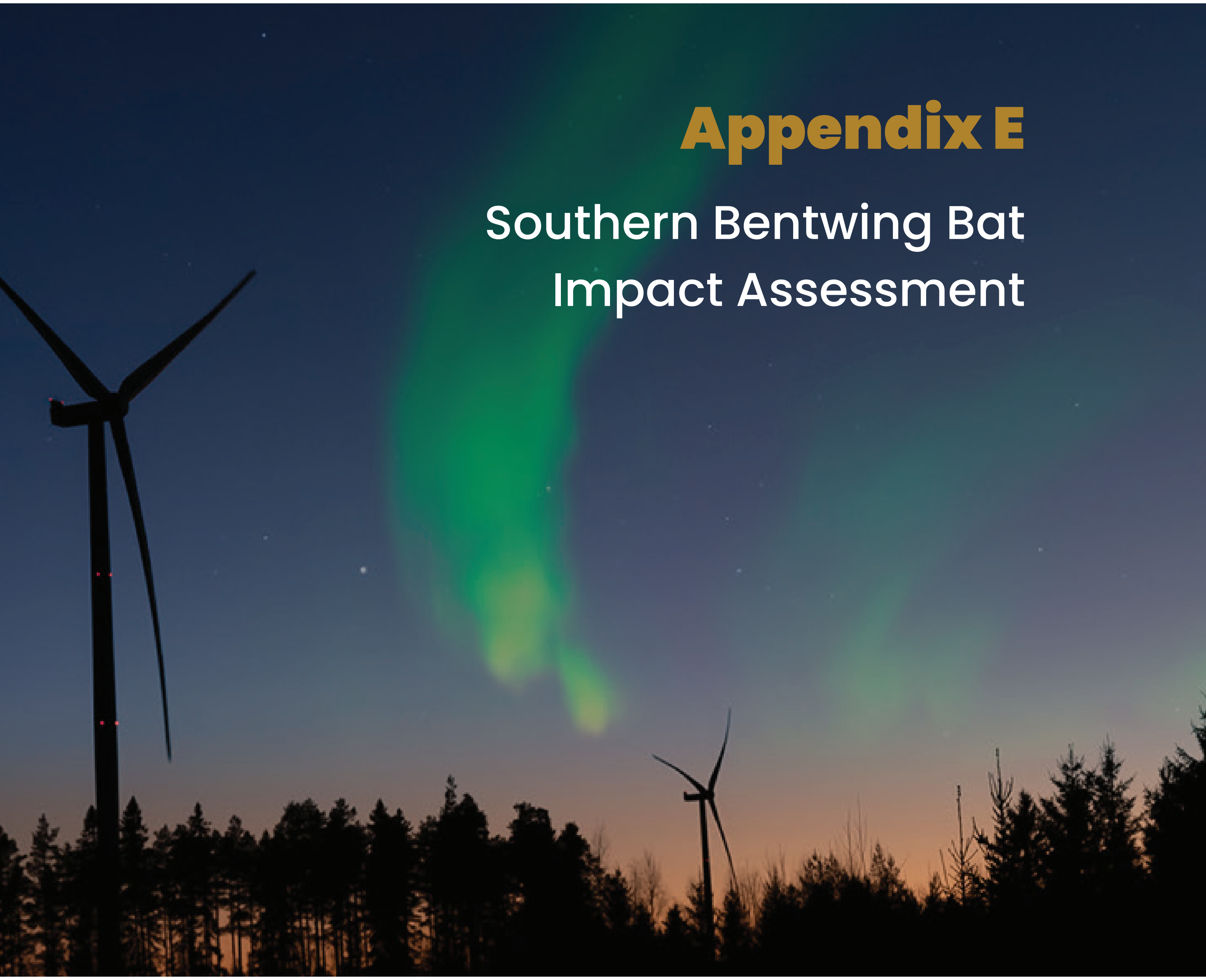


Appendix E

Southern Bentwing Bat Impact Assessment

KENTBRUCK GREEN POWER HUB

Kentbruck Green Power Hub

Environment Effects Statement Technical Report: Southern Bent-wing Bat Impact Assessment

Prepared for Neoen Australia Pty Ltd

19 November 2024

Biosis offices

NEW SOUTH WALES

Albury
Phone: (02) 6069 9200
Email: albury@biosis.com.au

Newcastle
Phone: (02) 4911 4040
Email: newcastle@biosis.com.au

Sydney
Phone: (02) 9101 8700
Email: sydney@biosis.com.au

Western Sydney
Phone: (02) 9101 8700
Email: sydneyoffice@biosis.com.au

Wollongong
Phone: (02) 4201 1090
Email: wollongong@biosis.com.au

VICTORIA

Ballarat
Phone: (03) 5304 4250
Email: ballarat@biosis.com.au

Melbourne (Head Office)
Phone: (03) 8686 4800
Email: melbourne@biosis.com.au

Wangaratta
Phone: (03) 5718 6900
Email: wangaratta@biosis.com.au

Document information

Report to:	Neoen Australia Pty Ltd
Prepared by:	Ian Smales, Matt Gibson, Mark Venosta
Biosis project no.:	35014
File name:	35014.KGPH.SBWB.20241119
Citation:	Biosis 2022. Kentbruck Green Power Hub Environmental Effects Statement Technical Report: Southern Bent-wing Bat Impact Assessment. Report for Neoen Australia Pty Ltd. Smales, I., Gibson, M. & Venosta, M. Biosis Pty Ltd. Port Melbourne, VIC. Project no 35014.

Document control

Version	Internal reviewer	Date issued
Draft 1	MSG / IS	14/02/2022
Draft 2		08/11/2022
Draft 3	MSG / IS	20/12/2023
Draft 4	MSG / JB	10/05/2024
Final v5	MSG	15/08/2024
Final v6	MSG	19/11/2024

Acknowledgements

Biosis acknowledges the contribution of the following people and organisations in undertaking this study:

- Neoen Australia Pty Ltd: Nathan Kelly, Thibault Peillon, Kristina Yan, Aidan O'Mahony, Garth Heron, Matt Parton, Damien Hegarty and Naomi Swift.
- Umwelt: David Knight, Keira Banks and Emily Scott.
- Department of Energy, Environment and Climate Action for access to the Victorian Biodiversity Atlas and Native Vegetation Information Tools
- Department of Climate Change, Energy, the Environment and Water for access to the Protected Matters Search Tool of the Australian Government.

Biosis staff involved in this project were:

- Felicity Williams, Danielle Eastick, Caitlin Potts, Matt Jones, Kristin Campbell, Sarah Hilliar, John Muchan, Georgie Zacks, Dan Gilmore, Katrina Sofo, Mark Venosta, Jules Farquhar, Wyn Russell, Erin Baldwin, Jack Fursdon, Julian Turner, James Shepherd, Sally Mitchell and Sam Panter.

Contents

Tables

Figures

Photos

Executive Summary

Project background

Biosis has been commissioned by Neoen to undertake an assessment of potential impacts on the Southern Bent-wing Bat *Miniopterus orianae bassanii* from the proposed Kentbruck Green Power Hub. The Southern Bent-wing Bat is listed as critically endangered under both the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the *Flora and Fauna Guarantee Act 1988* (FFG Act).

The proposed Kentbruck Green Power Hub is located 330 kilometres west of Melbourne between Portland and Nelson, Victoria. The project would comprise a wind farm of up to 105 wind turbines and a new 275 kV transmission line to connect the project to Heywood Terminal Station. Four megawatt (MW) to eight MW turbines are proposed with a maximum rotor tip height of 270 metres and a minimum lower blade sweep height of 60 metres. Most turbines are proposed within a managed timber plantation, with some turbines proposed on adjacent cleared agricultural land.

Study objective

The objective of investigating Southern Bent-wing Bat at the Kentbruck Wind Farm site and environs has been to obtain relative measures of the species' flight activity (using detected echolocation calls as a qualitative surrogate measure). The intention was to determine how call-frequency for the species might vary in relation to environmental variables that may be informative in relation to the proposed project. As any risk of collisions with turbines will exist only where turbines are located, bat call detectors were located at sites representative of proposed turbine sites.

Study methods

Preliminary acoustic surveys occurred between November 2018 and April 2019 at ground locations and on one meteorological monitoring mast. Further acoustic surveys were carried out between December 2019 and November 2020. This 12-month survey program for the Project involved 24 bat detectors, including eight stand-alone ground detectors and 16 detectors on four met masts, with each met mast having a detector at 1.5 metres, 28 metres, 56 metres and 84 metres above ground level.

Limitations on height of masts used for the Project prevented locating bat call detectors at greater than 84 metres. It is recognised that the highest detectors operated only within the lowest height zone of turbines proposed for the Project, but that is also a reflection of the substantially greater ground clearance (minimum of 60 metres) of blades for these turbines compared to other wind farms operating in western Victoria.

Met masts that were used for acoustic surveys were installed in both cleared and treed plantation coupes, close to and distant from wetlands. The approach incorporated stratification for variables such as distances from caves known to be in use and heights above the ground. Wind speed data were also derived from the four met masts for the period of the microbat surveys, to enable investigation of patterns between bat activity and wind speed, and to provide an assessment of the frequency distribution of wind speed throughout the study.

Bat calls were analysed using the automated identification software AnaScheme, which applies a conservative approach to identifying calls in that only clear, high-quality calls are assigned to a species. The system also counts recordings which match the criteria to be considered true bat calls but may be of insufficient quality to identify to species level. This allows a measure of overall bat activity to be calculated. Potential Southern Bent-wing Bat calls assigned by AnaScheme were examined manually to classify calls into confidence classes, including calls that are clearly SBWB, calls that may be SBWB but also have potential to be another species with overlapping characteristics, and calls that are clearly not SBWB.

Results

Bat survey results

Several species of bats were recorded in the acoustic surveys. Southern Bent-wing Bat is the only listed species that was recorded. The White-striped Free-tailed Bat *Austronomus australis* was most frequently recorded, with over 8,000 recordings from the 16 met mast mounted detectors across the survey period. Seven species of bats were detected within rotor swept height (84 metre detectors), including the Southern Bent-wing Bat.

2,743 Southern Bent-wing Bat calls (confirmed and potential according to AnaScheme) were recorded, resulting in an average detection rate of 0.29 bat passes per detector per night across all detectors. The detection rate for ground-based detectors (12 detector locations) was 0.57 bat passes per detector per night. The detection rate at 28 metres was 0.013 and detection rates for 56 metres and 84 metres were 0.003 and 0.002 passes per night, respectively.

These 2,743 confirmed and potential SBWB calls were all subject to a manual checking process. Of these recordings, 20 were confidently identified as SBWB, 290 were identified as probable SBWB and a further 2107 were assigned to a species complex that includes SBWB. The species complex also includes forest bat species *Vespadelus* sp. which have similar and overlapping call characteristics with SBWB. The remaining records were either considered unlikely to be SBWB (144), of insufficient quality to be identified, or noise (not bat calls). The manual checking process indicates that the AnaScheme identification process is conservative, and that the actual number of SBWB recorded may be lower than that indicated by the automated process. Notwithstanding this, detection of bat calls by ultrasonic detectors is subject to a range of limitations (as documented in this report) and does not provide accurate abundance or density data.

Southern Bent-wing Bat calls were recorded at all mast locations, although not all masts across all survey months, or at all detectors at each mast (with detected calls highest at the ground and lower (28 metre) mast detector heights). The Southern Bent-wing Bat call recordings indicate activity peaks within late summer and early autumn (February and March) and in spring (September to December). Activity levels were relatively low throughout late autumn and winter (May to August). Recent research summarised in the conservation advice (TSSC 2021) suggests that some activity is maintained in the colder months, including movement between non-maternity caves. Southern Bent-wing Bat were recorded throughout the time of darkness, but in general highest activity levels were recorded in the first few hours following sunset. This post sunset activity peak is seen in many microbat species and is likely due to warmer air temperatures and higher abundance of insects early in the night.

Met mast recordings and wind speed

Bat call data was also correlated with observed wind speeds at detector heights and at wind turbine hub height. This analysis could only be undertaken where extrapolated wind speed could be calculated, including three of the four detectors at 28 metres, and the higher mast-based detectors at 56 metres and 84 metres at all four masts. Only 11 recordings of Southern Bent-wing Bat were detected at these locations, and as a result little information is available to enable correlations between wind speed and activity levels. Except for one Southern Bent-wing Bat detection at 10-11 ms-1, all detections were at wind speeds of less than 9 ms-1.

Southern Bent-wing Bat recordings from all detectors were also correlated to wind speed recorded at 80 metres high on a single met mast. As most recordings of the species calls were from ground-level detectors where wind speeds are likely to be 2-4 metres/second slower than they are at 80 metres above the ground, this analysis only provides an indication of the potential relationship between wind speed and activity. Nonetheless, the results clearly demonstrate a decline in measures of call activity even close to the ground when wind speed at 80 metres reached 7-8 metres/second and the decline continued until there was virtually no activity at wind speeds of 13-14 metres/second.

Impact assessment

The Project does not entail substantive loss of any habitat for Southern Bent-wing Bat. Removal of plantation pines for turbine hardstands and other Project infrastructure will be minor and must be taken in context of the routine removal of mature pines as part of the production plantation operation within which the Project will be situated.

Assessment for project impacts on the SBWB is primarily focused on the potential for collisions with turbines.

<u>Distribution and flight paths</u>

No data is available regarding preferred or frequently used flight paths, but there is expected to be some movement across the site, between foraging areas within Discovery Bay Coastal Reserve and Lower Glenelg National Park, and there is expected to be some foraging activity within the plantation area and farmland where turbines are proposed to be situated. The Project is considered unlikely to impact upon or limit movement patterns of Southern Bent-wing Bat, with the exception that there is a risk that flights within rotor-swept height have some potential to result in collisions. Most flights are likely to be beneath rotor-swept height, less than 60 m above ground level, and the presence of turbines is unlikely to result in Southern Bent-wing Bat avoiding moving through the project area.

<u>Flight heights and temporal variation</u>

The impact assessment is presented in the context of considerable uncertainty regarding quantitative analysis of bat call data, including limited detection volume and the influence of a range of factors on detectability, including bat call characteristics and environmental conditions.

At all four masts there were greatly reduced levels of Southern Bent-wing Bat call activity detected at the higher detectors. The frequent calls of White-striped Free-tailed Bat recorded at the two higher detectors on the masts confirms that the high detectors functioned correctly and were able to detect bat calls. The significantly lower call activity of Southern Bent-wing Bat recorded by high detectors reflects actual lower call activity at those heights relative to call activity of the species closer to the ground.

Risk of collisions with turbines is confined to the hours of their nocturnal activity. For the year studied, levels of call activity were low during the months of December and January and again in May to August. It is considered likely that this reflects an annual routine, that the species is less active during the cooler months. It can be expected that any possible risk of turbine collisions may be low during the latter half of the night and at the lowest during winter.

Results of the study are not conclusive, but they suggest that Southern Bent-wing Bat flight activity is concentrated at heights well below the height of rotors of turbines proposed for the project. Potential reasons for this include that foraging resources for the species are likely to be more abundant in that height range and that kinetic energy of great wind speeds at higher heights may be less favourable for the species. Data obtained by the Project studies suggest that Southern Bent-wing Bat call activity peaked at wind speeds between 5 and 7 m/s, which was a commonly recorded wind speed close to the ground, and activity virtually ceased at wind speeds of 12 to 14 m/s. Such an effect will limit their flight activity – at any height – to periods when wind speed is amenable to their flight activity. This means that turbine collision is not likely to pose any risk to the species during periods of wind speed above those levels.

Implications for the Project are as for that part of the study in that risk of collisions, including the potential for barotrauma, appears likely to be low because of the relative rarity of fights within the rotor-swept height zone of the turbines proposed for the project.

Population viability analysis

A population viability analysis (PVA) on Southern Bent-wing Bat was carried out to assist in the assessment of impacts from the proposal (Symbolix 2021). The outputs of the PVA show the 'zero' harvest rate (rate without any wind farm mortalities included) shows a substantial decline in the Portland sub-population size, whereby it will decline by more than 50% within ten years and by almost 100% within 60 years.

Adding a range of predicted wind farm mortalities to the impact assessment PVA shows that with increasing numbers of wind farm mortalities the Portland sub-population declines more rapidly, noting that the wind farm is assumed to operate for 30 years. While no wind farm mortalities occur after 33 years (assuming wind farm operation started at year 3), the Portland sub-population continues to decline, which is consistent with the decline shown in the 'zero' harvest model described here and the overall population decline predicted by PVA in Approved Conservation Advice for the sub-species (TSSC 2021).

If the mortality value from the wind farm is low (around two Southern Bent-wing Bat per annum) there is no discernible difference in Portland sub-population outcomes after 60 years. For 10 additional mortalities per annum, there is a detectable downward effect on the 60-year Portland sub-population prediction. Southern Bent-wing Bat mortality in the range of 50 Southern Bent-wing Bat per year would have a substantive impact on the probability of extinction and shorten the predicted time frame for extinction of the Portland sub-population.

The targeted survey work completed and reported upon in this assessment has shown that Southern Bent-wing Bat is unlikely to regularly fly at rotor swept height. With this level of activity at rotor swept height, the impact of collision is low and resultant mortality should remain below the thresholds noted in the PVA that would otherwise accelerate extinction risk.

Cumulative impacts

Based on the information obtained during technical studies for this project, literature on the ecology of the sub-species and understanding of known impacts from other wind farms, there is a low to medium likelihood that the proposed wind farm, in conjunction with other wind farms, introduces a significant threat or additional impact likely to alter a cumulative impact assessment (if one could be completed) for the Southern Bent-wing Bat. Land clearing, habitat removal, climate change and drainage of permanent bodies of water, loss and disturbance of roosting and maternity sites have been identified as major risks to the species and are likely to be of substantially greater significance (TCCS 2021). The KGPH project will not contribute further to these key risks. Expansion of renewable energy generation is a key factor in addressing long-term risks relating to climate change.

Impacts to non-threatened bat species

The Scoping Requirements for Kentbruck Green Power Hub include provision for assessment of effects of the Project on 'protected species'. In Victoria species of flora and fauna that are indigenous are generally protected by provisions of the *Wildlife Act 1975* and the *Flora and Fauna Guarantee Act 1988*, whether or not they are listed under any category of threat. At least 12 other microbat species were recorded in acoustic monitoring undertaken for the project. Most of these species are common and widespread, and while collisions with turbines may occur, these are highly unlikely to result in population level impacts, based on the current knowledge of these species.

Operational microbat mortality monitoring at wind farms within south-west Victoria has resulted in large numbers of mortalities of White-striped Freetail Bat, which is a large, fast and high flying species that is common and widespread within eastern Australia. A recent IUCN assessment of this species determined the conservation status to be 'least concern' however there is there is concern the species may be in decline, as mortalities of this species represent a large proportion of total bat mortalities monitored at wind farms. This species is considered to be common and widespread across most of southern Australia, including the Project area, and based on currently available knowledge, the project is not considered likely to lead to an unacceptable impact on the species at the broader population level.

It is recommended that consideration be given to White-striped Freetail Bat, and all other microbat species, in the KGPH BBAMP.

Avoidance and mitigation

Lowest blade-tip height

The project plans to use turbines with a lowest blade-tip height of 60 metres above the ground. Data collected during the project surveys for flight-heights of birds and bats suggest that, by comparison with currently operating turbines at onshore wind farms in Australia, turbines with a rotor ground clearance of 60 metres can be expected to reduce the potential very significantly for collisions for the great majority of species.

Turbine free buffers

Turbine free buffers have been applied in specific in response to Department of Energy, Environment and Climate Action (DEECA) guidance aimed at minimising disturbance of Brolga breeding sites, that will also reduce the potential for collisions by all species of birds and bats.

Buffers at Gorae West provide a zone approximately six kilometres wide that will be free of collision risk between the coastal area of Discovery Bay to the south and Cobboboonee National Park and Lower Glenelg National Park to the north. Buffers adjacent to Long Swamp extend for approximately 15 kilometres along the southern boundary of the wind farm. While they are largely within pine plantation, they are intended to limit the potential for collisions by all species of birds and bats that utilise the important series of wetlands within Discovery Bay Coastal Park.

Turbine free buffers have been applied to the area within 5 km of the Glenelg River cliff roosts, and to all areas within 300 m of boundaries with surrounding conservation reserves, and other public land supporting native vegetation. The size of this buffer was increased during development of the project, in response to the relatively large number of SBWB calls recorded at the closest detector site to this section of the project area.

Turbine-free zones eliminate all risk of collision for all species of birds or bats flying within them.

Seasonal nocturnal low wind speed curtailment

Low wind speed curtailment is recommended at night during periods of higher activity to further reduce the risk of Southern Bent-wing Bat collisions with turbines. Low wind speed curtailment will be implemented in an adaptive management framework, to be detailed in the Bird and Bat Adaptive Management Plan. Any additional curtailment should be conducted as part of scientific trials, including intensive monitoring and reporting, to evaluate effectiveness of the curtailment in eliminating or reducing mortalities.

Monitoring and adaptive management

A Bird and Bat Adaptive Management Plan (BBAMP) management plan will be developed, including protocols for monitoring and triggers for implementation of adaptive management, including monitored low wind speed curtailment trials. The BBAMP is the key mechanism for responding to residual risk and unexpected bird or bat mortalities.

The proponent has made a commitment for a $1,000,000 recovery fund, which is to focus on SBWB recovery actions, but also to have the ability to assist in recovery actions for other species.

1. Introduction

1.1 Project background

Neoen is a developer and long-term renewable energy generator owner with an established Australian track record of constructing renewable energy projects throughout Australia.

Biosis has been commissioned by Neoen to undertake flora and fauna assessments and impact assessments for the proposed Kentbruck Green Power Hub (KGPH; the Project). This information will be used to:

- Inform ongoing design of the project in a responsive manner to avoid and minimise impacts to flora and fauna.
- Permit a comprehensive assessment of any impacts that may be associated with a fully developed project design.
- Provide the biodiversity technical report in response to the Environment Effects Statement (EES) Scoping Requirements for the Project.

1.1.1 Interdependencies with other EES technical studies

Reporting for the ecological component of the KGPH is provided in the following documents.

- Flora and existing conditions and impact assessment (Biosis 2024a)
- Southern Bent-wing Bat impact assessment (this report)
- Brolga Impact Assessment (Biosis 2024a).

A Bird and bat adaptive management plan has also been drafted for the KGPH project (Biosis 2024c).

A range of other technical studies are being undertaken for the Project. Where relevant, these studies have been consulted in preparing this assessment. Relevant studies include:

- Air quality – AECOM (June 2024)
- Groundwater – AECOM (June 2024)
- Surface water – AECOM (June 2024)
- Transport – AECOM (July 2024)
- Noise – Marshall Day Acoustics (July 2024)
- Landscape character and visual amenity – Green Bean Design (June 2024)
- Shadow flicker and blade glint – GHD (August 2024)
- Bushfire– Fire Risk Consultants (July 2024)
- Environmental Site Investigation – AECOM (July 2024)
- Groundwater dependent ecosystems impact assessment – CDM Smith (July 2024).

1.1.2 EES Scoping requirements

The final EES Scoping Requirements for the Kentbruck Green Power Hub were issued to Neoen in January 2020.

The project was also referred to the Commonwealth under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The Project was determined to be a controlled action on 7 November 2019, requiring assessment and approval under the EPBC Act. The controlling provisions are:

- Ramsar wetlands.
- Listed threatened species and ecological communities.
- Listed migratory species.

The EES process is accredited to assess impacts on matters of national environmental significance (MNES) under the EPBC Act through the Bilateral Assessment Agreement between the Commonwealth and the State of Victoria.

Section 4.1 of the Scoping Requirements details the key issues and information requirements for the existing environment, likely effects, mitigation measures and performance objectives. The key issues and existing environment reporting requirements as set out in the EES scoping requirements are outlined in Table 1 below. Table 1 indicates the report section where the corresponding scoping requirement is addressed in this report, for items relevant to Southern Bent-wing Bat, and references to other reports where appropriate for other ecological values.

Table 1 Key issues and existing environment reporting requirements as set out in the EES Scoping Requirements

Aspect	Scoping requirement	Report and section
Key issues	• Potential for significant effects and their acceptability on Southern Bent-wing Bat *Miniopterus schreibersii bassanii*, South-eastern Red-tailed Black Cockatoo *Calyptorhynchus banksii graptogyne*, Australasian Bittern *Botaurus poiciloptilus*, White-throated Needletail *Hirundapus caudactus* and Orange-bellied Parrot *Neophema chrysogaster*.	• Southern Bent-wing Bat (SBWB) addressed in this report including the Significant Impact Assessment in Appendix 2. • Biosis (2024a)
	• Potential cumulative effects on key threatened and listed fauna species including but not limited to those listed in Appendix A from the project in combination with other projects.	• 5.5
	• Disruption to the movement of fauna (both day and night) between areas of habitat across the broader landscape, including but not limited to movement between nearby conservation areas such as Discovery Bay Coastal Park, Lower Glenelg National Park and Long Swamp.	• 5.3
	• Direct or indirect loss, disturbance and/or degradation of listed or other protected species and nearby habitat that may support listed species or other protected flora, fauna or ecological communities.	• 5.3, 5.4.
	• Disturbance and increased risk of mortality for protected bird and bat species arising from project infrastructure, including collision with wind turbine blades and transmission lines.	• 5.1, 5.3

Aspect	Scoping requirement	Report and section
	• Potential for adverse effects on the ecological character and biodiversity values of the Glenelg Estuary and Discovery Bay Ramsar site (including those listed in Appendix A of the Scoping Requirements).	• Biosis (2024a)
	• The availability of suitable offsets for the loss of native vegetation and habitat for listed threatened species under the *Flora and Fauna Guarantee Act 1988* (FFG Act) and EPBC Act.	• Biosis (2024a)
Existing environment	• Characterise the type, distribution, and condition of biodiversity values within a suitable study area, comprising the project site and its environs, including native vegetation, terrestrial and aquatic habitat and habitat corridors or linkages. This includes identifying and characterising any ephemeral wetlands/habitat for threatened species and communities listed under the FFG Act or EPBC Act.	• 1.4, 2.2
	• Identify and characterise any areas of native vegetation and groundwater dependant ecosystems that may be affected by groundwater drawdown or surface hydrological changes.	• Biosis (2024a) • GDE report • Surface and Groundwater hydrology reports (AECOM 2024a, AECOM 2024b)
	• Identify the presence and movements of Southern Bent-wing Bats within and near the project site, including locations of roosting or breeding sites within movement distances from the project site, in consultation with the Department of Energy, Environment and Climate Action (DEECA).	• 1.4.1, 1.4.2 • 4.2-4.4
	• Identify the presence of foraging and roosting habitat for South Eastern Red-tailed Black Cockatoo within the project site and broader locality in consultation with DEECA and the National Recovery Team for the species	• Biosis (2024a)
	• Describe the biodiversity values that could be directly or indirectly affected by the project, including: – Native vegetation and any ecological communities listed under the EPBC Act and FFG Act. – Presence of, or suitable habitats for, protected flora and fauna species (including migratory species), in particular species listed under the EPBC Act and FFG Act. – Potential use of the site and its environs for movement and/or foraging by protected fauna species including: Southern Bent-wing Bat, Red-tailed Black Cockatoo, Australasian Bittern, White-throated Needletail, Orange-bellied Parrot and Brolga.	• Biosis (2024a) • Brolga (Biosis 2024a) • SBWB 1.4.1, 1.4.2, 4.2-4.4
	• Describe any existing threats to biodiversity values, including: – Direct removal of individuals or destruction of habitat. – Historic or ongoing disturbance or alteration of habitat conditions (e.g. habitat fragmentation, severance of wildlife corridors or habitat linkages, changes to water quantity or quality, fire hazards, etc. – Background threats that lead to the mortality of listed threatened fauna.	• SBWB 1.4.5

Aspect	Scoping requirement	Report and section
	– The presence of any declared weeds, pathogens and pest animals within and in the vicinity of the project area.	
	• Characterisation of the existing environment is to be informed by relevant databases, literature (and published data), community observations (including citizen science), appropriate targeted and/or seasonal surveys and modelling of the potential and actual presence of threatened species and communities consistent with Commonwealth and state survey guidelines, conservation advices and threatened species recovery plans. Where surveys do not identify a listed species or community, but past records and/or habitat analysis suggest that it may occur, a precautionary approach to the further investigation and assessment of its occurrence should be applied.	• Biosis (2024a)
Likely effects	• Assess the direct and indirect effects of the project and feasible alternatives, including transport route upgrades and use, on native vegetation, listed ecological communities, and listed threatened and other protected flora species (especially those listed in Appendix A).	• Biosis (2024a)
	• Assess the direct and indirect effects of the project and feasible alternatives, on listed threatened species, migratory species and other protected fauna species under the EPBC Act and FFG Act (especially those listed in Appendix A).	• Biosis (2024a) • SBWB 5.1-5.4
	• Assess the direct and indirect effects of the project and feasible alternatives, on the ecological character of the Glenelg Estuary and Discovery Bay declared Ramsar site.	• Biosis (2024a)
	• Assess the direct and indirect effects of the project, on biodiversity values, including: – disturbance or alteration of habitat conditions (e.g. habitat fragmentation, severance of wildlife corridors or habitat linkages, displacement due to avoidance of project infrastructure, changes to water quantity or quality, hydrological changes to wetland function, fire hazards, etc.) – the ability of wetlands, including Glenelg Estuary and Discovery Bay Ramsar site, to support listed species and communities – the potential for birds and other fauna to be disturbed or disoriented by project effects such as noise, vibration, or lighting – direct removal of individuals or destruction of habitat – threats of mortality of locally occurring listed threatened fauna (including site and species specific risk-factors) – the presence and potential spread of any declared weeds, pathogens and pest animals within and in the vicinity of the project area.	• Biosis (2024a) • SBWB 5.1-5.4
	• Assess the potential cumulative effects on listed species of fauna, in particular Brolga and Southern Bent-wing Bat, from the project in combination with other projects, in particular nearby proposed, approved or operating wind energy facilities.	• SBWB 5.5
	• Identify and describe potential alternatives, proposed design options and mitigation measures (including operational mitigation measures) and their	• 6.1-6.5 • BBAMP (Biosis 2024c)

Aspect	Scoping requirement	Report and section
Mitigation measures	effectiveness in avoidance or reduction of significant effects on any flora, fauna and/or ecological communities listed on the EPBC Act, FFG Act and other protected species or ecological character of the Ramsar site. Provide clear statements noting which avoidance or mitigation measure will be committed to.	
	• Justify and describe the assumptions and level of uncertainty associated with the proposed measures achieving their desired outcomes.	• 6.1-6.4 • BBAMP (Biosis 2024c).
	• Develop hygiene controls for vehicle and machinery movement to minimise the spread of pathogens and weeds.	• Biosis (2024a)
	• Describe the application of the three-step approach to avoiding the removal of native vegetation, minimising impacts from removal of native vegetation that cannot be avoided and providing offsets to compensate for the biodiversity impact from the removal of native vegetation.	• Biosis (2024a)
Performance objectives	• Describe and evaluate proposed commitments to manage residual effects of the project on biodiversity values, including an outline of an offset strategy and offset management plan to secure appropriate offsets to satisfy both Commonwealth and state offset requirements.	• Biosis (2022a) • BBAMP (Biosis 2024c).
	• Develop contingency measures to be implemented in the event of adverse residual effects (including ineffective mitigation) on flora and fauna values requiring further management.	• BBAMP (Biosis 2024c).

1.2 Description of the Project

The Project would comprise:

- A wind farm of up to 600 MW, consisting of up to 105 wind turbines and associated permanent and temporary infrastructure.
- A new 275 kV underground transmission line, which would connect the Project to the existing AusNet electricity transmission network. The transmission line would extend from the eastern boundary of the wind farm site to the existing 275/500 kV Heywood Terminal Station, a distance of approximately 26.6 km.

These project elements are located within close proximity of each other, as described in the following sections.

The Project is located around 330 kilometres west of Melbourne between Portland and Nelson, Victoria (Figure 1).

The flora and fauna project area encompasses a wind farm site of approximately 7,500 hectares of private and public land including some road reserves, and a transmission line connection to the electricity grid.

The project area is within the:

- Glenelg Plain, Bridgewater and Victorian Volcanic Plains Bioregions
- Glenelg River Basin
- Management area of the Glenelg Hopkins Catchment Management Authority (CMA)
- Glenelg Shire local government area.

1.2.1 Wind farm site

Portland-Nelson Road bisects the wind farm site in a generally east to west direction. The site is generally bound by plantation forestry to the north, highly-modified land used for grazing purposes to the east and west, Discovery Bay Coastal Park to the south, and the Lower Glenelg National Park and Cobboboonee National Park to the east and north-east (Figure 1a and b).

The proposed wind farm site is approximately 8,325 hectares and comprises 121 individual land parcels owned by 20 different landholders. The site is located primarily within an area that has been substantially modified and is used for commercial Radiata Pine softwood forestry production, with a small portion of land used for agricultural purposes (primarily grazing). The plantation area has an existing network of public and private roads.

At this stage, 4 MW to 8 MW wind turbines are proposed and will have the following features:

- Maximum hub height of 174 m.
- Maximum rotor tip height of up to 250 m.
- Maximum rotor diameter of 190 m.
- Minimum lower blade sweep height of at least 60 m above the ground.

1.2.2 Transmission line options

Two transmission line connection options were considered while the ecological surveys were being undertaken: a route with both underground and overhead lines (option one) and an overhead only route (option two). Both routes extend east of the proposed wind farm. The locations of the routes considered are described below and shown in Figure 1a and b.

- Option One: underground
  The Option One route generally extends between the eastern boundary of the proposed wind farm site and the existing Heywood Terminal Station located inside the western boundary of the Narrawong Flora Reserve / Mount Clay State Forest (on land owned by AusNet). This transmission line connection option is approximately 26.6 kilometres long. Within Cobboboonee National Park and Cobboboonee Forest Park, the transmission line would be located beneath Boiler Swamp Road (for a distance of approximately 17.6 km) which bisects the Parks in an east to west direction. The underground section would be constructed within a 6.5 m construction footprint, with cabling buried at a depth of approximately 1.25 m beneath the existing road. Construction mostly via trenching, with horizontal directional drilling (HDD) used in several locations to avoid impacts to waterway, including the Surrey River. After exiting Cobboboonee Forest Park the underground line would continue for 1.2 km through freehold agricultural land to the Surrey River. To the east of the Surrey River, the transmission line would continue as an underground line for approximately 8 km, until its connection point to the Heywood Terminal Station.
- Option Two: Overhead only route
  Option Two was removed as a viable option by Neoen in June 2021 and is therefore not considered in the impact assessment outlined in this report. This decision was made with consideration of land access, visual impact, vegetation removal and community concerns. A discussion of the options considered for the transmission line connection is provided in the EES.

Neoen has undertaken a detailed options assessment of several transmission line options (Umwelt 2024). Biosis has participated in this options assessment process, including through provision and interpretation of information about baseline conditions and potential impacts on ecology.

1.2.3 Other project elements

The Project is proposed to include (but is not limited to):

- Internal site access tracks and upgrades to existing access points from the public road network.
- Hardstand areas at each turbine location, with a footprint of approximately 0.4 ha.
- Three collector substations.
- Underground powerlines connecting the wind turbines to the collector substations.
- Overhead and underground electricity cabling (up to 275 kV) and a terminal station to provide connection to the 500 kV transmission line.
- Up to eight permanent meteorological monitoring masts (met masts).
- An operations and maintenance building.
- Temporary infrastructure including construction compounds, concrete batching plants, car parking, site buildings and amenities.
- A limestone quarry, to be located within the GTFP plantation on North Livingston Road. The quarry would have a maximum footprint of 11 ha and be up to 15 m deep, with actual dimensions to be determined following a comprehensive drilling, sampling and testing program during the detailed design of the Project.

1.2.4 Project alternatives and design evolution

The ecological database review and ecological survey program was initially designed to assess the Kentbruck Green Power Hub (KGPH) Project, as specified in the EES and EPBC referral documents. This included a project area with 157 turbines, two underground transmission line options (Boiler Swamp Road and Cut-out Dam Road), two overhead transmission line development envelopes and other project infrastructure. For the purpose of reference within these studies, this has been termed the “Original Layout”.

During the course of the technical studies, the design of the KGPH has undergone several changes. These changes have been responses to the findings of technical studies undertaken including the ecological assessments, and have resulted in:

- Reductions to the project area
- Reduction in the number of proposed turbines
- Revisions to the proposed locations of turbines (including siting turbines to avoid specific areas within the site)
- Revisions to the transmission line options.

The following design responses have been implemented to avoid and minimise potential impacts:

- Reduction in the extent of the wind farm project area. Several parcels of land that were shown in the Original Layout have been removed from the study area and will not be used for project infrastructure, including parcels to the south of the GTFP Plantation near the Glenelg Estuary and Discovery Bay Ramsar site.
- Exclusion of turbines from within 300 m of boundaries with surrounding conservation reserves, and other public land supporting native vegetation.

- Exclusion of turbines from within 500 m of wetlands within the Glenelg Estuary and Discovery Bay Ramsar site.
- Exclusion or relocation of turbines in areas where foundations may intersect groundwater near significant wetlands.
- Exclusion of turbines from within 5 km of known river cliff roost caves on the Glenelg River, near caves where SBWB are known to roost.
- Removal of the Cut-out Dam underground transmission line option.
- Exclusion of turbines from sections of farmland and Blue-gum plantation in the east of the Project area, in areas identified as breeding buffers or movement corridors for Brolga. These turbine-free areas would also provide for movement between areas of potential habitat for other bird species that were observed in this area.
- Narrowing of the overhead transmission corridor component of the proposed alignment, to an alignment with small alternative sections. This has included consideration of avoiding areas of remnant vegetation.
- Removal of the transmission line option involving vegetation removal along the boundary of Mount Richmond.
- Undergrounding of the internal electricity network in the areas identified as breeding buffers or movement corridors for Brolga.
- Undergrounding of the full transmission line through to the Heywood terminal station.

As a result of these changes, the current project layout (September 2023) has been reduced to 105 turbines. For the purpose of this report this is termed the “September23 Layout”.

A range of ecological studies were undertaken near the existing AusNet easement adjacent to Mount Clay State Forest near the Heywood Terminal Station. Construction of this component of the transmission line would have resulted in extensive clearance of native vegetation and habitat. This section has now been removed from the project.

1.3 Terminology

The following terms are used throughout the report to define the geographic extents of the assessment (Figure 1a and b):

- **Wind Farm** – the area where wind farm infrastructure is planned, including turbines, hard stands, internal access roads, collector stations, reticulation and the terminal substation.
- **Transmission Line** – the transmission line corridor, extending from the terminal substation in the eastern end of the wind farm to the Heywood terminal station.
- **Project** – the Kentbruck Green Power Hub project, including the wind farm, transmission line and associated infrastructure.
- **Project Area** – includes title lots containing the wind farm and ancillary infrastructure, and the construction footprint of the transmission line. The Project Area covers an area of approximately 8,350 ha.
- **Search Area** – the area used for collation of database records of flora and fauna, which includes the originally proposed project area plus a 10 kilometre buffer.

- **Investigation area** – the area in which field studies have been undertaken. This includes the project area plus areas surrounding the site where additional data collection was undertaken, including bird utilisation surveys, shorebird surveys, Brolga surveys and reference sites for threatened species. Where required, some field studies were undertaken more than 10km from the project area, for example checking reference sites for threatened flora species.
- **Plantation sub-area** – the Green Triangle Forest Products (GTFP) pine plantation, including the areas to the south and north of Portland-Nelson Road, and areas of Blue-gum plantation in the east of the project area.
- **Northeastern sub-area** – the portion of the Project Area to the north-east of Portland Nelson Road, primarily on farmland and blue-gum plantation.

1.4 Southern Bent-wing Bat

The Southern Bent-wing Bat (SBWB) is listed as critically endangered under both the EPBC Act and the *Flora and Fauna Guarantee Act 1988* (FFG Act). A National Recovery Plan (NRP) for the Southern Bent-wing Bat *Miniopterus orianae bassanii* was issued in 2020 (DELWP 2020) and a Conservation Advice [including an Appendix 1] for the species was published in mid June 2021 (TSSC 2021). The following information about taxonomy and distribution of the SBWB is drawn primarily from these two sources. The SBWB is recognised as a subspecies of the Common Bent-wing Bat *Miniopterus orianae.* This species was formerly called *M. schreibersii*, however genetic studies reveal that the Australian bats are distinct from the overseas *M. schreibersii*.

Within Australia there are three subspecies of the Common Bent-wing Bat *M. orianae*. The Northern Bent-wing Bat *M. o. orianae* is distributed across the north of Western Australia and Northern Territory; the Eastern Bent-wing Bat *M. o. oceanensis* along the east coast of Australia from Cape York to southern Victoria; and the Southern Bent-wing Bat *M. o. bassanii* in south-west Victoria and south-east South Australia. The Eastern Bent-wing Bat is listed as critically endangered under the FFG Act in Victoria and as vulnerable under *Biodiversity Conservation Act 2016* in NSW, but is not listed under the EPBC Act. The Northern Bent-wing Bat is not listed under any state or federal threatened species legislation. The distribution of the SBWB and the Eastern Bent-wing Bat overlap in a portion of western Victoria with both subspecies recorded from four caves in the Otways / Camperdown / Lorne area.

The three subspecies of the Common Bent-wing Bat are morphologically similar, but differ genetically and form separate maternity colonies and are believed to be reproductively isolated from each other. It is currently not possible to reliably distinguish the SBWB from the Eastern Bent-wing Bat using traditional field-based techniques. Due to this morphological similarity, the exact eastern extent of SBWB is not fully understood.

The SBWB is an obligate cave-dwelling bat (meaning that it relies on caves for roosting and breeding) with a distribution across south-east South Australia and south-west Victoria. During the non-breeding season, SBWB individuals are distributed throughout the region, roosting in caves and rock crevices. Fifty-two caves are known to be used as roosting sites in South Australia, and there are 18 known roost caves in Victoria (TSSC 2021). Victorian caves are distributed across the south-west region, and it is likely there are additional non-breeding caves that are yet to be located.

During the non-breeding season, some caves may hold several thousand SBWB individuals; however, smaller colonies are more typical and the bats may also roost singly (DELWP 2020).

During the breeding season, most of the SBWB population congregates in two regularly used breeding caves, located near Naracoorte in South Australia and near Warrnambool in Victoria (Figure 2). Breeding activity has also been observed annually since 2015 in a sea cave to the west of Portland and south east of the Project area, and this is now recognised as a third maternity cave (TSSC 2021). TSSC (2021) notes that there may be little migration of individuals between the Naracoorte and Warrnambool maternity caves, but that there may be interchange between those sites and the cave near Portland. Nonetheless, it also notes that, while the South Australian and Victorian population may operate discretely at some level, it is unlikely that a discrete geographic boundary exists between them. It also notes that recent information indicates that Southern Bent-wing Bats readily commute long distances.

The total population SBWB of all age classes combined is estimated at 63,100 (40,000 in South Australia and 23,100 in Victoria) with the mean total estimate of adults at 44,260 (TSSC 2021). The population has reportedly declined by 67% since the mid-1990s, when the species was estimated to be 134,500, consisting of 122,500 from Naracoorte cave and 12,000 from the Warrnambool cave (Reardon 2001).

While several potential threats to the species have been identified, there is little empirical evidence on which to base one or more causes for the current decline. Important factors for decline in south-west Victoria may include loss of historically used maternity caves, habitat clearance and wetland draining for agriculture, where the impact due to loss of foraging habitats may be significant. Agricultural practices such as pesticide spraying may also reduce prey species abundance (DELWP 2020). Collision with wind farm infrastructure has been identified as a threat in the NRP, and collisions are known to have been recorded at wind farms in south-west Victoria. Twenty-two mortalities are known to have occurred, including 8 mortalities documented in Moloney et al. (2019), and additional mortalities documented during the panel hearing for the Mount Fyans Wind Farm.

The species is also at risk from the likely introduction of the fungus that causes White-nose Syndrome, *Pseudogymnoascus destructans*, into Australia (TSSC 2021). This fungus has resulted in many deaths in cave roosting bats on other continents. It is not currently confirmed to be in Australia, but a risk assessment has concluded that introduction into Australia within the next 10 years is 'almost certain' (TSSC 2021, Holz et al. 2019). Threats and conservation actions are discussed further in Section 1.4.5.

1.4.1 Important populations

As described above, the three known currently used SBWB maternity caves may be considered to support separate sub-populations, although there is an unknown level of potential mixing between these sub-populations as there are no geographic barriers, and bats are known to undertake long-distance movements (TSSC 2021). Historic population trends at these maternity sites are discussed in TSSC (2021), and the difficulty in gaining reliable population counts in the past is acknowledged. More recently accuracy of population counts has improved, where fly-out population counts are obtained using thermal imaging technology (TSSC 2021).

The most recent estimate for the Naracoorte sub-population was 30,700 (TSSC 2021), where bat cave fly-outs have been filmed regularly since 2000. The sub-population was estimated to be 20,000 in 2008–2009 (Kerr & Bonifacio 2009). The population in 1963–1964 was 75,000–150,000 and remained stable until the mid-1990s (Reardon 2001). In the late 1990s, literature on the Naracoorte cave claimed that the SBWB population using the cave exceeded 400,000 (Bourne 2009 pers. ,comm. cited in Kerr and Bonifacio 2009), although local observers agree that this figure is likely to be an over-estimation (Gray 2001).

The most recent estimate for the Warrnambool population was 17,000 to 18,000 (TSSC 2021). The Warrnambool population was estimated at 10,000–15,000 in 2004 (Grant and Reardon 2004 cited in Kerr and Bonifacio 2009) and 12,000 in 2001 (Grant 2001 cited in Kerr and Bonifacio 2009). In 1963–1964, the population was estimated at 100,000–200,000 (Dwyer & Hamilton-Smith 1965).

SBWB were first noted in the Portland maternity cave in January 2015 (TSSC 2021), and it is unclear if this was a newly established maternity colony, or if it had been regularly used in the past. Annual monitoring of the Portland sub-population indicates the population size is in the range of 1,000-1,500 individuals, and that approximately 750 young are being born each year (TSSC 2021).

Regular population surveys at key breeding sites and other roosts are a key conservation and management priority (TSSC 2021).

Maternity roosts at Mount Widderin (Victoria) and Robertson Cave (South Australia) have disappeared due to guano mining in the 1800s, while Thunder Point Blowhole (Victoria) has ceased as a maternity roost since its collapse (Kerr & Bonifacio 2009). The NRP for the SBWB (DELWP 2020) mentions there may have been other maternity caves in the region that are no longer used.

The NRP for the SBWB (DELWP 2020) notes that due to the severe decline in numbers of the SBWB, all populations are considered important. The NRP also confirms that populations are centred on the two regularly used maternity caves and their associated non-breeding caves. These areas are generally described below:

- **Victoria**: Warrnambool maternity cave and Portland maternity cave, plus various caves used as non-breeding roosting sites in southwest Victoria, including in the Lower Glenelg, Bats Ridge, Portland, Byaduk Caves, Yambuk, Grassmere, Panmure, Pomborneit and Otways areas.
- **South Australia**: Naracoorte maternity cave, plus various caves used as non-breeding roosting sites in southeast South Australia, including Naracoorte Range, Mount Burr Range, Millicent, Mt Gambier and coastal sea cliffs.

1.4.2 Known caves within the region

DEECA has provided unpublished information regarding monitoring activities at local caves within 70 km of the project area. Locations of caves is summarised in the following section and shown in Figure 2.

- Cave within Bat's Ridge Wildlife Reserve
  This cave has been regularly monitored using call recordings and infra-red time lapse photography of the roosting chamber. This cave is used year-round by SBWB. Numbers of bats are variable, but DEECA consider this cave one of the most significant non-breeding roosts in Victoria. Numbers observed at counts range from less than 100 to approximately 3,500, with counts of more than 1,000 being regularly observed.
- Cashmore cave (near Bat's Ridge)
  DEECA has been regularly monitoring this cave using detectors and infrared cameras. DEECA state that this cave is used intermittently, but can be used by relatively large numbers SBWB. There does not appear to be a regular seasonal pattern of usage.
- Sea cave west of Portland
  This is a coastal cliff cave which is difficult to monitor regularly. DEECA has recorded 1000-1500 adult SBWB in this cave, with more than 500 pups confirming it as a third breeding site.
- Additional sea cave west of Portland
  This additional cave at appears to be a non-breeding cave. It is not regularly monitored.
- Lower Glenelg National Park
  These limestone caves are not regularly monitored. VBA records indicate that up to 281 bats have been recorded in these caves at once. The exact location of these caves has not been made known to the project team, and surveys of these caves were not conducted as part of this study.

1.4.3 General ecology

The species is long lived, with a couple of individuals being recaptured up to 22 years from original capture and banding (DELWP 2020). It is likely, however, that these individuals are not representative of the likely lifespan of the species, with it probably being considerably less. Little data exists to substantiate this. In the

Population Viability Analysis undertaken by TSSC (2021) to determine population size and trend, the maximum age parameter was set to 25 years.

Habitat preference is associated with the availability of foraging areas and proximity to suitable roosting caves. The species primarily roosts underground in caves (limestone and lava tubes) and mines, with some observations of usage of coastal cliff rock crevices, tunnels and road culverts (Churchill 2008). The species is dependent on the seasonal microclimatic conditions provided by these habitats, particularly the three regularly used maternity caves. At these three maternity sites, structural characteristics are present which allow heat and humidity to build up so that conditions are suitable for the nursing of young bats (Dwyer & Hamilton-Smith 1965).

Most SBWB occupy the three known maternity caves from spring to autumn, and recent tagging studies have indicated that there is considerable movement between the maternity caves and non-breeding roosts during this period (TSSC 2021). During the colder months the bats disperse throughout their range, utilising both non-maternity caves and maternity caves. Periods of torpor appear to be shorter than previously thought, with some activity during winter, including movements between caves. TSSC (2021) note that most of the significant SBWB caves are ‘probably known’, however it is recognised that the locations of some smaller roost sites may be unknown.

Foraging habitat includes locations that support populations of nocturnally active insects (as the principal diet of the SBWB). SBWB foraging activity therefore is largely aligned to include treed areas and areas of insect activity around standing water bodies, but foraging may also occur over cleared agricultural land (TSSC 2021). In forested/treed areas, the species is thought to forage above the canopy but in open environments it has been recorded foraging close to the ground as well as at height (Churchill 2008). Flight activity is likely to closely align to the activity of the foraging resource. Very little information is available regarding the vertical distribution of flight height for SBWB, and this has been identified as a knowledge gap and research priority within the Conservation Advice (TSSC 2021). A recent study of Eastern Bent-wing Bat in New South Wales recorded call activity up to approximately 100 metres above the ground, although the majority of recorded activity was within 30 m of the ground (Mills & Pennay 2017). The National Recovery Plan for the SBWB (DELWP 2020) and TSSC (2021) notes the availability of limited information on foraging habitat used by the species.

Radio tracking of individuals from the Naracoorte maternity site showed that they mostly foraged along a forested ridgeline within 3–4 kilometres of the cave (Grant 2004). Wetlands are also used extensively, with individuals recorded flying long distances to reach these foraging areas. Limited foraging occurred in open pastures and Radiata Pine *Pinus radiata* plantations (Grant 2004). Foraging has been recorded over vineyards (Bourne 2010).

Stratman (2005) compared bat call activity levels across a range of habitats in south-eastern South Australia, including pine plantations, native forests and wetlands. Stratman (2005) also compared activity levels on tracks and away from tracks, both within pine plantations and native forests. Seventy-four SBWB passes were recorded. The study did not detect a statistically significant difference in SBWB activity levels between habitat types, although more calls were recorded on tracks than away from tracks within both native forest and plantation habitat types. This apparent preference for tracks could also be due to higher detectability of lower flying bats, compared with bats potentially flying above the canopy away from tracks, as the Stratman (2005) study used detectors mounted close to the ground. Over half of the SBWB calls (58%) were recorded from wetlands, which represented only 20% of the sample sites. Although not statistically significant, likely due to the low number of observations, this suggests that wetlands provide important habitat, or at least that SBWB calls are more detectable at wetland sites.

The typical foraging strategy involves individuals constantly in flight, sometimes meandering between areas after 5–15 minutes of foraging, or flying to a particular foraging area and remaining there for one or more hours (Grant 2004). The SBWB can travel long distances from the roost site, with lactating females recorded repeatedly returning to areas 23–25 kilometres from the Naracoorte maternity cave (Grant 2004, Bourne 2010). One radio-tracked male was recorded 35 kilometres from the roost site (Bourne 2010).

Recent research, utilising PIT tagging and automated monitoring of cave entrances, has demonstrated that individuals can fly distances up to 70 kilometres from a roost site in a single night and that use of roost caves may vary considerably on a night-by-night and/or seasonal basis with little predictability (van Harten et al. 2022). These long-distance flights have also been acknowledged in the recent (June 2021) EPBC Act Conservation Advice for SBWB (TSSC 2021).

SBWB, and the closely related Common Bent-wing Bat are thought to forage predominantly of moths, with small quantities of other insect orders also taken (Kuhne 2020, Vestjens & Hall 1977). A recent dietary analysis of SBWB guano from the Naracoorte and Warrnambool maternity caves identified 67 moth species, as well as several other insect orders (Kuhne 2020). SBWB also require surface water for drinking (TSSC 2021).

1.4.4 Flight height

Microbat species exhibit a level of vertical stratification during flight, which is influenced by echomorphological characteristics such as body mass, wing shape and wing loading (body mass / wing area) (Rhodes, M 2002), habitat structure, prey selection and echolocation frequency. Bats with long, narrow wings have lower maneuverability in cluttered environments, and tend to fly in open spaces, such as above the tree canopy or within forest gaps such as roads and tracks (Stratman 2005). These high-flying bats generally have low frequency echolocation calls, as low frequency sounds travel further, providing information on obstacles and prey further from the bat. Low frequency echolocation calls are more suited to providing information on larger prey, and as a result these rapid, high-flying bats tend to forage on larger insects such as beetles and large moths. In contrast, bats that fly in cluttered environments are highly maneuverable, and have higher frequency echolocation calls, generally with a broad frequency band (Frequency Modulated), optimised to provide information on prey and obstacles of range of sizes at relatively short distances from the bat.

These relationships can be demonstrated by two species that occur within south west Victoria (using averaged morphological data from south-east Queensland bats published by Rhodes (2002)):

- White-striped Free-tailed Bat *Austronomous australis*
  Weight: 35 g, wingspan: 42 cm, wing area: 0.022 m^2, wing loading (mass / wing area): 15.46, aspect ratio ($wingspan^2$/wing area): 7.99.
  This species is one of the few microbats that emits echolocation calls audible to most humans with good hearing. Call frequency is 10-15 kHz (Pennay, Law, & Reinhold 2004). This species is known to forage in open environments, including above the tree canopy at a height of around 50 m (Churchill 2008) and closer to the ground in open environments.

