.

This report was prepared for Project Wing in response to their desire to understand more fully the potential risks associated with the drone trial, and to consider recommendations for mitigating potential impacts. The report was based entirely on a desktop review of the available literature on drone and avifauna impacts, and not informed by any field survey assessments or direct monitoring of the drone trial. The report was prepared for internal consideration and discussion between Project Wing officers and NGH Environmental, and was not prepared to address any legislative requirements, statutory impact assessment or approval processes.

1 INTRODUCTION

1.1 PROJECT BACKGROUND AND UNDERSTANDING

Project Wing is a drone (i.e. unmanned aerial vehicle; UAV) delivery project being undertaken by X (formerly Google [x]), which recently commenced (2017) from a base at Rowland Rees Crescent, Greenway, in the Australian Capital Territory (ACT).

It is understood that the delivery operations are set to increase in frequency as the project moves from a trial phase to the intended full delivery operations service that will cover most of the ACT and will potentially extend into the immediately surrounding areas of New South Wales (NSW). As part of the proposal to upgrade the project to a fully operational delivery service, Project Wing will require a better understanding of the current and potential impacts of the operations on native fauna (primarily avifauna) populations in the ACT region, to ensure that appropriate due diligence has been completed and that the project adheres to best practice principles in order to minimise harm to fauna.

The current base of operations is at Greenway ACT, which has been constructed to house food trucks, other temporary shelters (shipping containers and ATCO huts), vehicles and up to 100 small UAV drones. The hours of operation of this facility are currently 8 am - 4pm Thursday to Sundays. Drone operation will be within defined areas of the project operations map (refer to Figure 1-1 for the current test area), and drones will typically fly at varying altitudes between 0 m and 40 m above ground level, with average speeds in transit of approximately 120 km/h. At this stage, the (trial) delivery service involves home delivery of pharmacy items, take away food and various other small goods. It is understood that approximately 4,000 flights have already been undertaken from the Greenway base, with no reported incidents involving collisions with avifauna.

1.2 STUDY OBJECTIVE

The project objective is to assess the possible risks and associated potential impacts of the (current and future) impacts of Project Wing operations on native fauna (primarily birds), to enable Project Wing to adopt best practice management principles which minimise harm to wildlife.

This project aims to:

- inform the project team about possible interactions between drones and avifauna
- review significant fauna species known or likely to occur in the area, and consider their risk of being impacted by drone operations
- consider the potential for further study, including recommendations for any detailed scientific studies or monitoring to better understand risks and impacts
- suggest government agencies that should be consulted with, including a preliminary summary of the particular matters/topics that could be discussed with each agency.

This assessment is not a detailed impact assessment of the project, as the risks and potential impacts have been inferred from the literature review only. Future field surveys would support a more rigorous assessment, which could be required to satisfy regulatory processes or may be an appropriate response to an identified risk (i.e. Section 5.2.2).

1.3 STUDY SCOPE

This project draws on published literature and a desktop assessment of wildlife values within the study area. The scope of this review has been to advise on the following questions:

1. What does existing research tell us about the possible effects of drone operations on wildlife (particularly avifauna (birds), but also considering any available information in relation to other fauna groups including arboreal mammals such as bats and gliders, and to a lesser extent, terrestrial fauna)?
2. What are the likely/potential impacts of the operations from the Greenway base on nearby nesting birds?
3. What are the likely/potential impacts of missions on transient wildlife?
4. Are there any known listed threatened[2] avifauna species in the area in which operations are expected to occur that the project needs to be aware of? If so, could Project Wing operations cause potential impacts on these species? Are there any spatial or temporal (e.g. diurnal or seasonal) characteristics of potentially impacted species that the project needs to be aware of to minimise possible impacts as the future operations plan is developed?
5. What possible technical and operational measures should Project Wing consider in the future to ensure minimal negative impacts on avifaunal populations in the future?

1.4 STUDY AREA AND SITE CONTEXT

Base and operating area

The operating base is located in the suburb of Greenway in the far southwest of Canberra (Block 18, section 46, Greenway). The operating base is where the drones are housed and operated from. The current test area for Project Wing incorporates the suburbs of Bonython and Gordon (Figure 1-1). The operating area is expected to increase, however any expansion is out of scope for the present study.

For the most part the test area is within suburban zones, although there are a number of terrestrial and aquatic habitat areas that would provide habitat for fauna (including birds), such as scattered woodland and the Murrumbidgee River.

Environmental features

The focus in considering the surrounding environmental features has been the operating base, as this is where the highest volume of drone traffic will be concentrated. The base is within 500 m of Pine Island Reserve and the Murrumbidgee River. The river runs from the north-west corner of the test area along the western boundary (Bicentennial National Trail), for a length of approximately 300 m.

The Murrumbidgee River Corridor includes nature and recreation reserves, with both Pine Island Reserve and Point Hut Crossing in the vicinity of the test area (ACT Environment, Planning and Sustainability Directorate [EPSDD] 2016). The Murrumbidgee River Corridor is considered an important habitat, refuge and movement corridor for birds (Canberra Ornithologists Group 2017, Ginninderra Falls Association 2013). For example, Wedge-tailed Eagle is known to nest along the river corridor (Canberra Ornithologists Group undated).

Pine Island Reserve is a recreational reserve, popular for swimming and picnics (EPSDD 2018). The Bicentennial National Trail in this area is also called the Murrumbidgee Discovery Trail, a recreational hiking

[2] 'Threatened' species are those as defined in Section 2.2.

trail. The test area incorporates Mt. Stranger, which at approximately 660 m height rises around 100 m above the surrounding Tuggeranong Valley and is part of Canberra Nature Parks. The habitat of Mt. Stranger consists of open grassy areas with loose medium size rock, and it is a popular bushwalking site (Canberra Bushwalking Club 2014).

Lower Stranger Pond lies north of Mt. Stranger, and is within the test area. Lower Stranger Pond is primarily a water quality management pond, however receives a low level of use as an informal recreation reserve (Urban Services 2001). It is considered of low importance as fauna habitat (Urban Services 2001). Ginninderra Catchment Group (2017) show Lower Stranger Pond to be an area of open water with fringing vegetation (e.g. reeds and grasses) surrounded by mown grass and occasional nearby trees. Fauna species that can be seen there include Eurasian Coot and several common species of frog including Common Froglet *(Crinia signifera)* and Striped Marsh Frog *(Limnodynastes peronii)* (Ginninderra Catchment Group 2017). A Friends of Strangers Pond group has been established which aims, amongst other things, to "safeguard the integrity of the area." (Southern ACT Catchment Group 2014). A variety of waterbirds are also likely to use this feature on a (semi) regular basis.

Figure 1-1 Operations base (blue plane icon) and current test area (green shading). Image provided by client.

2 METHODS

This desktop assessment has been undertaken in the following steps:

1. Literature review to identify key risk factors for negative wildlife interactions with drones.
2. Review of Project Wing in relation to key risk factors.
3. Identification of species of concern based on literature review and relevant databases, with a focus on threatened or protected species.
4. Identification of measures that would reduce any potential impacts upon wildlife.

2.1 LITERATURE AND DATABASE REVIEW

The following databases were used to inform this review:

- Commonwealth EPBC Protected Matters Search: http://www.environment.gov.au/webgis-framework/apps/pmst/pmst
- ACTMapi Significant Species and Vegetation Communities database: http://app.actmapi.act.gov.au/actmapi/index.html?viewer=ssvcrt
- Wildlife records obtained from the Atlas of Living Australia (ALA) database: http://spatial.ala.org.au

  For the above database searches, the following is noted:

  - The EPBC protected matters search was undertaken on 1 June 2018 using a latitude/longitude point for the suburb of Greenway (-35.41867, 149.06349), with a buffer of 10 km. The client provided a latitude/longitude point for the operations base in late June (-35.425491, 149.066106). It is considered that the two points are sufficiently similar that the EPBC protected matters search does not need to be updated. The EPBC search returned 19 threatened fauna (including eight birds) and 13 listed migratory species. The search results are provided in Appendix A.
  - The ACTMapi Significant Species and Vegetation Communities database was also investigated for records of listed threatened species in the region. However, whilst the database provides good reliable records for a number of threatened flora and fauna types, it currently does not provide a records layer for birds (currently in preparation). As such, this database does not provide any records for birds, threatened or otherwise. For this reason, the ALA database was also used.
  - The ALA database search informed whether the threatened and migratory species returned from database searches are known to occur in the operations area. Search results are provided in Appendix B.

2.2 THREATENED OR SIGNIFICANT SPECIES

Threatened or significant species refers to those which are listed as:

- Critically Endangered, Endangered, Vulnerable or Migratory under the EPBC Act.
- Endangered and Vulnerable under the ACT NC Act.

The particular species which have been identified by this review as being potentially at risk from the project are described in Section 3 and listed in Tables 3-2 and 3-3.

3 DESKTOP ASSESSMENT FINDINGS

3.1 A REVIEW OF DRONE AND WILDLIFE INTERACTION

Four interrelated issues come up when reviewing the literature on animal interactions and drones:

1. Drones disturbing wildlife.
2. Birds (mostly large raptors) attacking drones.
3. Animal collision with drones.
4. Aerial habitat disruption.

To disturb is to cause a reaction in response to stimulus. In studies looking at drone flights and disturbance on birds, this was defined as the animal showing signs of vigilance (e.g. watching drone while foraging) and/or moving away from the drone, either slowly walking or swimming or in higher states of disturbance, flying (Vas et al. 2015, McEvoy et al. 2016). However, at least one study has found that behavioral signs may be insufficient to detect disturbance; physiological signs such as increased heartrate is more precise (Ditmer et al. 2015). Further, reactions to the disturbance may extend temporally beyond the immediate study period (e.g. Ditmer et al. 2015). Ongoing disturbance may affect foraging behavior, breeding success and local population size. However, it is difficult to link an animals' response to disturbance and population level impacts (Lambertucci et al. 2018).

3.1.1 Drones disturbing wildlife

There has been some research into the disturbance caused by drones upon wildlife, particularly birds. For example, Vas et al. 2015 tested the reactions of three different shorebird species in France using a small quadricopter flying at different speeds and approach angles. They recorded no reaction in the birds 70 to 87% of the time, with a clear exception being when the birds were approached directly from above. In this case, the birds usually moved away.

McEvoy et al. (2016) tested five different drone models on wild shorebirds at inland wetlands in NSW, including both fixed wing and multirotor models, finding a greater level of disturbance response than Vas et al. 2015 for some drone models. For four of the models, there was no disturbance response in the birds when the drone was flying above 60 m. One fixed-wing model (the Drone Metrex Topodrone-100) has a profile which resembles a White-bellied Sea-eagle. This model had the greatest impact and caused a disturbance response in the shorebirds when the drone was flying up to 80 m altitude (although the shorebirds' reaction was not as strong to the drones as to actual avian predators). The take-off of all fixed-wing models caused birds to take flight. Both multirotor models tests caused only vigilance responses at lower altitudes (below 50 m) and on take-off when close to the birds (within 15 m). No response was recorded at higher altitudes.

These studies (Vas et al. 2016, McEvoy et al. 2016) were undertaken on waterbirds, which are generally known for being particularly vigilant and sensitive to disturbance compared to, for example, songbirds. However, another Australian study (Lyons et al. 2016) found that colonial nesting birds (in this case, Straw-necked Ibis) were less disturbed by drones than solitary nesting birds (e.g. Australian Magpie, Pied Currawong). Lyons et al. (2018) conclude that the disturbance relates to the territoriality of the bird species and suggest that drones flying around non-territorial birds generally causes low level of disturbance even during breeding (e.g. brief flushing from nest).

