Yaloak South Wind Farm:
Year 2 Wedge-tailed Eagle Monitoring

Final report

Prepared for Pacific Hydro

22 October 2020

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

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

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Summary

Biosis Pty Ltd was commissioned by Pacific Hydro to undertake Wedge-tailed Eagle *Aquila audax* (WTE) monitoring as part of the implementation of the Bird and Avifauna Management Plan (BAM Plan) at the Yaloak South Wind Farm (YSWF). As per the approved BAM Plan (Biosis 2019a, 2019b), monitoring was undertaken of both WTE flight and breeding activity. The primary objective of the monitoring program is to provide a comparison of WTE activity prior to construction of the wind farm with activity during the early years of its operation.

YSWF reached practical completion in 2018 and the BAM Plan's minimum three year program commenced in July 2018. This report summarises the results from the second year of monitoring from the period of July 2019 through to June 2020. It also provides a comparison of WTE activity prior to construction of the wind farm with data accumulated over years 1 and 2 of wind farm operation. Concurrent with the monitoring of WTE flight and breeding activity addressed in this report, Elmoby Ecology has undertaken a carcass search program. The results of the carcass search program are not otherwise referenced in this report.

Monthly flight activity surveys were conducted at ten locations within YSWF from July 2019 to June 2020 (Year 2) using the same methods as pre-construction surveys and the first year of post-construction monitoring (Year 1). Consistent with previous iterations of post-construction monitoring, statistical comparisons have found no significant differences in mean WTE flight activity between the pre- and post-construction period at YSWF. Whilst no defined directional or seasonal patterns have been observed during the post-construction period to date, most WTEs were typically observed soaring near escarpments within YSWF and above the Brisbane Ranges National Park, where they are likely to rely on solar thermals for uplift in the surrounding flat terrain.

Breeding activity surveys were undertaken by locating nests in areas within and surrounding Yaloak Estate and YSWF to determine if successful breeding occurred during the Year 2 post construction period. Three active nests were identified during the 2019 breeding period both within the YSWF site and surrounding Yaloak Estate. Two of the three nests were monitored until January 2020, and juvenile WTEs at those nests were found to have fledged successfully.

The BAM Plan sets the reasonable measure of breeding success as approximately one fledgling per nest in which eggs are laid. Nest activity recorded during the 2019 breeding season therefore meets the standard for breeding success outlined in the BAM Plan.

There are no trends in WTE flight height and breeding activity during the post-construction monitoring phase (Years 1 and 2) that can be attributed to construction and operation of YSWF.

1. Introduction

1.1 Project background

Yaloak South Wind Farm (YSWF), located near Ballan in western Victoria (Figure 1), reached practical completion in May 2018 with a total of 14 turbines. Condition 19c of the Planning Permit for YSWF issued under the Moorabool Planning Scheme (Permit No: P2010002) requires the following:

> *A survey program to be carried out in at least three of the first five years after commissioning of the last turbine to determine the impact of the operation of the wind energy facility on the local Wedge-tailed Eagle population and will include:*
>
> *i. Assessment of the presence, behaviour and movements of any Wedge-tailed Eagles especially breeding pairs in the vicinity of the wind energy facility.*
>
> *ii. Requirements for periodic reporting, within agreed timeframes, of the findings of the survey program to the Department of Sustainability and Environment.*

The approved Bat and Avifauna Management Plan (BAM Plan) (Biosis 2019a, 2019b) specifies relevant monitoring and reporting requirements, which include monitoring of Wedge-tailed Eagle *Aquila audax* flight and breeding activity.

Biosis Pty Ltd was commissioned by Pacific Hydro to undertake monitoring activities for Wedge-tailed Eagles including the second year (Year 2) of the BAM Plan's implementation at YSWF, commencing July 2019 and completed in June 2020. This report presents the results of Year 2 post-construction monitoring, in combination with results obtained during Year 1, against pre-construction data obtained during 2009 and 2010.

YSWF reached practical completion in May 2018 and the BAM Plan's minimum three year program commenced in July 2018. Biosis undertook Year 1 monitoring which was completed in June 2019 (Biosis 2019c). Concurrent with the monitoring of Wedge-tailed Eagle flight and breeding activity addressed in this report, Elmoby Ecology has undertaken a carcass search program. The results of the carcass search program are not otherwise referenced in this report.

1.2 Scope of assessment

The objectives of this investigation are:

Monitoring of Wedge-tailed Eagle flight activity

The objective is to determine whether eagle flight activity is statistically significantly different between pre- and post-construction.

