City of Busselton

Assessment of the risk of disturbance to waterbirds of the Vasse-Wonnerup wetlands from the proposed expansion of the Busselton-Margaret River Regional Airport

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Executive Summary

The City of Busselton proposes to develop the Busselton-Margaret River Regional Airport through an expansion of the existing airport facilities, with the introduction of domestic interstate Regular Public Transport (RPT) jet aircraft. There is concern that the increased jet aircraft traffic may disturb migratory shorebirds and other waterbirds at the nearby Ramsar listed Vasse-Wonnerup wetlands, located approximately 3.5 kilometres north of the airport. The wetlands are considered highly significant, as they support tens of thousands of resident and migrant waterbirds of a wide variety of species. The proposed airport expansion is forecast to involve an additional six RPT movements per week in 2018/2019, 14 RPT movements per week in 2022/2023, 16 RPT movements per week in 2028/2029 and 24 RPT movements per week in 2038/2039. This will increase the current air traffic by 2.3%, 4.8%, 5% and 6.6% respectively. There are also forecast increases in general aviation movements at the airport, independent of the expansion project.

Bamford Consulting Ecologists was commissioned to investigate and assess the risk of disturbance to waterbirds in relation to the proposed airport expansion. This included a literature review of impacts upon waterbirds around airports in Australia and interpreting recent monitoring observations by the Department of Parks and Wildlife.

The importance of the Vasse-Wonnerup system for waterbirds is well-documented. It is Ramsar listed because it regularly supports large numbers of waterbirds, including some migratory species. The Vasse Estuary is rich in species and is where many ducks congregate, while the more northerly Wonnerup Estuary is a focus for shorebirds (plovers, stilts/avocets and several migratory sand piper species) and in addition supports a significant Black Swan breeding colony.

The issue of disturbance of waterbirds by human activity has been widely investigated around the world, and this includes disturbance due to aircraft movements (sight and sound). Responses of waterbirds vary for many reasons: with the species, activity of the birds, type of disturbance and extent of habituation being important factors. Studies on the effect of aircraft movements do not provide definitive results that can be immediately applied to the Busselton-Margeret River Regional Airport, but they can make it possible to predict what can be expected and how possible impacts can be managed. In general, waterbirds are tolerant of aircraft disturbance and factors such as a direct approach by a person on-foot may be of more concern than a large aircraft passing overhead. Even nesting birds appear tolerant of aircraft disturbance, and foraging shorebirds appear to be more tolerant of aircraft disturbance than roosting birds. The literature suggests a vertical buffer of at least 300m, a horizontal buffer of at least 200m and a noise limit of 85 dB(A) can be recommended for guidance with respect to aircraft. The sight of aircraft may be more of a concern than the noise it creates, and small aircraft with unpredictable movements may be more disturbing to waterbirds than large aircraft with a direct flight.

At Busselton-Margaret River Regional Airport, the main concern is with RPT flight arrivals from the north that overfly the Wonnerup Estuary. These fall within the guidance obtained from the literature for vertical buffer and noise limit, but not for horizontal buffer. Observations made by the Department of Parks and Wildlife in December 2015 suggest that some current flights are causing disturbance to waterbirds (albeit brief) despite the potential for habituation.

A number of general recommendations can be made:

- A vertical buffer of at least 300m should be maintained for arrival flights over the Wonnerup Estuary. Observations on waterbirds will need to be carried out to ensure this is adequate, particularly as there is no horizontal buffer at this point.
- General aviation and light aircraft operators need to be made aware of vertical and horizontal buffers over the Vasse-Wonnerup system.
- There is some concern with Black Swans during the late winter/early spring breeding season and there needs to be an awareness of this period by pilots and flight controllers. A preference could be shown to using southern approaches for landing aircraft during the swans' breeding period.
- Several studies indicate that people and pets at ground level are the most significant source of disturbance to waterbirds and that birds may be more sensitive when exposed to aircraft movements. Therefore, controlling access at ground level is important.
- The City of Busselton has a voluntary 'Fly Neighbourly Agreement' in place for the airport with the key objective being for aircraft operators to avoid noise sensitive premises as far as is practical, within the limits of weather, safety and economic constraints. It is recommended that this agreement be extended to include the Vasse-Wonnerup system, particularly for the FIFO and interstate RPT flights.

The expectation from observations of waterbirds near aircraft from many studies is that existing and predicted increases in aircraft activity at the Busselton-Margaret River Regional Airport should not adversely affect waterbirds, assuming buffers and noise limits are adhered to. However, the situation should be monitored both in terms of aircraft movements as well as waterbird behaviour.

Contents

List of tables

List of figures

List of appendices

1 Introduction

1.1 Background

The City of Busselton proposes to develop the Busselton-Margaret Regional Airport ('the airport') through an expansion of the existing airport facilities, with the introduction of domestic interstate Regular Public Transport (RPT) jet aircraft. There is concern that the increased jet aircraft traffic may disturb migratory shorebirds and waterbirds at the nearby Ramsar listed Vasse-Wonnerup wetlands, located approximately 3.5 kilometres (km) north of the airport (Figure 1). The wetlands are considered highly significant, as they support tens of thousands of resident and migrant waterbirds of a wide variety of species. More than 80 species of waterbirds have been recorded such as Red-necked Avocets, Banded and Black-winged Stilts, Wood Sandpiper, Sharp-tailed Sandpiper, Long-toed Stint, Red-necked Stint, Curlew Sandpiper and Common Greenshank. Up to 21 bird species are also known to breed at the Ramsar site, including the largest regular breeding colony of Black Swans in the southwest of Western Australia (DotE 2016).

Bamford Consulting Ecologists (BCE) was commissioned by the City of Busselton to investigate and assess the risk of disturbance to waterbirds in relation to the proposed airport expansion. The assessment builds on previous work conducted by Green Iguana (2010), which studied the effects of aircraft using the airport on waterbirds and migratory waders.

Two key issues have been highlighted for birds in the Vasse-Wonnerup wetlands: the impact of disturbance and the risk of bird-strike from aircraft. This report addresses the disturbance issue. Davidson (1995) notes that waterbirds could be a bird-strike risk for aircraft at Busselton Airport, but only 10 bird-strikes at the airport were reported to the Australian Transport Safety Bureau over the six year period from 2004 to 2009. The risk of birds-trike to aircraft exists and is an aviation safety issue, however the ecological consequences to waterbirds of a very low rate of bird-strike are negligible.

1.2 Study objectives

The main objectives of the study were to:

- Review the literature on the impacts of aircraft movements around airports upon migratory shorebirds and other waterbirds. This includes a review of the recent Environmental Impact Statements (EIS) for the Brisbane Airport New Parallel Runway, Sunshine Coastal Airport Expansion and introduction of the F-35A aircraft at RAAF Base Williamstown;
- Collate and interpret recent monitoring results and observations of aircraft disturbance to birds at the Vasse-Wonnerup wetlands in December 2015 from the Department of Parks and Wildlife (DPaW); and
- Assess the risks posed by increased movements of aircraft, such as disturbance to foraging, roosting and/or breeding waterbirds. This will be based on the findings of the literature review, impact assessments undertaken for other airport projects, recent bird monitoring results, and the existing and forecast aircraft movements at the airport.

Figure 1. Location of the project.

1.3 Project description

The airport expansion project includes the following ground works and additional infrastructure:

- Extension, widening and strengthening of the runway from the current size of 1800 metres (m) x 30m wide to 2340m x 45m wide;
- Construction of a new terminal building, 600 carpark bays, new entry statement and internal road networks;
- Two new aircraft aprons and taxiways;
- Drainage infrastructure and service utilities; and
- Land acquisition.

The expansion works will enable the airport to accept domestic interstate RPT flights. At the time of writing, the number and timing of the new interstate RPT flights was uncertain and is expected to be determined in negotiation with commercial airlines. An indicative forecast of aircraft movements has therefore been developed by the City of Busselton. Current (2015/2016) air traffic and projected weekly aircraft flight forecasts are provided in Table 1. All forecasts are listed in movements per week, with one flight comprising two movements: an arrival and a departure. The RPT flights are expected to involve Code 4C aircraft such as Boeing 737 (B737) and Airbus 320 (A320) aircraft.

The Busselton Regional Airport Noise Management Plan (July 2015), states that RPT flights can occur between the hours of 0600-2300 and are not to exceed 85 dB(A) (City of Busselton 2015). The airport is classified as a "G" airspace, which means that flights to and from the airport are uncontrolled, but in reality there are several flightpaths which will be most commonly used. These are illustrated and discussed in Section 3.1.1 and a key flightpath is over the Wonnerup Estuary.

At present (2015/2016) the airport supports approximately 230 movements (115 flights) per week of General Aviation aircraft and approximately 14 movements (7 flights) per week of scheduled Fly-In-Fly-Out (FIFO) aircraft involving Fokker 100 jet aircraft. Note, the percentage increase shown in Table 1 is the increase as a direct result of the expansion project (i.e. RPT flight growth only), as the increase in FIFO closed charter and General Aviation flights have been previously assessed in an earlier environmental approval for the existing airport. When considering the total combined increase in air traffic (i.e. RPT flights, FIFO closed charter and General Aviation flights, Table 1) the cumulative increase of flights at the airport would be 8% in 2018/2019, 16% in 2022/2023, 20% in 2028/2029 and 24% in 2038/2039. This means that there is the potential for aircraft movements to increase by up to a quarter within 20 – 25 years.

Table 1. Current (2015/2016) air traffic and forecast weekly aircraft movements to 2038-2039.

Class / Operator	2015/16 (weekly)	2018/19 (weekly)	2022/23 (weekly)	2028/29 (weekly)	2038/39 (weekly)
FIFO closed charter	14	16	20	24	24
RPT⁺ – Melbourne	**0**	**6**	**8**	**10**	**18**
RPT⁺ – Sydney	**0**	**0**	**6**	**6**	**6**
General Aviation*	230	242	255	266	271

Total Weekly Movements	**244**	**264**	**289**	**306**	**319**
% increase on Operations resulting from the expansion project (i.e increase in RPT Flights)	**0**	**2.3%**	**4.8%**	**5%**	**6.6%**

+ RPT: Regular Public Transport.* includes light aviation, recreational aviation aircraft and emergency services.

1.4 Study limitations

It should be highlighted that the assessment of disturbance impacts on waterbirds from aircraft is complex, poorly understood and has many knowledge gaps. Further, it can be difficult to transpose knowledge from site to site, or species to species. Although several waterbird surveys have been undertaken at the Vasse-Wonnerup wetlands, there are few observations on the effect of disturbance from aircraft or other factors at the site. The only field observations on aircraft and waterbird disturbance at the site are the results of field observations on a single day provided by K. Williams and J. Lane of DPaW.

2 Literature review

2.1 Background information on the Vasse-Wonnerup wetlands

Key ecological features of the Ramsar listed Vasse-Wonnerup wetlands are described in the Australian Wetlands Database DotE (2016) and briefly summarised below.

The Vasse-Wonnerup system is an extensive, shallow, nutrient-enriched wetland system of highly varied salinities and hydroperiods (i.e. flooded in winter, with large areas drying out in summer). The system is fringed by samphire and rushes with some melaleuca woodlands on higher ground. The Tuart Forest National Park component of the site is dominated by open forest of mature Tuart (*Eucalyptus gomphocephala*) and Peppermint (*Agonis flexuosa*). Tree hollows in these areas provide important breeding sites for Australian Wood Duck, Australian Shelduck and possibly other duck species. The native Rakali or Water-Rat (*Hydromys chrysogaster*) has been recorded at several locations. The wetlands cover an area of approximately 1,115 hectares (ha) and support tens of thousands of resident and migrant waterbirds of a wide variety of species.

The wetlands are of national and international importance and are justified as a Ramsar wetland on the basis that they meet two of the nine criteria:

> Criterion 5: More than 33,000 waterbirds have been counted at the Vasse-Wonnerup System. Waterbird data indicate that more than 20,000 waterbirds use the Ramsar site each year, suggesting that the wetland regularly supports 20,000 waterfowl. This includes species such as Red-necked Avocets, Banded and Black-winged Stilts, Wood Sandpiper, Sharp-tailed Sandpiper, Long-toed Stint, Curlew Sandpiper and Common Greenshank.
>
> Criterion 6: At least 1% of the Australian population of Black-winged Stilt and at least 1% of the world population of Red-necked Avocet use the Vasse-Wonnerup System in most years.

Further information on the Vasse-Wonnerup wetlands can be found in the following documents at the Australian Wetlands Database DotE (2016):

- Ramsar Information Sheet, Vasse-Wonnerup System (Number 38, updated in July 2014);
- Ecological Character Description for the Vasse-Wonnerup System Ramsar Site South-west Western Australia (Wetland Research and Management (2007); and
- Tuart Forest National Park – Draft Management Plan - 2011 (includes Vasse-Wonnerup Wetlands) (DPaW 2016).

2.2 Waterbird usage at the Vasse-Wonnerup wetlands

The Vasse-Wonnerup system is considered a highly significant coastal wetland on the basis that it supports large numbers of waterbirds, provides breeding habitat and an over-wintering area for migratory waders which breed in the northern hemisphere (Davidson 1995; Bamford *et al*. 2008).

Numerous waterbird surveys have been conducted at the site since the late seventies by the Royal Australasian Ornithologists Union (now BirdLife Australia), Western Australian Department of Parks and Wildlife and others including: Tingay *et al.* (1977), Bamford and Bamford (1995), Jaensch (1986), Jaensch *et al.* (1988), Lane (1990, 1997a, 1997b, 2002), Jaensch and Lane (1993), Halse *et al*. (1990) and Lane *et al.* (2007). More recently, BirdLife Australia has conducted monitoring surveys between 2007 and 2016 under the Shorebirds 2020 program, with the latest survey conducted in February 2016.

More than 80 bird species have been recorded at the site (Appendix 1). Four species exceed the 1% population threshold: Black-winged Stilt, Red-necked Avocet, Australian Shelduck and Australasian Shoveler. Twenty-one waterbird species are known to breed at the site, including the largest regular breeding colony of Black Swans in the south-west of Western Australia. Another five shorebirds have been recorded in numbers greater than 1% of the East Asian-Australasian Flyway population in some years: Wood Sandpiper, Sharp-tailed Sandpiper, Long-toed Stint, Curlew Sandpiper and Common Greenshank (Ramsar 2014).

Lane *et al.* (2007) report that up to 37,446 waterbirds were counted in December 1998 and in November 1994, Bamford and Bamford (1995) recorded 22,660 waterbirds. Bird counts from DPaW and BirdLife Australia from the Vasse-Wonnerup wetlands include:

- 2008 -13,138;
- 2010 - 13,146;
- 2012 - 15,556;
- 2015 – 30,771; and
- 2016 – 3,844.

