LAL LAL WIND FARM
PERMIT AMENDMENT APPLICATION

EXPERT WITNESS STATEMENT OF BRETT LANE

WestWind Energy Pty Ltd

Brett Lane & Associates Pty. Ltd.
Ecological Research & Management
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October 2016

Report No. 6150 (9.5)

CONTENTS

TABLES

APPENDICES

1. WITNESS INFORMATION

1.1. Expert witness information

1.1.1. Name and address

Brett Alexander Lane
Brett Lane & Associates Pty Ltd
Suite 5, 61-63 Camberwell Road
Hawthorn East, Vic. 3123

1.1.2. Area of expertise

Brett Lane has extensive expertise in terrestrial ecology and related legislation and policies. He has particular expertise in the impacts of wind farms on wildlife, having advised on such impacts for over 80 projects throughout Australia, from pre-feasibility assessments to post-operational monitoring and reporting programs.

His qualifications and experience are summarised in Appendix 1.

1.2. Information of other significant contributors

The names, addresses and areas of expertise of other significant contributors to this report, and associated background reports, are presented in Table 1.

1.3. Role of Brett Lane

I confirm that my role in the assessment of the Lal Lal Wind Farm has been:

- Project Director and internal peer reviewer for the original ecological assessments of the proposed wind farm (2006 onwards);
- Project Director and internal peer reviewer for the 2015 re-assessment of bird and bat impacts of the revised turbine design that is the subject of the exhibited amendment application; and
- Preparation of this witness statement.

Table 1: Details of other significant contributors

Name of contributor	Address	Area of Relevant Expertise	Location of summary of qualifications and expertise
Khalid Al-Dabbagh	Brett Lane & Associates Pty Ltd Suite 5, 61-63 Camberwell Road, Hawthorn East, Vic. 3123	Bird and bat utilisation surveys and data analysis	Appendix 2
Bernard O'Callaghan	Brett Lane & Associates Pty Ltd Suite 5, 61-63 Camberwell Road, Hawthorn East, Vic. 3123	Project Manager, Wind farm ecological impact assessments	Appendix 2

2. WORK UNDERTAKEN

Brett Lane & Associates Pty Ltd (BL&A) has completed a number of assessments of modifications to the turbine specifications and layout of the Lal Lal Wind Farm from that assessed for the permitted wind farm. These are described briefly below.

2.1. October 2015 Permit amendment application

In October 2015, BL&A prepared an assessment of the impacts on birds and bats of a revised turbine design proposed for the Lal Lal Wind Farm. This October 2015 assessment specifically compared the turbine design originally assessed in our work for the permit application with a proposed revised turbine design.

The revised turbine design used in this October 2015 assessment was a Rotor Swept Area (RSA) based on a maximum rotor diameter of 122 metres on a 100 metre tower which provides an envelope with a lower tip height of 39 metres and an upper tip height of 161 metres.

This assessment was documented in a letter dated 14th October 2015 to Stephen Crowe of WestWind Energy Pty Ltd titled: 'Lal Lal Wind Farm: Change in height of wind turbines – Impacts on birds (Report 6150 [3.8]). Note that information was also provided in this letter on the impacts of the proposed changes on bats.

2.2. August 2016 – Permit amendment application

In August 2016, BL&A prepared a further assessment of further amendments to turbines and layout. This report considered an alternative turbine design with an RSA ranging from 41 to 161 metres and three turbines being removed and compared their impacts on birds and bats with those of the permitted turbine design.

This assessment was documented in a letter dated 15 August 2016 (Report 10.3) and it accompanied the amendment application of August 2016.

2.3. Current assessment

This current Witness Statement assesses the impact of the largest possible turbine design on birds and bats compared with a turbine that sat within the dimensions approved by the permit, and that was slightly smaller than that ultimately permitted.

- The original turbine specifications assessed by BL&A, that were ultimately less than the turbine parameters approved, comprised:
  - Tower height of 80 metres;
  - Blade length of 40 metres (diameter of 80 metres);
  - Rotor Swept Area (RSA) maximum height of 120 metres above the ground; and
  - RSA minimum height of 40 metres above the ground.
- The largest possible turbine design assessed in this statement is:
  - Tower height of 105 metres;

- Blade length of up to 70 metres (140 metres diameter);
- RSA maximum height of 161 metres above the ground; and
- RSA minimum height of 20 metres above the ground.

The reduction in the proposed number of turbines was from 64 to 60 is also considered.

The current assessment involved comparing the original assessed RSA impact on birds with the largest possible turbine design by comparing the number of bird flights that could pass through the circular RSA plane of both turbine types. This involved generating a ratio of bird flight numbers of the latter to the former. The model assumed all flights were perpendicular to the RSA, which is clearly not realistic as flights can approach the RSA from any direction. However, as there is no empirical basis for generating an alternative scenario, this is therefore a 'worst case' comparison but one that still informs decision-making. A summary of the findings is presented in Section 3 of this statement and the modelling is described in Appendix 3.

- The original turbine assessed by BL&A for the original planning permit application was smaller than the turbine specifications ultimately approved, which was based on the Senvion MM92. It comprised:
  - Tower height of 80 metres;
  - Blade length of 40 metres (diameter of 80 metres);
  - Rotor Swept Area (RSA) maximum height of 120 metres above the ground; and
  - RSA minimum height of 40 metres above the ground.
- The largest possible turbine design assessed in this statement is:
  - Tower height of 105 metres;
  - Blade length of up to 70 metres (140 metres diameter);
  - RSA maximum height of 161 metres above the ground; and
  - RSA minimum height of 20 metres above the ground.

The reduction in the proposed number of turbines was from 64 to 60 is also assessed.

The original BLA assessment assessed a turbine with specifications that were smaller than the specifications ultimately approved by the Permit. Consequently, when we assessed the largest possible turbine design against this original assessment, the relative difference in impacts was slightly greater than if it had assessed it against the permitted turbine design.

2.4. Sources of information

Each of the above assessments involved reviewing the bird utilisation survey data for the Lal Lal Wind Farm, collected in 2007 and 2008 over two seasons (late spring and early autumn). This data was still considered valid as there were reported to be no significant changes that had occurred in the agricultural practices in the area to indicate bird species composition and activity would be substantially different. This was subsequently confirmed by a visit by myself to both sections of the wind farm on 4th August 2016.

In addition, data from more recent bird utilisation surveys at ten other similar sites in south eastern Australia were collated. Since the Lal Lal surveys, wind turbine technology change has accelerated. In anticipation of this, BL&A's more recent bird utilisation surveys (i.e. since the original Lal Lal surveys) have recorded bird height in 10 metre intervals up to 60 metres, then in 20 metre intervals up to 140 metres. Above this height, judging height to this level of precision is challenging. When the original Lal Lal bird utilisation surveys were undertaken, bird fight height was only recorded below, at and above RSA height according to the turbine specifications at the time (i.e. below 40 metres, between 40 and 120 metres and above 120 metres). The purpose of this analysis was to provide more accurate information on the level of bird activity at different heights below 40 metres, so that the impact of any lowering of the minimum RSA height could be assessed.

Although species composition differed slightly among these sites, using flight height data from these sites to understand impacts below 40 metres above the ground was considered valid for use as a quantitative estimate, as 95.4% of birds observed at these sites flew at less than 40 metres above the ground compared with 96% at Lal Lal, a very similar bird flight height distribution.

3. FINDINGS

A summary of BL&A's findings in relation to the impacts on birds and bats of the largest possible turbine design compared with the turbine design originally assessed by BLA is provided below. The detailed calculations on which this comparison is based are presented in Appendix 3 to this statement. The findings are summarised for birds and bats separately below.