- Lesser Long-eared Bat *Nyctophilus geoffroy*
  Weight: 7 g, wingspan 25 cm, wing area: 0.011 m^2, wing loading 5.91, aspect ratio: 5.6.
  This species flies in cluttered environments, foraging on insects around foliage, and gleaning insects from foliage. Echolocation calls of this species are frequency modulated, with frequency ranging from 35-80 kHz (Pennay, Law, & Reinhold 2004), although the upper part of the calls is often missing from ultrasonic recordings. Flight heights for this species are thought to be from ground level up to approximately 10 metres (Churchill 2008).

SBWB has ecomorphological and frequency characteristics between these two extreme examples. Mean body weight is 15.7 g (TSSC 2021) and the frequency of calls is between 45 and 50 kHz. The Rhodes (2002) study did not assess SBWB but did include south-east Queensland specimens identified at the time as

Miniopterus schreibersii, which has since been reclassified as *Miniopterus orianae oceanensis*. These specimens had a mean weight of 14 g, wingspan of 31 cm, wing area of 0.014 m^2, wing loading of 9.71 and aspect ratio of 6.66. While there have been few direct studies of SBWB flight behavior, they are generally considered to have a fast, direct flight pattern and to forage in open spaces (Dwyer 1965). In habitats with trees, SBWB typically forage above the canopy (DELWP 2020) or within gaps below canopy level such as clearings for roads and tracks. Further research into flight behavior, including into the heights that SBWB fly at, is identified as a key action in the NRP (DELWP 2020).

Some flight height information is available for the closely related Eastern Bent-wing Bat within New South Wales using detectors connected to a Balloon. Mills and Pennay (2017) carried out 'at height' surveying for Eastern Bent-wing Bats at:

- A location just over five kilometres from a maternity site
- At six locations in the area of the proposed Parsons Creek Wind Farm, which is over 20 kilometres from the maternity site.

Eastern Bent-wing Bats were recorded as flying at heights of 70–130 metres, at the site just over 5 kilometres from the maternity site on three of six nights. Close to ground level at the same recording site and time, Eastern Bent-wing Bats were recorded on all six nights and recording rates were found to be 9.3 times higher close to ground level (0–30 metres high) than within the 70–130 metres height range.

The concentration of Eastern Bent-wing Bats recorded at Parsons Creek over 20 kilometres from the maternity site was found to be much lower than at the location just over five kilometres from the maternity site. No bats of this species were detected flying at 70–130 metres elevation at any of the six sites surveyed at Parsons Creek across the 19 nights of sampling. Eastern Bent-wing Bats were recorded flying between 0–30 metres high on six of 19 nights across these six sites surveyed.

All calls at height were recorded from the location just over five kilometres from the maternity site at a low rate (0.26 passes per hour). The location closest to the maternity site also had much higher recordings of Eastern Bent-wing Bats close to ground level (2.46 passes per hour) compared with the six locations at the study area at a low rate (0.23 passes per hour). Bat activity was not monitored at heights above 130 metres; however, given the low level of activity recorded at heights of 70–130 metres at the study area, it is anticipated that the higher wind speed conditions and energy required to navigate the airspace would result in an increasingly lower level of bat activity at those heights.

The related Common Bent-wing Bat *Miniopterus schreibersii*, is classified by Roemer et al. (2017) as an edge space aerial foraging species which flies more often close to the ground than 'at height'. The Roemer et al. (2017) study, based in France, classified 'at height' as being higher than 20-45 m, and predicted that the species flies at or above theses heights for less than 7% of the time.

1.4.5 Threats and conservation actions

Summary of threats to the SBWB population

A range of threats identified in the Conservation Advice (TSSC 2021) as potentially impacting on the SBWB population are summarised in Table 2. The Conservation Advice, and Table 2 lists these threats in approximate order of severity (decreasing order), however the relative magnitude of each contributing factor on the observed past decline, or potential future decline, of the subspecies is not fully understood.

Table 2 Threats to the Southern Bent-wing Bat population

Threat	SBWB population impacts
Damage or destruction of roost sites	Historically, several known roost caves have been rendered unsuitable for SBWB, by guano mining activities, rubbish dumping, modification of entrances or collapse due to erosion. SBWB are currently only known to breed in three caves, two of which are located in dynamic coastal environments.
Clearing and modification of foraging habitat	Landscapes within the range of the sub-species have been highly modified and fragmented, including clearing for agriculture, clearing for plantation timber production, draining of wetlands and residential and industrial developments. The impact of this land use change on SBWB foraging habitat and their prey species is not well understood, but is likely to be a significant factor in the decline of the subspecies.
Disease including White-nose Syndrome	There is some past evidence of mortality due to disease, and there is currently concern regarding risk of introduction of White-nose Syndrome, caused by a fungus, which has recently resulted in the death of millions of cave-roosting bats in North America. The disease has also been recorded in Asia and Europe, but is yet to be detected in Australia. A recent risk assessment has determined that introduction within the next 10 years is 'highly likely/almost certain', and that the vector of introduction is most likely to be contaminated caving equipment. The risk assessment has determined that the entire distribution of SBWB is within the optimal climatic conditions for the fungus, and that it could quickly spread between sub-populations.
Climate change	SBWB have specific requirements regarding temperature and humidity within breeding and non-breeding caves, and there is a risk that changes in climate may influence survival or breeding success and potentially render some currently utilised caves unsuitable. Drought, in conjunction with unusually low temperatures, has been attributed to a significant pup mortality event in the Naracoorte cave in 2006. Increasing frequency and severity of extreme weather events is likely to impact upon the subspecies, its foraging habitat and prey species abundance.
Human disturbance to caves by visitation or vandalism	Inappropriate human presence within caves, particularly involving the use of bright white lights, can cause young to be dislodged from the ceiling, or adults to be awoken from torpor, resulting in premature depletion of fat reserves. Vandalism has also been reported at cave entrances. For this reason, information regarding exact locations of caves is not made publicly available.
Introduced predators	Domestic Cat (feral) *Felis catus*, Red Fox *Vulpes vulpes* and Black Rat *Rattus rattus* are all known to occur in or around caves, and there is evidence of substantial mortalities due to pest animal predation in both SBWB and Eastern Bent-wing Bats. The level of impact on populations is poorly understood.
Fencing around cave entrances	SBWB have been observed to be killed by collision or entanglement in fencing erected close to cave entrances.

Threat	SBWB population impacts
Wind farms	The conservation advice (TSSC 2021) notes that the impact of wind farm developments on SBWB are unknown, but any wind farms close to a roosting site could potentially have a major impact on that population. Impact pathways include direct impacts to caves, collision with turbines and powerlines, and altered access to foraging areas. The conservation advice notes that international studies have found there can be a cumulative impact on bat populations, particularly on migratory species, and that the risk of collision increases with proximity of windfarms to important sites, particularly maternity sites or migration paths.
Fire	The impact of fire on bats is not well understood, but there are potential impact pathways via entry of smoke into caves, and modification of foraging habitat or prey species availability. Severity and frequency of fires is likely to be influenced by climate change.
Pesticides	Pesticide residues have been detected within guano at the two major maternity sites, but it is unclear if the chemicals have contributed to the decline of the species. Use of agricultural pesticides may also impact upon prey species populations.

Wind farm mortality

Limited publicly available information exists regarding recorded SBWB mortalities at wind farms; however it is known that mortalities have been detected, and assumed that additional mortalities may be undetected, due to limitations inherent in carcass searches.

The following mortality information has been documented:

- Moloney et. al. (2019) collated data from post-construction mortality surveys at 15 Victorian wind farms between 2003 and 2018. They documented eight mortality records of SBWB, but did not provide details of which wind farms recorded the carcasses. Based on the list of wind farms from which data was obtained, eight are understood to be within the known geographic range of the SBWB. Additional mortalities have been documented recently, including information presented at the Mount Fyans Wind Farm Panel Hearing, and it is our understanding that there have been 22 SBWB mortalities documented in total.

- Two of the 15 wind farms investigated in the Moloney et. al. (2019) study had sufficient searcher efficiency and carcass persistence data to model annual mortality rates. One Southern Bent-wing Bat was found dead at one of these wind farms, resulting in a median annual mortality estimate of 14 individuals at that wind farm (95% CI + 1-70), corresponding with a mortality rate of 0.1 SBWB individuals per turbine per year across the wind farm. It is understood that these wind farms had lower rotor tip heights of 28 and 29 metres above the ground.

- Bennett et. al. (2022) undertook a study at the Cape Nelson North wind farm (11 turbines) near Portland during 2018 and 2019 to evaluate the effect of low wind speed curtailment on bat mortality. For SBWB, two carcasses were detected in the pre-curtailment survey period (turbine cut in speed of 3.0 ms^{-1}, January - April 2018) and one carcass was detected in the curtailment survey period (turbine cut in speed of 4.5 ms^{-1}, January – April 2019). The 11 turbines at the Cape Nelson North wind farm are located within 3 to 6 km from the Bats Ridge Wildlife Reserve non-breeding roost cave, and 10-13 km from the sea cave west of Portland, where SBWB breeding activity has been recently discovered.

Conservation actions

The National Recovery Plan (DELWP 2020) and the Conservation Advice (TSSC 2021) list a range of recovery objectives and actions for the sub-species. Actions relate to protection and management of important sites, habitat restoration, research, monitoring, and community engagement.

Due to the difficulty of studying the sub-species, and microbats in general, there are still many knowledge gaps that need to be filled to assist in formulating targeted management actions that may assist in halting or reversing the ongoing population decline.

Research priorities include:

- Clarification of the taxonomic status, distribution and population structure of the sub-species.
- Accurate and long-term monitoring of key roosting sites, including regular estimation of population size, seasonal usage, survival rates, health and breeding success within maternity caves.
- Understanding the relative contribution of the various identified threats to the past and ongoing population decline.
- Locating additional undocumented roosting sites.
- Investigating dietary requirements and availability of foraging resources.
- Determining the microclimatic conditions within the maternity caves.
- Investigating the feasibility and potential benefits of controlling climatic conditions within maternity caves, and construction of artificial maternity cave(s).

The recovery plan (DELWP 2020) makes several recommendations regarding knowledge needs to understand the impact of wind farm developments, including:

- Undertake a population viability analysis to assess the cumulative impacts of multiple wind farms within western Victoria and south-eastern South Australia, involving extensive data collection to improve estimates of population parameters.
- Develop guidelines for pre-construction assessments and post-construction mortality monitoring, including development of new techniques such as radar.
- Routine reporting of post-construction mortality studies to enable collation and sharing of data via a central registry.
- Determine movement behaviour between key breeding and non-breeding sites, including identification of movement corridors and timing of movements.
- Undertake regular monitoring of known bat roost caves located within 10 or 20 km of existing of planned wind farms.
- Investigate the behaviour of bats in the vicinity of turbines, including the height at which they fly.

The recovery plan also acknowledges that the wind industry is a potential source for funding and recommends development of a prioritised register of habitat management or research projects to identify opportunities for investment.

1.5 Detection of bats

Bats are primarily active during the hours of darkness and human observers are generally unable to detect them or accurately document their numbers or most of their activities. Various technological approaches are therefore necessary to detect their presence and activities. These either use detection of bat calls or some method, such as radar scanning, thermal imaging or night-vision equipment that allows bats to be 'seen'.

Some of these technologies, in particular ultrasonic bat call recorders, have been developed into automated systems that can be deployed to collect data for subsequent analysis to determine whether particular taxa occur at a site. Ultrasonic call detectors are applicable for species that emit calls within specified sound frequencies and because of the characteristic calls of most echo-locating species, permit the identification of many species.

Ultrasonic detectors record calls, but they cannot provide information about how many individuals of any species are present. They provide a sample of calls as they are generally limited by the capacity of microphones which are directional and can detect calls only within about 20 – 30 metres (Agranat 2014). Limitations with acoustic detection methods are noted below, and in Section 3.4.

Until recently large-scale bat detection projects, involving multiple detectors monitoring simultaneously for long periods of time, have recorded bat calls in zero-crossing mode. This method results in efficient data storage, and well-established automated identification tools are available to assist in processing the large volumes of data collected. A disadvantage of zero-crossing analysis, however, is that some information is not preserved in the call files, including amplitude (signal strength) and harmonics, as zero-crossing analysis only preserves the strongest frequency recorded at a particular time. Full spectrum recording and analysis is now becoming more widely used, but still has disadvantages of much greater data storage requirements and automated call identification tools are still under development.

Radar can detect flying objects of different size classes but does not have capacity to distinguish different species. Thermal imaging and night-vision equipment are both significantly limited by distance, obstacles like trees, and the need for human observers to be present. They also do not generally allow an observer to distinguish between species that are similar in size and behaviour. Thermal imagery is useful for counting bats exiting cave roosts, where bats are moving through a confined space and all bats are assumed to be of one species.

2. Site context

2.1 Bioregions, landform and geology

Based on a review of desktop information, the project area spans three bioregions:

- Glenelg Plain (majority of the wind farm site)
- Bridgewater (southern sections of the wind farm site)
- Victorian Volcanic Plain (portions of the transmission line route).

Geomorphological Units for the project area are provided in the Glenelg Hopkins Catchment Management Region Geomorphological Units Map (Victorian Resources Online). The project area includes the following main units:

- 6.1.4 – Western Plains: Volcanic derived plains with well-developed drainage and deep regolith (portions of the transmission line route).
- 6.2.1 – Western Plains: Sedimentary derived plains with ridges (portions of the transmission line and wind farm site in the eastern section).
- 6.2.3 – Western Plains: Sedimentary derived karst plains with depressions (majority of the wind farm site).
- 8.5.1 – Coast: Transgressive dunes: Sea level (coastal sections of the wind farm site).

The wind farm site is located within the Nelson land-system. This land system is associated with hardened limestone dunes of the coastal plains. These low-profile dunes produce soils ranging from sandy loams to orange sands with pockets of acidic white sand.

2.2 Land use and landscape context

The following sections describe the land use and landscape context associated with the project (Figure 1).

2.2.1 Pine plantations

The majority of the wind farm site is located within a commercial pine plantation. The GTFP plantation includes Radiata Pine *Pinus radiata* coupes of various ages and is actively managed for timber production. The plantation area also includes a network of tracks, including some public roads and numerous smaller private roads and tracks used for plantation access. The plantation is located on both sides of Portland-Nelson Road. The wind farm is mostly within the plantation situated south of the Portland-Nelson Road, with a small area of turbines to the north of the road in the far west of the Project area. The plantation is situated inland of Discovery Bay Coastal Park, approximately 2 to 3 kilometres from the coast.

Native vegetation and habitat have been cleared to establish the plantation, however there are signs of colonisation by some native understorey species within the plantation, particularly along the plantation fringe and adjacent to vegetated road reserves.

There are also small areas of remnant native vegetation within the plantation. These areas were not cleared during plantation establishment, mostly due to the steep terrain, and are excluded from disturbance by forestry operations.

2.2.2 Blue-gum plantations

The project area also includes areas of Blue-gum *Eucalyptus globulus* plantations near the eastern end of the site (Figure 1). One plantation is situated between the GTFP pine plantation and Discovery Bay Coastal Park near Mount Richmond, and there is an extensive area of Blue-gum plantations in the north-eastern section of the project area, surrounded by Cobboboonee National Park. The Blue-gum plantations are more recently established than the pine plantations, and generally have a higher cover of regenerating native species in the understorey.

2.2.3 Grazing land

The project area includes several areas of farmland, mostly at the eastern end of the project area near Mount Kincaid, and another section of farmland south of Portland-Nelson Road near Nelson. These farmland areas have been mostly cleared of native vegetation and are currently used primarily for dryland grazing by sheep and cattle. Cropping is also conducted in some areas. The cleared paddocks are dominated by introduced grasses, but may have scattered native species present, including grasses, rushes, Austral Bracken *Pteridium esculentum* and shrub species close to adjacent public land.

2.2.4 Nearby conservation reserves

Conservation reserves near the project area are shown in Figure 1 of Biosis (2024), and described in the following sections. Management of these reserves is guided by the Ngootyoong Gunditj Ngootyoong Mara South West Management Plan (Parks Victoria 2015).

Discovery Bay Coastal Park

The project area is located inland from Discovery Bay Coastal Park, which extends along the coastline between Cape Nelson in the east and Nelson in the west. All sections of the Discovery Bay Coastal Park including the Bridgewater Lakes and areas further west are included within the Glenelg Estuary and Discovery Bay Ramsar site.

The Discovery Bay Coastal Park protects the coastline and dune environments and includes wetlands and lakes including the Bridgewater Lakes, Lake Mombeong, The Sheepwash, Cain Hut Swamp, Long Swamp and the Glenelg River estuary. Most of the park supports Ecological Vegetation Class (EVC) 858 Coastal Alkaline Scrub, which has a bioregional conservation status of 'Least Concern' within the Bridgewater Bioregion. The park also contains one of the largest expanses of bare mobile dunes within Victoria.

Lower Glenelg National Park

Lower Glenelg National Park is located to the north of the wind farm site. The park shares a boundary with the wind farm in several locations, including to the east of Nelson and near Mount Piccaninny in the east of the proposed wind farm site. The Lower Glenelg National Park protects a diverse suite of values including Heathy Woodlands (EVC 48), Damp-Sands Herb-rich Woodland (EVC 3), Wet Heathland (EVC 8) and the Glenelg River Estuary and riverine corridor.

The Kentbruck Heath, which spans both Lower Glenelg National Park and Cobboboonee National Park, is one of the largest areas of Wet Heathland in Victoria (Figure 2).

A large section of Lower Glenelg National Park, to the west of the Winnap-Nelson Road, is included within the Glenelg Estuary and Discovery Bay Ramsar site. This includes the Glenelg River and adjacent woodlands and heathlands.

The Glenelg River is included within the recently EPBC Act listed (endangered) community: *Assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria ecological community.* The lower 67.9 kilometres of the Glenelg River is included within the definition of this community. This entire length is located within Lower Glenelg National Park, except for a short section where the river crosses into South Australia near Donovans.

Cave systems are known to be present surrounding and underneath the Glenelg River (White 1998).

Cobboboonee National Park and Cobboboonee Forest Park

Cobboboonee National Park was proclaimed a national park in 2008. Prior to that it was included within Cobboboonee State Forest. Other adjacent sections of the State Forest were proclaimed as Cobboboonee Forest Park. Cobboboonee National Park is continuous with the eastern section of Lower Glenelg National Park, and could be considered as an extension of Lower Glenelg National Park. These parks support extensive areas of Lowland Forest (EVC 16), Heathy Woodland (EVC 48), Herb-rich Foothill Forest (EVC 23) and Wet Heathland (EVC 8).

Cobboboonee National Park and Cobboboonee Forest Park are located to the east of the proposed wind farm. The proposed transmission line route includes underground cables beneath Boiler Swamp Road, which runs east to west through Cobboboonee National Park and Cobboboonee Forest Park (see Figure 2).

Mount Richmond National Park

Mount Richmond National Park is located to the south-east of the proposed wind farm (Figure 2). This park contains extensive areas of Damp Sands Herb-rich Woodland (EVC 3), Heathy Woodland (EVC 48), Damp Heathy Woodland (EVC 793), Damp Heathland and Wet Heathland (EVC 8).

Bushland Reserves and Flora Reserves

Other small reserves close to the project area are shown on Figure 2 and include:

- Jonstones Creek Flora Reserve
- Kentbruck H50 Bushland Reserve
- Mouzie Bushland Reserve
- Kentbruck H14 Bushland Reserve
- Hedditch Hill Scenic Reserve.

3. Methods

3.1 Acoustic surveys

The SBWB acoustic surveys undertaken for this project involved two stages:

1. Preliminary surveys at ground locations and on one met mast – November 2018 to April 2019.
2. Surveys involving four met masts and additional ground locations – December 2019 to December 2020. Detectors were installed in late November 2019, and removed in mid December 2020, so presentation of results is limited to the 12 full months including December 2019 though to November 2020.

Methods used in these surveys are outlined below.

3.1.1 Preliminary surveys – 2018 to 2019

Two rounds of passive echolocation surveys were conducted in November and December 2018 and February to April 2019 within the Kentbruck region (Figure 3 and Table 3). Surveys were conducted with the use of SM4BAT ZC Ultrasonic Recorders and SMM-U1 microphones. The detectors were scheduled to record from sunset to sunrise for every day of their deployment. Where surveys occurred over multiple months detectors were checked every four weeks to check microphone sensitivity, download data and change batteries. A total of 828 nights were surveyed across the two rounds.

The first survey involved ten recorders deployed from 27 and 28 November until 10 December 2018 at sites 1-10 (Figure 3). At each site detectors were deployed on trees at approximately two metres above ground level and with the microphone facing the direction of a cleared path, identified as a likely flyway which bats use to move through vegetated areas (Plate 1). The ten sites were spread across the original project and broader investigation area, with the inclusion of sites within Discovery Bay National Park (adjacent to the plantation), the GTFP Plantation (within which the project is proposed) and HVP Plantation to the north of Portland-Nelson Road (Figure 3).

Eight detectors were redeployed at sites 1-6, 8 and 9 from 6 February until 1 April 2019. Detectors were deployed at site 7 and 10 (HPV Plantation) on the 6 February 2019 but were collected on the 6 March 2019. Sites 7 and 10 were not used in further surveys as the HPV plantation land was removed from the Project.

In early March 2019, a met mast was installed within the GTFP Plantation near Lake Mombeong (Figure 2; Plate 2). Four detectors were deployed at different heights on the met mast from 6 March until 29 April 2019. For these surveys, each height location on the met mast was considered an individual site. Heights were approximately ground level (1.5 metre), and 28 metres, 56 metres and 84 metres above ground level. Except for the detector at ground level, which was attached to a star picket, the other detectors were suspended by individual pulley systems. The heights of each site were an approximate measure of the highest point of these pulleys. Each pulley system was placed in a different direction to the met mast in a triangle formation. The purpose of recording results at multiple heights at an individual location was to collect data showing stratification of bat-call data with height.

Table 3 Bat detector sites for preliminary surveys (2018 to 2019)

Site #	Site name	Area type	2018 Dec.	2019 Feb.	2019 Mar.	2019 Apr.	Total nights deployed
1	Strachan Lane	GTFP plantation	Y	Y	Y	N	67
2	Harolds Track	Mt Richmond Park	Y	Y	Y	N	67
3	Swan Lake	Discovery Bay Park	Y	Y	Y	N	67
4	Spring Road Plantation	GTFP plantation	Y	Y	Y	N	67
5	South Road	Discovery Bay Park	Y	Y	Y	N	66
6	Browns Road Coup	GTFP plantation	Y	Y	Y	N	66
7	Airstrip Road East	HPV plantation	Y	Y	N	N	40
8	Little Dam (Lake Mombeong)	Discovery Bay Park	Y	Y	Y	N	66
9	Nine Mile Road	GTFP plantation	Y	Y	Y	N	66
10	HPV airstrip	HPV plantation	Y	Y	N	N	40
11	Met mast top - 84m	GTFP plantation	N	N	Y	Y	54
12	Met mast upper middle - 56m	GTFP plantation	N	N	Y	Y	54
13	Met mast Lower Middle - 28m	GTFP plantation	N	N	Y	Y	54
14	Met mast bottom - ground	GTFP plantation	N	N	Y	Y	54

Note: Y indicates that the site was monitored in the corresponding survey period. N indicates no monitoring.

3.1.2 December 2019 to December 2020

The expanded 12-month SBWB acoustic monitoring program involved detectors mounted on the existing met mast, and three additional 80 metre tall met masts installed specifically for this monitoring. Nine additional ground detectors were deployed for the full period (Table 4).

The 12-month survey commenced in late spring 2019. This survey included sites 11 to 14 (on the met mast that was used during the preliminary surveys). It also included a further 12 sites, which consisted of four detectors at different heights on three new met masts with heights similar to those at the existing mast. Detectors were installed in late November 2020 (27-28 November) and collected in mid December 2021 (16-17 December). As November 2020 and December 2021 were only partially sampled, these months have been removed from the analysis and data summaries presented in this report. The information presented in this report is for the 12-month period from December 2020 to November 2021, inclusive.

Due to the met mast location used for the preliminary surveys (Mast 3, sites 26-29) described above being within a cleared plantation coupe near to Lake Mombeong it was proposed, in consultation with Lindy Lumsden (DEECA – Arthur Rylah Institute for Environmental Research), that the three other met masts be located within the following sites:

- One site within mature pines close to a wetland which would not be harvested during the study (Mast 4, detectors 31-34).

- One site within mature pines distant from any wetland which would not be harvested during the study (Mast 2, detectors 20-23).
- One site that might be in a movement corridor near wetlands but away from pines. The objective of this site would be to act as a control site representing SBWB usage in a zone of preferred local habitat away from turbines (Mast 1 detectors 25, 15-17).

The sites for the four met masts used for the current surveys are shown in Figure 2 and summarised in Table 4. These sites were selected based on where the parameters outlined above are met within the current project area and where project agreements are in place to install monitoring masts. The locations of the monitoring masts also allowed for a general spread across the project area.

Table 4 Bat detector sites for 2019 to 2020 surveys

Site #	Detector situation	Mast	Height	Within Rotor Swept Height?	Note
15	Met Mast	1	Lower (28 m)		Farmland between plantation and Discovery Bay Coastal Park
16	Met Mast	1	Middle (56 m)		
17	Met Mast	1	Upper (84 m)	Yes	
18	Separate ground detector	-	Ground (1.5 m)		New ground site. Within plantation, close to boundary with Lower Glenelg National Park.
19	Separate ground detector	-	Ground (1.5m)		New ground site. GTFP plantation.
20	Met Mast	2	Lower (28 m)		Central portion of GTFP plantation.
21	Met Mast	2	Middle (56 m)		
22	Met Mast	2	Upper (84 m)	Yes	
23	Met Mast	2	Ground (1.5 m)		
24	Separate ground detector	-	Ground (1.5 m)		New ground site within pine plantation. Site was destroyed in a wildfire in January 2020. Use of this site has been discontinued, and an additional site (39) was established as a replacement.
25	Met Mast	1	Ground (1.5 m)		Farmland between plantation and Discovery Bay Coastal Park
26	Met Mast	3	Ground (1.5 m)		Met mast within young plantation near Lake Mombeong.
27	Met Mast	3	Lower (28 m)		
28	Met Mast	3	Middle (56 m)		
29	Met Mast	3	Upper (84 m)	Yes	
30	Separate ground detector	-	Ground (1.5 m)		Preliminary site 8. Near wetland within Discovery Bay Coastal Park.

Site #	Detector situation	Mast	Height	Within Rotor Swept Height?	Note
31	Met Mast	4	Ground (1.5 m)		Eastern met mast, within GTFP plantation.
32	Met Mast	4	Lower (28 m)		
33	Met Mast	4	Middle (56m)		
34	Met Mast	4	Upper (84m)	Yes	
35	Separate ground detector	-	Ground (1.5 m)		Preliminary site 4. GTFP plantation, eastern end of site.
36	Separate ground detector	-	Ground (1.5 m)		New ground site. Within farmland on the edge of Blue Gum plantation.
37	Separate ground detector	-	Ground (1.5 m)		Preliminary site 6. GTFP plantation.
38	Separate ground detector	-	Ground (1.5 m)		Preliminary site 5. Interface between GTFP plantation and Discovery Bay Coastal Park.
39	Separate ground detector	-	Ground (1.5 m)		New site. GTFP plantation. Replacement for site 24 (burnt).

Detectors and microphones used were the same as described for the preliminary surveys, with the exception of four sites (18, 19, 37, 38), where Anabat Swift Detectors were deployed for the first month of monitoring, due to detector availability constraints. Detectors and microphones were deployed using the same methods as described for the preliminary surveys.

The approach incorporates stratification for variables such as distances from caves known to be in use and heights above the ground. While there are uncertainties and assumptions embedded within this approach (see Section 3.4), we considered it offered the best capacity for results that may help to quantify risk level for the future impact assessment because it:

- Measures call activity at a range of site types (forested, cleared, near-and-far from wetlands).
- Measures call activity at several locations spread horizontally across the site.
- Measures call activity within rotor-swept height at multiple locations, although the height of the masts does not allow for the full range of rotor-swept height to be covered by detectors.
- Allows for stratification data to be collected to see if there are patterns between height and number of calls detected.
- Measures across all seasons in a single year and includes multiple years of measurements at several locations.

A summary of the habitat types in which all detectors were deployed during all acoustic monitoring for bats is provided in Table 5.

Table 5 Summary of detector deployment within habitat types

Mast #	Original site #	New site #	Detector height	Environment	Habitat notes
	1	**1**	1.5 m	pine plantation	uniform pines
	2	**2**	1.5 m	native woodland	uniform woodland
	3	**3**	1.5 m	native woodland	uniform woodland
	7	**7**	1.5 m	pine plantation	near ecotone with patch of cleared pines
	10	**10**	1.5 m	pine plantation	near ecotone with patch of cleared pines
mast 1		**15**	28 m	cleared pasture	grazing land
mast 1		**16**	56 m	cleared pasture	grazing land
mast 1		**17**	84 m	cleared pasture	grazing land
		18	1.5 m	pine plantation	near ecotone with native woodland
		19	1.5 m	pine plantation	uniform pines
mast 2		**20**	28 m	pine plantation	uniform pines
mast 2		**21**	56 m	pine plantation	uniform pines
mast 2		**22**	84 m	pine plantation	uniform pines
mast 2		**23**	1.5 m	pine plantation	uniform pines
	9	**24**	1.5 m	pine plantation	uniform pines; burnt out during deployment
mast 1		**25**	1.5 m	cleared pasture	grazing land
mast 3	**14**	**26**	1.5 m	cleared pine plantation	near ecotone with native woodland
mast 3	**13**	**27**	28 m	cleared pine plantation	near ecotone with native woodland
mast 3	**12**	**28**	56 m	cleared pine plantation	near ecotone with native woodland
mast 3	**11**	**29**	84 m	cleared pine plantation	near ecotone with native woodland
	8	**30**	1.5 m	native woodland	near Lake Mombeong wetland
mast 4		**31**	1.5 m	pine plantation	uniform pines
mast 4		**32**	28 m	pine plantation	uniform pines
mast 4		**33**	56 m	pine plantation	uniform pines
mast 4		**34**	84 m	pine plantation	uniform pines
	4	**35**	1.5 m	pine plantation	uniform pines
		36	1.5 m	bluegum plantation	Near ecotone with grazing pasture
	6	**37**	1.5 m	pine plantation	uniform pines
	5	**38**	1.5 m	coastal heath	at ecotone with pine plantation
		39	1.5 m	pine plantation	uniform pines; replacement for site 24 (burnt).

3.1.3 Detector configuration

Details of detector configuration, for Songmeter SM4BAT detectors is provided in Table 6.

Table 6 Configuration of detectors

Component/Setting	Configuration
Detector type	SM4BAT ZC Ultrasonic Recorder
Power supply	Internal D cell batteries, changed monthly
Memory cards	2 x SDHC memory cards, downloaded monthly
Microphone	SMM-U1 Directly connected to detector. Sensitivity checked monthly as per the detector manual. Microphones were replaced if they failed the sensitivity test
Recording window	AEDT: 8:30 PM – 6:30 AM AEST: 5:30 PM – 7:30 AM
Recording mode	Zero crossing (limitations of zero crossing recordings are described in Section 3.4.2)

3.2 Bat call analysis

Bat calls were analysed using the automated identification software AnaScheme, developed by Matthew Gibson (Biosis) and used in the automated analysis of microbat vocalisations within Australia. The system allows for development of identification keys based on analysis of reference calls. The key used to analyse bat calls for this project was developed and tested by Lindy Lumsden and Peter Griffroen of Arthur Rylah Institute (ARI), DEECA (Key to bats of south-west Victoria, dated 20 June 2011).

The AnaScheme system applies a conservative approach to identifying calls in that only clear, high-quality calls are assigned to a species (bat call examples are provided in Appendix 9). The system also counts recordings which match the criteria to be considered true bat calls but may be of insufficient quality to identify to species level. This allows a measure of overall bat activity to be calculated. Identification settings used in the AnaScheme analysis are provided in Table 7.

Any calls identified by the system as significant or uncommon species were checked manually, by visual comparison with published reference calls by an experienced bat expert, to ensure accurate results.

Table 7 AnaScheme analysis settings

Setting	Configuration
Identification key	South West Victoria Key Arthur Rylah Institute Version: 20 June 2011
Minimum quality of pulses for inclusion	0.9
Minimum number of ZC data points for a pulse	5
Minimum number of pulses required for an identification	5

The AnaScheme system is known to have an issue with false-positive identifications, whereby the system sometimes attempts to identify data sequences that are within files that, upon manual review, are clearly noise. This is particularly an issue with low frequency bat species. To overcome this issue, a combination of manual checking and use of an additional system (Anabat Insight) was used. Anabat Insight includes a filtering algorithm that is very effective at eliminating noise files. The Anabat Insight filtering was conducted for all recordings from mast-based detectors, including the ground level (1.3 m) detector at each mast, to improve the accuracy of the height and wind speed analysis. This process was only applied to the mast-based detectors, as this subset of the data was subject to more detailed analysis than the remainder of the dataset (the isolated ground detectors). The AnaSheme system is conservative, and does not generally overlook valid bat calls, so false-negative errors are not generally an issue.

However, a proportion of bat calls may be unidentifiable to species level, due to poor quality of the recordings, such as calls that are detected towards the outer edge of the range of the detectors. This is an issue with all acoustic monitoring of bat calls, including both zero crossing and full spectrum recordings. A breakdown of the percentages of identifiable bat calls recorded at each height level on the four met masts is provided in Table 8. In the case of Southern Bent-wing Bat, all calls from categories 1 and 2, that were flagged as potential Southern Bent-wing Bat calls were subject to confirmation via a manual identification process, as outlined in Section 3.3. Limitations of acoustic studies, including specific limitations relating to zero-crossing analysis, are documented in Section 3.5.2 and 5.1.9.

Table 8 Percentage of identifiable calls recorded at each detector height on the four met masts

	Ground (1.5 m)	Lower (28 m)	Middle (56 m)	Upper (84 m)	Total
Total number of audio files recorded	202,133	14,408	5,040	28,187	249,768
1. Percentage identified to a species or species complex	10%	21%	24%	7%	11%
2. Percentage identified as a likely bat call but of insufficient quality for confident species identification	11%	7%	9%	3%	10%
3. Percentage of noise recordings unlikely to represent bat calls	79%	72%	66%	90%	80%

Potential SBWB calls were assigned classes following the method outlined in Table 9.

Results of the analysis were compiled into a Microsoft Access database to facilitate production of tabular and graphical outputs. This database included over 2.4 million records, where each record corresponds with an ultrasonic recording (file). The following information was included in each record:

- The filename and path to the file containing the ultrasonic recording, in zero crossing format.
- Site number.
- For mast-based recordings, the mast number and position (height) of the detector.
- Date and time of the recording.
- Average wind speed for the corresponding 10-minute period, where available (the wind speed analysis is described in detail below).
- The outcome of the AnaScheme key, including the species (or unknown) allocated and the confidence estimate.

- The outcome of the Anabat Insight filter, indicating if the recording is considered to contain a valid bat call, or all noise. This analysis was performed for mast-based detectors only.
- The file size (number of datapoints) for the recording.

Table 9 Call categorisation criteria applied to SBWB call files

	Criteria for categorisation
Confirmed SBWB	- Call identified as SBWB by the key for the bats of southwest Victoria.
Possible SBWB	- Majority of pulses in the sequence are within the target frequency range of 45–50khz ***AND*** show at least one of the following diagnostic features: – Pulses show some flattening/opening rather than long/steep downsweeps – Pulses show angular knee/heel – If 'hooks' are present, they are not cup-shaped (like *V. vulturnus*) and the downsweep is not as straight – If 'droop' is present, it is not just an 'afterthought' (like *C. morio*).
Unlikely SBWB	- May contain pulses showing one or more diagnostic features above but majority of pulses fall outside the target frequency range of 45–50kHz - Sequence is short and not readily identifiable but pulses are within 45–50kHz - Sequence is within target frequency range but pulses lack diagnostic features.
Confirmed other species/noise	- Sequence not a bat call - Sequence is of such low quality it is not possible to confirm an identification - Sequence is readily identifiable as a different species - Sequence is outside target frequency range of 45–50 kHz.

3.3 Manual checking

Recordings identified by the automated process as either confirmed or potential SBWB calls were subject to a manual checking process. Manual checking was undertaken by Senior Zoologist (Bat Ecology) Felicity Williams, who is experienced with the identification of SBWB and other microbat species from both zero crossing and multi-spectral ultrasonic recordings. 2,739 recordings were examined, and these were assigned to the following categories:

- Confident SBWB
- Probable SBWB
- Species complex including SBWB and *Vespadelus* spp.
- Unlikely to be SBWB
- Poor quality recording with insufficient information for identification
- Noise (not bat calls).

Graphical examples of these categories are shown in Appendix 9.

3.4 Wind speed analysis

The three eighty metre met masts were equipped with anemometers at heights of approximately 80 m, 70 m and 50 m. The taller met mast was equipped with anemometers at heights of approximately 109m, 105m, 90m, 70m and 50m. Please refer to the corresponding commissioning report for more details.

Wind speed data were derived from the four met masts for the period of the microbat surveys, to enable investigation of patterns between bat activity and wind speed, and to provide an assessment of the frequency distribution of wind speed throughout the study, using both 24-hour data and data from night time only.

Wind data were extracted for the period from 1/12/2019 to 31/12/2020. The extraction was conducted by Aurecon within 10 minute time periods. Average wind speed within each 10 minute time period was extrapolated to correspond with the three detector heights (28 m, 56 m and 84 m) and at the potential hub height of 143 m.

Aurecon note the following in relation to the extrapolation process:

- The extrapolation was done using the same method for each height and at each mast. It used measured shear for each timestep to preserve the diurnal, seasonal and directional patterns. The extrapolation was done from the line of best fit, and the same process was used for the wind speed standard deviation.
- The extrapolation method assumes that the shear profile is consistent (the shear between the anemometer heights is the same as the shear outside these heights).
- Meaningful extrapolations could not be performed at 1.5m, due to the presence of trees around several of the masts. This was also an issue for extrapolation of wind speed at 28 m at mast 2, where trees around the masts were approximately 30 m high.
- The extrapolation at 28 m is inaccurate in an absolute sense, however the data can be used to evaluate how wind speed changes over the day and with other weather changes.

Frequency distributions of wind speed were determined by assigning the 10 minute average wind speeds to speed classes, and calculating the number of 10 minute intervals corresponding to these classes over the survey period. This analysis was conducted using 1 ms wind speed classes (ie 0-1 ms, 1-2 ms etc.). Separate wind speed frequency distributions were calculated for each of the three detector heights and for hub height (143 m) for the full 24 hour period, and for night time only. Data were pooled across the four masts.

Each 10 minute period was assigned to either “day-time” or “night-time” with reference to sunrise and sunset times for each day at Portland, sourced from the timeanddate.com website.

Wind speed was allocated to all ultrasonic call recordings where data were available from the detector location and corresponding time period. This was done in 10 minute time intervals, where ultrasonic recordings were assigned the average wind speed for the corresponding 10 minute period from the extrapolated wind speed mast dataset. This allocation was conducted for detectors at 28 m for three masts and for detectors at 56 and 84 m for all four masts. No direct matching of wind speed was undertaken for detectors located at ground level (1.5 m).

3.5 Limitations of bat detector surveys

As with all survey methods, acoustic detection methods have limitations. The unavoidable and unmeasured limitations of this methodology included:

- **Limited detection zone (volume of airspace)**
  The size of the sample area is difficult to quantify, as detectability of bat calls is affected by environmental conditions, including humidity levels. It is also possible that detection distance varies with the frequency of the bat call (e.g. lower frequency sounds travel further), and calls broadcast by the bats below the decibel threshold of the equipment will be undetectable. Further information regarding determining the detection envelope is provided in Section 3.4.1.
- **Limited height zone**
  The maximum height at which detectors could be installed was 84 metres, which is in the lower portion of the rotor-swept height, which could extend as high as 270 metres, depending on the turbine model selected. Given it was impossible to collect data from above 84 metres, trends would need to be extrapolated using mathematical techniques.
- **Inability to distinguish between individuals, or to know how many individuals are present**
  Ultrasonic call recorders do not provide absolute abundance data, as it is not possible to distinguish between multiple individuals flying past the detector, or one individual making repeated passes.
- **Potential for species to fly without calling**
  International studies have identified situations where some bat species may sometimes fly without emitting echolocation calls. These flights would not be detected. As yet there is no documented evidence of this occurring with SBWB and it is understood that they are likely to call during all flights (L. Lumsden pers. comm. 2019).

Some factors that were considered limitations of the methodology could be examined and measured lending them to be considered minor limitations:

- **Impact of noise**
  Bat detectors are triggered to record by bats calling within the target frequency range, but may also be triggered by other noises. Additionally, when triggered by bats, detectors will record and distinguish between all sounds within the frequency range, which will include bat calls and other noises. An assessment of the impact of noise on the ability of detectors to record bat calls was undertaken by Marshall Day Acoustics (provided in Appendix 4) which determined that SBWB calls were easily distinguishable from noise recorded.
- **Issues identifying between species with overlapping characteristics**
  Bat species show overlapping characteristics in their echolocation calls. It is not always possible to confidently identify calls to species level. Therefore some data represent unknown valid bat calls. This did not impact SBWB calls which are easily identifiable (bat call examples are provided in Appendix 9).
- **Equipment failure**
  Equipment failure can be an issue in any monitoring using electronic equipment over long time periods. In this case, bat detectors were attached at height using rope pulleys to met masts. Some difficulties were encountered, but any issues were resolved during the monthly checks.
- **Inability to identify movement direction or behaviour (i.e. foraging vs commuting)**
  Similarly, the calls do not, generally, indicate the behaviour of the bat. In some cases foraging pulses (feeding buzzes) can be seen, but these occur at a different frequency and are often not

possible to identify to species. Directional call characteristics were considered a minor limitation to the results.

3.5.1 Acoustic detection envelope

It is not possible to definitively quantify the detection envelope for ultrasonic microphones used to detect microbats, in order to quantify the volume of airspace sampled for all sites, and all bat species, over the duration of this study. Detection distance is influenced by the characteristics of the sound source (i.e. the bat), the environment the sound travels through, and the microphone. No two microphones have exactly the same sensitivity profile, even when new. These sources of variability are further discussed below:

- **Variation at the sound source**
  Microbats may not produce consistent sounds. Calls may vary in frequency, both between species and individuals, and within individual call recordings. Calls below the decibel threshold of the detectors will not be detected. The spatial relationship between the bat and the detector, including orientation and direction of movement, may impact the validation of the call at the microphone although there is no evidence of this occurring.

- **Environmental influences**
  Movement of sound through the air is influenced by air pressure, air moisture and air temperature, and these factors have variable impacts on different sound frequencies. Air pressure is influenced by elevation and weather conditions including wind. Sound characteristics are also influenced by clutter, such as foliage, reflective surfaces or other structures which cause reflections or echoes which can result in reduced signal to noise ratios.

- **Microphone sensitivity**
  Ultrasonic detectors will only record sounds when a trigger is achieved, which requires the sound signal to exceed the background noise (noise floor) by a set threshold. Microphone sensitivity varies with all microphones, as it is impossible to manufacture microphones with identical sensitivity (Agnarat 2014). Microphones used in this study are expected to vary in sensitivity by ± 4bB, and this variation may not be consistent across the entire frequency range.

Wildlife Acoustics have undertaken sensitivity testing for microphones used in their detectors (Agranat 2014), in order to quantify the estimated detection distance in a controlled environment, with a controlled sound source. The testing was undertaken with constant temperature (20°C) and relative humidity (50%), using a signal generator with a sound pressure level (loudness) of 94 dB at 0.1 m from the source. This sound pressure level is considered ‘moderate’ as many microbat species are quieter than this, while others are louder. For sounds at 20 kHz frequency, average detection distance was 28.2 m, which could range from 24.2 m to 32.5 m due to the ± 4bB variation in microphone sensitivity. At 40 kHz, detection distance reduced to 20.0 m, ranging from 17.8 m to 22.3 m.

For the purpose of this study, it is likely the detection distance is in the order of 20 m. However, for the reasons explained above this is highly variable, and the analysis presented in this report does not attempt to quantify bat activity per unit volume of airspace.

The approximate detection distance of 20 m also means it is unlikely that individual bat calls have been detected on adjacent detectors, as they are spaced at approximately 28 m intervals on the masts (1.5m, 28m, 56m and 84m). This spacing was considered during the design of the project, to minimise the chance of duplicate recordings of the same individual microbat vocalisations.

3.5.2 Limitations with zero crossing recordings and analysis

As noted in Table 6, detectors were set to record in zero crossing mode, rather than full spectrum mode. Zero crossing analysis allows for the analysis of frequency and time information from bat calls, focusing on the strongest part of the signal. Unlike full spectrum analysis, no information is available regarding amplitude or harmonics.

Zero crossing mode was used for several reasons:

- The file format is highly efficient in terms of file size and data storage, which is particularly relevant for long term studies with multiple detector locations such as this study.
- Zero crossing analysis is widely used in Australia and overseas, and there are well established processes for automated identification of bat calls. Identification keys and reference calls are available for zero crossing data, but still under development for full spectrum data. Automated processes are not as well established for full spectrum data as yet, and while the files may contain more information, identification processes are highly labour intensive and subjective, involving manual examination of calls.

Key limitations of zero cross mode, in comparison with full spectrum recording mode, are:

- Lower proportion of calls identifiable
- Only higher quality calls can be identified, meaning that some calls from further away, or in noisier conditions might be overlooked.
- Difficulty identifying calls when multiple individuals or species might be calling at the same time.

3.6 Permits

Flora and fauna assessments undertaken by Biosis have been under provisions of the following permits and approvals:

- Approvals 30.17 and 19.18 issued by the Wildlife and Small Institutions Animal Ethics Committee of the Victorian Government Department of Energy, Environment and Climate Action (Animal Welfare Victoria).
- Scientific Procedures Fieldwork Licence issued by the Wildlife and Small Institutions Animal Ethics Committee (Licence Number 20020).

4. Survey results

A summary of the bat survey results for all species is provided below. Most of the results section, however, focuses on the critically endangered SBWB. Results relating to other species are also considered when examining relationships between wind speed and recording height.

4.1 Bat survey results

Species recorded in the acoustic surveys include:

- Gould's Wattled Bat *Chalinolobus gouldii*
- Chocolate Wattled Bat *Chalinolobus morio*
- Eastern False Pipistrelle *Falsistrellus tasmaniensis*
- Free-tailed Bats *Ozimops* spp.
- Southern Bent-wing Bat *Miniopterus orianae bassanii* (EPBC Act listed, FFG Act listed as critically endangered)
- Southern Myotis *Myotis macropus*
- Long-eared bats *Nyctophilus* spp. (Likely *N. geoffroyi* and *N. gouldi*)
- White-striped Free-tailed Bat *Austronomus australis*
- Large Forest Bat *Vespadelus darlingtoni*
- Southern Forest Bat *Vespadelus regulus*
- Little Forest Bat *Vespadelus vulturnus*
- Inland Broad-nosed Bat *Scotorepens balstoni.*

None of the recorded species, other than SBWB, are listed under Victorian or Commonwealth threatened species legislation. The Southern Myotis *Myotis macropus*, was previously considered near threatened on the Victorian Advisory List, but was not added to the FFG Act threatened list in the recent (2021) review of the Act.

The assemblage of species recorded is relatively typical for south-western Victoria. Although the Inland Broad-nosed Bat is generally recorded further north, it has been detected in several recent acoustic detection studies in south-west Victoria.

As noted in section 3.4.2, not all species can be confidently identified to species level due to overlapping call characteristics. The two Long-eared bat species *Nyctophilus geoffroyi* and *Nyctophilus gouldi*, both highly likely to be present, could not be separated, and calls of these species are also very similar to the Southern Myotis.

The most frequently recorded microbat species was the White-striped Free-tailed Bat *Austronomus australis*, with over 8,000 recordings from the 16 met mast mounted detectors across the survey period (Appendix 6). This corresponds with a recording rate of 1.8 bat passes per detector per night. This species was recorded at all detector levels and all masts. Recording rates were highest at the lower (28 m) and middle (56 m) detectors, although recording rates at the upper (84 m) detectors were also common, suggesting that this species does frequently fly within rotor-swept height.

Members of the Forest Bat genus *Vesperdalus* spp. were also frequently recorded with 2.63 passes per detector per night. The majority of these recordings were from the ground and lower (28 m) detectors, with very few recordings at 56 or 84 m. The Large Forest Bat *Vespadelus darlingtoni* and the Southern Forest bat *Vespadelus regulus*, were both recorded in low numbers at the two highest detector levels.

Other species recorded at all detector levels were the Free-tailed Bats *Ozimops* spp., the Inland Broad-nosed Bat and Gould's Wattled Bat *Chalinolobus gouldii*. The related, but smaller and higher frequency calling Chocolate Wattled Bat *Chalinolobus morio*, was recorded at all masts, mostly at ground level, with a small number of recordings at 28 m.

Species detected within rotor swept height (84 m detector) were, in decreasing order of number of recordings:

- White-striped Free-tailed Bat *Austronomus australis* (1663 recordings)
- Gould's Wattled Bat *Chalinolobus gouldii* (107 recordings)
- Free-tailed Bats *Ozimops* spp. (82 recordings)
- Inland Broad-nosed Bat *Scotorepens balstoni* (77 recordings)
- Large Forest Bat *Vespadelus darlingtoni* (8 recordings)
- Southern Forest Bat *Vespadelus regulus* (3 recordings)
- Southern Bent-wing Bat *Miniopterus orianae bassanii* (1 recording).

Species not recorded within rotor swept height (84 m detector) were:

- Chocolate Wattled Bat *Chalinolobus morio*
- Eastern False Pipistrelle *Falsistrellus tasmaniensis*
- Long-eared bats *Nyctophilus* spp. (Likely *N. geoffroyi* and *N. gouldi*)
- Little Forest Bat *Vespadelus vulturnus.*
- Southern Myotis *Myotis macropus*

4.1.1 Summary of manual checking

Manual examination of 2,743 recordings identified by the automated process as either 'confirmed' or 'potential' SBWB calls resulted in the outcome presented in Table 10. The manual identification process was limited to data collected during the 12 month survey (December 2019 to November 2020).

Table 10 Manual checking of SBWB calls

Automated identification	Manual Identification (likelihood of SBWB)						Total
	Confident	Probable	Complex	Unlikely	Poor quality	Noise	
SBWB	8	116	756	23	55	6	964
Potential SBWB	12	174	1351	121	120	1	1779
Total	20	290	2107	144	175	7	2743
Percentage of total	1%	11%	77%				
Cumulative percentage	1%	11%	88%				

The majority (77%) of recordings identified by the automated process as confirmed or potential SBWB were assessed in the manual ID process as species 'complex' calls. When combined with probable and confident SBWB identifications, this results in 88% of the calls having potential to be SBWB.

Data presented in Section 4.3, for the 12 month period from December 2019 to November 2020, makes use of the manual identification results. Unless otherwise stated, tables and graphs present numbers of calls within the following categories:

- **Confirmed and Probable SBWB** – these categories are generally grouped, as they represent recordings considered highly likely to be SBWB.
- **Complex** – a high proportion of calls identified in the automated identification process were, following manual examination, determined to belong to a species complex, which includes SBWB and other species including *Vespadelus* spp. These identifications are included separately in the tables and graphs, as an unknown number of them may be SBWB.
- **Unlikely, poor quality and noise** files are excluded from further analysis as these are considered unlikely to be recordings of SBWB activity.

4.2 Southern Bent-wing Bat survey results (preliminary surveys December 2018 to April 2019)

The number of confirmed SBWB recordings from the preliminary surveys carried out in December 2018 to April 2019 are summarised in Table 11. The SBWB was recorded across all ground detectors (sites 1 to 10 in Table 11). SBWB were also recorded at the ground detector at the one mast that was installed for these preliminary surveys (site 14 in Table 11) (installed prior to the March 2019 survey period). No SBWB calls were detected from the other three higher detectors on the mast (sites 11 to 13 in Table 11). Note that the manual identification process was limited to data collected during the 12 month survey (December 2019 to November 2020). The data presented in Table 11 shows confirmed SBWB calls as identified in the automated (AnaScheme) identification process only.

Table 11 Southern Bent-wing Bat recordings from preliminary surveys (December 2018 – April 2019)

Site #	Site name	Area type	Within current project boundary	Dec. 2018	Feb. 2018	Mar. 2019	Apr. 2019	Total nights deployed	Total number of SBWB calls recorded (confirmed[1])	Confirmed SBWB passes per night
1	Strachan Lane	GTFP plantation	Outside	Y	Y	Y	N	67	3	0.04
2	Harolds Track	Mt Richmond Park	Outside	Y	Y	Y	N	67	55	0.82
3	Swan Lake	Discovery Bay Park	Outside	Y	Y	Y	N	67	126	1.88
4	Spring Road Plantation	GTFP plantation	Within	Y	Y	Y	N	67	70	1.04

Site #	Site name	Area type	Within current project boundary	Dec. 2018	Feb. 2018	Mar. 2019	Apr. 2019	Total nights deployed	Total number of SBWB calls recorded (confirmed[1])	Confirmed SBWB passes per night
5	South Road	Discovery Bay Park	Outside	Y	Y	Y	N	66	1	0.02
6	Browns Road Coup	GTFP plantation	Within	Y	Y	Y	N	66	1	0.02
7	Airstrip Road East	HPV plantation	Outside	Y	Y	N	N	40	14	0.35
8	Little Dam (Lake Mombeong)	Discovery Bay Park	Outside	Y	Y	Y	N	66	3	0.05
9	Nine Mile Road	GTFP plantation	Within	Y	Y	Y	N	66	15	0.23
10	HPV airstrip	HPV plantation	Outside	Y	Y	N	N	40	125	3.13
11	Met mast top – 84m	GTFP plantation	Within	N	N	Y	Y	54	0	0.00
12	Met mast upper middle – 56m	GTFP plantation	Within	N	N	Y	Y	54	0	0.00
13	Met mast Lower Middle- 28m	GTFP plantation	Within	N	N	Y	Y	54	0	0.00
14	Met mast bottom - Ground	GTFP plantation	Within	N	N	Y	Y	54	4	0.07

Table note: 1. See Table 9 for a definition of confirmed calls. Y indicates monitoring was conducted at the site during the corresponding time period.