Surveys are conducted on an annual basis, rather than coinciding with peak activity or particular water levels. It is anticipated that if more intensive surveys were conducted over the whole wetland system and during optimal conditions, more bird counts would be recorded. The small number of waterbirds recorded in 2016 has been attributed to low water levels in the wetlands (K. Williams, DPaW, pers comm).

Recent field surveys by DPaW in the period between February 2014 and January 2016 indicate that the total number of waterbirds at the Wonnerup wetland (only), fluctuates considerably throughout the year (Figure 2) and between years. Higher bird counts are recorded during the peak summer period (December and January) and is likely to be attributed to the arrival of migratory waders from the northern hemisphere, seasonal fluctuations in hydroperiods, drying of smaller wetlands in the region and natural variation in local, regional and international populations. Such high variability makes it difficult to differentiate between natural variation in the system and the effect of disturbance from increased aircraft traffic or other factors.

Waterbirds are not evenly distributed across the Vasse-Wonnerup system. The key patterns of distribution are: most ducks and the greatest range of species on the Vasse Estuary; most shorebirds and high levels of abundance on the Wonnerup Estuary; Black Swans breeding on ‘Swan Lake’ at the far eastern end of the Wonnerup Estuary.

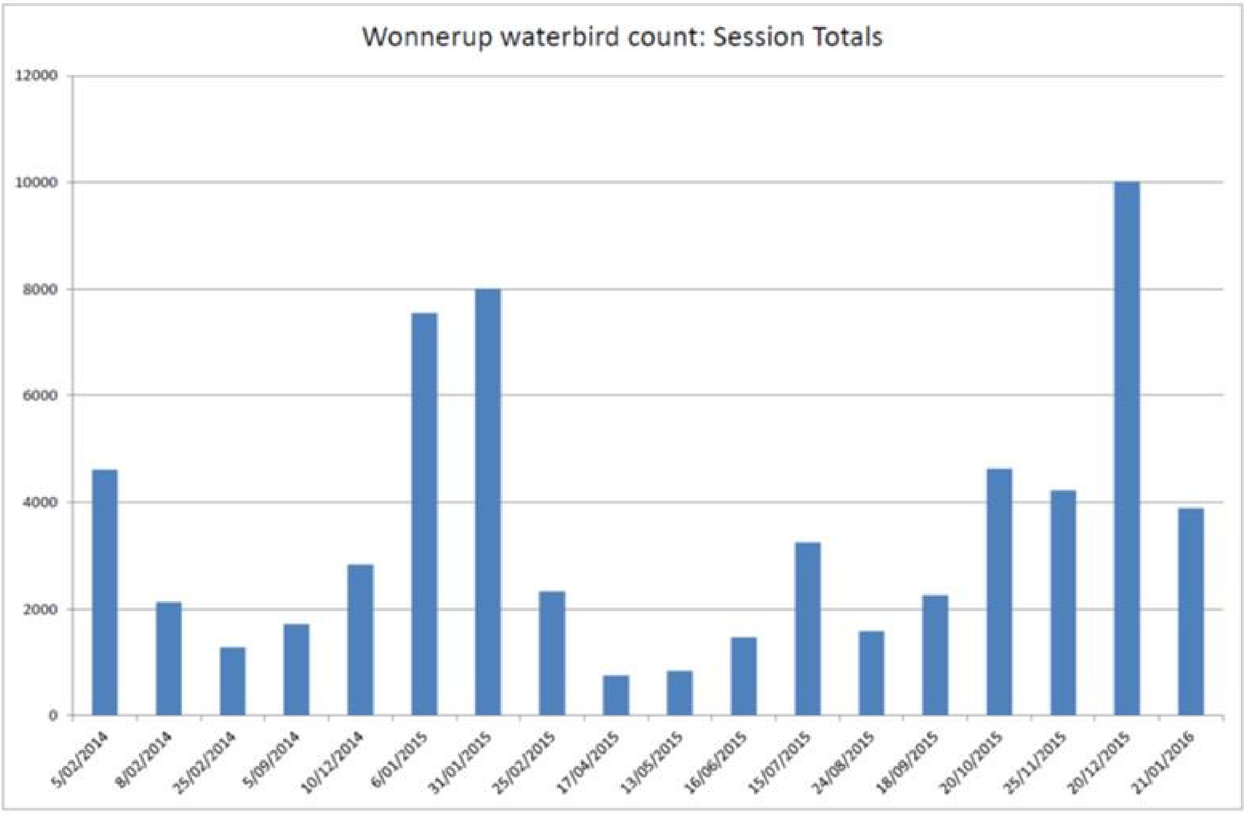

Figure 2. Waterbird counts from the Wonnerup wetland between February 2014 and January 2016 (Source: DPaW)

2.3 Waterbirds and disturbance

Green Iguana (2010) provides a comprehensive review of the literature on waterbirds and disturbance, including disturbance by aircraft. Key elements of that review are summarised below, supplemented with additional information where available. Sections of the Green Iguana (2010) report on which this summary is based are provided in Appendix 3.

Most studies document the effect of disturbance but not the consequences. Effect is how the birds change behaviour, how long that change persists and any other observations that can be made, whereas consequence is what population impacts result from the effect. Consequence is poorly studied because long term population changes are difficult to document and distinguish from other impacts. Furthermore, birds may change their behaviour, such as abandoning a roosting site due to disturbance, long before any population effect, such as increased mortality, is evident.

Effects of disturbance are complex. Different species may have different responses and the difference can extend to whether or not a species habituates to a disturbance. Habituation, in which individuals of a species exposed to a source of disturbance cease responding to it, is widely documented. Habituation can be very specific. As a local example, Red-necked Stints roosting alongside a cycleway in Milyu Nature Reserve on the Swan River will tolerate bicycles and pedestrians passing within 15m, but will take flight if someone stops to look at them at a distance of 25-30m (M. Bamford pers. obs.).

The behaviour of birds can affect their sensitivity to disturbance. Birds in breeding colonies may be sensitive to disturbance and the effect can be catastrophic as eggs and chicks can be crushed or knocked from nests (Carnay and Sydeman 1999), but studies by Black *et al.* (1984) found that nesting success in a mixed colony of herons and egrets was unaffected by military training flights (less than 200m from ground level), and this has also been found in a mixed colony including cormorant (Carnet and Sydeman 1999). Foraging shorebirds are more tolerant of disturbance such as an approach by pedestrians than are roosting shorebirds (Bamford 1995, Bamford *et al.* 2003). In mixed species flocks, general disturbance will take place as a result of the most sensitive species taking flight and then setting other birds off. There is no clear taxonomic pattern to sensitivity to disturbance. Bamford *et al.* (2003) studied reactions of a range of waterbird species on the Swan River and found that there were sensitive and tolerant species within each major group such as shorebirds and waterfowl (ducks and swans). Studies reviewed by Green Iguana (2010) considered a very wide range of species and found no pattern with species group, although one report was on the catastrophic impact of a helicopter on a breeding colony of penguins.

Changes in behaviour as a result of disturbance can pass within minutes, but at least one study (Goudie and Jones 2004; cited by Green Iguana 2010) has found changes in other factors, such as courtship, can be delayed for hours. This was the result of low-level flights by military aircraft.

Different sources of disturbance can have a cumulative effect. Koolhaas *et al.* (1993) found shorebirds more sensitive to disturbance from pedestrians if they had just been exposed to noisy aircraft.

Disturbance can result from a variety of factors such as noise, light, pedestrians, dogs, boats, wind-surfers and aircraft. In the case of aircraft, variables such as size, height, noise, direction and even shape may affect the response (e.g. Koolhaas *et al.* 1993). Observations made on the Wonnerup Estuary in December 2015 (K.Williams, DPaW, pers comm.) indicate that low-flying jet aircraft on approach disturb birds more than noisy but rapidly climbing aircraft, therefore the visual impact may be of more concern than the impact of noise. The study by Kooolhaas *et al.* (1993) found that slow-moving aircraft may be more disturbing than fast-moving aircraft, perhaps because they trigger a predator response. In contrast, Ward *et al.* (1986; cited by Green Iguana 2010) found a large helicopter to have a greater impact than a small fixed-wing aircraft, whereas Bamford and Doyle (2008) noted that a helicopter had little impact.

Effects of aircraft are variable and uncertain, and in general it seems that waterbirds are very tolerant of predictable aircraft movements with more concern from sight than sound; most concern may be with fast, very loud and low-flying military aircraft, and perhaps with low-flying, slow-moving aircraft. Even these extreme cases may vary with the subject birds. Height limits have been proposed under some circumstances and were reviewed by Harris (2005). Under different guidelines, the vertical height buffer ranged from 300 to 1000 metres, with horizontal buffers ranging from 200 to 2000 metres. The US Federal Aviation Administration has set minimum altitude levels for aircraft above nature areas at 610m (Dewey and Mead 1994), while Davidson (1995), in a review prepared for Busselton, indicated that aircraft flying higher than 200

- 300 m would not have any measurable detrimental effect on waterbirds within the Vasse-Wonnerup system. Komenda-Zehnder *et al.* (2003) found that birds settled to a relaxed behaviour after approximately five minutes in reaction to overflights and that a minimum flight altitude of 300m did not displace birds.

Noise as well as movement is a factor in the disturbance of waterbirds by aircraft. Burger (1981; cited by Green Iguana 2010) found no adverse or significant impact on nesting Herring Gulls at JFK Airport, New York, where noise levels were 85 to 110 dB on approach and 94 to 105 at departure. The experimental exposure of ducks to loud noise found that they rapidly became accustomed to it (Fleming *et al.* 1996; cited by Green Iguana 2010). Brown (1990; cited by Green Iguana 2010) found that noise greater than 85 dB alarmed Crested Terns but that lower levels caused little or no response. Brown also commented that visual rather than aural stimuli appeared more significant when considering impacts of aircraft.

From these summary points, it can be concluded that there are some common patterns to the response of waterbirds to disturbance, such as visual rather than aural stimuli possibly being more significant, roosting as opposed to foraging shorebirds being more sensitive, and slow moving and unpredictable aircraft potentially being more disturbing than direct and predictable aircraft. There are also some guidelines with respect to aircraft movements that are based on a range of observations that suggest waterbirds will tolerate aircraft under many circumstances. It is also important to note that responses vary greatly with the source of disturbance, interactions between disturbance sources, the extent of habituation, and both the species and activity of the birds. These general patterns can be expected to apply to the effect upon waterbirds of aircraft movements over the Vasse-Wonnerup system, but effects can be situation specific.

2.4 Review of impacts on birds from aircraft in recent Environmental Impact Statements

2.4.1 Summary of impact assessments within Australia

A review of the impacts of aircraft on waterbirds in three Environmental Impacts Statements (EIS) was conducted with the aim to provide some context for the consideration of the significance of disturbance to water birds at the Vasse-Wonnerup wetlands. A brief summary of each project and the outcomes of the impact assessment are provided below. The three projects reviewed were:

1. Brisbane Airport New Parallel Runway Draft EIS - October 2006;
2. Sunshine Coast Airport Expansion EIS - September 2014; and
3. Draft EIS for Flying Operations of the F-35A Lighting II - July 2014.

2.4.1.1 Brisbane Airport New Parallel Runway Draft EIS (EPBC 2005/2121)

Brisbane Airport is adjacent to the Moreton Bay Ramsar site that is recognised due to its importance for waterbirds including migratory species. The airport has hundreds of Regular Public Transport (RPT) jet aircraft movements per day (almost two orders of magnitude greater than the RPT flights for the Busselton-Margaret River Regional Airport). The New Parallel Runway project was determined as a controlled action for the following Matters of National Environmental Significance (MNES):

- Wetlands of international importance (Moreton Bay Ramsar site);
- Threatened species and communities;
- Migratory species; and
- Commonwealth land.

The risk to MNES was generally associated with clearing and construction impacts. The EIS did not explicitly assess the impact of aircraft movements on birds, however the potential for disturbance was considered with respect to aviation hazards and safety.

The EIS (EPBC 2005/2121) reported the following under Volume D8 Hazards and Risks of Airport Operations, Section 8.7.2 Bird Strike:

> "*A series of surveys [was] undertaken by WBM Oceanics as part of the current study to assess the response of feeding and roosting shorebirds to air traffic. Surveys were undertaken of shorebirds feeding on intertidal mudflats adjacent and to the north of runways 01R/19L and 14/32 with incoming and outgoing air traffic activity. Shorebirds were also observed at roost within saltmarsh and clay pan habitats adjacent and to the north of runway 01R/19L. In addition to visual observations, video footage was made for later assessment.*
>
> *Despite observations under a variety of tidal and weather conditions, there was no observable evidence that birds halted or reduced feeding activities or dispersed from feeding grounds whilst air traffic approached or was overhead. Furthermore, no observations were made of shorebirds leaving roost sites whilst air traffic approached or was overhead. Field data collected to date [do] not indicate that either feeding or roosting shorebirds were affected by approaching or overhead air traffic. Five shorebird surveys were conducted on Brisbane Airport Corporation (BAC) lands during the summers of 2004 and 2005 (refer Chapter B5, Lambert and Rehbein 2005). These included surveys of shorebirds at roost and feeding sites in the same areas as assessed in late 2005/early 2006 to investigate potential air traffic disturbance to shorebirds. None of those reports [notes] any visible reaction by the shorebirds whilst feeding or roosting to air traffic.*"

The Brisbane study therefore carried out field investigations and found no impact of aircraft movements upon waterbirds.

2.4.1.2 Sunshine Coast Airport Expansion EIS (EPBC 2011/5823)

The Sunshine Coast airport expansion project was determined a controlled action on the basis of the following MNES:

- Wetlands of international importance (Moreton Bay Ramsar site);
- Threatened species and communities; and
- Migratory species.

The effects of aircraft noise disturbance on birds were assessed in Chapter E2 Matters of National Environmental Significance, Section 2.14.6 Aircraft Noise as follows:

> "*While noise amplitude should not increase, flight activity on the new runway may increase the frequency of peak noise periods. Predicted 2040 RPT flight schedules suggest flight frequency will increase, although flight frequency is expected to be similar under both 'do minimum' and 'new runway' scenarios. Average flights during daylight hours (6 am to 5 pm),*

> *when birds are active and calling, will increase from 1.3 movements per hour to 3.5 movements per hour under the 'do minimum' scenario and 4 movements under the 'new runway' scenario. Peak flight frequency will coincide with the hour commencing at midday, with 8 predicted flights under the 'do minimum' scenario and 11 under the 'new runway' scenario. Far fewer flights (no more than 5 per hour) are expected under either scenario in the hours prior to 11am.*
>
> *Assuming each flight produces elevated noise levels sufficient to mask bird calls for a duration of 2.5 minutes, large periods of the day will remain unaffected. This may cause minor temporal changes in calling behaviour (i.e. individuals may cease calling during elevated noise), but on balance is not expected to affect vertebrate communities.*"

The Sunshine Coast Airport EIS does not appear to have included specific field investigations on the disturbance of waterbirds by aircraft. Instead, general bird surveys were undertaken and the assessment focussed on the impact of noise on the Eastern Ground Parrot (*Pezoporus wallicus*) which vocalises pre-dawn and post-sunset. The assessment concluded that while the increased frequency of aircraft movements and noise would temporarily mask calling by the species, this was considered to be intermittent and for short periods so would not result in significant impacts.