However, behavioral changes may not always be a useful indicator that an animal is stressed, particularly for larger mammals. For example, Ditmer et al. (2015) found that although black bears did not usually exhibit a behavioral response (such as running away) to drone flights, heartrate monitors on the wild bears indicated substantial increases in heartrate. These flights were within 43 m of the bears and generally around 20 m altitude. When ambient noise (such as wind) prevented the bear from detecting the drone prior to sighting it, the stress response was more pronounced (i.e. the bear was startled). The bears recovered to a normal heartrate within 15 minutes. However, repeat flights appear to have caused one bear (with cubs) to move nearly 7 km into another bear's territory where it had not been previously recorded, within 24 hours of the disturbance event.

One field of study considered whether the drones' sound travelling through the water might interfere with the acoustic communication used by marine mammals (Christiansen et al. 2016). They found the noise of the drone did not travel far through water and was not at a frequency detectable by many marine mammals (Christiansen et al. 2016).

Acoustic disturbance may be relevant for animals that use sonar to navigate such as microbats. The proposed hours of operation for Project Wing would generally overlap with the early twilight activity time of microbats (except for summer). Bat researchers are starting to use drones to monitor microbat populations, and the loud ultrasonic frequencies emitted by the drone engines appear not to hamper the research efforts (and therefore presumably do not interfere with bat echolocation) (Baraniuk 2017). Researchers have used a small multirotor drone to hover at varying heights (5 to 50 m) at a cave roost's entrance in New Mexico when microbats leave to forage at night in order to detect the echolocation calls – with no apparent negative effect upon the bats although the bats were seen to actively avoid collision with the drone (Fu et al. 2017, Langin 2018).

Generally, the impact of drones upon mammals is poorly documented or studied – with the exception of marine mammals – and there is instead some reliance on anecdotal evidence. A drone flying in Zion National Park in the United States reportedly caused a flock of Bighorn Sheep to scatter and young were separated from their parents (US National Park Service 2014). However, no information was available about the type or size of drone nor the distance that the drone flew to the sheep. Further, another document (about effects of hang gliding in National Parks) notes that sheep are particularly sensitive to disturbance, along with raptors, goats and caribou (Parks Canada 2015). In the Netherlands in 2015, a drone circling a chimpanzee enclosure at the zoo was pursued and swatted out of the air by one of the chimps using a long branch, suggesting that the drone was causing a disturbance (National Geographic 2015).

The flight height of drones appears to be an important factor in whether animals are disturbed. Rummler et al. (2015) found penguins were at the highest state of vigilance with drones flying at less than 20 m above ground level. Drones are being used at low altitude (20 m) above the canopy to scare away foraging flying-foxes (and lorikeets) from fruit crops in Queensland (Buchanan 2015). Although using drones has been touted as a potential management option for disbanding unwanted flying-fox camps (EcoLogical 2016), a flying-fox colony was not disturbed (upon returning to the camp at pre-dawn) by a close-flying drone (within 20 m of colony) (Backhouse 2017).

Not all drone flights negatively affect animals. Drones are increasingly being used for wildlife surveys, especially in remote or vast areas (Wallace et al. 2018, McEvoy et al. 2016). Thus, drones can be operated in a way which does not cause disturbance to wildlife, and a code of practice has been developed in Australia (refer to Section 5.1). For example, drones are being used to study (count) Koalas in Queensland (QUT 2017), with no apparent disturbance to the animal. Drones are being used to monitor bird populations, identify Orangutan nesting, map Bettong warrens and habitat, and more (University of Adelaide 2017).

Animals can habituate to an ongoing disturbance type in their environment (Ditmer et al. 2015). For example, birds have been found to habituate to 'novel shapes' flying above them (McEvoy et al. 2016) and habituation is likely to occur in an area of high use such as the planned operations area for Project Wing.

3.1.2 Attacks on drones

There are anecdotal reports of Wedge-tailed Eagles attacking drones which often seem to involve a measure of disturbance to the bird also. For example, drone pilots list 'tiring' the bird by evasive flight as one way of reducing attacks when moving the drone to another area is not an option (Waypoint 2017). This energy cost has potential to affect bird behavior and population ecology, particularly if persistent in one location. Anecdotal evidence also shows that evasive drone flight features (such as 'fast climb') can cause collisions between attacking birds and drones, with potential for injury to birds from the rotors (Waypoint 2017). Wedge-tailed Eagles also appear to pose a major threat to drones, with numerous anecdotal reports online of drones being attacked and destroyed.

One study found that raptors do not attack in every instance of a drone flying past, including flights within 100 m, 50 m and 15 m of Wedge-tailed Eagles, Black Kites and Nankeen Kestrels (Lyons et al. 2018). However, this study intentionally chosen to fly the drones early in the day so as to avoid the period when raptors are most active – in the afternoon when thermals have developed - and this may have affected bird behaviour. The drones also did not appear to affect raptor foraging behaviour or success (Lyons et al. 2018).

Canberra has a healthy population of raptors, with at least 12 species known to breed in the region (Fuentes 2005). Many raptors are strongly territorial (Fuentes 2005).

3.1.3 Collisions with drones

Bird attacks on drones can lead to collisions. Other birds (in addition to those discussed above) that are known to pursue and attack drones are Australian Magpies, Australian Kestrels and Brown Falcon. Collisions can also occur with drones accidentally or incidentally. For example, there is an anecdotal report of seagulls colliding with a drone when the birds did not alter their course of flight (i.e. give way to the drone). In this case, the drone crashed into the water and the seagulls appear to have been unscathed. The potential for collision between flying-foxes and drones has been given as a reason not to use drones to deter large numbers of flying-foxes at unwanted camps (EcoLogical 2016).

3.1.4 Habitat displacement or alienation

In theory, a regular or high volume of drone flights in a particular area have the potential to disturb animals to the point where they no longer occupy or utilise that space. This is known as habitat displacement or habitat alienation. Long term or permanent habitat alienation has been clearly demonstrated at overseas and offshore wind farms where rows of turbines create a barrier, but has yet to be demonstrated at Australian terrestrial wind farms (Masden et al. 2009, Hull and Muir 2013, EPHC 2010, Hull 2013). In part this is due to wind farm design, and in part due to different behaviour of Australian bird species compared to those in the northern hemisphere, particularly with regard to migration. While the magnitude of impacts related to wind turbines cannot be reasonably compared to drone use, the wind farm example demonstrates how habitat displacement could lead to significant impacts. Habitat displacement can also be caused by artificial lighting, frequent or constant noise, presence of pest animals or pets (dogs/cats) and other anthropogenic influences.

Habitat alienation does not appear to have been specifically considered in the literature for drones and wildlife, although passing reference to the risk can be found anecdotally. For example, DEW (2013) warn of drones disturbing nesting raptors and recommend that drones avoid known nesting areas. Habitat alienation for raptors due to increasing urbanisation is already a phenomenon documented in Canberra (e.g. Olsen & Fuentes 2005).

3.1.5 Summary of key risk factors

The key risk factors for wildlife disturbance, attacks, collisions and habitat alienation appear to be:

1. Angle of approach to wildlife – approach directly from above most disturbing (Vas et al. 2015)
2. Flight altitude - low altitude flight (less than 20 m above ground level) most disturbing (Lambertucci et al. 2018, Ditmer et al. 2015)
3. Volume of flights – most studies have been undertaken with one drone at a time.
4. Resemblance of drone to raptors – including size and shape.
5. Breeding – animals are most likely to be disturbed during the breeding season (Ditmer et al. 2015)
6. Territorial vs. non-territorial species – territorial species are more likely to be disturbed (Lyons et al. 2018)

3.2 A REVIEW OF PROJECT WING RISK PARAMETERS

The table below provides a review of the parameters of the Project Wing aircraft and flight style in relation to the identified key risk factors (Section 3.1.5). Only risk factors 1-4 are considered in this section as the remaining risk factors (i.e. 5, 6) relate to animals in the vicinity rather than project parameters.

Consideration of whether the below identified risk factors could lead to a significant impact on wildlife is presented in Section 4.2, with recommendations for how Project Wing can further mitigate against risk factors provided in Section 5.2.

Table 3-1 Review of project parameters in relation to risk factors

Risk factor	Project Wing parameters	Comments
Angle of approach	Vertical takeoff and landing.	Angle of approach directly overhead during takeoff and landing. Disturbance could be mitigated by avoiding fast climb/descent.
Flight altitude	Generally within or close to 20 m above ground level. Descend to and hover at 7 m for pick-up and drop-off.	Low altitude flight. Majority of bird flight is at or below 20 m.
Flight speed	Approximately 120 km/h. Speed is attained quickly and maintained to destination.	Speed likely too fast to allow attack.
Volume of flights	1 – 3 aircraft during the test phase	Relatively low volume of flights, not inconsistent with likely recreational drone usage.
Flight paths	Flights paths are direct between destinations and generally across	Relatively low volume of flights over intact remnant woodland areas where

Risk factor	Project Wing parameters	Comments
	urbanized areas. A low number of flights may occur over more natural landscapes, including nature reserves and other open spaces supporting woodland habitats.	more sensitive species may occur reduces probability of negative impacts.
Size of drone	Width: more than 1 m (1040 mm) Length: 1.2 m (1250 mm) Depth: 25 cm (254 mm)	Wingspan similar to a small to medium raptor such as Brown Falcon (88-115 cm) or Little Eagle (100-136 cm) but overall length is longer than most raptors.
Shape of drone	Similar to a fixed wing drone with additional struts for hover props.	Generally not similar to a bird shape (length is greater than width), and struts break up the raptor-like profile (Figure 3-1). Low potential to be mistaken for a bird in poor lighting.
Noise	Generally quiet operation (electric brushless motors). Quieter than average motor vehicle.	Noise from drones at any point would be minimal given low sound emissions and height, and of short duration.

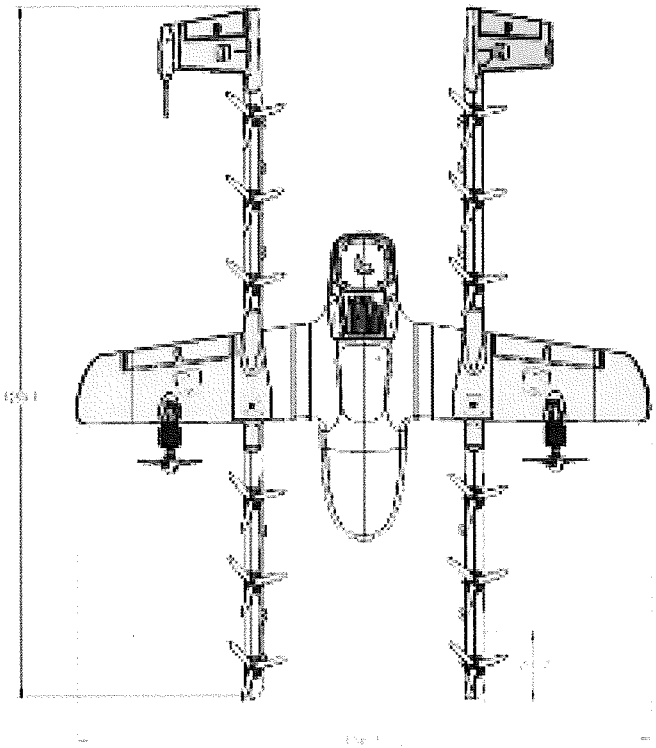


Figure 3-1 General shape of Project Wing aircraft is similar to that of a fixed-wing drone, with the addition of struts to carry hover props. Image provided by client.