3.1. Birds

- Birds most exposed to collision risk from turbines at Lal Lal Wind Farm are native and introduced species adapted to agricultural landscapes that are abundant and widespread in south eastern Australia, with no species listed on the FFG Act or EPBC Act as rare or threatened are considered to be at risk.
- The greatest change in area of RSA arises from the increase in area of the RSA above 40 metres, a zone where only four to five percent of birds are active. The contribution of this aspect of the largest possible turbine design to the increase in impact are therefore negligible for most birds;
- The lowering by twenty metres of the RSA to 20 metres above the ground will affect birds flying in the zone between 20 and 40 metres above the ground that was previously unaffected by the originally assessed wind turbine. In total, birds in this height zone represent an average across ten sites of 33 percent of all birds recorded during bird utilisation surveys. This represents the greatest difference in potential bird impact between the permitted and largest possible turbine design. Figure 1 in Appendix 3 shows this zone.
- The consequence of the largest possible turbine design was calculated by assuming that bird flights through the RSA in both the original and current assessments were perpendicular to the RSA (i.e. to the plane in which the turbine blades rotate). This comparative analysis found an increase in the maximum possible number of birds flying through the RSA of just over four times (4.08 – see Appendix 3). The main reason for this is the drop in RSA height to 20 metres instead of 40 metres above the ground, a zone of greater bird activity. As explained in Appendix 3, assuming bird flights are perpendicular to the RSA means that this estimate is conservative and worst case, and represents a highly unlikely maximum possible proportional increase in turbine impact from collision.
- Given the species of birds involved (common native and introduced species not listed as rare or threatened), the impacts of the modified turbine design on birds were not considered to be of conservation concern. This is because the species most affected are abundant, widespread and not threatened so population-scale consequences from the difference in turbine design are negligible.

3.2. Bats

- As ultrasonic bat detectors only record the number of bat calls, not the number of individual bats, it is possible to identify those bat species utilising the wind farm, but it is not possible to record absolute number of bats in the same way as for birds.

- The bat surveys in 2007/2008 used ultrasonic bat detectors deployed at ground level at Lal Lal Wind Farm. Recording of bat activity above 25 metres above ground level was not undertaken at Lal Lal, thus impacts of the change in turbine design were assessed based on pooled bat detector data from recording heights of 25 and 50 metres above the ground from other sites in similar settings in south eastern Australia (BL&A unpubl. records). As bat detectors generally do not record bat calls beyond about 25 metres and for some species less, a 25 metre height separation can be assumed to be sampling different height zones.
- These data show that at 50 metres above the ground bat call numbers are about 15% of the number recorded from ground level. At 25 m above the ground numbers are about 25% of the number recorded from ground level. The proposed change in turbine height and cross-sectional area occurs in the recording zone sampled at 25 metres and above. Therefore, the increased potential collision risk for bats occurs in the zone where 28% of bat activity occurs, indicating that a minority of bat flights would still pass through the revised RSA. The difference between the permitted and largest possible turbine design drops turbine blades into a zone of higher bat activity, representing an additional 17% of bat activity occurring at RSA height.
- The same pooled bat data (BL&A, unpubl. data) indicate that species diversity at 50 metres is lower, with recorded bats dominated by higher-flying species such as White-striped Freetail Bat and Gould's Wattled Bat.
- Given the species of bats involved (common, widespread species in agricultural landscapes in south eastern Australia and no species listed under FFG Act or EPBC Act as rare or threatened) and the small additional proportion of bat activity exposed in the larger RSA, the added impacts of the largest possible turbine design are unlikely to lead to effects on bat populations of conservation concern.

3.3. Conclusion

In conclusion, the largest possible turbine design will not have a significant additional impact on birds or bats of conservation concern under applicable threatened species legislation or policies including under FFG Act or EPBC Act.

BL&A also notes that there is no changes proposed to Conditions 17,18 and 19 in relation to the Bird and Bat Management Plan. We consider that the current conditions are adequate.

3.4. Collision risk

Biosis (2016) has undertaken a collision risk assessment of the permitted turbine design and a larger turbine design. The turbine dimensions were different from the dimensions considered in this statement. As mentioned previously, BLA compared the amendment application to the turbine specifications in its original assessment which is lower than the specification actually approved in the Pemrit. A copy of this assessment is provided as Appendix 4 to this statement.

The Biosis report concludes that approximately twice the number of birds would collide with the larger turbine compared with the smaller turbine. The difference in collision rates for the two turbines compared in the Biosis analysis is lower than the difference in the number of bird flights through the RSA in the BLA analysis. The BLA's analysis is therefore a maximum possible number of additional bird flights through the RSA (i.e. absolute worst-case scenario). The likely reasons for this difference are summarised below.

- The smaller turbine design used by Biosis had a lower RSA height than the original design assessed by BLA (i.e. 34 metres versus 40 metres), therefore encompassing a greater number of bird flights (more of which occur at lower heights) than the original design would have, even allowing for the different flight height distribution used (see below).
- Both turbine designs used relate to specific turbine models whereas this assessment relates to two different turbine envelopes, representing the smallest and largest possible turbines.
- The height distribution of bird flights adopted by Biosis is very different from that used in the current comparison. Notably, at 160 metres, Biosis has assumed that bird flight numbers would be 0.2 (ie. one fifth) of the rate a metre above the ground. The data assembled for the current analysis from 10 inland wind farm sites in agricultural settings (pasture and cropland) in mainland south-eastern Australia (Victoria and southern New South Wales) are considered more comparable with the Lal Lal project sites that the coastal and Tasmanian sites considered by Biosis. The assembled BLA data show that the combined rate of bird flights above 40 metres from the ground is around 0.05 (or one twentieth) of the rate below this height, a much steeper drop off in bird activity with height than that used by Biosis. This means that the current analysis is based on a much higher percentage of birds flying through the RSA between 20 and 40 metres above the ground (i.e. 33 percent) than is the case in the Biosis analysis.
- The Biosis collision risk model assumes birds approach turbines from all directions and that the potential for collision will therefore vary from highest when flight direction is perpendicular to the turbine RSA plane to lowest when it is parallel with the turbine RSA plane. In the current BLA analysis, all flights were assumed to be perpendicular to the turbine RSA plane, which results in an artificially high proportional estimate of collision rate (see Appendix 3).

This does not change the fact that for both comparisons, the increase in impact affects species that are not of concern. Notwithstanding the differences in approach between the BLA and Biosis analyses, we have both concluded that the proposed revised turbine design will not result in an increase in impacts of conservation concern.

4. REVIEW OF SUBMISSIONS

Of the 221 initial submissions and 27 submissions received in the second round by the state Minister for Planning, 39 raised concerns about flora and fauna impacts of the proposed revised turbine specifications and layout. Table 4 summarises the issues raised by each of these 35 submissions and provides a consolidated response to the issues raised.

Table 2: Response to submissions

Issue raised	Submission numbers	Response
Increase in rotor swept area (RSA) will lead to increased numbers of birds and bats (wildlife) colliding with turbines	4, 15, 38, 96, 97, 98, 104, 107, 108, 111, 113, 180, 184, 193, 195, 196, 201, 202, 204, 206, 209, 210, 219; 12B, 17B, 30B	The original impact assessment for the Lal Lal Wind Farm identified common, widespread bird species as dominating the avifauna of the area where wind turbines were proposed. There are no indications that the landscape has changed since the work done at the site (confirmed by site visit) to indicate that the mix and abundance of birds would be any different. Furthermore, the layout of the wind farm is to remain the same with the exception of the removal of four turbines. The conclusion that the site is not home to any regular or significant numbers of any threatened bird or bat species still holds. The increase in RSA from the original 5,027 m^2 up to 15,616 m^2 will increase the airspace occupied by the turbine blades. The additional analysis in this witness statement showed that most of the increase in RSA occurs above 40 metres, where bird activity is comparatively low (i.e. about four to five percent of observed birds were above this height). Given this, it has been estimated that approximately four times more bird flights will be exposed to collision risk by the proposed amended design compared with the original design. This increased potential for collision is not considered of conservation concern as it affects common, widespread bird and bat species adapted to agricultural landscapes. The proposed change will not change the impacts of the project on threatened bird and bat species as none occurs in the area consistently or in significant numbers.
Increase in rotor swept area will increase impacts on the local Wedge-tailed Eagle population.	4, 15, 32, 38, 40, 45, 68, 86, 95, 97, 98, 103, 104,	The extent of impact on the Wedge-tailed Eagle from the larger RSA will increase collision risk to the Wedge-tailed Eagle. Results from the Lal Lal Wind Farm bird utilisation surveys indicated that this species was observed on five occasions, four times at RSA height. This means that the increase in RSA will occur predominantly within the usual flight height of the Wedge-tailed Eagle, therefore affecting it disproportionately compared to other birds.