2.4.1.3 Draft EIS for Flying Operations of the F-35A Lighting II (EPBC 2010/5747)

The EIS for the F-35A aircraft covered a number of RAAF bases in Australia, including RAAF Base Williamtown near Newcastle in New South Wales. The flying operations of the F-35A aircraft were determined a controlled action due to the following MNES for RAAF Base Williamtown:

- Wetlands of international importance (Moreton Bay Ramsar site);
- Threatened species and communities; and
- Migratory species.

The document focussed on the effects of aircraft noise on birds as follows.

> "*Noise has the potential to impact on biodiversity by disrupting feeding, roosting and breeding patterns of fauna. Currently, there has been limited research conducted into understanding the effects of noise on wildlife. Specifically, noise disturbance on fauna by the proposed flying operations of the F-35A aircraft has the potential to:*
>
> - *Reduce vocal communication perception, leading to a decreased ability to communicate between individuals of a species, and reduced reproductive success in species that use vocal cues for breeding;*
> - *Elicit a reactionary response, such as mild alert responses or permanent abandonment of habitat, or roosting and breeding sites; and*
> - *Increase susceptibility to predation, as is the case of Gould's Petrel, which emit a stress call in response to sudden noise generated by low level fly overs that could reveal nest position to predatory birds (NSW Department of Environment and Conservation 2006).*

In addition, it was suggested that "*Noise disturbance [could lead] to reduced survivability and life-cycle support of species that are dependent on the wetland".*

Despite these concerns and the apparent lack of any field assessment, the study concluded that impacts would be low because:

- “*Noise disturbance may increase over habitat for migratory shorebirds including Australian Bittern and Australian Painted-snipe habitat. However, there will be areas of habitat that will not experience increased noise, which may be used by affected fauna individuals;*
- *Noise disturbances from the F-35A aircraft will be short-term and intermittent, allowing birds to resume feeding and roosting quickly;*
- *These species exhibit a tolerance to military aircraft noise disturbance as they already inhabit areas overflown by the F/A-18A/B Hornet aircraft;*
- *Noise levels may increase in some parts of the Hunter Estuary Wetlands Ramsar site. However, there will be large areas within the wetlands where no change in noise levels is predicted; and*
- *Noise disturbances from the F-35A aircraft will be short-term and intermittent, causing short-term disruption to fauna*.”

3 Discussion; aircraft impacts upon waterbirds on the Vasse-Wonnerup System

Considerable research on the impact of aircraft movements upon waterbirds has been carried out around the world, reflecting concern that such impacts may be significant, and the common placement of airports close to wetlands. Conclusions from these studies are that waterbirds have a high tolerance to the noise and movement of aircraft, with some concerns with respect to irregular, low-level, noisy and high speed military aircraft, and possibly low-level erratic small aircraft. Three recent environmental impact assessments in Australia investigating aircraft impacts upon waterbirds tended to focus on the effect of noise (despite some evidence that visual stimuli are more significant) from aircraft and only one carried out field investigations. These studies generally concluded that impacts would be low because disturbance events would be of short duration, would affect only parts of areas occupied by waterbirds, and waterbirds were habituated to aircraft movements in these areas.

Studies into the effect of aircraft on waterbirds identify two key issues that are applicable to the Busselton airport expansion project:

- Disturbance to waterbirds (roosting, feeding, breeding); and
- Risk of bird strike.

These two issues were also raised in the Western Australian Environmental Protection Authority (EPA) Report and Recommendations for the original airport proposal (EPA 1995). The impact of the proposed expansion project (i.e. increasing air traffic) on waterbirds from disturbance is discussed below.

3.1 Disturbance to waterbirds

The disturbance to waterbirds from aircraft is a concern for the conservation values of the Ramsar listed Vasse-Wonnerup system. However, what is clear from the literature is that impacts are difficult to predict. This is due to the lack of site specific research coupled with a poor understanding of the actual effect of disturbance from aircraft on waterbirds. In addition, species specific disturbance data for individual projects are often absent and constrained by time and financial resources. Changes to breeding behaviour of waterbirds (e.g. Black Swans which breed in the wetlands) are unknown in terms of nest abandonment, egg survival and/or egg predation risk. Similarly, impacts to feeding behaviour are generally uncertain, but are anticipated to be low and temporary based on the frequency of flights.

In the absence of these data, the assessment of impacts is based on the location, frequency and intensity of the disturbance (i.e. aircraft noise) and the status of waterbird populations at the wetlands.

3.1.1 Flight altitudes and paths

The airport is located approximately 3.5 km south of the Vasse-Wonnerup system, although the system is approximately 14 km long (Figure 1). The northern approach and departure flight paths (Figure 3) are currently aligned to traverse the eastern end of the system, which includes the majority of the Wonnerup wetland (located approximately nine km north of the airport).

Southern flight paths will not affect the wetlands (Figure 4). Preliminary modelling of the northern arrival and departure flight altitudes were conducted by To70 Aviation Australia. The flight altitude data show that different types of aircraft (i.e. Jet or Propeller) will fly over the Wonnerup Estuary at various altitudes. For example:

- Northern arrival flight height over the Wonnerup Estuary (aircraft type not specified)
    - Between 300 to 600 m (based on a 3 degree glide slope).

- Northern departure flight height over the Wonnerup Estuary
    - Jet Aircraft
        - Boeing 737-800: Between 1000 to 1500 m;
        - Airbus 320-211: Between 1000 to 1250 m; and
        - Fokker 100: Between 1000 to 1250 m.

    - Propeller Aircraft
        - Dornier 328: Between 1800 to 2800 m;
        - Cessna 172: Between 700 to 1100 m;
        - Cessna 206: Between 800 to 1100 m; and
        - Dash 8: Between 1200 to 1700 m.

Arrival altitudes are generally lower than departures but all are above 300m when over the Vasse-Wonnerup system. The lowest heights are for arrivals as departing planes climb steeply. All predicted aircraft movements are above the minimum height guidelines reported by Harris (2005), but do not accommodate the horizontal buffer of at least 200m that he proposed.

The classification of Busselton airport as a “G” airspace means that while flight paths are typically expected as per Figures 3 and 4, flights to and from the airport are uncontrolled. There are currently no defined flight paths and pilots are free to choose any flight path they desire on the basis of economy, safety and/or weather. The effect of an uncontrolled airspace could mean that not all the increase in flight frequency as detailed in Table 1 will occur over the Vasse-Wonnerup system.

Figure 3. Indicative flight paths for Runway 03 (red: arriving from the south, green: departing to the north).

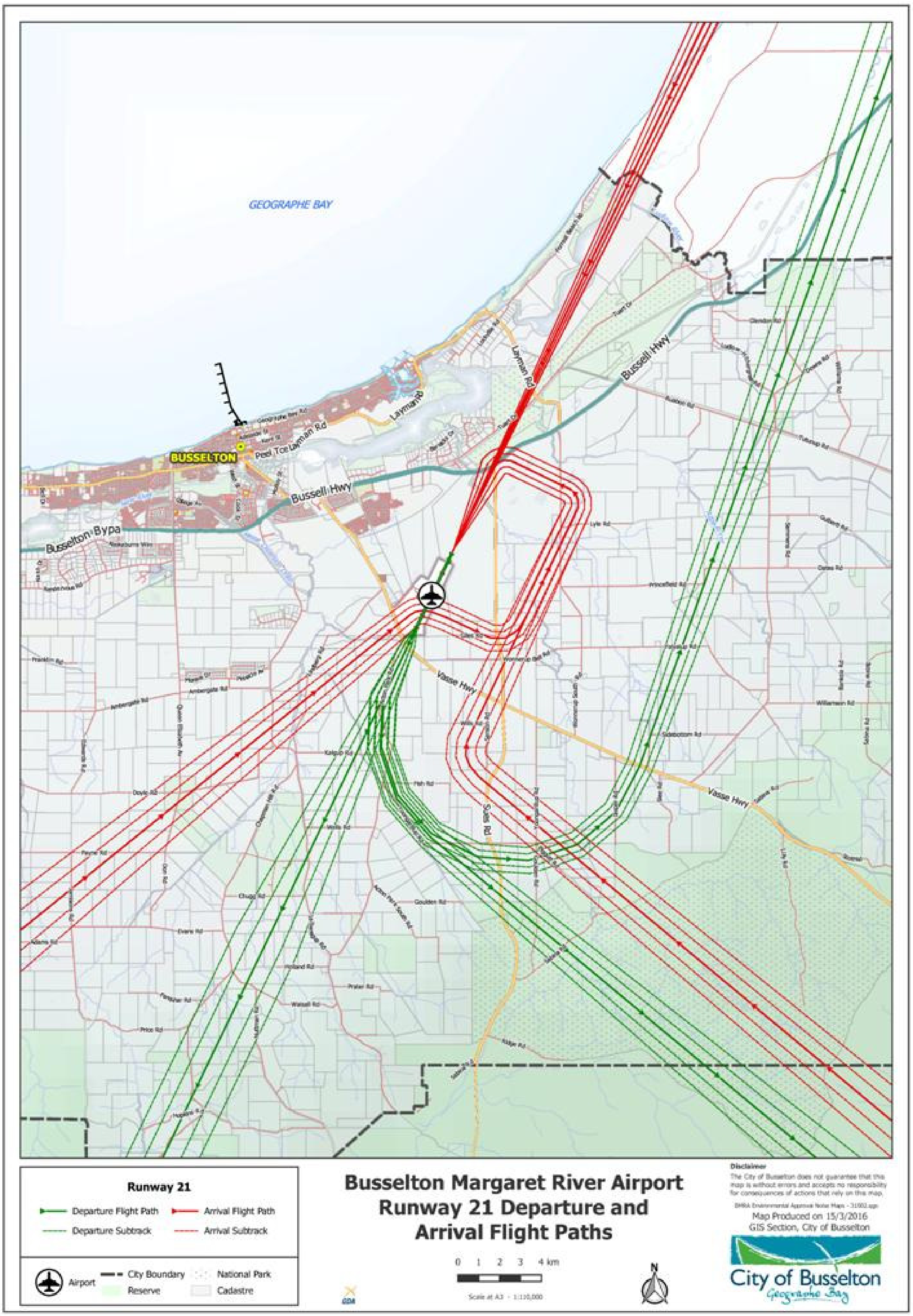

Figure 4. Indicative flight paths for Runway 21 (red: arriving from the north, green: departing to the south).

3.1.2 Noise

The proposed expansion is expected to increase the level and frequency of noise events due to the increased number of larger jet aircraft using the airport. Predicted noise levels were modelled by To70 Aviation Australia and modelled noise contours for Runway 03 (departing to the north) and Runway 21 (arriving from the north) from three different aircraft types (F100, B737 and A320) are provided in Figure 5. The FIFO jet aircraft (Fokker 100) are provided for reference for the proposed RPT (B737 and A320) aircraft.

Key points from the noise modelling relevant to the disturbance of waterbirds include:

- The existing **FIFO jet aircraft (F100) flights** would have maximum noise levels (LAmax) of approximately **60-70 dB(A)** along the Wonnerup Estuary. Flights arriving from the north via Runway 03 WEST flight tracks (Figure 3) are likely to have similar noise levels for aircraft crossing the Vasse Estuary. The northern-most extent of the Wonnerup Estuary, Swan Lake, would have an LAmax of about 60 dB(A), and close to the Tuart Forest along Tuart Drive it would be approximately 70 dB(A). Therefore, the southern extent of the Wonnerup Estuary would be exposed to the most noise;
- **A320 flights** would have LAmax of about **65-75 dB(A)** along the Wonnerup Estuary; and
- **B737 flights** would have an LAmax of approximately **68-78 dB(A)** along the Wonnerup Estuary.

Under the proposed expansion, the increase in RPT flights in 2022/2023 (Table 1) would result in up to an additional 14 movements per week (an average of 2 movements per day) over the Wonnerup Estuary. By 2038/2039, there would be up to an additional 24 movements per week (an average of 3.4 movements per day) over the Wonnerup Estuary. These additional movements would have an LAmax of **65-78 dB(A)** (based on A320 and B737 aircraft) over the Wonnerup Estuary which is 5 to 8 dB(A) higher than current noise levels from F100 flights.

Overall, noise contours extend more over the Wonnerup Estuary in particular for arrivals from the north than departures. Arrivals or departures from the south do not overfly the Vasse-Wonnerup system. Maximum noise levels experienced at any location will be temporary (ca. 20-40 seconds) and the City of Busselton (2015) requires that aircraft noise be restricted to the period 0600-2300 hours and is not to exceed 85 dB(A). This is consistent with at least some observations that it is noise levels above 85 dB that are a concern for waterbirds.