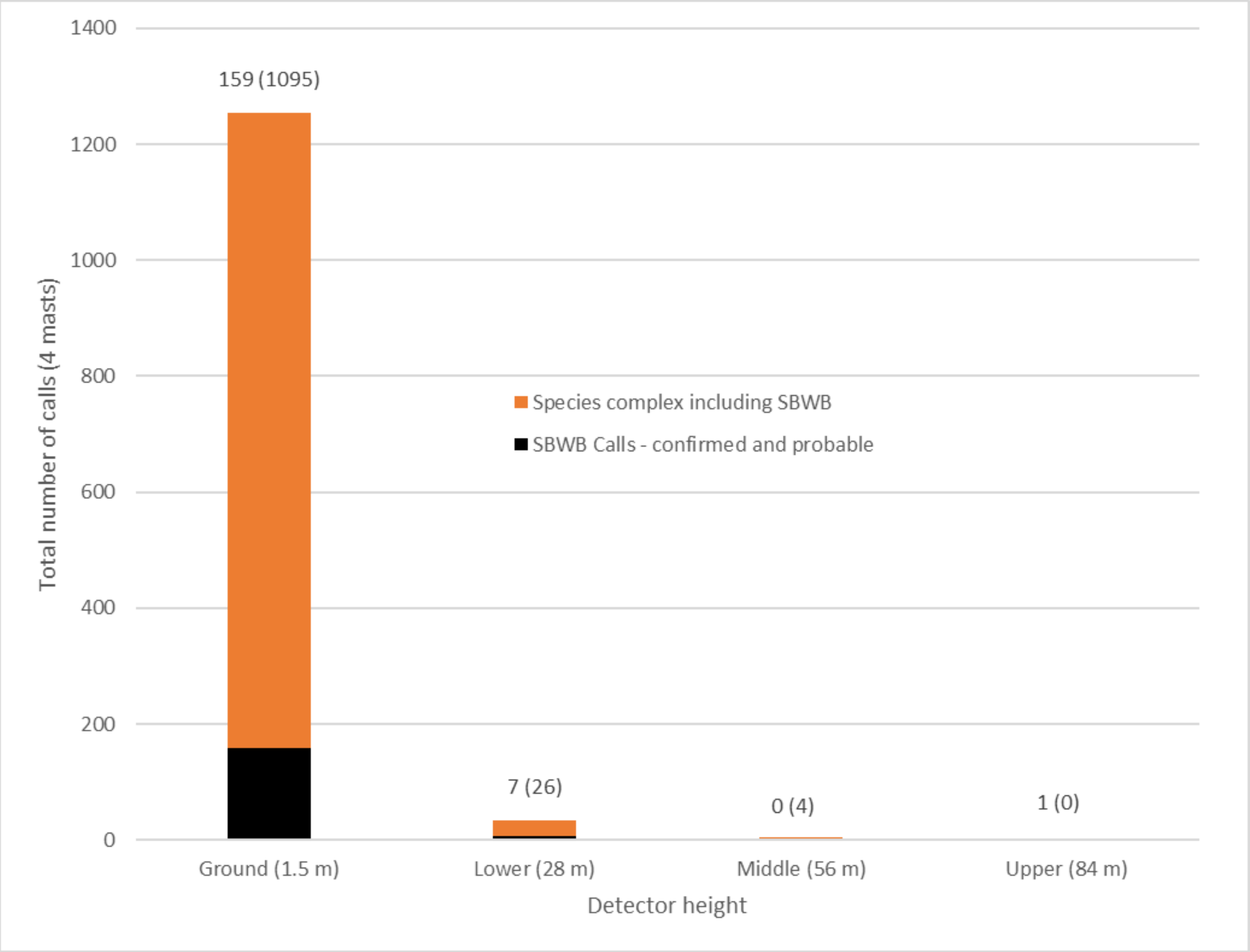
4.3 Southern Bent-wing Bat survey results (December 2019 – November 2020 surveys, inclusive) – mast mounted detectors

The number of confirmed SBWB calls recorded during the 12-month SBWB survey at the mast mounted detectors is summarised in Table 12. The locations of the four masts used for this survey are shown in Figure 2. SBWB calls have been recorded at all masts, although not at all masts across all survey months. Call activity reduced in late autumn (May) and early winter (June). The majority (1,254 calls, 97% of total (confirmed, probable and complex calls) of calls were recorded on the ground detectors (1.5 metres above ground), with 33 calls recorded at the lower (28 m) detectors, 4 calls at the middle (56 m) detector and 1 call at the upper (84 m) detector (Graph 1).

Table 12 Southern Bent-wing Bat (SBWB) call recordings from the four met masts

Numbers of calls shown represent the total of confirmed and probable SBWB calls, as identified in the manual identification process.
Numbers in parentheses show the total number of calls identified as the species 'complex' that includes SBWB.

	Mast 1				Mast 2				Mast 3				Mast 4			
Month	Ground (1.5 m)	Lower (28 m)	Middle (56 m)	Upper (84 m)	Ground (1.5 m)	Lower (28 m)	Middle (56 m)	Upper (84 m)	Ground (1.5 m)	Lower (28 m)	Middle (56 m)	Upper (84 m)	Ground (1.5 m)	Lower (28 m)	Middle (56 m)	Upper (84 m)
2019_12	(13)	-	-	-	(3)	(17)	(3)	-	-	(1)	-	-	(5)	-	-	-
2020_01	(6)	-	-	-	7 (7)	-	-	-	4 (2)	-	-	-	(2)	-	-	-
2020_02	(121)	(1)	-	-	6 (15)	-	-	-	6 (10)	-	-	-	9 (41)	(1)	-	-
2020_03	(110)	-	-	-	15 (29)	-	(1)	-	7 (30)	-	-	-	5 (55)	(1)	-	-
2020_04	1 (31)	-	-	-	(1)	-	-	-	2 (7)	-	-	-	5 (18)	-	-	-
2020_05	(7)	(1)	-	-	-	-	-	-	3 (12)	-	-	-	3 (7)	-	-	-
2020_06	(3)	-	-	-	-	-	-	-	1 (5)	-	-	-	2 (4)	-	-	-
2020_07	(4)	-	-	-	-	-	-	-	-	-	-	-	(2)	-	-	-
2020_08	(50)	-	-	-	(1)	-	-	-	6 (3)	-	-	-	(7)	(1)	-	-
2020_09	1 (149)	-	-	-	2 (5)	-	-	-	11 (28)	2 (1)	-	-	(35)	-	-	-
2020_10	(7)	-	-	-	3 (10)	2 (1)	-	-	19 (3)	-	-	-	3 (6)	-	-	-
2020_11	(157)	-	-	-	19 (44)	2 (1)	-	-	8 (23)	1 (0)	-	-	11 (17)	-	-	1 (0)
Total	2 (658)	0 (2)	-	-	52 (115)	4 (19)	0 (4)	-	67 (123)	3 (2)	-	-	38 (199)	0 (3)	-	1 (0)



Graph 1 Total number of confirmed SBWB calls recorded from mast mounted detector locations

4.4 Southern Bent-wing Bat survey results (December 2019 – November 2020 surveys) – ground-based detectors

SBWB activity data for the 12-month survey period – December 2019 to November 2020 (inclusive) – is presented using the number of confirmed SBWB classifications, as described in Table 9.

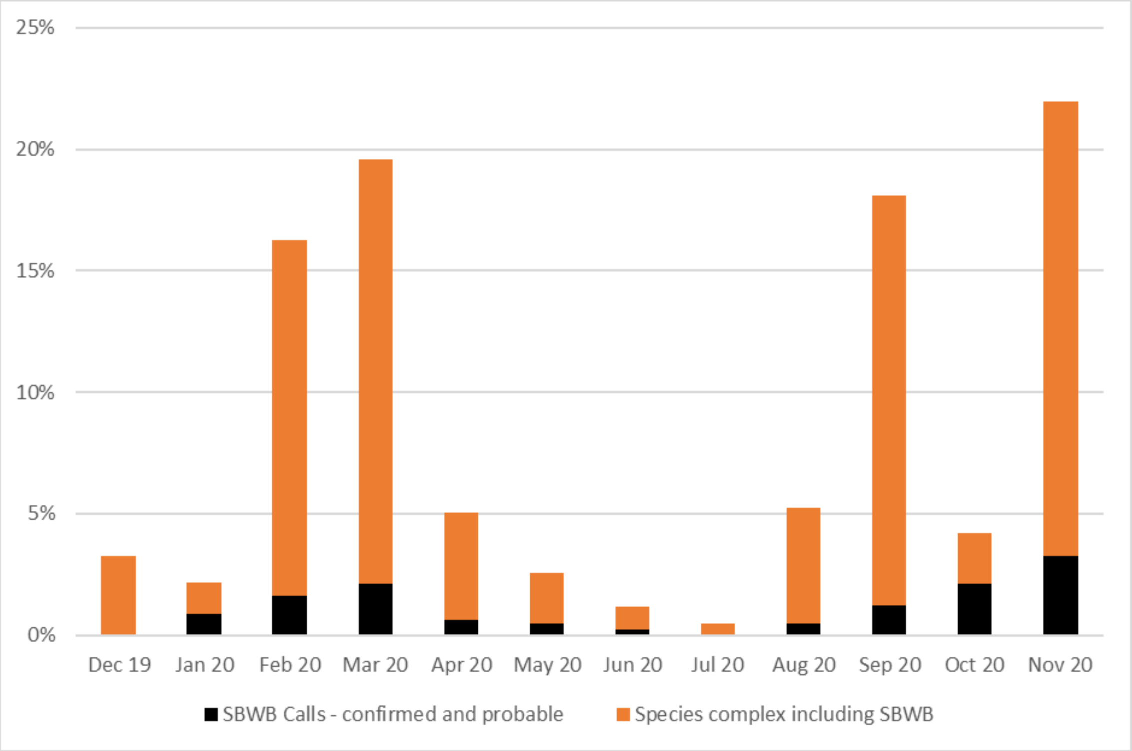
Recordings of SBWB from ground-based detectors (including detectors at the base of the four masts) are summarised in Table 13. The locations of the ground-based detectors are shown in Figure 3. SBWB have been recorded across the project area. The detector with the highest numbers of recorded calls (site 18) is in the west of the project area, close to the southern edge of Lower Glenelg National Park, approximately 4 kilometres south of the Glenelg River. Other ground-based detectors with relatively high numbers of calls include site 25 (also in the west of the project area), site 31 (in the east) and site 39 (near the centre of the site).

Table 13 Southern Bent-wing Bat (SBWB) call recordings from ground detectors (2020)

Numbers of calls shown represent the total of confirmed and probable SBWB calls, as identified in the manual identification process.
Numbers in parentheses show the total number of calls identified as the species 'complex' that includes SBWB.

Site	2019	2020											Total
	12	1	2	3	4	5	6	7	8	9	10	11	
Site 18	- (13)	- (6)	- (121)	- (110)	1 (31)	- (7)	- (3)	- (4)	- (50)	1 (149)	- (7)	- (157)	**2 (658)**
Site 19	-	- (15)	1 (27)	- (36)	- (6)	-	-	-	-	- (1)	-	- (7)	**1 (92)**
Site 23 (Mast 2)	- (3)	7 (7)	6 (15)	15 (29)	- (1)	-	-	-	- (1)	2 (5)	3 (10)	19 (44)	**55 (115)**
Site 25 (Mast 1)	-	- (23)	4 (35)	6 (55)	2 (7)	1 (4)	-	-	3 (-)	1 (10)	2 (11)	13 (39)	**32 (184)**
Site 26 (Mast 3)	-	4 (2)	6 (10)	7 (30)	2 (7)	3 (12)	1 (5)	-	6 (3)	11 (28)	19 (3)	8 (23)	**70 (123)**
Site 30	-	- (3)	1 (9)	- (20)	1 (14)	2 (20)	-	-	3 (3)	6 (10)	- (13)	4 (23)	**19 (115)**
Site 31 (Mast 4)	- (5)	- (2)	9 (41)	5 (55)	5 (18)	3 (7)	2 (4)	- (2)	- (7)	- (35)	3 (6)	11 (17)	**38 (199)**
Site 35	-	- (-)	- (35)	- (66)	- (3)	- (1)	- (1)	-	- (4)	- (10)	- (3)	- (4)	**0 (127)**
Site 36	12 (-)	2 (4)	4 (13)	1 (14)	2 (16)	4 (17)	- (-)	- (5)	- (7)	- (5)	- (2)	5 (13)	**30 (96)**
Site 37	-	-	-	- (5)	- (4)	- (2)	-	-	-	- (3)	- (3)	1 (4)	**1 (21)**
Site 38	-	-	-	- (2)	-	- (2)	-	-	-	- (3)	-	-	**0 (7)**
Site 39	- (11)	- (15)	2 (54)	5 (50)	7 (46)	- (7)	- (7)	-	- (2)	- (10)	2 (13)	5 (76)	**21 (291)**
Total	**12 (32)**	**13 (77)**	**33 (360)**	**39 (472)**	**20 (153)**	**13 (79)**	**3 (20)**	**0 (11)**	**12 (77)**	**21 (269)**	**29 (71)**	**66 (407)**	**269 (2028)**

The seasonal distribution of SBWB recordings is summarised in Graph 2. This graph shows the proportion of calls recorded within each month included in the survey. The data indicate activity peaks within late summer and early autumn (February and March) and again in spring (September to December), although activity levels in October were relatively low in comparison. Activity levels were relatively low throughout late autumn and winter (May to August), when foraging is less energetically beneficial in cold conditions, and SBWB enter periods of torpor (TSSC 2021). Recent research summarised in the conservation advice (TSSC 2021) suggests that some activity is maintained in the colder months, including movement between non-maternity caves.



Graph 2 Temporal distribution of SBWB calls

The temporal distribution of recordings throughout the night-time recording period is presented in Table 14 (calls identified in the manual identification process as confirmed and probable SBWB calls) and Table 15 (calls identified in the manual identification process as confirmed, probable or belonging to a complex including SBWB). The table shows the distribution of calls throughout the night, expressed using the percentage of calls within 1 hour periods. During the summer months, the earliest recordings identified as SBWB were in the one-hour period following 8 PM. In winter activity levels were much lower (particularly in July), but the first detected calls were also recorded in the first one or two hours follow sunset (5-6 PM).

SBWB were recorded throughout the time of darkness, but in general highest activity levels were recorded in the first few hours following sunset. This post sunset activity peak is seen in many microbat species and is likely due to warmer air temperatures and higher abundance of insects early in the night.

There does not appear to be a second, pre-dawn activity peak that is sometimes observed in microbat acoustic studies.

Table 14 Percentage of Southern Bent-wing Bat (SBWB) call recordings by time of night for each month of the survey period – confirmed and probable SBWB calls

	PM							AM								Pooled monthly activity (%)
Month	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	
2019 December	0	0	0	0	33	8	8	17	17	8	8	0	0	0	0	**4**
2020 January	0	0	0	0	0	23	23	38	15	0	0	0	0	0	0	**5**
2020 February	0	0	0	6	12	27	24	9	0	9	9	3	0	0	0	**12**
2020 March	0	0	0	49	15	8	0	5	8	10	3	3	0	0	0	**14**
2020 April	0	0	20	15	5	5	5	0	10	5	15	10	10	0	0	**7**
2020 May	0	8	15	15	0	8	8	15	15	0	15	0	0	0	0	**5**
2020 June	0	0	0	0	0	0	33	0	67	0	0	0	0	0	0	**1**
2020 July	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
2020 August	0	0	58	25	17	0	0	0	0	0	0	0	0	0	0	**4**
2020 September	0	0	22	26	17	9	13	4	4	0	4	0	0	0	0	**9**
2020 October	0	0	0	13	26	10	13	3	13	3	16	3	0	0	0	**12**
2020 November	0	0	0	1	17	17	14	16	6	10	13	6	0	0	0	**26**

Table 15 Percentage of Southern Bent-wing Bat (SBWB) call recordings by time of night for each month of the survey period – confirmed, probable and complex SBWB calls

	PM							AM								Pooled monthly activity (%)
Month	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	
2019 December	0	0	0	0	14	18	17	12	9	9	20	0	0	0	0	**3**
2020 January	0	0	0	0	27	21	23	18	7	1	2	1	0	0	0	**4**
2020 February	0	0	0	3	29	32	16	6	3	4	4	2	0	0	0	**17**
2020 March	0	0	0	29	16	7	6	7	13	9	6	4	2	2	0	**22**
2020 April	0	0	16	18	6	3	3	5	12	10	11	9	6	1	1	**7**
2020 May	1	17	12	8	10	8	8	5	10	13	8	2	0	0	0	**4**
2020 June	9	17	0	0	0	4	4	17	26	13	9	0	0	0	0	**1**
2020 July	27	45	9	0	18	0	0	0	0	0	0	0	0	0	0	**0**
2020 August	0	21	23	13	3	11	3	1	3	3	11	6	0	0	0	**4**
2020 September	0	1	15	13	13	8	10	13	8	11	7	3	0	0	0	**13**
2020 October	0	0	0	12	21	14	13	9	12	6	12	2	1	0	0	**4**
2020 November	0	0	0	3	27	15	12	9	8	8	10	6	2	0	0	**21**

The monthly distribution of SBWB calls recorded at all levels, including the ground, at the four met masts is presented in Table 12. Ground level detectors at the masts recorded SBWB activity levels that are relatively consistent with the remaining (non-mast) ground level detectors deployed throughout the project area. Small numbers of SBWB calls were recorded at the lower position on three of the masts, and very few calls were recorded on any of the masts in the middle or upper position.

4.5 Analysis of met mast bat recordings and climatic variables

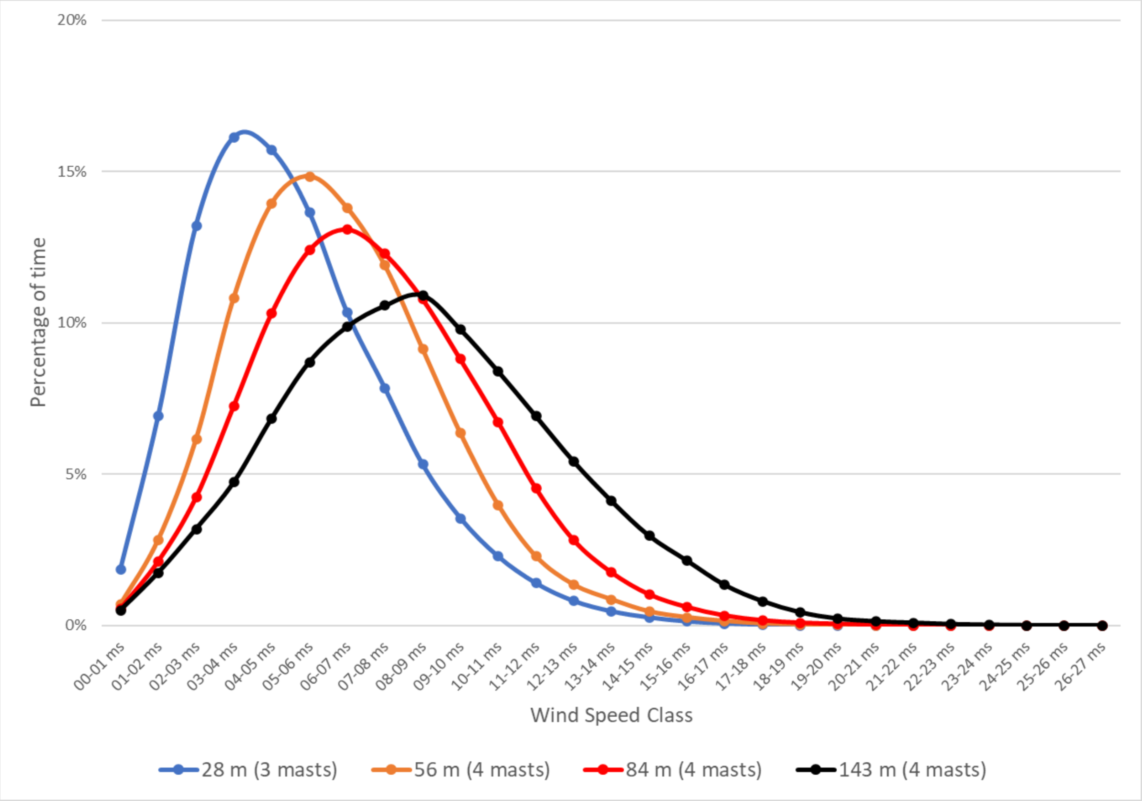
Bat call data collected for this Project can be correlated with wind speeds observed. This can be analysed at respective detector heights (4.5.2) or it can be analysed relative to hub height wind speeds (4.5.3).

4.5.1 Wind speeds at detector heights and hub height

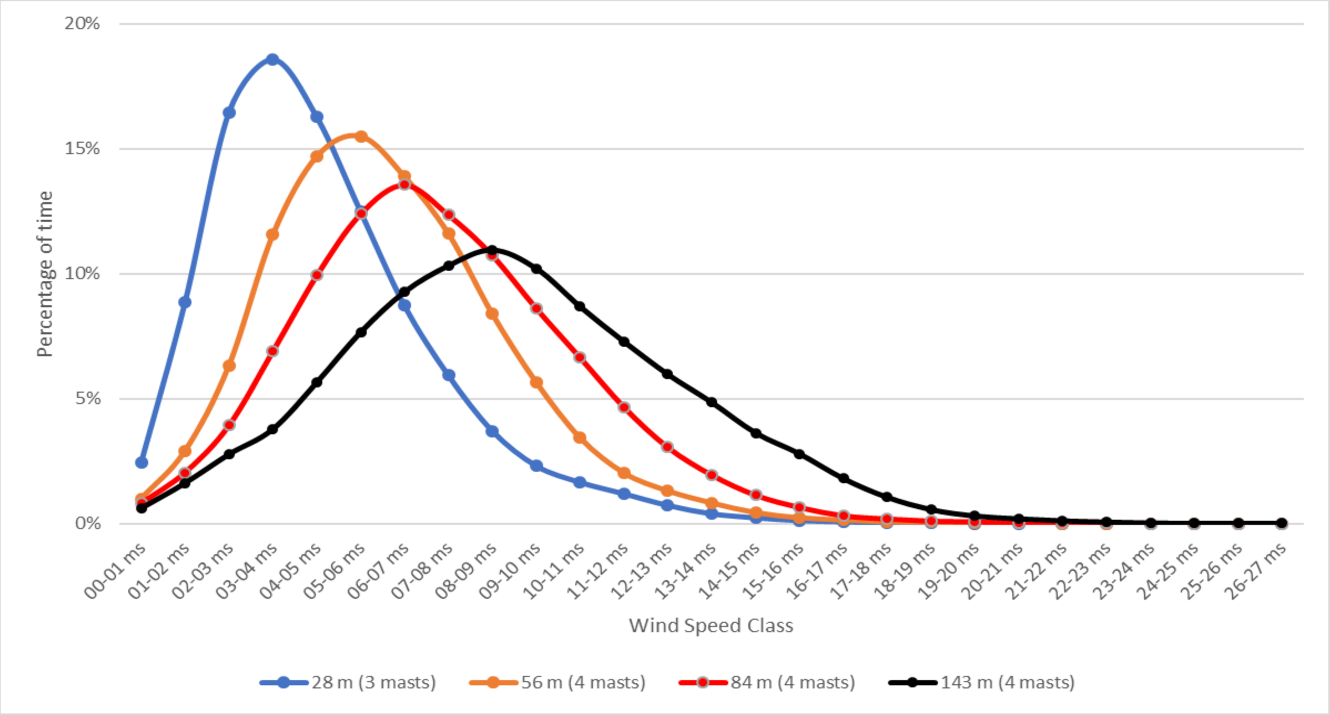
Wind speeds are measured in real time but due to data volumes being remotely downloaded the data is converted into 10-minutes averages. This is distinctly different to how bat calls are recorded. Detectors are idle and not recording until triggered by a noise, then detectors are operational until the noise ceases. Therefore, the wind speed at the moment a bat call is detected is not possible to determine. However, it is possible to compare the average wind conditions measured during the bat activity. It is useful to compare this data in order to assess bat behaviour in averaged wind speeds and therefore operational status of the wind turbines.

Wind speed has been calculated at the three mast-based detector positions (heights) across the survey period, as per the process described in Section 3.3. A frequency histogram of wind speed, in 1 m/s speed classes, is shown in Graph 3 and Graph 4. Graph 3 shows the distribution of wind speed across the full 13-month SBWB survey period, including all 24 hours of each day, and Graph 4 shows the distribution of night-time (after sunset and before sunrise) winds for the same period.

Wind shear is a measure to show the change in wind speed at different heights from ground. Graphs 3 and 4 show a similar average wind shear pattern between the 143 m (used as a proxy for hub height) and 24 m positions for the 24 hour data (Graph 3) and the night data (Graph 4).



Graph 3 **Distribution of wind speeds (24 hour) at 28 m, 56 m 84 m and 143 m between 1/12/2019 and 31/12/2020**



Graph 4 **Distribution of night wind speeds at 28 m, 56 m 84 m and 143 m between 1/12/2019 and 31/12/2020**

The average difference between wind speeds at 143 m (which is being used as a proxy for hub height) and the detector locations is summarised in Table 16. This is shown for each of the four masts, and has been calculated using wind speed averaged across all 10 minute periods, including day and night, for the 12 month period between December 2019 and November 2020. Wind speed at the hub position and each of the detector heights has been interpolated and extrapolated from the wind sensor positions.

Wind speed typically increases with increasing height, however there were also situations with no detectable wind across all heights. Average wind speed difference between hub height and 28 m was approximately 3-4 ms^{-1} and the difference between hub height and 84 m was in the order of 1-1.5 ms^{-1}.

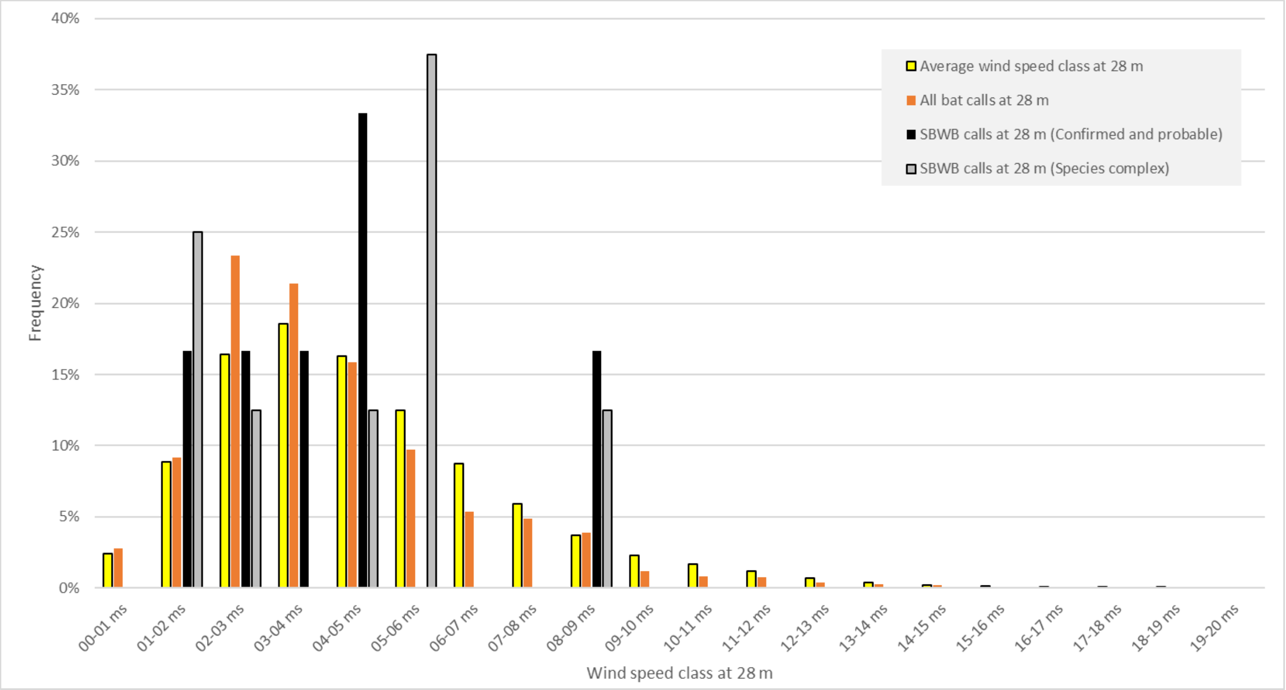
Table 16 Average difference (ms^{-1}) between wind speed at hub height (143 m) and detector heights

Mast	Average wind speed difference (ms^{-1}) 143 - 28 m	Average wind speed difference (ms^{-1}) 143 - 56 m	Average wind speed difference (ms^{-1}) 143 - 84 m
1	2.87	1.88	1.16
2	No data	2.83	1.59
3	4.37	2.50	1.47
4	2.84	1.85	1.13

4.5.2 Bat calls analysed at detector height wind speeds

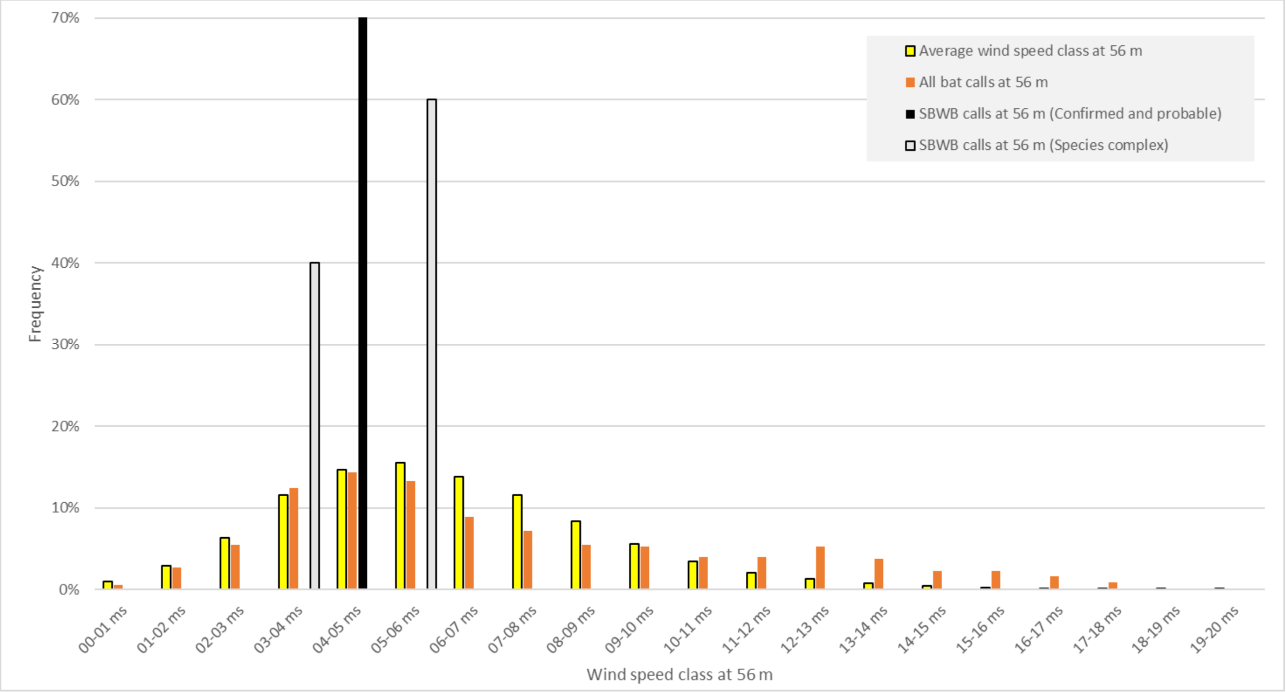
Comparison of bat calls in relation to wind speed is presented separately for each detector height (where wind data has been extrapolated) in Graph 5 -Graph 6. These graphs present wind speed and detected bat call data for 28 m (Graph 5), 56 m (Graph 6) and 84 m (Graph 7), showing the frequency of all valid bat recordings, and SBWB recordings in relation to average 10 minute wind speed classes. Extrapolated wind speeds have been matched to bat calls at the same height, on the same mast, and within the same 10 minute period.

Very few calls of SBWB were recorded at 28 m and above (indicated by black bars). In Graph 6, all valid SBWB calls (n=4) were recorded from one wind speed class (4-5 m/s), so the bar represents 100%, but the graph has been scaled to 0-35% to show detail for all bats and wind speed. Similarly in Graph 7 only a single valid SBWB call was recorded, at 11-12 m/s.



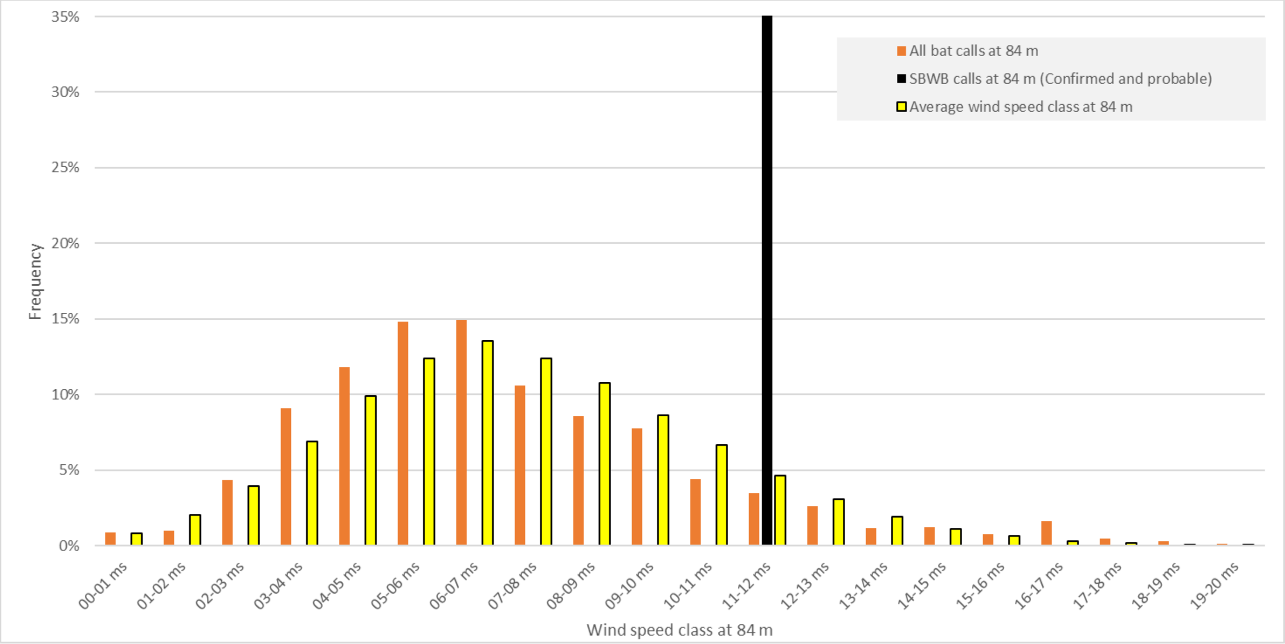
Graph 5 **Bat calls detected at 28 m compared to wind speeds at 28 m**

Note: No wind data available for the 28 m position on mast 2, resulting in 9 SBWB calls being excluded from the analysis. Total number of valid recordings *n* = 15,830, SBWB Confirmed and probable *n* = 6, Species complex *n* = 8.



Graph 6 **Bat calls detected at 56 m compared to wind speeds at 56 m**

Total number of valid recordings *n* = 8,125, valid SBWB Confirmed and probable *n* = 4, Species complex *n* = 5.

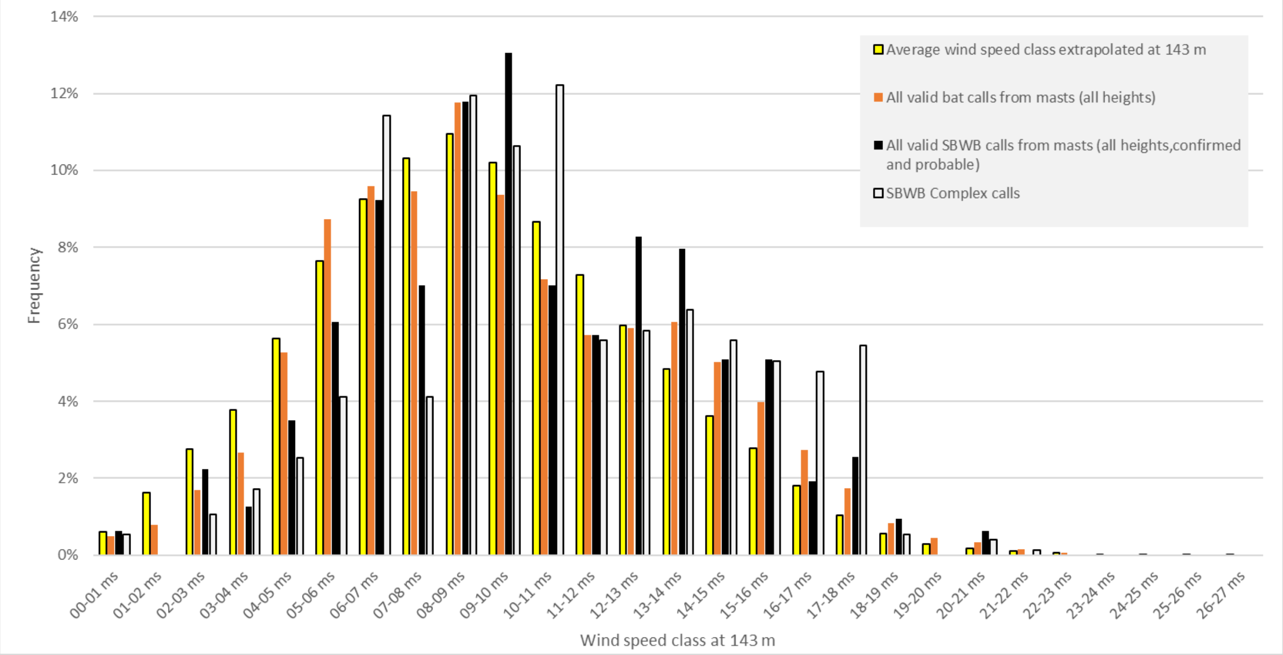


Graph 7 **Bat calls detected at 84 m compared to wind speeds at 84 m**

Total number of valid recordings *n* = 10,703, valid SBWB (Confirmed and probable *n* = 1, Species complex n = 0 (not shown)).

4.5.3 Bat calls analysed at hub height (143 m) wind speeds

Graph 8 presents the frequency distribution of recordings of valid bat calls for all species, and SBWB, in relation to extrapolated wind speed at hub height (143 m). Extrapolated wind speed at hub height has been matched to call recordings for the corresponding mast, and 10 minute time period. Graph 8 only includes data for masts, including the ground (1.5 m) detector at the base of the mast, and the detectors at 28, 56 and 84 m. Data from other ground detectors (not associated with masts) is not included as there was no wind speed data from those locations.

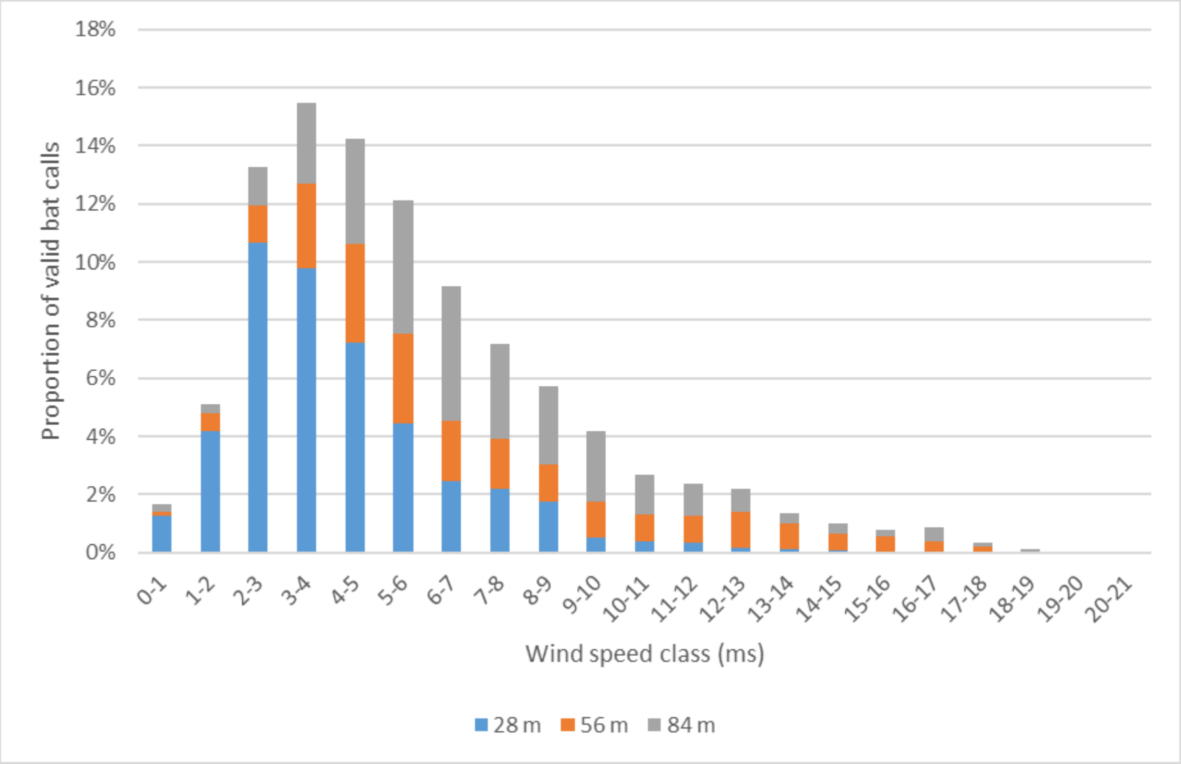


Graph 8 **Bat calls detected at all heights compared to wind speeds extrapolated to 143 m**

Total number of valid recordings *n* = 155,004, valid SBWB Confirmed and probable *n* = 314, Species complex *n* = 753.

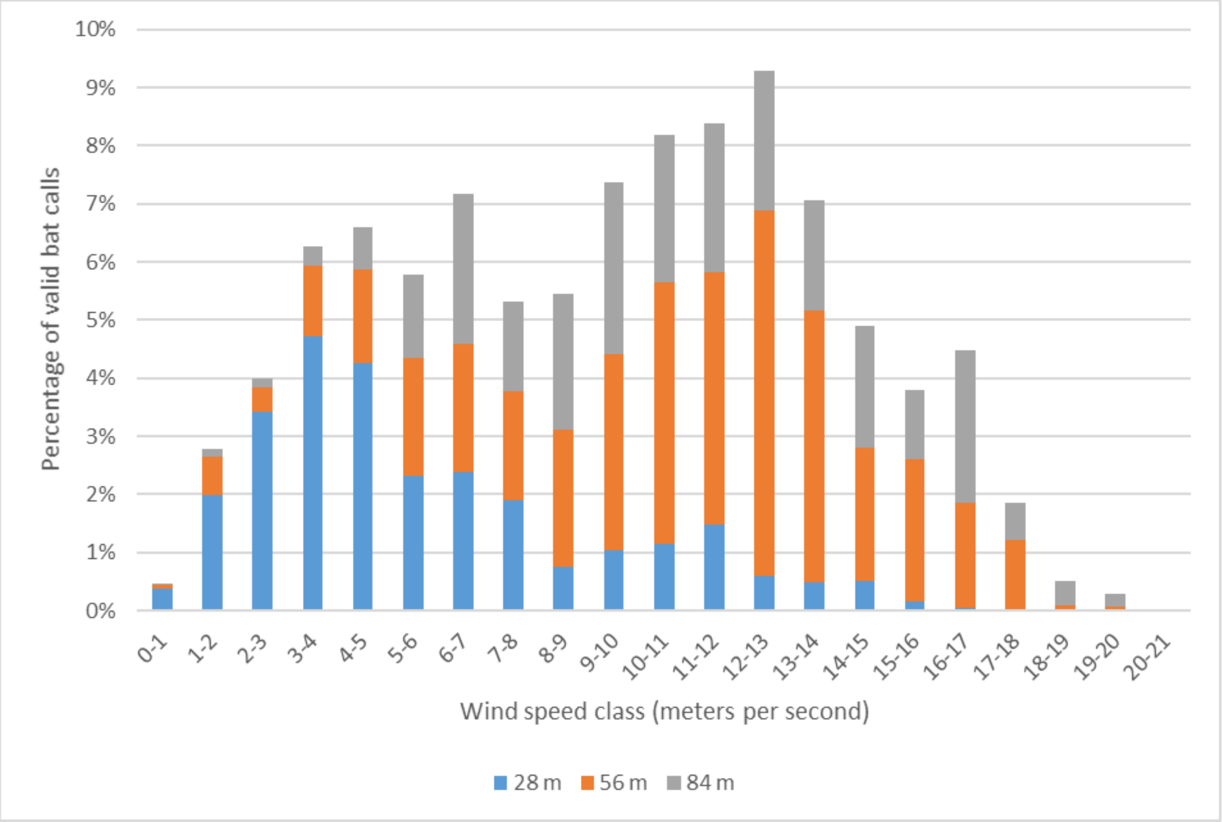
4.5.4 Species analysis at detector wind speeds

Bat activity has been analysed in relation to wind speed and detector height for all valid bat calls in Graph 9. Wind speed has been matched to call activity by determining the 10-minute period of the recording and relating this to the average wind speed for the same period. Wind speeds have been extrapolated (Section 3.3) for each of the detector levels (28 m, 56 m, 84 m) where possible. This windspeed analysis has also been undertaken for species or species groups where sufficient data are available, including the White-striped Free-tailed Bat (Graph 10), Forest Bats (*Vespadelus* spp. - Graph 10), Long-eared Bats (*Nyctophilus* spp. – Graph 12) and Gould's Wattled Bat (Graph 13).



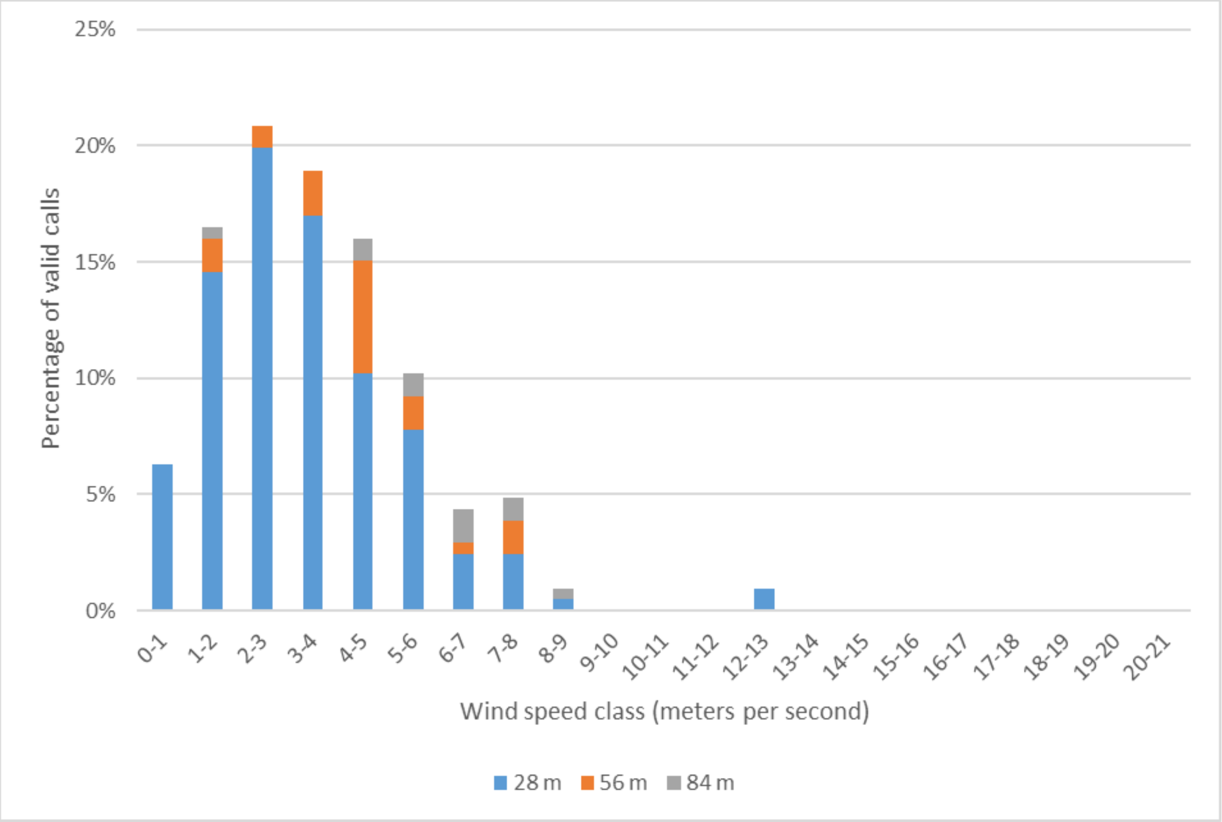
Graph 9 Relationship between valid bat call recordings (all species) and average wind speed classes (m/s) at the three detector heights with extrapolated wind speed data
Total number of valid recordings *n* = 34,658.

White-striped Free-tailed Bat were recorded across the full range of wind speeds (Graph 10). For detectors within RSH, 90% of detected recordings were at average wind speeds between 4 and 17 ms^{-1}. This species is known to fly high, within RSH, and is one of the most frequently recorded species within carcass searches at operational wind farms.



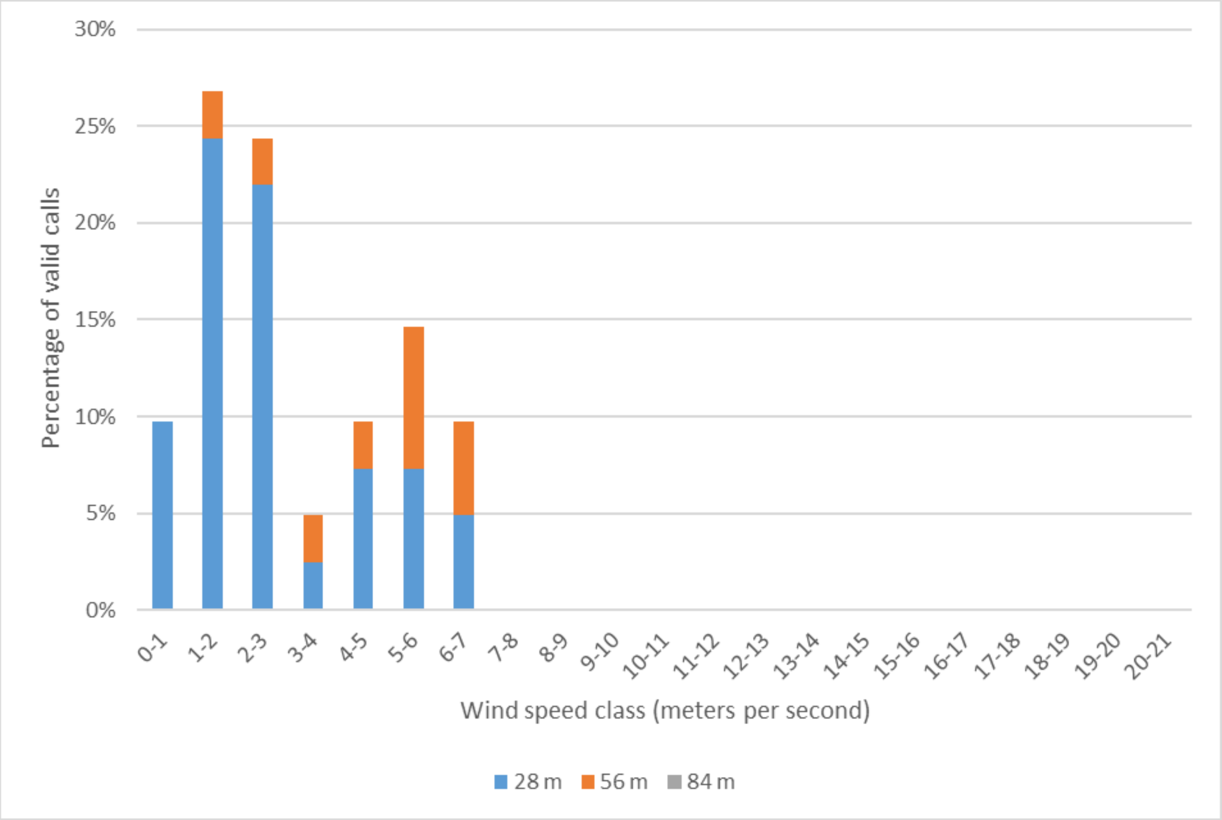
Graph 10 **Relationship between valid bat call recordings of White-striped Free-tailed Bat *Austronomus australis* and average wind speed classes (m/s) at the three detector heights with extrapolated wind speed data**
Total number of valid recordings *n* = 5,768.

For the forest Bats *Vespadelus* spp. (Graph 11), 82% of 206 detected recordings were from 28 m, 13% at 56 m and 5% at 84 m (within RSH). Two passes were recorded from a 28 m detector when the average 10 minute wind was between 12 and 13 ms^{-1}, but all other recordings were at wind speeds of less than 9 ms^{-1}. Ninety percent of recordings were at average wind speeds below 6 ms^{-1}.



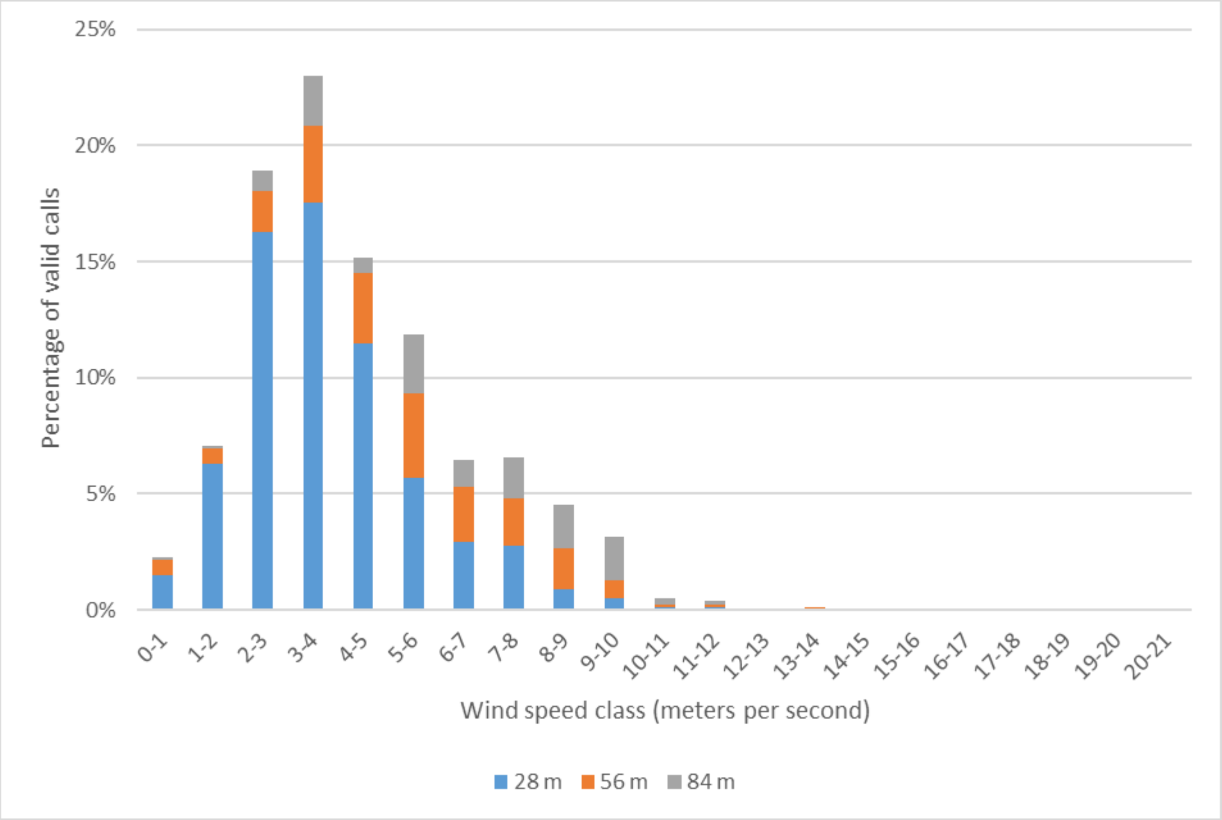
Graph 11 **Relationship between valid bat call recordings of Forest Bats *Vespadelus* spp. and average wind speed classes (m/s) at the three detector heights with extrapolated wind speed data**

Total number of recordings *n* = 206.



