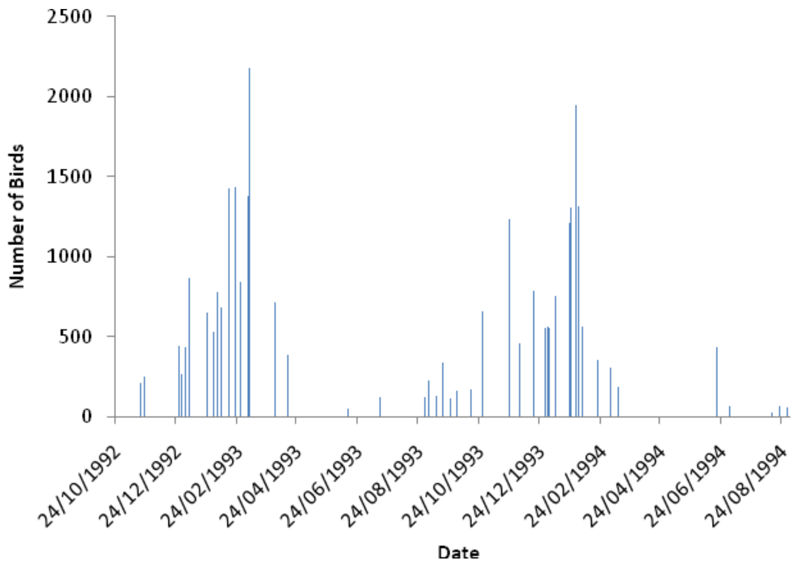
However, since 1996 water levels in the lake have either been absent or very low, resulting in a significant reduction, and in some years, a complete absence of shorebird activity. In addition to the species observed at the lake, species such as Bar-tailed Godwit and Pacific Golden Plover have been historically present.

Figure 23: Total Number of Birds (all species combined) Present at Lake Goldsmith during the BOCA Surveys between October 1992 and September 1994



Dedicated Bird Survey Method

Two bird surveys were undertaken; the first was carried out over seven days between January 8 and 16, 2008 (summer 2008), and the second survey over seven days between March 20 and 31, 2009 (autumn 2009).

The design of the method followed standards recommended by Australian Wind Energy Association (AusWEA 2005). Twelve fixed survey points were established in the wind farm area (referred to as wind farm survey location). The methodology was designed to allow for monitoring following the construction of the wind farm. Therefore, ten sites were situated within the wind farm boundary, whilst two reference sites were located outside the wind farm boundary in similar agricultural landscapes to those of the proposed wind farm site. It will then be possible to compare the monitoring results within and outside the wind farm boundary, to determine whether the operation of the wind farm significantly impacts bird populations.

During this survey an observer recorded all bird species within 200 metres of the survey point over 15 minutes. Species, number, distance from the centre point and flight height were documented, with flight height being classified as below, at or above rotor swept area height (RSA height) defined during the survey as between 40 and 120 metres above the ground. Flight height was estimated in 20 metre intervals by an experienced observer by reference to objects of known height, such as power poles and vertical transposition of fence post distances (usually four to five metres apart).

Ten counts were conducted at each point during the survey period at different times of the day, to allow for time-of-day differences in bird movements and activity (Appendix 16).

The choice of a larger turbine during project planning altered RSA height from 28 to 130 metres. Therefore, some of the birds recorded in the zone originally deemed to be below RSA height may in fact be within the new RSA height. Investigations undertaken elsewhere by BL&A (unpubl. data) indicate that between 30 and 40 metres above the ground, an average of less than 5% of observed bird movements occur. Therefore, the reduced RSA height that arose as a consequence of turbine model choice will not result in a significantly different impact on birds from that predicted for the higher RSA height.

Location of Survey Points

Wind farm survey locations were established on elevated ground, allowing a clear view of surrounding areas, and were placed in areas of proposed sites for the wind turbines (Figure 22). The two reference sites were located on public roads within 1 kilometre of the wind farm site.

Incidental Observations

In addition to the observations during formalised, fixed-point counts, incidental observations of waterbirds and raptors were also made while moving about the wind farm site. Emphasis was placed on observing birds that were moving about the site at RSA height. Also, incidental observations were recorded for the Brolga and Wedge-tailed Eagle; both are known to occur in the region.

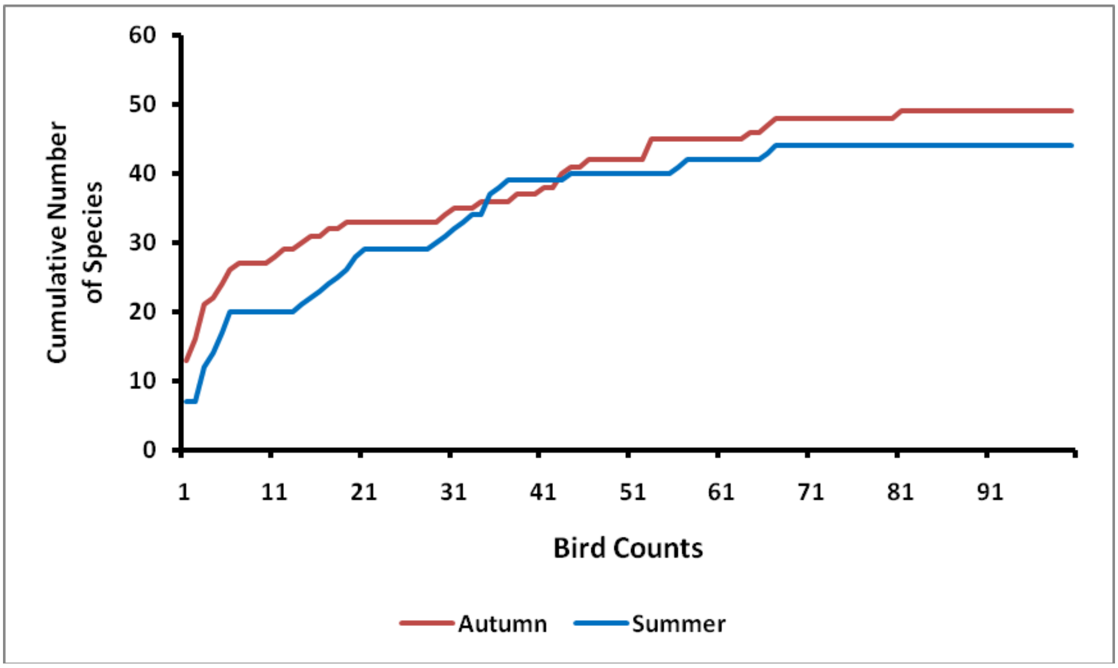
Results

Representativeness of the Survey

The bird species richness and relative abundances recorded during the survey were broadly comparable with results from full-year surveys elsewhere in southern Victorian agricultural landscapes (BL&A, unpublished data).