Monitoring of wedge-tailed Eagle breeding activity

The objective is to assess whether Wedge-tailed Eagle nesting activity and success in the vicinity of YSWF differs substantially from nesting activity and success at locations not in the vicinity of wind energy facilities.

Reporting

This report describes the methods of the two monitoring investigations conducted in Year 2; presenting the results in combination with results of Year 1 (Biosis 2019c) against pre-construction studies conducted by Biosis (formerly Biosis Research) at YSWF in 2009 and 2010 (Biosis Research 2010).

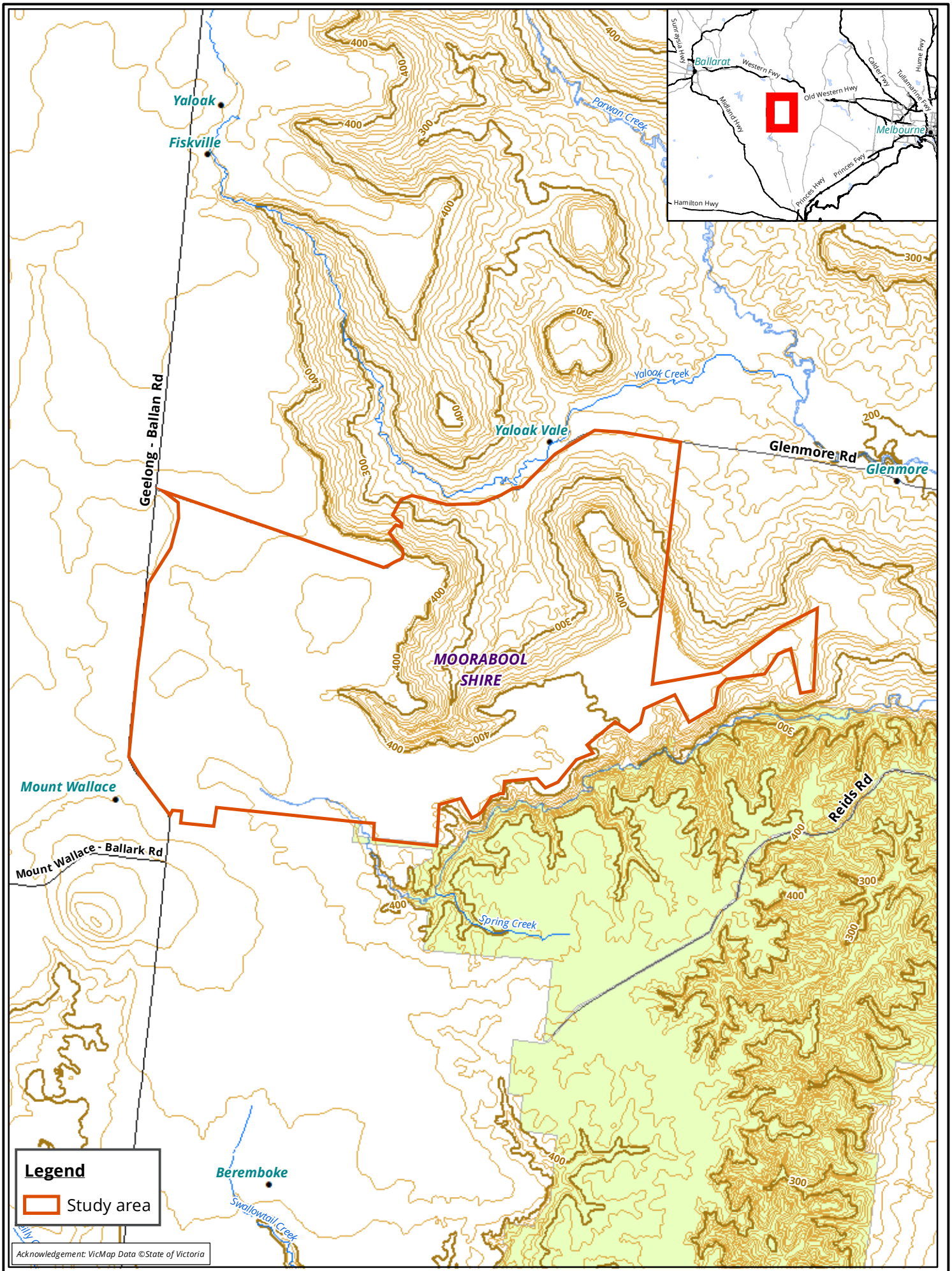

Figure 1 Location of the Study Area - Yaloak South Windfarm, Victoria

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2. Methods

The approved BAM Plan specifies a program of monitoring for WTE flight activity based on methods applied by Biosis Research (2010). Methodologies applied during the post-construction period remain consistent with those provided in the BAM Plan to allow baseline data to continue to be compared to subsequent years of post-construction monitoring. Detailed methodologies for Year 2 of monitoring are described in the below sections.