Issue raised	Submission numbers	Response
	107, 108, 111, 113, 180, 184, 193, 195, 196, 199, 200, 201, 202, 204, 206, 209, 210, 219, 10B, 12B, 23B, 30B	It is of interest that the utilisation rate of the Wedge-tailed Eagle during the bird utilisation surveys for the project was very low, with it being seen on only five occasions during a total of 10 days of formal counts. This equates to a utilisation rate of 0.008 bird per hectare per hour. This is at the lower end of the range for wind farm sites in south eastern Australia, where BL&A have recorded utilisation rates of up to 0.4 birds per hectare per hour but more usually less than 0.1 birds per hectare per hour. The Wedge-tailed Eagle is a common and widespread raptor. Like all raptors, as a predator, it occurs in the landscape in comparatively low densities. The Australian population has been estimated as 10,000 adults and an equivalent number of non-breeding birds[1]. The impacts of collisions on this species' population are unlikely to lead to significant declines in the species' regional or wider population. Some disruption to local breeding pairs is likely but they do not appear to utilise the wind farm site consistently or in numbers. It is noteworthy that BL&A records from 10 wind farms where monitoring for bird carcasses has been undertaken consistently (unpubl. data) indicate that most eagles affected are juveniles and sub-adults. Adult eagles appear less affected. Given that maintaining adult breeding eagle numbers is the priority for maintaining the species' population (i.e. mortality of adults disproportionately affects population trends), population impacts from wind farms are unlikely to be of conservation concern. In conclusion, the Wedge-tailed Eagle will not be significantly affected by the project apart from occasional loss of adult breeding birds from local pairs. This is unlikely to have regional or wider consequences for the species' population

[1] Olsen, P (2005) 'The Wedge-tailed Eagle.' CSIRO Publishing, Melbourne.

Issue raised	Submission numbers	Response
Increase in rotor swept area will lead to increased indirect impacts on local wildlife	20, 38, 95, 104, 108, 111, 113, 196	The wildlife of the wind farm site is dominated by species that are adapted to highly modified, agricultural landscapes. Little research has been done on the impacts of disturbance from wind turbines on these species. As they are not species of conservation concern, impacts are not considered to be significant at a population scale
Out-of-date ecological assessment	38, 104	The ecological assessment for the Lal Lal Wind Farm was undertaken in 2006 and 2007, about 10 years ago. Notwithstanding this, it is still considered a valid basis for assessing the impacts of the wind farm on biodiversity as there have been no significant changes in land use or site characteristics that could alter the mix of habitats and, therefore, species affected as confirmed by discussions with Westwind staff and a site visit in 2016. As the wind farm layout will not change, with the exception of the removal of four turbines and associated tracks and power cables, impacts on biodiversity are considered to be of a similar scope and scale. The implications of the larger wind turbines and their RSA are discussed in more detail at the beginning of this review.
Inaccurate records of species	38, 104, 12B	The assessment of ecological impacts does not include any inaccuracies. The surveys and assessments were undertaken by qualified and experienced ecologists. If a species was not seen on the wind farm site during the surveys it is unlikely that it occurs in numbers sufficient to be significantly affected. Observations by others elsewhere may include species that were not recorded or considered likely to occur on the wind farm site but these are not considered to occur consistently on the wind farm site in a way that would put them at regular risk of being affected.
Presence of wildlife species from the Narmbool Conservation Property at the wind farms site	38	The Narmbool property is described in submission 38 as having high conservation values. A range of species is reported to have occurred there, including some threatened species. The ecological assessment of the Lal Lal wind farm site indicated that it did not support high conservation values so it was unlikely that the same species would occur there. It is noteworthy that it included

Issue raised	Submission numbers	Response
		targeted surveys for the Powerful and Barking Owl. None of the species mentioned as occurring on Narmbool were seen during site investigations and habitat suitable for them was either absent or of such limited extent it did not support the species of concern (e.g. owls). The assessment therefore appropriately concluded that significant impacts on species of conservation concern were highly unlikely.
Impacts on flying wildlife have not been minimised	38	There are no significant impacts on flying wildlife that require mitigation. The results of the ecological assessment indicated that there were unlikely to be impacts on wildlife of conservation concern that required specific mitigation.
Impacts on Fat-tailed Dunnart and Growling Grass Frog have not been considered	38	Larger farm dams on the wind farm site and some waterways may provide habitat for dispersing Growing Grass Frogs, although here are no confirmed records on the wind farm site. Provided wind turbines and associated infrastructure are separated from these potential habitats by buffers of at least 30 metres, significant impacts are not considered likely. The site supports some areas of remnant native vegetation. Most of this is treed and unlikely to support a significant population of the Fat-tailed Dunnart. The wind farm layout has been carefully designed to avoid impacts on native vegetation on the site so impacts on indigenous terrestrial habitats on the site and their associated biodiversity have been avoided.
Impacts on the wildlife corridor function of the Narmbool Conservation Property	38	The wind farm will be confined to the participating properties and no element will be located on the Narmbool Conservation Property. Therefore, the current conservation values of this property, including its purported wildlife corridor function, will not be affected by the Lal Lal Wind Farm.
DELWP letter 17 October 2016		Note the agreement by DELWP that the proposed amendment will not have a significant impact on Wedge-tailed Eagle populations. It is noted on page 2, first paragraph that the figure should read "four times ***the number*** **of flights"**

Issue raised	Submission numbers	Response
		(due to a change in both RSA area and a lower RSA minimum height) has been predicted…. In relation to the cumulative barrier effect the increase in rotor size will not result in any additional be partially offset by the reduction in number of turbines to be installed at Lal Lal Wind Farm.

5. DECLARATION

I have made all the inquiries that I believe are desirable and appropriate and no matters of significance which I regard as relevant have to my knowledge been withheld from the Panel.

Signed:

Brett Alexander Lane
Director
Brett Lane & Associates Pty Ltd
Suite 5, 161-163 Camberwell Road,
Hawthorn East, Vic. 3123

28th October 2016

Appendix 1: Qualifications and experience of Brett Lane

Brett Lane & Associates Pty. Ltd.
Ecological Research & Management

Brett Lane
Principal Consultant and Director

Profile

Brett has over 35 years' experience in ecological research and management. He has worked in a range of positions with environmental consultancies in Melbourne and Brisbane and with non-government environmental groups in Australia and East Asia. He has specialist knowledge in birds and wetlands, and extensive experience in ecological impact assessment, including in the infrastructure, renewable energy, property development and mining industries. Brett has undertaken and managed many hundreds of ecological assessments and prepared and reviewed documents that have accompanied development applications on behalf of private companies, government infrastructure agencies and private individuals. His extensive experience has given him an excellent knowledge of the regulatory environment relevant to native vegetation, flora and fauna and he can advise on the scope of scientific information needed to inform the development assessment and decision-making process. He has also defended his scientific work as an expert witness in courts and tribunals. Brett founded BL&A in 2001.