The cumulative number of species observed from the consecutive fixed-point bird counts conducted at the wind farm survey points during the summer 2008 and autumn 2009 surveys is plotted in Figure 24. This shows that the number of new species observed at the wind farm sites in both seasons almost levelled off after about 40 counts, after which the occasional new species was found. Over 70% of species were found after less than 40% of the surveys. This suggests that the surveys collectively provided a representative picture of the diversity of bird species flying over the wind farm during the survey period. Species recorded incidental to the fixed point counts either have very low utilisation rates or do not occur regularly on the parts of the wind farm site on which generators would be placed.

Figure 24: The Cumulative Number of Bird Species of Recorded in 100 Consecutive Counts at Stockyard Hill Wind Farm



Bird Observations

Database searches identified 121 species of birds for the search region; 76 species were seen at the wind farm and reference observation points, and incidentally while moving between the observation points (Appendix 17). Of the 76 bird species, 62 species were recorded during formal survey times at the impact observation points. The difference between the bird utilisation survey results and the overall species total reflects the highly altered nature of the habitats in areas where the observation points were located. These sites were at likely turbine locations.

During the summer 2008 survey, 42 species of birds were observed utilising the wind farm site while 50 species were recorded during the autumn 2009 survey. The difference between the two surveys is mainly due to changes in the seasonal diversity of birds at the wind farm site. While summer visitors leave the area, more winter and passage migrants arrived in autumn, slightly inflating the number of bird species (diversity) utilising the wind farm site. Resident birds were the same for both seasons, but they were more abundant in autumn compared to summer. The number of birds recorded during the summer was 1757 compared to 2657 individual birds (total of 10 counts at the 10 observation points).

The main source of the differences in bird numbers between the two seasons emerged from the differences in the number of the dominant species. The dominant bird species and their abundance were:

- Australian Magpie: 298 in summer; 517 in autumn;
- Yellow-rumped Thornbill: 188 in summer; 411 in autumn; and
- Raven spp.: 156 in summer; 320 in autumn.

The numbers of these dominant species almost doubled between the two seasons. This was not surprising since all of the above three species were found to form large family groups or flocks during autumn. The abundance of remaining bird species utilising the wind farm site was almost similar between the two seasons.

The data collected from the two seasons were amalgamated and presented as a single survey in the ensuing chapters.

The species diversity and numbers of birds observed during the survey (amalgamated data) at the wind farm survey points are shown in Appendix 17. Some 62 species of birds were observed utilising the proposed turbine sites (wind farm survey points) during the survey and 24 species were observed at the reference points. Most of the species observed utilising the wind farm survey point and reference observation points, and consequently most of the wind farm area, were common farmland birds.

Whilst there was little variation in species richness at the 10 wind farm survey points, it was however slightly higher at wind farm survey points P1, P2 and P3, which supported higher habitat diversity, particularly the last site which was the only one to include water habitat within its counting area.

Appendix 17 lists the species observed during the bird utilisation survey and the numbers in which they were seen in each height zone. The most abundant species at the wind farm survey points were:

- Australian Magpie;
- Yellow-rumped Thornbill;
- Raven species, mainly Little Raven;
- European Goldfinch; and
- Superb Fairywren.

The five species accounted for 57% of the individual birds counted. They were common in all parts of the study area. The first five species were followed by another six species whose abundance was between 90 and 180 birds, and those 11 species accounted for 74% of all individual birds counted at the wind farm survey points during the survey (total of 20 counts per point).

The abundance of the remaining species ranged between 1 and 91 birds and their distribution among the observation points was uneven, depending on the occurrence of their preferred habitats, such as the proximity of dams holding waterbirds, or native trees holding bush birds. The abundant species were, predictably, common farmland birds, species that are broadly distributed in farmland areas across south-eastern Australia.

The ranking of species by abundance was almost the same at the wind farm survey points, with the Australian Magpie being the most common resident farmland bird at all points (Appendix 17). The mix of bird species at each wind farm survey point reflected the area of patches of either native trees or exotic pines within the counting area of the observation points, although at no point was there a significant area of either.

At the reference sites (Appendix 17), the most abundant species were, in order:

- Australian Magpie;
- European Goldfinch;

- Raven spp., mainly Little Raven;
- Yellow-rumped Thornbill; and
- Common Starling.

The first three species accounted for 52% of individual birds counted and the five species accounted for 72% of individual birds counted. The most abundant species were common farmland birds, of which two species were introduced.

The more abundant species at the reference points were similar to those wind farm survey point; this is expected since the habitats were similar at the impact and reference points.

The total number of birds counted at the wind farm survey point varied between 302 birds at P7, to 630 birds at P6 (Table 20). Wind farm survey points with higher bird numbers supported higher quality habitat.

At the two reference sites, bird abundance was noticeably lower than on most wind farm survey points, reflecting the availability of suitable habitat. The reference sites were either on public roads or in middle of open large paddocks with few pine trees within the counting area.

Table 20: Number of Birds Counted at Each Survey Point

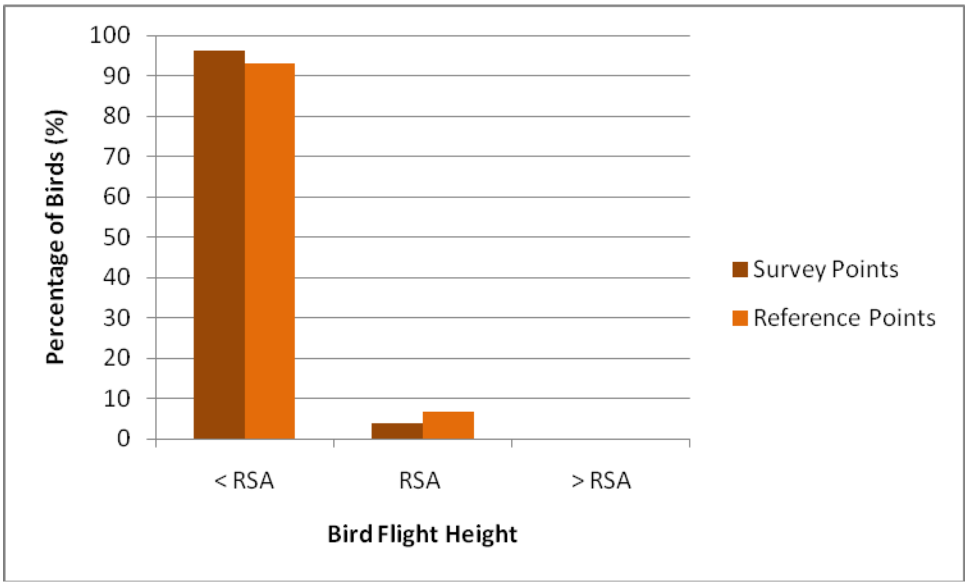
Observation Points	Number of birds at			Total	% of total birds	% at RSA Heights	% RSA of Tot. birds
	A	B	C				
Wind farm survey points							
P1	616	9	0	625	14.2	1.4	0.2
P2	418	41	0	459	10.4	8.9	0.9
P3	527	18	0	545	12.3	3.3	0.4
P4	292	11	0	303	6.9	3.6	0.2
P5	345	10	0	355	8.0	2.8	0.2
P6	594	36	0	630	14.3	5.7	0.8
P7	298	4	0	302	6.8	1.3	0.1
P8	316	8	0	324	7.3	2.5	0.2
P9	403	12	0	415	9.4	2.9	0.3
P10	439	17	0	456	10.3	3.7	0.4
Total	4248	166	0	4414	100.0	3.8	3.8
Reference Points							
R1	208	16	0	224	40.4	7.1	2.9
R2	309	22	0	331	59.6	6.6	4.0
Total	517	38	0	555	100.0	6.8	6.8