3.3 REVIEW OF WILDLIFE IN THE OPERATION AREA

3.3.1 Types of animals most likely to be disturbed

Based on the literature review, the animals most likely to be disturbed by the nearby operation of drones are:

1. Animals with young (including mammals).
2. Animals that typically fall prey to small to medium raptors (e.g. small mammals, birds, reptiles).
3. Territorial birds, particularly during nesting and breeding periods (including Australian Magpies and raptors).
4. Birds that mistake drones as an intruder in territory (closely linked to the point above, territorial birds).
5. Birds and bats that may be susceptible to collision with drones (in addition to those listed in the literature review, this may include large-bodied birds with low maneuverability).

In addition to this list, birds tend to exhibit behaviour that indicates disturbance more often than mammals. Birds, as a group, are therefore taken to suffer disturbance more readily than other animals, and the remainder of this report is more focused on the effect upon birds than mammals or reptiles, although these other fauna types may be discussed where relevant.

Animals with young

Assuming almost any animal with young may be disturbed by drone operation (as in point 1 above) leads to the assumption that just about any fauna species could be at risk from Project Wing. The main impact likely to occur in relation to disturbance of animals with young is associated with noise emitted from the operations of the drones.

In considering the potential risks from operational noise, the drones utilise electric motors that are relatively quiet, and generally at or below the noise levels of an average motor vehicle. The majority of flights will be within the more built-up suburban areas of the ACT, and less likely to occur with west of the Greenway base towards the Murrumbidgee River Corridor, or with any frequency in the larger areas of remnant woodland, such as in the identified ACT Nature Reserve system (see Section 4.3). Given the low noise emissions from the drones, and the majority of operational flights to be in areas where there are already existing ambient noise levels associated with general human activity (including noise from traffic, televisions/music, operation of lawn mowers and whipper snippers etc), the noise emissions from the project are not expected to be substantially greater or otherwise notably contribute toward any increase in these existing ambient noise levels to the extent that they are likely to impact on animals with young.

In addition to this, it is likely that for many animals that already occur in the urban areas of the ACT, including many larger birds that may be more prone to negative interactions with drones, it is reasonable to assume that these animals, being already adapted to human activity, would eventually habituate to the regular flight of drones in their neighbourhood.

Further to the above, for less common or threatened fauna types where there may be some concern over local population level impacts associated with interruptions to breeding success (including threatened Superb Parrot, Little Eagle, Painted and Regent Honeyeaters, as well as common Robins, and Wedge-tailed Eagles and other raptors, refer to Tables 3.2 and 3.3), many of these species (including suitable available nesting habitat) are typically restricted to the more intact woodland areas, including the Murrumbidgee River Corridor west of the Greenway base, as well as more broadly in the ACT Nature Reserves (such as

most of the areas identified as Hill Ridges and Bushlands in the ACT National Capital Plan, see Section 4.3). Records of these species have been made within the suburban areas and so their presence in these areas cannot be discounted in these areas, although, as stated above, resident fauna of suburban areas (threatened or otherwise) are not considered likely to be affected by drone noise because of the existing ambient noise levels and the increased likelihood to be able to adapt to any noise from drones operating in these areas.

Flights over larger areas of intact remnant bushland are therefore considered to have greater potential to result in negative impacts from drone operations on animals with young. However, given these flights are likely to be infrequent, as well as the overall low noise levels of the drones, the overall level of risk of substantially disturbing animals with young (to the point of affecting breeding success) is considered to be low. Notwithstanding this, any proposal to operate drones over areas of intact remnant bushland should be considered in more specific detail (to the particular area where the flights may occur) and should also be considered for an ongoing monitoring or pilot study to determine if negative effects are observed.

In addition to the above, two long occupied flying-fox camps are known in the ACT: one occurs along Lake Burley Griffin in Canberra city and the other along Lake Ginninderra. Neither of these locations are close to the base or near the proposed operations area (of Stages 1 to 4), and Project Wing is therefore unlikely to cause a disturbance to these colonies of flying-foxes, including any animals with young. Future operations in these areas would however need to be considered in more detail to ensure that potential impacts to any animals with young within these colonies are minimised. The risk of Project Wing causing a negative impact on flying-fox is considered unlikely, given the low noise of drones, likely limited frequency of flights in or near the area of the camps (and specifically, that drones would not hover around the camp for any length of time, but rather would occasionally swiftly fly past the camp).

Animals preyed upon by small to medium raptors

Many of the smaller to medium-sized birds listed as threatened under the EPBC Act and the NC Act (i.e. Honeyeaters, Robins and possibly parrots, refer to Table 3-2 may be preyed upon by medium to large sized raptors. As such, these birds may potentially mistake a raptor-like drone as a predator and become unnecessarily disturbed. Consequently, if drones were to operate regularly in areas where these threatened species occur (such as in larger intact remnant woodland patches and riparian corridors, although to a lesser extent they may also in and along the urban fringes), there is the potential that the extant individuals could begin to avoid the area, which would then lead to a form of habitat alienation. This would be particularly problematic in areas of important breeding habitat, as that breeding habitat could be essentially lost to the species if individuals avoided those areas due to drones.

Many of these birds have been previously recorded in or near the operations area (refer to Appendix B). The overall risk to these small to medium sized bird species from this impact is largely dependent upon the species' ability to habituate to the occurrence of drones, as discussed in the next section. However, the level of risk is considered to be reduced by the fact that the drones fly at relatively high speed, and only stop to hover at the destination (pick/delivery) points, are located in urban areas, and will infrequently, if at all, fly over remnant woodland, where better quality habitat occurs. As a result, the frequency or duration of disturbance (drones flying overhead) is likely to be low, and consequently, the level of risk of drones alienating animals preyed on by raptors, is also considered to be low.

Habituation

As mentioned, animals can habituate to disturbance in their environment (Murfin 2017) including drones (Barnas et al. 2017), particularly when the disturbance becomes regular and predictable. For example, the

AeroDrone Avian Scout (used to scare birds from crops) makes use of random flight paths and times to "protect against" habituation of birds (Bask Industries 2016).

As the predominant flight paths of the drones are expected to be over suburban areas, the fauna types that typically inhabit these areas are likely to become habituated to their presence.

The main risks include circumstances that may change a species behaviour, such as breeding season behaviour (for example, Australian Magpie is common in the urban areas and can become territorial and aggressive in the breeding season, which may make them more prone to attacking drones), as well as flights into non-urbanised areas, particularly on an infrequent basis where local fauna are less likely to become acclimatised to the occurrence of drones.

Importantly, the use of drones is not expected to result in any alienation impacts whereby a group of sensitive (or threatened) fauna are likely to avoid an area because of the drones, although the area immediately surrounding the base which is likely to experience the greatest frequency of drone flights may experience some minor reduction in local bird activity. Further survey and monitoring would be required to determine this.

Bird groups not considered at risk

Although many of the studies on drone disturbance center on shorebird species (due in part to the apparent sensitivity to disturbance of such birds), waterbirds as a group have not emerged as an animal likely to be disturbed by drones operating from Greenway. Waterbird habitat occurs at Murrumbidgee River and to a lesser extent at Stranger Pond. Waterbirds that would be found in these habitats would be nomadic species such as ducks, snipes and resident species such as swamp hens. These species groups don't fall into the categories listed above.

3.3.2 Threatened and listed migratory species

Based on results of database and threatened species searches, threatened or migratory fauna that would fall into the above groups are listed in Table 3-2. The majority of the birds listed below have been recorded in the operations area (as shown on Atlas of Living Australia, refer to Appendix B). However, as discussed many of these birds have potential to habituate to the presence of drones.

Note that terrestrial ground-dwelling species have collectively been excluded from the list of threatened (and common) species in Table 3-2 (and Table 3-3) as these fauna types are considered unlikely to be affected by drones given drones will only (generally) land at the operations base and destination (residential) point, whilst being airborne and flying at high speed for the rest of the time. As such, it is expected that there would be minimal direct physical interactions between terrestrial ground-dwelling animals and drones.

Indirect, or non-physical, interactions, including mainly noise, are also expected to be limited in scale given that the drones are relatively quiet (as described previously), and that the duration and frequency of the noise would be generally low, with drones flying at relatively high speed, and only stopping to hover briefly at the destination points.

This review has considered possible issues associated with incidents such as the accidental loss of packages (such as medicines) that could be accessed by ground dwelling fauna. Based on information provided by Project Wing, it is understood these packages are very secure and tamper-proof, and as a result wildlife are unlikely to be affected by inadvertent access to goods being transported by drones. No other issues associated with impacts to terrestrial ground-dwelling species are considered likely.

3.3.3 Common species

In terms of common (native) species, birds which may be at risk of disturbance can be identified by disturbance behaviour, such as mobbing the drone. In this case, the likelihood that a bird species or group would habituate to the regular presence of drones would influence the extent of disturbance in the long term. For most common territorial non-raptor species, this seems entirely likely (refer to discussion above). Birds that would attack the drone to drive the perceived intruder from its territory would mostly be raptors. However, from the literature reviewed it is unclear whether raptors (particularly large raptors) would habituate to the drones. Many raptors including Wedge-tailed Eagle are highly sensitive to disturbance near the nest during the breeding period, and may abandon the nest with repeat disturbance (Olsen 1998). In general though, the risk of raptor attacks on drones is considered to be low given the location of most flights will be within urban areas thus avoiding the more open space areas where raptors would occur, combined with the speed of the drone (at approximately 120 km/hr) and that it will only stop to hover at the destination points, making an attack on drone in flight an unlikely (although still possible) occurrence.

Table 3-3 assesses the potential for drones to impact on common wildlife species, and notes their likelihood to become habituated.

Table 3-2 Threatened or migratory species that may be disturbed by drones and the likelihood of habituation

Animals likely to be disturbed	EPBC threatened or migratory species	ACT threatened species or migratory species	Likelihood of habituation
Animals that typically fall prey to small to medium raptors (e.g. small mammals, birds, reptiles).	Superb Parrot *Polytelis swainsonii* (V) Swift Parrot *Lathamus discolour* (CE) Regent Honeyeater *Anthochaera phrygia* (CE) Painted Honeyeater *Grantiella picta* (V) Black-faced Monarch *Monarcha melanopsis* (M) Yellow Wagtail *Motacilla flava* (M) Satin Flycatcher *Myiagra cyanoleuca* (M) Rufous Fantail *Rhipidura rufifrons* (M) Large-eared Pied Bat *Chalinolobus dwyeri* (V)	Regent Honeyeater *Anthochaera phrygia* (E) Painted Honeyeater *Grantiella picta* (V) Hooded Robin *Melanodryas cucullata* (V) Scarlet Robin *Petroica boodang* (V) White-winged Triller *Lalage sueurii* (V) Superb Parrot *Polytelis swainsonii* (V) Swift Parrot *Lathamus discolour* (V) Varied Sittella *Daphoenositta chrysoptera* (V)	For migratory or nomadic species, (including the Swift Parrot and to a lesser extent, the Superb Parrot) there is considered to be Low to Moderate likelihood of habituation given these species are generally infrequent visitors to the area. However habituation to drones is expected to increase, albeit slowly, over time (i.e. Moderate). Resident species (such as the Honeyeaters and Robins) are more likely to habituate (Moderate).
Territorial birds, particularly during nesting and breeding periods (including mainly raptors).	None	Little Eagle *Hieraaetus morphnoides* (V)	Moderate to High. Resident birds likely to habituate whilst vagrants unlikely to habituate. Vagrants unlikely to breed in the operations area and therefore impacts on such individuals are not likely to be significant.
Birds that mistake drones as an intruder in territory (closely linked to the point above, territorial birds).	Osprey *Pandion haliaetus* (M),	Little Eagle *Hieraaetus morphnoides* (V)	Moderate. Osprey are unlikely to occur in area on any regular or semi-regular basis, and occurrences would be very infrequent.
Birds and bats that may be susceptible to collision with drones.	Grey-headed Flying-fox *Pteropus poliocephalus* (V) Large-eared Pied Bat *Chalinolobus dwyeri* (V)	Glossy Black-cockatoo *Calyptorhynchus lathami* (V)	Moderate.