Graph 12 **Relationship between valid bat call recordings of Long-eared Bats *Nyctophilus* spp. and average wind speed classes (m/s) at the three detector heights with extrapolated wind speed data**
Total number of recordings *n* = 41.

The relationship between detection heights and wind speed is shown for the Long-eared Bats *Nyctophilus* spp. in Graph 12. There were only 41 detections of this ground from the mast mounted detectors (excluding the ground detector) where extrapolated wind speeds have been calculated. As discussed in Section 1.5.4, this group of species are thought to be highly manoeuvrable bats that generally fly in the lower portion of treed environments. No passes were recorded at wind speeds above 7 ms^{-1}.



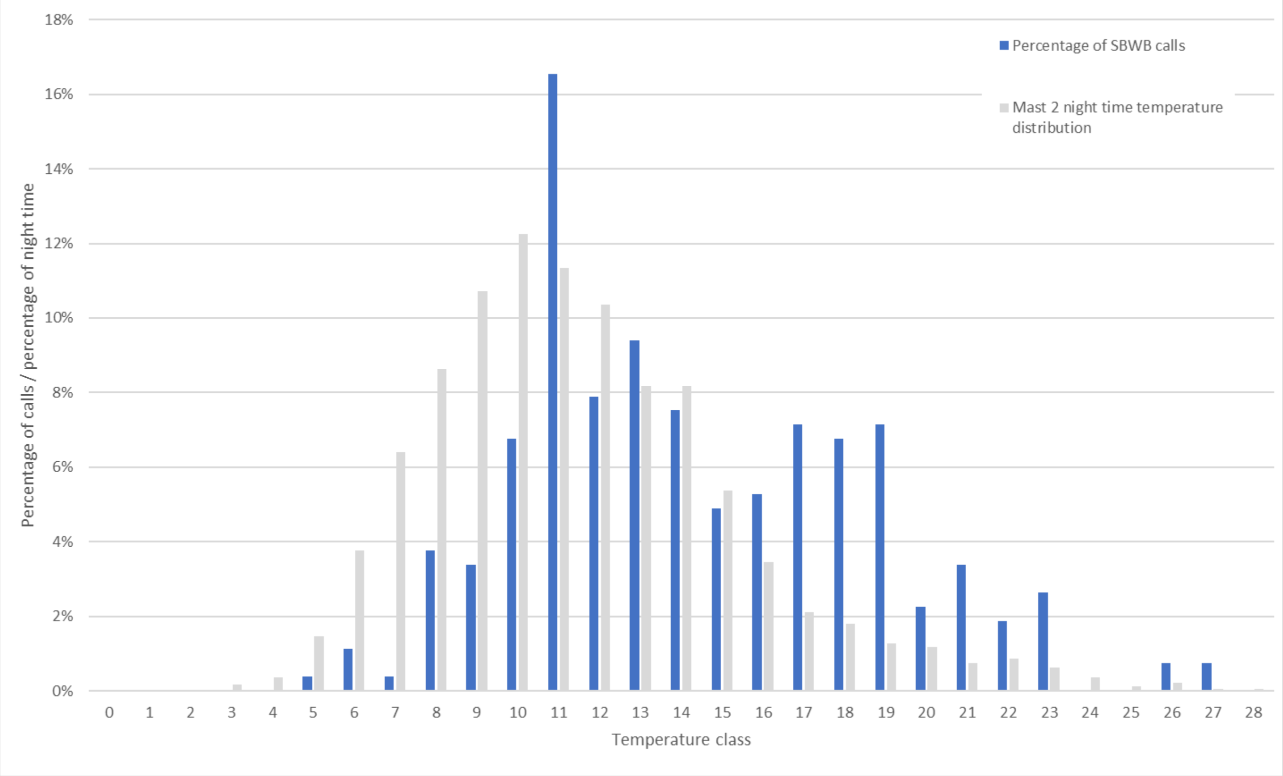
Graph 13 **Relationship between valid bat call recordings of Gould's Wattled Bat *Chalinolobus gouldii* and average wind speed classes (m/s) at the three detector heights with extrapolated wind speed data**
Total number of recordings *n* = 792.

The relationship between detection heights and wind speed is shown for the Gould's Wattled Bat *Chalinolobus gouldii* in Graph 13. There were 792 detections attributed to this species, which was recorded at all detector heights. Ninety-one percent of detections were at wind speeds of less than 8 ms-^{1}.

4.5.5 Southern Bent-wing Bat activity in relation to temperature

The distribution of Southern Bent-wing Bat calls was also examined in relation to temperature, as shown in Graph 14, which shows the distribution of night-time temperatures recorded at Mast 2, and the frequency distribution of calls in relation to 1°C temperature classes. Figure 14 includes all calls manually identified as confirmed, probable or belonging to a species complex including SBWB. The recording time of calls was matched, within 10 minute intervals, to the average temperature recorded from mast 2. As such the analysis is an indication of the relationship, as temperature data has only been used from a single mast, and calls recorded above ground height have been assigned a temperature value from the lowest (1.5m) sensor from mast 2.

Calls were recorded at temperatures ranging from 5°C to 27°C. Nine percent of calls were recorded when the average 10 minute temperature was below 10°C.



Graph 14 Southern Bent-wing Bat activity in relation to temperature

4.5.6 Southern Bent-wing Bat activity in relation to humidity

The distribution of Southern Bent-wing Bat calls was also examined in relation to humidity, as shown in Graph 15, which shows the distribution of night-time relative humidity recorded at Mast 1 on the 103 m high sensor, and the frequency distribution of calls in relation to 5% relative humidity classes. Figure 15 includes all calls manually identified as confirmed, probable or belonging to a species complex including SBWB. The recording time of calls was matched, within 10 minute intervals, to the average relative humidity recorded from the mast sensor.

Average relative humidity ranged from 10% to 100%, and SBWB calls were recorded at humidity levels between 20% and 95%. Ninety percent of calls were recorded when relative humidity was less than 90%.

The linked image cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the link points to the correct file and location.

Graph 15 Southern Bent-wing Bat activity in relation to humidity

4.6 Influence of noise on the ability to detect bat calls on met masts

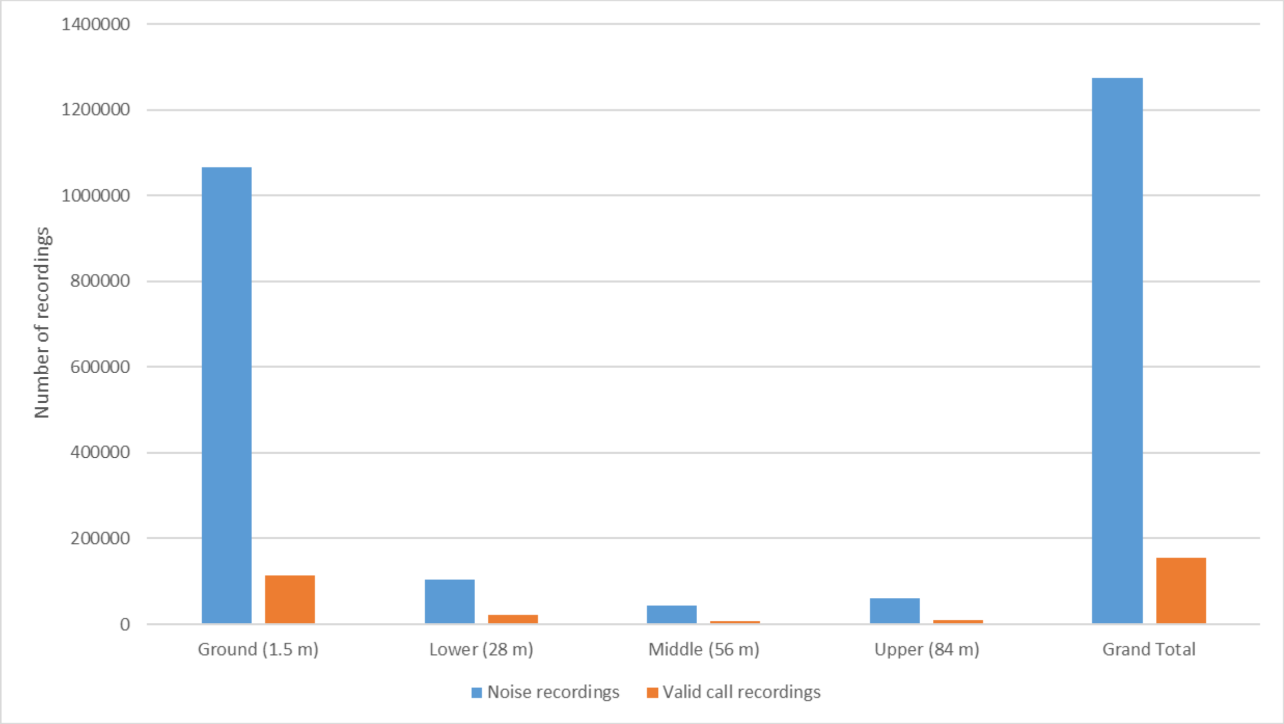
Bat detectors are triggered to record data when sounds are detected within the target frequency range, above an intensity threshold. Detectors may be triggered by valid bat calls, or by other sources of sound within the target frequency range. When detectors are triggered by valid bat calls, they will record the bat calls, but also any other background noise present at the same time within the target frequency range. In this context, the term 'noise' is used to refer to data points within bat call files that are not recognisable by the software. Components of bat calls, and 'valid calls' are recordings containing recognisable sections of bat calls. Recorded call files with 'valid calls' may still contain 'noise' data points.

Recordings may entirely consist of 'noise' data points, without any recognisable bat call information. These recordings are filtered out and discarded during the analysis process.

Analysis was undertaken to investigate the influence of noise on the ability to record bat calls at height on the mast mounted detectors. In addition to the findings presented in this report, an analysis was undertaken by acoustic specialists Marshall Day Acoustics (MDA - report provided in Appendix 4). The MDA analysis was conducted on a two-week subset of the dataset, from all four met masts. MDA analysed bat calls in relation to wind speed and the number of data points present within recordings. Valid recordings with high numbers of data points, represent recordings of both valid bat calls and background noises.

> The MDA report concluded that valid bat detections were recorded across a wide range of wind speeds, and the presence of noise within recordings (ie. data points not recognised as bat calls) did not limit the ability of detectors to record valid bat calls.

Graph 16 presents a summary of the quantities of noise recordings and valid bat call recordings (as determined by the Anabat insight filter) at the four heights on the four met masts over the full survey period. Note that not all valid calls were of sufficient quality to identify to species level, but this provides an assessment of activity across the heights. Ground detectors experienced the highest incidence of noise, and while it is not possible to determine exact sources of noise, this is presumably due to more clutter and additional sources of wind interference (mast infrastructure, trees and other vegetation) close to the ground.



Graph 16 Numbers of valid bat call recordings, and noise recordings at met mast detectors over the full survey period.

It is most likely that a high percentage of calls were detected since the proportion of valid calls in relation to total noise recordings was relatively low and consistent across the detector heights: ground detectors: 10%, lower detectors 17%, middle detectors: 15% and upper detectors: 15%. Overall, 11% of noise recordings were of valid bat calls.

5. Impact assessment

The Southern Bent-wing Bat (SBWB) *Miniopterus orianae bassanii* is listed as critically endangered under both the EPBC Act and FFG Act.

The Project does not entail direct removal of any vegetation or impacts on known caves or wetlands that are important habitats for the species. Potential minor removal of vegetation for the underground transmission line along Boiler Swamp Road is unlikely to significantly alter the habitat value of the area for SBWB. Removal of plantation trees for construction of access tracks, cabling and clearances around turbines (50 m radius) is not expected to impact upon availability of foraging habitat for the species.

Internationally and in Australia microbats are known to collide with the blades of wind turbines and a small number of SBWB have been found as collision victims at existing wind energy facilities in south-western Victoria (Moloney, Lumsden, & Smales 2019). Wind farms are listed as a threat in the Conservation Advice for SBWB (TSSC 2021), which states that '*any windfarms close to a roosting site could potentially have a major impact on that population'*.

The potential for Southern Bent-wing Bat mortalities due to collisions with turbines is assessed in the following sections.

5.1 Wind farm

Assessment for project impacts on the SBWB is primarily focused on the potential for collisions with turbines.

'Collision' is used here in reference to incidents in which a bat physically strikes, or is struck by, the moving blades of a turbine and to the potential for barotrauma. Barotrauma in bats was described by Baerwald *et. al*. (2008) as the fatal effect on an animal's respiratory tract due to its encountering a rapid change in air pressure close to a moving turbine blade. The effect has since been questioned as it has been shown to be difficult to diagnose and may have been confused with traumatic injury associated with direct collisions (Rollins et al. 2012).

5.1.1 Summary of Southern Bent-wing Bat collisions at existing wind farms

Available evidence from operational wind farms offers some information about the incidence of turbine collisions by the species in Victoria. At the time of preparing this report (October 2023) a total of 22 SBWB fatalities due to collisions with turbines have been documented across wind farms in Victoria where carcass searches have been undertaken since 2003. Data for these are collated from Moloney et al. (2019), Symbolix (2020), Bennett et al (2022), DEECA (Forest, Fire and Regions Group) submission to Mount Fyans Wind Farm Planning Permit Application Planning Panel (2023) and Biosis records.

This information is for the number of SBWB fatalities that have been detected during search regimes. It is important to note that search regimes are sampling exercises. They are not designed to detect every carcass and the sampling is influenced by the portion of turbines searched; the frequency of searches, the efficiency of searchers and the rate at which scavengers or other factors may remove carcasses. For these reasons, mortality searches are undertaken in accordance with a rigorous design that maximises capacity to incorporate these variables into subsequent estimates of total fatalities.

Two investigations, one by DELWP (now DEECA) (Moloney, Lumsden, & Smales 2019) and the other commissioned by DELWP (Symbolix 2020), have collated and analysed data about bird and bat collisions with turbines at multiple wind farms in Victoria. However, the primary objective of both studies was to evaluate the efficacy of methods used to survey for bird and bat collision carcasses and to estimate total fatalities, rather than to provide estimates of total fatalities *per se*.

Moloney *et al.* (2019) collated data from post-construction mortality surveys for 15 Victorian wind farms up to early 2018. The wind farms are named but mortality results were not identified for individual wind farms. Eight of the wind farms are understood to be within the known geographic range of the SBWB. Most were monitored for a two-year period, with some monitored for up to 3.5 years. At a number of facilities purpose-trained dogs were used to detect carcasses.

Due to variables of quality and quantity of data from the various wind farms, detailed statistical analyses to estimate annual mortality rates for various species were only able to be undertaken for six, unidentified wind farms. Surveys comprised a total of 4,196 searches under turbines at the six facilities. Due to variables of detection methods and results, the report cautions against extrapolation of results to different wind farms.

Symbolix (2020) also reviewed all detected bird and bat collisions from 10 wind farms for the period between 2014 and 2019, with a total of 5,432 turbine searches and over 14,746 hectares searched for carcasses. The data available for their study is believed to have been drawn from the same data available to Moloney *et al.* (2019).

Estimates of average turbine collision mortalities provided by both Moloney *et al.* (2019) and Symbolix (2020) are measured in terms of potential mortalities per turbine per year for the various species detected.

Both reviews document a total of eight mortalities of SBWB detected at two wind farms. Given the overlap between the studies, it is understood the same eight records are common to both reviews and that they represent the total of detected wind turbine fatalities for the species until the time of the two investigations. Both of the studies provide details of analytical methods to estimate total mortalities on the basis of carcasses detected and factoring for others than may not have been detected due to the sampling entailed in search regimes. Symbolix (2020) did not attempt to estimate total wind farm mortalities for SBWB. Moloney et al. (2019) were able to calculate total mortality estimates for the species at one wind farm.

Because all wind farms differ from each other and because a consistent standard of carcass monitoring regime has not been applied by regulators to different facilities, a simple whole-of-wind-farm multiplication factor is not appropriate for any species. For this reason, the approach adopted by Moloney et al. (2019) was to determine a total mortality rate per turbine per annum. Using this approach, on the basis of carcasses found, a total annual mortality for a given species can be estimated for the number of turbines at a particular wind farm. Due to limitations on capacity for statistical analyses for the available data, Moloney et al. (2019) were able to estimate a possible total number of SBWB collisions based only on one SBWB that was detected at one wind farm. They concluded that the total of collisions by the species at that facility was likely to be in the order of 0.1 SBWB collisions per turbine per annum with a 95% credible interval of between 0.0 and 0.5 collisions per turbine per annum. For that particular case their estimate was that this equated to a mean mortality rate of 14 SBWB annually for the whole wind farm, with the range of plausible values

(95% CI) being between zero and 70 individuals. They note that site-specific conditions preclude extrapolation of results for one wind farm to any other. All operational wind farms in the region have rotors that sweep down to approximately 30 metres above the ground. It is understood that the two wind farms included in the Moloney et al (2019) study where SBWB collision fatalities had been detected have lower rotor tip heights of 28 and 29 metres above the ground. The lower rotor ground clearance of those turbines is less than half the 60-metre clearance height proposed for turbines at the KGPH Project. For this reason, it is expected that SBWB collisions with turbines at the KGPH Project are likely to occur at a lower rate than is the case at existing wind farms where the species is known to have collided.

5.1.2 Comparison of Southern Bent-wing Bat call detection rates at other wind farms

The 12-month survey program for the Project involved 24 bat detectors, including eight stand-alone ground detectors and 16 detectors on four met masts, with each met mast having a detector at 1.5 m, 28 m, 56 m and 84 m above ground level. This program ran from 21 November 2019 to 17 December 2020 (393 nights). The total number of detector nights was 9,432.

Limitations on height of masts used for the Project prevented locating bat call detectors at greater than 84 metres height. It is recognized that the highest detectors operated only within the lowest height zone of turbines proposed for the Project, but that is also a reflection of the substantially greater ground clearance (minimum of 60 metres) of blades for these turbines. The upper three detector heights were within, or very close to, the rotor swept heights of turbines at wind farms where SBWB have been found to have collided.

2,739 SBWB calls (confirmed and potential) were recorded, resulting in an average detection rate of 0.29 bat passes per detector per night across all detectors. The detection rate for ground-based detectors (12 detector locations) was 0.57 bat passes per detector per night. The detection rate at 28 m was 0.013 and detection rates for 56 m and 84 m were 0.003 and 0.002 passes per night, respectively.

A summary of survey effort and SBWB recording rates for several other recently proposed (and some now operational) wind farms within south-west Victoria is provided in Appendix 5. The information presented relates to 'turbine representative' habitats only. No information is provided regarding surveys of reference sites or other locations that may be unsuitable for turbine placement. SBWB were recorded at Dundonnell, Bulgana, Mortlake South, Mortlake East, Mount Fyans, Ryan's Corner and Macarthur wind farms. The Kentbruck study, with 9,432 detector nights and four specifically installed met masts, is by far the most intensive study, in terms of duration, numbers of detectors and numbers of detectors at height, including within rotor swept height.

Direct comparison of detection rates is difficult, as many of the other studies involved multiple short periods (not continuous recording), with variable numbers of detectors.

The Kentbruck ground level detection rate of 0.57 is similar to those recorded at Mount Fyans (0.55), and Mortlake South and East (0.42). Those wind farms are not yet operational and thus they offer no information about any impacts on SBWB. The short surveys at Macarthur wind farm in 2005 (53 detector nights in total) resulted in a recording rate of 1.21 passes per detector night.

There is no known information that indicates any correlation between SBWB call rate with effects of wind energy on the species.

5.1.3 Project investigation objectives for Southern Bent-wing Bat

The ideal objective of an investigation of SBWB would be to numerically quantify potential risk of collisions, to determine whether or how they might affect the overall population of the subspecies. However, unlike the situation for diurnal birds, there is no available technique to accurately record or measure numbers of bats or bat flights for species in an environment like the Project area. As a consequence, there are also no available methods to model or forecast potential numbers of collisions that might occur. Records of bat echolocation calls are the best available method to consistently determine species of bats present and to provide a representation of the variable activity of a given species. But it should be noted that bat calls may not be an accurate surrogate measure of bat flight activity and that detection and recording of echolocation calls are subject to a variety of limitations (Section 3.4 and Section 5.1.6).

Therefore, the objective of investigating SBWB at the Kentbruck Wind Farm site and environs has been to obtain relative measures of the species' flight activity (using detected echolocation calls as a qualitative surrogate measure). The intention was to determine how call-frequency for the species might vary in relation to environmental variables that may be informative in relation to the proposed project. As any risk of collisions with turbines will exist only where turbines are located, bat call detectors were located at sites representative of proposed turbine sites.

The study program entailed bat call detection of more than 12 full months at 12 locations across the wind farm site and included four sites at each of which call detectors were deployed at four heights between 1.5 and 84 metres above the ground.

The study was aimed at providing empirical information about the following aspects which may inform design and operation of the Project and the potential for it to impact on the species:

- The extent and variation of SBWB use of the wind farm study area.
- Whether flights of SBWB in the study area occur more or less frequently at different heights, including in the lower portion of turbine rotor height.
- The extent to which flights of SBWB in the study area have temporal variations, including nightly or seasonally.
- The extent to which wind-speed correlates with SBWB activity and operation of turbines.

These aspects of the study are discussed in further detail in the next four sections, along with their potential implications for the Project.

5.1.4 Southern Bent-wing Bat distribution across the wind farm site

Using detected call rates and capture of bats, Stratman (2005) compared activity of microbat species between native forest, pine plantations and swamps. From call data, that study recorded lower activity of SBWB in pine plantations than in the other two environments, but the difference was not statistically significant. No difference could be discerned for capture rates between the three habitat types for SBWB but this was based on the capture of a total of just four individuals of the species for the entire study.

Acoustic bat-call surveys confirmed that SBWB routinely fly within the wind farm site including areas occupied by pine plantations, and it is assumed these bats fly from caves within the local area or within the documented nightly flight range for the species which may be as great as 70 kilometres (van Harten et al. 2019). Known local roosts within 70 km of the project area include caves within the

Lower Glenelg National Park to the north-west of the wind farm, several caves to the west of Portland, and multiple caves spread throughout far south-east South Australia.

SBWB were recorded at all 12 ground monitoring locations across the proposed wind farm site (Table 13) and the four met masts. Greatest call activity levels were recorded at Site 18, in the far north-west corner of the wind farm, approximately 150 m from the boundary of the project area with Lower Glenelg National Park (see Figure 3 Bat Detector Locations). Detected call activity levels at site 18 were significantly higher (more than double) than at any other site.

Lowest call activity levels were recorded at sites 37 and 38, near the centre of the site on Browns Road. These sites are approximately 1 km north of the southern boundary of the project area with Discovery Bay Coastal Park, and 3 km west of the closest section of Lower Glenelg National Park (the Kentbruck Heath).

The higher call activity level at site 18 compared to the measured call activity at other sites could be due to the proximity of this site to caves within Lower Glenelg National Park, approximately 4 km from the detector location. Biosis intentionally positioned Site 18 in this location, due to it being the closest section of the Project to a documented roost cave for the species (DEECA data). There may also be other undocumented roost sites within Lower Glenelg National Park. Site 18 is also the closest site to a large, forested area supporting suitable foraging habitat for the species within Lower Glenelg National Park. A turbine exclusion area has now been applied to the wind farm design, resulting in no turbines being located within 5 km of these caves.

Activity of SBWB within the project area may include foraging, movements between roost caves and movements between roost caves and other foraging environments. It is understood that SBWB call during all flights (L. Lumsden pers. comm. 2019) and it is thus not possible to distinguish between flight behaviours from calls recorded by the Project study.

Project implications

The study program covered more than an entire 12-month period and encompassed the full annual cycle of the species activities, including any variation in use of the Project site, for the period studied.

The study found that SBWB occurred at all detector sites and it is thus likely that the species utilizes the entire Project site and may be expected to continue to do so if the Project is approved. Call activity had a higher concentration in the north-west of the site in proximity to the nearest known cave location used by the species and it is reasonable to expect that pattern will continue if the Project is approved.

It will be important to ensure that turbines in the north-west portion of the Project site are included in operational monitoring for carcasses, along with others across the Project.

5.1.5 Southern Bent-wing Bat flight height

The study involved bat call detectors installed close to ground level (1.5 m above ground) and detectors mounted at four levels on four met masts installed specifically for the SBWB monitoring program. The met mast detectors were positioned at 1.5 m (ground level), 28 m (lower), 56 m (middle) and 84 m (upper). Depending on the turbine model selected, it is anticipated that rotor blade tip clearance will be between 60 and 90 metres above the ground or higher. Thus, depending on the final turbine specifications, the detectors at 56 m and 84 m were close to, or within the lower portion of the rotor swept height of turbines for the Project. Greater heights of detectors were not feasible due to limitations on met mast height and it is recognised that this is a limitation relative to the potential overall rotor-swept height of proposed turbines for the project.

SBWB were recorded at all four monitoring masts (Table 12), with ground level detectors showing similar call activity levels to nearby stand-alone (non-mast) ground level detectors (Table 13). At all four masts there were greatly reduced levels of call activity detected at the higher height-level detectors (Table 12). In combination, over the 12-month continuous study at the four met masts there were totals of 1,254 (97% of total of 1292 calls) SBWB calls recorded at 1.5 m; 33 (3%) at 28 m; 4 (0.3%) at 56 m and 1 (0.1%) at 84 m.

There is little pre-existing published information regarding flight heights of SBWB. Churchill (2008) (cited in Kerr & Bonifacio 2009) indicates that where there are trees, the species flies from just above the canopy to many times the height of the canopy, however, in open country, flight may be as low as six metres above the ground. The recovery plan also states that where there are trees, the species *typically forages above the canopy, but can fly closer to the ground in more open areas* (DELWP 2020). In this study, masts were installed in a range of age classes of plantation, but an area around each mast was cleared for the mast installation, meaning that all masts were effectively positioned within small relatively open areas, where bats could fly close to the ground. As such, the survey program was unable to sample the airspace above a full, uncleared pine canopy. The plans for the wind farm specify that plantation trees will be cleared around each turbine base out to a distance (radius) of 50 m.

Flight height information was summarised for several other species or species groups, to confirm the findings of this study are consistent with our understanding of other species (Graphs 9-13 and Appendix 6). The White-striped Free-tailed Bat *Austronomus australis* (Graph 7) was frequently recorded at the two higher detector locations (56 m and 84 m). This species is known to fly at height, either above tree canopies or high above open areas (Churchill 2008). White-striped Free-tailed Bat was the most frequently recorded species in carcass searches at operational wind farms within Victoria between 2003 and 2018, with 296 mortalities (carcasses) located (Moloney, Lumsden, & Smales 2019).

Calls of Long-eared Bats *Nyctophilus* spp. were predominantly recorded from ground level or 28 m, with few calls detected by the 56 m detector. This group of species are known to fly under the tree canopy. Carcasses of this species have been recorded at operational wind farms (Moloney, Lumsden, & Smales 2019), although at very low numbers (1 Gould's Long-eared Bat and 6 Lesser Long-eared Bats) considering how widespread and abundant this group is, particularly Lesser Long-eared Bat (Menkhorst 1995).

Gould's Wattled Bat *Chalinolobus gouldii* were recorded at all levels, with reducing recording rates at higher locations. This species typically forages in open spaces, or within tree canopies (O'Neil & Taylor 1986). This species is abundant and widespread within Victoria and was found to be the second most frequently encountered species in carcass searches, with 49 carcasses reported in the review by Moloney, Lumsden and Smales (2019).

Project implications

The study program covered more than an entire 12-month period and encompassed the full annual cycle of the species activities, including any variation in height of flights, at the site for the period studied.

At all four masts there were greatly reduced levels of SBWB call activity detected at the higher detectors. Recorded calls of other bat species indicate that detectors functioned and recorded calls, although it is acknowledged that there are factors that reduce the detectability of calls at height. The frequent calls of White-striped Free-tailed Bat recorded at the two higher detectors on the masts are in accord with published information that this species often flies at greater height than many other microbats of south-eastern Australia and also confirms that the high detectors were able to detect bat calls. We conclude that the significantly lower call activity of SBWB recorded by high detectors reflects actual lower call activity at those heights relative to call activity of the species closer to the ground. We also acknowledge that there is considerable uncertainty regarding quantitative analysis of bat call data, including limited detection volume and the influence of a range of factors on detectability, including bat call characteristics and environmental conditions. Limitations of ultrasonic detection of bat calls is discussed further in Section 3.4.

It is our understanding from Dr L. Lumsden (pers. comm.) that SBWB are likely to call consistently during all flight activity. It is thus reasonable to assume that the lower call activity detected at high detectors reflects reduced flight activity by the species at those heights. Limitations on mast height prevented locating bat call detectors at greater than 84 metres height. It is recognized that the highest detectors operated only within the lowest height zone of turbines proposed for the Project, but that is also a reflection of the substantially high ground clearance (minimum of 60 metres) of blades for these turbines. SBWB may fly at greater heights than those detected by the highest recorders that were able to be deployed, but evidence from call data indicates that the very great majority of SBWB flight activity at the site occurs close to the ground and substantially below rotor swept-height of the proposed turbines and that an extremely small proportion of SBWB flights occurred within rotor-swept height. On the basis of flight height assessment for the species at the Project area, the risk of collisions with turbines, including the potential for barotrauma, is likely to be low because of the relative rarity of fights within the rotor-swept height zone of the turbines proposed for the project.

The masts on which bat call detectors were deployed were necessarily within areas that were immediately clear of trees, although some were surrounded by plantation pines. This reflects the situation that will apply in which turbines will be situated within similarly cleared sites, with all trees removed within 50 m of the turbine base.

5.1.6 Temporal variation in Southern Bent-wing Bat activity

Patterns of temporal variation in SBWB call activity were discernible for the quantum of call data obtained at lower heights, and especially from all ground-level detectors. The number of SBWB calls detected at heights of 56 and 84 metres were far too few to discern any patterns of temporal variation for flights at those heights. In the study, SBWB were recorded throughout the year during nocturnal hours (Graph 2). Peak activity periods were February to April and September to November. Lower activity levels were noted throughout most of winter (May and August). Recording rates within December 2019 and January 2020 were also relatively low compared with the peak periods. The reason for this low activity in December and January is unclear. Recorders were also in place for part of December 2020, and although this is not a complete month of recording (and hence not shown in Figure 1), recording rates also appeared to be relatively low (70 recordings in 16-17 days), although this is approximately twice the recording rate achieved in December 2019.

In the warmer months when SBWB were most active, bats were recorded soon after dark and were active throughout the night, until one or two hours before dawn (Table 14 and Table 15). Recorded

SBWB call activity was generally highest in the first half of the night, with a peak in activity levels soon (1-2 hours) after sunset noted at most ground detectors (Table 14 and Table 15).

Project implications

As the study program covered more than an entire 12-month period and encompassed the full annual cycle of the species activities at the site, it is reasonable to assume that it documented temporal variation in SBWB activity for the period studied. Although call data from detectors within rotor-swept heights were insufficient to discern any temporal pattern, it is reasonable to consider that the temporal variation in call activity at lower heights reflects the patterns of SBWB flight activity.

As for all bats, risk of collisions with turbines is confined to the hours of their nocturnal activity. For the year studied, levels of call activity were low during the months of December and January and again in May to August. It is considered likely that this reflects an annual routine, in particular that the species is less active during the cooler months. It can be expected that any possible risk of turbine collisions may be low during the latter half of the night and at the lowest during winter. These temporal factors should be considered when developing any plans for turbine curtailment.

5.1.7 Wind speed and Southern Bent-wing Bat activity

Relationships between wind speed, height and bat activity were investigated for SBWB, a range of other species, and total bat activity (see Section 4.5). This analysis could only be undertaken where extrapolated wind speed could be calculated, including three of the four detectors at 28 m, and the higher mast-based detectors at 56 m and 84 m at all four masts. Only 11 recordings of SBWB were detected at these locations, and as a result little information is available to enable correlations between wind speed and activity levels. With the exception of one SBWB detection at 10-11 ms^{-1}, all detections were at wind speeds of less than 9 ms^{-1}.

SBWB recordings from all detectors were also correlated to wind speed recorded at 80 metres high on a single met mast. As most recordings of the species calls were from ground-level detectors where wind speeds are likely to be significantly slower than they are at 80 metres above the ground, this analysis only provides an indication of the potential relationship between wind speed and activity. Nonetheless, the results clearly demonstrate a decline in measures of call activity even close to the ground, when wind speed at 80 metres reached 7-8 metres/second and the decline continued until there was virtually no activity at wind speeds of 13-14 metres/second (Graph 3).

A number of investigations overseas have demonstrated that flight activity of small species of bats is concentrated on periods when wind-speeds are relatively low (Martin et al. 2017, Arnett 2017, Arnett, Schirmacher, & Hayes 2011). Wellig et al. (2018), for example, found that bat activity within the rotor swept zone (50-150 m) declined with increasing wind speed, with activity levels dropping below five per cent when wind speed exceeded 5.4ms^{-1}.

Most modern wind turbines commence rotation of the blades only once the wind speed reaches an average of above 3.5 metres per second (m/s). The rotation (RPM) is relatively constant but as wind speed increases, the RPM also increases (marginally) until a wind speed of approximately 11 m/s. Above 11 m/s, the RPM remains constant until blades are prevented from rotating at wind speeds in excess of approximately 25 m/s.

When considering the possible effects of wind speed, there are two important concepts. The relationship between wind speed and the power of the wind (kinetic energy) is such that:

- The power of the wind at a speed of 10 metres per second (m/s) will be twice the power at 7 m/s.
- The power of the wind at 14 m/s will be four times greater than the level of the power at 7 m/s.

Increasing wind speed with height is described as a process called 'wind shear'. Vertical wind shear is used to describe the relationship between the changes in wind speed and the change in altitude. In landscapes such as the airspace above pine plantations, the profile of wind shear from the ground surface layer to the height of the rotor-swept area (with the latter being the area through which the rotor blades of a wind turbine spin) is generally logarithmic in nature. This means that as height increases per metre from ground level, wind speed increases by a disproportionately increasing amount (wind velocity). For example, where the wind speed is 7 m/s at a height of 10 metres above the ground level, it is likely to be around 9.5 m/s at 40 metres above ground level and 11 m/s at 80 metres above ground level. Therefore, small increases in wind speed or flight height (where wind shear occurs) result in a significantly greater level of exposure to kinetic energy.

Under a normal movement scenario, we would expect that SBWB would aim to conserve energy where possible and therefore we reasonably assume that the species would be most active in lower wind speed conditions and at heights that minimise their exposure to high levels of wind and kinetic energy. The open airspace characteristics above pine plantations that occupy the great majority of the project wind farm are likely to provide pockets of shelter in some places, but generally provide large expanses of exposed airspace. This landscape is generally free of obstructions that would require flight height changes and therefore bats could move through the landscape or forage without interruption.

Project implications

Results of the study are not conclusive, but they suggest that SBWB flight activity is concentrated at heights well below the height of rotors of turbines proposed for the project. Potential reasons for this include that foraging resources for the species are likely to be more abundant in that height range and that kinetic energy of great wind speeds at higher heights may be less favourable for the species. Data obtained by the Project studies suggest that SBWB call activity peaked at wind speeds between 5 and 7 m/s and activity virtually ceased at wind speeds of 12 to 14 m/s. Such an effect will limit their flight activity – at any height – to periods when wind speed is amenable to their flight activity. This means that turbine collision is not likely to pose any risk to the species during periods of wind speed above those levels.

Increased wind speed associated with greater altitude likely explains, at least in part, the simple correlation between SBWB call activity and height recorded at the Project site and discussed above. Implications for the Project are that risk of collisions, including the potential for barotrauma, appears likely to be low because of the relative rarity of fights within the rotor-swept height zone of the turbines proposed for the project.

5.1.8 Population viability analysis

The proposed Kentbruck Green Energy Hub Project carried out population viability analysis (PVA) on SBWB to assist in the assessment of impacts from the proposal (Symbolix 2021). Symbolix (2021) is provided at Appendix 3. Until recently PVA had not been attempted for the species, however the Threatened Species Scientific Committee (TSSC 2021) reports that to assess likely future decline, the Southern Bent-wing Bat Recovery Team undertook modelling using PVA software (Vortex) (Lacy &

Pollak 2017). TSSC (2021) calculations for future population decline were based on the best available data, including survival rates from the Naracoorte maternity cave, the proportion of adult females breeding each year in each of the maternity caves, total population sizes, and the proportional representation of each cohort (TSSC 2021). While knowledge on the above aspects has increased more recently, assumptions were required to be made in the calculations. Assumptions are often used in modelling and where possible these are based on expert opinion. TSSC (2021) provide the assumptions and associated caveats that were used. It should be noted that the PVA conducted by TSSC (2021), and by Symbolix (2021) for this study, does not include consideration of the success of recovery plan actions. The Conservation Advice (TSSC 2021) includes a range of recovery actions, as summarized in Section 1.4.5 of this report. None of the recovery measures are quantified in terms of their known or potential influences on the demographics of the SBWB population and it was thus not feasible to incorporate them into the PVA conducted by Symbolix (2021) for this study.

TSSC (2021) note wind farm mortality as one of several potential effects that would likely result in a higher rate of decline for the species. For this reason, in consultation with DAWE and DEECA, it was decided to undertake PVA to investigate the potential effects of the proposed Kentbruck Green Energy Hub Project. As there is no existing quantitative model for predicting mortality from proposed wind energy projects, the impact assessment based on PVA investigates a range of potential mortality rates acknowledging that PVA cannot predict which mortality scenario is most likely.

In this impact assessment PVA has been used to simulate the forward trajectory of the population and allows for investigation of the relative impact of different intrinsic and extrinsic events, in this case exploration of the effect of additional mortality from wind turbine collision.

Within this impact assessment PVA is used to predict whether various levels of additional mortality represent a substantive population impact. This requires:

- Estimation of the expected additional mortality (which may be a range).
- Agreed, regulatory definition of the impacted population (e.g. the whole population or a specific sub-group).
- Detailed data on life-cycle parameters such as the breeding success, expected background mortality.
- Estimation of background mortality rate for different life stages.

Consultation was conducted by Symbolix with DEECA whose SBWB technical experts provided agreed population definitions and model input settings. This consultation concluded that there is little mixing between the sub-populations associated with each maternity site. It was concluded that this PVA should only consider the Portland sub-population given the location of the proposed Kentbruck Green Energy Hub Project, with the Portland maternity site and other caves being closer than the Warrnambool and Naracoorte maternity sites. As a consequence, the Project is not considered likely to have an effect on the latter two sub-populations which encompass a significant majority of the total population.

TSSC (2021) provides population information (mean numbers of mature adults) as at summer 2019-20 for the three sub-populations as shown in Table 17.

Table 17 Mean numbers of mature adult SBWB at the three known sub-populations as at 2019 (TSSC 2021)

Sub-population	Mean sub-population size
SA Naracoorte	27,265
Vic Warrnambool	15,550
Vic Portland	1,445
Total	44,260

For mature adults, the Portland-sub-population thus represents around 3.3% of the total estimated SBWB population and around 8.5% of the Victorian sub-population. The values that were used as parameters in the PVA are described in Table 1 of Symbolix (2021) in Appendix 3. Estimated annual mortality rates were provided by Dr Emmi van Harten, La Trobe University. DEECA provided information that the total Portland sub-population size should be set at 3,500 individuals to encompass the annual cohort of juveniles in addition to mature adults.

The population used in the PVA encompasses all age-classes (this is the population of 3500 stipulated by DEECA). The PVA tests for effects on the extinction risk for this population of iteratively greater numbers of mortalities (between 2 and 500 extra deaths) per year. In this manner, the PVA covers potential deaths for all age-classes and regardless of whether they are actually due to collisions or other potential effects of the Project, such as deaths of orphaned pups.

The outputs of the PVA (Symbolix 2021, Appendix 3) show several results from the different scenarios that were investigated. In summary, the 'zero' harvest rate (rate without any wind farm mortalities included) shows a substantial decline in the Portland sub-population size, whereby it will decline by more than 50% within ten years and by almost 100% within 60 years. In comparison, the TSSC (2021) PVA for the entire population (Victoria and South Australia) predicts a total adult population decline of 84-97% over the next 36 years. The TSSC (2021) modelling does not include impacts from wind farms or other potential threats such as the introduction of White-nose Syndrome into the population. Also, neither the TSSC (2021), nor the Symbolix modelling was able to consider any scenarios where recovery actions lead to positive impacts on the population.

Adding a range of predicted wind farm mortalities to the impact assessment PVA (Symbolix 2021, Appendix 3) shows that with increasing numbers of wind farm mortalities the Portland sub-population declines more rapidly, noting that the wind farm is assumed to operate for 30 years. While no wind farm mortalities occur after 33 years (assuming wind farm operation started at year 3), the Portland sub-population continues to decline, which is consistent with the decline shown in the 'zero' harvest model described here and the overall population decline predicted by PVA in TSSC (2021).

With two mortalities per year there is little to no difference in comparison to the 'zero' harvest model at any time interval. With 50 or more annual mortalities the median Portland sub-population size after 30 years reduces to zero, with the effect compared to the 'zero' harvest model being very significant (Symbolix 2021, Appendix 3). Table 18 shows the probability of the Portland sub-population reaching zero over a range of time periods. The probability that the Portland sub-population will reach zero within 30 years increases substantially when annual mortality is 50 individuals or more (Symbolix 2021, Appendix 3).

Table 18 Probability of SBWB population reaching zero for Portland sub-population by year with varying numbers of wind farm mortalities (Table from Symbolix 2021)

Annual wind farm mortalities	Probability of extinction (Portland sub-population[1])		
	10 years	30 years	60 years
0	0%	0%	13%
2	0%	0%	17%
10	0%	16%	49%
50	0%	94%	99%
100	2%	100%	100%
500	100%	100%	100%

Table notes:

1. Portland sub-population 3,500 individuals.
2. Operational life of the wind farm is 30 years.

If the mortality value from the wind farm is low (up to 2 SBWB per annum) there is no discernible difference in Portland sub-population outcomes after 30 years, which is the projected life of the wind farm. For 10 additional mortalities per annum, there is a detectable downward effect on the Portland sub-population predictions over 30 years and greater. SBWB mortality in the range of 50 SBWB per year would have a substantive impact on the probability of extinction and shorten the predicted time frame for extinction of the Portland sub-population.

The targeted survey work completed and reported upon in this assessment indicates that SBWB is unlikely to routinely fly at rotor swept height. Monitoring call activity at four separate wind monitoring towers over a twelve-month period, we recorded a total of four SBWB calls (0.071 calls per night) within rotor swept height. Based on these data, it appears that SBWB flights within rotor-swept height occur rarely and thus that turbine collisions are likely to also be rare events, but it is not possible to quantify a potential collision rate for the species at the KGPH wind farm. Results of the PVA show that no detectable increase in extinction risk for the Portland sub-population of SBWB over the projected life of the wind farm is expected to occur if up to 2 SBWB collisions occur annually. A detectable increase in extinction risk for the sub-population will be realized if somewhere between 2 and 10 SBWB collisions occur annually.

With this level of activity at rotor swept height, the impact of collision is low and resultant mortality should remain below the thresholds noted in the PVA that would otherwise accelerate extinction risk.

5.1.9 Limitations

It is recognised that there are limitations and various sources of uncertainty associated with characterising the potential for impacts of the project on the SBWB population, in addition to the limitations relating to acoustic detection surveys outlined in Section 3.4. These include the following aspects:

- **HEIGHT:** Limited capacity to sample at greater height within the rotor-swept area. Masts were erected for the specific purpose of detecting bats at height but, due to the practicable height limits of masts, the highest detectors were located at 84 m above the ground. Depending on the final selection of turbine model, it is likely that minimum tip height will be between 60 and 90 m and maximum tip height could extend up to 270 m above the ground. There is also limited information in the literature regarding any quantitative assessment of the heights at which SBWB may fly.

- **ROOST LOCATIONS:** Incomplete understanding of roost cave locations. Biosis was provided with all information held by DEECA about the locations of known roost caves but there are potentially undocumented caves, particularly within limestone structures along the Glenelg River and coastal cliffs on the Portland capes. No landforms likely to support caves suitable for roosting or breeding were located within the project area, however the potential for undocumented roosts within the area cannot be completely ruled out.
- **ACCESS TO EXPERTS AND DATA:** The parameters used in the PVA were developed in consultation with species experts within DEECA, including findings from recent research projects on the species. This includes the use of the Portland sub-population and reproduction and survivorship estimates.
    - Some of this information is based on data collected from Naracoorte, as very limited information is available regarding the Portland sub-population. The level of movement of individuals between the Portland sub-population and either the Warrnambool or Naracoorte sub-populations is unknown. Only a single PVA has been performed, incorporating a base case scenario, and scenarios with a range of additional mortality estimates. No sensitivity analysis has been conducted to test alternative parameter estimates, and there has been no alternative PVA incorporating recruitment of individuals into the population as a result of recovery actions, as this would be highly speculative. The mortality scenarios modelled used fixed 'take' numbers across the modelling period, which is unlikely to be accurate, as the level of mortality (number of deaths per year) would be expected to decrease as the population size decreases.
    - Limited understanding of SBWB usage of documented caves, and the degree of movement between caves and between caves and foraging sites. Recent and current post-graduate research is underway to improve this knowledge. It is noted that because the primary concern for microbats relates to potential collisions with wind turbines and due to potential for disturbance of SBWB at roost caves, it was agreed with DEECA (L. Lumsden ARI) that the project investigations should focus on the environments where turbines are proposed to be located and that surveys should not be undertaken at roost caves.

5.2 Transmission line

These is no known information to suggest that microbat fatalities occur due to collisions with transmission lines. SBWB are likely to forage or commute throughout sections of the project area where overhead transmission lines already exist, and additional lines are planned. Given that transmission lines are static structures, it is expected that SBWB would exhibit a high level of avoidance due to their use of echolocation with which they navigate highly efficiently through trees. Additionally, large sections of the proposed transmission line would be installed underground, thereby eliminating any collision risk for those sections.

5.3 Potential for direct impacts

In line with consultation with relevant authorities, consideration of extent and severity of any potential for the Project to result in direct impacts on the SBWB is made in reference to the Portland sub-population, which represents roughly 3.3% of the total population of the subspecies.

PVA undertaken for the potential effects of the Project on the Portland sub-population, initially predicts that the sub-population is in substantial decline in the absence of any effects of the project. The PVA considers a single scenario only, with input parameters developed in consultation with DEECA species experts. Positive impact of recovery actions are not quantifiable and the PVA does not make allowance for impacts of any positive effects.

The Project does not entail substantive loss of any habitat for SBWB. Removal of plantation pines for turbine hardstands and other Project infrastructure will be minor and must be taken in context of the routine removal of mature pines as part of the production plantation operation within which the Project will be situated.

The Project is considered unlikely to impact upon or limit movement patterns of SBWB and the presence of turbines is unlikely to result in SBWB avoiding moving through the project area.

No data is available regarding preferred or frequently used flight paths or whether such exist, but there is expected to be some movement across the site, between foraging areas within Discovery Bay Coastal Reserve and Lower Glenelg National Park, and there is expected to be some foraging activity within the plantation area and farmland where turbines are proposed to be situated.

The principal potential for impact on the subspecies is considered to relate to possible collisions with turbine rotors. Any such impact can be expected to exist for the operational life of the wind farm. The majority of flights are likely to be less than 60 m above ground level (Graph 1) and thus beneath rotor-swept height. Due to the substantially greater height of rotors above the ground, it is expected that SBWB collisions with turbines at the KGPH Project are likely to occur at a lower rate than is the case at existing wind farms where the species is known to have collided.

In the absence of numerical data for SBWB flights measured against time and airspace – and the recognised lack of a mechanism to obtain this for any species of microbat – it is not feasible to undertake quantified collision risk modelling in the manner in which it can be undertaken for some diurnal birds. It is also acknowledged that a collision rate at one wind farm may not apply to another (Moloney et al. 2019).

It is acknowledged that no two wind farms are likely to be directly comparable in respect of their values to SBWB (Moloney et al. 2019). The only available comparative measure is the rate of SBWB calls from ground-level detectors. As discussed above (Section 5.1.2), the rate recorded at the Project site is within the range of rates recorded at some other sites but, other than the data for eight fatalities at two unidentified wind farms detailed in Moloney et al. (2019), definitive data about collisions by the species are not available for operational wind farms.

There is residual uncertainty regarding our understanding of potential impacts, mostly relating to gaps in our understanding of flight behaviour and movement patterns, and limitations in survey methods. These are documented throughout this report.

While it is not possible to confidently estimate potential fatalities that may result from the KGPH Project, the PVA for the Portland sub-population indicates that, over the expected life of the Project additional loss of individuals of somewhat greater than two and less than ten individuals per annum can be expected to increase the rate of its decline.

On the basis of information obtained during investigation for the project, it is considered that turbine collisions at the proposed wind farm are unlikely to result in a long-term decrease in the size of the overall population of the subspecies, due to:

- The apparently low levels of SBWB activity at increasing height above the ground, including the apparently very low levels of their activity as documented for the lower portions of turbine rotor-swept heights, which will be substantially higher than those of turbines at existing operational wind farms in Victoria.
- Patterns of temporal activity of SBWB indicate that risk of turbine collisions will be reduced due to substantially low use of the site during winter and possibly early summer. It is also likely to be low during the latter part of the night when activity was also reduced.
- The preference of bats to fly in lower wind speed conditions (noting that the wind farm will not be operating due to low wind at wind speeds of <3.5 metres per second) and that turbine rotor swept height is likely to routinely experience substantially greater wind speeds that appear not to be favourable for SBWB activity.

In addition, adaptive management of the wind farm may include the capacity to manage operation of turbines to minimise possible impacts on SBWB. For example, operational steps such as operating turbines at higher cut-in wind speeds may reduce the risk of collisions. Recommendations for monitoring and adaptive management approaches are set out in Section 6 of this report and the draft Bird and Bat Management Plan for the Project.

Based on the information obtained during technical studies for this project, literature on the ecology of the sub-species and understanding of known impacts from other wind farms, there is a low to medium likelihood that the proposed wind farm, in conjunction with other wind farms, introduces a significant threat or additional impact likely to alter a cumulative impact assessment (if one could be completed) for the SBWB. Land clearing/habitat removal, climate change and drainage of permanent bodies of water, loss and disturbance of roosting and maternity sites have been identified as major risks to the species and are likely to be of substantially greater significance (TCCS 2021).

5.4 Potential for indirect impacts

Effects of construction and operational noise, traffic and artificial light and hydrological impacts on natural vegetation, wetlands and roost locations outside the project area have all been considered. However, the project design does not include mechanisms whereby effects on the species or its habitats are likely to affect the subspecies. Neither the Portland sub-population nor the greater population of SBWB is considered likely to be impacted indirectly by the project.

5.5 Significance of impacts under EPBC Act

An assessment for SBWB against significant impact criteria for endangered and critically endangered species listed under the EPBC Act (DoE 2013) is provided in Appendix 2. For the purposes of assessment under the EPBC Act the potential for impact is evaluated for the listed taxon, which is the subspecies, not a regional subpopulation. As such, the Project is not considered likely to have a significant impact on the subspecies as per the EPBC Act significant impact criteria.

5.6 Cumulative impacts

The *Scoping Requirements for Kentbruck Green Power Hub Environment Effects Statement* (DELWP 2018) call for a consideration of the potential for the Project to contribute to a greater cumulative effect on biodiversity in combination with other projects or actions taking place or proposed in the region.

Excerpts from the Scoping Requirements pertinent to consideration of cumulative impacts on biodiversity values are as follows:

- Effects from a cumulative perspective, including threatened flora and fauna, social and amenity values, with particular consideration of the currently operating and already approved wind farm projects in the region.
- Potential cumulative effects on key threatened and listed fauna species including but not limited to those listed in Appendix A from the project in combination with other projects.
- Assess the potential cumulative effects on listed species of fauna, in particular Brolga and Southern Bent-wing Bat, from the project in combination with other projects, in particular nearby proposed, approved or operating wind energy facilities.

The *Ministerial Guidelines for Assessment of Environmental Effects under the Environment Effects Act 1978* (DTP 2023) provides information about how cumulative effects may be considered in light of practical ability for a proponent to know the types or extent of impacts that other projects may entail. The Ministerial Guidelines say that an EES assessment should consider:

> Any other activities in the vicinity of the proposed project that a decision-maker or proponent might reasonably be aware of that may have the potential for cumulative effects.

By way of further explanation, the Ministerial Guidelines say:

> Projects may give rise to environmental effects through relatively direct cause-effect pathways, or through more complex, indirect pathways. In addition, the cumulative effect of a project in combination with other activities may need to be assessed if there is a risk of significant adverse effects.
>
> An EES should identify the potential for cumulative effects, i.e. where a project, in combination with one or more other proposed projects, or existing activities in an area, may have an overall significant effect on the same environmental asset. A regional perspective can be helpful in this regard, by putting the potential effects of a project in a wider context. While cumulative effects may be a relevant consideration for the assessment of a project, a proponent may not have a practical ability to provide such an assessment, for example because of their limited access to information on the effects of other existing activities or potential projects. Similarly, the ability of a proponent to provide a regional perspective in an EES will depend on the availability – usually from government agencies – of relevant regional policies, plans, strategies, as well as regional data. A proponent will at least need to provide an assessment of relevant effects (e.g. on landscape values, risks to fauna or emissions to air) in a form that can be integrated with information relating to other projects or activities, and thus enable the Minister to assess the potential cumulative effects. A specific need for a proponent to document potential cumulative effects may arise where a project is to be undertaken in a series of stages. Because of the factors constraining quantitative assessment of cumulative effects, often only a qualitative assessment will be practicable.

Additional policy guidance specific to wind energy is provided in *Development of Wind Energy Facilities in Victoria Policy and Planning Guidelines* (DELWP 2021). It notes that:

> In evaluating wind energy facility impacts on birds and bats including cumulative impacts of a number of discrete wind energy developments within a broad area, it is important to place the collision risks inherent in wind energy facilities in context with other anthropogenic collision risks such as fences, windows and motor vehicles. However, potential impacts of specific developments should still be identified, quantified, minimised and where necessary offset to ensure that the net impact of wind energy facility developments on biodiversity values, especially with regard to threatened species, is at worst neutral.

The location and region of the Project have been subject to significant anthropogenic disturbance since European settlement, much of which is on-going. This includes loss or modification of habitat for SBWB due to clearing of vegetation and replacement with agriculture, plantation forestry and urban development, in addition to collisions with road traffic entanglement in fences. The species has also been subjected to destruction, modification and/or major disturbance of maternity and roost caves since European colonisation (DELWP 2020, TSSC 2021). None of these impacts, past or on-going, are quantified at any geographic scale in a manner that might be assessed in combination with the Project in order to consider their cumulative effects.