Notes: A =below 40 m; B = 40-120 m; C = >120 m).

Bird Flight Heights

Overall, the majority of birds flew below RSA at the survey site locations (Table 20, Figure 25). During the survey period, a total of 166 individual birds of 16 species were observed flying at RSA height at the wind farm survey points, or 3.8% of the total number of birds counted. There was little variation in birds flying below and at RSA between the two reference points.

Figure 25: Percentage of birds counted between 40 and 120 metres above the ground



< RSA = below 40 metres, RSA = 40 metres to 120 metres, > RSA = more than 120 metres

A species-specific analysis has indicated that the most abundant species observed flying at RSA height at the impact observation points were:

- Raven spp.;
- Long-billed Corella;
- Common Starling;
- Yellow-tailed Black Cockatoo; and
- Galah.

These five species accounted for 75% of the birds counted at RSA height. All species flying at RSA height were common farmland birds (Figure 26). Ravens usually fly close to the ground while moving between paddocks, but they may at times fly high when moving longer distances.

The Long-billed Corella is a very common farmland bird, usually found in flocks feeding in open paddocks; they usually fly low when flying short distances, but fly high when moving between paddocks or when dispersing to feeding grounds from roosting sites.

Starlings are similar to ravens, and usually move and feed in big flocks; they usually fly close to the ground, but fly high when moving longer distances.

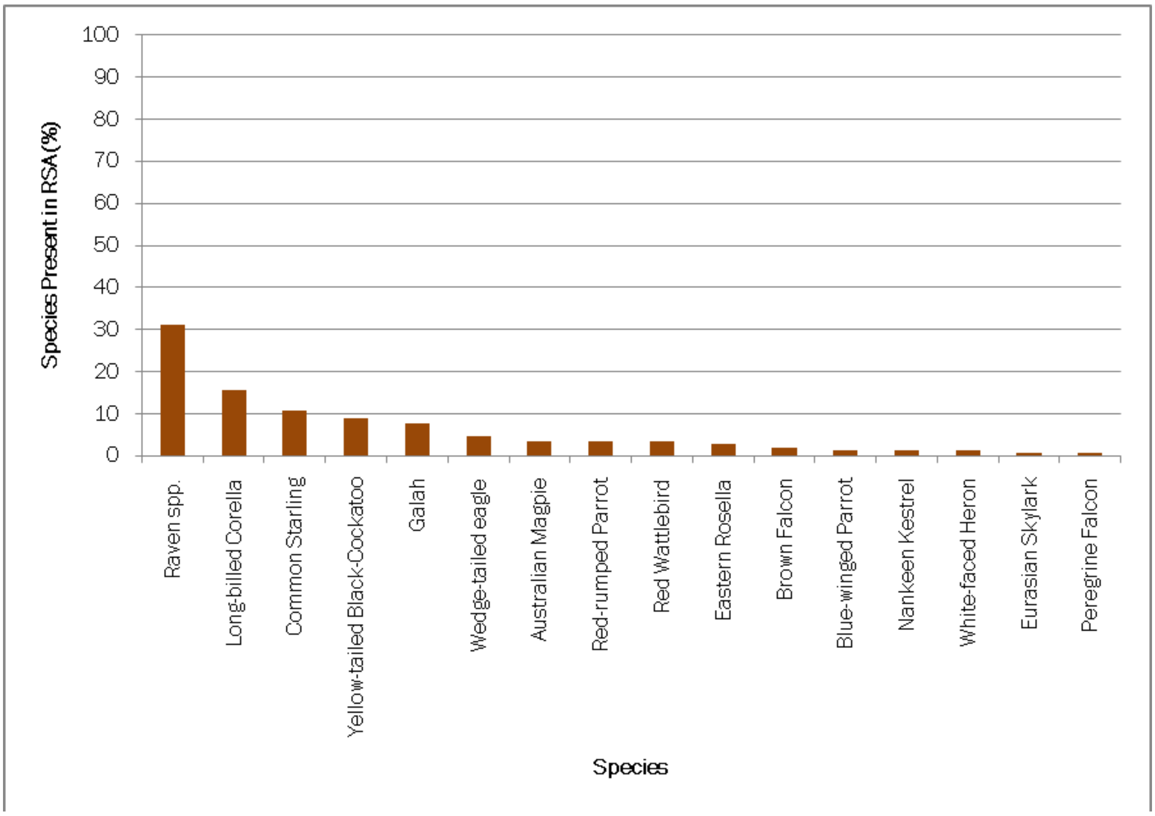
Yellow-tailed Black Cockatoos, like the above species, usually move in flocks of varying sizes. They feed in large pine trees and mature eucalypts. When moving between feeding sites they usually fly at tree heights, but when crossing long distances they fly at RSA heights. Cockatoos recorded in this study were part of a large flock flying across the counting point, of which 15 birds were at RSA heights.

The remaining species recorded at RSA heights were four birds of prey, and a collection of farmland birds that are found to occasionally fly at RSA heights. Birds of prey, a group most likely to be observed regularly flying at RSA height, are discussed below in more detail.

At the reference sites 38 birds of seven species were recorded flying at RSA heights, 22 of which were ravens. The remaining birds were starlings (8 individuals), birds of prey (4), swallows (2) and skylarks (2).

The presence of birds at RSA height at the wind farm survey points varied from 4 birds at P7 to 41 birds at P2. In common with the total number of birds at the observation points, there were no particularly apparent patterns of distribution of birds at RSA height among the wind farm survey points.

Figure 26: Percentage of Species counted between 40 to 120 metres above the ground



Birds of Prey

Few birds of prey were observed on the site. During the formal bird counts at the wind farm survey point, five species were recorded and these formed 1.1% of all individuals surveyed on the wind farm site and 8.4% of birds seen at RSA height (Figure 27 and Table 21).