Table 3-3 Common birds and bats that may be disturbed by drones, and the likelihood of habituation

Animals likely to be disturbed	Bird type, by disturbance behaviour	Hazard to bird	Examples of species	Likelihood of habituation
Territorial birds, particularly during nesting and breeding periods (including Australian Magpies, Masked Lapwing and raptors).	• Territorial birds • Mobbing birds that would chase • Attacking birds (refer below)	Expenditure of energy and leaving nest unprotected from predators	Australian Magpie *Cracticus tibicen* Australian Raven *Corvus coronoides* Masked Lapwing *Vanellus miles* Noisy Miner *Manorina melanocephala*	High
Birds that mistake drones as an intruder in territory and attack drone (closely linked to the point above, territorial birds).	Attacking birds: • Small raptors • Large raptors	Expenditure of energy and leaving nest unprotected Abandonment of nest Abandonment of territory	Peregrine Falcon *Falco peregrinus* Wedge-tailed Eagle *Aquila audax*	Uncertain
Birds and bats that may be susceptible to collision with drones.	• Small raptors • Large, low maneuverability birds • Flying-foxes • Small insectivorous birds	Injury Death	Wedge-tailed Eagle *Aquila audax* Swallow & Martins (insects attracted to drones)	Uncertain

4 SUMMARY OF POTENTIAL RISKS

4.1 ANALYSIS SUMMARY

The objective of this report is to identify potential risk of impacts occurring upon native fauna as a result of the operation of Project Wing and recommend principles to minimise harm to wildlife. This has been achieved through a literature review and use of online databases. This assessment sought to answer a number of questions, given in Section 1.3, as set out below.

What does existing research tell us about the possible effects on wildlife, particularly avifauna?

Project Wing has the potential to disturb fauna and thereby affect the foraging and breeding behaviour of surrounding wildlife, particularly avifauna. These effects are, in general, considered likely to be minimal, given the following:

- Most flights will occur within the urban footprint, where there is a lower probability of drones interacting with threatened avifauna
- The drones are relatively quiet and therefore are unlikely to create substantial noise that may disturb native fauna
- Related to the above, many fauna species likely to encounter drones (including mainly common urbanized species) are likely to adapt to some degree to the presence of drone (i.e. become habituated)
- The speed of the drones is likely to be too fast to result in direct attacks on drones by raptors when in flight. There may be some risk of attack from raptors while drones are stationary/hovering, however given this will only occur at destination points, this risk is considered to be low.
- Accidental collisions are a possibility, although expected to be relatively rare. Common species are more likely to collide with drones given their greater abundance in the urban areas, whilst collisions with threatened species are less likely given their occurrences mainly outside of the urban footprint and away from the main flying areas of the drones, as well as the generally low population densities of these species.

As noted above, it is considered that most resident fauna would habituate to some extent to the regular and frequent flights of the drones. Therefore, most effects would be in the short-term during the establishment of the project and these could be expected to diminish over time.

What are the likely/potential impacts of the operations from the Greenway base on nearby nesting birds?

For some territorial bird species, such as the Australian Magpie, Project Wing may cause ongoing disturbance during breeding season. The outcome of such disturbance is difficult to predict with the information to hand. In any case, where common and abundant species are concerned, the population effect of Project Wing is likely to be insignificant.

In the case of large raptors, particularly Wedge-tailed Eagles and Little Eagles, the effect of ongoing disturbance may be greater. Large raptors are top-order predators and therefore occur at relatively low densities in the landscape. As already mentioned, there is discussion in the local birdwatching community as to the population status of the raptors of the ACT, with many reports that raptors are in decline (e.g. Olsen & Fuentes 2005), particularly Little Eagle which has been recorded in the suburbs and parks near

Greenway. Little Eagle is a threatened species in NSW. However, existing research does not provide definitive answers as to the long-term effect of drone flights in raptor territory, and much uncertainty exists.

Many raptor species typically display nesting site fidelity (i.e. return to the same nesting site each breeding season). Monitoring, as well as consultation with local avifauna experts/groups can enable known nesting locations to be identified and avoided during breeding season if necessary.

For Project Wing, the main operations will be within the urban footprint and away from likely/potential areas of breeding habitat for the Little Eagle or other raptors, such as within the Murrumbidgee River corridor, and larger nature reserve areas. Importantly, there would be no "drop-off" points in areas where these species occur, and therefore any operations in these areas would be direct flights over and past any potential habitats. Given the drone flying speeds, and infrequent flights through these areas, direct interactions between raptors and drones (i.e. attacks) are considered to be generally unlikely.

Common avifauna, (in particular magpies but also the Masked Lapwing and Noisy Miner) which are known to be aggressive and territorial during breeding periods, have a higher risk of interactions with drones, particularly as these species are relatively common and well-dispersed throughout the urban footprint of Canberra. The main risk will be when drones have stopped briefly and hover above the "drop-off" point, at which time an attack could occur. Although magpies in particular, are known to attack humans (and their pets), there is no conclusive literature on magpies (or Masked Lapwings or Noisy Miners) attacking drones. Given that the "drop-offs" would be on an infrequent basis, and of very short duration, attacks on drones by these species is likely to be a generally uncommon occurrence. Further, as these species are all abundant, the risk of the drones having an impact on a local population of these species is considered to be low.

What are the likely/potential impacts of missions on transient wildlife?

Whereas most resident wildlife is considered likely to habituate to frequent and/or regular drone flights, transient wildlife may not have such opportunity. Transient wildlife would include migratory and nomadic species. Such species protected under EPBC Act and NC Act and with records in the area (Appendix B) are Swift Parrot, Painted Honeyeater, Regent Honeyeater, Scarlet Robin, Great Egret, Cattle Egret and Grey-headed Flying-fox.

The Swift Parrot, honeyeaters and Scarlet Robin are associated with woodland and forest vegetation and generally migrate by short flights between patches of habitat, generally flying within 20 m of the ground (NGH Environmental, unpublished data). Swift Parrot breeds in Tasmania and therefore Project Wing would not affect breeding for this species. Swift Parrots move about in flocks searching for winter-flowering eucalypt species upon which to feed, including Box eucalypt species that occur in grassy woodlands nearby. There are several records of Swift Parrot around Stranger Pond.

Regent Honeyeaters gather in several known areas for breeding (DOE 2016). Project Wing is not located near a known breeding area. Painted Honeyeaters are strongly associated with woodland and mistletoe and may breed where this is prevalent, occurring in pairs or small flocks (DOE 2015). It is not known whether mistletoe occurs locally near the base; grassy woodland occurs at Lanyon Landscape Conservation Reserve and Urambi Hills Nature Reserve (refer to Section 1.4 for more information on these reserves). Scarlet Robin is generally resident in an area of habitat although may move to more open grassy areas during autumn and winter (OEH 2018). There are many Scarlet Robin records nearby to the base, but this species is generally found within wooded habitat rather than the open areas that would be used for drone flight. Thus, Regent Honeyeater, Painted Honeyeater and Scarlet Robin are associated with wooded vegetation. Painted Honeyeater and Scarlet Robin may breed locally. Project Wing would be unlikely to

encounter these species if flights are conducted along suburban streets and outside of no-fly zones over woodland vegetation patches.

The egrets are associated with wetlands and moist grasslands and major breeding sites are located along the coast (DoEE 2018a). Breeding habitat (wooded and shrubby swamps - DoEE 2018a) does not occur near the base. They occur solitarily outside of breeding season and disperse across Australia. Populations of both species are considered secure (DoEE 2018a). Project Wing may encounter Great Egret and Cattle Egret in low numbers around Stranger Pond but impact upon breeding or population numbers is unlikely. No-fly zones around Stranger Pond would minimise the likelihood of encountering the species.

The Grey-headed Flying-fox is nomadic across Australia and gather in large camps over the warmer months to breed where food supplies are abundant (DoEE 2018a). DoEE administers the *National Flying-fox Monitoring Viewer*, which is an interactive online map showing known flying-fox camps around Australia (DEE 2018b). Neither of the two known flying-fox camps within the ACT are close to the base or near the proposed operations area, and Project Wing is therefore unlikely to cause a disturbance to a colony of flying-foxes. It can be assumed that although foraging Grey-headed Flying-foxes are likely to be encountered around the base from time to time, this would generally be outside of operating hours (flying-foxes are nocturnal), minimising the likelihood of collisions.

Are there any known listed threatened avifauna species in the area that could be impacted?

Threatened species (under the EPBC Act and NC Act) are listed in Table 3-2 and Appendix B. In brief, threatened avifauna that have been recorded in the operations area (based on Atlas of Living Australia (2018) records) are:

- Swift Parrot.
- Regent Honeyeater.
- Painted Honeyeater.
- Superb Parrot.
- Hooded Robin.
- Scarlet Robin.
- White-winged Triller.

As already discussed, most resident fauna ought to habituate to the regular and/or frequent drone flights over time, and thus any disturbance impacts should be short-term. However, migratory and nomadic species may be affected. Although discussed above, a brief consideration of the likelihood of a significant impact occurring to any of these species is also provided below. Measures to reduce potential impacts are discussed in Section 5.

4.2 POTENTIAL FOR A SIGNIFICANT IMPACT

A 'significant impact' is an impact which is important, notable, or of consequence, having regard to its context or intensity. The EPBC Act *Significant impact guidelines 1.1* (for Matters of National Environmental Significance) guidelines are intended to assist with a 'self-assessment' to decide whether or not the action is likely to have a significant impact on any matters of national environmental significance.