In the absence of capacity to assess the accumulated effects of these broader impacts it would be valuable to consider the combined effects of the wind energy sector within the range of the SBWB. The potential for this is discussed below. For SBWB, the 'region' for this assessment is the range of the population and more specifically the range of the Portland sub-population.

5.6.1 Baseline information

Details of SBWB mortalities at other wind farms are set out in section 5.1.1. In summary, information available at the time of preparing this report (October 2023) indicates that a total of 22 SBWB fatalities due to collisions with turbines have been documented across wind farms in Victoria where carcass searches have been undertaken since 2003. As explained by Moloney et al (2019), and briefly outlined in section 5.1.1, estimation of the total numbers of collisions by SBWB is not feasible on the basis of these data.

5.6.2 Discussion of cumulative effects and Southern Bent-winged Bat

Moloney *et al*. (2019) provide the following discussion of the concepts and capacity to assess cumulative impacts of multiple wind farms on birds and bats:

> Population and cumulative impacts.
>
> Obtaining accurate estimates of annual mortality rates is just the first step in assessing whether wind farms are impacting the various species of birds and bats. The next step is determining whether the mortality rates are having a negative impact on the Victorian population of the relevant species. The third step is determining whether there is a cumulative impact on the relevant populations as a result of mortalities occurring at multiple wind farms. These latter two issues are very difficult to resolve. A range of modelling approaches (such as Population Viability Analysis, Integrated Population Modelling, and Potential Biological Removal Modelling), each with their advantages and disadvantages, can be informative; however, for many species the required basic demographic data is lacking, which would necessitate the use of more assumptions, and hence reduce confidence in the findings. For some key species, the collection of additional demographic data is likely to be required. Planning regulators have increasingly called for consideration of cumulative impacts from multiple wind farms; however, methods of assessing cumulative impacts are yet to be developed. There are a number of challenges that need to be overcome before a sound assessment of the cumulative impacts of wind farms in Victoria can be made. These include (i) the need for reduced uncertainties in the mortality estimates from individual wind farms, (ii) the need for all assessments to be undertaken using an agreed set of standards, (iii) the need for mortality estimates to be undertaken over the entire lifetime of a wind farm, (iv) the need for greater understanding of the impact of other anthropogenic causes of declines in populations, and (v) the need for the effects of all existing wind farms to be available before the likely effects of a new one can be predicted, which requires a centralised coordinated repository for all relevant information.

The *EES Inquiry and Panel Report Willatook Wind Energy Facility* (Planning Panels Victoria 16 January 2023) reiterated the need for consolidated and collated information from wind energy facilities in order to consider cumulative effects of the industry on fauna and that this information should be available to stakeholders through a central information hub.

In the present circumstances, the Project has provided available information about SBWB collision (section 5.6.1) but we do not know if these data is comprehensive. They are not sufficient to calculate estimates of total collisions for any wind energy facilities as this requires detailed information about search effort, carcass persistence rates and multiple other factors that are specific to individual wind farms.

Current knowledge is not sufficient to permit quantitative evaluation of cumulative effects of turbine collisions on either the entire population of SBWB or the Portland subpopulation.

5.6.3 Potential for the Project to contribute to cumulative impacts

The distribution of SBWB (DELWP 2020) intersects with multiple operational on-shore wind farms. The key effect of wind energy on SBWB is mortality due to collisions with wind turbines.

Suitable habitat occurs at most SW Victorian wind farms. Moloney *et al* (2019) estimated 0.1 fatalities per turbine per year (from 1 wind farm) based on a single fatality detected at one wind farm. It is not appropriate to extrapolate that result to other wind farms and that result offers no insight into possible population-level effects either for the entire SBWB population or for the Portland subpopulation.

At the time of preparing this report, the following onshore wind farms are operational, in construction or approved, within the range of the SBWB:

- Canunda (S.A.)
- Lake Bonney (S.A.)
- Portland (Vic.)
- Codrington (Vic.)
- Macarthur (Vic.)
- Morton's Lane (Vic.)
- Oaklands Hill (Vic.)
- Salt Creek (Vic.)
- Dundonnell (Vic.)
- *Berrybank (Vic.)
- *Mount Gellibrand (Vic.)
- *Golden Plains (Vic.)

[Wind farms marked with an asterisk may be outside the distributional range of SBWB]

The Portland Wind Farms are geographically closest to the Portland SBWB maternity cave and all other wind farms, with the possible exception of Codrington which is approximately equidistant from the Portland and Warrnambool maternity caves, appear to be closer to one or other of the Naracoorte or Warrnambool maternity caves.

At the time of preparing this report, there are believed to be two offshore wind farm proposals that have been mooted for waters in the region between Portland and the South Australian border. No impact assessment information is known to yet be available for those projects and it is therefore it is not feasible to offer any consideration of their possible contribution to cumulative effects on SBWB in combination with the Kentbruck Green Power Project. However, it is unlikely that the marine components of these offshore projects would affect and contribute to a cumulative impact on the SBWB.

In the context of the entire SBWB population, for which TSSC (2020) estimated the summer 2019-20 adult population to consist of a mean of 44,260, it is reasonable to assume that existing wind farms within the geographic range of the subspecies may be having a low, unquantified population-level effect. The PVA run by the Project assessed hypothetical effects on extinction risk for the Portland sub- population for five incrementally greater numbers of between 2 and 500 additional mortalities per annum. This sub-population represents around 3.3% of the total estimated SBWB population and around 8.5% of the Victorian sub-population. We do not currently have information about the actual numbers of SBWB mortalities that may be occurring at wind farms and thus cannot be certain about actual project-specific or cumulative effects, but as the PVA does not discriminate between any potential causes of additional deaths, the PVA and its results provide an appropriate and specific method for considering possible cumulative effects on the Portland sub-population.

6. Impact assessment – other microbat species

The Scoping Requirements for Kentbruck Green Power Hub (DELWP 2020) include provision for assessment of effects of the Project on 'protected species'. In Victoria species of flora and fauna that are indigenous are generally protected by provisions of the *Wildlife Act 1975* and the *Flora and Fauna Guarantee Act 1988*, whether or not they are listed under any category of threat.

Potential impacts to protected (non-threatened) fauna species other than microbats are considered in Section 35 of Biosis (2024a). Potential impacts to protected microbat species are considered in this section.

Other than SBWB, a range of microbat species were detected in acoustic surveys undertaken for the KGPH project, including:

- Gould's Wattled Bat *Chalinolobus gouldii*
- Chocolate Wattled Bat *Chalinolobus morio*
- Eastern False Pipistrelle *Falsistrellus tasmaniensis*
- Free-tailed Bats *Ozimops* spp.
- Southern Myotis *Myotis macropus*
- Long-eared bats *Nyctophilus* spp. (Likely *N. geoffroyi* and *N. gouldi*)
- White-striped Free-tailed Bat *Austronomus australis*
- Large Forest Bat *Vespadelus darlingtoni*
- Southern Forest Bat *Vespadelus regulus*
- Little Forest Bat *Vespadelus vulturnus*
- Inland Broad-nosed Bat *Scotorepens balstoni.*

Detection rates for these species (expressed as calls / night) are summarised in Appendix 6.

None of these species are listed under either the FFG Act or the EPBC Act. Southern Myotis was previously listed as near threatened under the Victorian Advisory List but was not added to the FFG Act during the recent (2020) review. That said, unforeseen circumstances, such as widespread land-use change, widespread fire or outbreaks of disease, can rapidly alter the conservation status of populations currently considered not to be under threat. Additionally, some species may be on a downward population trend but have not been assessed for listing in detail, or do not yet satisfy the listing criteria.

The proposed Project is contained within a geographic area that is small relative to the distributional ranges of the populations of all non-threatened species in the context of both Victoria and their ranges beyond the state. The Project is largely confined to areas of commercial pine plantations, Blue-gum plantations and cleared pastoral land. As such it generally has low value as habitat for non-threatened species. The non-threatened species it does support are generally widespread and have adapted to such modified environments.

The principal potential effects on non-threatened species are likely to be collisions by birds and bats with wind turbines. The Project will entail very minor removal of habitat for any non-threatened species through mechanisms such as clearing of vegetation for the creation or widening of roads and hardstands for wind energy infrastructure.

Most microbat species are known to collide with turbines. The review undertaken by Moloney et. al. (2019) provides a useful summary of the numbers of detected mortalities at windfarms between 2003 to 2018, and indicates that some species are more frequently encountered in mortality surveys than others. All of the species recorded in acoustic surveys for the KGPH project (the above dot points), have been recorded in carcass searches at windfarms (Moloney et. al. 2019), except for the Southern Myotis and the Inland Broad-nosed Bat. Carcasses of the larger-bodied species tend to be encountered more frequently which could be partly due to them being easier to detect in surveys, but also more likely to fly higher, and therefore be at more risk of collision.

The review by Moloney et. al. (2019), and more recent carcass monitoring undertaken at windfarms, indicates that considerable numbers of White-striped Freetail Bats have been killed at windfarms, with 296 carcasses detected between 2003 and 2018. This equates to and an estimated mortality rate of 6.2 individuals mortalities per turbine per year (95% confidence intervals 3.3 – 9.9) at one monitored wind farm (Wind Farm A) and 2.7 (95% confidence intervals 1.2 – 4.8) at another (Wind Farm B).

The White-striped Freetail Bat was the most frequently recorded species in the acoustic survey program for the KGPH, with 1.8 detections per night (Appendix 6), however it must also be acknowledged that the calls of this species are loud and low in frequency, compared with other microbats, resulting higher detectability, as the calls are detectable at larger distances from the microphone.

Due to the apparent abundance of this species within the project area, and the high recording rate of mortalities at other wind farms, this species is given special consideration in this section.

6.1 White-striped Freetail Bat

The White-striped Free-tailed Bat is a common and widespread species occurring across virtually all habitats in southern Australia, including alpine areas and urban areas. The species roosts in trees across their range either individually or in roosts of up to 20 individuals (Churchill 2008). Females produce one young per year (Churchill 2008). Their diet primarily consists of moths and beetles, and they are known to fly 50 metres or more above the ground (Churchill 2008), which places them at particular risk of colliding with wind turbines (Pennay 2019).

The species is listed as ‘least-concern’ but is recognised as being in decline according to an IUCN assessment undertaken in July 2019 by Pennay (2019). No information is available on population numbers for the species, and it is therefore not currently possible to differentiate between different population scales, nor assess the broader implications of the mortalities observed so far at other wind farms, or potential mortalities at the KGPH.

In the absence of population information, other wind farms provide additional and useful context to the mortalities observed. White-striped Free-tailed Bats represent the majority (67%) of all bat carcass finds at wind farms across Victoria between 2003 and 2018 (Moloney et al 2019). More recent mortalities have been recorded (and are on the public record), at Salt Creek Wind Farm and Dundonnell Wind Farm.

At Salt Creek Wind Farm, a 15 turbine wind farm located in western Victoria approximately 20 kilometres north of Mortlake, 34 White-striped Free-tailed Bat carcasses were found from August

2019 to July 2020, which represented 63% of all microbat mortalities detected within that monitoring year (Biosis 2020).

At the nearby Dundonnell Wind Farm, comprising 80 turbines 10-15 kilometres east of Salt Creek, 34 white-striped Freetailed Bats mortalities detected within the first year of monitoring (Biosis 2022), representing 54.76% of all bat mortalities detected. Most (33) of these mortalities were detected between mid-February and May, with a notable peak (representing 50% of carcasses) in April. Estimated total annual mortality rates, considering detection probability and scavenger rates, were not provided in the year 1 monitoring report (Biosis 2022).

Most young White-striped Free-tailed Bats are weaned between mid-February and May (Churchill 2008). Given the addition of juveniles into the population between mid-February and May, these months are likely to represent periods of peak mortalities for wind farms in south-western Victoria.

White-striped Free-tailed Bats are not known to hibernate and are thought to migrate from southern parts of their range during the cooler months, with very few records of the species occurring in Victoria from June to August (Churchill 2008). Therefore, we consider that White-striped Free-tailed Bat collisions at KGPH Wind Farm are likely to occur but only during the period from September to April/May, with peaks occurring in March and April in association with the known weaning period.

The White-striped Free-tailed Bat is considered a common and widespread species, due to its ability to utilise a wide range of habitats and its occurrence across much of southern Australia. Despite this, collision with turbines is recognised as a localised threat to the species in south-western Victoria (Pennay 2019). Biosis consider that ongoing risk of collision is unlikely to lead to an unacceptable impact on the species at the broader population level. This is consistent with an assessment from Pennay (2019), which states that these localised impacts are unlikely to cause significant decline in the species overall population.

7. Mitigation and offsets

A variety of management measures and techniques have been employed internationally with the aim of reducing turbine collisions by birds and bats. These differ according to their applicability to these two faunal groups. They are considered under three basic categories:

1. Project design measures specifically intended to limit collisions by birds and bats (avoidance)
2. Methods to deter birds or bats from close approach to operational turbines (deterrence)
3. Methods to shut down operating turbines when birds or bats may be in close proximity to turbines (turbine curtailment)

The review of measures to limit collisions presented here is intended as a summary only of currently available information. A summary of the references reviewed is provided in Appendix 7. Due to the rapid development underway in this field, the review was concentrated on literature published since 2017. Appendix 7 firstly lists reports of management measures and systems from operational commercial-scale wind farms as these are considered to represent the most robust indication of real-life experience. The table also lists a number of wider reviews and meta-analyses of techniques. There is a very extensive literature on experimental investigations, most of which have not been applied at commercial-scale facilities. A number of those are included in Appendix 7 for completeness and because it is possible that some of those methods may ultimately be proven.

Most of the methods considered have been implemented only overseas and there is little information about their applicability or efficacy for Australian species. Many techniques have been experimental and have not been implemented with any measurable success at operating commercial wind energy facilities. Technological systems have been in rapid development and refinement, and it can be expected that this will continue. With these aspects in mind, the following review is intended to provide an overview of potential measures and techniques that have been implemented at commercial-scale onshore wind farms.

7.1 Project design measures

In addition to siting the proposed wind farm substantially within an area occupied by production pine plantation which has very limited value to the majority of fauna, the project has adopted two fundamental design measures aimed at reducing the potential for bird and bat collisions with turbines. These are:

- turbine-free zones (buffers) in areas identified as having particular values for important birds and;
- the use of turbines with substantially high clearance between the ground and lowest blade-tip height.

7.1.1 Turbine-free buffers

Turbine-free buffers have been recommended to avoid impacts to a range of species including Brolga and other birds, as well as microbats. These buffers have been adopted by the proponent during the development of the project design. All buffers are from the rotor swept area.

Buffers include:

- A number of buffers for the specific protection of Brolga breeding sites and movement corridors, as described in the Brolga report (Biosis 2022b).
- Exclusion of turbines from within 300 m of boundaries with surrounding conservation reserves, and other public land supporting native vegetation.
- Exclusion of turbines from within 500 m of wetlands within the Glenelg Estuary and Discovery Bay Ramsar site.
- Exclusion of turbines from within 5 km of known roost sites.

No buffer is proposed from turbines to neighbouring plantation trees. SBWB are known to fly within most habitat types, including plantations and cleared farmland, and there is very little information available regarding microbat activity levels, within rotor-swept area, at varying distances from habitat features such as native woodland. The 300 m turbine exclusion recommendation included in this report, and in the project design, is considered an appropriate, conservative approach to minimising collision risk, in conjunction with the high turbines (no blade sweep within 60 m of the ground).

7.1.2 Rotor height

The project plans to use turbines with a lowest blade-tip height that will be 60 metres above the ground. The majority of existing wind turbines in Australia have lowest blade-tip heights of between 20 and 35 metres.

Of a total of 2743 Southern Bent-wing Bat calls detected, nine (0.33%) were at or above 54 metres above the ground. While limitations on these data are acknowledged in this report, it is apparent that the vast majority of the species flights occur below the project's proposed rotor height.

Potential for project application

Data for flight-heights of bats, including SBWB, suggest that, by comparison with currently operating turbines at onshore wind farms in Australia, turbines with a rotor ground clearance of 60 metres can be expected to very significantly reduce the potential for collisions of Southern Bent-wing Bat.

7.1.3 Smart curtailment

The project plans to develop a smart curtailment strategy, to be finalised during the development of the BBAMP. This will include consideration of temporal factors (seasonal and daily) and climatic factors (temperature, rainfall and windspeed).

Recommended parameters for curtailment timing include:

- Seasons of highest activity: September to November and February to March (5 months in total). 76% of confirmed, probable or complex calls were recorded during this time.
- Daily timing: Curtailment to commence 30 minutes following sunset and extend until three hours before sunrise. 86% of confirmed, probable or complex calls were recorded during this time.
- Cut-in wind speed of 4.5 ms^{-1}.

- Climatic conditions: low wind speed curtailment to be implemented when temperature is above 10ºC and when it is not raining (relative humidity < 95%). 91% of SBWB calls were recorded when the temperature was 10oC or greater.

These recommended low wind speed curtailment parameters are summarised in Table 19.

Table 19 Recommended curtailment regime

Time period	Climate parameter	Environmental conditions in which turbines are to be curtailed
September to November	Time	30 minutes after sunset until 3 hours before sunrise; and
	Wind speed	Below 4.5 ms^{-1}; and
	Temperature	10ºC or higher; and
	Humidity	Not raining (relative humidity < 95%).
February to March	Time	30 minutes after sunset until 3 hours before sunrise; and
	Wind speed	Below 4.5 ms^{-1}; and
	Temperature	10ºC or higher; and
	Humidity	Not raining (relative humidity < 95%).

7.2 Deterrence from proximity of turbines

7.2.1 Turbine lighting

Poorly designed lighting of tall structures can attract some species of birds and result in their 'entrapment' within a light pool which in turn may result in death or injury due to exhaustion or collision. Turbines in onshore situations generally only require aviation warning lighting at locations within a prescribed proximity to airfields. The red flashing lights required under such circumstances are not known to be attractive to birds or bats and there is no known international literature to suggest that this kind of lighting is of any concern at onshore wind farms.

Potential for project application

The use of flashing red aviation warning lights mounted high on turbines is not likely to impact upon bats.

7.2.2 Ultraviolet lighting

Limited experiments have attempted to evaluate the responses of bats to ultraviolet lighting of structures including wind turbines (Gorresen et al. 2015). The published studies indicate very limited and mixed results.

Potential for project application

The use of ultraviolet lighting of turbines is not known to have been implemented at any commercial-scale wind farms and information from experiments do not provide confidence that it is a technique likely to reduce effects on bats.

7.3 Active deterrence

7.3.1 Audible noise

Limited experiments have been undertaken to broadcast audible noise in attempts to deter birds from close approach to turbines. Information from an experiment at an operational wind farm found no change in collisions by birds (Dorey, Dicky, & Walker 2019). No studies were found evaluating the effectiveness of this approach to deterrence of microbats.

Potential for project application

Information from experiments does not provide confidence that use of audible noise is a technique likely to reduce effects on bats.

7.3.2 Ultrasonic noise

A number of experiments have been carried out at operational wind farms to evaluate the effectiveness of broadcasting ultrasound noise with the intent of deterring microbats that rely on their own emission of ultrasound for navigation and foraging (Kinzie & Miller 2018, Schirmacher 2020, Cooper et al. 2020, Sievert et al. 2021, Romano et al. 2019, Weaver et al. 2020, Gilmour et al. 2020). The concept is that the broadcast noise will 'jam' the ultrasonic calls of bats as they approach a turbine. They have found a general, but variable reduction in fatalities of some, but not all, bat species at treatment turbines when compared with control turbines (Kinzie & Miller 2018, Romano et al. 2019, Weaver et al. 2020, Gilmour et al. 2020). They have also found that effectiveness of ultrasonic deterrence was limited by distance and area covered by broadcast ultrasound and that this was in part due to rapid attenuation (Kinzie & Miller 2018, Good et al. 2022). At least some studies have also indicated that turbine components themselves impede the broadcast of ultrasonic noise. The experiments have been conducted overseas and the potential applicability of the method to Australian species is unknown.

Potential for project application

Microbats use ultrasonic calls as their primary sense for navigation and, if technical limitations can be overcome, the method may be applicable to microbats.

7.4 Turbine curtailment

Rotating turbine blades clearly present a greater risk of collision for birds and bats than the static turbine components. Stopping rotors from turning, termed 'turbine curtailment', has been widely applied overseas to reduce the incidence of collisions. Turbine curtailment falls into two basic approaches:

- Turbine curtailment aimed at minimising collisions based on prediction of periods or conditions when particular species are most likely to be active near turbines (programmed curtailment).
- Methods to detect birds or bats and to curtail a turbine rotor when an animal approaches to within a prescribed distance of it (on-demand curtailment).

To-date, turbine curtailment is understood to have been applied experimentally at two wind farms in Australia (see *Low wind-speed curtailment*, below). While a substantial reduction in overall bat mortality was demonstrated at one of them, no effect was found at the other. If turbine curtailment was to be applied as a purely precautionary measure from commencement of operation of a wind farm that would preclude an understanding of any level of collisions that might occur in the absence of curtailment. This is particularly important where other measures are implemented, such as the use of turbines with significantly higher than usual lower blade-tip height.

7.4.1 Programmed curtailment

7.4.1.1 Seasonal or periodic curtailment

Programmed curtailment generally refers to shutdown of turbines for short periods during which a species of concern is likely to be present or likely to be present in higher than usual numbers. Overseas It has mostly been used to coincide with short periods of seasonally concentrated migratory movements through a wind farm. It should be noted that in the northern hemisphere, where such programmed curtailment has been most applied, many species of birds and bats migrate along well-defined, often relatively narrow routes in short, highly predictable seasonal movements, often involving entire populations. The majority of birds and bats of south-eastern Australia do not undertake migrations of that kind. South-eastern Australia, including south-western Victoria, is the endpoint of annual migrations by many species of shorebirds and annual migration by various resident species between southern and northern Australia also occurs. In addition, many Australian species are nomadic and move throughout the continent in response to changeable environmental conditions and weather events. Migrations and nomadic movements by Australian species are generally diffuse across the broad landscape and are not confined to narrow geographic routes.

With sufficiently detailed knowledge it may be feasible for programmed curtailment to be applied to specific periods of the diel cycle or to the duration of particular activities of relevant species. In some cases, individual turbines may be curtailed for periods where they present greater risk than other turbines at a wind farm.

Programmed curtailment has occasionally been suggested as a response to high numbers of detected collisions by particular species, but it is not known to have been used for this purpose at any Australian wind farm to-date.

Potential for project application

Data collected by the project indicates the seasonality and periods of the night when peak activity of Southern Bent-wing Bat calls were recorded in 2019 and 2020 (Section 5.1.5). Peaks of activity occurred in February and March; December; and at a lower level in September (Graph 2). For all months combined, nightly activity rose to a peak at 1900 hrs and then gradually declined until 0500 hrs (Table 14). These results offer some level of information for the species, which is likely to be broadly relevant for other bats, but it should be noted that these results apply only to call data for the species that was almost entirely from ground-level detectors. Of a total of 2743 Southern Bent-wing Bat calls detected, nine were at or above 54 metres above the ground. While limitations on these data are recognised (Section 3.4, 5.1.8), it is apparent that the vast majority of the species flights occur below the project's proposed rotor height and that programmed curtailment is not likely to be of value in limiting collision risk for this species or most other species of microbats. Seasonal low wind speed curtailment is recommended, as detailed in Section 6.5.

7.4.1.2 Low wind-speed curtailment

The rotor on a wind turbine generator is passive, requiring the external force of the wind to induce rotation. By default, wind turbines adjust the pitch of the blades to present the full surface area to the oncoming wind direction so that when the minimum wind conditions are present, rotation will begin. As the wind speed increases, the rotational speed of the turbine will also increase until it reaches a point where it is effective to generate electricity, this is the electrical 'cut-in' wind-speed. It is often the case that turbine rotors are allowed to turn while wind-speed is below the cut-in wind speed and thus generating no electricity. This is done to reduce wear on turbine components by preventing overly frequent starting and stopping of the machines.

A number of investigations overseas have demonstrated that flight activity of small species of bats is concentrated on periods when wind-speeds are relatively low. A number of studies have demonstrated that preventing turbines from rotating during periods of low wind speed has reduced collisions by some bat species (Bennett et al. 2022, Good et al. 2022, Rabie et al. 2022, Mantoui et al. 2020, Anderson et al. 2022, Hayes et al. 2019). This is termed a 'low wind-speed curtailment', and adjusts settings in the turbines operations, where the rotor blades are pitched to minimise surface area, effectively stopping rotation and reducing the risk of collision when electricity is not being generated. The turbine's blades will only adjust their pitch to begin rotation after a threshold wind speed has been exceeded (typically for a two minute average). These settings typically match or exceed the electrical cut in speed, resulting in increasing levels of electricity generation loss.

Low-wind speed curtailment is known to have been applied at two commercial-scale wind farms in Australia, Cape Nelson North Wind Farm near Portland in south-western Victoria and Mount Emerald Wind Farm in north Queensland. A peer-reviewed paper has been published about the Cape Nelson North Wind Farm (Bennett et al. 2022), which is close to the project site. Reports describing the Mount Emerald Wind Farm study are provided on the wind farm's website (https://mtemeraldwindfarm.com.au/compliance/).

The species of principal concern at Cape Nelson North is Southern Bent-wing Bat. The wind farm incudes Senvion MM82 and MM92 turbines, with a maximum hub height of 80 m, a maximum tip height of 126.5 m and a ground clearance (below RSA) of approximately 33 m. The study of curtailment there involved increase of cut-in wind-speed from 3 metres/second to 4.5 m/s. The study documented a 54% reduction in detected bat fatalities during curtailment relative to a preceding period without curtailment (Bennett et al. 2022). This result is for the pooled data encompassing eight identified species of microbats. Low numbers of detected fatalities for individual species, including Southern Bent-wing Bat (of which there was a total of three detected over the entire study), prevent conclusions from being drawn about any species.

At Mount Emerald, the species of principal concern are Spectacled Flying Fox *Pteropus conspicillatus* (EPBC Act: Endangered) and Bare-rumped Sheathtail Bat *Saccolaimus saccolaimus nudicluniatus* (EPBC Act: Vulnerable). The wind farm consists of 53 turbines (37 Vestas V117 and 16 V112). Ground clearance is approximately 28-32 m, depending on the turbine model. The study there has now completed two years of curtailment in which all turbines were curtailed in the first year, so that their rotors did not begin to turn until the cut-in wind-speed of 3.0 m/s was reached. During the second year of the study, half of the turbines had their cut in wind-speed increased to 4.5 m/s. Throughout the study to-date, no Bare-rumped Sheathtail Bat fatalities have been detected. The number of Spectacled Flying Fox fatalities detected has also been so low that there has been no statistical power to demonstrate any change in mortality rate for that species. As a consequence, the curtailment experiment does not demonstrate any direct value of one level of wind-speed curtailment over the other for these two threatened species.

In order to further explore the possible relative values of the curtailment for Mount Emerald results were analysed for all flying foxes (i.e. the pooled results for Spectacled Flying Foxes and Little Red Flying Foxes) and for the pooled results for all microbat species. Results of analyses were non-significant at the 0.05 level for both groups. This means that at Mount Emerald the mortality rate of both groups of bats at turbines operating with cut-in wind-speed of 4.5 m/s was not significantly different from the mortality rate experienced at turbines with a cut-in wind-speed of 3.0 m/s. The study at Mount Emerald is continuing in its third year, comparing curtailment on 50% of turbines (3 m/s cut in), against no curtailment.

Potential for project application

Low wind-speed curtailment may be applicable to reduction of collisions by microbats, potentially including Southern Bent-wing Bat.

As noted above (*Seasonal or periodic curtailment*), turbine curtailment can be expected to be of value only to bats flying within rotor-swept height. Data from the site suggests that the vast majority of flights by microbats, including those of the Southern Bent-wing Bat, occur below the project's proposed rotor height. If that remains the case during wind farm operation, it is not likely that low wind-speed curtailment would contribute substantively to limiting collision risk for this species or most other species of microbats.

7.4.2 On-demand curtailment

This section provides a review of various automated systems designed to prevent potential collisions. The majority of systems reviewed here are designed to do that by using a monitoring system linked to an automated mechanism for shut-down and re-start of turbine(s). All turbines have existing SCADA (supervisory control and data acquisition) mechanisms for shut-down and re-start in response to wind conditions.

Automated systems designed simply to record and document collisions are not included here.

Automated turbine curtailment systems require a mechanism to detect a bird or bat that may be at risk (usually because it has entered a prescribed distance from the turbine) and use the detection as a trigger to shut down the turbine, or turbines, until the animal is no longer within the danger zone. SCADA is integral to functioning of the system by eliminating the need for monitoring or response intervention by human controllers and because of its rapid response capability.

On-demand systems may be both more efficient in reduction of collision risk than programmed or simple low wind-speed curtailment because they respond to the actual detected presence of a bird or bat. They may also minimise loss of energy generation by their more targeted approach.

7.4.2.1 Bat call detection

Recording of ultrasonic bat calls is undertaken routinely in surveys for microbats and was used as the primary means of survey for small bats at the project site. The use of detected bat-calls to trigger turbine shut-down to reduce collision risk requires a substantial additional system and a minimum number of detectors on every turbine. At least two commercially available systems using ultrasonic bat-call detection for this purpose have been developed in Europe and the USA (Hayes et al. 2019).

The capacity to curtail turbines on the basis of detecting ultrasonic calls for a particular species of concern is dependent on an automated positive and instantaneous identification of the species from its characteristic calls. In the case of Southern Bent-wing Bat, a degree of uncertainty in discriminating its calls from those of some other taxa that occur at the project site currently exists.

Bat-call detectors function by recording the calls of bats flying within the sensitivity range of the detector microphone. Detector technology has seen on-going improvement over recent years and can be expected to continue to be refined and improved, nonetheless at present the capacity to detect a call and the quality of the recorded call are strongly influenced by the distance between the bat and the microphone and other factors that affect call-attenuation, including climatic conditions and the frequency spectrum of the bat call. Current model bat-call detectors generally have a maximum detection distance of approximately 30 metres under optimal conditions and, in normal operation the turbines to be installed at the project are likely to take at least 30 seconds for rotors to come to a complete standstill. These factors present a problem particularly in light of the call detection distance relative to the proposed rotor span that is very much greater than 30 metres.

Potential for project application

Current limits on the distance over which ultrasonic bat calls can be reliably detected relative to the size of proposed turbines indicate that this technology is not likely to provide a consistent and reliable mechanism to curtail turbines if threatened species of bats fly in close proximity to turbines.

7.4.2.2 Radar

Radar uses radio waves to scan a given radius to detect objects within the airspace. Simultaneous use of horizontal and vertical surveillance radars allows scanning in three dimensions. Radar has a substantial history of use for detection of flying birds and bats and is widely used at airports to reduce aircraft bird and bat-strikes. A number of commercially available radar systems have been developed and are in use at wind farms overseas (Nilsson et al. 2018, Moll et al. 2020). Radar has been used at wind farms overseas to obtain information about the overall use of the local airspace by birds and bats.

Where the surrounding terrestrial landscape has a complex topography or multiple obstacles such as trees or buildings, this ‘clutter’ renders radar ineffective for detecting targets that are close to the ground or amongst those obstacles. This clutter effect would be likely to place a severe constraint on the value of radar as a primary trigger mechanism at the project site due to its undulating topography and the presence of plantation trees over much of it.

Radar does not have intrinsic capacity to distinguish individual species and it does not readily discriminate large objects (like a single large animal) from a tight cluster of smaller objects (like a small flock of birds or insects), but with local experience it is possible to categorise flying animals into basic size classes. Radar has now been in use at various wind farms, primarily in the northern hemisphere, for the purpose of triggering curtailment to reduce collision risk. Available information about use of radar for this purpose suggests that its primary applications are where the species of concern are large birds or flocks of birds that are approaching a wind farm from outside its boundaries. It has been of value in detecting the approach of migrating flocks of birds or of individuals of large species like eagles, vultures or cranes. This type of application is of relevance where such events may occur seasonally or infrequently and a turbine shutdown can be used to reduce collision risk while the animals pass through the wind farm.

A radar system is in operation for the purpose of triggering shutdown of individual turbines to reduce fatalities of the EPBC Act listed Tasmanian Wedge-tailed Eagle at Musselroe Wind Farm in Tasmania (https://woolnorthrenewables.com.au/wp-content/uploads/2022/10/MRWF-Public-Environmental-Report-2019-2022.pdf). Several Tasmanian Wedge-tailed Eagles with home ranges overlapping the site have also been fitted with GPS tracking devices, allowing for independent checking of the detection rate from the radar system.

Radar functions by sweeping through the radius of airspace and there are intervals between sweeps. Anecdotal information suggests that the intervals allow for a bird to make a rapid change of direction in which it might collide with a turbine without its previous trajectory having triggered a turbine shutdown.

Potential for project application

The small body sizes of microbats would make it unlikely that radar could reliably detect them. In addition, a range of microbat species occur at the site and are likely to be in flight for most nights of the year. It would not be feasible for radar to distinguish threatened microbat species as a trigger for turbine curtailment.

7.4.2.3 Camera tracking

A few automated camera-tracking systems have now been developed and used at operational wind farms. These are systems use high precision optical cameras (with the potential option for thermal imaging cameras also) located strategically to provide coverage of all turbines. The cameras track the movement of birds and calculate the trajectory of a detected bird relative to the rotor-swept area of turbines in real time. The system of cameras is interconnected to the SCADA system.

The system uses artificial intelligence to ‘learn’ to distinguish target species from other species and make curtailment ‘decisions’. The learning process requires multiple different images of the target species which can be obtained during the early period of the system’s operation.

Once functional the system tracks the movement of objects in the sky around the wind farm and determines whether an object is a target species. If it is, the system commences tracking and determining its trajectory in real time relative to turbines. Pre-defined distances from turbines are then used to trigger curtailment if the trajectory of the bird indicates it will enter a zone too close to a turbine. The system can track multiple eagles simultaneously and shut down any turbines required to avoid a collision.

A camera tracking system is in operation to minimise collisions by the Tasmanian Wedge-tailed Eagle and White-bellied Sea-eagle at Cattle Hill in Tasmania (https://cattlehillwindfarm.com/wp-content/uploads/2022/03/Assessment-of-IDF-Avian-Detection-System-FINAL_updated.pdf). The 2022 report on the system there suggests it has been highly effective in prevention of eagle collisions. The system in use at Cattle Hill has also been the subject of a peer-reviewed paper that assessed its effectiveness for eagles (McClure, Martinson, & Allison 2018). That paper indicates that the system has the ability to detected species as large as, or larger than an American Kestrel (i.e. a body length of approximately 25 cm and a wingspan of approximately 56 cm).

Camera tracking systems appear to be the most effective currently available systems for triggering of on-demand turbine curtailment for medium to large target species of diurnal birds. It is possible that integration of thermal imaging capacity would allow them to also function for similar sized nocturnal birds and flying-foxes.

Potential for project application

Available information about camera tracking system suggest that, at present, they would not be suited to discriminatory detection of threatened microbats, due to their small body sizes and their similarity to non-threatened species. The nocturnal activity of microbats would necessitate the availability of thermal imaging capacity.

7.4.2.4 Thermal imaging

Thermographic cameras detect radiation in the long-infrared range of the electromagnetic spectrum. Effectively this allows an image to be made from the variable temperatures of items in the absence of visible light. Thermal imaging cameras have now been used widely to detect and ‘see’ nocturnal wildlife. At least one system has been developed using thermal imaging to trigger monitoring of bat activity in proximity of turbines to trigger curtailment (Georgiev & Zehtindjiev 2022, Matzner, Warfel, & Hull 2020). This system differs from camera-tracking systems described above and uses thermal imagers positioned on individual turbines.

While thermal imaging of this kind would have a primary application to bats and nocturnal birds, it would not be suited to discriminatory detection of threatened microbats, due to their similarity to non-threatened species.

To-date little information has been obtained about the effectiveness of this type of system.

Potential for project application

While thermal imaging of this kind would appear to have a primary application to bats, it would not be suited to discriminatory detection of threatened microbats, due to their similarity to non-threatened species. In addition, limitations on coverage of turbines would appear to significantly constrain the value of this technology to reducing collisions by bats.

7.4.2.5 Integrated systems

A system that integrates radar with optical and thermal camera-tracking in the offshore environment has been reported recently from Scotland (https://group.vattenfall.com/uk/siteassets/wind-pdf-documents/eowdc/aowfl-aberdeen-seabird-study_annual-report-2020_v3_final-2.pdf). In effect, this system combines the capabilities of radar and camera-tracking as described above.

The radar is used to initially detect birds. High-speed processing software then allows birds discovered by the radar to be automatically targeted by the cameras and followed, using motion detection and video. Thermal imaging is incorporated and permits detection during the hours of darkness.

To-date, this system is in use to obtain data about the flight activity and turbine-avoidance behaviours of birds. However, there would appear to be no reason why an integrated system of this kind could not also be employed to trigger curtailment.

Potential for project application

The integrated system outlined here has not been applied for triggering of turbine curtailment and the system has not been operated in the onshore environment. At present the potential for its application is unknown.

7.5 Mitigation recommendations

This report will inform the environment effects statement and the planning permit applications to be made for the wind energy facility and the transmission line (utility installation).

Environmental impacts are expected to be managed during the construction and operation of the Kentbruck Green Energy Hub under an Environmental Management Plan (EMP), that is likely to be comprised of a range of specific plans including:

- Construction Environmental Management Plan (CEMP)
- Bird and Bat Adaptive Management Plan (BBAMP) (Biosis 2024c)

These plans will likely be required as a condition of any planning permits issued for the project, and will be informed by this impact assessment and the recommended mitigation measures. These plans will also be informed by recommended mitigation measures included in other technical studies prepared for the EES and planning permit applications.

Table 20 provides recommendations related to SBWB for various project stages, including design, detailed design, pre-approval and construction. It should be noted that many of the recommendations related to exclusion of turbines from sensitive areas have already been incorporated into the project design, as outlined in Section 1.2.4 of the ecology report.

Although we consider the key design mitigation measure of raising the lower blade tip height to 60 m above ground level will significantly reduce collision risk, application of the precautionary principle suggests that low wind speed curtailment, at night during periods of high activity, may further reduce the risk.

Table 20 Mitigation measures relevant to Southern Bent-wing Bat

Mitigation Measure	Details	Timing
Turbine design	Minimum lower blade tip height raised to be at least 60 m or higher than ground level.	Pre-Construction
Turbine exclusion area	Implement appropriate turbine setbacks (exclusion areas) from the Ramsar Site and other protected areas (National Parks and Discovery Bay Coastal Park). The closest proposed turbine to a known SBWB roost site was a distance of 4 km away. The current design has excluded all turbines from within 5 km of this site.	Already incorporated in turbine layout
Seasonal nocturnal low wind speed curtailment	It is recommended that low wind speed curtailment be implemented. The plan would be developed during finalisation of the BBAMP, and should include consideration of seasonality, time of day, temperature and rainfall. Suggested settings include: • Daily timing to be finalised during development of the BBAMP. Suggest: 30 minutes following sunset to three hours before sunrise • Seasonal timing: September-November and February-March (5 months); • Climatic conditions: Temperature above 10oC and it is not raining (relative humidity < 95%). • Cut-in wind speed: 4.5 m/s.	Operation

Mitigation Measure	Details	Timing
	This recommendation will be contained and assess as directed by the BBAMP. Any additional curtailment should be conducted as part of scientific trials, including intensive monitoring and reporting, to evaluate effectiveness of the curtailment in eliminating or reducing mortalities.	
Development of a Bird and Bat Adaptive Management Plan	Bird and Bat Adaptive Management Plan (BBAMP) management plan to be developed, including protocols for monitoring and triggers for implementation of adaptive management, including monitored low wind speed curtailment trials. The BBAMP is the key mechanism for responding to residual risk and unexpected bird or bat mortalities. • The plan must include intensive carcass monitoring across the wind farm, particularly in the early stages of operation. • Turbines selection for monitoring should consider stratification by habitat type (Plantation and Farmland), distribution throughout the site and proximity to known caves. • Frequency of monitoring should be at least monthly during the monitoring period, and the plan should consider pulse surveys during peak activity periods, including autumn and spring. • Within plantation areas the ideal searchable area for carcass searches will include both cleared areas (50 m radius) and areas under the pine canopy. This will need to be considered in the development of the search regime (including searcher efficiency and carcass retention trials) and mathematical approaches to extrapolating findings will need to be customised to the study. • The plan should specify a sequence of actions to be undertaken if SBWB mortalities are recorded, including intensification investigations, and potential increase in low-wind speed curtailment of specific turbines.	Draft plan provided with EES documentation. Plan to be finalised and approved Pre-Construction, subject to permit conditions, and consultation with DEECA.
Potential indirect offset measures, including funding recovery actions and funding research.	To be workshopped with the SBWB recovery team and other relevant conservation organisations. The Recovery Plan (DELWP 2020) and the Conservation Advice (TSSC 2021) detail proposed recovery actions, which includes a range of research to address knowledge gaps relating to understanding population dynamics, movement behaviour and mitigation approaches. These are summarised in Section 1.4.5. The EPBC Act Environmental Offsets policy is currently being reformed, including the development of national standards for environmental offsets. The proponent has made a commitment for a $1,000,000 recovery fund, which is to focus on SBWB recovery actions, but also to have the ability to assist in recovery actions for other species.	Operations

8. Conclusion

This report presents an assessment of potential impacts on the Critically Endangered Southern Bent-wing Bat from the proposed Kentbruck Green Power Hub.

The objective of the study was to obtain relative measures of the species' flight activity (using detected echolocation calls as a qualitative surrogate measure) and determine how call-activity may vary temporally and spatially across the Project area, including consideration of the vertical distribution of bat activity.

Preliminary acoustic surveys occurred between November 2018 and April 2019 at ground locations and on one meteorological monitoring mast. Further acoustic surveys were carried out between December 2019 and November 2020. This 12-month survey program for the Project involved 24 bat detectors, including eight stand-alone ground detectors and 16 detectors on four met masts, with each met mast having a detector at 1.5 metres, 28 metres, 56 metres and 84 metres above ground level. This level of survey effort represents one of the most comprehensive pre-approval bat activity monitoring exercises conducted to date for an on-shore wind farm in Australia.

Limitations on height of masts used for the Project prevented locating bat call detectors at greater than 84 metres. It is recognised that the highest detectors operated only within the lowest height zone of turbines proposed for the Project, but that is also a reflection of the substantially greater ground clearance (minimum of 60 metres) of blades for these turbines compared to other wind farms operating in western Victoria.

Southern Bent-wing Bat calls were recorded at all mast locations, indicating that the species can fly and forage through the project area. The detection rate for ground-based detectors (12 detector locations) was 0.57 bat passes per detector per night. The detection rate at 28 metres was 0.013 and detection rates for 56 metres and 84 metres were 0.003 and 0.002 passes per night, respectively.

The Southern Bent-wing Bat call recordings indicate activity peaks within late summer and early autumn (February and March) and again in spring (September to December). Activity levels were relatively low throughout late autumn and winter (May to August). Recent research summarised in the conservation advice (TSSC 2021) suggests that some activity is maintained in the colder months, including movement between non-maternity caves. Southern Bent-wing Bat were recorded throughout the time of darkness, but in general highest activity levels were recorded in the first few hours following sunset.

Impact assessment

The Project does not entail substantive loss of any habitat for Southern Bent-wing Bat. Minor removal of plantation pines for turbine hardstands and other Project infrastructure will be minor and must be taken in context of the routine removal of mature pines as part of the production plantation operation within which the Project will be situated.

Assessment for project impacts on the SBWB is primarily focused on the potential for collisions with turbines.

No data is available regarding preferred or frequently used flight paths, but there is expected to be some movement across the site, between foraging areas within Discovery Bay Coastal Reserve and Lower Glenelg National Park, and there is expected to be some foraging activity within the plantation area and farmland where turbines are proposed to be situated. The Project is considered unlikely to impact upon or limit movement patterns of Southern Bent-wing Bat, with the exception that there is a risk that flights within rotor-swept height have some potential to result in collisions. Most flights are likely to be beneath rotor-swept height, less than 60 m above ground level, and the presence of turbines is unlikely to result in Southern Bent-wing Bat avoiding moving through the project area.

The impact assessment is presented in the context of considerable uncertainty regarding quantitative analysis of bat call data, including limited detection volume and the influence of a range of factors on detectability, including bat call characteristics and environmental conditions.

At all four masts there were greatly reduced levels of Southern Bent-wing Bat call activity detected at the higher detectors. The frequent calls of White-striped Free-tailed Bat recorded at the two higher detectors on the masts confirms that the high detectors functioned correctly and were able to detect bat calls. The significantly lower call activity of Southern Bent-wing Bat recorded by high detectors reflects actual lower call activity at those heights relative to call activity of the species closer to the ground.

Risk of collisions with turbines is confined to the hours of their nocturnal activity. For the year studied, levels of call activity were low during the months of December and January and again in May to August. It is considered likely that this reflects an annual routine, that the species is less active during the cooler months. It can be expected that any possible risk of turbine collisions may be low during the latter half of the night and at the lowest during winter.

Results of the study are not conclusive, but they suggest that Southern Bent-wing Bat flight activity is concentrated at heights well below the height of rotors of turbines proposed for the project. Potential reasons for this include that foraging resources for the species are likely to be more abundant in that height range and that kinetic energy of great wind speeds at higher heights may be less favourable for the species.

Increased wind speed associated with greater altitude likely explains, at least in part, the simple correlation between Southern Bent-wing Bat call activity and height recorded at the Project site and discussed above. Implications for the Project are as for that part of the study in that risk of collisions, including the potential for barotrauma, appears likely to be very low because of the relative rarity of fights within the rotor-swept height zone of the turbines proposed for the project.

Population viability analysis

A population viability analysis (PVA) on Southern Bent-wing Bat was carried out to assist in the assessment of impacts from the proposal (Symbolix 2021). The outputs of the PVA show the 'zero' harvest rate (rate without any wind farm mortalities included) shows a substantial decline in the Portland sub-population size, whereby it will decline by more than 50% within ten years and by almost 100% within 60 years.

If the mortality value from the wind farm is low (around two Southern Bent-wing Bat per annum) there is no discernible difference in Portland sub-population outcomes after 60 years. For 10 additional mortalities, there is a detectable downward effect on the 60-year Portland sub-population prediction. Southern Bent-wing Bat mortality in the range of 50 Southern Bent-wing Bat per year would have a substantive impact on the probability of extinction and shorten the predicted time frame for extinction of the Portland sub-population.

The targeted survey work completed and reported upon in this assessment has shown that Southern Bent-wing Bat is unlikely to regularly fly at rotor swept height. Based on these data, it appears that Southern Bent-wing Bat flights within rotor-swept height occur rarely. With this level of activity at rotor swept height, the impact of collision is low and resultant mortality should remain below the thresholds noted in the PVA that would otherwise accelerate extinction risk.

Cumulative impacts

Based on the information obtained during technical studies for this project, literature on the ecology of the sub-species and understanding of known impacts from other wind farms, there is a low to medium likelihood that the proposed wind farm, in conjunction with other wind farms, introduces a significant threat or additional impact likely to alter a cumulative impact assessment (if one could be completed) for the Southern Bent-wing Bat. Land clearing/habitat removal, climate change and drainage of permanent bodies of water, loss and disturbance of roosting and maternity sites have been identified as major past, current and ongoing risks to the species and are likely to be of substantially greater significance (TCCS 2021). There is residual uncertainty regarding our understanding of potential impacts, mostly relating to gaps in our understanding of flight behaviour and movement patterns, and limitations in survey methods.

Impacts to non-threatened bat species

The Scoping Requirements for Kentbruck Green Power Hub include provision for assessment of effects of the Project on 'protected species'. In Victoria species of flora and fauna that are indigenous are generally protected by provisions of the *Wildlife Act 1975* and the *Flora and Fauna Guarantee Act 1988*, whether or not they are listed under any category of threat. At least 12 other microbat species were recorded in acoustic monitoring undertaken for the project. Most of these species are common and widespread, and while collisions with turbines may occur, these are highly unlikely to result in population level impacts, based on the current knowledge of these species.

Operational microbat mortality monitoring at wind farms within south-west Victoria has resulted in large numbers of mortalities of White-striped Freetail Bat, which is a large, fast and high flying species that is common and widespread within eastern Australia. A recent IUCN assessment of this species determined the conservation status to be 'least concern' however there is there is concern the species may be in decline, as mortalities of this species represent a large proportion of total bat mortalities monitored at wind farms. This species is considered to be common and widespread across most of southern Australia, including the Project area, and based on currently available knowledge, the project is not considered likely to lead to an unacceptable impact on the species at the broader population level.

It is recommended that consideration be given to White-striped Freetail Bat, and all other microbat species, in the KGPH BBAMP.

Mitigation and adaptive management

Avoidance and mitigation recommendations are provided in Section 6.5, including a review of currently available mitigation approaches. The key measures applied are the adoption of turbine free areas, and a proposal to use turbines with a blade sweep that will not extend to within 60 m of the ground. Data collected during the project surveys for flight-heights of birds and bats suggest that, by comparison with currently operating turbines at onshore wind farms in Australia, turbines with a rotor ground clearance of 60 metres can be expected to reduce the potential very significantly for collisions for the great majority of species, including SBWB.

The scoping requirements have been considered and the residual impact to the species following adoption of avoidance and design measures is a potential small number of collisions per year, that is unlikely to substantially change the trajectory of the population. Residual impacts will be managed through the Bird and Bat Adaptive Management Plan (BBAMP). The proponent has also made a commitment to establishing a fund to support recovery actions for the species.

Low wind speed curtailment at night during periods of higher activity may further reduce the risk of Southern Bent-wing Bat collisions with turbines. Low wind speed curtailment may be implemented in response to detected mortalities.

Seasonal low wind speed curtailment will be considered as an adaptive management response in the BBAMP. Any additional curtailment should be conducted as part of scientific trials, including intensive monitoring and reporting, to evaluate effectiveness of the curtailment in eliminating or reducing mortalities.

A Bird and Bat Adaptive Management Plan (BBAMP) management plan will be developed, including protocols for monitoring and triggers for implementation of adaptive management, including monitored low wind speed curtailment trials. The BBAMP is the key mechanism for responding to residual risk and unexpected bird or bat mortalities.

References

Adams EM, Gulka J, & Williams K 2021. 'A review of the effectiveness of operational curtailment for reducing bat fatalities at terrestrial wind farms in North America', *PLoS One*, 16, 11: e0256382.

AECOM 2024a. *Kentbruck Wind Farm: Surface Water Impact Assessment*, Prepared for Neoen Australia Pty Ltd. Authors: Kasraie. L, Meyer. P, Aecom Australia Pty Ltd. Adelaide, SA. Project no. 60591699.

AECOM 2024b. *Groundwater Impact Assessment. Kentbruck Green Power Hub Project EES Technical Report*, Report prepared for Neoen.

Anderson AM, Jardine CB, Zimmerling J, Baerwald EF, & Davy CM 2022. 'Effects of turbine height and cut-in speed on bat and swallow fatalities at wind energy facilities', *FACETS*, 7, 1: 1281–97.

Arnett E, Schirmacher W, & Hayes J 2011. 'Altering turbine speed reduced bat mortality at wind-energy facilities.', *Frontiers in Ecology and the Environment*, 9, 4: 209–14.

Arnett EB 2017. *Wildlife and Wind Farms, Conflicts and Solutions. Onshore: Monitoring and Mitigation. // Chapter: Mitigating bat collision*, Perrow M (ed.), Pelagic Publishing, Exeter, UK.

Arnett EB, Schirmacher M, Huso MMP, & Hayes JP 2010. *Effectiveness of changing wind turbine cut-in speed to reduce bat fatalities at wind facilities*, Report prepared for Bats and Wind Energy Cooperative. Bat conservation International, Austin, Texas, USA.

Baerwald EF, D'Amours GH, Klug BJ, & Barclay RMR 2008. 'Barotrauma is a significant cause of bat fatalities at wind turbines', *Current Biology*, 18, 16: 695–6.

Bennett E, Florent SN, Venosta M, Gibson M, Jackson A, & Stark E 2022. 'Curtailment as a successful method for reducing bat mortality at a southern Australian wind farm', *Austral Ecology*, 47, 6: 1329–39.

Biosis 2020. *Salt Creek Wind Farm: Second Year Annual Report – Bat and Avifauna Management Plan 2019 / 2020*, Report prepared for Tilt Renewables Australia Pty Ltd. Author: Veltheim, I, Gibson, M, and Potts, C. Biosis Pty Ltd, Ballarat, VIC. Project no. 30622.

Biosis 2022. *Dundonnell Wind Farm: First Year Annual Report - Bat and Avifauna Management Plan*, Report prepared for Tilt Renewables Pty Ltd. Authors: McCutcheon, C and Russell, W. Biosis Pty Ltd, Melbourne, VIC. Project no. 33578.

Biosis 2024a. *Kentbruck Green Power Hub Environmental Effects Statement Technical Report: Brolga Impact Assessment.*, Report prepared for Neoen Australia Pty Ltd. Authors: Smales. I, Gibson. M, Venosta. M, Biosis Pty Ltd, Melbourne, VIC. Project no. 35014.

Biosis 2024b. *Kentbruck Green Power Hub: Southern Bent-wing Bat Impact Assessment*, Report prepared for Neoen Australia Pty Ltd. Authors: Smales. I, Gibson, M. & Venosta, M. Biosis Pty Ltd, Melbourne, VIC. Project no. 35014.

Biosis 2024c. *Bird and bat adaptive management plan for Kentbruck Green Power Hub*, Report prepared for Neoen Australia Pty Ltd. Authors: Smales. I, Gibson. M & Venosta. M, Biosis Pty Ltd, Melbourne, VIC. Project no. 35014.

Bourne S 2010. ‘Bat research at Naracoorte’, *The Australian Bat Society Newsletter*, 34: 24–9.

Churchill S 2008. *Australian Bats*, 2nd edn, Allen & Unwin, Sydney, NSW.

Cooper D, Green T, Miller MF, & Rickards E 2020. *Bat Impact Minimization Technology: An Improved Bat Deterrent for the Full Rotor Swept Area of Any Wind Turbine*, Report prepared for California Energy Commission. Authors: Cooper. D, Green. T, Myron. M, Rickards. E, Frontier Wind, Pennsylvania, USA. Report no. EPC-14-071.

Cryan PM, Gorresen PM, Straw BR, Thao S, & DeGeorge E 2021. ‘Influencing Activity of Bats by Dimly Lighting Wind Turbine Surfaces with Ultraviolet Light’, *Animals*, 12, 1: 9.

DELWP 2020. ‘National Recovery Plan for the Southern Bent-wing Bat *Miniopterus orianae bassanii*’, Department of Environment, Land, Water and Planning, Victoria, Melbourne, VIC. https://www.dcceew.gov.au/environment/biodiversity/threatened/publications/recovery/southern-bent-wing-bat.