The Brown Falcon was the most abundant raptor on the wind farm site. It constituted 57% of raptors seen on the wind farm site. A very small proportion was seen flying at RSA height compared to other raptors; Brown Falcons tend to fly low over open land while searching for their prey.

The Wedge-tailed Eagle was next in abundance and 11 birds were recorded utilising the survey area. However, despite being less common than Brown Falcon, it was almost three times as likely to be seen at RSA height. The use of the wind farm site was different between the summer and autumn surveys. While only two eagles were recorded during the summer survey from the southern section of the wind farm, nine individual encounters were recorded during the autumn survey and most of these counts were from the central and northern section of the wind farm site. Eagles were seen on eight occasions, including those recorded during official bird count from the observation points. In each occasion, number of birds seen flying varied between one to three birds (one immature and two adults).

This species has the potential to collide with wind turbines. The utilisation rates of Wedge-tailed Eagles at Victorian and eastern South Australian wind farm sites have varied from 0.001 to 0.44 birds per hectare per hour (BL&A, unpublished data). The utilisation rate at the site is low (0.035 birds per hectare per hour) compared with elsewhere.

The proposed Stockyard Hill Wind Farm site is believed to be within the foraging territory of two families of Wedge-tailed Eagles. One family of the eagles utilised the southern section of the wind farm, though seen only during the summer survey, and a second family utilised the central and northern sections of the wind farm and was seen only during autumn survey. In most of the observations in autumn, the eagles were seen flying northward after a period of soaring and disappearing over the large native woodland located few kilometres north of the wind farm site.

Table 21: Number of Raptors Recorded During the Bird Surveys.

Species of raptors	Su 2008			Au 2009			Combined			Total	% of raptors	% RSA raptors	% all RSA birds
	A	B	C	A	B	C	A	B	C				
Brown Falcon	8	2	0	17	1	0	25	3	0	28	57	21	1.8
Wedge-tailed Eagle	0	2	0	3	6	0	3	8	0	11	22	57	4.8
Nankeen Kestrel	2	2	0	4	0	0	6	2	0	8	16	14	1.2
Peregrine Falcon	0	1	0	0	0	0	0	1	0	1	2	7	0.6
Swamp Harrier	1	0	0	0	0	0	1	0	0	1	2	0	0
Totals	11	7	0	24	7	0	35	14	0	49	99	99	8.4

Notes: * All birds = 4414 individuals; All RSA birds = 166 individuals.

Waterbirds

Waterbirds were scarce at the proposed Stockyard Hill Wind Farm site. Five common species, White-faced Heron, Chestnut Teal, Pacific Black Duck, Australian Shelduck and Australian Wood Duck, were recorded at the observation points during formal counts; most of these originated from a farm dam located within the counting area of observation point P3.

The proposed Stockyard Hill Wind Farm site contains a number of large water bodies, and many farm dams. These water bodies, such as Lake Goldsmith, were completely dry at the time of the survey. The farm dams, on the other hand, attracted a few waterbirds, but most of these birds were resident and rarely moved beyond the edges of the dams. A careful watch of some of the large dams, particularly those with vegetation, did not reveal any mass movements of the waterbirds in and out of these water bodies, except for a few flights by herons.

The waterbirds recorded as part of the bird utilisation survey are detailed in Appendix 17. Fifty-one birds from five species (mainly wood ducks) were recorded (1.0% of all birds), of which two individuals were at RSA height.

Two pairs of Brolgas were seen incidentally at two dams located outside of the observation points. None were observed during the formal bird utilisation point surveys.

Migratory Birds

Latham's Snipe, the only migratory bird species observed in the study area, was observed on two occasions.

3.4 Impact Assessment

Based on the results of database searches, consultation and field investigation, the following species or groups are likely to occur in the study area and are the subject of the impact assessment:

- Striped Legless Lizard;
- Fat-tailed Dunnart;
- Birds; and
- Bats.

3.4.1 Introduction

The degree to which wind farms impact fauna communities varies depending on a number of factors including wind farm area, species, turbine number, weather conditions, topography and lighting (Drewitt & Landston 2006). For example, species with a high reproductive productivity are better adapted to sudden increases in mortality unlike slow-reproducing species (Drewitt & Landston 2006). This is because long-lived species, such as raptors and Brolga, generally produce smaller clutch-sizes (Exo *et al.* 2003). Therefore, the impacts of wind farms on raptors are expected to be higher than on species with a higher reproductive productivity, such as wildfowl (i.e. ducks and swans).

Potential impacts of wind farms on birds during construction and operational phases are listed below.

- Habitat loss;
- Displacement and disturbance;
- Collision risk with wind turbines; and
- Collision risk with wind mast guys.

These impacts have been assessed on the ecological features identified during the surveys by examining the literature of the impact of wind farms on the species groups and comparing instances of significant impact to the conditions observed at the proposed Stockyard Hill Wind Farm. Sources of impact are described below, followed by the impact assessment.

3.4.2 Habitat Loss

Impacts of habitat loss are either permanent or temporary, as some construction infrastructure is temporary, such as construction pads, whilst others are permanent such as access tracks.

The degree to which species are impacted by habitat loss is dependent on the landscape's carrying capacity for that species, the availability of suitable habitat in the wider landscape and the degree to which species can recover / recolonise areas that are temporarily removed. Populations of most animals are generally considered to vary around carrying capacity, which in turn depends on conditions that may fluctuate over time. Any loss of habitat is likely to result in a loss of carrying capacity by the extent to which this is significant depends on both the role of that species in biodiversity (structure, function and composition, its population viability and its ability to recolonise. The vulnerability of animals is also dependent on their degree of habitat-dependence, existing habitat fragmentation and whether they are particularly mobile or philopatric species e.g. return annually to the same locations.

Birds are generally mobile and are able to relatively easily move to alternative habitats but this does not necessarily mean that habitat is available or it will definitely be used.

Species, such as Striped Legless Lizards and Golden Sun Moth are susceptible to loss of habitat as their mobility is restricted and they occur in heavily fragmented habitat. Existing population viability within remnant habitat may not be known but can perhaps be inferred by their persistence since European settlement. Little is known about the movements of Striped Legless Lizards, however studies have shown that the species can move approximately 20 metres in one day (Smith and Robertson 1999). Similarly, male Golden Sun Moths will not fly more than 100 metres from suitable habitat (O'Dwyer *et al.* 2000). Therefore, the loss of suitable habitat can be significant.

As can be demonstrated, suitable habitat for listed threatened fauna species has been avoided when designing the turbine layout. Therefore, impacts to these species are not considered to be significant.

3.4.3 Disturbance

During the construction and operation of the wind farm, disturbance will temporarily increase through increase human and plant activity, and permanently increase from the movement and noise caused by functioning turbines. Fauna may respond to this increased disturbance by moving away from its source which corresponds to an indirect loss of habitat. Numerous studies have investigated this potential problem, with a range of results. In many cases, no significant disturbance effect has been detected, including studies at upland, coastal and offshore wind farms (Percival 2003) (see Table 22).