Biography

Working in industry since 1979

Qualifications

BA (Zoology & Physical Geography) *Monash University*

Certificates and Licenses

Management Authorisation – Salvage and Translocation

Victorian Animal Ethics Approval

Employment History

2001 – present
Director, *Brett Lane & Associates Pty Ltd, Melbourne*

1999 – 2000
Natural Resource Specialist, *PPK Environment & Infrastructure Pty Ltd, Melbourne*

1996 – 1998
Senior Ecologist, Ecology Australia Pty Ltd, *Melbourne*

1993 – 1996
Principal Terrestrial Ecologist, *WBM Oceanics Australia, Brisbane*

1991 – 1993
Assistant Director (East Asia), *Asian Wetland Bureau, Kuala Lumpur, Malaysia*

1987 – 1991
Director, *Brett A Lane Pty Ltd (Melbourne)*

1980 – 1986
Wader Studies Co-ordinator*, Royal Australasian Ornithologists' Union (now Birdlife Australia, Melbourne*

1979
Research Assistant, Kinhill Planners Pty Ltd., Melbourne

Key Skills

- Experienced advisor on state and federal biodiversity legislation and policy
- EPBC Act and EES Referrals
- Preparation of environmental assessment reports (preliminary documentation, public environmental report and environmental impact statement)
- Preparation of native vegetation planning permit applications
- Design of developments to comply with biodiversity legislation and policies
- Expert witness for VCAT, planning panels and courts
- Ecological risk assessment
- Native vegetation assessment
- Terrestrial fauna assessment and wetland ecology
- Ornithologist specialising in wetland and migratory shorebirds
- Wind energy development specialist and minimizing impacts on wildlife including collision risk modelling

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Project Examples

Property Development

Eynesbury Township, Eynesbury, Victoria: Flora, Fauna and Habitat Hectare Assessment, Targeted Flora Surveys, Growling Grass Frog Survey, Plains-wanderer Survey and Development of an Offset Tracking Tool. Net Gain Analysis for Planning Permit Applications of subsequent stages and advice on offset management (2003 – present)

Taylors Rd, Sydenham, Victoria (Broadcast Australia): EPBC Act Referral, preparation of EPBC Act Public Environment Report (PER), Offset Site Search and Offset Management Plan, Spiny Rice-flower Propagation and Translocation Plans, Seed Collection (2006 – present)

Somerfield Estate, Keysborough, Victoria: Flora, Fauna and Growling Grass Frog Survey and Offset Plan Preparation, preparation of offset tracking reports for each stage of development (2008 – present)

Modena Estate, Burnside, Victoria: Flora and Fauna Assessment, targeted threatened species surveys, EPBC Act referrals and assessment approvals, development of offset and mitigation plans (2002 – present)

Renewable Energy

Dundonnell Wind Farm, Dundonnell, Victoria: Overview and Targeted Assessments including Brolga, bat, migratory bird, Striped Legless Lizard, Flora Surveys, assessment of powerline route and road access options, EPBC Act Referral, Input to EES Referral, preparation of EES technical appendix on flora and fauna, Brolga impact assessment, collision risk modelling (2009 – present)

Granville Wind Farm, Granville Harbour, Tasmania: Overview Assessment, targeted surveys including Orange-bellied Parrot and bat surveys, EPBC Act Referral and advice for regulator negotiations (2011 – present)

MacArthur Wind Farm, MacArthur, Victoria: Overview assessment, detailed flora and fauna surveys, impact assessment, input to EPBC Act Referral and state EES, assessment of powerline and road rout options, appearance at state Planning Panel hearings as expert witness, preparation of pre-construction and operational flora and fauna management plans, net gain analysis and identification of suitable offsets (2004 – 2012)

Cherry Tree Wind Farm, Victoria: Overview assessment, native vegetation and threatened flora surveys, targeted threatened fauna surveys, assessment of powerline and road route options, offset site sourcing and assessment, preparation of expert witness statement and appearance at VCAT (2010 - 2015)

Mt Gellibrand Wind Farm, Mt Gellibrand, Victoria: Overview assessment, detailed flora and fauna surveys, including targeted Brolga and migratory bird surveys, and Striped Legless Lizard tile grid surveys, input to state planning permit application, preparation of witness statement and appearance at state Planning Panel hearing, preparation and early implementation of pre-construction flora and fauna management plans, including bat and avifauna management plan, native vegetation mapping, offset mapping, development of Brolga monitoring and mitigation strategies (2004 – present).

Road and Rail Infrastructure

Avalon Airport Rail Link, Little River, Victoria: Flora and Fauna Mapping, Constraint Analysis and Net Gain Analysis (2011 – 2013)

Dingley Bypass, Keysborough, Victoria: Flora and Fauna Assessment, including targeted flora surveys, habitat hectare assessment and Net Gain analysis, expert witness at VCAT case (approved) (2008 – 2014)

Nagambie bypass, Nagambie Victoria: Flora and Fauna Assessment, including habitat hectare assessment and Net Gain analysis (2008)

Second Murray River Bridge Crossing at Echuca-Moama: Detailed Flora Assessment, Targeted Flora Survey (2008 – present)

Ecosystem Monitoring and Management

Scientific Review Panel, Kerang Lakes Bypass project (North Central Catchment Management Authority, Goulburn Murray Water): Scientific review of detailed technical reports to inform decisions of water savings plans and associated watering plans for five wetlands that form part of the Ramsar-listed Kerang Lakes wetlands system. (2013)

Northern Victoria Irrigation Renewal Program (NVIRP): Assessed the impact of a major federal water industry investment project on Matters of National Environmental Significance, including threatened flora, threatened fauna and listed migratory birds using wetlands located in the potential impact area. (2009-2011)

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Appendix 2: Qualifications and experience of Khalid Al-Dabbagh and Bernard O'Callaghan

Brett Lane & Associates Pty. Ltd.
Ecological Research & Management

Dr. Khalid Al Dabbagh

Senior Zoologist

Profile

Khalid has over 35 years' experience in Zoology, specialising in ornithology and animal ecology. Khalid has extensive experience in identifying fauna species and their habitat as well as undertaking impacts assessments for a wide range of other projects types. Khalid is particularly experienced in assessing development impacts on birds and bats. He has helped to prepare environmental management plans and mitigation recommendations for numerous projects. Khalid has worked on over 50 wind farm projects, undertaking bird utilisation studies, bat surveys and bird and bat mortality estimates.

Biography

Working in industry since 1980

Qualifications

PhD (Animal Population Ecology), *University of Leicester, England*
MSc (Ornithology), *University of Baghdad*
BSc (Biology), *University of Baghdad*

Certificates and Licenses

Management Authorisation – Salvage and Translocation
Construction Induction 'White Card'

Employment History

2002 – Present
Zoologist & Ecologist, *BL&A, Melbourne*.
1994– 2002
Section Editor, *Handbook of Australian, New Zealand and Antarctic Birds*, *Birds Australia, Melbourne*
1993 – 1994
Research assistant, *Arthur Rylah Institute for Environmental Research, Heidelberg, Victoria*
1980 – 1992
Senior lecturer, *University of Baghdad, Iraq*.
1983 – 1989
Senior research Scientist, Iraqi Biological Research Centre
1976 – 1983
Lecturer, University of Basrah, Iraq

Key Skills

- Ornithologist
- Implementation of bird and bat management plans at wind farms
- Mortality assessment at wind farms
- Terrestrial Fauna Assessments
- Targeted surveys for listed flora and fauna species
- Bird and Bat Utilisation Surveys
- Scoping assessments
- Management plan preparation for listed fauna values and offset sites
- Striped Legless Lizard salvage protocol implementation
- Project design recommendation
- EPBC Act and EES Referrals
- Offset site selection

Project Examples

Property Development

Manor Lakes, Wyndham Vale, Victoria: Flora and fauna assessment and targeted fauna surveys (2010–2011).

Eynesbury, Victoria*:* Flora and fauna assessment and targeted fauna surveys (2008, 2011).

Somerfield Estate, Keysborough, Victoria: Flora, Fauna and Growling Grass Frog surveys (2008 – 2009)

Renewable Energy

Wonthaggi Wind Farm, Vic. 2005–2007, bird and bat utilization studies; mortality studies.