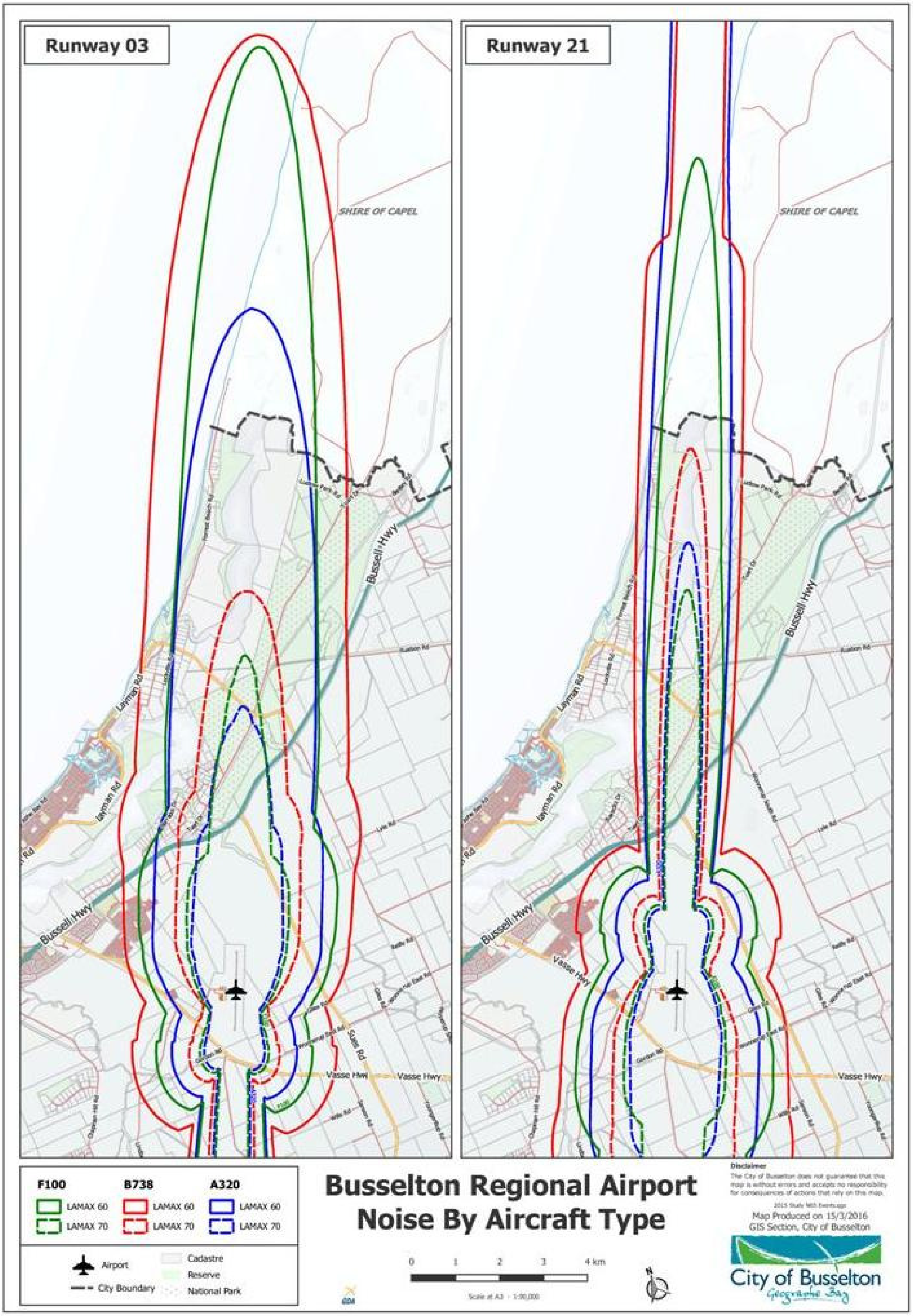

Figure 5. Noise contours for three different aircraft types (F100, B737 and A320). Runway 03: departing to the north, Runway 21: arriving from the north. The modelling of 'LAmax' contours shows maximum noise levels in A-weighted decibels or dB(A) of aircraft. The existing flights, F100, are compared with the proposed flights of B737 and A320 aircraft.

3.1.3 The potential impact of aircraft flight paths and noise on waterbirds on the Vasse-Wonnerup

Based on information and modelling of flight paths and noise, aircraft movements with the greatest potential to affect waterbirds are arrivals from the north that pass over the Wonnerup Estuary. Such aircraft are low-flying (but predicted to be greater than 300m) and will expose the Wonnerup Estuary to more frequent flyovers and noise levels of up to 78 dB(A); higher than under current operations. The height and noise level are, however, within suggested international guidelines (Harris 2005; Brown 1990 cited in Green Iguana 2010).

The northern end of the Wonnerup Estuary is important for shorebirds and for breeding by Black Swans. It is very difficult to predict how nesting Black Swans will react to planes passing overhead at a height of more than 300m. Bamford and Doyle (2008) noted that Black Swans were among the more tolerant of waterbirds when approached by a slow-flying helicopter at a height of just 20-30m, not reacting until the machine was less than 100m away, although some young birds momentarily panicked. Brant and Snow Geese, waterfowl in some ways similar to Black Swans (large and mainly herbivorous, and forming flocks), have been reported in a number of studies to be tolerant of aircraft, more disturbed by pedestrians than planes, to habituate to regular flights within three days, and to react to a small (Cessna) overflight at heights of less than 300m (various references cited by Green Iguana 2010). Observations on brooding Brant Geese noted they were more concerned by human presence than aircraft flyovers. Based on these observations on other species, it seems likely that even breeding Black Swans will be tolerant of flights at heights of more than 300m.

3.1.4 Observations on impacts and waterbirds on the Vasse-Wonnerup; – December 2015

The only recent observations on reactions of waterbirds to aircraft movements to and from the Busselton airport were made by Department of Parks and Wildlife (DPaW) personnel on 22nd December 2015. These involved observations during two arrivals and one departure by Fokker 100 aircraft. These found some disturbance to birds on the Wonnerup Estuary took place due to aircraft on arrival (on both occasions) as predicted above. On one of the two disturbance events observed, birds took flight when the plane was overhead at an estimated height above the ground of only 100m, which is well below the height predicted for planes on approach over the Wonnerup Estuary (see Section 3.1.1 above), however this is a visual estimate and could be inaccurate. These observations were made on flights that were regular and to which the birds would have had some opportunity to habituate. Details of observations are given below (K. Williams, DPaW, pers comm).

1. <u>Wonnerup North Site – Approaching aircraft (06:02am)</u>
   Incoming aircraft observed from the north flying along the length of the Wonnerup wetland. Landing gear was in the down position and the aircraft was at a height of approximately 100m or more. As the plane came immediately overhead of the northern section of the Wonnerup Estuary (i.e. south of Swan Lake) approximately 200+ Silver Gulls took flight and in the process disturbed approximately another 100 birds of mixed species – mainly Grey Teal, Australian Shelduck and some Heron and Egret. The Silver Gulls circled (at maybe 30m height) and resettled approximately 300-500m further south and west of their original

position (i.e. away from directly under the aircraft). The total time that the birds were in the air was approximately less than 3 minutes. Prior to the aircraft appearing the Silver Gulls and other bird species were relatively quiet in behaviour with no large flocks observed taking to the air.

2. Wonnerup South Site – Approaching aircraft (06:40am)
   A second aircraft following same flight path and altitude as noted above. Landing gear was also in down position. When the plane was immediately overhead of the main resting/feeding area in the southern end of the Wonnerup wetland, approximately 100 birds of predominately mixed duck species took to the air (10-20m in height) and returned to the same position approximately 2 minutes later.

3. Wonnerup South Site – Departing aircraft (06:42am)
   An outgoing aircraft flew west over the Wonnerup Estuary at a much higher altitude and climbed rapidly. No disturbance or behavioural changes were observed in the birds.

3.2 Conclusions on potential disturbance of waterbirds on the Vasse-Wonnerup System due to an expansion of the airport

Based on a small number of observations by DPaW personnel, current aircraft movements associated with the airport are disturbing waterbirds at least occasionally, but the responses were short term and of a low intensity. However, that disturbance occurred at all when the birds should have been habituated to the aircraft movement and noise suggests that an increase in aircraft movement may have implications for the waterbirds.

Research from around the world, including Australia, suggests that waterbirds will tolerate at least moderate levels of aircraft movement and noise. This includes breeding colonies of most waterbird groups. Research also identifies low-flying aircraft as posing the greatest risk, although there is some lack of consistency due to the many variables that can affect the response of waterbirds to a stimulus. In general, waterbirds do habituate to regular stimuli and this could make small, manoeuvrable aircraft a concern at Busselton, rather than the large jet aircraft as is proposed for the domestic interstate RPT flights. There are guidelines and observations that suggest a vertical buffer of greater than 300m, a horizontal buffer of greater then 200m and a noise limit of 85 dB(A) are appropriate to minimise impacts to waterbirds.

The greatest concern at the airport is that the existing arrivals flightpath from the north overflies the Wonnerup Estuary with planes predicted to remain greater than 300m at this point, but with some possibly passing at a lower height above the ground. The current flightpath has no horizontal buffer over the Wonnerup Estuary, whereas there is a horizontal buffer with respect to the Vasse Estuary. The estimated LAmax maximum noise levels of 65-78dB(A) for B737 and A320 aircraft over the Wonnerup Estuary is within the 85 dB(A) limit suggested by the literature. The Wonnerup Estuary is noted for shorebirds and, in late winter/spring, a large breeding colony of Black Swans. Waterbirds on the Vasse Estuary are dominated by ducks and have both a vertical and horizontal buffer from the current flightpath.

Change associated with the airport expansion will be an increase in the number of commercial jet aircraft flights along this route. Irrespective of the expansion, it is expected that there will be an increase in general aviation, including small planes. The implications for waterbirds are uncertain but a number of recommendations can be considered.

- Observations by DPaW personnel suggest that some arrival flights may be passing lower over the Wonnerup Estuary than predicted. A vertical buffer of 300m (or more) should be maintained by approaching aircraft. As the current flightpath allows no horizontal buffer and is determined by the alignment of the runway, a greater vertical buffer should be considered. Observations on waterbirds will need to be carried out to review the effectiveness of the 300m buffer.
- General aviation and light aircraft need to be made aware of vertical and horizontal buffers over the Vasse-Wonnerup system.
- There is some concern with Black Swans during the late winter/early spring breeding season and there needs to be an awareness of this period by pilots and flight controllers. While not all the estuary system is affected by overflights, the Black Swans and to some extent shorebirds are limited to the Wonnerup Estuary and can’t necessarily ‘go somewhere else’ for the duration of a disturbance event. A preference could be shown to using southern approaches for landing aircraft in the swans’ breeding period.
- Because of the uncertainty, observations need to be made to determine the circumstances of current levels of disturbance and the nature of waterbirds’ responses.
- Several studies indicate that people and pets at ground level are the most significant source of disturbance and that birds may be more sensitive when exposed to aircraft movements. Therefore, controlling access at ground level is important.
- The City of Busselton has a voluntary ‘Fly Neighbourly Agreement’ in place for the airport with the key objective being for aircraft operators to avoid noise sensitive premises as far as is practical, within the limits of weather, safety and economic constraints. It is recommended that this agreement be extended to include the Vasse-Wonnerup system, particularly for the FIFO and interstate RPT flights.

The expectation from observations of waterbirds near aircraft from many studies is that existing and predicted increases in activity at the Busselton-Margaret River Regional Airport should not adversely affect waterbirds assuming buffers and noise limits are adhered to. However, the situation should be monitored both in terms of aircraft movements as well as waterbird behaviour.

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5 Appendices

Appendix 1. Waterbirds recorded at the Vasse-Wonnerup wetlands and their conservation status.

Updated species list is based on Wetland Research and Management (2007).

Mig: Migratory

JAMBA/CAMBA/ROK/Bonn: listed under international JAMBA, CAMBA, ROKAMBA and Bonn agreements.

CR EN, EN, VU: listed as Critically Endangered, Endangered or Vulnerable under the EPBC Act.

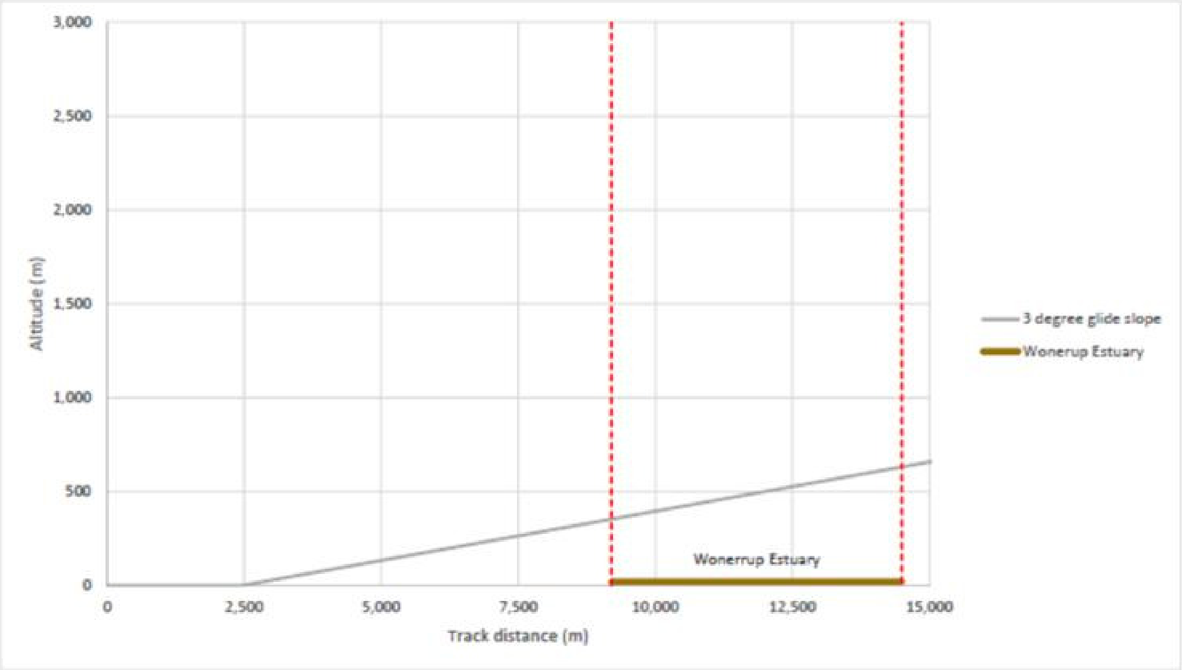
Common name	Scientific name	Conservation status	Recorded breeding at the wetland
Ducks & allies (Family Anatidae)			
Blue-billed Duck	*Oxyura australis*	Mig, Bonn	
Musk Duck	*Biziura lobata*		**Yes**
Black Swan	*Cygnus atratus*		**Yes**
Australian Shelduck	*Tadorna tadornoides*		**Yes**
Australan Wood Duck	*Chenonetta jubata*		**Yes**
Pacific Black Duck	*Anas superciliosa*		**Yes**
Australasian Shoveler	*Anas rhynchotis*		**Yes**
Grey Teal	*Anas gracilis*		**Yes**
Chestnut Teal	*Anas castanea*		
Pink-eared Duck	*Malacorhynchus membranaceus*		
Hardhead	*Aythya australis*		**Yes**
Grebes (Family Podicipedidae)			
Hoary-headed Grebe	*Poliocephalus poliocephalus*		**Yes**
Darters (Family Anhingidae)			
Darter	*Anhinga melanogaster*		
Cormorants (Family Phalacrocoracidae)			
Little Pied Cormorant	*Phalacrocorax melanoleucos*		
Pied Cormorant	*Phalacrocorax varius*		
Little Black Cormorant	*Phalacrocorax sulcirostris*		
Great Cormorant	*Phalacrocorax carbo*		
Pelicans (Family Pelecanidae)			
Australian Pelican	*Pelecanus conspicillatus*		
Herons, Egrets, Bitterns (Family Ardeidae)			
White-faced Heron	*Ardea novaehollandiae*		
Little Egret	*Ardea garzetta*		
Eastern Reef Egret	*Ardea sacra*	CAMBA	
White-necked Heron	*Ardea pacifica*		
Great Egret (White Egret)	*Ardea modesta*	Mig, JAMBA, CAMBA, Bonn	
Nankeen Night Heron	*Nycticorax caledonicus*		
Australasian Bittern	*Botaurus poiciloptilus*		
Ibis, Spoonbills (Family Threskiornithidae)			
Glossy Ibis	*Plegadis falcinellus*	CAMBA, Bonn	
Australian White Ibis	*Threskiornis molucca*		**Yes**
Straw-necked Ibis	*Threskiornis spinicollis*		
Royal Spoonbill	*Platalea regia*		
Yellow-billed Spoonbill	*Platalea flavipes*		**Yes**
Osprey, Kites, sea Eagles, Harriers (Family Accipitridae)			
Osprey	*Pandion haliaetus*	Mig, Bonn	**Yes**
Whistling Kite*	*Haliastur sphenurus*	Bonn	
White-bellied Sea Eagle	*Haliaeetus leucogaster*	CAMBA	**Yes**
Swamp Harrier	*Circus approximans*	Bonn	
Rails, Crakes, Water-hens, Coots (Family Rallidae)			
Buff-banded Rail	*Gallirallus phillipensis*		**Yes**
Australian Spotted Crake	*Porzana fluminea*		
Spotless Crake	*Porzana tabuensis*		**Yes**
Purple Swamphen	*Porphyrio porphyrio*		**Yes**
Dusky Moorhen	*Gallinula tenebrosa*		**Yes**