European studies reported displacement effects ranging from 75 metres to as far as 800 metres away from turbines and up to 300 metres for breeding birds (Percival 2003; Strickland 2004). The results of some studies may have been influenced by other factors, such as:

- Increased human disturbance in the area;

- Lack of prior studies to determine birds' habitat preferences; and thus
- Lack of consideration about appropriate wind farm location and layout; and

Whilst birds appear to avoid flying near turbines, the presence of these structures does not seem to deter birds from their foraging areas (Danish Wind Industry Association 2001). Breeding birds appear to have a greater tolerance to turbines than migrating birds (Danish Wind Industry Association 2001). Local breeding populations of waterfowl, grouse, shorebirds, gulls and passerines were not significantly affected by the construction of turbines in a bog in the Orkney Islands (Meek *et al*. 1993). There was also little effect on breeding birds at other wind farm sites in Great Britain, with many examples of birds breeding in close proximity to wind turbines (Percival 1998).

The available evidence summarised here strongly suggests that beyond approximately 800 metres disturbance of birds by wind turbines is not common. Therefore, turbines have been positioned to avoid significant disturbance to species of conservation concern, including Brolga. The residual impacts are over areas of farmland, where the species complement comprises common farmland birds that are not of conservation significance. Therefore, the risk from disturbance is considered to be negligible.

Table 22: Studies of Possible Bird Disturbance Effects of Wind Farms

Site	Habitat	Species Present	Size of Wind Farm*	Distance Affected (metres)
Tjaereborg, Denmark**	Coastal grassland	Waterfowl, mainly waders and gulls	S	Max. 800
Urk, Netherlands	Coastal - on dyke wall	Waterfowl, including geese and swans	M	Max. 300
Oosterbierum, Netherlands***	Coastal - on dyke wall	Waterfowl	M	Max. 500
Vejlerne, Denmark	Farmland	Pink-footed Geese	L	1–200
Westermarsch, Germany	Farmland	Barnacle Geese	M	Max. 600
Haverigg, Cumbria	Coastal grassland	Golden Plover, gulls	S	None
Blyth, Northumberland	Coastal shoreline	Cormorants, waders, gulls	S	None
Bryn Tytli, Wales	Upland moorland	Upland species, raptors	M	None
Carno, Wales	Upland moorland	Upland species	L	None
Ovenden Moor, NW England	Upland moorland	Golden Plover and Curlew	M	None
Nasudden, Gotland, Sweden	Coastal marsh	Waterfowl inc. geese and breeding waders	L	None
Various UK sites	Uplands	Lapwings, curlews, skylarks and pipits	M	None
Zeebrugge, Belgium	Coastal shoreline	Waterfowl	M	Up to 300
Novar	Upland Moorland	Upland species	M	None
Urgrunden	Offshore	Long-tailed Duck	S	None

(after Percival 2003).

Notes: * L = large (50–200 turbines); M = medium (10–50); S = small (<10); ** = breeding Lapwing up to 300 m; *** = no effect on breeding waders.

3.4.4 *Mortality Caused by Wind Turbines*

The intensity of impacts on birds and bats from mortality effects of operating wind farms depends on site characteristics, particularly habitat and topography, which influences animal density, and the location of specific movement corridors.

Table 23 summarises reported collision rates from a range of European and North American wind farms. The rate varied between 0.04 – 3.4 birds per turbine per year. A rate of 4.3 birds per turbine per year was recorded from two wind farms in the eastern US outside California.

Studies using radar tracking have helped to provide further information on birds' general ability to avoid collisions. Dirksen *et al*. (1998), for example, showed that Pochard (*Aythya ferina)* and Tufted Duck (*Aythya fuligula)* flew regularly through a wind farm in the Netherlands at night under moonlight but flew around the turbines at greater distance from them when it was dark and foggy.

Analysis of North American and European bird collisions at wind farms (Erickson *et al.* 2001; Percival 2003; NWCC 2004) shows that birds affected by operational turbines varied between wind farms but mostly depended on the type of habitat on which the wind farm is built. Most wind farm bird mortality was to migrating birds. The northern hemisphere has a large number of migratory species. These are often night-flying and congregate at high density in southern areas during winter when vast areas become snow and ice-covered in northern latitudes. Australia has few night-migrating birds (which are greater risk of collision with turbines) but observations have shown that it has does still have periodically high bird congregations which may be susceptible to collisions with wind turbines.

Table 23: Bird Mortality Estimates for Wind Farms in Europe and North America

Site	Habitat	Species Present	Size of Wind Farm*	Number of collisions (turbine^{-1} yr^{-1})
USA sites (review of 12 projects outside California)	Various	Various	Mixed	2.3 (1.5–4.3)
Altamont, California	Ranch land	Raptors	VL	0.05– 0.06
Buffalo Ridge (all phases), Minnesota, USA	Various	Waterfowl and passerines	L	2.83
Tarifa, S. Spain	Coastal Hills	Raptors, storks and many migrants	VL	0.34
Navarre, Spain	Inland hills	Various, including raptors and passerines	VL	0.34
Burgar Hill, Orkney	Coastal moorland	Upland species	S	0.15
Blyth, Northumberland	Coastal Shoreline	Shorebirds	S	2.52
Zeebrugge, Belgium	Coastal shoreline	Gulls, terns and migrants	M	11–29***

Site	Habitat	Species Present	Size of Wind Farm*	Number of collisions (turbine^{-1} yr^{-1})
Bryn Tytli, Wales	Upland moorland	Upland species, including Peregrine Falcon	M	0.0
Cemmaes, Wales	Upland moorland	Upland species	M	0.04
Urk, Netherlands	Coastal - on dyke wall	Waterfowl	M	1.7
Oosterbierum, Netherlands	Coastal - on dyke wall	Waterfowl and migrants	M	1.8
Kreekrak, Netherlands	Coastal - on dyke wall	Waterfowl	S	3.4
Ovenden Moor, South Pennines	Upland moorland	Upland species	M	0.04
Tjaereborg, Denmark	Coastal grassland	Waders and gulls	S	3.0
Nasudden, Gothland, Sweden	Coastal marsh and arable	Waterfowl, including breeding waders and migrants	L	0.7
Utgrunden	Offshore	Eiders	S	0.0

(Sources: Erickson *et al* 2001; Percival 2003; NWCC 2004).

Notes: * **VL**=very large (>200 turbines); **L**=large (50–200 turbines); **M**=medium (10–50 turbines); **S**=small (<10 turbines); ** = collision rate = Number of birds killed per turbine per year; all rates are corrected for observer efficiency and scavenging rate; *** = the study included high correction factors (detecting only 11% of collisions).