Bald Hills Wind Farm 2004–2011, Bird and bat utilization surveys; Bird, Bat and Animal Pest Management Plans.

Stockyard Hill Wind farm 2008; bird and bat utilisation survey; Brolga Surveys.

Lal Lal Wind Farm, Vic. 2006-2007; bird and bat utilisation survey; Powerful and Barking Owls Surveys.

Ryan Corner Wind Farm, 2006-2007; bird and bat utilisation survey; Brolga and Southern Bentwing Bat Surveys.

Dundonnell Wind Farm, 2009; bird and bat utilisation survey; Brolga Surveys.

Ararat Wind Farm, 2008, 2012; bird and bat utilisation survey; Bird, Bat and Animal Pest Management Plans.

Rugby Wind Farm 2011; bird and bat utilization survey.

Taralga Wind Farm 2012; bird and bat utilization survey.

Woodlawn Wind Farm , NSW (20011–2012), Bird utilisation surveys; mortality studies.

Capital Wind Farm, NSW, (2010–2011), Bird utilisation surveys; mortality studies.

Granville Wind Farm, Tasmania 2012 – 2013, bat and threatened species surveys.

Road and Rail Infrastructure

Second Murray River Crossing at Echuca – Moama –Flora, fauna and native vegetation assessment, Threatened flora and fauna surveys and Bat survey (2011–2012).

Dingley Bypass: Flora and fauna assessment and targeted fauna surveys (2010–2011).

Avalon Airport Rail Link: Flora and fauna assessment and targeted fauna surveys (2011–2012).

Ecosystem Monitoring and Management

Warrambeen Monitoring, Victoria: Ecological Monitoring of threatened fauna species (2010).

BL&A Brett Lane & Associates Pty. Ltd.
Ecological Research & Management

Bernard O'Callaghan

Senior Ecologist and Project Manager

Profile

Bernard O'Callaghan has significant expertise in environment, biodiversity, and coastal management and development with the private sector, development agencies and environmental organisations in Australia and over 25 Asia-Pacific countries. Bernard has extensive experience in the design and implementation of environmental management plans to manage the impacts of development, conservation and renewable energy projects on threatened flora and fauna. He has prepared and reviewed environmental assessment reports for surveys carried out in Victoria, New South Wales, Vietnam, Fiji, Vanuatu and Tonga. Bernard has been responsible for the project management for large-scale ecological surveys in urbanised and highly remote locations. Since joining BL&A, Bernard has advised on a range of wind farm and housing developments and has provided strong technical and regulatory QA for these and other development impact assessments for the company.

Biography

Qualifications

Master of Environmental Management, University of New England

Bachelor of Science, Melbourne University

Employment History

2015 – present
Senior Ecologist and Project Manager, *BL&A, Melbourne, Australia*

2013-2015
Independent international consultant Asia– Pacific, Vanuatu

2008 - 2013
Regional Program Coordinator, IUCN Regional Program, Suva, Fiji

2007 – 2008
Regional Program Coordinator, IUCN Vietnam Country Program, Vietnam

2001 – 2005
Chief Technical Advisor, *Vietnam, World Bank—IUCN*

1993-2001
International environmental management assignments, including IUCN, Wetlands International, Asian Development Bank and Mekong River Commission

Key Skills

- Project Manager including programming, staffing, client liaison, production of high quality technical reports
- Bat and avifauna management plans for wind farms preparation and implementation
- Biodiversity and Climate Change policy advice
- Protected Area Management Planning processes
- Flora and Fauna Assessments
- Targeted surveys for listed flora and fauna species
- Constraints analysis
- Scoping assessment
- Management plan preparation for listed fauna and flora values and offset sites
- Salvage protocol preparation and implementation
- Project design recommendation
- EPBC Act and EES Referrals
- Offset site selection
- Preparation of assessment reports (preliminary documentation, public environmental report and environmental impact statement)

Project Examples

Property Development

St. Andrews Golf Course, Fingal, Vegetation assessment and bushfire assessment

O'Herns Road, Epping 2015, native vegetation assessment

Maroondah Hwy, Lilydale, Biodiversity Assessment Guidelines

Renewable Energy

Mt Gellibrand Wind Farm, Mt Gellibrand, Victoria: Rotor Swept Area proposed modification assessment (2015).

Coonooer Wind Farm, Coonooer Bridge, Victoria: Bird and Bat Management Plan (2015)

Kiata Wind Farm, The Environment Protection and Biodiversity Conservation Act 1999 referral (2015)

Capital II Wind Farm, New South Wales: Bird and Bat Adaptive Management Program, Bird Utilisation Surveys (2015)

Capital Wind Farm, New South Wales: Implementation of Bird & Bat Management Program – Monthly Mortality Monitoring (2015)

Cullerin Range Wind Farm, New South Wales: Implementation of Bird & Bat Adaptive Management Program – Specialist surveys (2015 –2016)

Taralga Wind Farm, New South Wales: Implementation of Bird and Bat Adaptive Management Plan (2015-)

White Rock Wind Farm. Northern New South Wales: - Pre-construction bat utilisation surveys (2015)

White Rock Wind Farm. Northern New South Wales: - Development of Draft Bird & Bat Adaptive Management Program (2015-2016)

Road and coastal infrastructure

Vanuatu Coastal Adaptation Project, United Nations Development Program (UNDP) - Assessment of coastal infrastructure and the needs for "climate proofing" - 2013-2015.

Pilot Program for Climate Resilience—Asian Development Bank— Initial Environmental Examination coastal road construction and rehabilitation, Kingdom of Tonga (2013)

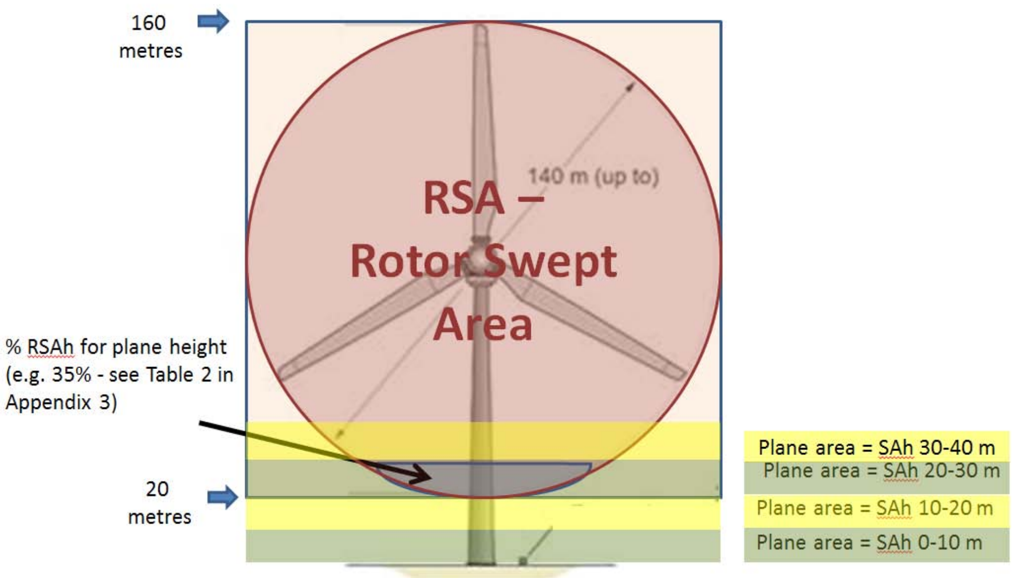
Ecosystem Monitoring and Management

Nha Trang Bay, Vietnam—completion of baseline marine and coastal surveys; development of Plan of Management; Regulation development and enforcement; and Monitoring (2001-2005)

Appendix 3: Analysis of additional potential bird flights at risk for the largest possible turbine design

The tables include the following variables:

- The height range from ground level to >140 metres above the ground that birds were observed flying during bird utilisation surveys;
- The area in square metres of the plane that represents the survey area corresponding to the turbine dimensions (i.e. the RSA diameter times the height in metres) (SA), and in particular the area of that plane at each height zone (SAh);
- The percentage of bird flights observed at each height zone (%H) based on findings from bird utilisation surveys at 10 (pre-development) wind farm sites in south–eastern Australia (BL&A, unpubl. data);
- The number of bird flights that would pass through this plane assuming a total number of flights through the survey plane averaging one per square metre* (SN) and the number of these flights at each height zone (SNh), based on %H (i.e. SNh = %H x SN);
- The area of the RSA plane (RSA) at each of the height zones (RSAh) – see figure below;



- The percentage of the plane that represents the survey area occupied by the RSA plane at each of the height zones (%RSAh) (i.e. %RSAh = RSAh/SAh).
- The number of flights that pass through the RSA plane at each height zone (Nh) (i.e. Nh = %RSAh x SNh); and
- The sum of those flights (N) (i.e. N = sum (Nh for each height zone)).