Common name	**Scientific name**	**Conservation status**	**Recorded breeding at the wetland**
Black-tailed Native Hen	*Gallinula ventralis*		
Eurasian Coot	*Fulica atra*	Bonn	
Sandpipers, Knots, Stints & allies (Family Scolopacidae)			
Pin-tailed Snipe	*Capella stenura*	Mig, CAMBA, Bonn, ROK	
Black-tailed Godwit	*Limosa limosa*	Mig, JAMBA, CAMBA, Bonn, ROK	
Bar-tailed Godwit	*Limosa lapponica*	Mig, JAMBA, CAMBA, Bonn, ROK	
Whimbrel	*Numenius phaeopus*	Mig, JAMBA, CAMBA, Bonn, ROK	
Marsh Sandpiper	*Tringa stagnatilis*	Mig, CAMBA, Bonn, ROK	
Common Greenshank	*Tringa nebularia*	Mig, JAMBA, CAMBA, Bonn, ROK	
Wood Sandpiper	*Tringa glareola*	Mig, JAMBA, CAMBA, Bonn, ROK	
Terek Sandpiper	*Xenus cinereus*	Mig, JAMBA, CAMBA, Bonn, ROK	
Common Sandpiper	*Actitis hypoleucos*	Mig, JAMBA, CAMBA, Bonn, ROK	
Grey-tailed Tattler	*Heteroscelis brevipes*	Mig, JAMBA, CAMBA, Bonn, ROK	
Great Knot	*Calidris tenuirostris*	Mig, JAMBA, CAMBA, Bonn, ROK	
Red Knot	*Calidris canutus*	Mig, JAMBA, CAMBA, Bonn, ROK	
Red-necked Stint	*Calidris ruficollis*	Mig, JAMBA, CAMBA, Bonn, ROK	
Long-toed Stint	*Calidris subminuta*	Mig, JAMBA, CAMBA, Bonn, ROK	
Pectoral Sandpiper	*Calidris melanotos*	Mig, JAMBA, CAMBA, Bonn	
Sharp-tailed Sandpiper	*Calidris acuminata*	Mig, JAMBA, CAMBA, Bonn, ROK	
Curlew Sandpiper	*Calidris ferruginea*	Mig, JAMBA, CAMBA, Bonn, ROK, CR EN (EPBC)	
Ruff	*Philomachus pugnax*	Mig, JAMBA, CAMBA, Bonn, ROK	
Painted Snipe (Family Rostratulidae)			
Painted Snipe	*Rostratula benghalensis australis*	EN (EPBC), Bonn	
Oystercatchers (Family Haematopodidae)			
Pied Oystercatcher	*Haematopus longirostris*		
Stilts, Avocets (Family Recurvirostridae)			
Black-winged Stilt	*Himantopus himantopus*	Bonn	**Yes**
Banded Stilt	*Cladorhynchus leucocephalus*	Bonn	
Red-necked Avocet	*Recurvirostra novaehollandiae*	Bonn	
Plovers, Dottrels (Family Charadriidae)			
Pacific Golden Plover	*Pluvialis fulva*	Mig, Bonn, ROK	
Grey Plover	*Pluvialis squatarola*	Mig, JAMBA, CAMBA, Bonn, ROK	
Red-capped Plover	*Charadrius ruficapillus*		**Yes**
Greater Sand Plover	*Charadrius leschenaultii*	Mig, Bonn, ROK	
Black-fronted Dotterel	*Elseyornis melanops*		
Red-kneed Dotterel	*Erythrogonys cinctus*		
Banded Lapwing	*Vanellus tricolour*		
Gulls, terns (Family Laridae)			
Silver Gull	*Larus novaehollandiae*		
Caspian Tern	*Hydropogne tschegrava*	CAMBA, Bonn	
Crested Tern	*Sterna bergii*	JAMBA, Bonn	
Fairy Tern	*Sterna nereis nereis*	VU (EPBC)	
Gull-billed Tern	*Sterna nilotica*		
Whiskered Tern	*Chldonias hybridus*		
White-winged Black Tern	*Chlidonias leucopterus*	JAMBA, CAMBA, Bonn, ROK	
Honeyeaters, Australian Chats (family Meliphagidae)			
White-fronted Chat	*Ephthianura albifrons*		**Yes**
Swallows, Martins (Family Hirundinidae)			
Welcome Swallow*	*Hirundo neoxena*		
Tree Martin*	*Hirundo nigricans*		
Old World warblers (Family Sylviidae)			
Clamorous Reed-Warbler	*Acrocephalus stentoreus*	Bonn	
Little Grassbird	*Megalurus gramineus*		**Yes**
Total: 83			**Total: 21**

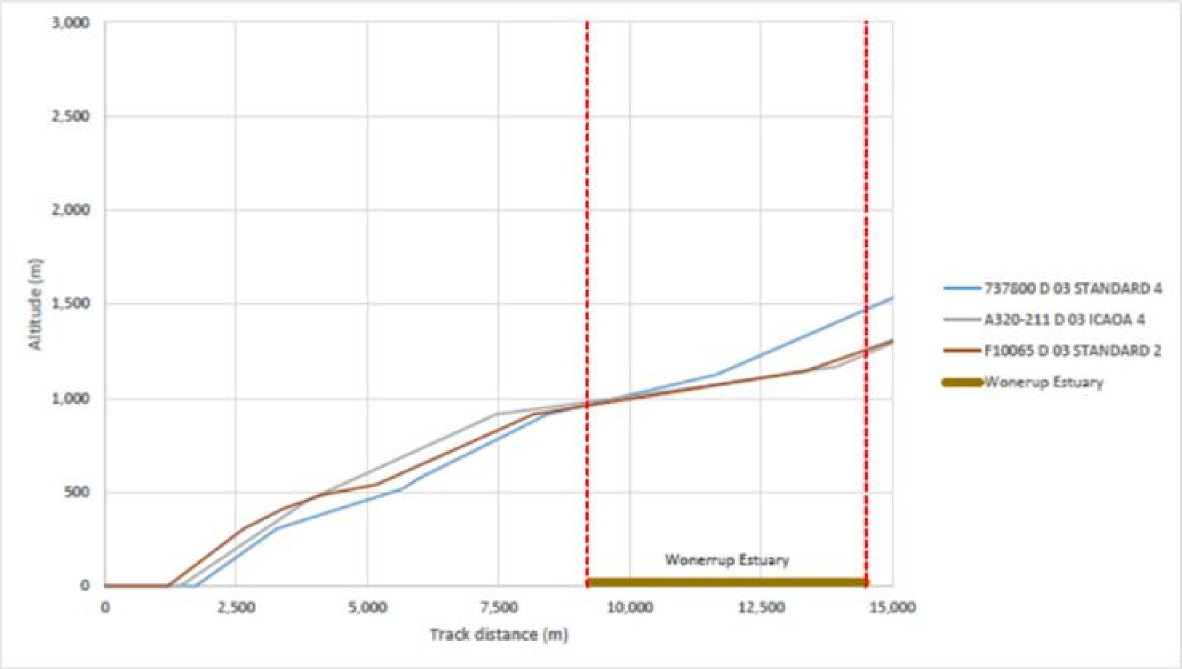
*Species not considered waterbirds.

Appendix 2. Aircraft altitude profiles (Source: To70 Aviation Australia).

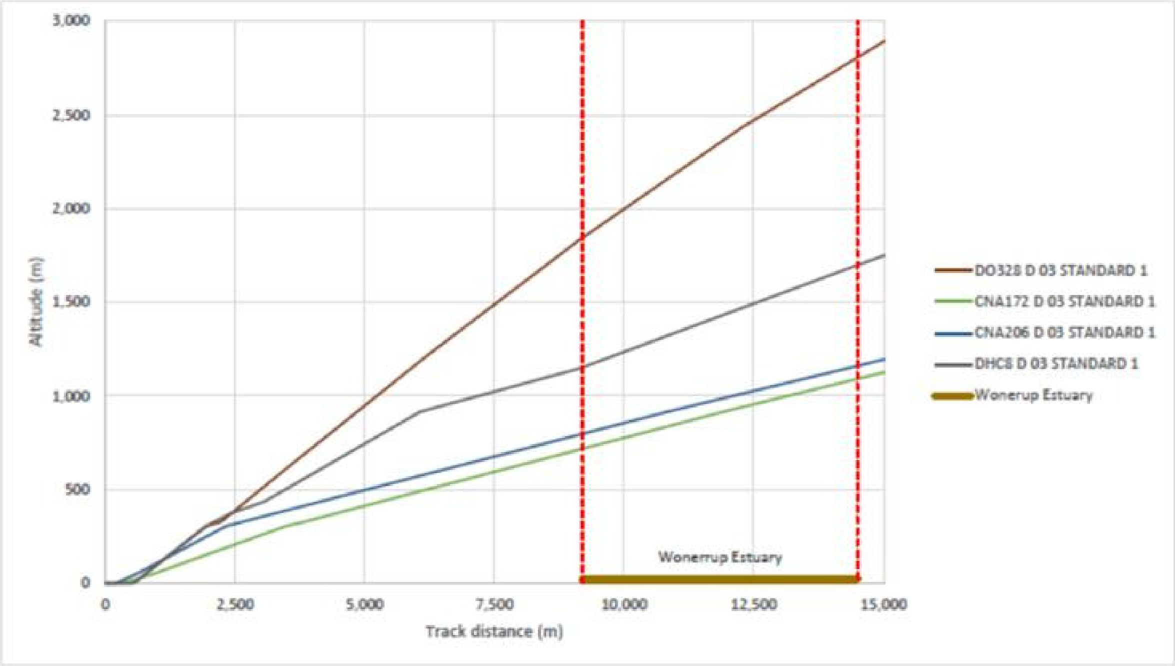
1. Arriving aircraft (all types)



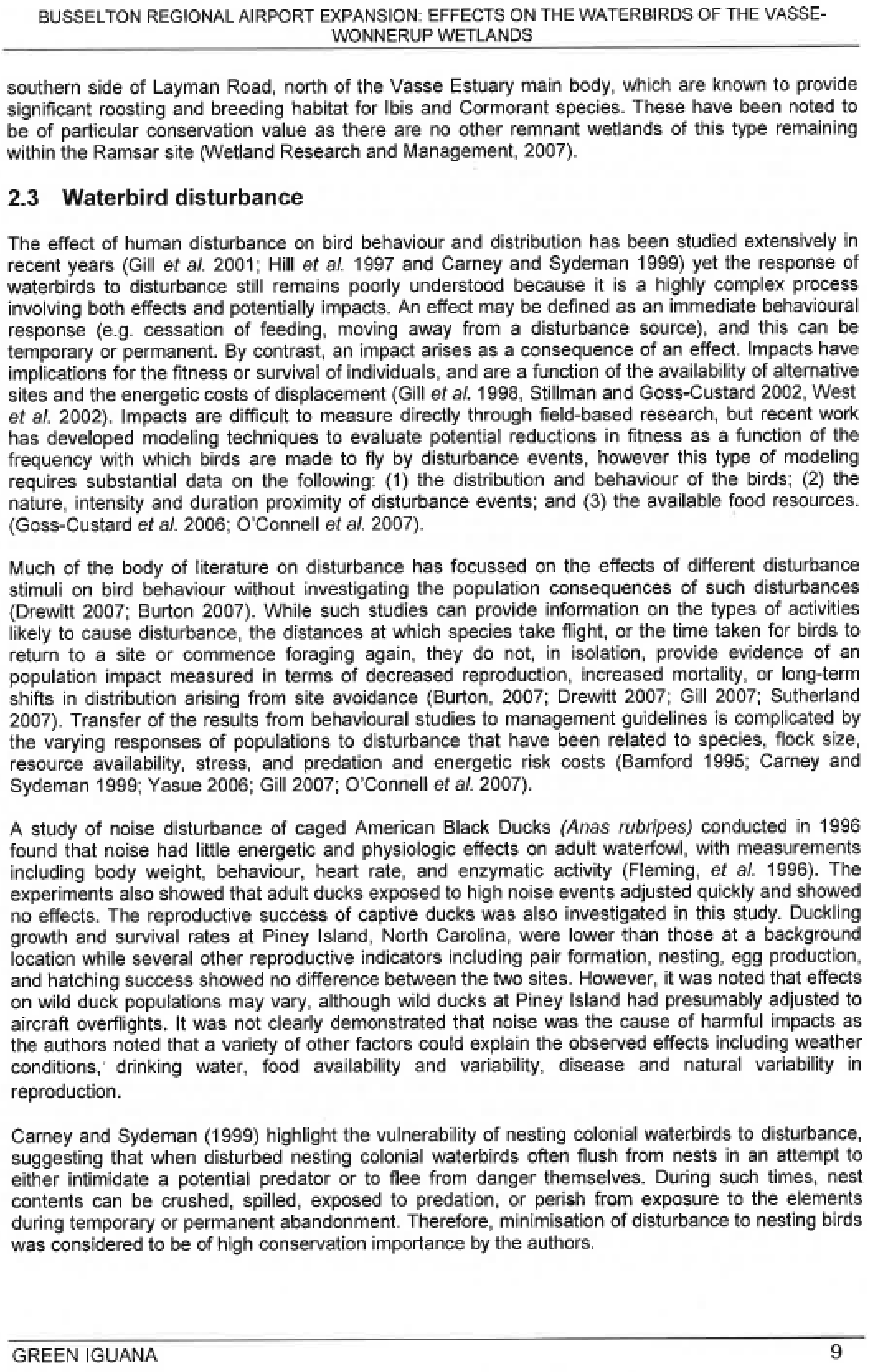
2. Departing jet aircraft (Boeing 737, Airbus 320 and Fokker 100)



3. **Departing propeller aircraft**



Appendix 3. Excerpt from Green Iguana (2010). Busselton Regional Airport Expansion: Effects on the waterbirds of the Vasse-Wonnerup Wetland System



southern side of Layman Road, north of the Vasse Estuary main body, which are known to provide significant roosting and breeding habitat for Ibis and Cormorant species. These have been noted to be of particular conservation value as there are no other remnant wetlands of this type remaining within the Ramsar site (Wetland Research and Management, 2007).