Collisions with wind turbines is a particular problem when either the effect is biased toward species whose population viability is sensitive to change in the rate of mortality, or where there are high densities of birds flying at rotor-sweep height. In Australia, this includes sites with large raptors occurring regularly within the wind farm (large raptors usually fly at RSA height). In Australia species that fall into this category would include Wedge-tailed Eagle, Nankeen Kestrel and Peregrine Falcon.

3.4.4.1 Australian Studies

Bird mortality results in the public domain include:

- Codrington, Vic. (14 turbines): 3 birds (2.5 years, weekly, monthly or six-weekly searches);
- King Island, Tas. (3 turbines): 1 bird (5 years, weekly – monthly searches);
- Woolnorth, Tas. (6 turbines): 8 birds, <1 year, daily to weekly searches);

(Source: Meredith, C (2003) Australian Wind Energy Association presentation, Sydney, July 2003).

Allowing for observer efficiency and scavenger correction (the number of carcasses missed because they were eaten / removed by animals), the Australian results correspond to a collision rate of between one and four birds per generator per year.

The Australian wind farms that were monitored for bird mortality are mostly in agricultural settings, and all are located on or close to the coast. Birds that fatally collided with turbines were mostly farmland birds, except at Woolnorth, where the list included three seabird species and occasional Wedge-tailed Eagle collisions.

Raptors are considered vulnerable to collision with wind turbines. The species of greatest concern at Stockyard Hill is Wedge-tailed Eagle. However, although this was responsible for just under 1 in 20 flights above RSA rotor height during studies (section 3.3.2.1), it is not listed threatened and the overall utilisation rate is considered low (0.035 birds per hectare per hour). There still remains a residual risk that this species may be affected by the proposal.

Only one species, Brolga, is listed threatened and has been identified as being potentially susceptible to impacts from wind farm operation at Stockyard Hill. The potential for impacts on this species is considered in Chapter 4.

3.4.5 Mortality Caused by Powerlines and Wind Mast Guys

An additional source of impact to birds and bats are collisions with powerlines and wind mast guys (Kingsley and Whittam 2001). Species most susceptible to collisions with wires include those which fly fast in flocks at low altitude, such as waterfowl and shorebirds and those with large wingspans which are less able to manoeuvre around the wires, such as raptors (James and Haak 1979 and Olsen and Olsen 1980).

A 12 month study was undertaken by van Rooyen and Ledger (1999) between August 1996 and July 1997. During this period, they observed a number of collisions in 23 species, including a number of raptor and crane species. Electrocutions were also found for many of these species. Impacts were found to be significant. However, these studies assisted in the development of a number of strategies, outlined below, which reduce these impacts.

Several recommendations have been made to reduce wire-induced bird mortality (Kingsley and Whittam 2001):

- Lines should be built underground if possible;
- Line visibility should be increased by adding markers, and increasing the size of wire;
- Lines should not be built over water or other areas of high bird concentration; and
- Lines should be made parallel to prevailing wind direction.

3.4.6 Impacts to Bats

Impacts to bats from wind farms are similar to those for birds. Therefore, impacts have the potential to arise from the following two sources:

- Collision Risk; and
- Habitat Loss from disturbance, barrier effect and habitat exclusion.

Studies have demonstrated that bats collide with wind turbines at approximately the same rate as birds. In Minnesota Johnson *et al.* 2003 demonstrated that bat fatalities with wind turbines ranged between 0.07 bats per turbine per year to 2.04 bats per turbine per year. However, during these studies it was found that resident bats were at a lower collision risk compared with migratory species, possibly due to habituation to the wind farm structures, or different habitat utilisation behaviours. Studies in the Unites States have demonstrated that bat fatalities were highest in forested habitats, and during the migration season (Kunz *et al.* 2007), as was observed by Johnson *et al.* (2003)

Bat fatalities arise from two sources, direct collisions with wind turbines and impacts arising from barotrauma resulting in direct mortality (Baerwald *et al, 2008).* Barotrauma is caused by air pressure changes around turbine blades, which can result in tissue and lung damage. Studies were conducted on dead bats collected at a wind farm in Canada. The results indicated that the majority of the bats (90%) suffered internal and external injuries, or internal injuries only, thereby suggesting barotrauma was a contributing or primary factor in bat fatalities at the site. Whilst this impact has the potential to be significant, very few studies have investigated this impact, and few mitigation measures exist.

The following three factors contribute to determining impact significant:

- Bat species present in an area;
- Time of year; and
- Habitat and landscape features, including the presence of forested ridges (OMNR 2006).

The proposed Stockyard Hill Wind Farm is primarily situated away from suitable bat habitat. Although turbines are found in the north of the proposed wind farm, near forested areas suitable for bat species, the propose turbines are approximately 250 metres from suitable habitat, considered sufficient to minimise impacts to bats.

Although the time of year has been found to be an important factor in determining impact significance, this is more relevant to European and North American bats which are migratory. Although Australian bats display some migratory behaviour, migrations are local and not considered to be significant. Therefore, timing is not assessed as being an important consideration for bats at the proposed Stockyard Hill Wind Farm.

Taking these factors into consideration, impacts to bats are not expected to be significant. Nevertheless, measures have been implemented at the design phase of the wind farm to avoid areas of suitable habitat.

3.4.7 Vulnerability of Fauna to Impacts

3.4.7.1 Migratory Shorebirds

In 2002 Brett Lane conducted field studies in wetlands in south-western Victoria on the movement of waterbirds, including shorebirds in and around wetlands. Three survey points were established at 0 metres, 300 metres and 600 metres from the edge of the wetland with a 150 metre observation radius. Although the results cannot be published, due to client confidentiality, waterbird numbers were higher at the 0 and 300 metre observation points. At the 600 metre observation point waterbird numbers were comparable to background levels from similar agricultural settings. This therefore indicates that in the course of their usual movements within wetlands, waterbirds generally do not move further than 450 metres beyond the edge of the wetland habitat. It is likely that shorebirds behave in a similar way as they are dependent on wetland habitats and would not move far beyond wetland edges unless moving to an alternative habitat. The nearest turbine to Lake Goldsmith has been kept at least 450 metres away from the Lake to minimise the risk of collision by waterbirds using Lake Goldsmith, including shorebirds. Shorebirds also move between wetland habitats. The findings reported in Chapter 3 indicate that larger wetlands on and near the proposed Stockyard Hill Wind Farm site do not regularly support significant numbers of migratory shorebirds. Extensive wetland surveys were undertaken twice over substantial proportion of the wetlands within 20 kilometres of the wind farm site:

- Once in October and November 2007: a year of average rainfall and a high availability of shallow seasonal wetland habitat; and
- All wetlands within three kilometres of the wind farm at least once in November 2008, a drier year.