2.1 Temporal and spatial patterns of WTE occurrence in the study area

2.1.1 Methods

Point count surveys were conducted at ten locations at a frequency of one day per month for a period of 12 months. Monitoring point locations were the same as used in the pre-construction surveys (Biosis Research 2010) (Figure 2). The coordinates of the points are presented in Table 1. The numbering of point locations ("11 – 19", "A, B") is the same as used during the pre-construction monitoring and has been maintained for consistency. Each monitoring point was surveyed twice per survey, one AM and one PM. In order to account for variable eagle activity, counts were carried out during all seasons, across all daylight hours and during a variety of weather conditions, with the exception of conditions that would impede the ability of observers to undertake the surveys. Surveys for Year 2 commenced on 18 July 2019 and concluded on 23 June 2020. During each point count survey, the point was monitored by one stationary observer for a period of 20 minutes. Within this period the following information was recorded:

- Start time and date.
- Weather conditions.
- Observations of WTEs, including descriptions of their behaviour, distance from observer and height of observation.

During these surveys, each new sighting of a WTE was recorded as one activity. If a WTE disappeared from view of the observer and then came back into view it was recorded as a separate activity. The number of records therefore relates to flight activity and not a count of the number of individuals.

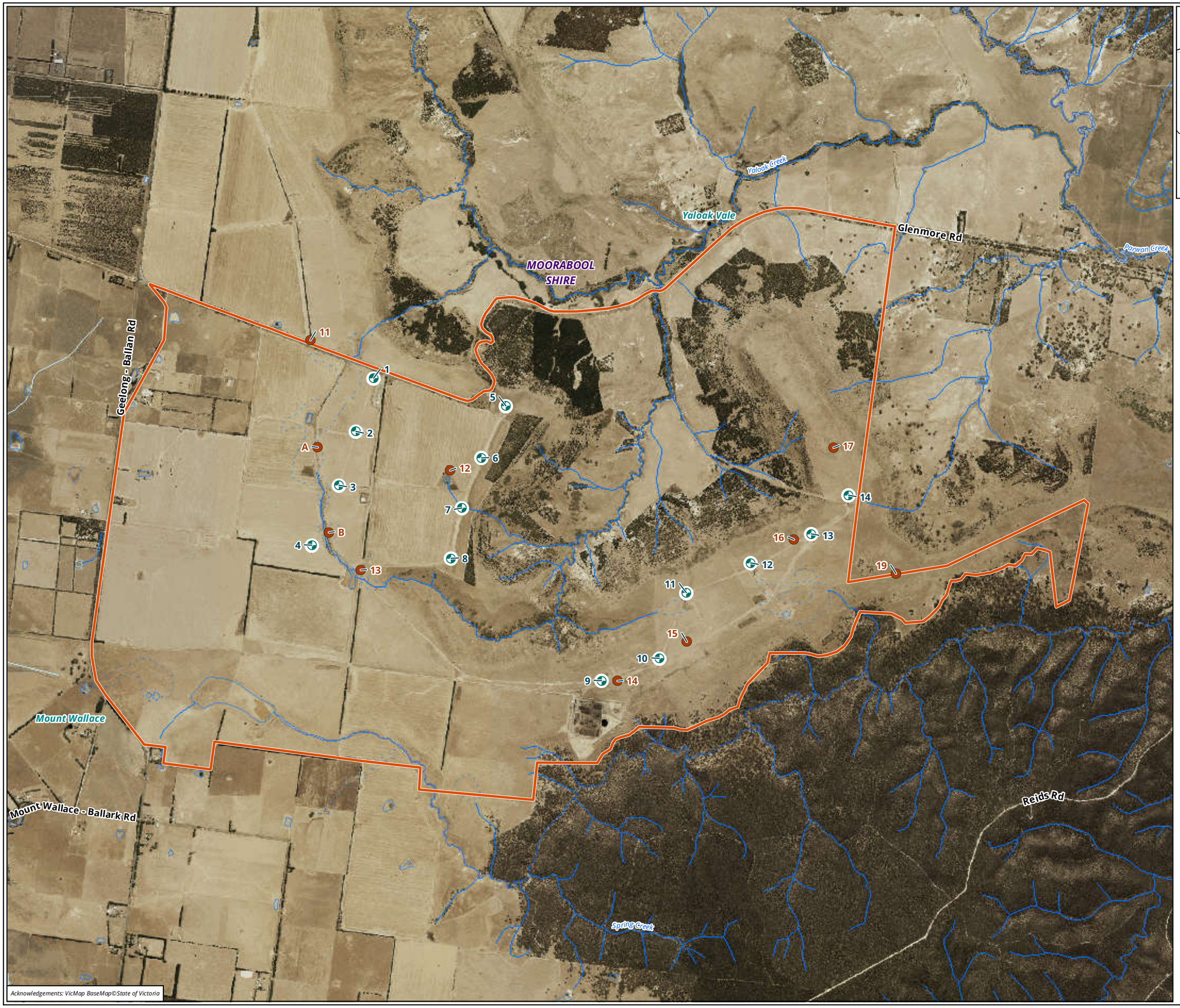
Flight paths of Wedge-tailed Eagles were also recorded, as this approach may improve understanding of trends in eagle activity over the landscape. The flight path was mapped from the first sighting of an individual eagle until it was no longer within sight. If multiple eagles were observed flying at the same time, whichever was sighted first was mapped.