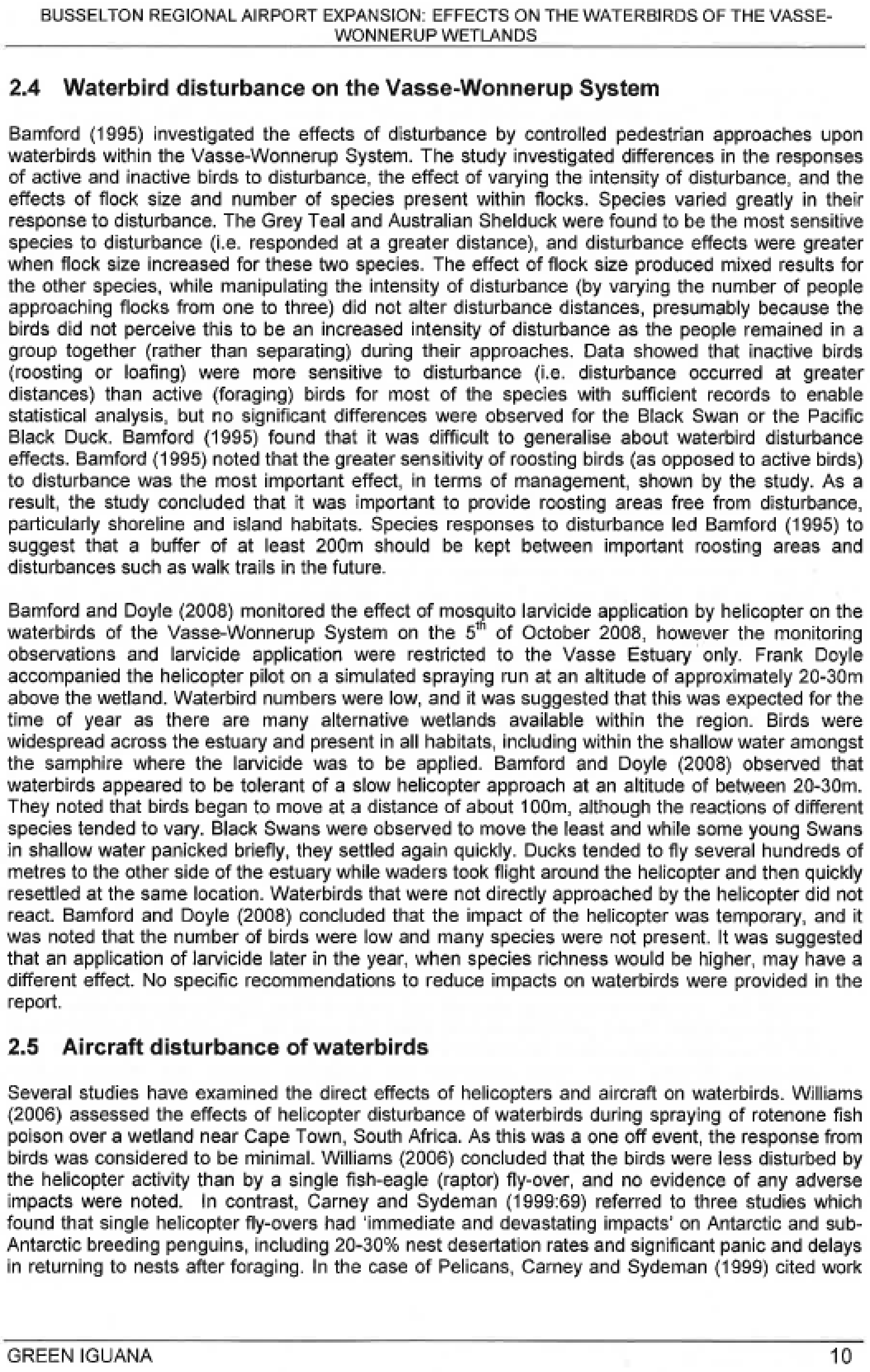
2.3 Waterbird disturbance

The effect of human disturbance on bird behaviour and distribution has been studied extensively in recent years (Gill *et al.* 2001; Hill *et al.* 1997 and Carney and Sydeman 1999) yet the response of waterbirds to disturbance still remains poorly understood because it is a highly complex process involving both effects and potentially impacts. An effect may be defined as an immediate behavioural response (e.g. cessation of feeding, moving away from a disturbance source), and this can be temporary or permanent. By contrast, an impact arises as a consequence of an effect. Impacts have implications for the fitness or survival of individuals, and are a function of the availability of alternative sites and the energetic costs of displacement (Gill *et al.* 1998, Stillman and Goss-Custard 2002, West *et al.* 2002). Impacts are difficult to measure directly through field-based research, but recent work has developed modeling techniques to evaluate potential reductions in fitness as a function of the frequency with which birds are made to fly by disturbance events, however this type of modeling requires substantial data on the following: (1) the distribution and behaviour of the birds; (2) the nature, intensity and duration proximity of disturbance events; and (3) the available food resources. (Goss-Custard *et al.* 2006; O'Connell *et al.* 2007).

Much of the body of literature on disturbance has focussed on the effects of different disturbance stimuli on bird behaviour without investigating the population consequences of such disturbances (Drewitt 2007; Burton 2007). While such studies can provide information on the types of activities likely to cause disturbance, the distances at which species take flight, or the time taken for birds to return to a site or commence foraging again, they do not, in isolation, provide evidence of an population impact measured in terms of decreased reproduction, increased mortality, or long-term shifts in distribution arising from site avoidance (Burton, 2007; Drewitt 2007; Gill 2007; Sutherland 2007). Transfer of the results from behavioural studies to management guidelines is complicated by the varying responses of populations to disturbance that have been related to species, flock size, resource availability, stress, and predation and energetic risk costs (Bamford 1995; Carney and Sydeman 1999; Yasue 2006; Gill 2007; O'Connell *et al.* 2007).

A study of noise disturbance of caged American Black Ducks *(Anas rubripes)* conducted in 1996 found that noise had little energetic and physiologic effects on adult waterfowl, with measurements including body weight, behaviour, heart rate, and enzymatic activity (Fleming, *et al.* 1996). The experiments also showed that adult ducks exposed to high noise events adjusted quickly and showed no effects. The reproductive success of captive ducks was also investigated in this study. Duckling growth and survival rates at Piney Island, North Carolina, were lower than those at a background location while several other reproductive indicators including pair formation, nesting, egg production, and hatching success showed no difference between the two sites. However, it was noted that effects on wild duck populations may vary, although wild ducks at Piney Island had presumably adjusted to aircraft overflights. It was not clearly demonstrated that noise was the cause of harmful impacts as the authors noted that a variety of other factors could explain the observed effects including weather conditions, drinking water, food availability and variability, disease and natural variability in reproduction.

Carney and Sydeman (1999) highlight the vulnerability of nesting colonial waterbirds to disturbance, suggesting that when disturbed nesting colonial waterbirds often flush from nests in an attempt to either intimidate a potential predator or to flee from danger themselves. During such times, nest contents can be crushed, spilled, exposed to predation, or perish from exposure to the elements during temporary or permanent abandonment. Therefore, minimisation of disturbance to nesting birds was considered to be of high conservation importance by the authors.



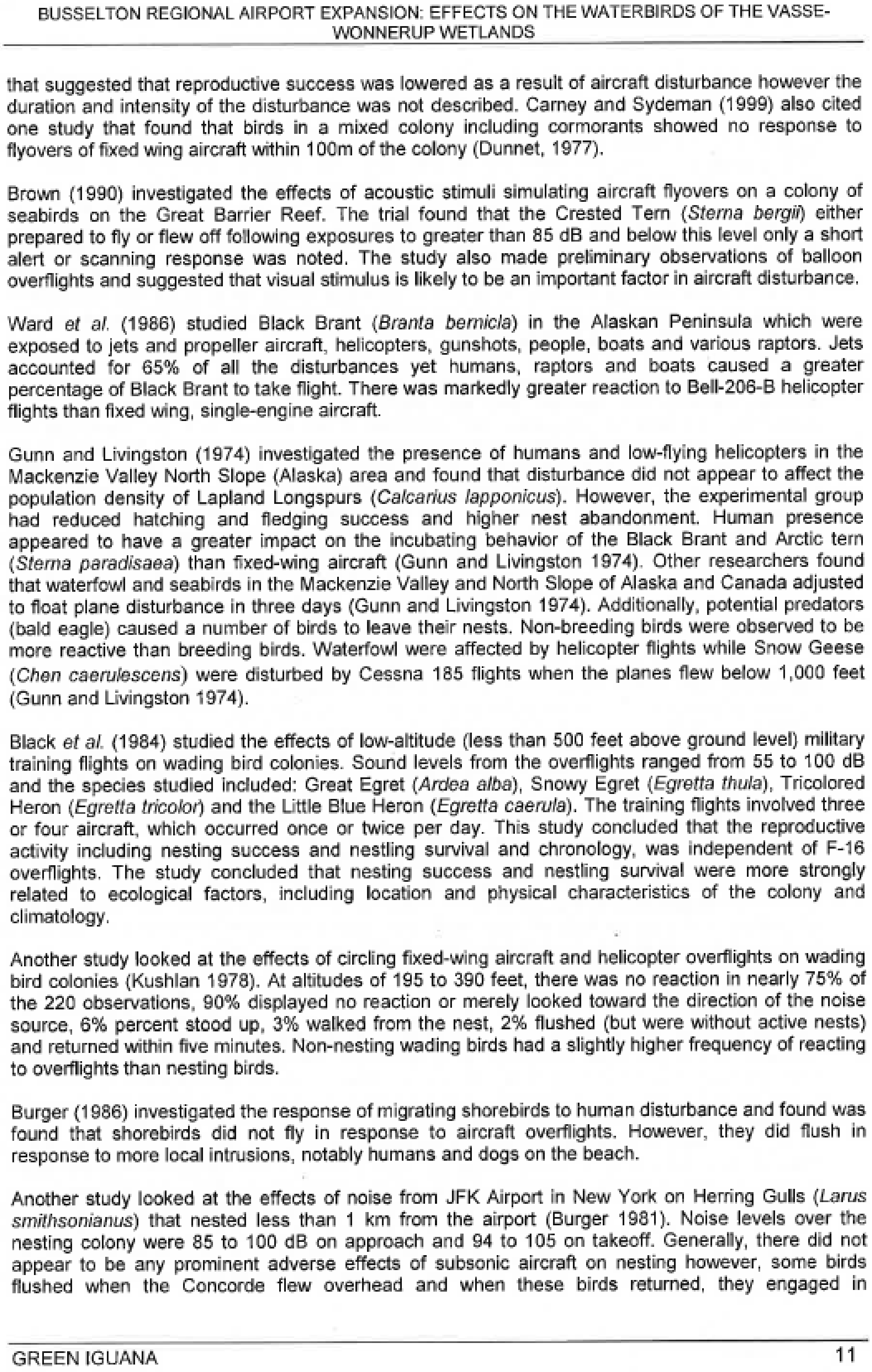
2.4 Waterbird disturbance on the Vasse-Wonnerup System

Bamford (1995) investigated the effects of disturbance by controlled pedestrian approaches upon waterbirds within the Vasse-Wonnerup System. The study investigated differences in the responses of active and inactive birds to disturbance, the effect of varying the intensity of disturbance, and the effects of flock size and number of species present within flocks. Species varied greatly in their response to disturbance. The Grey Teal and Australian Shelduck were found to be the most sensitive species to disturbance (i.e. responded at a greater distance), and disturbance effects were greater when flock size increased for these two species. The effect of flock size produced mixed results for the other species, while manipulating the intensity of disturbance (by varying the number of people approaching flocks from one to three) did not alter disturbance distances, presumably because the birds did not perceive this to be an increased intensity of disturbance as the people remained in a group together (rather than separating) during their approaches. Data showed that inactive birds (roosting or loafing) were more sensitive to disturbance (i.e. disturbance occurred at greater distances) than active (foraging) birds for most of the species with sufficient records to enable statistical analysis, but no significant differences were observed for the Black Swan or the Pacific Black Duck. Bamford (1995) found that it was difficult to generalise about waterbird disturbance effects. Bamford (1995) noted that the greater sensitivity of roosting birds (as opposed to active birds) to disturbance was the most important effect, in terms of management, shown by the study. As a result, the study concluded that it was important to provide roosting areas free from disturbance, particularly shoreline and island habitats. Species responses to disturbance led Bamford (1995) to suggest that a buffer of at least 200m should be kept between important roosting areas and disturbances such as walk trails in the future.

Bamford and Doyle (2008) monitored the effect of mosquito larvicide application by helicopter on the waterbirds of the Vasse-Wonnerup System on the 5th of October 2008, however the monitoring observations and larvicide application were restricted to the Vasse Estuary only. Frank Doyle accompanied the helicopter pilot on a simulated spraying run at an altitude of approximately 20-30m above the wetland. Waterbird numbers were low, and it was suggested that this was expected for the time of year as there are many alternative wetlands available within the region. Birds were widespread across the estuary and present in all habitats, including within the shallow water amongst the samphire where the larvicide was to be applied. Bamford and Doyle (2008) observed that waterbirds appeared to be tolerant of a slow helicopter approach at an altitude of between 20-30m. They noted that birds began to move at a distance of about 100m, although the reactions of different species tended to vary. Black Swans were observed to move the least and while some young Swans in shallow water panicked briefly, they settled again quickly. Ducks tended to fly several hundreds of metres to the other side of the estuary while waders took flight around the helicopter and then quickly resettled at the same location. Waterbirds that were not directly approached by the helicopter did not react. Bamford and Doyle (2008) concluded that the impact of the helicopter was temporary, and it was noted that the number of birds were low and many species were not present. It was suggested that an application of larvicide later in the year, when species richness would be higher, may have a different effect. No specific recommendations to reduce impacts on waterbirds were provided in the report.

2.5 Aircraft disturbance of waterbirds

Several studies have examined the direct effects of helicopters and aircraft on waterbirds. Williams (2006) assessed the effects of helicopter disturbance of waterbirds during spraying of rotenone fish poison over a wetland near Cape Town, South Africa. As this was a one off event, the response from birds was considered to be minimal. Williams (2006) concluded that the birds were less disturbed by the helicopter activity than by a single fish-eagle (raptor) fly-over, and no evidence of any adverse impacts were noted. In contrast, Carney and Sydeman (1999:69) referred to three studies which found that single helicopter fly-overs had 'immediate and devastating impacts' on Antarctic and sub-Antarctic breeding penguins, including 20-30% nest desertation rates and significant panic and delays in returning to nests after foraging. In the case of Pelicans, Carney and Sydeman (1999) cited work



that suggested that reproductive success was lowered as a result of aircraft disturbance however the duration and intensity of the disturbance was not described. Carney and Sydeman (1999) also cited one study that found that birds in a mixed colony including cormorants showed no response to flyovers of fixed wing aircraft within 100m of the colony (Dunnet, 1977).