Apart from two Latham's Snipe, no listed migratory shorebirds were observed. If we assume this is an average year and consider the data presented in Chapter 3, this suggests the region's wetlands do not regularly support significant numbers.

Shorebirds are not often found to have collided with operating wind turbines. The few instances where this has occurred have been at coastal European wind farms near habitats that support significant numbers of roosting or breeding shorebirds (Percival 2003).

Longer distance shorebird migration has been described by a number of authors (Lane & Jessop 1985; Piersma et al. 1990; Swennen 1992; Tulp et al 1994). These studies show that wherever it has been studied, shorebird migratory departure has remarkably consistent characteristics, described below.

- Shorebirds depart in flocks of between 5 and 250, with occasional observations of larger flocks (averages: 52, Lane & Jessop 1985; 10 – 151, depending on species, Piersma et al. 1990;127, Swennen 1992; 13 – 94, depending on species, Tulp et al. 1994).
- They fly in an elongated, shallow "V" formation, termed an "echelon" (see Piersma et al. 1990).
- They ascend rapidly and steeply, and are usually still ascending when lost from sight by the observer. Angles of departure have not been measured but possible angles are explored below. Estimated angles of ascent for migrating shorebirds in Victoria and at Broome, Western Australia range from 10 to 30 degrees (B. Lane, pers. obs.) When moving between habitats more than several kilometres apart, a height of 130 metres (the height of a wind turbine) would be reached after approximately 800 metres at 10 degrees, or 500 metres at 15 degrees, placing them thereafter at a height well above turbine height in flat terrain, such as the terrain around the proposed Stockyard Hill Wind Farm site. Two turbines lie within 800 metres of Lake Goldsmith.
- Observations of flight altitude using weather radar show that during migration, shorebirds fly at between 0.5 and 6 kilometres (Williams et al. 1981; Piersma et al. 1990; Tulp et al. 1994). Altitudes of migration given in the last two studies are of birds still ascending when they disappeared from sight, often at altitudes of greater than 1 kilometre, and are therefore likely to be at the lower range of altitude estimates for level migratory flight. The first two studies used radar on oceanic islands to study shorebirds on long-distance, level, migratory flights. Altitudes in these circumstances ranged from 2.5 to 6 kilometres.
- Shorebirds often circle and call to one another while ascending to heights of over 100 metres or more before fixing on a direction and departing, although this does not always happen (B. Lane, Pers. obs.).

Shorebirds generally do not fly low over land and only fly low over water or mudflats (B. Lane, pers. obs.). Whereas it is not unusual to find wetland terns, such as Whiskered and Gull-billed Terns flying across farmland between wetlands, shorebirds are not seen moving about the landscape in the same way, indicating high flight across land. When moving one or two kilometres between habitats, shorebirds are likely to fly at turbine height or higher. Longer distance movements are more likely to be higher still given the behaviour described above involving the most efficient climb rates for longer distance flight (Piersma et al. 1990, 1997) is most likely to be exhibited.

There are fewer observations of shorebirds arriving at habitats. Only anecdotal information is available (e.g. Brett Lane, pers. obs.) but combined with the observations of others, it indicates that shorebirds descend rapidly from a great height (usually beyond normal visibility) on reaching their destination.

Movements between habitats would involve the occasional flock of 100+ of the three more abundant species of shorebirds (i.e. Red-necked Stint, Sharp-tailed Sandpiper and Curlew Sandpiper) and smaller numbers of other species. If collisions were to occur, they would involve a very small number of shorebirds irregularly when the lake was in a suitable condition to support these birds (i.e. not every year given that the lake dries out). The impacts of collisions with turbines therefore are very unlikely to result in significant disruption to the population or movements of an ecologically significant proportion of the known populations of the species that regularly inhabit Lake Goldsmith. The project is well set back from the lake so indirect impacts on water regime and quality are expected to be negligible and the habitat will continue to support shorebirds in the future when water levels are suitable.

These principles and findings indicate that the probability of a significant impact occurring on listed migratory shorebirds at Lake Goldsmith is considered to be negligible.

3.4.7.2 Waterbirds

Available waterbird count data from DSE indicates that Lake Goldsmith occasionally holds significant numbers of common waterbirds. Impacts on waterbirds at Lake Goldsmith are unlikely as turbines are positioned at least 500 metres from the edge of the lake. This distance has been found in studies around wetlands elsewhere in south-western Victoria (B. Lane, pers. obs.) to be the distance from wetlands at which waterbird utilisation rates fall to background levels in agricultural landscapes. Therefore, collision-related impacts on waterbirds during their routine use of Lake Goldsmith are unlikely.

Some movements of waterbirds to and from Lake Goldsmith are likely to cross the wind farm site. The layout of the wind farm includes a turbine-free corridor either side of Lake Goldsmith. Waterbirds that avoid turbines would be able to move within this corridor. The frequency with which Lake Goldsmith holds high numbers of waterbirds is limited based on historical records so the frequency with which large numbers would fly over the site would be low, with a correspondingly low collision risk over time.

3.4.7.3 Striped Legless Lizard

A population of Striped Legless Lizard was recorded in the study area (Figure 14), and data from DSE suggests a population is also present approximately two kilometres from the study area at Blacks Creek Nature Conservation Reserve (G. Peterson, DSE).

The Striped Legless Lizard records were located within patches of Plains Grassland that will not be impacted by the proposed wind farm. Therefore, no core indigenous habitat for Striped Legless Lizard will be removed. The risks in relation to this species are confined to non-core habitat within small areas of the exotic grassland that *potentially* support Striped Legless Lizard. We did not find Striped Legless Lizard in this habitat. Any potential populations that may exist are expected to be at a low density. Therefore, the project is not expected to have any significant impacts on Striped Legless Lizard.

The Striped Legless Lizard can occur in non-native grasslands adjacent to native grasslands where they have been recorded. As a population of this species exists in the Stockyard Hill area, construction of turbines and associated access roads and powerlines could be undertaken consistent with a salvage protocol for this species. However, it is uncertain to what extent this would mitigate any impact or whether the costs would outweigh the benefits. Further consideration will be given after consultation with the relevant authorities.

3.4.7.4 Fat-tailed Dunnart

A population of Fat-tailed Dunnart was recorded as being present within the study area in remnant patches of Plains Grassland. As with Striped Legless Lizard, this habitat has been avoided and the percentage of contiguous introduced pasture areas affected by the proposed wind farm that may support them is small. For these reasons, impacts on the population of this species in the Stockyard Hill area are not expected to be significant.

However, taking into consideration this species regularly occurs in this part of the proposed Stockyard Hill Wind Farm, construction work in the vicinity of Grid 5 could be subject to a Fat-tailed Dunnart survey and salvage protocol prior and during construction works. However, it is uncertain to what extent this would mitigate any impact or whether the costs would outweigh the benefits. Further consideration will be given after consultation with the relevant authorities.