DELWP 2021. *Policy and Planning Guidelines for Development of Wind Energy Facilities in Victoria*, Report prepared for Victorian State Government. Department of Environment, Land, Water and Planning, Melbourne, VIC.

DoE 2013. *Matters of National Environmental Significance Significant impact guidelines 1.1 - Environment Protection and Biodiversity Conservation Act 1999*, Department of the Environment, Canberra, ACT, accessed 14 February 2024, https://www.dcceew.gov.au/environment/epbc/publications/significant-impact-guidelines-11-matters-national-environmental-significance.

Dorey K, Dicky S, & Walker TR 2019. ‘Testing efficacy of bird deterrents at wind turbine facilities: a pilot study in Nova Scotia, Canada’, *Proceedings of the Nova Scotian Institute of Science*, 50, 1: 91–108.

DTP 2023. ‘Ministerial guidelines for assessment of environmental effects under the Environment Effects Act 1978 (Eigth edition, 2023)’, https://www.planning.vic.gov.au/__data/assets/pdf_file/0028/682453/DTP0497-Ministerial-Guidelines-8th-edition-web-FA44.pdf.

Dwyer P & Hamilton-Smith E 1965. ‘Breeding caves and maternity colonies of the bent-winged bat in south eastern Australia’, *Helictite*, 4: 3–21.

Dwyer PD 1965. ‘Flight patterns of some eastern Australian bats.’, *The Victorian Naturalist*, 82: 36–41.

Georgiev M & Zehtindjiev P 2022. *in*, Wind Europe Electric City 2021, Copenhagen, 11.

Gilmour LRV, Holderied MW, Pickering SPC, & Jones G 2020. ‘Comparing acoustic and radar deterrence methods as mitigation measures to reduce human-bat impacts and conservation conflicts’, *PLoS ONE*, 15, 2: e0228668.

Good RE, Iskali G, Lombardi J, McDonald T, Dubridge K, Azeka M, & Tredennick A 2022. ‘Curtailment and acoustic deterrents reduce bat mortality at wind farms’, *The Journal of Wildlife Management*, 86, 6: e22244.

Gorresen MP, Cryan PM, Dalton DC, Wolf S, Johnson JA, Todd CM, & Bonaccorso FJ 2015. ‘Dim ultraviolet light as a means of deterring activity by the Hawaiian hoary bat Lasiurus cinereus semotus’, *Endangered Species Research*, 28, 3: 249–57.

Grant C 2004. 'The conservation biology of southern bent-wing bat, Miniopterus schreibersii', *13th International Bat Research Conference, Museum and Institute of Zoology, Warszawa, Mikolajki, Poland*.

Gray P 2001. *Cave Microclimate and Population Estimates of Southern Bent-wing Bats (Miniopterus schreibersii bassanii) at Starlight Cave, Warrnambool*, Report prepared for South-West TAFE, Author: Gray. P, Warrnambool, VIC.

van Harten E, Lawrence R, Lumsden LF, Reardon T, & Bennett AF 2022. 'Population Dynamics of the Critically Endangered, Southern Bent-winged Bat Miniopterus', *Wildlife Research*, 49, 7: 646–58.

van Harten E, Reardon T, Lumsden L, Meyers N, Prowse T, Weyland J, & Lawrence R 2019. 'High detectability with low impact: Optimizing large PIT tracking systems for cave-dwelling bats.', *Ecology and Evolution*, 9, 19: 10916–28.

Hayes MA, Hooton LA, Gilland KL, Grandgent C, Smith RL, Lindsay SR, Collins JD, Schumacher SM, Rabie PA, Gruver JC, & Goodrich-Mahoney J 2019. 'A smart curtailment approach for reducing bat fatalities and curtailment time at wind energy facilities', *The Ecological Society of America*, 29, 4.

Holz P, Hufschmid J, Boardman W, Cassey P, Firestone S, Lumsden L, Prowse T, Reardon T, & Stevenson M 2019. 'Does the fungus causing white-nose syndrome pose a significant risk to Australian bats?', *Wildlife Research*, 46, 8: 657–68.

Huso M & Maurer J 2016. *in*, Wind Wildlife Research Meeting XI, American Wind Wildlife Institute, Colorado.

Kelm DH, Lenski J, Kelm V, Toelch U, & Dziock F 2014. 'Seasonal bat activity in relation to distance to Hedgerows in an agricultural landscape in Central Europe and implications for wind energy development.', *Acta Chiropterologica*, 16, 1: 65–73.

Kerr G & Bonifacio R 2009. 'Regional Action Plan for the Southern Bent-wing Bat Miniopterus schreibersii bassanii in the South East of South Australia', Department for Environment and Heritage, Mount Gambier, South Australia.

Kinzie KW & Miller MF 2018. *Ultrasonic Bat Deterrent Technology*, Report prepared for GE Company. Myron, M. Wind Advanced Technologies. Report DOE-GE-07035, https://www.osti.gov/servlets/purl/1484770.

Lacy R & Pollak J 2017. *Vortex: A Stochastic Simulation of the Extinction Process. Ver. 10.2.17.0.*, Chicago Zoological Society, Brookfield, IL, USA.

Mantoui DS, Kravchenko K, Lehnert LS, Vlaschenko A, Moldovan OT, Mirea IC, Stanciu RC, Zaharia R, Popescu-Mirceni R, Nistorescu MC, & Voigt CC 2020. 'Wildlife and infrastructure: impact of wind turbines on bats in the Black Sea coast region', *European Journal of Wildlife Research*, 66, 3: 1–13.

Martin CM, Arnett EB, Stevens RD, & Wallace MC 2017. 'Reducing bat fatalities at wind facilities while improving the economic efficiency of operational mitigation', *Journal of Mammalogy*, 98, 2: 378–85.

Matzner S, Warfel T, & Hull R 2020. 'ThermalTracker-3D: A thermal stereo vision system for quantifying bird and bat activity at offshore wind energy sites', *Ecological Informatics*, 57: 101069.

McClure CJW, Martinson L, & Allison TD 2018. 'Automated monitoring for birds in flight: Proof of concept with eagles at a wind power facility', *Biological Conservation*, 224: 26–33.

Menkhorst P 1995. *Mammals of Victoria: distribution, ecology and conservation*, Oxford University Press Australia.

Mills M & Pennay D 2017. 'Landscape Utilisation by the Threatened Eastern Bent-wing Bat (Miniopterus schreibersii oceanensis): A Pilot Study at Parsons Creek, Adjungbilly, NSW', New South Wales Office of Environment and Heritage.

Moll J, Zadeh AT, Malzer M, Simon J, Krozer V, Kramer C, Friedmann H, Nuber A, Durr M, Pozdniakov D, & Salman R 2020. *in*, 23rd International Microwave and Radar Conference, Institute of Electrical and Electronics Engineers, Warsaw.

Moloney P, Lumsden L, & Smales I 2019. *Investigation of existing post-construction mortality monitoring at Victorian wind farms to assess its utility in estimating mortality rates*, Report prepared for Department of Environment, Land, Water and Planning, Authors: Molony. P, Lumsden. L, Smales. I, Arthur Rylah Institute for Environmental Research Heidelberg, VIC. Report no. 302.

Nilsson C, Dokter, Schmid B, Scacco M, Verlinden L, Backman J, Haase G, Dell'Omo G, Chapman JW, Leijnse H, & Liechti F 2018. 'Field validation of radar systems for monitoring bird migration', *Journal of Applied Ecology*, 55, 6: 2552–64.

O'Neil MG & Taylor RJ 1986. 'Observations on flight patterns and foraging behaviour of Tasmanian bats', *Wildlife Research*, 13, 3: 427–32.

Oregon TSate University 2021. *Final Technical Report: A Heterogeneous System for Eagle Detection, Deterrent, and Wildlife Collision Detection for Wind Turbines*, Report for US Department of Energy. Authors: Albertani, R. Clocker, K. Hu, C. Johnston, M. Oregon State University.

Pennay M 2019. *White-striped Free-tailed Bat Austronomus australis.*, *The IUCN Red list of Threatened Species 2020.*, https://www.iucnredlist.org/species/21313/22121905.

Pennay M, Law B, & Reinhold L 2004. 'Bat calls of New South Wales', https://www.environment.nsw.gov.au/resources/nature/batcallsofnsw.pdf.

Rabie PA, Welch-Acosta B, Nasman K, Schumacher SM, Schueller S, & Gruver JC 2022. 'Efficacy and cost of acoustic-informed and wind speed-only turbine curtailment to reduce bat fatalities at a wind energy facility in Wisconsin', *PLOS ONE*, 17, 4: e0266500.

Reardon T 2001. *Population Size Estimates and Conservation of the Southern Bentwing Bat (Miniopterus bassanii) in South Australia*, Report to Wildlife Conservation Fund Committee.

Rhodes, M 2002. 'Assessment of sources of variance and patterns of overlap in microchiropteran wing morphology in southeast Queensland, Australia.', *Canadian Journal of Zoology*, 80, 3: 450–60.

Richardson SM, Lintott PR, Hosken DJ, Economou T, & Mathews F 2021. 'Peaks in bat activity at turbines and the implications for mitigating the impact of wind energy developments on bats', *Scientific Reports*, 11: 3636.

Rodrigues L, Bach L, Dubourg-Savage MJ, Karapandza B, Kovac D, Kervyn T, Dekker J, Kepel A, Bach P, Collins J, Harbusch C, Park K, Micenski B, & Minderman J 2014. 'Guidelines for consideration of bats in wind farm projects - Revision 2014', https://www.eurobats.org/sites/default/files/documents/publications/publication_series/pubseries_no6_english.pdf.

Roemer C, Disca T, Coulon A, & Bas Y 2017. 'Bat flight height monitored from wind masts predicts mortality risk at wind farms', *Biological Conservation*, 215: 116–22.

Rollins KE, Meyerholz DK, Johnson GD, Capparella AP, & Loew SS 2012. 'A Forensic Investigation Into the Etiology of Bat Mortality at a Wind Farm: Barotrauma or Traumatic Injury?', *Veterinary Pathology*, 49, 2: 362–71.

Romano WB, Skalski JR, Townsend RL, Kinzie KW, Coppinger KD, & Miller MF 2019. 'Evaluation of an Acoustic Deterrent to Reduce Bat Mortalities at an Illinois Wind Farm', *Wildlife Society Bulletin*, 43, 4: 608–18.

Schirmacher MR 2020. *Evaluating the Effectiveness of an Ultrasonic Acoustic Deterrent in Reducing Bat Fatalities at Wind Energy Facilities*, DOE, https://doi.org/10.2172/1605929.

Sievert P, Modarres-Sadeghi Y, Smotherman M, Seyedaghaza B, Dowling Z, Carlson D, & Lackner M 2021. *A Biomimetic Ultrasonic Whistle for Use as a Bat Deterrent on Wind Turbines*, University of Massachusetts Amherst, https://www.energy.gov/sites/prod/files/2019/05/f63/UMass%20-%20M16%20-%20Sievert_draft_rt_revised.pdf.

Smallwood KS & Bell DA 2020. 'Effects of Wind Turbine Curtailment on Bird and Bat Fatalities', *The Journal of Wildlife Management*, 84, 4: 685–96.

Squires KA, Thurber BG, Zimmerling JR, & Francis CM 2021. 'Timing and Weather Offer Alternative Mitigation Strategies for Lowering Bat Mortality at Wind Energy Facilities in Ontario', *Animals*, 11, 12: 3503.

Stratman B 2005. *Comparison of pine plantations and native remnant vegetation as habitat for insectivorous bats in south-eastern South Australia*, School of Ecology and Environment, Deakin University.

Symbolix 2020. *Post construction bird and bat monitoring at wind farms in Victoria*, Report prepared from 13th Wind Wildlife Research Meeting. Authors: Symbolix Pty Ltd, North Melbourne, VIC.

TSSC 2021. *Approved Conservation Advice for Miniopterus orianae bassanii Southern Bent-wing Bat*, Authors: Threatened Species Scientific Committee, Commonwealth of Australia. Canberra, ACT.

Vestjens W & Hall L 1977. 'Stomach Contents of Forty-Two Species of Bats From the Australasian Region.', *Wildlife Research*, 4, 1: 25.

Voigt CC, Russo D, Runkel V, & Goerlitz HR 2021. 'Limitations of acoustic monitoring at wind turbines to evaluate fatality risk of bats', *Mammal Review*, 51, 4: 559–70.

Weaver SP, Hein CD, Simpson TR, Evans JW, & Castro-Arellano I 2020. 'Ultrasonic acoustic deterrents significantly reduce bat fatalities at wind turbines', *Global Ecology and Conservation, Elsevier*, 24.

Wellig SD, Nussle S, Miltner D, Kohle O, Glaizot O, Braunisch V, Obrist MK, & Arlettaz R 2018. 'Mitigating the negative impacts of tall wind turbines on bats: Vertical activity profiles and relationships to wind speed', *PLoS ONE*, 13, 3.

White S 1998. 'Karst of the Caonozoic limestones of the Otway Basin, south-eastern Australia', *Geological Society of Australia Abstracts*, 46: 10–35.

Appendices

Appendix 1 Photographs

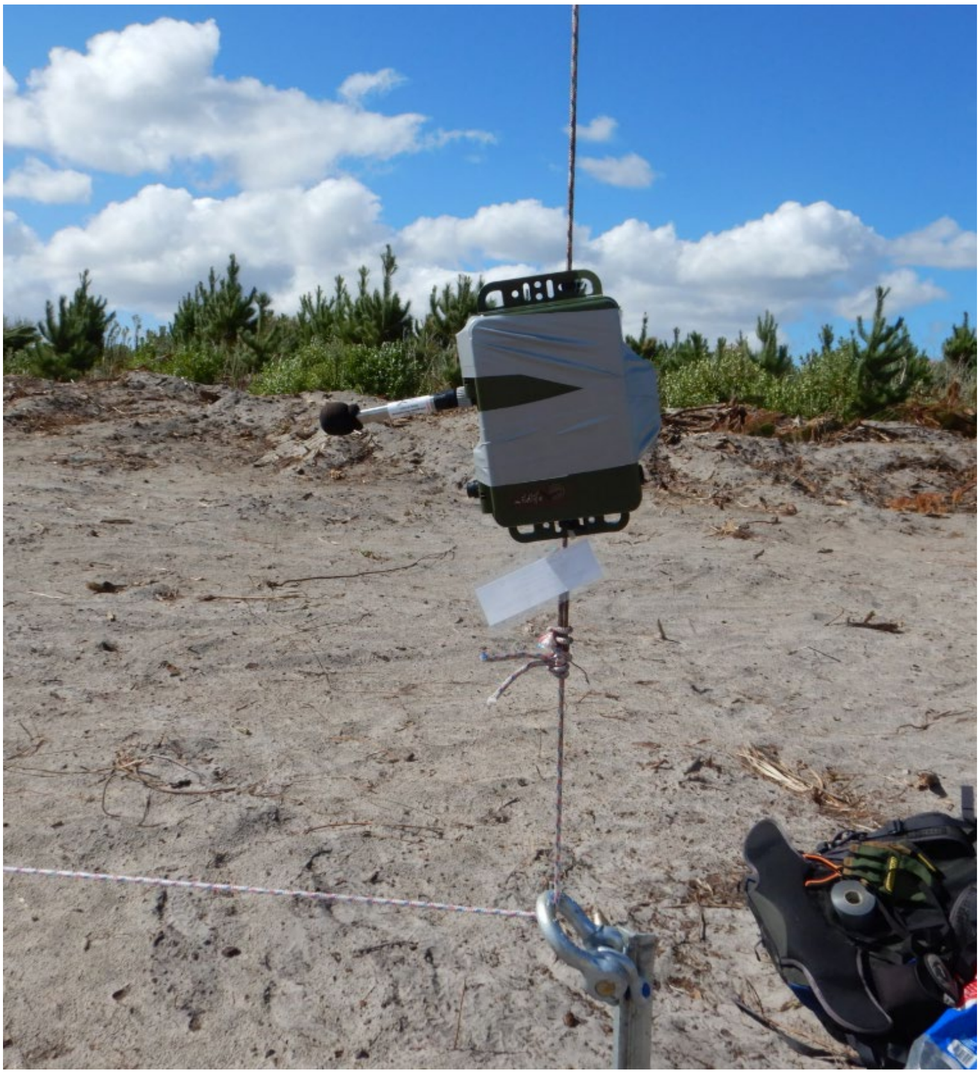


Plate 1 Songmeter accoustic detector at mast showing pulley system

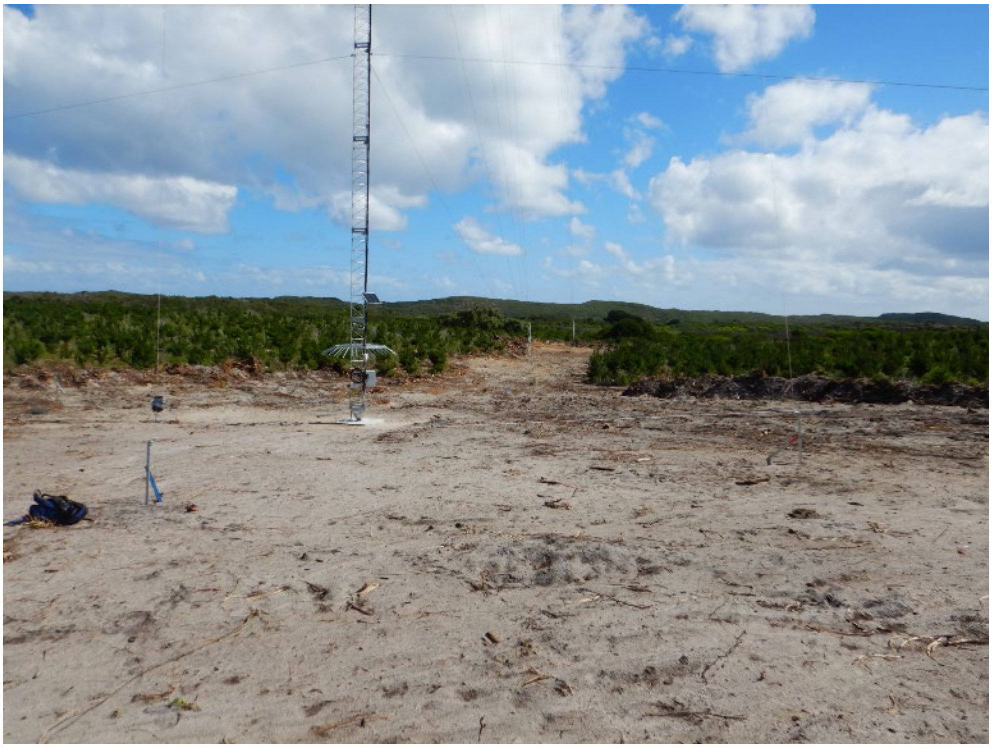


Plate 2 Base of met mast 3

Appendix 2 EPBC Act Significant Impact Assessment

Table A2.1 Southern Bent-wing Bat. Assessment against significant impact criteria for endangered & critically endangered species (CoA 2013)

Significant impact criteria	Likelihood of significant impact	Justification
Lead to a long-term decrease in the size of a population	Unlikely	The principal potential risk to the species is collision with turbines. The species flights are generally expected to be below turbine rotor heights as evidenced by survey results. While occasional collisions may occur the potential for the project to lead to a long-term decrease in the size of the population is low. The PVA has evaluated the impact of a range of additional mortality scenarios on the Portland sub-population.
Reduce the area of occupancy of the species	Unlikely	The site contains habitat for the species. Existing land use and vegetation of the site will remain substantially unchanged. The project is not likely to lead to a reduction in the area occupied by the species.
Fragment an existing population into two or more populations	Unlikely	As the project will not entail substantive alterations to existing habitats, there are no effects or mechanisms that might fragment the existing population.
Adversely affect habitat critical to the survival of a species	Unlikely	The project will not adversely affect habitat critical to the survival of the species. No critical habitat is defined for the species. Lower Glenelg, Bats Ridge, Portland, Mt Gambier and coastal sea cliffs are noted as supporting Important Populations. The proposed wind farm site does not contain any caves.
Disrupt the breeding cycle of a population	Unlikely	There is some potential that individuals roosting (and raising young) at the Portland maternity site may forage within the wind farm, and therefore be at risk of collision, but this impact on a small number of individuals would not disrupt the breeding cycle of the population.
Modify destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Unlikely	The project has no potential to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Significant impact criteria	Likelihood of significant impact	Justification
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	Unlikely	The project does not include any known mechanism that would result in establishment of invasive species that are not already present in the environment.
Introduce disease that may cause the species to decline	Unlikely	The project does not include any known mechanism that would result in introduction of any disease that is not already present in the environment.
Interfere with the recovery of the species	Unlikely	Wind farm developments are noted as a Threat in the Recovery Plan (DELWP 2020). Wind farm related risks are noted to include cave destruction during construction, mortalities due to collisions, and altered access to foraging areas. Mortalities due to collision are considered unlikely to be significant and there will be no cave impacts or altered access to foraging areas. The project is not likely to interfere with the recovery of the species. The project is a potential source of funding to assist with recovery actions.

Appendix 3 Southern Bent-wing Bat Population Viability Analysis

This appendix includes the Population Viability Analysis (PVA), undertaken by Symbolix.

Southern Bent-wing Bat PVA - Kentbruck Green Energy Hub

Prepared for Neoen, 23 July 2024, Ver. 0.96

1 Introduction

To assess potential effects of the proposed Kentbruck Green Energy Hub Project on Southern Bent-wing Bat (SBWB), Neoen is required to undertake a population viability analysis (PVA). In this document, we describe and document the results of the PVA.

We first ran benchmark models as specified in TSSC (2021) to validate the model specification and inputs. After demonstrating that we could reproduce the results, we then ran project-specific models.

The inputs to the project specific models were informed by population parameters published in TSSC (2021), and discussions with SBWB experts. These models included only the Portland SBWB population and there were minor parameter adjustments compared to the benchmark models. A wide range of possible wind farm effects were included (0, 2, 10, 50, 100, or 500 SBWB mortalities per year).

2 Methods

2.1 Model benchmarking

All population modelling was performed using Vortex version 10.5.5 (Lacy and Pollak 2017). To validate our model specifications, we first ran the input parameters as specified in TSSC (2021). Comparison of our test model against the public results verified:

- Similar overall population declines predicted
- Similar final population predictions for the sub-populations
- We could reproduce the impact of drought and disease.

This step did not influence the results for the project-specific model, but confirmed our interpretation of the published population statistics.

2.2 PVA within an impact assessment

PVA is used to simulate the forward trajectory of a population. The simulated nature of the analysis allows investigation of the relative impact of different intrinsic and extrinsic events. For example, a PVA might model the impact of drought, additional mortality ("harvest") from human activity, and population supplementation from conservation activities.

In impact assessment it can predict whether the expected additional mortality represents a substantive population impact. This requires:

- Some estimate of the expected additional mortality (which may be a range),
- An agreed, regulatory definition of the impacted population (e.g. the whole population or a specific sub-group)
- Detailed data on life-cycle parameters such as the breeding success, expected background mortality rate for different life stages, etc.

There is no existing quantitative model for predicting the rate of bat mortality from proposed wind infrastructure. In this scenario the PVA can only provide information about the population impact from a range of potential mortality rates (but provides no insight into which mortality rate is most likely).

We consulted with SBWB experts, Dr Lindy Lumsden and Dr Emmi van Harten, regarding appropriate population definitions and settings to assess population impacts. The advice suggests minimal population mixing between the sub-populations associated with each maternity cave. As such, the Portland cave population is the reference population for assessing impact.

Following that advice, we modelled the Portland subpopulation alone.

All input data was sourced from TSSC (2021), or direct advice from SBWB experts (where input parameters needed adjusting for the Portland sub-population).

2.3 Portland sub-population

The PVA input parameters are shown in Table 1. Definitions of each term are found in Vortex user manuals (Lacy and Pollak 2017) and detailed study methods in Harten (2021) and TSSC (2021).

Annual mortality rates for male and females juveniles (0-1 years) and adults (1+ years) over three years were provided by Dr. Emmi van Harten, La Trobe University[1]. Only data from the final two years were used to calculate the mean mortality rate, as per TSSC (2021).

---

[1] This data is currently being prepared for publication and was shared under a non-disclosure agreement. Methods are described in Harten (2021).

Table 1: Parameters used in Portland PVA

Parameter	Value
No. years	60
No. iterations	1000
Subpopulations	1: Portland
Annual mortality rate	Values for juveniles (0-1 years) and adults (1+ years) of both sexes as provided by Dr. Emmi van Harten
Percentage of breeding females	97% (SD: 25%)
Initial population size	3500
Age distribution	Stable
Carrying capacity	3500 (SD: 350)
Maximum breeding age	25
Environmental variation	0.5
Catastrophe - Drought	Frequency: 8.3%, Severity (survival): Calculated from annual mortality rates as provided by Dr. Emmi van Harten
Catastrophe - White-nose syndrome	Not included
Harvest	0 (no project), 2, 10, 50, 100, 500 per year for years 3 to 33

3 Results

3.1 Portland population without wind farm effects

The ‘zero’ harvest rate in Table 1 represents the baseline Portland population trajectory in the absence of any additional mortality from turbine infrastructure.

The no-project population curve for the Portland population is shown in Figure 1. Although this model doesn’t include any impacts from wind farms, there is a substantial decline in population size.

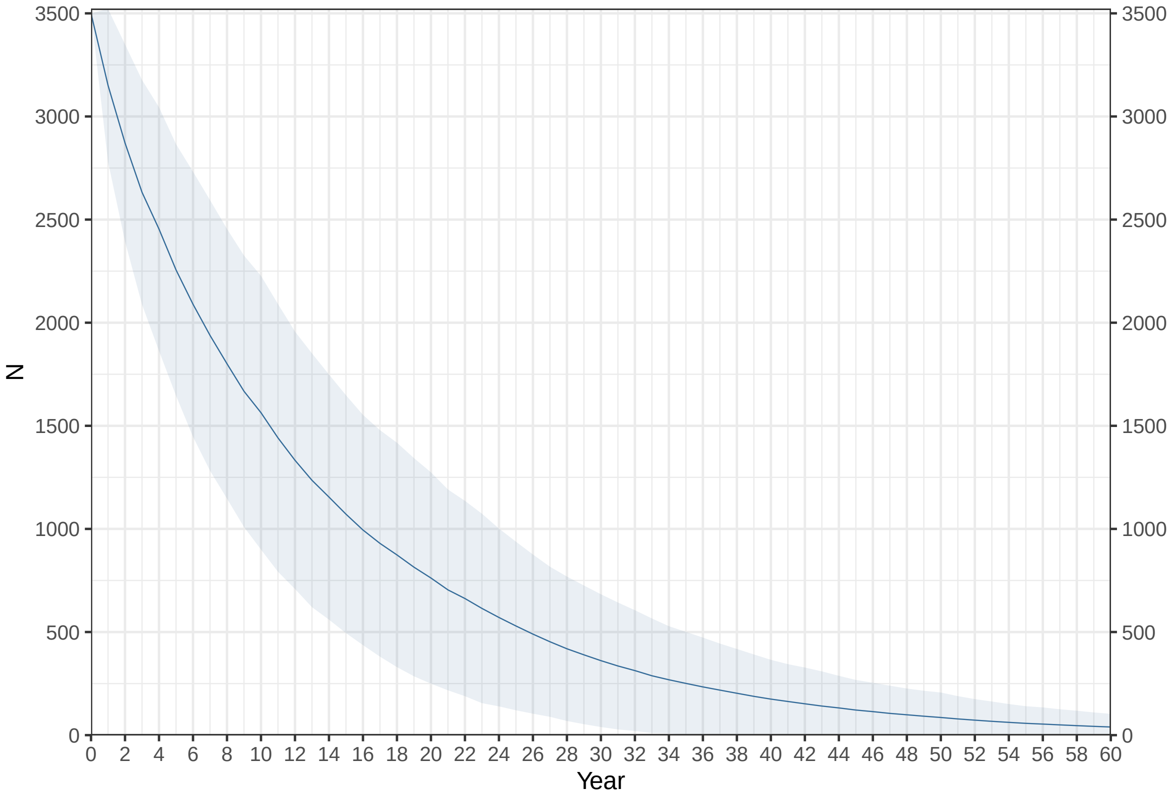


Figure 1: Population curve for Portland population. The mean and standard deviation are shown.

Table 2 shows the median predicted population size and percentage decline since year zero from the starting population after different time periods, assuming no wind farm mortalities occur. Similarly, Table 3 shows the probability of the population reaching zero over different time periods.

Table 2: Portland population size and percentage decline by year.

10 year	30 year	60 year
1507 (57%)	260 (93%)	20 (99%)

Table 3: Probability of population reaching zero for Portland population by year.

10 year	30 year	60 year
0%	0%	13%

Even without introducing impacts from a wind farm, the population modelling predicts that the Portland population will decline by more than 50% within ten years and by almost 100% within 60 years.

3.1.1 Portland population with wind farm effects

Figure 2 shows the population curves for the Portland population with varying numbers of wind farm mortalities each year. Although the model runs for 60 years, the wind farm is assumed to operate only for 30 years (from year 3 to year 33). As expected, with increasing numbers of wind farm mortalities the population declines more rapidly.

Although wind farm mortalities no longer occur after 33 years, no recovery of the population is apparent. This is consistent with the background population decline seen in the no-project model.

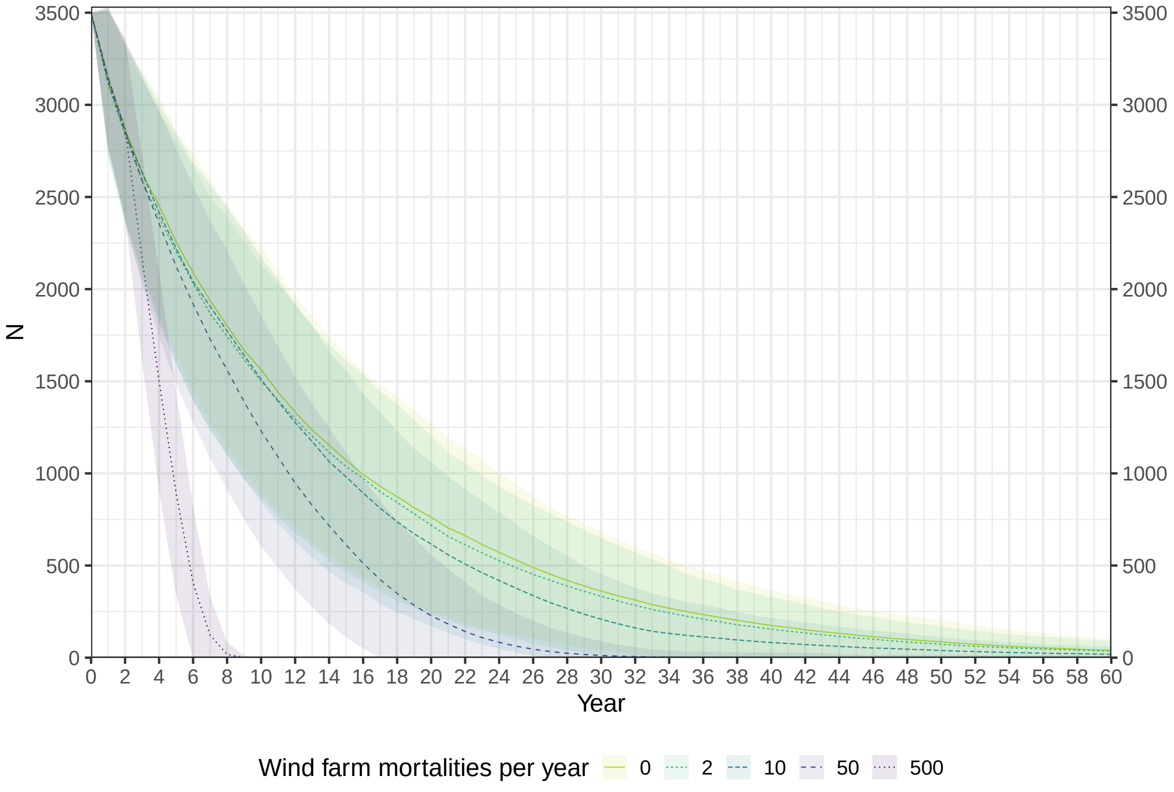


Figure 2: Population curves for Portland population with varying numbers of wind farm mortalities. The mean and standard deviation are shown. The wind farm was assumed to be operational for only the first 30 years.

Table 4 shows the median predicted population size and percentage decline from the starting population after different time periods with varying numbers of wind farm mortalities each year.

We also used Cohen's U_3 (Cohen 2013) to compare the impact of different numbers of wind farm mortalities on population size (Table 5). We include an interpretation of this value using the interpretation benchmarks from Cook, Cook, and Therrien (2018).

A value of 0.5 means that the 50th percentile in the no wind farm scenario is also the 50th percentile in the comparison scenario. This is the case when there are only two wind farm mortalities each year, indicating that there is no substantive difference from the no wind farm scenario. In contrast, at year 10 Cohen's U_3 is 0.9 for the 100 mortalities per year scenario. This means that the median population size in the no wind farm scenario is the 90th percentile in the comparison scenario, indicative of a large difference.

Figure 2 along with Tables 4 and 5 combine to show the lack of measurable additional downward population pressure from the wind farm in the first decade. There is no significant difference between the 0, 2, and 10 mortality models at the ten year mark - in fact the PVA predicts a nominally higher population median for the 2-mortality model then the 10.

Table 4: Portland population size and percentage decline by year with varying numbers of wind farm mortalities.

	Population size (% decline since year 0)		
Annual WF mortalities	10 year	30 year	60 year
0	1507 (57%)	260 (93%)	20 (99%)
2	1430 (59%)	238 (93%)	16 (100%)
10	1468 (58%)	131 (96%)	1 (100%)
50	1142 (67%)	0 (100%)	0 (100%)
100	824 (76%)	0 (100%)	0 (100%)
500	0 (100%)	0 (100%)	0 (100%)

Table 5: Cohen's U_3 for Portland population by year with varying numbers of wind farm mortalities. All comparisons are to the no wind farm scenario for the same year.

Annual WF mortalities	Cohen's U_3 value	Interpretation
Year 10		
2	0.54	V. small
10	0.53	V. small
50	0.70	Medium
100	0.86	Large
500	1.00	V. large
Year 30		
2	0.54	V. small
10	0.70	Medium
50	0.93	V. large
100	0.94	V. large
500	0.94	V. large
Year 60		
2	0.52	V. small
10	0.65	Small
50	0.80	Large
100	0.81	Large
500	0.81	Large

With only two mortalities per year there is no practical difference compared to the no wind farm scenario at years 10, 30, or 60. However, with 50 or more wind farm mortalities each year, the median population size after 30 years is zero and the effect compared to the no wind farm scenario is large or very large.

Table 6 shows the probability of the population reaching zero over different time periods. The probability of the Portland population reaching zero increases substantially if the annual number of mortalities is 50 or more.

Table 6: Probability of population reaching zero for Portland population by year with varying numbers of wind farm mortalities.

	Probability of extinction		
Annual WF mortalities	10 year	30 year	60 year
0	0%	0%	13%
2	0%	0%	17%
10	0%	16%	49%
50	0%	94%	99%
100	2%	100%	100%
500	100%	100%	100%

4 Conclusion

The baseline (no project) population analysis for the Portland SBWB sub-population shows sustained decline. This mirrors the overall population decline reported in TSSC (2021).

If the additional mortality rate is low (~2 SBWB per annum) there is no discernible difference in population outcomes after 60 years. For 10 additional mortalities, there is a small but detectable downward effect on the 60 year population prediction. Additional SBWB mortality in the range of 50 SBWB per year would have substantive impact on the probability of extinction, and shorten the predicted time frame for extinction of the sub-population.

We present a range of outcomes because the actual expected mortality rate is unknown and PVA does not provide information about the likelihood of a given mortality rate.

Under the assumption of minimal mixing between the Warrnambool, Portland, and Naracoorte sub-populations (*Dr L. Lumsden pers.comm.*), only the Portland population is impacted by the additional mortality. The other populations are also declining (TSSC (2021) predicts total population size of less than 10,000 after 36 years).

The expected dynamics of the populations as numbers decrease is unknown. As such we have not attempted to model any additional small population factors like inbreeding depression or low-density carrying capacity impacts. We have also assumed each sub-population remains distinct, as there are no data to suggest substantial mixing. For this reason, we follow the advice from DELWP that the Portland sub-population is the relevant population for the purposes of impact assessment.

References

Cohen, Jacob. 2013. *Statistical Power Analysis for the Behavioral Sciences*. Academic press.

Cook, Bryan G, Lysandra Cook, and William J Therrien. 2018. "Group-Difference Effect Sizes: Gauging the Practical Importance of Findings from Group-Experimental Research." *Learning Disabilities Research & Practice* 33 (2): 56–63.

Harten, Emmi van. 2021. "Population Dynamics of the Critically Endangered, Southern Bent-Winged Bat Miniopterus Orianae Bassanii." PhD thesis, La Trobe.

Lacy, RC, and JP Pollak. 2017. "Vortex: A Stochastic Simulation of the Extinction Process. Ver. 10.2. 17.0." *Chicago Zoological Society, Brookfield, IL, USA*.

TSSC. 2021. "Conservation advice Miniopterus orianae bassanii, Southern Bent-wing Bat." Threatened Species Scientific Committee. http://www.environment.gov.au/biodiversity/threatened/species/pubs/87645-conservation-advice-14062021.pdf.

Appendix 4 Assessment of noise on detectability of bat calls recorded from met masts

This appendix includes a memo summarising analysis by Marshall Day Acoustics regarding the impact of noise on the detectability of microbat calls recorded on meteorological monitoring masts.

Southern Bent-wing Bat PVA - Kentbruck Green Energy Hub

Prepared for Neoen, 8 December 2021, Ver. 0.95

1 Introduction

To assess potential effects of the proposed Kentbruck Green Energy Hub Project on Southern Bent-wing Bat (SBWB), Neoen is required to undertake a population viability analysis (PVA). In this document, we describe and document the results of the PVA.

We first ran benchmark models as specified in TSSC (2021) to validate the model specification and inputs. After demonstrating that we could reproduce the results, we then ran project-specific models.

The inputs to the project specific models were informed by population parameters published in TSSC (2021), and discussions with SBWB experts. These models included only the Portland SBWB population and there were minor parameter adjustments compared to the benchmark models. A wide range of possible wind farm effects were included (0, 2, 10, 50, 100, or 500 SBWB mortalities per year).

2 Methods

2.1 Model benchmarking

All population modelling was performed using Vortex version 10.5.5 (Lacy and Pollak 2017). To validate our model specifications, we first ran the input parameters as specified in TSSC (2021). Comparison of our test model against the public results verified:

- Similar overall population declines predicted
- Similar final population predictions for the sub-populations
- We could reproduce the impact of drought and disease.

This step did not influence the results for the project-specific model, but confirmed our interpretation of the published population statistics.

2.2 PVA within an impact assessment

PVA is used to simulate the forward trajectory of a population. The simulated nature of the analysis allows investigation of the relative impact of different intrinsic and extrinsic events. For example, a PVA might model the impact of drought, additional mortality ("harvest") from human activity, and population supplementation from conservation activities.

In impact assessment it can predict whether the expected additional mortality represents a substantive population impact. This requires:

- Some estimate of the expected additional mortality (which may be a range),
- An agreed, regulatory definition of the impacted population (e.g. the whole population or a specific sub-group)
- Detailed data on life-cycle parameters such as the breeding success, expected background mortality rate for different life stages, etc.

There is no existing quantitative model for predicting the rate of bat mortality from proposed wind infrastructure. In this scenario the PVA can only provide information about the population impact from a range of potential mortality rates (but provides no insight into which mortality rate is most likely).

We consulted with SBWB experts, Dr Lindy Lumsden and Dr Emmi van Harten, regarding appropriate population definitions and settings to assess population impacts. The advice suggests minimal population mixing between the sub-populations associated with each maternity cave. As such, the Portland cave population is the reference population for assessing impact.

Following that advice, we modelled the Portland subpopulation alone.

All input data was sourced from TSSC (2021), or direct advice from SBWB experts (where input parameters needed adjusting for the Portland sub-population).

2.3 Portland sub-population

The PVA input parameters are shown in Table 1. Definitions of each term are found in Vortex user manuals (Lacy and Pollak 2017) and detailed study methods in Harten (2021) and TSSC (2021).

Annual mortality rates for male and females juveniles (0-1 years) and adults (1+ years) over three years were provided by Dr. Emmi van Harten, La Trobe University[1]. Only data from the final two years were used to calculate the mean mortality rate, as per TSSC (2021).

---

[1] This data is currently being prepared for publication and was shared under a non-disclosure agreement. Methods are described in Harten (2021).

Table 1: Parameters used in Portland PVA

Parameter	Value
No. years	60
No. iterations	1000
Subpopulations	1: Portland
Annual mortality rate	Values for juveniles (0-1 years) and adults (1+ years) of both sexes as provided by Dr. Emmi van Harten
Percentage of breeding females	97% (SD: 25%)
Initial population size	3500
Age distribution	Stable
Carrying capacity	3500 (SD: 350)
Maximum breeding age	25
Environmental variation	0.5
Catastrophe - Drought	Frequency: 8.3%, Severity (survival): Calculated from annual mortality rates as provided by Dr. Emmi van Harten
Catastrophe - White-nose syndrome	Not included
Harvest	0 (no project), 2, 10, 50, 100, 500 per year for years 3 to 33

3 Results

3.1 Portland population without wind farm effects

The ‘zero’ harvest rate in Table 1 represents the baseline Portland population trajectory in the absence of any additional mortality from turbine infrastructure.

The no-project population curve for the Portland population is shown in Figure 1. Although this model doesn’t include any impacts from wind farms, there is a substantial decline in population size.

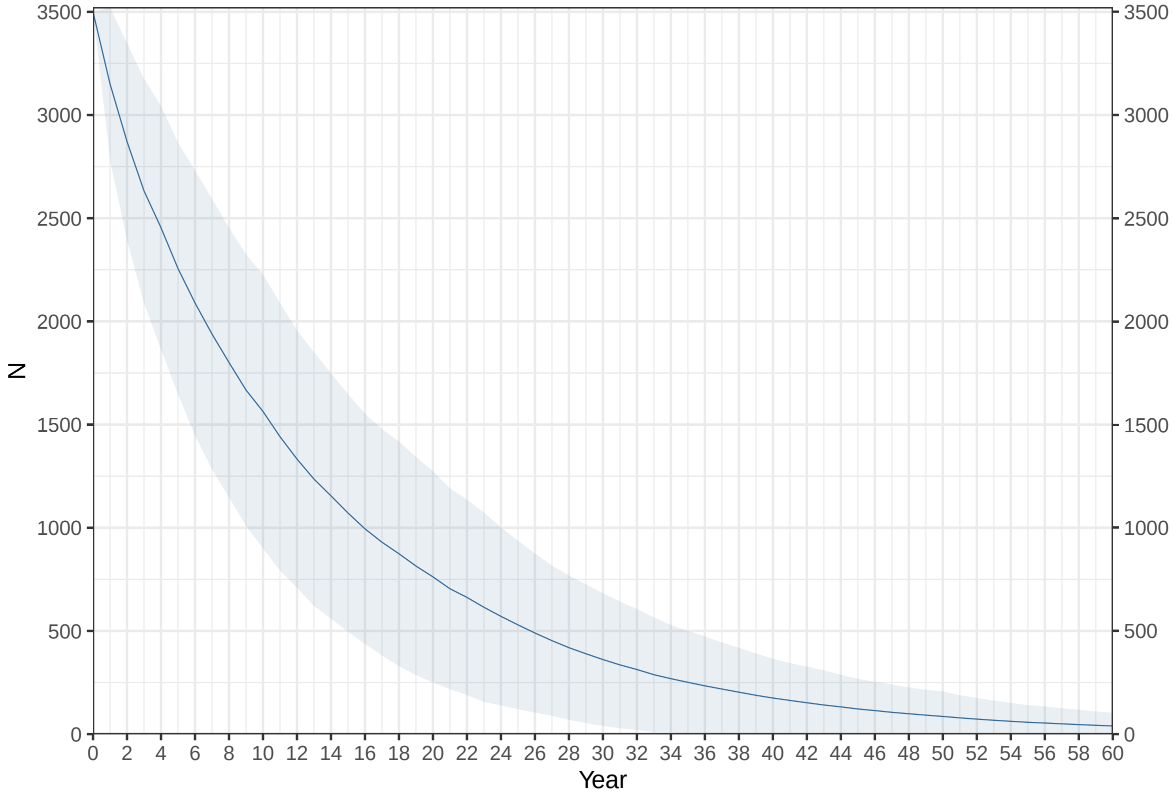


Figure 1: Population curve for Portland population. The mean and standard deviation are shown.

Table 2 shows the median predicted population size and percentage decline since year zero from the starting population after different time periods, assuming no wind farm mortalities occur. Similarly, Table 3 shows the probability of the population reaching zero over different time periods.

Table 2: Portland population size and percentage decline by year.

10 year	30 year	60 year
1507 (57%)	260 (93%)	20 (99%)

Table 3: Probability of population reaching zero for Portland population by year.

10 year	30 year	60 year
0%	0%	13%

Even without introducing impacts from a wind farm, the population modelling predicts that the Portland population will decline by more than 50% within ten years and by almost 100% within 60 years.

3.1.1 Portland population with wind farm effects

Figure 2 shows the population curves for the Portland population with varying numbers of wind farm mortalities each year. Although the model runs for 60 years, the wind farm is assumed to operate only for 30 years (from year 3 to year 33). As expected, with increasing numbers of wind farm mortalities the population declines more rapidly.

Although wind farm mortalities no longer occur after 33 years, no recovery of the population is apparent. This is consistent with the background population decline seen in the no-project model.

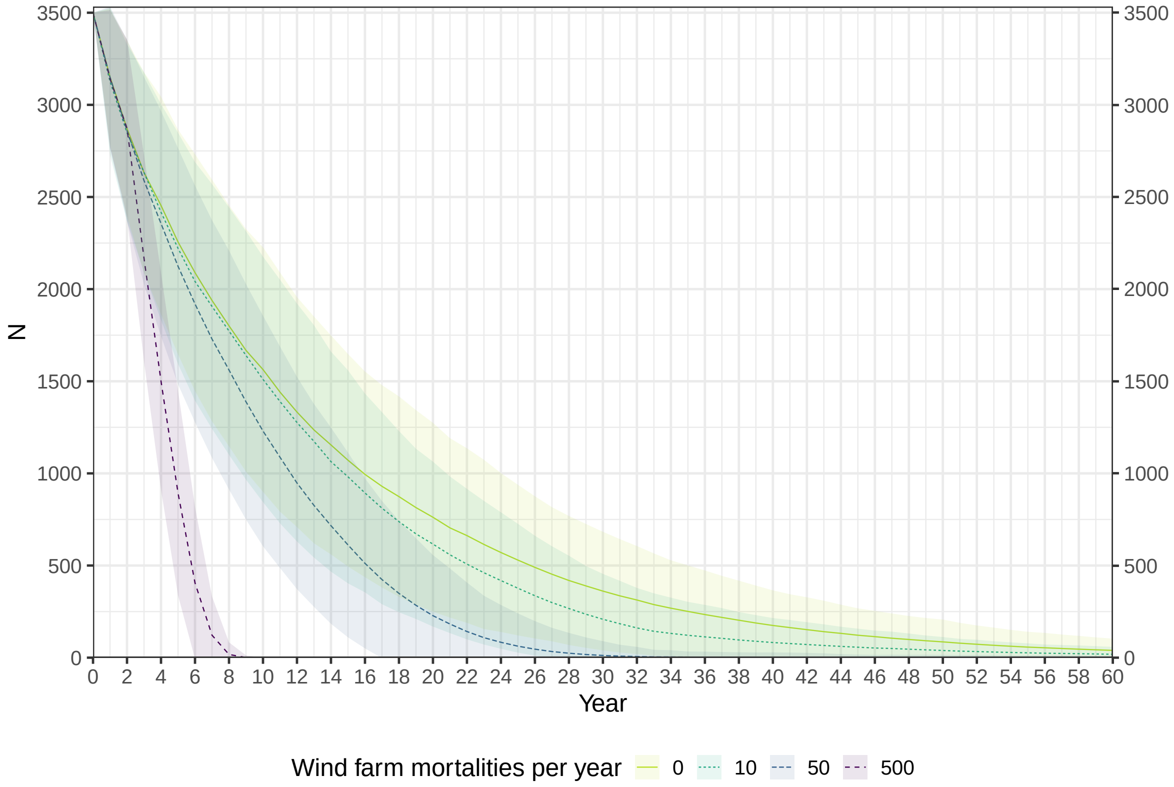


Figure 2: Population curves for Portland population with varying numbers of wind farm mortalities. The mean and standard deviation are shown. The wind farm was assumed to be operational for only the first 30 years.

Table 4 shows the median predicted population size and percentage decline from the starting population after different time periods with varying numbers of wind farm mortalities each year. We also used Cohen's U_3 (Cohen 2013) to compare the impact of different numbers of wind farm mortalities on population size (Table 5). We include an interpretation of this value using the interpretation benchmarks from Cook, Cook, and Therrien (2018).

A value of 0.5 means that the 50th percentile in the no wind farm scenario is also the 50th percentile in the comparison scenario. This is the case when there are only two wind farm mortalities each year, indicating that there is no substantive difference from the no wind farm scenario. In contrast, at year 10 Cohen's U_3 is 0.9 for the 100 mortalities per year scenario. This means that the median population size in the no wind farm scenario is the 90th percentile in the comparison scenario, indicative of a large difference.

Table 4: Portland population size and percentage decline by year with varying numbers of wind farm mortalities.

	Population size (% decline since year 0)		
Annual WF mortalities	10 year	30 year	60 year
0	1507 (57%)	260 (93%)	20 (99%)
2	1430 (59%)	238 (93%)	16 (100%)
10	1468 (58%)	131 (96%)	1 (100%)
50	1142 (67%)	0 (100%)	0 (100%)
100	824 (76%)	0 (100%)	0 (100%)
500	0 (100%)	0 (100%)	0 (100%)

Table 5: Cohen's U_3 for Portland population by year with varying numbers of wind farm mortalities. All comparisons are to the no wind farm scenario for the same year.

Annual WF mortalities	Cohen's U_3 value	Interpretation
Year 10		
2	0.54	V. small
10	0.53	V. small
50	0.70	Medium
100	0.86	Large
500	1.00	V. large
Year 30		
2	0.54	V. small
10	0.70	Medium
50	0.93	V. large
100	0.94	V. large
500	0.94	V. large
Year 60		
2	0.52	V. small
10	0.65	Small
50	0.80	Large
100	0.81	Large
500	0.81	Large

With only two mortalities per year there is no practical difference compared to the no wind farm scenario at years 10, 30, or 60. However, with 50 or more wind farm mortalities each year, the median population size after 30 years is zero and the effect compared to the no wind farm scenario is large or very large.

Table 6 shows the probability of the population reaching zero over different time periods. The probability of the Portland population reaching zero increases substantially if the annual number of mortalities is 50 or more.

Table 6: Probability of population reaching zero for Portland population by year with varying numbers of wind farm mortalities.

	Probability of extinction		
Annual WF mortalities	10 year	30 year	60 year
0	0%	0%	13%
2	0%	0%	17%
10	0%	16%	49%
50	0%	94%	99%
100	2%	100%	100%
500	100%	100%	100%

4 Conclusion

The baseline (no project) population analysis for the Portland SBWB sub-population shows sustained decline. This mirrors the overall population decline reported in TSSC (2021).

If the additional mortality rate is low (~2 SBWB per annum) there is no discernible difference in population outcomes after 60 years. For 10 additional mortalities, there is a small but detectable downward effect on the 60 year population prediction. Additional SBWB mortality in the range of 50 SBWB per year would have substantive impact on the probability of extinction, and shorten the predicted time frame for extinction of the sub-population.

We present a range of outcomes because the actual expected mortality rate is unknown and PVA does not provide information about the likelihood of a given mortality rate.

Under the assumption of minimal mixing between the Warrnambool, Portland, and Naracoorte sub-populations (*Dr L. Lumsden pers.comm.*), only the Portland population is impacted by the additional mortality. The other populations are also declining (TSSC (2021) predicts total population size of less than 10,000 after 36 years).

The expected dynamics of the populations as numbers decrease is unknown. As such we have not attempted to model any additional small population factors like inbreeding depression or low-density carrying capacity impacts. We have also assumed each sub-population remains distinct, as there are no data to suggest substantial mixing. For this reason, we follow the advice from DELWP that the Portland sub-population is the relevant population for the purposes of impact assessment.

References

Cohen, Jacob. 2013. *Statistical Power Analysis for the Behavioral Sciences*. Academic press.

Cook, Bryan G, Lysandra Cook, and William J Therrien. 2018. "Group-Difference Effect Sizes: Gauging the Practical Importance of Findings from Group-Experimental Research." *Learning Disabilities Research & Practice* 33 (2): 56–63.

Harten, Emmi van. 2021. "Population Dynamics of the Critically Endangered, Southern Bent-Winged Bat Miniopterus Orianae Bassanii." PhD thesis, La Trobe.

Lacy, RC, and JP Pollak. 2017. "Vortex: A Stochastic Simulation of the Extinction Process. Ver. 10.2. 17.0." *Chicago Zoological Society, Brookfield, IL, USA*.

TSSC. 2021. "Conservation advice Miniopterus orianae bassanii, Southern Bent-wing Bat." Threatened Species Scientific Committee. http://www.environment.gov.au/biodiversity/threatened/species/pubs/87645-conservation-advice-14062021.pdf.

Appendix 5 Southern Bent-wing Bat detection rates from southwest Victorian wind farm projects

The table below presents a summary of detection rates (calls per detector nights) within potential turbine locations for a range of proposed and constructed wind farms within south-west Victoria. The table also indicates the level of survey (sites and nights) and recording methods.