Brown (1990) investigated the effects of acoustic stimuli simulating aircraft flyovers on a colony of seabirds on the Great Barrier Reef. The trial found that the Crested Tern (*Sterna bergii*) either prepared to fly or flew off following exposures to greater than 85 dB and below this level only a short alert or scanning response was noted. The study also made preliminary observations of balloon overflights and suggested that visual stimulus is likely to be an important factor in aircraft disturbance.

Ward *et al.* (1986) studied Black Brant (*Branta bernicla*) in the Alaskan Peninsula which were exposed to jets and propeller aircraft, helicopters, gunshots, people, boats and various raptors. Jets accounted for 65% of all the disturbances yet humans, raptors and boats caused a greater percentage of Black Brant to take flight. There was markedly greater reaction to Bell-206-B helicopter flights than fixed wing, single-engine aircraft.

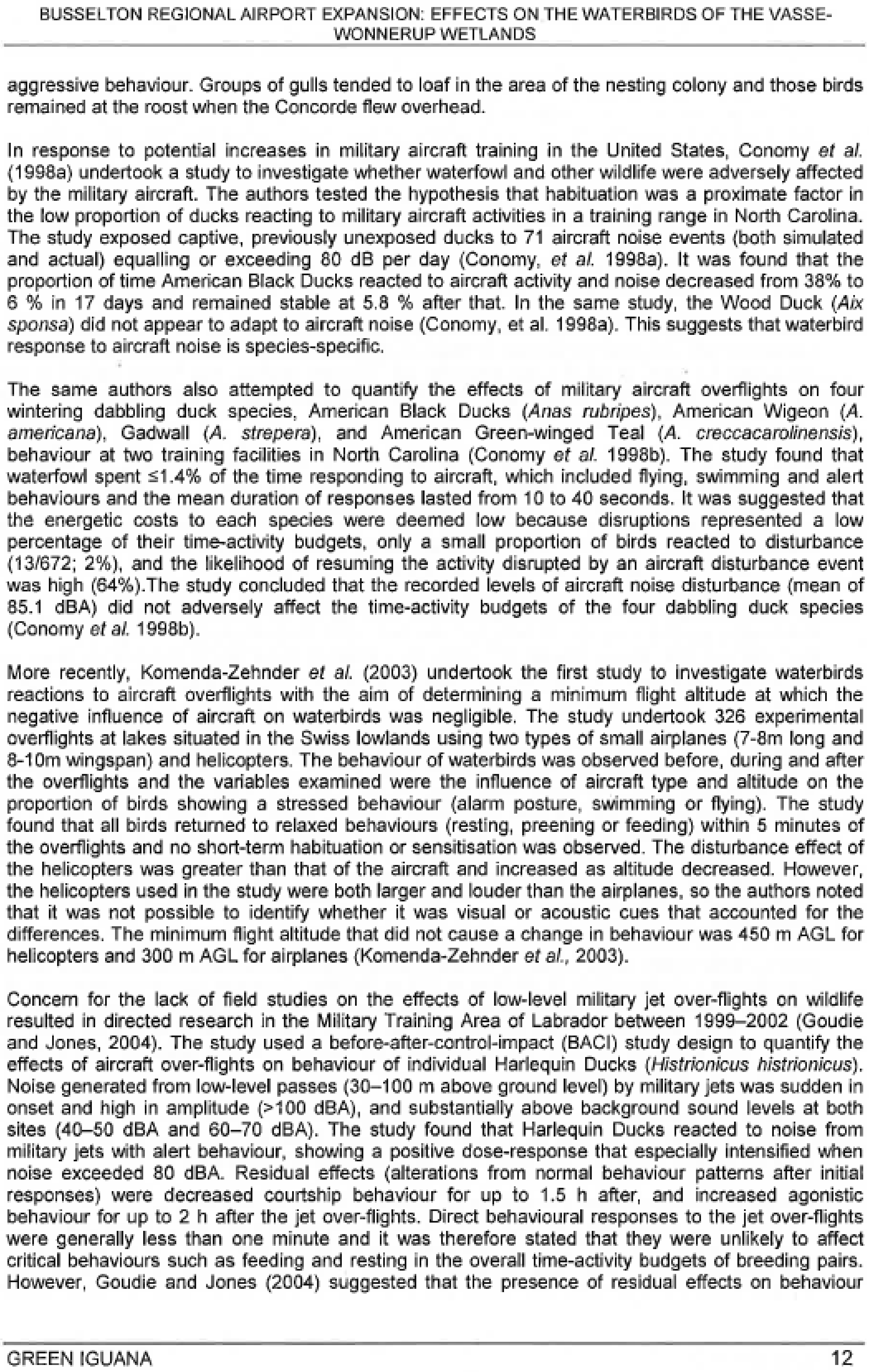
Gunn and Livingston (1974) investigated the presence of humans and low-flying helicopters in the Mackenzie Valley North Slope (Alaska) area and found that disturbance did not appear to affect the population density of Lapland Longspurs (*Calcarius lapponicus*). However, the experimental group had reduced hatching and fledging success and higher nest abandonment. Human presence appeared to have a greater impact on the incubating behavior of the Black Brant and Arctic tern (*Sterna paradisaea*) than fixed-wing aircraft (Gunn and Livingston 1974). Other researchers found that waterfowl and seabirds in the Mackenzie Valley and North Slope of Alaska and Canada adjusted to float plane disturbance in three days (Gunn and Livingston 1974). Additionally, potential predators (bald eagle) caused a number of birds to leave their nests. Non-breeding birds were observed to be more reactive than breeding birds. Waterfowl were affected by helicopter flights while Snow Geese (*Chen caerulescens*) were disturbed by Cessna 185 flights when the planes flew below 1,000 feet (Gunn and Livingston 1974).

Black *et al.* (1984) studied the effects of low-altitude (less than 500 feet above ground level) military training flights on wading bird colonies. Sound levels from the overflights ranged from 55 to 100 dB and the species studied included: Great Egret (*Ardea alba*), Snowy Egret (*Egretta thula*), Tricolored Heron (*Egretta tricolor*) and the Little Blue Heron (*Egretta caerula*). The training flights involved three or four aircraft, which occurred once or twice per day. This study concluded that the reproductive activity including nesting success and nestling survival and chronology, was independent of F-16 overflights. The study concluded that nesting success and nestling survival were more strongly related to ecological factors, including location and physical characteristics of the colony and climatology.

Another study looked at the effects of circling fixed-wing aircraft and helicopter overflights on wading bird colonies (Kushlan 1978). At altitudes of 195 to 390 feet, there was no reaction in nearly 75% of the 220 observations, 90% displayed no reaction or merely looked toward the direction of the noise source, 6% percent stood up, 3% walked from the nest, 2% flushed (but were without active nests) and returned within five minutes. Non-nesting wading birds had a slightly higher frequency of reacting to overflights than nesting birds.

Burger (1986) investigated the response of migrating shorebirds to human disturbance and found was found that shorebirds did not fly in response to aircraft overflights. However, they did flush in response to more local intrusions, notably humans and dogs on the beach.

Another study looked at the effects of noise from JFK Airport in New York on Herring Gulls (*Larus smithsonianus*) that nested less than 1 km from the airport (Burger 1981). Noise levels over the nesting colony were 85 to 100 dB on approach and 94 to 105 on takeoff. Generally, there did not appear to be any prominent adverse effects of subsonic aircraft on nesting however, some birds flushed when the Concorde flew overhead and when these birds returned, they engaged in



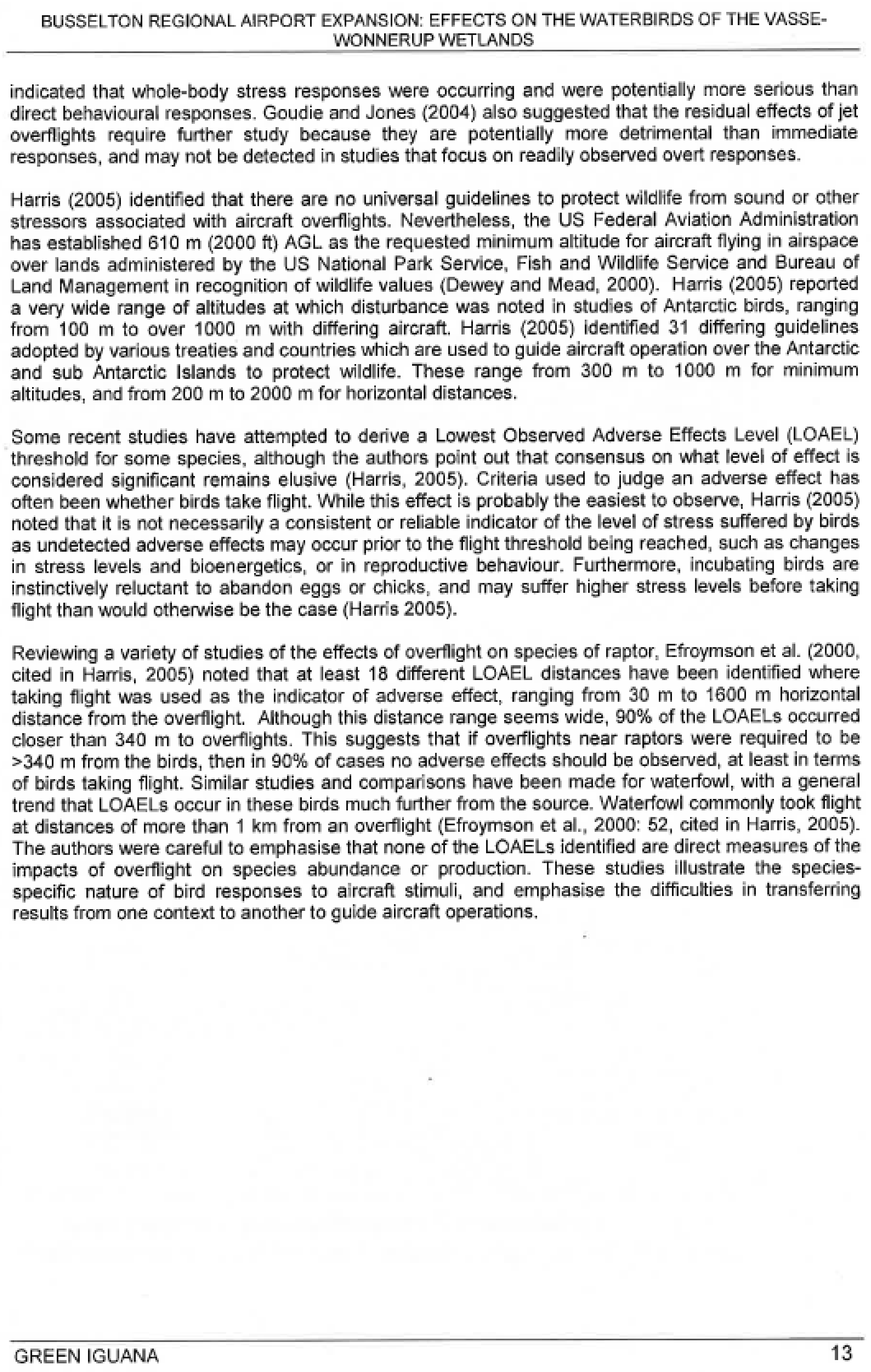
aggressive behaviour. Groups of gulls tended to loaf in the area of the nesting colony and those birds remained at the roost when the Concorde flew overhead.

In response to potential increases in military aircraft training in the United States, Conomy *et al.* (1998a) undertook a study to investigate whether waterfowl and other wildlife were adversely affected by the military aircraft. The authors tested the hypothesis that habituation was a proximate factor in the low proportion of ducks reacting to military aircraft activities in a training range in North Carolina. The study exposed captive, previously unexposed ducks to 71 aircraft noise events (both simulated and actual) equalling or exceeding 80 dB per day (Conomy, *et al.* 1998a). It was found that the proportion of time American Black Ducks reacted to aircraft activity and noise decreased from 38% to 6 % in 17 days and remained stable at 5.8 % after that. In the same study, the Wood Duck (*Aix sponsa*) did not appear to adapt to aircraft noise (Conomy, et al. 1998a). This suggests that waterbird response to aircraft noise is species-specific.

The same authors also attempted to quantify the effects of military aircraft overflights on four wintering dabbling duck species, American Black Ducks (*Anas rubripes*), American Wigeon (*A. americana*), Gadwall (*A. strepera*), and American Green-winged Teal (*A. creccacarolinensis*), behaviour at two training facilities in North Carolina (Conomy *et al.* 1998b). The study found that waterfowl spent ≤1.4% of the time responding to aircraft, which included flying, swimming and alert behaviours and the mean duration of responses lasted from 10 to 40 seconds. It was suggested that the energetic costs to each species were deemed low because disruptions represented a low percentage of their time-activity budgets, only a small proportion of birds reacted to disturbance (13/672; 2%), and the likelihood of resuming the activity disrupted by an aircraft disturbance event was high (64%).The study concluded that the recorded levels of aircraft noise disturbance (mean of 85.1 dBA) did not adversely affect the time-activity budgets of the four dabbling duck species (Conomy *et al.* 1998b).

More recently, Komenda-Zehnder *et al.* (2003) undertook the first study to investigate waterbirds reactions to aircraft overflights with the aim of determining a minimum flight altitude at which the negative influence of aircraft on waterbirds was negligible. The study undertook 326 experimental overflights at lakes situated in the Swiss lowlands using two types of small airplanes (7-8m long and 8-10m wingspan) and helicopters. The behaviour of waterbirds was observed before, during and after the overflights and the variables examined were the influence of aircraft type and altitude on the proportion of birds showing a stressed behaviour (alarm posture, swimming or flying). The study found that all birds returned to relaxed behaviours (resting, preening or feeding) within 5 minutes of the overflights and no short-term habituation or sensitisation was observed. The disturbance effect of the helicopters was greater than that of the aircraft and increased as altitude decreased. However, the helicopters used in the study were both larger and louder than the airplanes, so the authors noted that it was not possible to identify whether it was visual or acoustic cues that accounted for the differences. The minimum flight altitude that did not cause a change in behaviour was 450 m AGL for helicopters and 300 m AGL for airplanes (Komenda-Zehnder *et al.*, 2003).