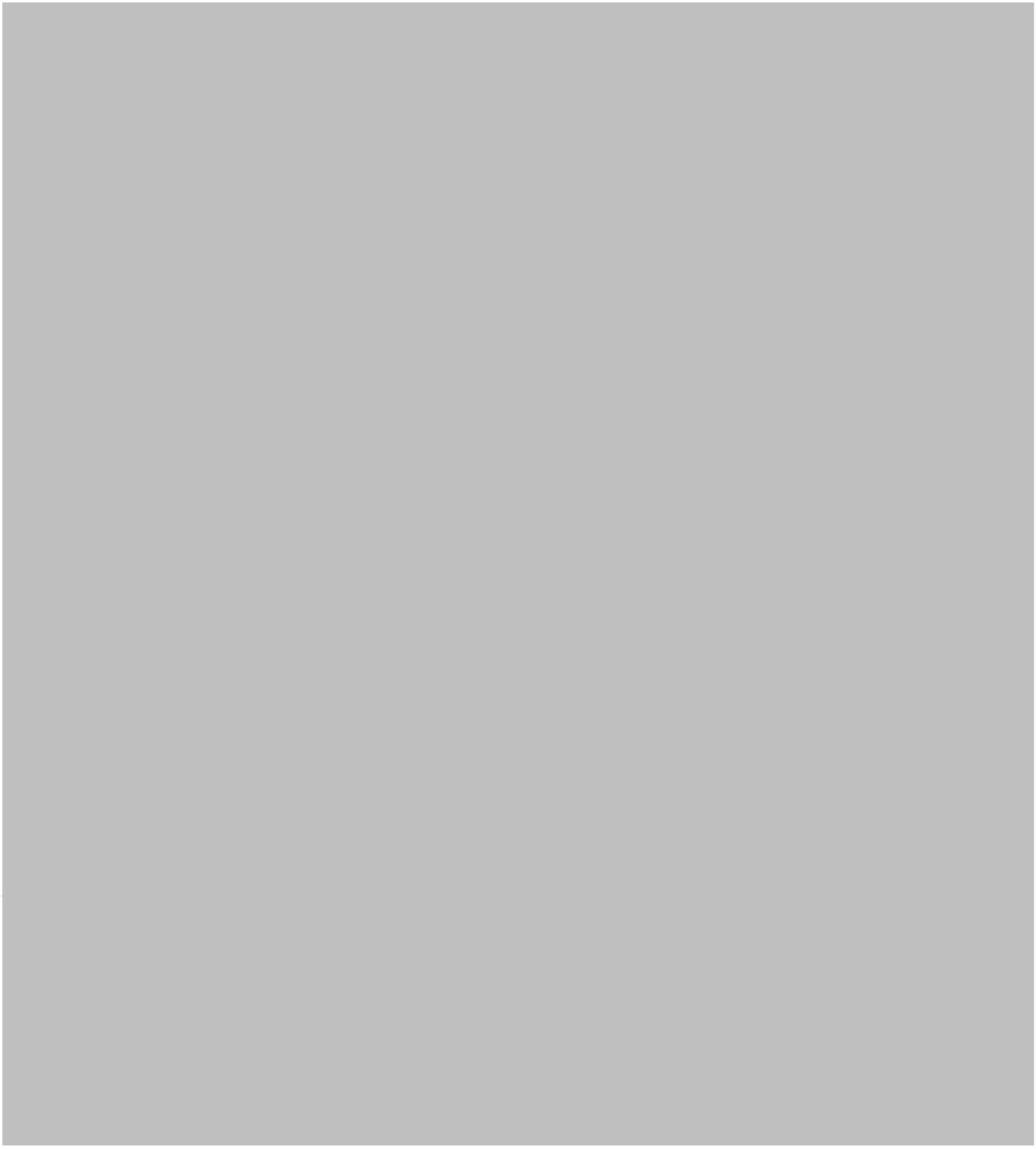
The purpose of these guidelines is to assist any person who proposes to take an action to decide whether or not they should submit a referral to the Australian Government Department of the Environment

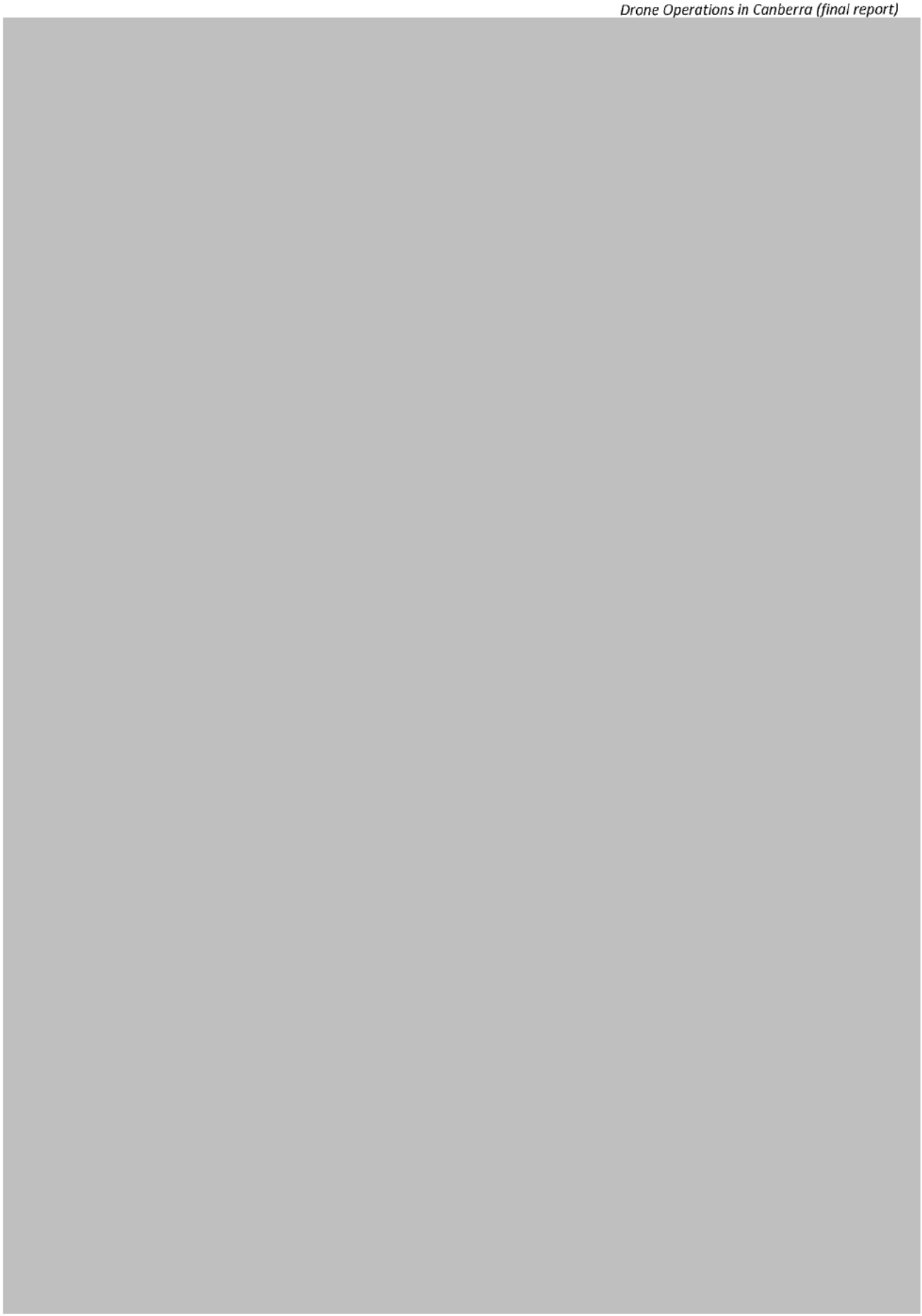
For a significant impact to be 'likely', it is not necessary for the significant impact to have a greater than 50% chance of happening; it is sufficient if a significant impact on the environment is a real or not remote

chance or possibility. If there is scientific uncertainty about the impacts of an action and potential impacts are serious or irreversible, the precautionary principle is applicable. Accordingly, a lack of scientific certainty about the potential impacts of an action will not itself justify a decision that the action is not likely to have a significant impact on the environment.

To date, there is no available quantitative data (such as by way of direct field studies) to confirm the presence or habitat availability of listed threatened species in the operations area. Additionally, there has been no specific field trials to determine the likelihood/type of interactions that local threatened fauna may have with drones operating in this region (noting that interactions between drones and birds may change regionally depending on local environmental qualities). Given this lack of quantitative, site-specific data or results from field trials, it is not possible to undertake an accurate assessment of the project's impacts on threatened fauna in accordance with the specific criteria set-out in the guidelines. Notwithstanding this, a brief consideration of the project against the criteria in the guidelines notes that for the impact to be significant it generally (and amongst other things) needs to result in a long decrease in the size of a population, reduce the area of occupancy or fragment populations, affect habitat critical to the survival of species, disrupt breeding cycles, modify destroy or decrease habitat availability or interfere with the recovery of a species.

Whilst the project may result in some potentially negative interactions with individuals of some species, it is generally considered unlikely that the impacts would affect an entire population, or result in a widespread reduction in available habitat (such as through alienation impacts), or disruption to the breeding cycles. Notwithstanding this, measures to reduce or limit potential impacts are discussed in Section 5.





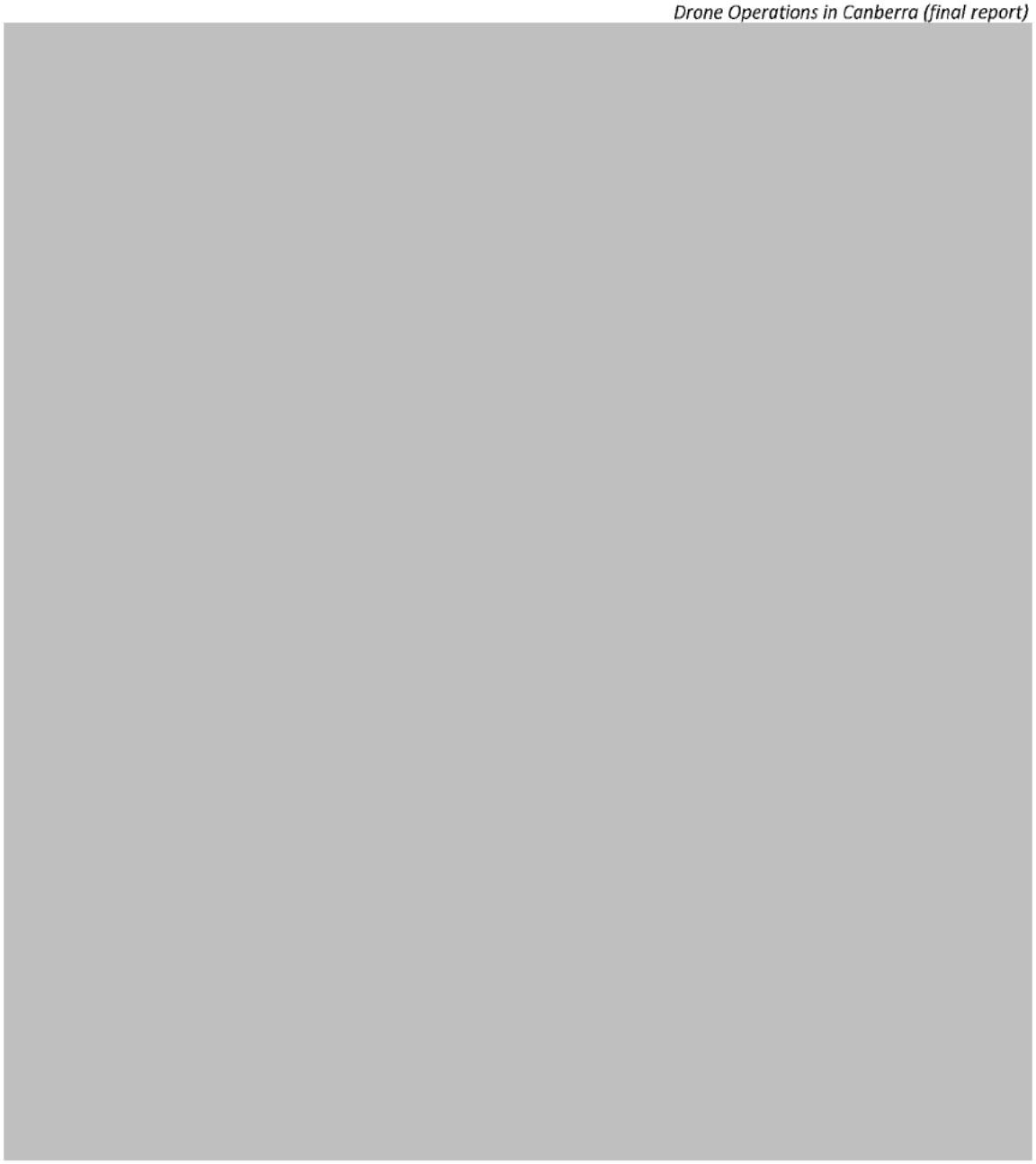
5 MEASURES TO MINIMISE IMPACTS TO WILDLIFE

5.1 PRINCIPLES FOR INTERACTIONS BETWEEN DRONES AND WILDLIFE

Hodgson & Koh (2016) have proposed best practice principles for drone flights near wildlife. These are shown in Table 5-1. Most are not directly relevant for the commercial operation undertaken by Project Wing (e.g. cease operations if they become excessively disruptive). However, the fifth principle (to publish findings of any impact studies) has potential to be implemented during the operation stage of Project Wing. This would contribute to the body of scientific information available for assessments such as this, particularly as there is a paucity of information about wildlife interactions near a drone base where flights are regular and/or frequent. Further, undertaking monitoring and publishing findings (particularly if on a public platform such as the project's website, with potential for journal publication) could dispel local myths about drone impacts and raise the public profile of the project.