3.4.7.5 Golden Sun Moth

This species was not recorded at the proposed Stockyard Hill Wind Farm. Two areas of high quality habitat were identified outside the proposed wind farm. Whilst grassland habitats of low and moderate quality were present in the development footprint, it was considered highly unlikely that this species would be present, due to low habitat connectivity to other areas of suitable habitat.

In conclusion, no issues arise in relation to the Golden Sun Moth's status as a matter of national environmental significance under the *Environment Protection and Biodiversity Conservation Act 1999*, or its status under the *Flora and Fauna Guarantee Act 1988*.

3.4.7.6 Bats

No species listed on national or state threatened species legislation was recorded during the bat surveys. Bat activity was recorded as highest in areas of native vegetation. In view of the lack of listed species, the relatively low level of bat activity and the non-native habitat across much of the proposed wind farm site, the likelihood that significant numbers of bat species would be affected is considered to be low. This is also because most turbines in the proposed Stockyard Hill Wind Farm are located in areas that lack remnant native vegetation or have only scattered trees or are plantations.

3.5 Operational and Management Commitments

The project will be constructed and operated consistent with Construction and Operational Environmental Management Plans that incorporate these measures. The implementation of these plans will become a contractual obligation of the construction contractor, who will be required to operate consistent with an appropriate environmental management system. These plans will provide clearly identified responsibilities for the implementation of environmental management measures, including, but not limited to:

- Contractor personnel engaged to ensure compliance with environmental management plan procedures;
- Minimum fortnightly Independent project owner on-ground audits of the construction contractor's implementation of CEMP measures aimed at avoiding impacts on listed matters;
- Monthly compliance reports to the owner's management in relation to measures to avoid impacts on listed matters; and
- A procedure for dealing with non-conformances.

Areas and habitats confirmed to support or with the potential to support *EPBC Act* listed threatened species and communities have been subject to detailed consideration in the development of construction environmental management measures. Among other things, these measures will aim to ensure no impacts occur to known or potential habitats for listed threatened species. Clear commitments by the proponent to ensure that the project will not have a significant impact on species known or likely to occur include:

- Turbines and associated infrastructure have been sited to avoid the need to cross waterways, including avoidance of the Mount Emu Creek, thereby avoiding impacts on potential habitat on and associated with the creek for the Growling Grass Frog.
- During construction, areas of grassland that known to or with the potential to support the Striped Legless Lizard and Golden Sun Moth, and the threatened community Natural Temperate Grassland of the Victorian Volcanic Plain, will be temporarily fenced. This measure will be implemented near the development footprint to prevent inadvertent access to or disturbance of habitat. Storage and lay-down areas will be sited away from these potential habitats to avoid impacts.
- Strict erosion and sedimentation controls will apply during and after construction near grassland habitat at Stockyard Hill to avoid indirect impacts on these habitats.

The implementation of these measures during the four year construction period will ensure that impacts on listed threatened species, and on the threatened community Natural Temperate Grassland of the Victorian Volcanic Plain, will be avoided.

CHAPTER 4 TARGETED BROLGA ASSESSMENT

Key Findings

- No direct removal of habitat is expected, as turbines are sited well up-slope of breeding sites.
- Indirect (disturbance) effects on Brolgas during the breeding season may occur from operating wind turbines and these have been mitigated through the adoption of turbine exclusion zones comprising 400 metres of pasture, plus a 300 metres disturbance exclusion around a core ‘breeding home range’ linking all useable wetlands within 3.2 kilometres of all useable historic and current known breeding sites.
- Migration season impacts may arise as a consequence of collision with operating turbines. They are considered to be very low. Barrier effects during the migration seasons may occur so these have been mitigated through the adoption of a turbine exclusion zone comprising a northern (>1.5 kilometres wide) and southern (>two kilometres wide) movement corridor for Brolgas.
- In the flocking season, a five kilometre exclusion zone around traditional flocking sites (as distinct from one-off stopover sites) has been adopted to prevent indirect disturbance of habitats used by flocking Brolgas.
- The residual impacts of the project on the Brolga have been modelled using a collision risk model and the resulting potential population effects have been evaluated using PVA (McCarthy 2008). This has estimated that across all seasons, the total likely annual collision rate of Brolga with operating wind turbines at the proposed Stockyard Hill Wind Farm is 0.2 birds per year (Smales 2008). Powerline collisions (internal and external) have been estimated at another 0.03 birds per year (Smales 2009).
- PVA modelling (McCarthy 2008) indicates that this order of mortality would result in the loss of an extra one or two birds from the population over 20 years and that an increase of 0.22 birds recruited to the adult population per annum would be sufficient to mitigate this impact. The impact of powerline collision would not significantly alter this effect
- Further, specific mitigation measures will be developed to offset the modelled population impacts arising from the project, including provision of additional breeding habitat through wetland restoration, and reduced adult mortality from marking powerlines near flocking sites.
- Detailed mitigation plans will be developed if Brolgas breed or flock within critical distances from the proposed wind farm to further reduce risk.

4.1 INTRODUCTION

The Brolga is listed as a threatened species under the *FFG Act*. The policy and planning guidelines for wind farms in Victoria require that the potential impacts of wind farms on species listed under the Act be assessed (Sustainable Energy Authority of Victoria 2003).

In order to provide a workable impact assessment framework of the Brolga, BL&A initiated discussions with DSE in the early stages of Brolga investigations. These discussions agreed a comprehensive framework for impact assessment that comprised:

- Agreed data collection on site and search-region specific data on the status and behaviour of Brolga for particular wind farm proposals (as presented in this chapter);
- The application of a collision risk model to the findings of these investigations to predict the number of Brolga potentially affected by the proposed wind farm, commissioned by Stockyard Hill Wind Farm Pty. Ltd. and reported separately in Smales (2008a) for the turbines and Smales (2008b) for the powerlines; and
- The development and application of a PVA model for the Victorian Brolga population to ascertain the state-wide consequences of individual wind farm project impacts, to set performance standards for mitigation measures and to enable DSE to undertake a cumulative impact assessment for each project (developed separately by DSE with application to the current project commissioned by Stockyard Hill Wind Farm Pty. Ltd. and reported separately, McCarthy 2008).

Detailed assessment of wind farm impacts on this species of concern has been undertaken consistent with the interim risk assessment standards for wind farms and birds (AusWEA 2005), and following the impact assessment approach agreed with DSE. This investigation of the Brolgas has been undertaken in regular consultation with the DSE. In particular, Andrew Pritchard, Richard Hill and Nick Wynn made themselves available for regular discussions to scope the investigation.

There are potentially three steps in the investigation (Table 24) and at each stage, information is gathered that informs both the impact assessment and mitigation strategies. Each step also informs the next and all three steps would only be needed if there is likely to be a significant impact on any species of concern, as was the case with Brolga in this assessment.