The ratio of N for the largest possible turbine design option to N for the permitted turbine design was then compared.

*Note that the number of bird flights adopted for this analysis (i.e. one per square metre of RSA) is notional and assumes all flights are perpendicular to the RSA plane. By applying it consistently between the two turbine designs a ratio can be generated that compares the number of bird flights potentially at risk of collision if passing through the RSA. The increased numbers of flights passing through the RSA can therefore be compared between the permitted and largest possible turbine designs.

The number of flights that pass through the RSA is not the number affected by collision as only a small proportion of the air space is occupied by the turbine blades and other turbine parts. A comparison of collision risk has been undertaken by Biosis (2016). This report is attached to this statement (see Appendix 4) and commented upon in the body of this witness statement.

Table 1 below presents the results of the analysis for the original turbine design. Table 2 presents the same analysis for the largest possible turbine design.

Table 1: Analysis of impact on birds of original turbine design

H	%H	SAh	Nh	RSAh	%RSAh	Nh
Ht range (m)	% flights	Area at Ht (sq. m)	No. flights	Area of 80 m diam. Turbine (sq. m)	% area at RSA	No. flights
0-10	0.18	800	2318			
10-20	0.23	800	2962			
20-30	0.20	800	2576			
30-40	0.13	800	1674			
40-50	0.14	800	1803	363	0.45	817
50-60	0.06	800	772	620	0.77	599
60-80	0.04	1600	515	1,531	0.96	493
80-100	0.01	1600	128	1,531	0.96	123
100-120	0.00	1600	0	983	0.61	0.00
120-140	0.01	1600	128		0.000	0.00
>140	0.00	1680	0.000			
Total	SA =12,880		RSA = 5,027		N = **2,032**	

Table 2: Analysis of impact on birds of amended turbine design

H	%H	SAh	Nh	RSAh	%RSAh	Nh
Ht range (m)	% flights	Area at Ht (sq. m)	No. flights	Area of 80 m diam. Turbine (sq. m)	% area at RSA	No. flights
0-10	0.180	1400	4057			
10-20	0.230	1400	5184			
20-30	0.200	1400	4508	488	0.35	1571
30-40	0.130	1400	2930	861	0.62	1801
40-50	0.140	1400	3155	1,080	0.77	2434
50-60	0.060	1400	1352	1,241	0.89	1198
60-80	0.040	2800	901	2,752	0.99	886
80-100	0.010	2800	225	2,772	0.99	223
100-120	0.000	2800	0	2,752	0.98	0
120-140	0.010	2800	225	2,321	0.83	186
>140	0.000	2940	0	1,349	0.43	0
Total	SA = 22,540		RSA = 15,616		N = **8,302**	

The increase in RSA from the original 5,027 m^2 to 15,616 m^2 will increase the airspace occupied by the turbine blades by more than three times.

The ratio of the modelled number of bird flights passing through the RSA for the amended turbine design to the number passing through in the original design is 8,302/2,032, or 4.08.

Therefore, about four times more bird flights are modelled to pass through the RSA for the proposed turbine design change. The assumption in this modelling that bird flights are perpendicular to the RSA plane is conservative as more flights are likely to approach the RSA plane at an angle, with a lower probability therefore of encountering a turbine blade within this plane. The difference is therefore a maximum possible difference based on a worst case assumption. The difference in bird impact from collision with turbine blades within the RSA plane will probably be lower than this. It is not possible to calculate how much lower without making further assumptions and the empirical basis for these is lacking. Notwithstanding this, this worst-case scenario is still informative for decision-making purposes.

The species affected by this additional impact are abundant, widespread native and introduced species that occur throughout south eastern Australia that are adapted to agricultural landscapes. These additional impacts are not of concern from a conservation perspective as no threatened species will be significantly affected by the change.

Appendix 4: Collision risk modelling report of Biosis

Lal Lal Wind Farm:

Comparative bird collision risk for two models of turbine

Confidential and subject to legal professional privilege

Prepared for WestWind Energy Pty Ltd

18 October 2016

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Biosis project no.:	23150
File name:	23150.LalLal.bird turbine risk asst.FIN01.18102016.docx

Citation: Biosis 2016. Lal Lal Wind Farm – Comparative collision risk assessment for two models of turbine.

Document control

Version	Date issued
Draft version 01	26/09/2016
Final version 01	18/10/2016

Contents

1. Introduction

Biosis Pty Ltd has been engaged by WestWind Energy Pty Ltd to prepare this report for the purpose of comparing the relative collision risks for birds and bats with wind turbines that may be used at Lal Lal Wind Farm in western Victoria.

WestWind Energy Pty Ltd has approval to develop the wind farm under conditions of Planning Permit PL-SP/05/0461 issued under the Moorabool Planning Scheme. This report compares the relative collision risks associated with two different models of wind turbines. The first is a smaller machine that meets conditions of the existing permit and the second is a larger turbine that is the subject of August 2016 amendment to the Planning Permit Amendment 8th October 2015 being sought by WestWind for Lal Lal Wind Farm.

A flora and fauna assessment of the two land parcels comprising the sites of the Lal Lal Wind Farm is provided in Brett Lane & Associates (2008). The data provided there suggests that birds using the sites are mainly species common to similar rural environments of the region and that threatened or otherwise significant species are unlikely to use the site routinely or frequently. The report concluded that there is little likelihood of significant impacts of the wind farm on populations of these fauna. For this reason, turbine collisions at the proposed wind farm are also not considered likely to result in a significant impact on any species. In light of this, the present assessment is not focussed on any particular species but is intended to simply compare the generic collisions risks associated with two different models of turbines.

Brett Lane & Associates (2008) a list of bird species detected at the sites and bird utilisation data collected there. That information has been considered in preparation of the present assessment.

This report refers to birds and uses a 'generic' bird for the purposes of quantifying the relative risks posed by the two models of turbines, however the comparison is applicable to species of bats.

2. Background

2.1 Purpose & approach of this assessment

This work compares potential risk of bird collisions with two models of wind turbines. The turbines differ in size and various other specifications. The first turbine is within the size approved under conditions of an existing Planning Permit issued for Lal Lal Wind Farm. The second turbine is within size dimensions sought in a Planning Amendment submitted for Lal Lal Wind Farm.

The two turbines are:

- Senvion MM92, a turbine with a rotor diameter of 92 metres mounted on a tower with a centre hub height of 80 metres and thus with an uppermost tip height of 126 metres and a lowest tip height of 34 metres.
- Senvion 3.4M140, a turbine with a rotor diameter of 140 metres mounted on a tower with a centre hub height of 90 metres and thus with an uppermost tip height of 160 metres and a lowest tip height of 20 metres.

Other specifics differ between the two turbine models including rotor speed and multiple dimensions of the tower, nacelle and blades.

This assessment is *not* intended to provide predictions of potential bird mortalities due to turbine collisions at Lal Lal Wind Farm. Rather it is a hypothetical exercise with the sole purpose of ascertaining the relative risks posed by the two turbine models.