Table 5-1 Best practice principles for drones and wildlife

Best practice principles (Hodgson & Koh 2016)	Relevant?
1. Adopt the precautionary principle if there is scientific uncertainty	Possibly, at the planning stage
2. Use the animal ethics committee process to determine if drone use suitable for project	No
3. Adhere to civil aviation rules, adopt equipment maintenance and operator training schedules	Yes, during planning and operation
4. Cease drone operations if excessively disruptive	Possibly, although undesirable
5. Report findings of any impact study in publications to contribute to the body of scientific knowledge	Yes, during operation stage

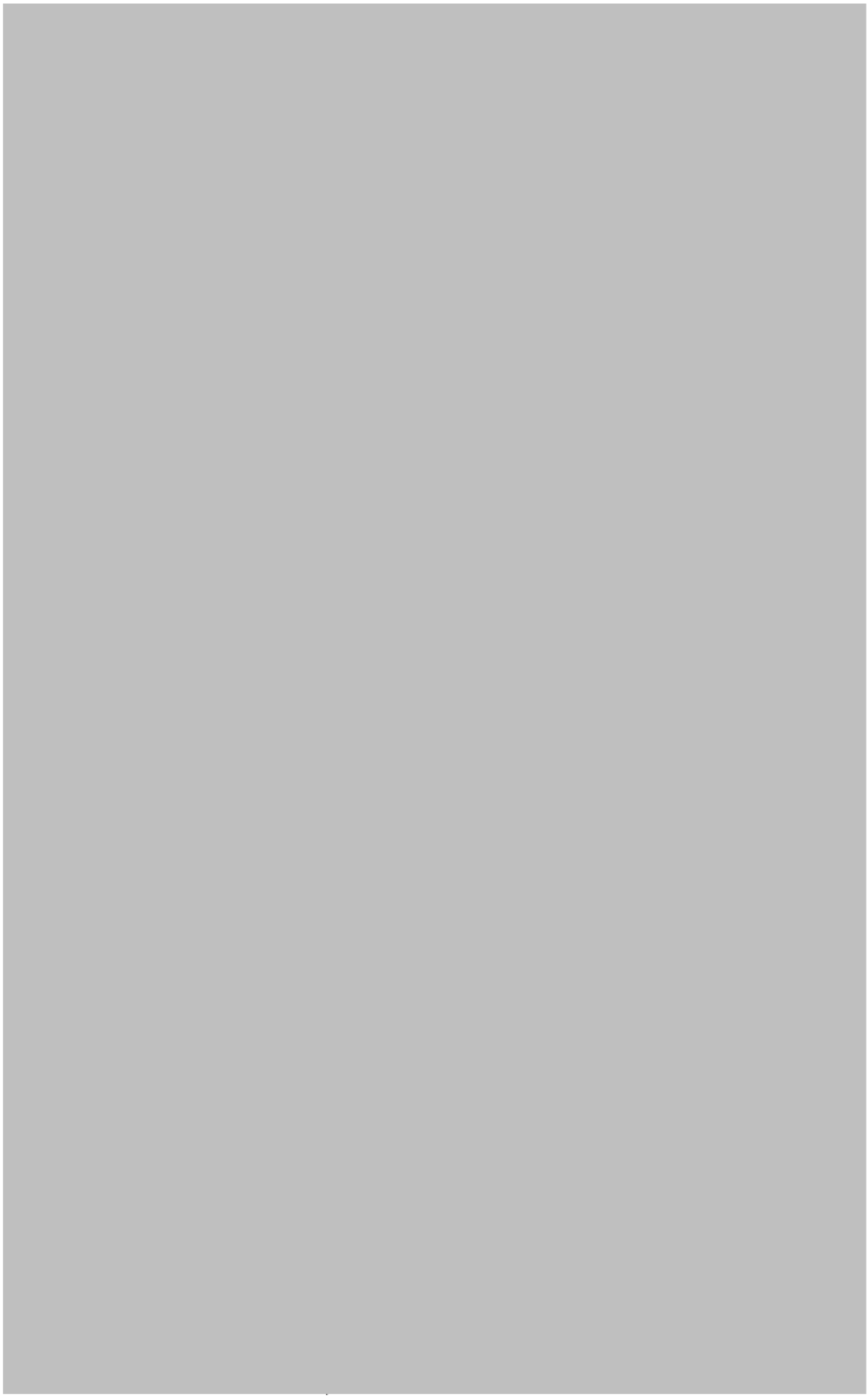


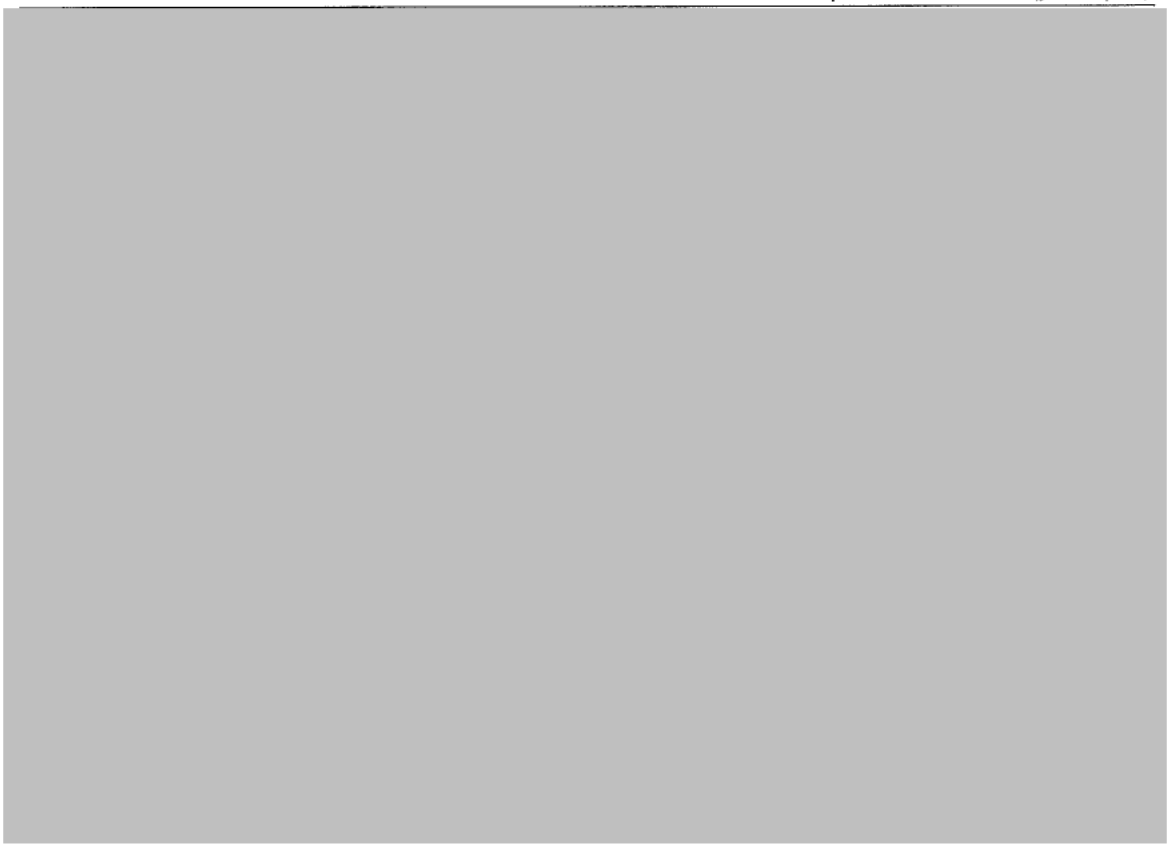
5.2.2 Response to identified risk

Avian monitoring program

As this assessment has found that the project is unlikely to result in a significant impact to any listed threatened or migratory species (or an otherwise unacceptable level of impact to a non-threatened species), the establishment of an avian monitoring program is not considered necessary at this point in time.

However, should the project be suspected or confirmed to negatively impact on avifauna, then an avian monitoring program should be implemented to ascertain the likelihood of an unacceptable impact occurring. As such, the requirement to monitor would be based on a 'trigger' as set out in a stepwise manner below.





5.2.3 Consultation (proposed)

Section 5.2.2 identifies that consultation may be warranted as part of a response to a suspected or confirmed impact on wildlife.

Consultation with government agencies and other relevant organisations may be relevant in order to gain additional data about threatened and at risk species, confirm legislative approval requirements, and to appreciate current or similar monitoring within the operations area which could contribute to an on-going monitoring program. Table 5-2 suggests those parties who it may be beneficial to consult with and includes a summary of potential matters for discussion.

Table 5-3 Proposed consultation

Agency/Organisation	Nature of consultation/possible topics for discussion
ACT Conservator of Flora and Fauna	Make Conservator aware of project, confirm that no legislative trigger for approval (i.e. EIS), discuss any possible questions/concerns they may have about the project.
ACT Conservation Planning and Research Unit	Enquire into mapping of birds of ACTMapi and what data they may have (not yet publicly available) on potential threatened or at risk birds in the ACT.
Canberra Ornithologists Group	Ask about what regular or special/targeted surveys they have been or intend to do, including for threatened species, or surveys within (southern) ACT that may be of relevance. Confirm if any recent trends they have observed with any threatened or at risk species. Identify known raptor nesting sites.

Agency/Organisation	Nature of consultation/possible topics for discussion
Experts from the University of New South Wales	Find out what latest research they have been doing in this field, and what current/upcoming projects (i.e. post-grad research etc) that are being undertaken that may be of relevance.
Researchers from Australian National University	Find out what latest research they have been doing (i.e. post-grad research etc) on threatened birds or raptors in ACT (that may be of relevance).
Researchers from University of Canberra	Find out what latest research they have been doing (i.e. post-grad research etc) on threatened birds or raptors (that may be of relevance).

5.2.4 Project Wing – expansion into new areas

There is potential for Project Wing to expand into new geographic areas, or for the base operations to move. If this occurs, the following is recommended:

7. **Conduct a desktop review of site specific ecological values.** Consider the potential for Commonwealth or State listed threatened species to occur. Identify potential risk areas (as per Section 4.3) and incorporate these into flight plans.

6 CONCLUSION

Drones are known to impact wildlife including mammals and birds. The literature reviewed pointed to four main issues that can lead to impacts on native wildlife: disturbance leading to behavioural change, attacks on drones, collisions with drones and potential habitat alienation. However, it is also possible for drones to be operated in a way that minimises impacts and for animals to habituate to the presence of drones.

A number of key risk factors for wildlife impacts were identified: angle of approach, flight altitude, flight volume, resemblance of drones to raptors, breeding season and whether given fauna are territorial. Project parameters were considered against these factors along with aspects of ecology of both threatened and common species that are known to occur in the operations area.

Project Wing has the potential to affect native fauna, particularly threatened migratory birds and resident raptors. The overall level of risk of the project resulting in a significant impact to native fauna is however considered to be low. Specifically, the flight paths (predominantly within the urban footprint), flight approach angles (generally flat to the destination hover points), flight speed and generally low noise of the drones indicate that the risks of drone attacks, behavioral changes and habitat avoidance of native avifauna (and other wildlife generally) are low.

The likelihood of any disturbance or negative interactions (e.g. collisions) can be further reduced by following the recommendations summarized below.