Project	Turbine-representative habitat average calls/detector nights	Survey nights and timing	Turbine-representative survey locations	Method
Dundonnell 70 kilometres north of the Warrnambool Cave maternity site	0 confirmed 0 confirmed and potential	28 detector nights, 16 – 23 Nov. 2009	4	Anabat bat detectors (Titley Electronics). Analysed by Greg Richards.
	0.15 confirmed 0.60 confirmed and potential	116 detector nights, 1 – 29 March 2011	13	
	0.009 confirmed 0.11 confirmed and potential	532 detector nights, 18 Feb. – 30 April 2013	23	
	0 confirmed 0.04 confirmed and potential	135 nights, 817 detector nights	4 (excludes Sites 3 & 8 next to swamp) autumn, summer and spring	
	Total: 0.03 confirmed 0.16 confirmed and potential			
Bulgana 140 kilometres north of the Warrnambool Cave maternity site	0.03 confirmed 0.22 confirmed and potential	126 detector nights, 27 Nov. – 26 Dec. 2013	9 (includes Site 10, 120 metres from turbine)	Anabat detectors (Titley Electronic, Billina, NSW) and SongMeter SM2BAT detectors (Wildlife Acoustics Inc., USA). Analysed by Greg Richards and Rob Gration.
	0.17 confirmed 0.19 confirmed and potential	104 detector nights, 28 Jan. – 11 Feb. 2014		
	Total: 0.10 confirmed 0.21 confirmed and potential	28 nights, 230 detector nights		
Mortlake South 40 kilometres north of the Warrnambool Cave maternity site	0.25 confirmed 0.30 confirmed and potential	10 nights, 20 detector nights, Nov. – Dec. 2007	2	Anabat (R) Ultrasound detectors. Analysis of bat calls undertaken by Lindy Lumsden
Mortlake (East and South) 45 kilometres northeast of the Warrnambool Cave maternity site	0.07 confirmed 0.5 confirmed and potential	14 nights 28 detector nights, 25 Oct. – 8 Nov. 2007	4	Anabat (R) Ultrasound detectors. Analysis of bat calls undertaken by Lindy Lumsden

Project	Turbine-representative habitat average calls/detector nights	Survey nights and timing	Turbine-representative survey locations	Method
	Total: 0.15 confirmed 0.42 confirmed and potential	24 nights, 48 detector nights		
Mount Fyans 45 kilometres north of the Warrnambool Cave maternity site	0.24 confirmed 0.72 confirmed and potential	14 nights, 42 detector nights, 30 Mar. – 12 April 2017	3	SM4 Songmeters analysed using Anascheme automated software and analysis with the South-West Victorian microbat identification key supplied by Lindy Lumsden.
	0.27 confirmed 0.37 confirmed and potential	35 nights, 105 detector nights, 19 April – 8 June 2018	3	
	1.7 likely	46 nights, 115 detector nights, 22 Oct. – 6 Dec. 2019	3	Titley Anabat Swift detectors Analysed using Anabat insight with manual checking of potential SBWB calls.
	Total: 0.26 confirmed 0.55 confirmed and potential 1.7 likely	95 nights, 262 detector nights	(excludes 14 night met mast recordings, 0 calls)	
Ryan's Corner 40 kilometres east of the Warrnambool Cave maternity site	0.50 – 1.10 confirmed (pg. 58 EES panel report)	Surveys across 36 nights, 5 – 29 March 2007 & summer 2007	Unclear (6 sites recorded overall)	Three reports prepared by Dr Richards and submitted to Inquiry
Macarthur 50 kilometres northwest of the Warrnambool Cave maternity site	0.34 confirmed	41 detector nights, 7 Feb. – 10 Mar. 2005	5	Anabat ultrasonic bat detectors and analysed by Dr Greg Richards
	4.17 confirmed	12 detector nights, 16 – 21 April 2005	2 (excludes met mast recordings, 5 calls)	
	Total: 1.21 confirmed	53 detector nights		

Appendix 6 Bat species detection rates from mast detectors

Summary of number of calls of each species per night, across the full monitoring period, based on mast data including ground, lower, middle and upper detectors. Note number of monitoring nights varies across the detectors due to differing deployment and collection dates, and some equipment failures.

Summary of recordings (calls per night) of all species across the four detector heights for the full survey period.

Species / species group	Mast 1				Mast 2				Mast 3				Mast 4				Grand Total
	Ground (1.5 m)	Lower (28 m)	Middle (56 m)	Upper (84 m)	Ground (1.5 m)	Lower (28 m)	Middle (56 m)	Upper (84 m)	Ground (1.5 m)	Lower (28 m)	Middle (56 m)	Upper (84 m)	Ground (1.5 m)	Lower (28 m)	Middle (56 m)	Upper (84 m)	
Chalinolobus gouldii	1.660	0.535	0.152	0.018	0.821	0.581	0.109	0.123	1.573	0.806	0.147	0.127	2.748	0.605	0.203	0.140	0.633
Chalinolobus morio	1.906	0.003	0.000	0.000	2.281	0.010	0.000	0.000	0.458	0.008	0.000	0.000	1.345	0.013	0.000	0.000	0.386
Falsistrellus tasmaniensis	0.835	0.015	0.000	0.000	0.235	0.040	0.003	0.000	0.322	0.012	0.000	0.000	0.613	0.046	0.000	0.000	0.133
Mormopterus lp	2.495	0.526	0.125	0.027	0.705	0.746	0.145	0.056	2.350	1.798	0.302	0.105	3.013	0.672	0.179	0.101	0.817
Mormopterus sp 2	0.512	0.085	0.036	0.006	0.285	0.092	0.017	0.007	0.465	0.040	0.016	0.007	0.571	0.050	0.000	0.000	0.138
Miniopterus orianae bassanii	0.522	0.003	0.000	0.003	0.142	0.026	0.000	0.000	0.154	0.016	0.016	0.000	0.227	0.004	0.000	0.000	0.071
Nyctophilus spp. and Myotis macropus	4.232	0.030	0.009	0.000	1.026	0.020	0.000	0.086	4.689	0.016	0.110	0.004	1.139	0.038	0.010	0.010	0.736
Nyctophilus spp.	0.418	0.018	0.003	0.000	2.599	0.013	0.003	0.000	1.605	0.043	0.012	0.000	1.811	0.017	0.000	0.000	0.412
Scotorepens balstoni	0.182	0.097	0.079	0.055	0.146	0.178	0.053	0.086	0.479	0.364	0.110	0.073	0.567	0.239	0.116	0.063	0.174
Austronomus australis	0.966	1.413	3.444	1.438	1.689	2.950	1.776	1.013	1.000	2.530	2.371	2.600	1.147	2.059	1.246	0.816	1.805
Vespadelus darlingtoni	8.774	0.170	0.015	0.006	0.768	0.106	0.007	0.013	2.983	0.198	0.024	0.007	2.210	0.067	0.024	0.000	0.990
Vespadelus regulus	4.128	0.046	0.009	0.003	0.444	0.056	0.000	0.003	1.143	0.055	0.016	0.004	1.382	0.025	0.005	0.000	0.468
Vespadelus vulturnus	4.259	0.018	0.000	0.000	9.626	0.020	0.000	0.000	0.657	0.000	0.000	0.000	3.521	0.025	0.000	0.000	1.174

Appendix 7 Review of wind farm mitigation technology

Table A7.1 Review of wind farm mitigation technology relevant to microbats

Basic approach	Study type	Citation	Title	Method	Summary
Deterrent	Experiment / pilot study	(Gorresen et al. 2015)	Use of dim ultraviolet light as a means of deterring activity by the Hawaiian hoary bat near turbines	Visual deterrent	Illuminated trees with dim flickering ultraviolet (UV) light. Bat activity was reduced but experimental treatment did not completely inhibit bat activity near trees, nor did all measures of bat activity show statistically significant differences due to high variance in bat activity among sites.
Deterrent	Meta-analysis / review of operational wind farms	(Kinzie & Miller 2018)	Ultrasonic Bat Deterrent Technology	Acoustic deterrent	Tested effect of ultrasonic signals (pulsed and continuous) on bats in a bat flight room. Found pulsed and continuous both deterred foraging behaviour. Then deployed on a turbine and found reduced bat fatalities by 38% for all species. Water vapour was a significant issue, potentially affecting the frequency of the device.
Deterrent	Results of management of operational wind farm(s) / commercial system(s)	(Schirmacher 2020)	Evaluating the Effectiveness of an Ultrasonic Acoustic Deterrent in Reducing Bat Fatalities at Wind Energy Facilities	Acoustic deterrent	Tested ultrasonic deterrents by placing on the nacelle. Two turbines were used for 70 nights and cameras were deployed to map 3D bat movements. Found no significant difference between control and acoustic deterrent, however, much of the data was removed due to survey issues.
Deterrent	Results of management of operational wind farm(s) / commercial system(s)	(Cooper et al. 2020)	Bat Impact Minimization Technology: An Improved Bat Deterrent for the Full Rotor Swept Area of Any Wind Turbine	Acoustic deterrent	Project report for the "Strike Free" system. Ultrasonic coverage to the entire area of the turbine blade as opposed to broadcasting ultrasonic transmission to the centre of the turbine. Designed specifically for echolocation frequency of four main bat species in USA. Transmitters can be customised to different frequencies as needed. Requires further testing before it can be commercialised.
Deterrent	Results of management of operational wind farm(s) / commercial system(s)	(Sievert et al. 2021)	A Biomimetic Ultrasonic Whistle for Use as a Bat Deterrent on Wind Turbines	Acoustic deterrent	Designed and tested biomimetic bat whistle which can be attached to the blades and passively create noise. Currently still in test/design phase. Has been designed, created and tested on lab bats to assess deterrence. Has also been deployed on small turbines to test wind speeds and rotation effects. Still missing realworld applications.

Basic approach	Study type	Citation	Title	Method	Summary
Deterrent	Results of management of operational wind farm(s) / commercial system(s)	(Romano et al. 2019)	Evaluation of an acoustic deterrent to reduce bat mortalities at an Illinois wind farm	Acoustic deterrent	Air-jet ultrasonic emitters with frequency range of 30-100kHz mounted on nacelles and towers. Deterrents were rotated out every 3 days. Observed significant reduction in overall bat mortality in 2014-2015, but not 2016. Also found deterrent was species specific. 35-56% of rotor swept area was within ensonified zone
Deterrent	Results of management of operational wind farm(s) / commercial system(s)	(Weaver et al. 2020)	Ultrasonic acoustic deterrents significantly reduce bat fatalities at wind turbines	Acoustic deterrent	Tested ultrasonic deterrents which emit s ix frequencies (20-50kHz) on wind turbines. Found significantly reduced bat fatalities of 54 and 78% for two species, but no impact on other species.
Deterrent	Results of management of operational wind farm(s) / commercial system(s)	(Voigt et al. 2021)	Limitations of acoustic monitoring at wind turbines to evaluate fatality risk of bats	Acoustic deterrent	Concludes that technical, physical, and biological factors severely constrain acoustic monitoring in its current form.
Deterrent	Results of management of operational wind farm(s) / commercial system(s)	(Gilmour et al. 2020)	Comparing acoustic and radar deterrence methods as mitigation measures to reduce human-bat impacts and conservation conflicts	Acoustic deterrent	Deployed Ultrasonic speakers and radar after 10 minutes (i.e. control) to deter bats. Found no impact of radar, but significant impact of ultrasonic speakers.
Curtailment	Results of management of operational wind farm(s) / commercial system(s)	(Rabie et al. 2022)	Efficacy and cost of acoustic-informed and wind speed-only turbine curtailment to reduce bat fatalities at a wind energy facility in Wisconsin	On demand curtailment	TIMR system (ReBAT) implemented using wind speed and bat acoustic presence data to inform curtailment algorithm. Control was curtailment at 4.5m/s, TIMR is active at <8m/s winds. Found reduced mortality up to 75% compared with control. Found higher curtailment night hours due to TIMR system, so revenue losses increased by 280%, however study area is known for low wind speeds.
Curtailment	Experiment / pilot study	(Mantoui et al. 2020)	Wildlife and infrastructure: impact of wind turbines on bats in the Black Sea coast region	Low wind-speed curtailment	Examined mortality of wind farms. Implementing curtailment at wind speeds below 6.5m/s reduced fatality rates by 78%.

Basic approach	Study type	Citation	Title	Method	Summary
Curtailment	Experiment / pilot study	(Adams, Gulka, & Williams 2021)	A review of the effectiveness of operational curtailment for reducing bat fatalities at terrestrial wind farms in North America	Low wind-speed curtailment	Meta-analysis of curtailment across Canada and USA. Found that in general curtailment reduced bat strikes and that it was most effective at >2m/s curtailment
Curtailment	Experiment / pilot study	(Anderson et al. 2022)	Effects of turbine height and cut-in speed on bat and swallow fatalities at wind energy facilities	Low wind-speed curtailment	Study doesn't focus on curtailment, but includes a section on statistical analysis of curtailment indicating a 33% reduction in bat fatalities. No significant reduction in bird impacts.
Curtailment	Experiment / pilot study	(Hayes et al. 2019)	A smart curtailment approach for reducing bat fatalities and curtailment time at wind energy facilities	Low wind-speed curtailment	Use of new system of tools for analysing bat activity and wind speed data to make near real-time curtailment decisions when bats are detected. Found significantly reduced fatality estimates for treament turbines for each of the five bat spp detected. Reduced power generation by <3.2% and estimated reduced curtailment time by 48% if operated under standard rules.
Curtailment	Experiment / pilot study	(Arnett et al. 2010)	Effectiveness of changing wind turbine cut-in speed to reduce bat fatalities at wind facilities.	Low wind-speed curtailment	Early review noting the effectiveness of low wind-speed curtailment in reduction of bat collisions.
Curtailment	Experiment / pilot study	(Martin et al. 2017)	Reducing bat fatalities at wind facilities while improving the economic efficiency of operational mitigation	Low wind-speed curtailment	Incorporation of temperature with wind speed into curtailment regime for bats improved efficiency of curtailment and reduced loss of productivity.
Curtailment	Results of management of operational wind farm(s) / commercial system(s)	(Huso & Maurer 2016)	Smart Curtailment: Improving efficiency by using more than wind speed	Low wind-speed combined with temperature for curtailment	Incorporation of temperature with wind speed into curtailment regime for bats improved efficiency of curtailment and reduced loss of productivity.

Basic approach	Study type	Citation	Title	Method	Summary
Curtailment	Results of management of operational wind farm(s) / commercial system(s)	(Bennett et al. 2022)	Curtailment as a successful method for reducing bat mortality at a southern Australian wind farm	Low wind-speed curtailment	Assessed pre and post curtailment, with curtailment significantly reducing pooled species mortality by 54%. Cut-in speed from 3 to 4.5ms
Curtailment	Results of management of operational wind farm(s) / commercial system(s)	(Squires et al. 2021)	Timing and Weather Offer Alternative Mitigation Strategies for Lowering Bat Mortality at Wind Energy Facilities in Ontario	Low wind-speed curtailment	Looked at more detailed region specific weather and timing to predict bat activity and mortality when curtailment was not in effect. Found bat activity occurred in waves, with distinctive peaks during the season. Most activity occurred in first half of the night.
Curtailment	Results of management of operational wind farm(s) / commercial system(s)	(Good et al. 2022)	Curtailment and acoustic deterrents reduce bat mortality at wind farms	Low wind-speed curtailment and acoustic deterrent	Tested combination of curtailment and acoustic deterrent (ultrasonic). Deterrent emits sound at 20-50kHz frequency from 8 speakers. Found significant reduction in bat mortality from just curtailment where wind speeds were <5m/s. Curtailment and acoustic deterrent saw a further decrease of between 31.6 and 66.9% depending on species. Two issues: limited control as could not determine just acoustic effects alone, and effectiveness of deterrent is unknown past 110m due to sound attenuation.
Curtailment	Results of management of operational wind farm(s) / commercial system(s)	(Richardson et al. 2021)	Peaks in bat activity at turbines and the implications for mitigating the impact of wind energy developments on bats	Low wind-speed curtailment	Bat activity assessed at paired turbine and control locations at 23 wind farms. P. pipistrellus activity was 37% higher at turbines than control locations, while P. pygmaeus activity showed no change. Discussion suggests that curtailment during high risk may reduce collisions, but further study needed.
Curtailment	Experiment / pilot study	(Georgiev & Zehtindjiev 2022)	Real-time bird detection and collision risk control in wind farms	On demand curtailment	Thermal imaging used to determine presence of birds and bats. Cameras installed on wind turbines and autonomously detected at 500+ meters. Custom-built detection software provides live picture and video logs. Human observations were compared with detection system (post analysis and checking by a human to confirm accuracy). Found 83.1-91.8% accuracy.

Basic approach	Study type	Citation	Title	Method	Summary
Test only	Experiment / pilot study	(Oregon TSate University 2021)	Final Technical Report: A Heterogeneous System for Eagle Detection, Deterrent, and Wildlife Collision Detection for Wind Turbines	Visual deterrent	Technical report for designing, testing and implementing of anti-collision and strike detection system. Testing has been completed on 3 separate short term field tests, and 1 multi-day on-turbine test. Tested visual deterrent only with drones. Visual deterrent is an inflatable anthropomorphic sculpture.
Test only	Experiment / pilot study	(Cryan et al. 2021)	Influencing Activity of Bats by Dimly Lighting Wind Turbine Surfaces with Ultraviolet Light	Visual deterrent	Deployed UV emitting LED lights which flash a minimum frequency of 0.5 seconds. Placed 20m up the turbines to cast dim UV light on turbine surface and some of the blade. Found no significant difference in present of bats, birds or insects, with insects and bats potentially having a non-significant increase in activity when UV lights were present.
Test only	Experiment / pilot study	(Smallwood & Bell 2020)	Effects of Wind Turbine Curtailment on Bird and Bat Fatalities	Low wind-speed curtailment	Two studies. Found wind turbine curtailment significantly reduced near-misses and rotor-disrupted flights of bats, and reduced bat deaths but not birds. Study 2 found converting inoperable to operable status had no significant impact on bird deaths, and sheltered-ledge nesters or roosters on turbines died more in vacant towers.
Test only	Experiment / pilot study	(Matzner, Warfel, & Hull 2020)	ThermalTracker-3D: A thermal stereo vision system for quantifying bird and bat activity at offshore wind energy sites	Thermal imaging	Testing of thermal stereo tracking for birds and bats. Deemed effective and cheap, however real world testing still required.

Appendix 8.1 Summary of Independent Peer Review

An independent peer review (IPR) was commissioned by DELWP, involving review by an independent expert on Southern Bent-wing Bat *Miniopterus orianae bassanii*.

The IPR was conducted in two stages. Stage A was primarily concerned with proposed approaches and methodology, and stage B was to review the impact assessment findings. A full copy of the peer review (Tasks A and B) is provided in Appendix 8.2.

A summary of the scope, findings and responses to the Southern Bent-wing Bat peer review is provided below.

Independent reviewer was Dr Emmi van Harten.

The scope provided to the reviewer by DELWP is repeated below.

Scope - Task A

The proponent will provide the IPR their documentation covering all work completed to date, including clear articulation of intended approach and specific methods applied to assess the potential impacts of the project on the Southern Bent-wing Bat.

The output from the independent peer review will be a concise report (initially in draft form for DELWP to review) advising whether the proponent's proposed methods:

- *a) provide a scientifically robust technical response to the matters related to the Southern Bent-wing Bat specified in the EES scoping requirements, in the context of best practice ecological investigations;*
- *b) identify and makes appropriate use (comparison and extrapolations) of the best available data sources and scientific literature;*
- *c) is able to generate empirical data and/or modelled scenarios that enable valid interpretations, predictions and conclusions to be drawn in assessing potential project impacts on the Southern Bent-wing Bat; and*
- *d) provide a reasonable response to relevant uncertainties related to the population ecology and behaviour of the Southern Bent-wing Bat.*

Where the proposed method does not offer the veracity sought in a-d, the IPR should recommend alternative methods.

Scope - Task B

The second task is to review the final impact assessment report(s) prepared by Neoen's specialist consultants. It is anticipated that the impact assessment work will be finalised by Neon's consultants between June 2021 and July 2021 (depending on seasonal survey requirements, to be confirmed following receipt and review of study methods).

IPR output will be a report to advise whether:

- *e) the study methods adopted were indeed appropriate and applied/implemented effectively;*
- *f) the analysis and interpretation of relevant results, conclusions and information relating to the environmental characteristics of the species are scientifically sound; mitigation measures recommended (and assumed for the purposes of impact assessment) are reasonable and could be effective in addressing likely impacts;*

g) the results and conclusions provide an adequate level of certainty and confidence to enable an informed impact assessment;
h) the conclusions adequately address and/or take account of current uncertainties relating to local population ecology and species behaviour; and
i) the range of matters related to the Southern Bent-wing Bat specified in the scoping requirements have been addressed as far as practicable.

Response to Kentbruck Green Energy Hub EES independent expert peer review of matters relating to Southern Bent-wing Bat

Dr van Harten undertook a peer review of the Biosis Kentbruck Green Power Hub (KGPH) Environment Effect Statement Technical Report: Southern Bent-wing Bat Impact Assessment as drafted at May – July 2021. The peer review provided 23 comments as part of Task A and 24 comments as part of Task B. The proponent provided responses to all comments in August 2021. On the basis of the peer-review and proponent responses, the Technical Reference Group provided further comments on various items. The proponent provided responses in October 2022. Subsequently, the Department of Transport and Planning Impact Assessment Unit provided further comments. The proponent provided final responses in July 2023.

The peer review (Task A) (25 May 2021) raised a number of aspects related to the approach and specific methods applied to assess the potential impacts of the project on the Southern Bent-wing Bat. This part of the review was provided after the program of field studies for the species had been completed.

The peer review (Task B) (28 July 2021) raised a number of aspects related to the impact assessment for the species. The Task B component of the review was undertaken on a draft impact assessment report, completed in July 2021. The final EES impact assessment is contained in the present report.

The review provided significant information and references and the proponent acknowledges this assistance, particularly in respect of the results of recent research largely undertaken by the reviewer and which may not have been available without her participation and generous provision of that information. Both sections of the peer-review called for the proponent to provide additional detail; further explanations of methods and results and also suggested refinements based on new information, some of which was unpublished at the time and was provided by the reviewer. In response, the proponent has incorporated revisions and iterative updates to the Southern Bent-wing Bat report, above.

The following provides discussion of matters raised by the peer review process (dot points below) that we consider require further response. Overall, many of the peer review comments about capacity of the project investigations to inform the impact assessment related to limitations of study methods. As a consequence, there is considerable overlap in peer-review Task A and Task B comments. For clarity, those matters are considered in a consolidated format below, rather than separately under the two tasks.

Use of acoustic bat surveys as primary means to obtain data for microbats

- The difficulty in identifying the target species by echolocation call data due to the overlap of call characteristics with other species.
- The potential difficulty in identifying the target species by echolocation call data due to extraneous noise and factors that may be associated with the methods used to record bat calls at height.

- The use of zero crossing vs full spectrum call detectors and the case for the latter being 'best practice'.
- The use of acoustic surveys alone and not in combination with other methods such as radar and/or thermal or infra-red imaging.
- Spatial limitations on airspace sampled for bats relative to the size of the project area.

Proponent response:

It is acknowledged that there is overlap in ultrasonic call characteristics between SBWB and other microbat species. For this reason, this analysis has taken a conservative approach to identification of SBWB calls and the impact assessment does not make conclusions based on absolute numbers of identified calls. Since the peer review was conducted there have been significant expansion of section 3.4, which documents sources of uncertainty and limitations relating to bat detector surveys, in particular the surveys conducted in this study, using zero crossing detection at a range of detector heights. The study has recorded SBWB calls throughout the study area, and acknowledges that SBWB are likely to be passing through the project area, and foraging within the project area. The analysis has found reduced levels of activity at height, and it is acknowledged that this reduction may be in part due to limitations of the monitoring methods.

Zero crossing mode was used rather than full spectrum mode for the reasons detailed in section 3.4.2. The primary purposes of the study required collection of data from a total of 24 detectors deployed for a full 12-month period and the capacity to identify bat taxa at each location. The study required capacity to collect and store a very large volume of bat-call data which necessitated the used of zero crossing mode. It is recognised that full spectrum mode offers other capacities, but it was not feasible to collate and store the required volume of data using that mode at the time of the study.

It is acknowledged that a combination of acoustic surveys with other technologies could have complemented the study results. However, radar cannot discriminate between species of bats (or potentially other airborne items) and imaging technologies, which also may not be able to discriminate between species of bats, could feasibly be deployed only for very short or periodic sampling. Neither of those technologies are known to have been used in combination with acoustic surveys for pre-approval assessments of wind energy projects in Australia, and these techniques are not currently developed to a level that they could assist in reducing uncertainty relating to SBWB activity within the project area.

With regard to that aspect and the spatial limitations of the areas sampled relative to the overall Project area, we note that the study design was developed in consultation with Dr L. Lumsden of DELWP and was considered to be a substantially more intensive and extensive investigation than had been attempted to that time. All ecological studies of fauna involve procedures that provide samples of temporal and/or spatial use of a study area, and the report acknowledges these limitations.

Analyses and interpretation of acoustic bat calls

- Uncertainty about capacity of Anascheme to reliably identify bats of south-western Victoria and consequent requirement for some manual checking of results.
- Provision of additional technical details about criteria used to identify and discriminate Southern Bent-wing Bat calls from those of other species.

Proponent response:

Any automated identification of ultrasonic bat call data requires some level of manual checking to attempt to quantify the rate of both Type I (false-positive) and Type II (false-negative) errors, and the level of data that has been discarded due to insufficient call quality. A manual checking process was undertaken, focusing on checking the 2,743 recordings identified as confirmed or potential SBWB calls in the automated identification process.

These 2,743 confirmed and potential SBWB calls were all subject to a manual checking process. Of these recordings, 20 were confidently identified as SBWB, 290 were identified as probable SBWB and a further 2107 were assigned to a species complex that includes SBWB. The species complex also includes forest bat species *Vespadelus* sp. which have similar and overlapping call characteristics with SBWB. The remaining records were either considered unlikely to be SBWB (144), of insufficient quality to be identified or to be noise. The manual checking process indicates that the AnaScheme identification process is conservative, and that the actual number of SBWB recorded may be lower than that indicated by the automated process. Notwithstanding this, detection of bat calls by ultrasonic detectors is subject to a range of limitations (as documented in this report) and does not provide accurate abundance or density data.

Interpretation of site-study results in impact assessment

- Given that absolute risks cannot be quantified, how relative risks are evaluated in assessment of potential project impacts.
- Potential limitations of techniques used to obtain bat calls at height to permit appropriate interpretations about levels of species activity or mortality risk, particularly relative to height above the ground and variable wind speed.
- Overseas studies have found little or no relationship between pre-construction bat activity and bat fatalities at operational wind farms.

Proponent response:

Results for bat call detection at various heights are summarised in section 5.1.4. At each of four met masts, three bat call detectors were positioned at 28 metres, 56 metres and 84 metres above the ground on a pulley system. A fourth detector was positioned at 1.5 metres at the base of the met mast. It is recognised that the capacity for detectors to record bat calls at the three higher levels may have been affected by a number of variables and that their capacity could have differed from the detector at 1.5 metres. However, the high detectors were able to record calls of other bat species (see section 5.1.4), which indicates successful operation of detectors.

It is recognised that the key issue for impact assessment is the absolute rate of Southern Bent-wing Bat flight activity that may be within rotor height and thus at risk of collisions. In that respect information about the predominant heights at which Southern Bent-wing Bats fly is vital to turbine design related to the height of rotors if that aspect is to be used to minimise collision risk. Existing turbines in Victoria routinely have rotor clearances of approximately 30 metres. The project has determined to use turbine design with substantially greater clearance as a planned mechanism aimed at minimising potential for collisions. For that reason information about the relative heights at which the species flies is of real relevance.

It is acknowledged that studies elsewhere have found no consistent relationship between pre-construction measures of bat activity and post-construction mortalities of bats. For that reason, the project makes no quantified prediction of SBWB mortality and PVA considers a range of possibilities covering order(s) of magnitude of potential fatalities due to the project.

Accounting for geography, demography and species behaviours in impact assessment

- Whether sufficient consideration is given to the project location relative to distribution and movements of the species.
- Whether sufficient consideration is given to background survival rates of age-classes and sexes of the species.
- Concern that the site is within nightly foraging distance of Southern Bent-wing Bats using the Portland maternity cave and that there may thus be an impact on breeding success of that colony.
- Whether sufficient consideration is given to known and uncertain aspects of the species foraging and flight behaviours.

Proponent response:

Since the peer review was conducted there have been several report revisions, including further consideration of the location of the project in relation to roost sites, nightly foraging distances and potential movements between roosts. This includes consideration of the updated conservation advice, and other material provided by the peer reviewer. The site is clearly within the nightly foraging range of the Portland roost, which is known to be used as a maternity site, and there are other known roosts within nightly foraging range, including roosts near Portland and along the Glenelg River. There may be additional undocumented roosts within the nightly foraging range of the species, including potential for additional undocumented roosts within the limestone cliffs associated with the Glenelg River. It is also acknowledged that although pine plantation habitats are not thought to be preferred foraging habitats, the species is likely to forage within the plantations. The degree to which the species forages in pine plantations, in comparison with native forest, wetlands or cleared farmland, is not well understood, due to the difficulty in monitoring movements of the species, or detecting foraging activity.

A population viability analysis (PVA) has also been conducted since the peer review, as documented in section 5.1.7 and Appendix 3. The PVA considers a range of scenarios, including the base case, and scenarios with additional mortalities.

Mitigation and impact reduction measures

- Concern about the capacity of mitigation measures to limit impacts at the population level.

Proponent response:

Potential mitigation measures and discussion of their potential efficacy are set out in section 6, above, and the preliminary Bird and Bat Management Plan for the project. Section 6 includes a review of recent technological developments in this field, and provides commentary on the applicability of these techniques to mitigation for the KGPH. We also acknowledge that this is a rapidly developing field, and there are likely to be ongoing advancements in technology prior to construction of the KGPH.

Assessment of cumulative effects

- How potential cumulative impacts of the project in combination with other wind farms are assessed.

Proponent response:

The potential for the project to contribute to cumulative impacts is addressed in Section 5.5.1. This section discusses the information required to conduct cumulative impacts, and the challenges associated with understanding impacts on SBWB due to wind energy and other anthropogenic factors. The peer reviewer also included a recommendation for population viability analysis (PVA) to be conducted. This has now been undertaken, in consultation with experts from DEECA. The PVA is documented in Section 5.1.7 and Appendix 3.

Appendix 8.2 Independent Peer Review

The independent peer review on matters relating to Southern Bent-wing Bat, commissioned by DELWP (now DEECA) is provided in this section. The review is in two parts: Task A and Task B. The peer review and responses are summarised in Appendix 8.1.

Independent peer-review: Task A

Kentbruck Green Power Hub Environmental Effects Statement and the Southern Bent-wing Bat *Miniopterus orianae bassanii*

Emmi van Harten

25 May 2021

Table of Contents

1. Scope

This document provides an independent peer-review on matters relating to the Southern Bent-wing Bat for the Kentbruck Green Power Hub Environment Effects Statement (EES). Details of the proposed wind farm are outlined in the Scoping Requirements for Kentbruck Green Power Hub EES (hereon 'Scoping Requirements'). The EES must outline the development's potential for significant impacts on the Southern Bent-wing Bat, which is listed as Critically Endangered under the *Environment Protection and Biodiversity Conservation Act 1999* and on the Advisory List of Threatened Vertebrate Fauna in Victoria (2013), and is listed as a threatened species under Victoria's *Flora and Fauna Guarantee Act 1988* – in addition to other potential environmental effects which are beyond the scope of this peer-review.

The EES is required to identify the presence and movements of Southern Bent-wing Bats within and near the project site, including locations of roosting or breeding sites within movement distances from the project site, in consultation with DELWP. Further, the EES must describe the biodiversity values that could be directly or indirectly affected by the project, including the presence of, or suitable habitats for, the Southern Bent-wing Bat; and potential use of the site and its environs for movement and/or foraging. Some of the key issues outlined in the Scoping Requirements that relate to the Southern Bent-wing Bat include:

- Potential for significant effects and their acceptability
- Potential for cumulative effects
- Disruption to the movement between areas of habitat across the broader landscape
- Direct or indirect loss, disturbance and/or degradation of listed or other protected species and nearby habitat that may support listed species
- Disturbance and increased risk of mortality arising from project infrastructure

To address the issues outlined in the Scoping Requirements, the following relevant reports have been prepared by Biosis for the proponent, Neoen Australia Pty Ltd:

- Kentbruck Green Power Hub Project Flora and Fauna Survey Program, dated 11 March 2020 (hereon 'Survey Program')
- Plan for investigations of Southern Bent-wing Bat for proposed Kentbruck Wind Farm, dated 26 February 2020 and attached as Appendix 1 to the Survey Program (hereon 'Appendix 1')
- Interim Flora and Fauna Existing Conditions, dated 21 December 2020 (hereon 'Interim Existing Conditions')

This document addresses Task A of the Independent Review requested by DELWP and will address several points outlined in the scope of work. The review will advise whether the proponent's methods:

a) provide a scientifically robust technical response to the matters related to the Southern Bent-wing Bat specified in the EES scoping requirements, in the context of best practice ecological investigations;

b) identify and makes appropriate use (comparison and extrapolations) of the best available data sources and scientific literature;

c) is able to generate empirical data and/or modelled scenarios that enable valid interpretations, predictions and conclusions to be drawn in assessing potential project impacts on the Southern Bent-wing Bat; and

d) provide a reasonable response to relevant uncertainties related to the population ecology and behaviour of the Southern Bent-wing Bat.

Where the proposed method does not offer the veracity sought in a–d, the independent peer-review should recommend alternative methods.

This review primarily provides comment on the Survey Program, particularly Appendix 1. However, some additional methods and preliminary results provided in the Interim Flora and Fauna Existing Conditions were also reviewed.

Please note that whilst citations of relevant literature are included in this peer-review as examples or references to certain statements, this is not a literature review and therefore the citations included are not intended to be exhaustive.

2. Review

2.1 Survey design: rationale and limitations

The survey program outlined for monitoring presence and activity of the Southern Bent-wing Bat at the proposed development site consists of acoustic surveys, including preliminary surveys, followed by 12 months of continuous monitoring using detectors placed at ground level. In addition, bat call data at various heights up to 84 m is being recorded using detectors fixed to four met masts. A 70 km ‘buffer zone’ has been used to identify roost sites within nightly flight distance of the proposed wind farm – aligning with recent research findings on the Southern Bent-wing Bat (van Harten 2020).

Rationale for the proposed survey design has been outlined in Appendix 1 under section ‘1.4. Challenges’ (pp 4–5). In this section, some of the limitations and challenges associated with other survey techniques are outlined. However, little information is provided about the challenges associated with the chosen method of acoustic bat surveys, except that this method cannot identify the number of individuals or the number of flights (p 4.).

Acoustic analysis of bat echolocation calls is complex. For example, there are a number of bat species with similar or overlapping call characteristics, and calls can differ based on geographic regions, environmental conditions (e.g. weather, open vs cluttered environments) and bat behaviour at the time of recording (Barclay 1999; Parsons and Szewczak 2009; Goerlitz 2018). Critically, there is no acknowledgement in the reviewed documents about the difficulty in identifying the target species, the Southern Bent-wing Bat, by echolocation call data due to the overlap of call characteristics with other species that might be expected to be present at the proposed development site. Identifying characteristics of the Southern Bent-wing Bat calls are often only distinguishable in loud, clear calls, where the bats are flying reasonably close to the detectors and under low noise conditions (or other factors affecting the noise-to-signal-ratio). This issue is further compounded by the Southern Bent-wing Bat’s flight behaviour, which includes flying at heights above the detection range of acoustic detectors placed at ground level (see also issues with data recorded on met masts, below). All these issues will affect the proportion of Southern Bent-wing Bat calls that can be positively identified. It is therefore important that the relevant limitations of the survey methods are outlined, and wherever possible, clearly demonstrate how these limitations will be addressed or considered during analysis and interpretation of the survey data.

Recording surveys in ‘full spectrum’ instead of ‘zero crossing’ may help (to a certain degree) with some of these issues. As the name suggests, ‘full spectrum’ records the full spectral information within a sound file. Though computationally efficient, ‘zero crossing’ only records the loudest points of the calls or sound over time, and is therefore more susceptible to noise (e.g. Parsons and Szewczak 2009), among other drawbacks, such as louder or closer bats masking quieter or more distant bats. Experiments suggest that in most cases zero crossing tends to record fewer calls than full spectrum (Adams *et al.* 2012). Even if access to full spectrum reference-call libraries are limited, recording and analysing data in full spectrum is still preferred because viewing calls in full spectrum (e.g. by switching view between zero-crossing and full-spectrum spectrograms on-screen) can reveal further information to assist with identification, particularly in noisy data and for species that are more cryptic or difficult to identify. The main detectors used in this survey record in zero crossing (but see section 2.4 below, as it is unclear if some data will be in full spectrum). The use of zero crossing is still relatively common practice in Australia (though less common internationally and becoming less common in Australia over time); however, a clear case can be made for full spectrum now being ‘best practice’. Where zero crossing is still used, it is important that the inherent limitations on the resultant data is understood and outlined.

Another factor being discussed in the current international scientific literature is that not all bats may always echolocate during flight, particularly when flying in open spaces (Corcoran and Weller 2018; Solick *et al.* 2020; Voigt *et al.* 2021). There is also recent evidence, for example, that at times some bats may use a type of echolocation called ‘micro’ calls, that until recently were undocumented and produce significantly less sound energy than ‘normal’ echolocation calls (and hence undetectable using standard survey techniques and reference libraries) (Corcoran and Weller 2018). This point is raised here simply to highlight that whilst echolocation surveys are the best available option for surveying bat activity at the proposed development site, the field of study of bat acoustics is complex and data needs to be analysed and interpreted with caution.

Finally, whilst it is explained in Appendix 1 why radar or imaging has not been used as the main survey method, there has been no reason outlined why radar or imaging (e.g. infra-red or thermal) has not been used in conjunction with acoustic surveys. These techniques cannot currently differentiate between different small insectivorous bat species; however, it may be possible to estimate the overall bat activity to assess the proportion of activity being recorded on the detectors. Radar is also useful for assessing flight height. For example, a pilot study in New South Wales using a combination of radar and novel acoustic methods found that Eastern Bent-wing Bats fly at heights that put them at risk of wind farms, and demonstrated that acoustic methods underestimated true bat activity at the proposed wind farm site (Mills and Pennay 2018; Pennay and Mills 2018).

2.2 Met mast surveys

The acoustic surveys in this study include the use of four met masts, with detectors placed at 1.5 m, 28 m, 56 m and 84 m. Detectors attached to met masts are commonly used by consultants to investigate activity at heights, which is clearly an important consideration for assessing collision risk.

Internationally, the success of using detectors at height to detect bat activity at proposed wind farms have been debated. For example, a recent study in North America found that less bat activity was recorded at height compared to ground detectors; however, neither the activity recorded at ground-level or at height successfully predicted mortality risk at wind farms (Solick *et al.* 2020). In Australia, experience indicates that the data from met mast surveys often produce low-quality data and therefore low detection rates. Likely reasons for this include:

- noise interference impacting the noise-to-signal ratio, including from high levels of wind, movement of the detectors and/or microphones on the cable or pulley system, and reverberations from the mast itself, which severely impacts detectability.
- atmospheric and geometric attenuation, which distort the calls and are influenced by a complex range of interdependent factors, including distance, echolocation frequency and weather (Goerlitz 2018; Voigt *et al.* 2021).

For the present study, the issues affecting acoustic detectability of bats may be compounded by the stated approach of only using ‘high quality calls’ (which may represent only a small proportion of the data, especially at height, due to the reasons outlined), and lower rates of identifiability of Southern Bent-wing Bat calls.

Examples of steps that may increase detectability of bat calls from met mast surveys include reducing noise wherever possible (e.g. by protecting microphones and decreasing movement of mounted equipment on the met masts – though care needs to be taken to maintain the desired directionality and detection distance), recording and analysing data in full spectrum instead of zero crossing, and attempting to analyse all data. It has also been recommended that acoustic methods are coupled with other methods, such as radar and imaging techniques (Voigt *et al.* 2021).

Another consideration is the small amount of airspace that is monitored during these surveys. For example, Voigt *et al*. (2021) found that for a species echolocating at a frequency of 40 kHz, just 4% of the risk zone of a single turbine is monitored, assuming a blade length of 60 m. Whilst these results cannot be directly compared to the present study, the proportion of area monitored by each detector would be much smaller in this study because the Southern Bent-wing Bat echolocates at a higher frequency of 47.7 kHz (Conole 2000) and thus the calls will attenuate faster, and the proposed turbines are much larger, therefore creating a larger risk zone. The use of multiple detectors for each mast in this study (instead of a single detector, which has hitherto been common practice) meets one of the recent recommendations to increase the area being monitored in acoustic surveys conducted at height (Voigt *et al.* 2021). Nevertheless, the area being surveyed by the four met masts is still very small compared to the size of the proposed development site and the dimensions of the proposed turbines – the met masts reach a height of 84 m but the proposed wind turbines are 270 m high with a rotor diameter of 190 m.

These factors do not preclude the use of met mast surveys in the current study. Given the propensity of the Southern Bent-wing Bat to fly at heights well above tree height and in open spaces (DELWP 2020), surveys of bat activity at height is an important element of the current study. However, the limitations associated with met mast surveys need to be clearly understood, transparently outlined, and addressed when interpreting the data. The survey design (e.g. Appendix 1, p. 3) states that the objective is to determine how flight activity may vary in relation to height above ground. The met mast surveys will provide supplementary data to the ground detectors and may confirm that bats are flying at the heights being monitored at the proposed wind farm site (i.e. up to 84 m); however, current evidence suggests that these techniques may not enable valid or meaningful interpretations to made on levels of bat activity or mortality risk, and that direct comparisons of the results cannot be made between the ground detectors and those fixed to met masts.

2.3 Analysis of call data and reporting of results from AnaScheme

The specific methods used for recording and analysing bat calls is a critical component of echolocation call surveys. Currently, insufficient detail is provided in the reports about the methods used to record and analyse the call data, and this should be added to the method descriptions and future reporting of the results, to demonstrate whether the survey is consistent with best practice ecological surveys and whether the data will allow for valid interpretations to be made in response to key issues in the Scoping Requirements. Additional information should include:

- The number of pulses used to define/identify a pass or call
- Trigger settings used during the surveys
- Reporting of the proportion of data not able to be analysed to species and the proportion analysed to 'species complex', i.e. where two or more species are unable to be separated from each other due to similar characteristics, such as the Southern Bent-wing Bat and the Little Forest Bat *Vespadelus vulternus*
- Description and/or examples of the characteristics used to distinguish species with similar call attributes
- The reference call library and/or keys used (this is partially mentioned in the Existing Conditions but not the Survey Program/Appendix 1)
- Detail of microphone set up (currently only the model specifications are mentioned). For example, how were the microphones mounted, were extender cables used, was any housing or weather protection used, and how may any of these factors have impacted directionality and call distance? Were there any differences in these approaches for different detectors, or those placed at ground level compared to those on met masts?

An example of how some of these recommendations can be reported is presented in the 'Recommendations of the Australasian Bat Society Inc for reporting standards for insectivorous bat surveys using bat detectors', which are included in Appendix A of the Australian Government's 'Survey guidelines for Australia's threatened bats' (available at https://environment.gov.au/system/files/resources/2f420bf1-d9e4-44ec-a69c-07316cb81086/files/survey-guidelines-bats.pdf).

Despite the assertion that AnaScheme is widely used in Australia (Appendix 1, p. 6 and Interim Existing Conditions, p. 28), there are very few bat researchers that currently use the program. The software saves time by partly automating analysis through the development of regional keys; however the levels of successful identification are species dependent (Gibson and Lumsden 2003; Lumsden and Bennett 2005; Adams *et al.* 2010). For example, in the Northern Victorian Riverina region, whilst some species could reliably be identified from calls in a reference library, species with overlapping call characteristics were identified at a rate of less than 40% (Lumsden and Bennett 2005). Overall success was 25% for unknown calls collected in the field and run through the system (i.e. calls collected during a survey, rather than calls from a reference call library where the species for each call is known) (Gibson and Lumsden 2003). Testing of the south-west Victorian key has not been published, however due to the known difficulties in identifying Southern Bent-wing Bat calls, it will be critical that an adequate level of manual checking is undertaken to verify the results.

The method descriptions in the Interim Existing Conditions and Appendix 1 state that any calls identified by the system as significant or uncommon will be manually checked. However, it is not stated the proportion (if any) of 'unknowns', or other subsets of the data, that will be manually checked. This is particularly important in the current study because it is stated that call frequency will be used as 'surrogate measure' for bat activity at the site. Among bat researchers it is considered best practice to manually vet at least a proportion of all call data when using any semi-automated data analysis or self-constructed ‘decision trees’, and that this proportion and determined accuracy is clearly outlined in the methods. The proportion of data being treated as insufficient quality to be included for species analysis through AnaScheme should also be disclosed, as this could represent a large portion of the dataset if methodological or environmental factors impact the quality of the data.

2.4 Use of different acoustic detectors and analysis methods

In the Survey Program the methods only refer to the use of Song Meter detectors; however, the Interim Existing Conditions report also mentions the use of Anabat Swift detectors. The full method details associated with the use of these detectors needs to be specified, including the microphone and set up used, for which study periods and sites the respective detectors were used, and whether the Anabat Swifts were set to record in Zc (zero crossing) or wav (full spectrum). If recording in full spectrum and analysing in zero crossing, details of the conversion process should be given. The full call analysis procedure should also be detailed because, to my knowledge, AnaScheme is not currently compatible with data recorded from Anabat Swift detectors.

Detector choice can impact the results of the data obtained (e.g. Fenton *et al.* 2001; Adams *et al.* 2012; Smith *et al.* 2020). The reviewed reports state that 12 months of continuous monitoring will be undertaken, and that missing periods and sites from the preliminary results in the Interim Existing Conditions are due to the data from Anabat Swift detectors still being analysed. The preliminary results only present data from January to June 2020. If all missing data periods in the preliminary results are due to the use of Anabat Swift detectors, this means that different methods will be used for the first six months (January to June) and the subsequent six months (July to December) of the dataset. It is difficult to compare datasets obtained from different detector systems (Adams *et al.* 2012). It will be important in this study to clearly demonstrate how the datasets are comparable despite the different detectors and analysis methods used, and whether this will impact the ability to discern seasonal patterns in the data. Were any controls used across the study period? Analysing a proportion of the Song Meter data using the methods that will be used for analysing the Anabat Swift data may also reveal any potential differences in results due to analysis methods.

2.5 Proposed assessment of impacts on the Southern Bent-wing Bat

Overall, greater clarity is needed on how the data will be presented, analysed and interpreted to respond to key issues outlined in the Scoping Requirements, particularly in regard to the potential for significant impacts and cumulative effects on the Southern Bent-wing Bat. There are a number of other wind farms within the Southern Bent-wing Bat range, and I have been unable to find any information in the reviewed documents about how potential cumulative impacts will be assessed.

Appendix 1 (p.3) states that the objective of the study is to inform decision-making about ‘relative risks’ to the Southern Bent-wing Bat; however, there is a lack of information about how these risks will be inferred from the data and what these risks will be relative to. Further, it stated that ‘The objective of investigating Southern Bent-wing Bats at the Kentbruck Wind

Farm site and environs is to obtain relative measures of the species [*sic*] flight activity (using call frequency as a surrogate measure).' As already outlined, there are many factors that will contribute to the under-detection of Southern Bent-wing Bat activity from echolocation calls, particularly due to the chosen methods in this study. More information in needed to explain how call frequency will be used as a surrogate measure for bat activity and how the many limitations of the methods will be considered when making these assessments.

The preliminary results have not yet been interpreted or modelled, etc; however, it is clear that there are more confirmed and potential Southern Bent-wing Bat calls in February and March (Existing Conditions, p. 58). Whilst the acoustic data is unable to provide any information on population demographics, the rise in activity in February to March is consistent with the seasonal movements undertaken by adult female and juvenile Southern Bent-wing Bats at that time of year, resulting in an influx of these bats moving from maternity sites across the landscape (van Harten 2020). Adult females and juveniles are already experiencing lower survival rates compared to adult males (van Harten 2020; van Harten *et al.* 2020), and juveniles are more susceptible to collisions with infrastructure (Ingeme *et al.* 2019). In addition, the proposed development is in flight distance of many roosting caves, including over the most direct flight path between the Portland maternity cave and many non-breeding sites in south-west Victoria and south-east South Australia, and potential foraging locations such as the wetlands adjacent to the development site (Appendix 1 of Appendix 1, p. 13). This raises several possible concerns about the potential impact of the proposed wind farm on the Southern Bent-wing Bat. In order to adequately meet the Scoping Requirements, much more information will be needed about how the impacts associated with the proposed wind farm (and cumulative impacts with other developments) to the Southern Bent-wing Bat will be assessed, and to justify the risk assessment presented, proposed management strategies and other key issues in the EES.

2.6 Appropriate use of the best available data sources and scientific literature

The main data source used in the reviewed documents is the Draft National Recovery Plan for the Southern Bent-wing Bat. This has now been adopted by the Commonwealth (DELWP 2020) and is available at https://environment.gov.au/system/files/resources/457208a6-146d-4ebb-90f0-2a3c977556a1/files/draft-recovery-plan-southern-bent-wing-bat.pdf. Note that there are some minor changes and additional information in the newly adopted version.

Since the drafting of the Recovery Plan in 2013, a significant amount of relevant research has been undertaken on the Southern Bent-wing Bat that is therefore not included in the final adopted plan. For example, as stated in the reviewed documents, the Recovery Plan describes a cave near Portland as a potential third maternity site. It is now known that this cave is regularly used as a maternity cave, and it is likely that it has been used as a maternity site for many years: a maternity site was predicted to occur in the Greater Portland region as far back as the 1960s, due to the movement patterns of banded bats and spacing between Warrnambool and Naracoorte maternity sites (Dwyer 1969). There has also been significant research on population dynamics of the species. Most of this research is still under peer-review, being prepared for publication, or has not yet been released; however, some of this research is expected to be available in the coming months and it is strongly recommended that any new information that is released in the near future is carefully consulted and included in the EES.

2.7 Minor revisions or typos

Taxonomy should be updated as per Armstrong *et al*. (2020) and Jackson and Groves (2015):

- *Miniopterus schreibersii bassanii* is now *Miniopterus orianae bassanii*
- *Tadarida australis* is now *Austronomus australis*
- *Mormopterus* spp. are now *Ozimops* spp.

Typo in the heading of Survey Program Appendix 1 (p41); currently reads ‘Ben-wing’.

Currently the map of known and potential roost caves is attached as Appendix 1 of Appendix 1 in the Survey Program. This is confusing and could be avoided by imbedding the map as a figure, attaching as Appendix A, or attaching as Appendix 2 to the Survey Program.

3. Conclusions

This section provides a summary of the peer-review and any potential implications in relation to a)–d) outlined in the Scope.

a) [whether the proponent's methods] provide a scientifically robust technical response to the matters related to the Southern Bent-wing Bat specified in the EES scoping requirements, in the context of best practice ecological investigations;

Use of echolocation call surveys are a common, standard survey technique and is a suitable primary approach to investigating bat activity at the proposed wind farm site. However, bat call analysis is complex, and the analysis, interpretation and reporting process are critical to meet best-practice. A range of specific details about the methods and results need to be added in subsequent reports to determine whether the methods are scientifically robust (see Section 2.3).

Constraints of feasible and available methods, as well as behaviour, ecology and call characteristics of the Southern Bent-wing Bat will result in call data under-estimating true bat activity at the study site. Several aspects of the chosen methods are also likely to contribute to an under-detection of Southern Bent-wing Bats at the proposed development site. The use of different detectors (as well as different analysis methods) over different periods of the 12-month surveys may impact the ability to accurately identify seasonal patterns at the study area.

Though commonly used, data obtained from detectors fixed to met masts should be used cautiously due to the effect of noise, and other factors which will limit the number of bat calls that can be recorded and identified, particularly for the Southern Bent-wing Bat (see Section 2.2). Met mast surveys may still provide valuable information in regard to the EES, but the results should not be directly compared to the surveys at ground level. Direct comparisons would be misleading because these height surveys are expected to detect only a small proportion of true bat activity, and this may lead to an inaccurate assessment of potential impact and/or contribute to inadequate management or mitigation strategies.

Radar or imaging could be used in conjunction with the echolocation call surveys to assess overall levels of bat activity. I am not aware of feasible survey methods that can be used to distinguish Southern Bent-wing Bats from other small insectivorous bats at heights greater than those being monitored on the met masts at the study site and that could be used to obtain information of bat activity and flight height (excluding the use of loggers attached to bats that are captured and released, which is not recommended here). However, given that Southern Bent-wing Bats have been recorded flying at heights ranging from near-ground level to heights of 1 km (unpublished), it may be more practicable to assume presence of Southern Bent-wing Bats throughout blade sweep of the proposed wind turbines (45–270 m) – particularly since presence in the study area has already been determined in the current survey design.

Some aspects of the methodology could be improved – wherever possible, possibilities have been outlined in the peer review (Sections 2.1–2.4). Where no alternatives exist, or where solutions are not considered feasible by the proponent, it is critical that these limitations are nevertheless clearly outlined, including how this will be addressed in the interpretation of data and the assessment of potential impacts of the project on the Southern Bent-wing Bat.

b) [whether the proponent’s methods] identify and makes appropriate use (comparison and extrapolations) of the best available data sources and scientific literature;

At this stage, the reviewed documents suggest that the main information-source that has been used is the Draft National Recovery Plan. The newly adopted version should now be consulted and cited (which was adopted after the preparation of the Survey Plan and Appendix 1). A lot of research has been undertaken after the Recovery Plan was drafted several years ago. Continued efforts should be made to stay up to date with relevant information about the Southern Bent-wing Bat – particularly with informative literature that is expected to become openly available in the coming months, which will include information relevant to the EES. A minor point is that taxonomy/nomenclature of bat species referred to in the reviewed document should be updated, including the Southern Bent-wing Bat (see Section 2.6).

c) [whether the proponent’s method] is able to generate empirical data and/or modelled scenarios that enable valid interpretations, predictions and conclusions to be drawn in assessing potential project impacts on the Southern Bent-wing Bat;

It is currently unclear whether the methods will generate empirical data and/or modelled scenarios that will enable valid interpretations, predictions, and conclusions to be drawn in assessing potential project impacts on the Southern Bent-wing Bat. Further information is needed about the methods used (including analysis methods), the limitations of these methods, and how these limitations have or will be addressed when interpreting the data/results and assessing potential project impacts on the Southern Bent-wing Bat. Wherever possible, guidance has been provided in the peer-review about what limitations should be outlined and addressed. Critically, virtually no information is provided about *how* the survey data will be used to make an assessment on impacts and key issues in relation to the Southern Bent-wing Bat, as outlined in the Scoping Requirements, so I am unable to determine whether the approach would allow for valid predictions and conclusions to be made. While peer-review of the impact assessment comprises a subsequent stage of the peer-review (Task B), it would have been helpful to have a stronger indication of intentions in terms of data interpretation and/or modelling for impact assessment.

d) [whether the proponent’s methods] provide a reasonable response to relevant uncertainties related to the population ecology and behaviour of the Southern Bent-wing Bat.