The assessment has done this by using the Biosis Deterministic Collision Risk Model which provides a quantitative evaluation of risk. The model is described in detail in a peer-reviewed paper (Smales et al. 2013) that is provided as Appendix 1 to this report. The salient aspects of the model related to the present comparative assessment are set out in Section 3 below.

Fully quantified risk models take account of numerous specific dimensions and rotor speed of particular turbines and can evaluate these for the purposes of comparing the risks they represent. For example, whilst one model of turbine may have a rotor-swept area that is very much larger than another, that measure of itself is not directly correlated with risk. This is because the rotor-swept zone includes not only the blades but also large areas of vacant air space. Collisions will be more closely related to the size and speed of the blades than with the simple rotor-swept area.

The primary reason that this assessment considers relative risks, rather than absolute risks of the two turbine models, is as follows. Collision risk modelling for birds at a particular site requires a representative sample of data for frequency and heights of flights by birds of interest ('bird utilization' data) collected from the site. These data are used along with specific values for the turbines as inputs to a collision risk model.

In the case of Lal Lal Wind Farm, bird utilization data was collected from the two sites in 2008 (Brett Lane & Associates 2008; 2015). However, that data assigns all bird flight records to pooled height classes (0-39 m; 40-59 m; 60-79 m; 80-99 m; 100-119 m; >120 m). Accordingly, it does not allow for evaluation of turbines with different dimensions and specifications as is required for collision risk modelling used to make the present comparison.

The approach taken here is designed to determine the relative risks posed by the two turbine models. This was undertaken using a hypothetical set of bird utilization data that hold all values as constant other than those of the turbines themselves. It thus provides results, expressed as a number of flights-at-risk per turbine per annum that are directly comparable between the turbines.

While parameter values used in the modelling exercise, such as those for the bird and its flights, are generic, they were chosen to conform with values for real bird utilization data from the Lal Lal sites and similar environments of western Victoria.

2.2 Background to quantitative risk modelling

Collisions of birds and bats with wind turbines have been documented to occur at variable frequencies at numerous sites around the world. Quantitative modelling to estimate the number of collision mortalities of threatened taxa is widely used as part of environmental impact assessments for proposed wind energy facilities (Huppop *et al.* 2006, Masden & Cook 2016, Smales in press).

Mathematical modelling of risk is intended to provide an articulated, transparent and replicable evaluation of what may occur in the real world. The rationale is explicitly stated in the mathematics of the model, which means that the logical consistency of the results can be easily evaluated. Although it is necessary to include some assumptions and choices when deciding on the structure and parameters of a model, these choices are explicit.

The only alternative to a quantitative modelling approach is one of qualitative subjective judgement. The benefits of using mathematical modelling outlined above are difficult to achieve with a subjective assessment.

The Biosis turbine collision risk model is the only model of its kind developed in Australia and has been used to provide quantitative evaluation of risks to birds since 2004.

3. Assumptions & parameters used for this assessment

A published description of the Biosis collision risk model is provided as Appendix 1 to this report. Parameter values and assumptions used to run the model for the purpose of the present comparison are set out in this section.

3.1 Turbines

A turbine is considered to present an obstacle of given dimensions in the flightpath of a bird on course to intersect with it. In the collision risk model the turbine is decomposed into its static and dynamic components. The entire turbine (including the tower, nacelle and rotor) represents the static component. The dynamic component is the volume swept by the rotor blades in the time it takes a bird to pass across the depth of the rotor-swept disk.

Multiple specifications of the turbine, including dimensions of component parts and rotor speed, are used as inputs to the model to calculate the size of the obstacle that the turbine represents to a bird of a given size and flight speed. Specifications of the two turbines under consideration here are set out in Table 1.

Table 1 Turbine specifications used as Input values to Biosis collision risk model

Turbine	Senvion MM92	Senvion 3.4M140
Start up wind speed (m/s)	3.0	3.0
Shut down wind speed (m/s)	24.0	22.0
Tower height (m)	80	90
Tower diameter (bottom) (m)	4.3	5.1
Tower diameter (top) (m)	2.955	3.4
Nacelle maximum height (m)	3.864	4.91
Nacelle maximum width (m)	4.466	5.1
Nacelle maximum length (m)	10.28	13.4
Hub height above ground at rotor centerline (m)	80	90
Rotor swept diameter (m)	92.5	140
Rotational speed (rpm) (median if variable)	11.4	7.4
Number of blades	3	3

Turbine	Senvion MM92	Senvion 3.4M140
Blade length (m)	45.2	68.5
Blade chord (widest point) (m)	3.64	4.257
Blade chord (tip) (m)	0.3	0.38
Blade thickness (widest point) (m)	2.16	3.117
Blade thickness (tip) (m)	0.15	0.25
Blade angle of attack (deg)	5	5

The turbine specifications are used to calculate the mean area (m^2 per turbine), of tower nacelle and rotor blades of a wind generator that present a risk to birds. The mean presented area of the static turbine is between a maximum (where the direction of the bird is perpendicular to the plane of the rotor sweep) and a minimum (where the direction of the bird is parallel to the plane of the rotor sweep). The mean presented area was determined from the turbine specifications supplied for the two models of Senvion turbines. For each of them it represents the average area presented to an incoming flight from any direction.

The dynamic area (m^2 per turbine) presented by the movement of rotors during the flight of a bird presents additional risk. It is calculated from the dimensions and speed of the rotor blades and the flight speed and body length of the species of bird. It is incorporated into the mean presented area specific to the particular species of bird. In the present comparison the values for the bird are held constant but the speed of the rotors differs between the two turbines. The Senvion MM92 turbine has a variable speed range of between 7.8 and 15.0 rpm (median speed of 11.4 rpm). The Senvion 3.4M140 has a variable speed range of between 5.2 and 9.6 rpm (median speed of 7.4 rpm). The median rotor speed of each turbine was used in the collision risk model.

The turbine tower below rotor swept height poses minimal collision risk to most species, while the moving rotor blades are considered to pose a greater risk. The model takes this into account by dividing flights into those below rotor height, and those within the height zone swept by rotors and allocating different risk rates to these two height classes. The two height zones for each of the two turbines are set out in Table 2.

Table 2 Essential height zones of the two turbines

Turbine	Height zone below rotor	Height zone swept by rotor	Rotor-swept span
Senvion MM92-80HH	0 - 34 metres	34 - 126 metres	92 metres
Senvion 3.4M140-90HH	0 - 20 metres	20 – 160 metres	140 metres

The allocation of different risk factors to the static and dynamic parts of a turbine is achieved in the model by assigning different avoidance rates to them (see explanation of avoidance rates in 3.2, below).

The question for the present assessment relates to the collision risk rate per turbine. Hence the number of turbines proposed to be used at Lal Lal Wind Farm is not a factor included for the purposes of the comparison.

3.2 Bird flights

For the purposes of the comparative exercise, a set of parameters for bird flights have been selected that are constant for the two turbine models. As no particular species has been suggested to be at particular risk at the Lal Lal sites, parameter values have been chosen to represent a generic, medium sized bird with flight characteristics that are within the range documented from wind farm sites in south-eastern Australia. These are drawn from experience of Biosis and others in intensive collection of bird utilization data at multiple wind farms over the past 15 years. These include monitoring of sites prior to wind farm development and during their operation, such as during 18 seasons over 6 years at Musselroe Wind Farm, and similar monitoring at numerous others including Bluff Point, Studland Bay, Yaloak, Dundas, Murra-Warra, Penshurst, and Mortons Lane wind farm sites. The bird utilization data for the Lal Lal Wind Farm sites (Brett Lane & Associates 2008) indicate that they are similar to comparable rural locations in western Victoria.