Continuing to implement:

1. Limited flying over sensitive areas, with flights over the Murrumbidgee River Corridor to remain within 100 m of nature reserve/urban interface (i.e. outer edge of the corridor)
2. Vary flight height if necessary
3. Avoid using 'fast climb' flight features
4. Fly light coloured drones.

Additional recommendations include:

5. Develop a fauna incident procedure, incorporating a responsive fauna monitoring program
6. If expanding operations into new geographic areas, conduct a desktop review of site specific ecological values.

7 REFERENCES

Allan-Petale, D. (2018) 'Drones stand no chance as WA's birds of prey defend their skies' *WA Today.* https://www.watoday.com.au/national/western-australia/drones-stand-no-chance-as-wa-s-birds-of-prey-defend-their-skies-20180315-p4z4l3.html accessed in June 2018.

Atlas of Living Australia (2018) *Spatial Portal.* http://spatial.ala.org.au accessed in June and July 2018

Backhouse, A. (2017) 'Stealth infra-red drone spies on sleeping flying-foxes', *The Chronicle.* https://www.thechronicle.com.au/news/stealth-infrared-drone-spies-sleeping-flying-foxes/3162726/#/0 accessed June 2018

Baraniuk, C. (2017) 'Drones listen in on bats to reveal their in-flight secrets', *New Scientist.* https://www.newscientist.com/article/2128525-drones-listen-in-on-bats-to-reveal-their-in-flight-secrets/ accessed in June 2018

Barnas, A., Newman, R., Felege,C.J., Corcoran, M.P., Hervey, S.D., Stechmann, T.J., Rockwell, R.F., and Ellis-Felege, S.N. (2017) 'Evaluating behavioural response of nesting lesser snow geese to unmanned aircraft surveys' *Ecology & Evolution,* 2017: 1-11. DOI: 10.1002/ece3.3731

Bask Industries (2016) *AeroDrone Avian Scout.* https://baskaerospace.com.au/aerodrone/avian-scout/ accessed in June 2018

Buchanan (2015) 'Using drones to scare off flying-foxes could help the lychee industry expand' *ABC News.* http://www.abc.net.au/news/rural/2015-10-05/drones-to-fight-flying-foxes/6827694 accessed May 2018

Canberra Bushwalking Club (2014) *Short-notice Walks.* http://www.canberrabushwalkingclub.org/program/short-notice-walks.html accessed in June 2018

Canberra Ornithologists Group (2017) *Murrumbidgee River walk.* http://canberrabirds.org.au/trips/murrumbidgee-river-walk/ accessed in June 2018

Canberra Ornithologists Group (undated) *Wedge-tailed Eagle.* http://canberrabirds.org.au/our-birds/canberra-garden-birds/raptors/wedge-tailed-eagle/ accessed in June 2018

Christiansen, F., Rojano-Doñate, .L, Madsen, PT. and Bejder, L. (2016) 'Noise Levels of Multi-Rotor Unmanned Aerial Vehicles with Implications for Potential Underwater Impacts on Marine Mammals.' *Front. Mar. Sci.* 3:277. doi: 10.3389/fmars.2016.00277. https://www.frontiersin.org/articles/10.3389/fmars.2016.00277/full accessed in June 2018

DEE (2018a) *Species Profile and Threats Database*, Department of the Environment and Energy, Australian Government. http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl accessed July 2018.

DEE (2018b) *National Flying-fox Monitoring Viewer*, Department of the Environment and Energy, Australian Government. www.environment.gov.au/webgis-framework/apps/ffc-wide/ffc-wide.jsf accessed July 2018.

DEW (2013) *Steering drones away from wildlife*, Natural Resources, Kangaroo Island. South Australian Department of Environment and Water. http://www.naturalresources.sa.gov.au/kangarooisland/news/171025-steering-drones-away-from-wildlife accessed in June 2018.

Ditmer, M., Vincent, J., Werden, L.K., Iaizzo, P.A., Garshelis, D.L., Fieberg, J.R. (2015) 'Bears shows a physiological but limited behavioural response unmanned aerial vehicles' *Current Biology*, 25, 2278–2283

DOE (2015) *Conservation Advice: Grantiella picta, Painted Honeyeater*. Department of the Environment, Australian Government. http://www.environment.gov.au/biodiversity/threatened/species/pubs/470-conservation-advice.pdf accessed in July 2018

DOE (2016) *National Recovery Plan for the Regent Honeyeater, Anthochaera phrygia*. Department of the Environment, Australian Government.

Eco Logical Australia (2016) *Batemans Bay Flying-fox Camp Management Options*. Prepared for Eurobodalla Shire Council.

EPHC (2010). Draft National Wind Farm Development Guidelines. Environment Protection and Heritage Council, Australia.

EPSDD (2016) *Murrumbidgee River Corridor.* Environment, Planning and Sustainable Development Directorate, ACT Government. https://www.environment.act.gov.au/parks-conservation/parks-and-reserves/explore/murrumbidgee-river-corridor accessed in June 2018

EPSDD (2018) Pine Island, Environment, Planning and Sustainable Development Directorate, ACT Government. https://www.environment.act.gov.au/parks-conservation/parks-and-reserves/find-a-park/murrumbidgee-river-corridor/pine-island accessed in June 2018

Fu, Y., Kinniry, M., and Kloepper, L.N. (2017) 'The Chirocopter: A UAV for recording sound and video of bats at altitude' *Methods Ecol Evol*. 2018;00:1–5

Fuentes, E. (2005) *Ecology of Raptors in the Canberra Region, ACT.* Thesis for Masters, Applied Science, University of Canberra. http://www.canberra.edu.au/researchrepository/file/cb6de79c-4d72-e30e-8a01-8552265e0723/1/full_text.pdf accessed in June 2018.

Ginninderra Catchment Group (2017) *Frogwatch ACT and Region, BON 200 – Stranger Pond Central – Bonython*. http://fw.ginninderralandcare.org.au/site/bon200 accessed in June 2018

Ginninderra Falls Association (2013) *Birds of Ginninderra Gorge and Murrumbidgee River Corridor.* http://ginninderra.org.au/node/353 accessed in June 2018

Hull, C. (2013) Wind farm researcher debunks bird 'myths', http://www.abc.net.au/radionational/programs/ockhamsrazor/5046460 accessed in May 2018

Hull, C., and Muir, S. (2013) 'Behaviour and Turbine Avoidance Rates of Eagles at Two Wind Farms in Tasmania, Australia', Wildlife Society Bulletin 37(1): 49-58.

Langin (2018) 'Meet 'Chirocopter': a drone that flies within swarms of bats', *Science*. http://www.sciencemag.org/news/2018/03/meet-chirocopter-drone-flies-within-swarms-bats, accessed in May 2018

Laurance WF, Nascimento HEM, Laurance SG, Andrade A, Ewers RM, Harms KE, et al. (2007) Habitat Fragmentation, Variable Edge Effects, and the Landscape-Divergence Hypothesis. *PLoS ONE* 2(10): e1017. https://doi.org/10.1371/journal.pone.0001017

Lyons, M., Brandis, K., Callaghan, C., McCann, J., Mills, C., Ryall, S., and Kingsford, R. (2016) 'Bird interactions with drones, from individuals to large colonies' *Australian Field Ornithology* 2018, **35**, 51–56

Madsen, J. & Boertmann, D. (2008) 'Animal behavioral adaptation to changing landscapes: spring-staging geese habituate to wind farms' *Landscape Ecology* 23: 1007-1011.

McEvoy, J.F., Hall, G.P., McDonald, P.G. (2016) 'Evaluation of unmanned aerial vehicle shape, flight path and camera type for waterfowl surveys: disturbance effects and species recognition', *PeerJ* 4:e1831; DOI 10.7717/peerj.1831

Murfin, T. (2017) 'Drone-bird to scare away flocks tested at airport', *GPS World.* http://gpsworld.com/drone-bird-to-scare-away-flocks-tested-at-us-airport/ accessed in June 2018

National Geographic (2015) *Watch a curious chimp knock a drone out of the sky.* https://news.nationalgeographic.com/2015/04/150413-chimpanzee-drone-curious-clever-chimp-attack-zoo/ accessed June 2018.

OEH (2018) *Threatened Species Profile*, Office of Environment and Heritage, NSW Government, http://www.environment.nsw.gov.au/threatenedspecies/index.htm accessed in June 2018

Olsen, J. and Fuentes, E. (2005) 'Collapse in numbers of breeding Little Eagles in the Australian Capital Territory' *Canberra Bird Notes* 30: 141–145.

Olsen, P. (1998) 'Australia's Raptors: diurnal birds of prey and owls', *Birds Australia Conservation Statement No. 2,* Supplement to *Wingspan* 8: 3

Oxford University Press (2018) *English Oxford Living Dictionaries.* Website accessed at https://en.oxforddictionaries.com/ in June 2018

Parks Canada (2015) *Appendix 1: Best Management Practices for Hang Gliding and Para Gliding in Jasper National Park.* https://www.hpac.ca/pub/doc/bestpracticesfreeflightinJasper_2015.pdf accessed June 2018

Pockock, Z. & Lawrence, R. (2005). How far into a forest does the effect of a road extend? Defining road edge effect in eucalypt forests of South-Eastern Australia. Conference Paper, 2005 Proceedings of the International Conference on Ecology & Transportation.

QUT (2017) *QUT to use drones to find and protect Koalas,* Queensland University of Technology News. https://www.qut.edu.au/news?news-id=120417, accessed June 2018

Rummler, M., Mustafa, O., Maercker, J., Peter, H., and Esefeld, J. (2016) 'Measuring the influence of unmanned aerial vehicles on Adelie penguins', *Polar Biology* 39: 7: 1329-1334

Southern ACT Catchment Group (2014) *Southern ACT Catchment Group.* http://sactcg.org.au/node/2556 accessed in June 2018

University of Adelaide (2017) *Unmanned Research Aircraft Facility.* https://www.adelaide.edu.au/environment/uraf/projects/ accessed in June 2018.

Urban Services (2001) *Canberra's Urban Lakes and Ponds, Plan of Management.* https://www.tccs.act.gov.au/city-living/recreation/waterways/lakesandponds/lakesandpondspom accessed in June 2018

US National Park Service (2014) *Drone harasses Bighorn Sheep at Zion National Park.* https://www.nps.gov/zion/learn/news/droneharassesbhs.htm accessed in May 2018

Vas, E., Lescroel, A., Duriez, O., Boguszewski, G., Gremillet, D., (2015) 'Approaching birds with drones: first experiments and ethical guidelines', *Biol. Lett.* 11: 20140754.

Wallace, P. Martin, R. and White, I. (2018) 'Keeping pace with technology: drones, disturbance and policy deficiency', *Journal of Environmental Planning and Management*. 61:7: 1271-1288

Waypoint 2017 'When Birds Attack! Experienced Drone Operators Discuss this (Surprising Common) Mission Threat', *Waypoint: Drone Insights and Inspiration*. https://waypoint.sensefly.com/bird-drone-attacks-avoid-threat/ accessed in June 2018

APPENDIX A THREATENED AND MIGRATORY SPECIES DATABASE SEARCHES

A.1 STATE (ACT) LISTED THREATENED SPECIES

The following fauna species are listed as Endangered or Vulnerable under the NC Act.