Concern for the lack of field studies on the effects of low-level military jet over-flights on wildlife resulted in directed research in the Military Training Area of Labrador between 1999–2002 (Goudie and Jones, 2004). The study used a before-after-control-impact (BACI) study design to quantify the effects of aircraft over-flights on behaviour of individual Harlequin Ducks (*Histrionicus histrionicus*). Noise generated from low-level passes (30–100 m above ground level) by military jets was sudden in onset and high in amplitude (>100 dBA), and substantially above background sound levels at both sites (40–50 dBA and 60–70 dBA). The study found that Harlequin Ducks reacted to noise from military jets with alert behaviour, showing a positive dose-response that especially intensified when noise exceeded 80 dBA. Residual effects (alterations from normal behaviour patterns after initial responses) were decreased courtship behaviour for up to 1.5 h after, and increased agonistic behaviour for up to 2 h after the jet over-flights. Direct behavioural responses to the jet over-flights were generally less than one minute and it was therefore stated that they were unlikely to affect critical behaviours such as feeding and resting in the overall time-activity budgets of breeding pairs. However, Goudie and Jones (2004) suggested that the presence of residual effects on behaviour

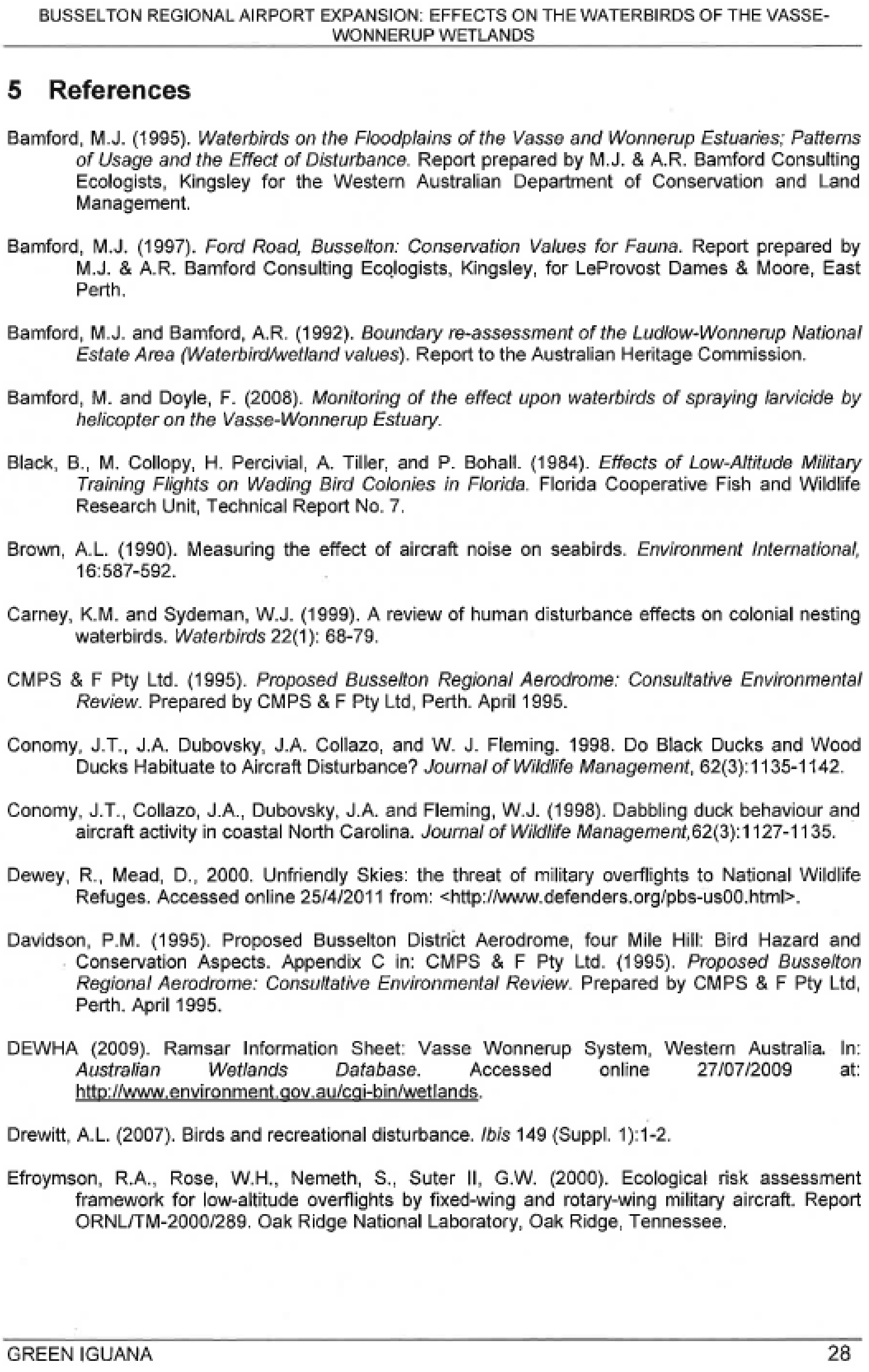


indicated that whole-body stress responses were occurring and were potentially more serious than direct behavioural responses. Goudie and Jones (2004) also suggested that the residual effects of jet overflights require further study because they are potentially more detrimental than immediate responses, and may not be detected in studies that focus on readily observed overt responses.

Harris (2005) identified that there are no universal guidelines to protect wildlife from sound or other stressors associated with aircraft overflights. Nevertheless, the US Federal Aviation Administration has established 610 m (2000 ft) AGL as the requested minimum altitude for aircraft flying in airspace over lands administered by the US National Park Service, Fish and Wildlife Service and Bureau of Land Management in recognition of wildlife values (Dewey and Mead, 2000). Harris (2005) reported a very wide range of altitudes at which disturbance was noted in studies of Antarctic birds, ranging from 100 m to over 1000 m with differing aircraft. Harris (2005) identified 31 differing guidelines adopted by various treaties and countries which are used to guide aircraft operation over the Antarctic and sub Antarctic Islands to protect wildlife. These range from 300 m to 1000 m for minimum altitudes, and from 200 m to 2000 m for horizontal distances.

Some recent studies have attempted to derive a Lowest Observed Adverse Effects Level (LOAEL) threshold for some species, although the authors point out that consensus on what level of effect is considered significant remains elusive (Harris, 2005). Criteria used to judge an adverse effect has often been whether birds take flight. While this effect is probably the easiest to observe, Harris (2005) noted that it is not necessarily a consistent or reliable indicator of the level of stress suffered by birds as undetected adverse effects may occur prior to the flight threshold being reached, such as changes in stress levels and bioenergetics, or in reproductive behaviour. Furthermore, incubating birds are instinctively reluctant to abandon eggs or chicks, and may suffer higher stress levels before taking flight than would otherwise be the case (Harris 2005).

Reviewing a variety of studies of the effects of overflight on species of raptor, Efroymson et al. (2000, cited in Harris, 2005) noted that at least 18 different LOAEL distances have been identified where taking flight was used as the indicator of adverse effect, ranging from 30 m to 1600 m horizontal distance from the overflight. Although this distance range seems wide, 90% of the LOAELs occurred closer than 340 m to overflights. This suggests that if overflights near raptors were required to be >340 m from the birds, then in 90% of cases no adverse effects should be observed, at least in terms of birds taking flight. Similar studies and comparisons have been made for waterfowl, with a general trend that LOAELs occur in these birds much further from the source. Waterfowl commonly took flight at distances of more than 1 km from an overflight (Efroymson et al., 2000: 52, cited in Harris, 2005). The authors were careful to emphasise that none of the LOAELs identified are direct measures of the impacts of overflight on species abundance or production. These studies illustrate the species-specific nature of bird responses to aircraft stimuli, and emphasise the difficulties in transferring results from one context to another to guide aircraft operations.



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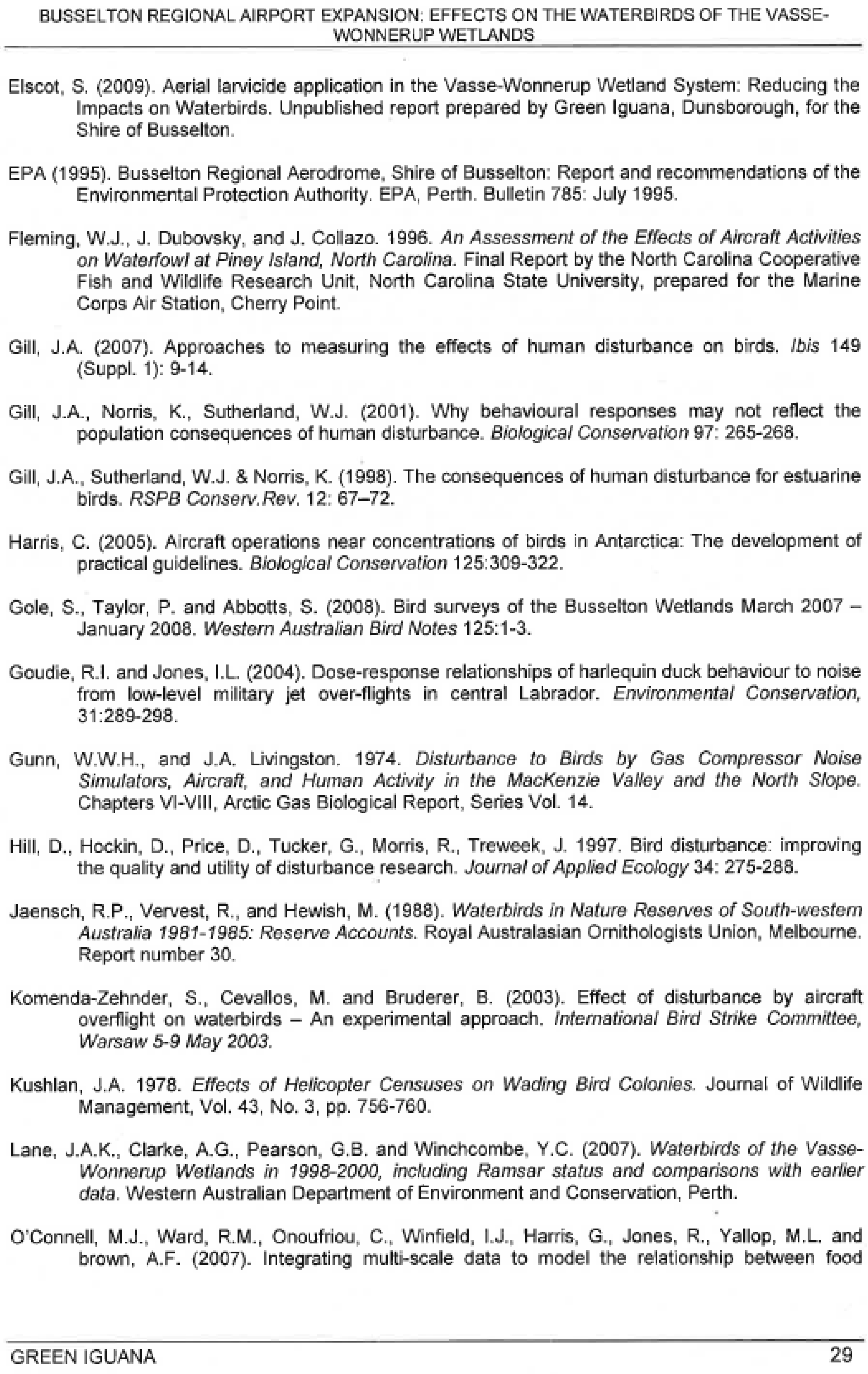

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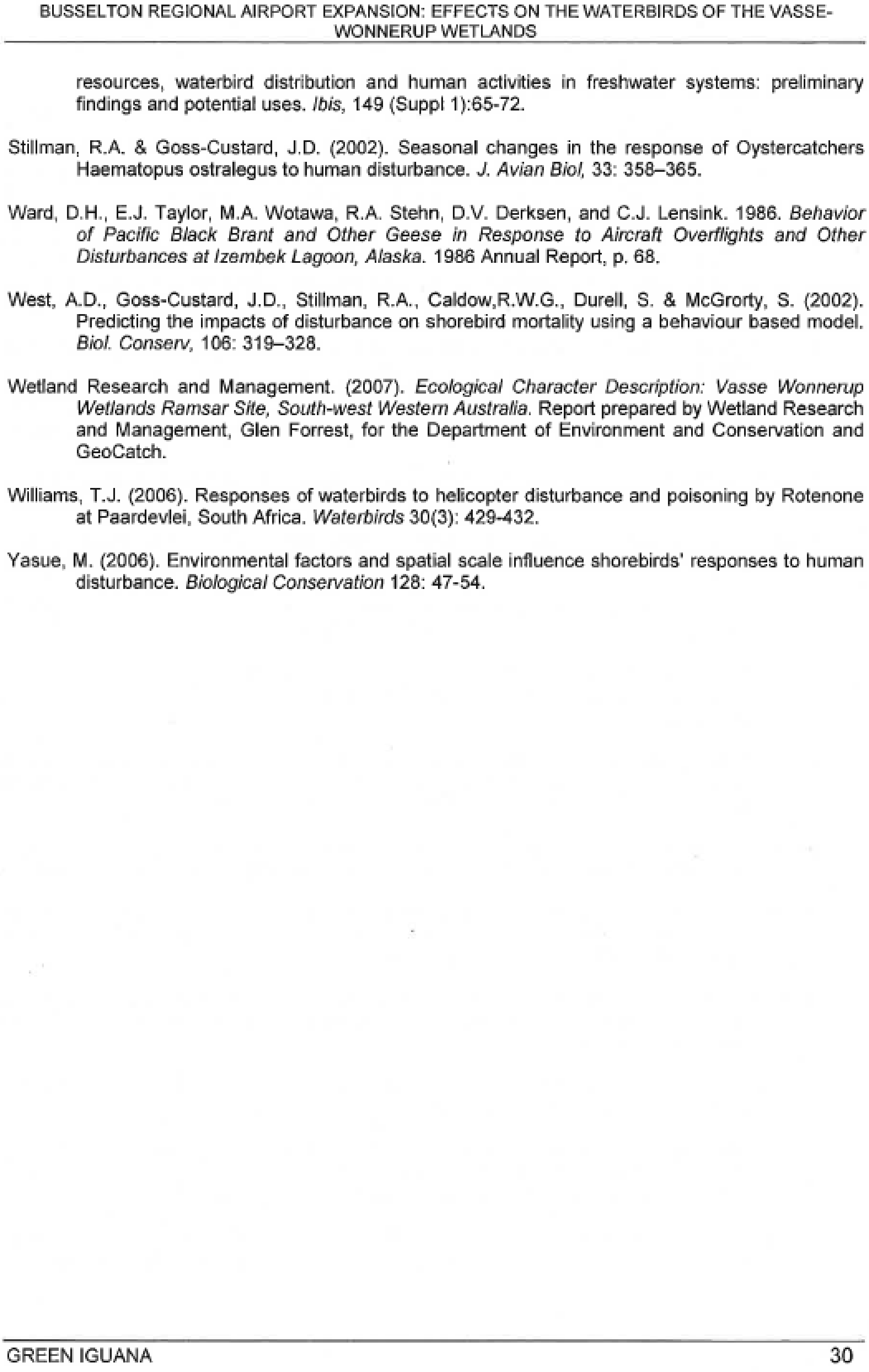

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