No particular species is considered to be of concern at Lal Lal Wind Farm (Brett Lane & Associates 2008), so for the current exercise a generic bird has been used that is similar to some species that occur in agricultural environments of western Victoria. For bird flights in the comparative modelling the bird is 60 centimetres long and has a mean flight speed of 45 km/h.

Our data indicates that, for many species of birds that fly within the height zones of modern wind turbines, the frequency of their flights diminishes with increased height. On the basis of empirical data, an assumption has been used in which the number of flights diminishes with height on a scale graduated at 1-metre intervals, such that the frequency of flights at 160 metres above the ground is 0.2 of the rate within the first metre of the ground. This graduated scale was held constant and used for both turbines. It is based on empirical data from rural locations in western Victoria.

The model requires an input defining the number of flights for a measured unit of space. A standard real point count for birds uses a consistent radius from an observer and for the purposes of the present modelling a radius of 200 metres was used. This provides flight frequency rates for an area of approximately 12.6 hectares.

Collision risk is measured as a rate per annum, so the numbers of flights input to the model are those for one year in which the bird in question is diurnal and flies during daylight hours only.

Table 3 sets out the number of flights per annum for the height specifics of the two turbines using the graduated scale of flight frequency for the height increments and the defined rate of flights for the defined area.

Table 3 Number of flights per annum in the zones below -, and within- rotor swept height for the two turbines, as determined for the defined scale of flight frequencies.

Turbine	Flights below rotor height	Flights within rotor height
Senvion MM92-80HH	237 (0 - 34 metres)	438 (35 - 126 metres)
Senvion 3.4M140-90HH	143 (0 - 20 metres)	619 (21 – 160 metres)

Avoidance rate is the capacity for a bird to avoid a collision when it is otherwise on a flightpath toward a turbine, whether avoidance occurs due to a cognitive response on the part of the bird or for any other reason. Avoidance rate is expressed as a percentage so that, for example a 95% avoidance rate equates to one flight in 20 in which a bird takes no action to avoid a turbine and 99% avoidance rate equates to one flight in 100 in which a bird does not do so.

Avoidance is incorporated into risk modelling because it is a real phenomenon. It also provides a mechanism in the model to vary the risk represented by the static and dynamic components of a turbine. On the basis of empirical experience with a wide range of species, it is clear that most birds have very high capacity to avoid collisions with the static components of turbines. For the purposes of the comparative modelling avoidance rate for the static components is set at 99% and for the dynamic component of moving rotors is set at 95%.

4. Results & discussion

4.1 Results

Model results are expressed in terms of the number of flights per annum that are at risk of collision. Results for the two turbine models under consideration and the modelled assumptions about bird flights, are shown in Table 4.

Table 4 Number of bird flights per annum at risk of collision with the two turbines

Turbine	Flights per annum at risk of collision
Senvion MM92-80HH	2.2
Senvion 3.4M140-90HH	4.5

The model results indicate that collision risk for the Senvion 3.4M140 turbine is slightly more than twice that of the Senvion MM92 turbine.

The use of 99% avoidance rate for the turbine tower below rotor height means that flights that may intersect with that part of the turbine contribute very little to the overall results. By far the greatest contribution to risk is represented by the parts of the two turbine models within rotor-swept height. In the present case, the number of flights per annum that are at risk of collision within rotor-swept height for the Senvion MM92 turbine is 2.14 and for the Senvion 3.4M140 is 4.48.

The assumption of a diminishing rate of flight frequency with increasing height above the ground is supported by empirical evidence for most species of birds. It means that there is a higher concentration of flights closer to the ground than there is toward the upper parts of a turbine. In the present case, the lowest point of rotor sweep of the Senvion 3.4M140 turbine is 20 metres above the ground whereas that for the Senvion MM92 turbine is 34 metres above the ground. This means that the rotor of the larger turbine sweeps a greater portion of airspace in the zone where there are more bird flights and this is a primary contributor to the greater collision risk posed by the large turbine.

The difference in risks between the two turbine models would be even greater if their rotor speeds were the same, but the smaller turbine has a higher rotor speed which contributes to the relative risk it poses.

4.2 Conclusion of turbine comparison

It must be emphasized that the results are intended simply to offer a comparison between the two turbines on the basis of an informed hypothetical scenario. Within the assumptions used however, the collision risk modelling has provided a quantitative comparison of the relative risks likely to be posed by the two turbines. By this comparison, the Senvion 3.4M140 turbine on a 90 metre tower represents slightly more than twice the risk posed by the Senvion MM92 turbine on an 80 metre tower. The principal contributors to the difference are the larger rotors of the bigger turbine and the sweep of its blades closer to the ground.

4.3 Empirical evidence for collision risk

There are few available examples from operational turbines that permit direct comparison of the real collision risks presented by different models of turbines. This is due to many variables of individual sites including such things as the habitats they contain and their topographies.

The best available comparison from Australia for which real results for detected collision are published, are Bluff Point and Studland Bay Wind Farms. The two sites are approximately 3 kilometres distant from each other and are situated in a similar environment near the coast of north-western Tasmania. Bluff Point comprises 37 Vestas V66 turbines (tower height 60 metres, blade length 33 metres) and Studland Bay comprises 25 V90 wind turbines (tower height 80 metres, blade length 45 metres) (Hull et al. 2013). A subset of turbines at each site has been subject to intensive monitoring for bird and bat collisions and the process used fences to exclude mammalian scavengers from removing carcasses. Analysis of multiple years of collision monitoring at the two sites is presented in Hydro Tasmania (2012). Our evaluation of the rates at which dead birds were detected at the two sites indicates that despite the difference in size between the turbines, the rate (per turbine per survey) at which bird mortalities were detected was very similar, at 0.22 for V66 turbines at Bluff Point and 0.24 for V90 turbines at Studland Bay. Nonetheless, the suite of species involved at the two sites differed somewhat (Hull et al. 2013) and, as for the comparison provided here, aspects other than simple overall size of the two turbines also differed.

It is worth noting that one key determinant of turbine collision risk for birds is simply whether a particular species flies within rotor-swept height and the frequency with which it does so. Evidence from multiple bird utilization studies for wind farm sites in south-eastern Australia show that many species rarely fly within the rotor height zone of modern wind turbines, while some species do so routinely. Within a first group are many smaller species that forage between the ground and tree canopy height. While such species generally have capacity to fly at greater heights, they do that infrequently for reasons such as avoidance of predators and due to the unnecessary energetic costs of doing so. Another group of birds will routinely fly at rotor-swept height during limited activities such as flying from one area of habitat to another, but within an area of suitable habitat generally confine their activities to the ground or fly at low heights. Many wetland birds behave in this way. Some birds that are often year-round residents of agricultural landscapes forage on, or close to the ground in but also frequently fly within rotor-swept height. These include birds such as Australian Magpie, Eurasian Skylark and species of raven. A further group, such as some raptors, swifts and needletails, forage from, or in the air and spend the majority of their time in flight, often within the turbine rotor-swept height zone. Evidence from studies such as Hull et al. (2013) and Smales (2014) suggest that a relatively few species, principally from the latter two groups, predominate amongst detected collision mortalities at Australian wind farms.

4.4 Potential impacts on birds and bats at Lal Lal Wind Farm

For the purposes of planning approval for the revised Lal Lal Wind Farm project, the primary interest related to potential for impacts on fauna will revolve around whether proposed changes to the wind farm are likely to increase risks to threatened or migratory species of birds or bats that are listed under provisions of the Environment Protection and Biodiversity Conservation (EPBC) Act or the Flora and Fauna Guarantee (FFG) Act. Available evidence, including biodiversity databases maintained by the Victorian Government and results of bird and bat surveys of the Lal Lal Wind Farm sites (Brett Lane & Associates 2008), indicates that the sites are rarely used by any such listed species. On the basis of that evidence, and the comparative risk modelling presented here, it is reasonable to conclude that the proposed changes to turbine configuration, including use of Senvion 3.4M140 turbines, do not represent a risk of significant impact on any listed species of birds or bats.

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