Class	Common name	Scientific name	Declared status
Amphibian	Northern Corroboree Frog	*Pseudophryne pengilleyi*	endangered
Aves	Brown Treecreeper	*Climacteris picumnus*	vulnerable
Aves	Glossy Black-cockatoo	*Calyptorhynchus lathami*	vulnerable
Aves	Hooded Robin	*Melanodryas cucullata*	vulnerable
Aves	Little Eagle	*Hieraaetus morphnoides*	vulnerable
Aves	Painted Honeyeater	*Grantiella picta*	vulnerable
Aves	Regent Honeyeater	*Anthochaera phrygia*	endangered
Aves	Scarlet Robin	*Petroica boodang*	vulnerable
Aves	Superb Parrot	*Polytelis swainsonii*	vulnerable
Aves	Swift Parrot	*Lathamus discolor*	vulnerable
Aves	Varied Sittella	*Daphoenositta chrysoptera*	vulnerable
Aves	White-winged Triller	*Lalage sueurii*	vulnerable
Crustacean	Murray River Crayfish	*Euastacus armatus*	vulnerable
Fish	Macquarie Perch	*Macquaria australasica*	endangered
Fish	Silver Perch	*Bidyanus bidyanus*	endangered
Fish	Trout Cod	*Maccullochella macquariensis*	endangered
Fish	Two-spined Blackfish	*Gadopsis bispinosus*	vulnerable
Insects	Golden Sun Moth	*Synemon plana*	endangered
Insects	Perunga Grasshopper	*Perunga ochracea*	vulnerable
Mammals	Brush-tailed Rock-wallaby	*Petrogale penicillata*	endangered
Mammals	Smoky Mouse	*Pseudomys fumeus*	endangered
Mammals	Spotted-tailed Quoll	*Dasyurus maculatus*	vulnerable
Reptiles	Grassland Earless Dragon	*Tympanocryptis pinguicolla*	endangered
Reptiles	Pink-tailed Worm Lizard	*Aprasia parapulchella*	vulnerable
Reptiles	Striped Legless Lizard	*Delma impar*	vulnerable

A.2 COMMONWEALTH (EPBC ACT) LISTED SPECIES

Australian Government
Department of the Environment and Energy

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

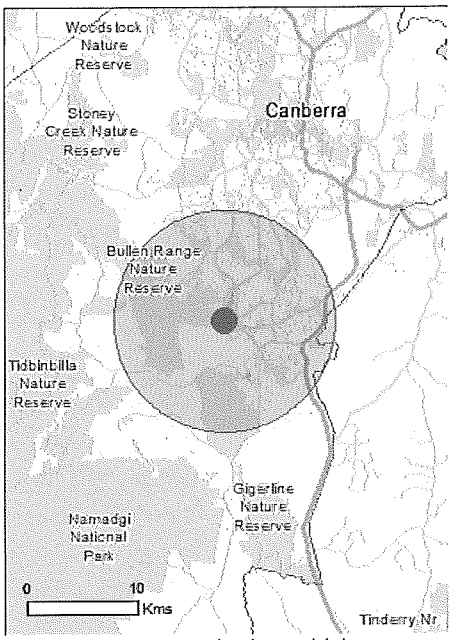
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 01/06/18 14:28:14

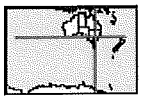
Summary
Details
- Matters of NES
- Other Matters Protected by the EPBC Act
- Extra Information

Caveat
Acknowledgements



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

Coordinates
Buffer: 10.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	1
Wetlands of International Importance:	4
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	3
Listed Threatened Species:	36
Listed Migratory Species:	13

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	2
Commonwealth Heritage Places:	None
Listed Marine Species:	19
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	16
Regional Forest Agreements:	1
Invasive Species:	37
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

National Heritage Properties		[Resource Information]
Name	State	Status
Natural		
Australian Alps National Parks and Reserves	NSW	Listed place

Wetlands of International Importance (Ramsar)	[Resource Information]
Name	Proximity
Banrock station wetland complex	700 - 800km upstream
Hattah-kulkyne lakes	500 - 600km upstream
Riverland	700 - 800km upstream
The coorong, and lakes alexandrina and albert wetland	800 - 900km upstream

Listed Threatened Ecological Communities		[Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Alpine Sphagnum Bogs and Associated Fens	Endangered	Community may occur within area
Natural Temperate Grassland of the South Eastern Highlands	Critically Endangered	Community likely to occur within area
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered	Community likely to occur within area

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Anthochaera phrygia Regent Honeyeater [82338]	Critically Endangered	Species or species habitat known to occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat likely to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Polytelis swainsonii Superb Parrot [738]	Vulnerable	Species or species habitat known to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species

Name	Status	Type of Presence
		habitat may occur within area
Fish		
Maccullochella peelii Murray Cod [66633]	Vulnerable	Species or species habitat may occur within area
Macquaria australasica Macquarie Perch [66632]	Endangered	Species or species habitat known to occur within area
Frogs		
Litoria aurea Green and Golden Bell Frog [1870]	Vulnerable	Species or species habitat may occur within area
Litoria castanea Yellow-spotted Tree Frog, Yellow-spotted Bell Frog [1848]	Endangered	Species or species habitat likely to occur within area
Insects		
Synemon plana Golden Sun Moth [25234]	Critically Endangered	Species or species habitat likely to occur within area
Mammals		
Chalinolobus dwyeri Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat likely to occur within area
Dasyurus maculatus maculatus (SE mainland population) Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat known to occur within area
Petauroides volans Greater Glider [254]	Vulnerable	Species or species habitat may occur within area
Petrogale penicillata Brush-tailed Rock-wallaby [225]	Vulnerable	Species or species habitat likely to occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT) Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat known to occur within area
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Plants		
Amphibromus fluitans River Swamp Wallaby-grass, Floating Swamp Wallaby-grass [19215]	Vulnerable	Species or species habitat may occur within area
Calotis glandulosa Mauve Burr-daisy [7842]	Vulnerable	Species or species habitat likely to occur within area
Dodonaea procumbens Trailing Hop-bush [12149]	Vulnerable	Species or species habitat may occur within area
Eucalyptus aggregata Black Gum [20890]	Vulnerable	Species or species habitat likely to occur within area
Lepidium hyssopifolium Basalt Pepper-cress, Peppercress, Rubble Pepper-cress, Pepperweed [16542]	Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
Leucochrysum albicans var. tricolor Hoary Sunray, Grassland Paper-daisy [56204]	Endangered	Species or species habitat likely to occur within area
Muehlenbeckia tuggeranong Tuggeranong Lignum [64934]	Endangered	Species or species habitat likely to occur within area
Pelargonium sp. Striatellum (G.W.Carr 10345) Omeo Stork's-bill [84065]	Endangered	Species or species habitat may occur within area
Pomaderris pallida Pale Pomaderris [13684]	Vulnerable	Species or species habitat known to occur within area
Prasophyllum petilum Tarengo Leek Orchid [55144]	Endangered	Species or species habitat may occur within area
Pterostylis oreophila Blue-tongued Orchid, Kiandra Greenhood [22903]	Critically Endangered	Species or species habitat may occur within area
Rutidosis leptorrhynchoides Button Wrinklewort [7384]	Endangered	Species or species habitat likely to occur within area
Swainsona recta Small Purple-pea, Mountain Swainson-pea, Small Purple Pea [7580]	Endangered	Species or species habitat known to occur within area
Thesium australe Austral Toadflax, Toadflax [15202]	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
Aprasia parapulchella Pink-tailed Worm-lizard, Pink-tailed Legless Lizard [1665]	Vulnerable	Species or species habitat known to occur within area
Delma impar Striped Legless Lizard [1649]	Vulnerable	Species or species habitat likely to occur within area
Tympanocryptis pinguicolla Grassland Earless Dragon [66727]	Endangered	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat known to occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Defence - CHURCHES CENTRE - TUGGERANONG
Defence - MAWSON OFFICE ACCOMM

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat known to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Bullen Range	ACT
Callum Brae	ACT
Cooleman Ridge	ACT
Farrer Ridge	ACT
Isaacs Ridge	ACT
McQuoids Hill	ACT
Mt Mugga Mugga	ACT
Mt Taylor	ACT
Namadgi	ACT
Oakey Hill	ACT
Red Hill	ACT
Rob Roy	ACT
Tuggeranong Hill	ACT
Unnamed	ACT
Urambi Hills	ACT
Wanniassa Hills	ACT

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included.

Name	State
Southern RFA	New South Wales

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Alauda arvensis Skylark [656]		Species or species habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Carduelis chloris European Greenfinch [404]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Lepus capensis Brown Hare [127]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus norvegicus Brown Rat, Norway Rat [83]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Alternanthera philoxeroides Alligator Weed [11620]		Species or species habitat likely to occur within area
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera subsp. monilifera Boneseed [16905]		Species or species habitat likely to occur within area
Cytisus scoparius Broom, English Broom, Scotch Broom, Common Broom, Scottish Broom, Spanish Broom [5934]		Species or species habitat likely to occur within area
Genista monspessulana Montpellier Broom, Cape Broom, Canary Broom, Common Broom, French Broom, Soft Broom		Species or species habitat likely to occur

Name	Status	Type of Presence within area
[20126] Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Nassella neesiana Chilean Needle grass [67699]		Species or species habitat likely to occur within area
Nassella trichotoma Serrated Tussock, Yass River Tussock, Yass Tussock, Nassella Tussock (NZ) [18884]		Species or species habitat likely to occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Senecio madagascariensis Fireweed, Madagascar Ragwort, Madagascar Groundsel [2624]		Species or species habitat likely to occur within area
Ulex europaeus Gorse, Furze [7693]		Species or species habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-35.41867 149.06349

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

Department of the Environment
GPO Box 787
Canberra ACT 2601 Australia
+61 2 6274 1111

APPENDIX B THREATENED AND MIGRATORY SPECIES RECORDS IN THE OPERATIONS AREA

Species	Listing	Records on ALA within Operations Area
Aves		
Swift Parrot	CE EPBC, V NC Act	✓
Regent Honeyeater	CE EPBC, E NC Act	✓
Painted Honeyeater	V EPBC, V NC Act	✓
Superb Parrot	V EPBC, V NC Act	✓
Hooded Robin	V NC Act	✓
Scarlet Robin	V NC Act	✓
White-winged Triller	V NC Act	✓
Osprey	M EPBC	×
White-bellied Sea-eagle	M EPBC	×
Great Egret	M EPBC	✓
Cattle Egret	M EPBC	✓
Mammals		
Grey-headed Flying-fox	V EPBC	✓
Large-eared Pied Bat	V EPBC	×
Smoky Mouse	E NC Act	×
Reptiles		
Grassland Earless Dragon	E EPBC, E NC Act	×
Pink-tailed Worm Lizard	V EPBC, V NC Act	×
Striped Legless Lizard	V EPBC, V NC Act	×

trail. The test area incorporates Mt. Stranger, which at approximately 660 m height rises around 100 m above the surrounding Tuggeranong Valley and is part of Canberra Nature Parks. The habitat of Mt. Stranger consists of open grassy areas with loose medium size rock, and it is a popular bushwalking site (Canberra Bushwalking Club 2014).

Lower Stranger Pond lies north of Mt. Stranger, and is within the test area. Lower Stranger Pond is primarily a water quality management pond, however receives a low level of use as an informal recreation reserve (Urban Services 2001). It is considered of low importance as fauna habitat (Urban Services 2001). Ginninderra Catchment Group (2017) show Lower Stranger Pond to be an area of open water with fringing vegetation (e.g. reeds and grasses) surrounded by mown grass and occasional nearby trees. Fauna species that can be seen there include Eurasian Coot and several common species of frog including Common Froglet *(Crinia signifera)* and Striped Marsh Frog *(Limnodynastes peronii)* (Ginninderra Catchment Group 2017). A Friends of Strangers Pond group has been established which aims, amongst other things, to "safeguard the integrity of the area." (Southern ACT Catchment Group 2014). A variety of waterbirds are also likely to use this feature on a (semi) regular basis.

Figure 1-1 Operations base (blue plane icon) and current test area (green shading). Image provided by client.