The survey design makes a reasonable response to uncertainties of Southern Bent-wing Bat ecology and behaviour by undertaking surveys to investigate bat activity across the site, including a continuous 12-month survey to examine seasonal patterns and attempts to record bat activity at various heights up to 84 m. As outlined in earlier points, the response taken to data interpretation in relation to the Scoping Requirements is currently not as clear. The response taken to data interpretation and assessment of likely impacts (including cumulative impacts) on the Southern Bent-wing Bat will need careful consideration of both the known and uncertain aspects of the population ecology and behaviour, including:

- nearby maternity caves, non-breeding caves, foraging habitat and likely flight paths
- movement patterns, foraging preferences, and flight height
- population dynamics and recent population trends

4. References

Adams, A. M., Jantzen, M. K., Hamilton, R. M., and Fenton, M. B. (2012). Do you hear what I hear? Implications of detector selection for acoustic monitoring of bats. *Methods in Ecology and Evolution* **3**, 992–998. doi:10.1111/j.2041-210X.2012.00244.x

Adams, M. D., Law, B. S., and Gibson, M. S. (2010). Reliable automation of bat call identification for eastern New South Wales, Australia, using classification trees and AnaScheme software. *Acta Chiropterologica* **12**, 231–245. doi:10.3161/150811010X504725

Armstrong, K. N., Reardon, T., and Jackson, S. M. (2020). A current taxonomic list of Australian Chiroptera. Version 2020-06-09. Available at: http://ausbats.org.au/species-list/4593775065

Barclay, R. M. R. (1999). Bats are not birds -- Cautionary note on using echolocation calls to identify bats: a comment. *Journal of Mammalogy* **80**, 290–296. doi:10.2307/1383229

Conole, L. (2000). Acoustic differentiation of Australian populations of the Large Bentwing-bat *Miniopterus schreibersii* (Kuhl, 1817). *Australian Zoologist* **31**, 443–446. doi:10.7882/AZ.2000.004

Corcoran, A. J., and Weller, T. J. (2018). Inconspicuous echolocation in hoary bats (*Lasiurus cinereus*). *Proceedings of the Royal Society B: Biological Sciences* **285**, 20180441. doi:10.1098/rspb.2018.0441

DELWP (2020). National Recovery Plan for the Southern Bent-wing Bat *Miniopterus orianae bassanii*. Victorian Government, Melbourne.

Dwyer, P. D. (1969). Population ranges of *Miniopterus schreibersii* (Chiroptera) in south-eastern Australia. *Australian Journal of Zoology* **17**, 665–686. doi:10.1071/ZO9690665

Fenton, M. B., Bouchard, S., Vonhof, M. J., and Zigouris, J. (2001). Time-expansion and zero-crossing period meter systems present significantly different views of echolocation calls of bats. *Journal of Mammalogy* **82**, 721–727. doi:10.1644/1545-1542(2001)082<0721:TEAZCP>2.0.CO;2

Gibson, M., and Lumsden, L. (2003). The AnaScheme automated bat call identification system. *The Australasian Bat Society Newsletter* **20**, 24–26.

Goerlitz, H. R. (2018). Weather conditions determine attenuation and speed of sound: environmental limitations for monitoring and analyzing bat echolocation. *Ecology and Evolution* **8**, 5090–5100. doi:10.1002/ece3.4088

van Harten, E. (2020). Population dynamics of the critically endangered, southern bent-winged bat *Miniopterus orianae bassanii*. PhD thesis, La Trobe University Melbourne.

van Harten, E., Lawrence, R., Lumsden, L., Reardon, T., and Prowse, T. A. A. (2020). Low apparent summer-autumn survival of the critically endangered Southern Bent-winged

Bat in south-eastern Australia, paper presented at the 19th Australasian Bat Society Conference, Te Anau, New Zealand. *The Australasian Bat Society Newsletter* **54**, 45.

Ingeme, Y., Bush, A., Lumsden, L., van Harten, E., Bourne, S., and Reardon, T. (2019). Hit or miss could mean life or death for juvenile southern bent-wing bats. In 'Proceedings of the 31st Biennial Conference of the Australian Speleological Federation'. pp. 195–201. (ASF: Hobart.) Available at: https://www.caves.org.au/resources/category/37-conference-proceedings

Jackson, S., and Groves, C. (2015). 'Taxonomy of Australian Mammals'. (CSIRO Publishing: Melbourne.) doi:10.1071/9781486300136

Lumsden, L. F., and Bennett, A. F. (2005). Scattered trees in rural landscapes: foraging habitat for insectivorous bats in south-eastern Australia. *Biological Conservation* **122**, 205–222. doi:10.1016/j.biocon.2004.07.006

Mills, D., and Pennay, M. (2018). Using marine radar to image and track flying bats, paper presented at the 18th Australian Bat Society Conference, Sydney. *The Australasian Bat Society Newsletter* **50**, 66–67.

Parsons, S., and Szewczak, J. (2009). Detecting, recording and analysing the vocalisations of bats. In 'Ecological and Behavioral Methods for the Study of Bats'. (Eds T. H. Kunz and S. Parsons.) pp. 91–111. (Johns Hopkins University Press: Baltimore.)

Pennay, M., and Mills, D. (2018). Measuring bat activity in the landscape and at 100m altitude; a pilot study using ground and balloon mounted acoustic detectors to determine windfarm development risk, paper presented at the 18th Australasian Bat Society Conference, Sydney. *The Australasian Bat Society Newsletter* **50**, 66.

Smith, D. H. V., Borkin, K. M., and Shaw, W. B. (2020). A comparison of two bat detectors: which is most likely to detect New Zealand's *Chalinolobus tuberculatus*? *New Zealand Journal of Zoology* **47**, 233–240. doi:10.1080/03014223.2020.1754864

Solick, D., Pham, D., Nasman, K., and Bay, K. (2020). Bat activity rates do not predict bat fatality rates at wind energy facilities. *Acta Chiropterologica* **22**, 135–146. doi:10.3161/15081109ACC2020.22.1.012

Voigt, C. C., Russo, D., Runkel, V., and Goerlitz, H. R. (2021). Limitations of acoustic monitoring at wind turbines to evaluate fatality risk of bats. *Mammal Review*, mam.12248. doi:10.1111/mam.12248

Appendix 8.3 Correspondence regarding the Independent Peer review

This section includes a copy of the letter from Neoen to DELWP regarding Task B of the Independent Peer Review, and a copy of the response from DELWP.

3/08/2021

Department of Environment, Land Water and Planning

Level 8, 8 Nicholson Street, East Melbourne, Victoria 3002

Dear Mr John Bradley,

Kentbruck Green Power Hub (KGPH) – Kentbruck Peer review Task B – Southern Bent Wing Bat (SBWB)

Neoen is writing this letter in relation to the process undertaken by the Department of Environment, Land, Water and Planning (DELWP) in respect to the ***Independent Peer Review: Task B Kentbruck Green Power Hub Environmental Effects Statement and the Southern Bent-wing Bat Miniopterus orianne bassanii by Dr Emmi van Harten*** which was provided to Neoen on the 30/07/2021.

The independent peer review initiated by DELWP in December 2020 is being used to advise the department and Neoen on the suitability of methodologies, adequacy, and accuracy of analysis, as well as the reliability of conclusions on impacts and risk mitigation.

Specifically, the review is being conducted in two parts as set out in the scope of work dated 26 February 2021: Task A, which consisted of a review of the methodology, and Task B, which consists of a review of the final impact assessment report(s) prepared by Neoen's specialist consultants. Task A was completed on 25 May 2021. Task B is in progress.

Neoen has previously expressed to DELWP concern regarding the timing of this independent peer review (refer our letter dated 8 April 2021) given the extent of discussions, liaison, and effort between Neoen, its consultants and DELWP in developing the survey methodology for the relevant species for Kentbruck Green Power Hub. We would like to raise the following additional concerns with DELWP in respect to the process of Task B of the independent peer review and how it has been undertaken:

1. Neoen was advised on the 26 July 2021 by DELWP that the independent peer reviewer initiated and contracted by DELWP in March 2021 will be taking up a new role with Department of Environment, Land, Water and Planning, Barwon South West (DELWP BSW) region. DELWP BSW is a member agency of the Technical Reference Group (TRG) for the Kentbruck Green Power Hub Environmental Effects Statement (EES) process.
2. This unexpected development creates a situation where there is at least an appearance of actual or potential conflict of interest involving the independent peer reviewer. It is not clear to Neoen at this stage what actions (if any) have been taken (or could be taken) to ensure the preservation of the independence of the independent peer reviewer which is critical to the peer review scope is maintained when the independent peer reviewer commences in their new role.

3. Neoen discussed the issue of an appearance of an actual or potential conflict of interest with DELWP on 30 July 2021. It was agreed that DELWP would implement measures to maintain the independence of the peer reviewer for at least the period necessary to complete the scope of the independent peer review. Neoen requests confirmation of what measures have been (or will be taken) to ensure the independence of the independent peer review process.
4. In addition to the above, Neoen wishes to express concern with the way Task B has been progressed by [DELWP / the independent peer reviewer], particularly in relation to the timing of the review having regard to the process steps outlined in Figure 1 of the peer review scope. Specifically:
    a. For unexplained reasons, Part B of the peer review process was carried out on a draft impact assessment report rather than the final impact assessment report (as required under Task B). This may have occurred because of miscommunication between Neoen and DELWP as to the completeness of the studies presented in the draft impact assessment report made available to the TRG on 9 July 2021 and presented to the TRG on 14 July 2021. However, Neoen is concerned that the peer review of the relevant section of this report was expedited using a draft version as an expediency to allow the review to be completed before the peer reviewer commenced in their new role with DELWP.
    b. That the restrictions placed on the peer reviewer due to their new role within DELWP BSW means that the process for consultation with Neoen in accordance with the agreed IPR process (refer flowchart located on page 4 of bat-scope_V2_2021.02.26) is no longer available. The importance of this process is amplified due to the concerns expressed above in relation to the Part B review being carried out on a draft version of the impact assessment.
    c. The ongoing availability of technical advice from specialists within TRG agencies including DELWP BSW on this matter.

Notwithstanding the concerns expressed above, Neoen's primary intent is that the relationship with the peer reviewer as established through the peer review scope be maintained. It would have been best if the circumstances giving rise to at least an appearance of a conflict of interest had not occurred. Nevertheless, our view is that DELWP now needs to take appropriate action to manage this risk. The matter of an appearance of actual or potential conflict of interest must be resolved in an acceptable manner so that all interested parties can have confidence in the process. We will continue to engage with DELWP on this matter to seek an agreeable outcome.

If you have any questions, please do not hesitate to me.

Yours Sincerely,

Louis De Sambucy

Managing Director, Neoen Australia

Department of Environment,
Land, Water and Planning

PO Box 500, East Melbourne,
Victoria 8002 Australia
delwp.vic.gov.au

Mr Louis De Sambucy
Managing Director
Neoen Australia Pty Ltd
Level 10, 227 Elizabeth Street
SYDNEY NSW 2000

Ref: SEC015276

Dear Mr De Sambucy

KENTBRUCK GREEN POWER HUB – KENTBRUCK PEER REVIEW TASK B – SOUTHERN BENT-WING BAT

Thank you for your correspondence of 3 August 2021 regarding probity matters and the independent peer review for the Kentbruck Green Power Hub project environment effects statement (EES). I apologise for the delayed response.

Thank you for your patience whilst the Department of Environment, Land, Water and Planning (DELWP) progressed the examination and management of probity matters, to address the potential for actual or perceived conflict of interest associated with the independent peer reviewer and DELWP Barwon South West Region (BSW). This process has concluded, and the matter is now resolved as set out below.

Conflict of interests are defined by DELWP policy as "*a situation where a conflict arises between a public duty and private interest. The term refers to circumstances where a public official could be influenced, or could be reasonably perceived to be influenced, by a private interest when performing an official function.*" The Integrity Unit at DELWP did not identify any conflict of interest for either DELWP BSW or Dr van Harten in her capacity as an independent peer reviewer completing work for DELWP during the EES process.

All review work Dr van Harten conducted on the draft biodiversity report supplied by Neoen was completed prior to her commencing work at DELWP and enabled her expert views to be input to your approach to assessing impacts on the Southern Bent-wing Bat (SBWB). The independence of the peer review itself has been maintained effectively by DELWP during the process.

It was, however, acknowledged that a perception of conflict could remain regarding Dr van Harten. As you note in your letter, Dr van Harten has taken up a position at DELWP BSW, after her completion of the independent peer review. There could be a perception that she may have a conflict of interest if she works on the Kentbruck project while in her new capacity at DELWP BSW. To address this concern, DELWP is ensuring Dr van Harten will play no role in the review and advice on the Kentbruck Green Power Hub EES and planning documentation. This includes her having no role in DELWP BSW inputs to the associated panel inquiry process. This has been formally documented, approved by DELWP BSW Regional Director and recorded by the DELWP Integrity Unit.

I note that Neoen intends to address a key recommendation of the peer review, which recommended that Neoen undertakes a population viability analysis (PVA) for the project's impacts on the SBWB. Neoen has requested survivorship data to use in the analysis. As Dr van Harten is a subject matter expert and custodian of very recent SBWB ecological data, it will be necessary for her to participate in discussions about data inputs to development of the ecological model to be used by Neoen. These discussions would be with the service provider undertaking the PVA and conducted solely to ensure the input data, including limitations, were fully understood and the PVA was underpinned by the best scientific data available.

In correspondence dated 16 August 2021 from Garth Heron (attached), Neoen raised concerns DELWP BSW has been compromised by a conflict of interest and that it is Neoen's wish that DELWP BSW be excluded from further involvement with the project. DEWLP does not consider there to be any reasonable perceived or actual conflict of interest in relation to DELWP BSW on this matter.

Since 2018, DELWP BSW has been providing advice to Neoen in its capacity as an environmental referral authority for any future planning permit application. DELWP BSW has also provided advice to Neoen as a member of the technical reference group established for the EES. The peer review process was managed by DELWP Impact Assessment Unit.

DELWP BSW has provided technical advice and expertise during the EES process in accordance with normal practice. It has not received any formal or informal guidance from Dr van Harten in relation to SBWB or any other component of the project requiring assessment as a part of the EES, beyond that provided to all parties via the peer review completed before commencing at DELWP.

DELWP BSW will continue to sit on Kentbruck Green Power Hub's EES technical reference group and will continue to provide technical advice to Neoen in relation to biodiversity and policy matters, as well as input to subsequent phases of the EES and planning process.

Task B and initiation of the peer review

Task B of the peer review was initiated upon request by Neoen via correspondence dated 8 July 2021. I note that the scope of work (enclosed) uses the term 'complete report'. Complete, in this sense, refers to sufficient content/information available to inform a review or assessment. It is DELWP's view that the draft biodiversity document provided by Neoen for the TRG to review had sufficient information to inform and benefit from the peer review. Consequently, Neoen's request to initiate the peer review was supported and thus proceeded.

Neoen has provided additional comment on Task B outputs, requesting changes be made to the peer reviewer's document. The changes requested are mostly editorial in nature. To manage the ongoing probity issue, DELWP will not ask Dr van Harten to amend her Task B report, other than adding a cover letter that describes the peer review's professional background. Any additional clarifications or requests regarding SBWB will be addressed by DELWP BSW.

DELWP Impact Assessment's SBWB peer review process is complete and was undertaken in line with the scope of work for the process. Neoen has received the outputs of the review process, which are intended to inform the progress of biodiversity studies to support the EES.

If you would like more information about this matter, please call [redacted], Acting Director Impact Assessment, Department of Environment Land Water and Planning, on (03) 8508 0945 or at [redacted]

Yours sincerely

John Bradley
Secretary

27 / 10 / 2021

Encl.

From: Garth Heron
To: [redacted]
Cc: [redacted]
Subject: RE: OFFICIAL-Sensitive: Kentbruck Green Power Hub - technical response to peer review
Date: Monday, 16 August 2021 11:07:51 AM
Attachments: image001.png
image002.png
image003.png
image004.png
image005.png
image006.png
image007.png
image008.png
image009.png
Task-B-Emmi-van-Harten_Neoen_Comments_20210816 GH.docx
Importance: High

EXTERNAL SENDER: Links and attachments may be unsafe.

Hello [redacted],

Hope you are well. This email is to give you an update on the Neoen comments to the peer review, and to request information to complete a PVA with Michael McCarthy of University of Melbourne.

1. **Updated Neoen comments on the peer review of the draft report**

I have combined our comments on the independent review of the draft report attached. These comments can be separated into two types,

- The ones marked ***Neoen*** are comments we would like to see corrected or addressed by the reviewer and DELWP.
- The ones marked ***Garth Heron*** are general comments, which have previously been provided to DELWP, but are important and should be left against the review for context of anyone reading the review. I note that anyone reading the review without the benefit of these comments is reading the review of the draft report out of context.

2. **Request for information to complete a PVA as suggested in the peer Review**

In addition, the review of the draft report highlighted the need for a PVA to be done. We have had discussions with Prof. Michael McCarthy of University of Melbourne, who has offered to evaluate data and its capacity to be used for PVA and to run a PVA for the purposes of assessing potential effects of wind energy mortalities of SBWB. The intention of running PVA will be to test a range of reasonable potential effects of wind farm collisions on viability (measured as altered quasi-extinction) on the SBWB population.

Noting that the Conservation Advice (TTSC 2021) mentions that the Recovery Team has recently run PVA, we presume that data for relevant parameters are available and would like to request that DELWP/peer reviewer provide the following data for the subject species of the peer review:

- Current census data for population(s) to be incorporated in PVA (ideally census data should include numbers of juveniles and adults of each sex).
- Life-table data (i.e. survivorship/mortality rates for both sexes and each age-class (juvenile and adult) or annual rates from birth to maximum longevity). Life-table data allows for calculation of mean and maximum longevity. If these are based on current empirical data they will incorporate background effects of pre-existing impacts.
- Reproductive life-span (mean age at commencement of maturity to mean age of reproductive senescence (or death, if reproductively active until then). The reproductive life-span data will permit calculation of mean generation length.
- Mean fecundity rate (the mean number of pups born to each female per annum). This is a rate so will incorporate potential for not all females to reproduce every year.

3. **Resolution of the conflict of interest with the independent reviewer**

As noted in your email below, the conflict of interest now established with the independent reviewer needs to be resolved. Neoen is not satisfied that this can be managed without a process change, and to maintain the integrity of the independent review of the draft report we expect that **the part of DELWP that the reviewer has joined will have no further participation in the evaluation of the impact of this particular species** (that is the subject of the review).

Please let the team and myself know if there are any further questions, and feel free to give me a call if you or Geoff want to discuss anything above.

Kind regards,

Garth Heron
Head of Development, Australia

NEOEN

Level 6 – 16 Marcus Clarke Street, Canberra, ACT 2601
M. +61 (0) 408 998 425

From: [redacted]
Sent: Wednesday, 11 August 2021 9:23 AM
To: [redacted]
Cc: [redacted]
Subject: OFFICIAL-Sensitive: Kentbruck Green Power Hub - technical response to peer review
Importance: High

Hi [redacted]

Further to our discussion on the phone, I'd like to clarify and close out the matter of Neoen's formal response to peer review Task B.

The purpose of the technical peer review was to advise DELWP, the TRG and the proponent on whether the primary ecology consultant's survey and assessment methods could meet the scoping requirements and to make recommendations for Neon's consideration to address identified issues. Another key objective of the peer review was to advise whether the scientific principles considered by the consultants and the results from surveys could be used to draw sound and reliable conclusions that could feed into a sufficient impact assessment of significant/key ecological risks needed for the EES. Such a review also entails identifying issues and providing recommendations for consideration by Neon's ecology consultant before they finalise the impact assessment report for the proponent/ EES.

I understand from our recent discussions, Neon's correspondence and my Director's discussion with Garth that Neoen is dissatisfied that the peer review (for task B) was undertaken on draft V2 of the Biodiversity report. It is usual and appropriate practice for a draft (not final) report to be provided for technical peer review, especially when you consider the role the peer review is playing in the overall process (see above paragraph). Comments from both the TRG agencies and technical peer reviewer are provided to inform Neon's refinement and finalisation of the impact assessment report.

It also worth noting that the current version (V2) of the biodiversity documents were provided to DELWP's technical peer reviewer upon the request of Neoen (emails dated 08/07/2021). DELWP's technical peer reviewer completed the task assigned, in line with the scope of work set by DELWP (and over the allotted 5 business days). The draft report (V2) had all the information needed to inform the DELWP technical peer review and TRG agencies review; the methods were clearly articulated and the scientific principles underpinning the study were clearly articulated. Following Neon's provision of the draft report and request for review (by TRG and DELWP's peer reviewer), DELWP confirmed ~~felt~~ it was appropriate to progress with Task B. The review comments /outputs of Task B confirm this, as well as highlight the importance of Neon responding to these comments in a considered manner.

We appreciate Neon has concerns about the current stage/status of DELWP's technical peer review. However, the technical peer review DELWP has commissioned of the draft report (under task B) is now complete. The only remaining task for DELWP's technical peer reviewer is to provide concise feedback to us on your approach to addressing the comments/advice in her task B review.

It is essential that Neoen and your primary ecological consultants directly engage with the technical comments and recommendations raised through DELWP technical peer review process. If the matters raised in the peer reviewer's comments are not addressed it is possible that the impact assessments completed for Neon's EES may not fully address the EES scoping requirements. It is very much in Neoen's interest to provide a more considered and detailed response to each of the comments than has been provided to date. The final impact assessment and EES prepared by/for Neon will need to demonstrate how/whether the proposed project will avoid unacceptable impacts on Critically Endangered and protected taxon (i.e. with respect to Southern Bent-winged Bat as well as several species of listed threatened and listed migratory birds).

Please provide an updated comment register that details your ecological consultant's response/approach to addressing the reviewer's specific comments, prior to COB Tuesday 17 August 2021. Also please advise when the next draft of the impact assessment report (taking account of the peer reviews comments) will be provided for DELWP and TRG review.

We are working through the conflict of interest issue, in accordance with DELWP integrity procedures. We will be in touch with you as soon as we have further information on the matter. However this does not affect or hold up the progression of your ecologist's technical response to the DELWP's technical peer review comments. We are also cognisant of the ambitious EES schedule proposed by Neoen.

If you have any queries prior to our next catch up, please don't hesitate to contact me.

Kind Regards,

[redacted]
Impact Assessor | Impact Assessment Unit | [redacted]
Planning Facilitation | Planning | Department of Environment, Land, Water and Planning

Level 8, 8 Nicholson Street, East Melbourne, Victoria 3002
[redacted]

We acknowledge Victorian Traditional Owners and their Elders past and present as the original custodians of Victoria's land and waters and commit to genuinely partnering with them and Victoria's Aboriginal community to progress their aspirations.

delwp.vic.gov.au

I am currently working flexibly. Please feel comfortable that I don't expect you to read or action correspondence outside of your working hours.

OFFICIAL

OFFICIAL-Sensitive

OFFICIAL-Sensitive

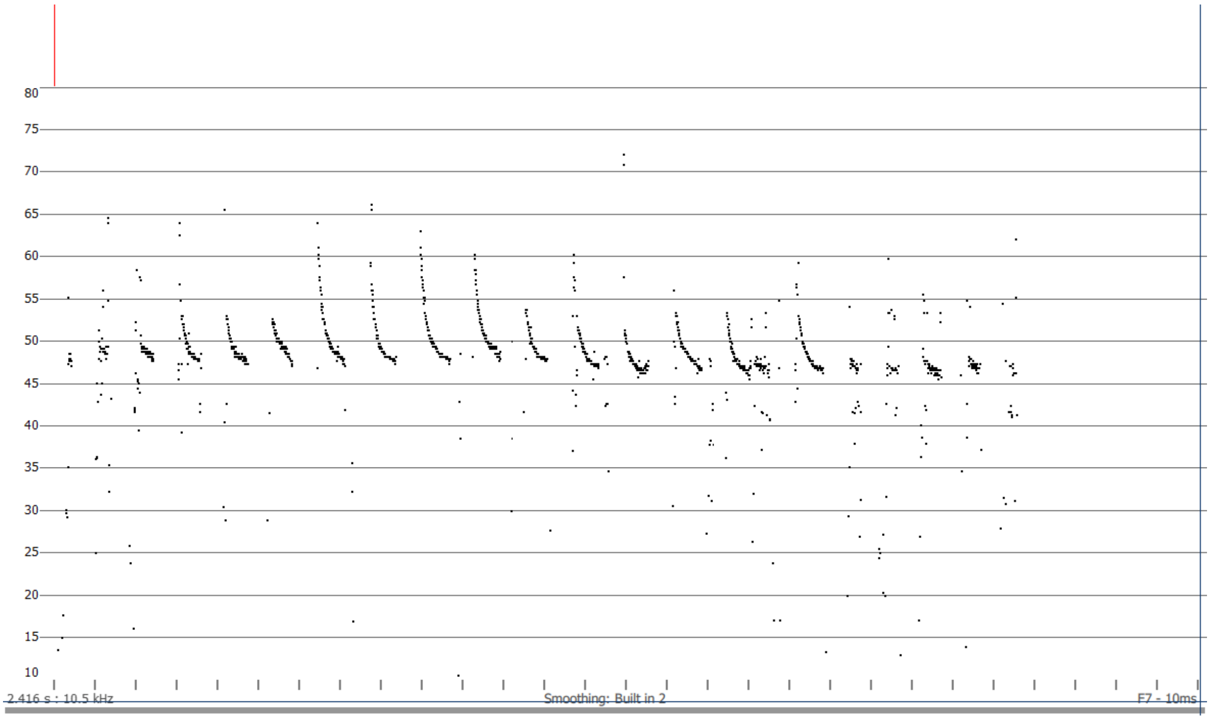
Appendix 9 Example bat calls

This appendix provides some graphical examples of bat calls to demonstrate calls that, during the manual identification process, were assigned to the following categories:

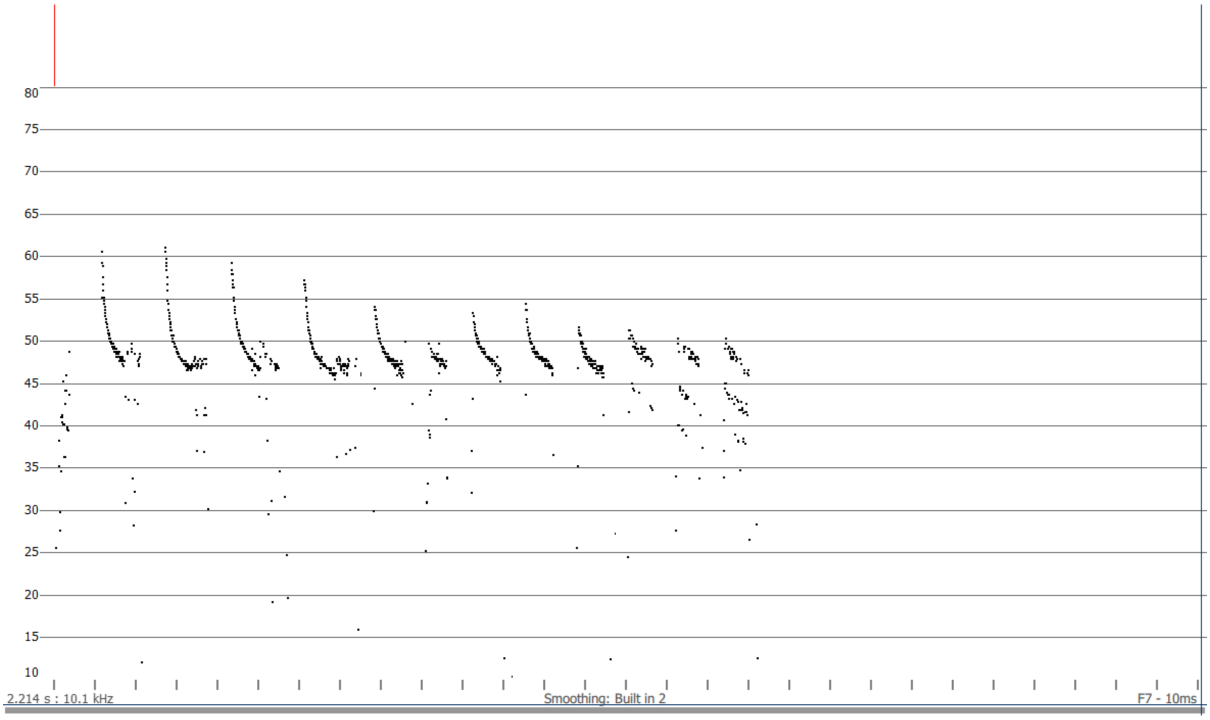
- Confident Southern Bent Wing Bat (SBWB) recordings.
- Recordings assigned to a species complex, that includes SBWB.
- Recordings that are likely bat calls but of insufficient quality for identification.
- Recordings that are not bat calls.

The graphical representations of recordings provided below are screen captures from the Anabat Insight software, showing zero crossing data points, with frequency (in kHz) on the Y axis and time in the X axis. In most cases, files are shown with the time (X) axis compressed, to remove blank space between data points representing vocalisations or other sources of noise.

Examples of confident Southern Bent-wing Bat recordings

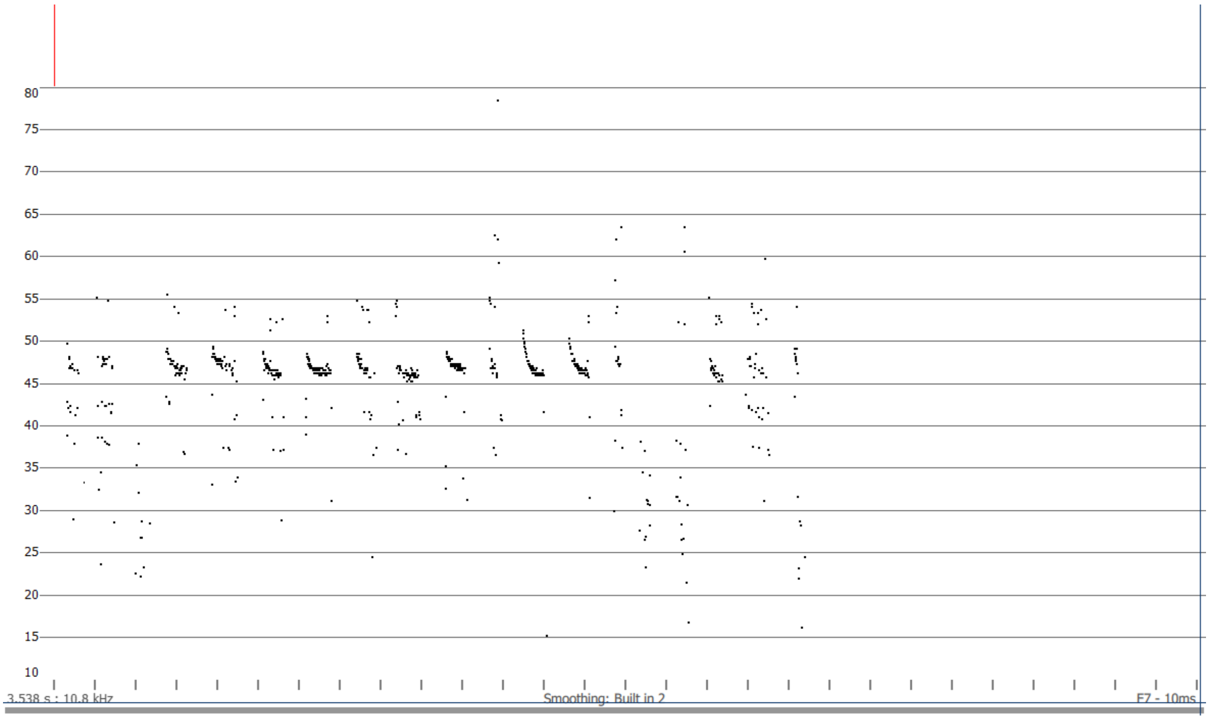


Bat call example 1 – Confident SBWB

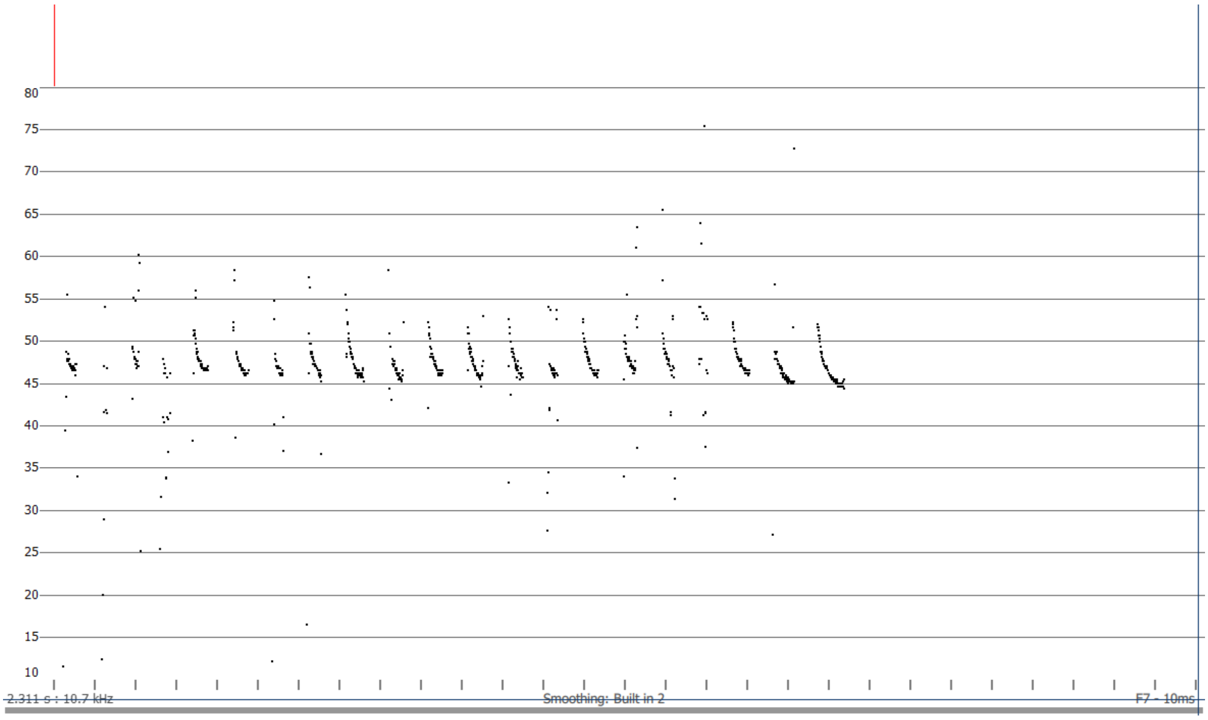


Bat call example 2 – Confident SBWB

Examples of species complex recordings

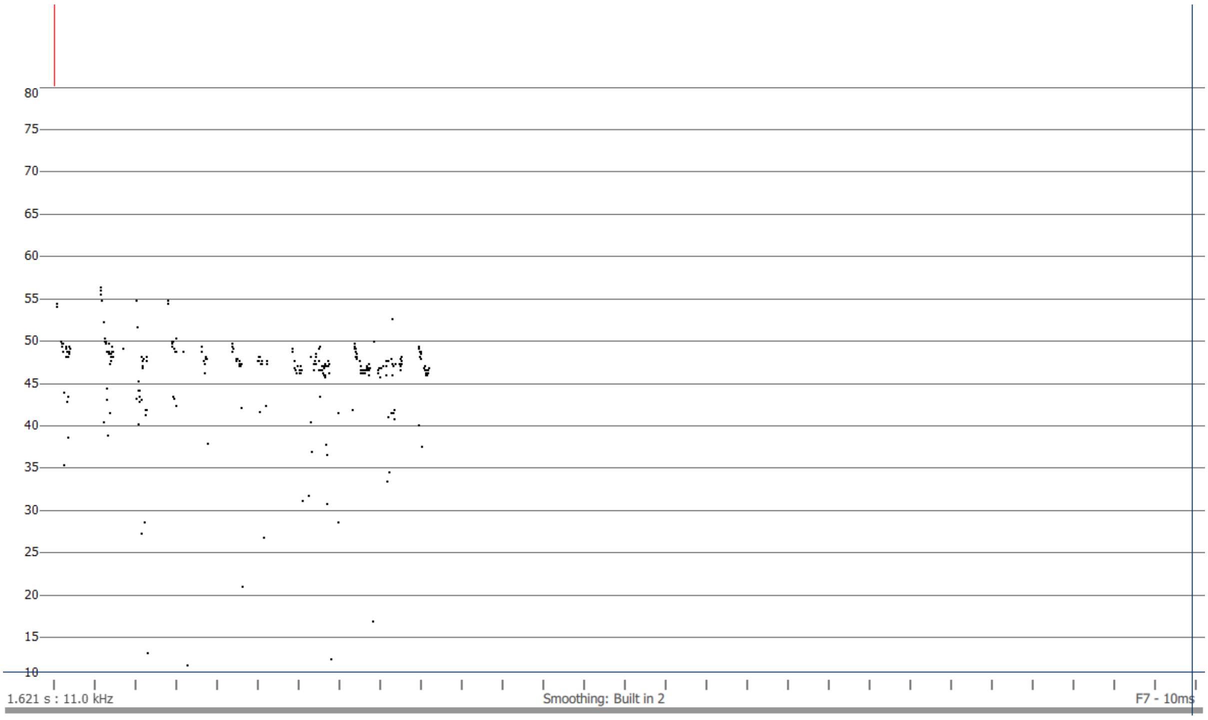


Bat call example 3 – Species complex

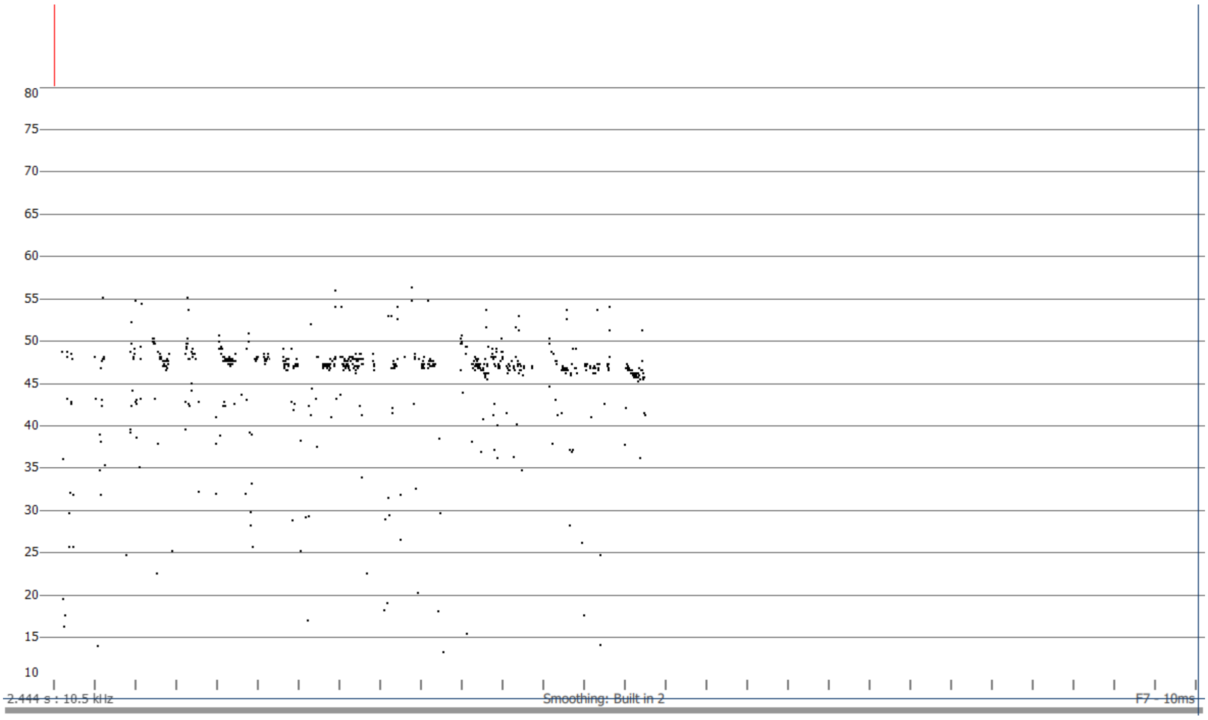


Bat call example 4 – Species complex

Examples of poor quality bat calls

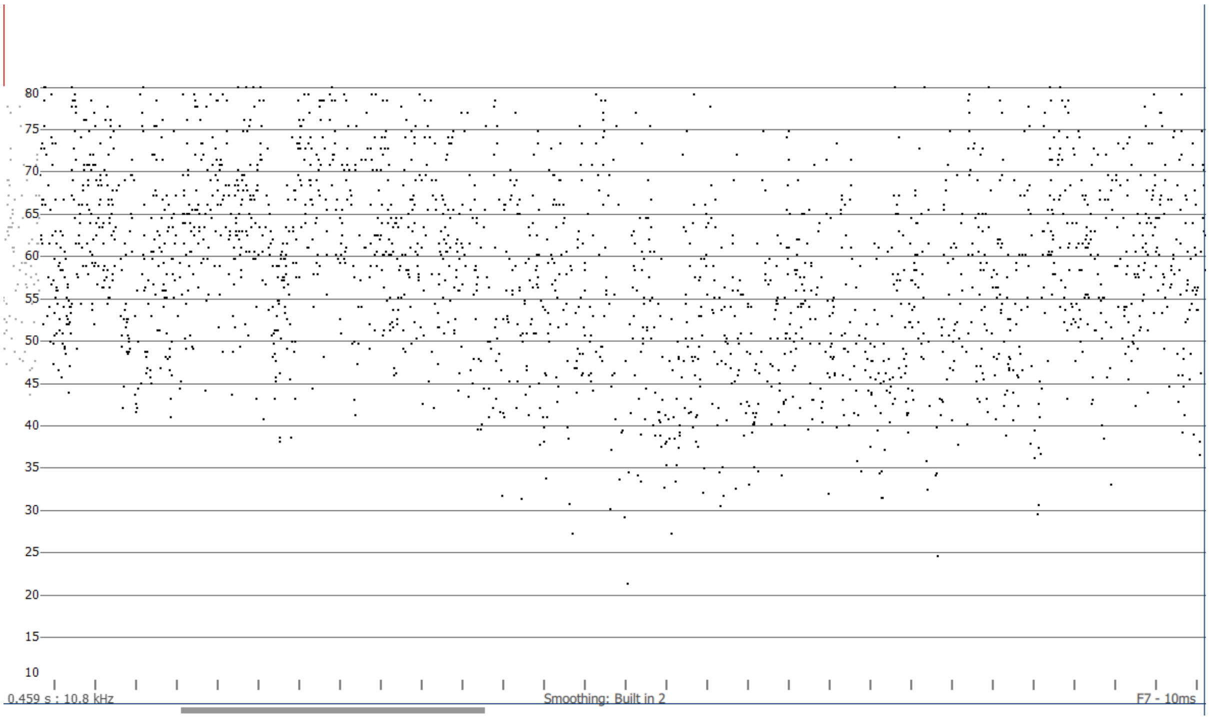


Bat call example 5 – Poor quality bat call recording



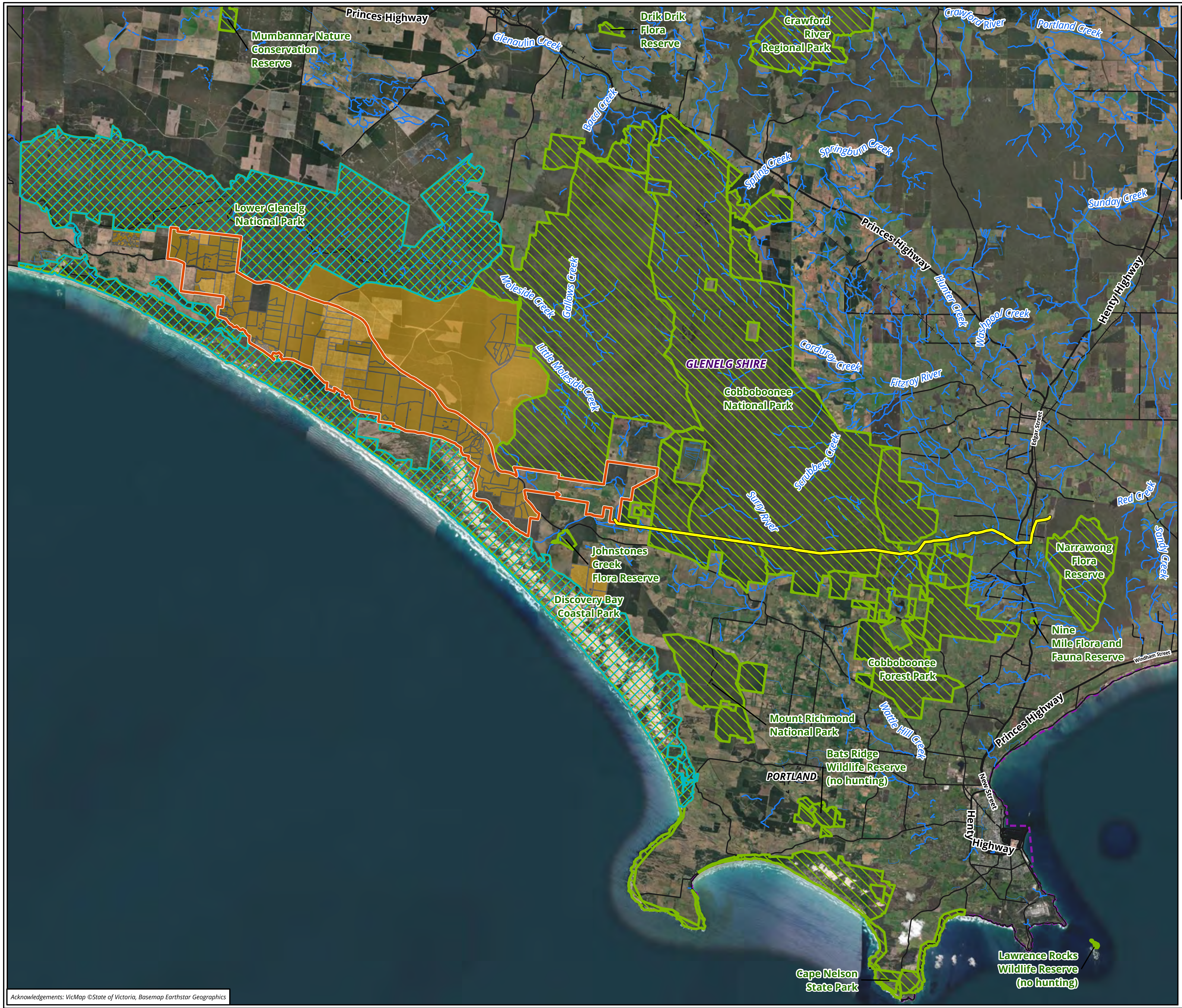
Bat call example 6 – Poor quality bat call recording

Examples of noise (non-bat) recordings



Bat call example 7 – Noise (non-bat) recording

Figures



Acknowledgements: VicMap ©State of Victoria, Basemap Earthstar Geographics

Legend

🟥	Wind farm footprint
━	Transmission line
🟨	Pine plantations
▨	National Parks Act and Nature Conservation Reserves
▨	Glenelg Estuary and Discovery Bay RAMSAR site

Figure 1 Project area location

0 2.5 5 7.5
Kilometres
Scale: 1:200,000 @ A3
Coordinate System: GDA 1994 MGA Zone 54

N

Matter: 35014,
Date: 01 December 2023,
Checked by: IV, Drawn by: JPT, Last edited by: jturner
Layout: aa_F1_Locality_singlepage
Location: P:\31900s\31983\Mapping\31983_Project.aprx

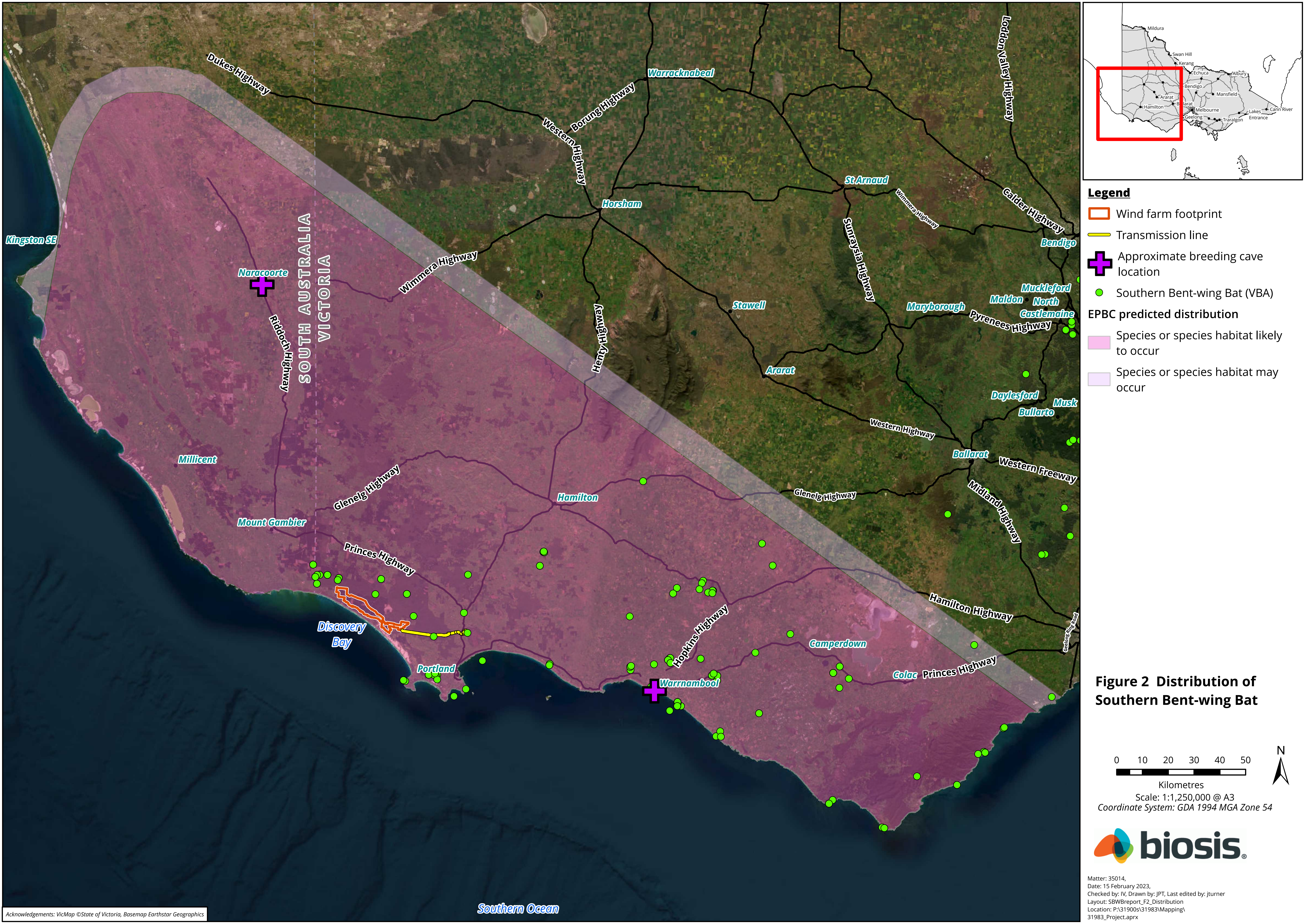


Figure 2 Distribution of Southern Bent-wing Bat

Scale: 1:1,250,000 @ A3
Coordinate System: GDA 1994 MGA Zone 54

biosis.

Matter: 35014,
Date: 15 February 2023,
Checked by: IV, Drawn by: JPT, Last edited by: jturner
Layout: SBWBreport_F2_Distribution
Location: P:\31900s\31983\Mapping\31983_Project.aprx

Acknowledgements: VicMap ©State of Victoria, Basemap Earthstar Geographics

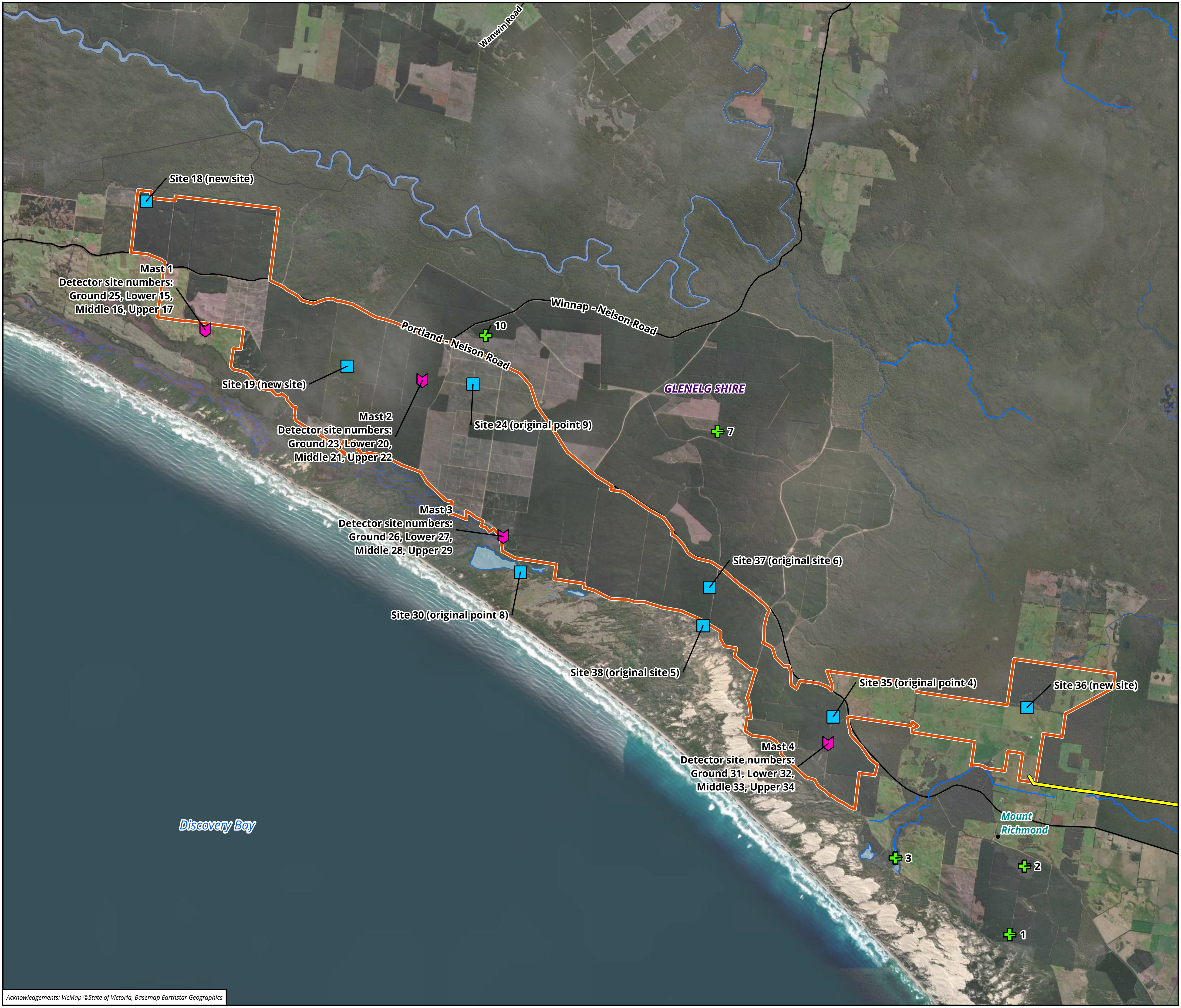


Figure 3 Bat detector locations

Acknowledgements: VicMap ©State of Victoria, Basemap Earthstar Geographics

Matter: 33361,
Date: 14 February 2023,
Checked by: IV, Drawn by: JPT, Last edited by: jturner
Layout: SBWBreport_F3_Detectors
Location: P:\31900s\31983\Mapping\
31983_Project.aprx