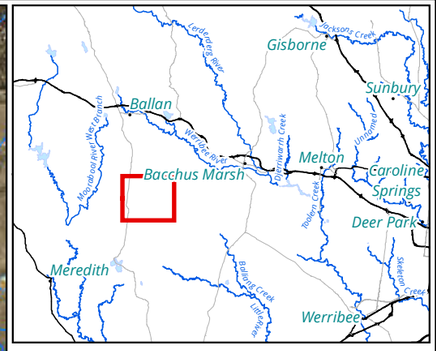
2.1.2 Monitoring locations

Ten monitoring points are positioned at different vantage points across and surrounding the YSWF site to best enable the greatest number of WTE occurrences to be documented. The locations of monitoring points are provided in Table 1 and Figure 2.

Table 1 Location of monitoring points.

Point code	Location description	Easting (GDA94) Zone 55	Northing (GDA94) Zone 55
11	Near turbine YS01	256374	5822287
12	Between turbines YS06 and YS07	257394	5821375
13	Between turbines YS04 and YS08	256769	5820647
14	Between turbines YS09 and YS10	258625	5819893
15	Between turbines YS10 and YS11	259115	5820185
16	Between turbines YS12 and YS13	259866	5820934
17	North of turbine YS14	260137	5821596
19	East of the wind farm	260603	5820706
A	Between turbines YS02 and YS03	256440	5821522
B	Between turbines YS03 and YS04	256534	5820914





Legend

- Survey point
- Turbine location
- Study area

Figure 2 Wedge-tailed Eagle monitoring points

0 250 500 750 1,000

Metres

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Scale: 1:25,000 @ A3

Coordinate System: GDA 1994 VICGRID94

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Matter: 30298,
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Acknowledgements: VicMap BaseMap©State of Victoria

2.1.3 Data analysis

Statistical analysis of pre-construction and post-construction WTE flight data was undertaken using the statistical software SPSS. Data conversions and test choices to determine significant changes in mean WTE flight activity are outlined below.

Data conversions

Prior to statistical analysis, raw flight data for both the pre- and post-construction phases were averaged in order to compare the two years of post-construction data to the one year of pre-construction data collected.

Normality

In statistics, normality tests are used to determine if a data set is well-modelled by a normal distribution and to guide whether the data should be assessed under a parametric test or non-parametric equivalent.

The difference in mean flight activity between the pre- and post-construction period was assessed for a normal distribution using both the Shapiro-Wilk and Kolmogorov-Smirnov normality tests. Results for both tests are provided in Table 2 below.

Table 2 Normality test results. Note that 'difference' stands for the difference calculated between the pre and post-construction mean WTE flight activity datasets.

Normality Test Results						
TEST parameter	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Difference	0.149	80.0	0.000	0.882	80.0	0.000

Wilcoxon Signed-rank Test

Results of the normality tests highlight that the differences recorded between the pre- and post-construction mean WTE flight activities do not follow a normal distribution (Table 2; $p < 0.05$). As the Wilcoxon signed-rank test does not assume normality in the data to be analysed, it was selected as the alternative to the parametric *t*-test to determine if significant differences in WTE flight activity have occurred as a result of the construction and operation of YSWF.

2.2 Wedge-Tailed Eagle breeding behaviour and success

The BAM Plan specifies a program of monitoring Wedge-tailed Eagle breeding activity by determining nest locations and monitoring activity and success, the primary measure of success being the number of juveniles fledged from nests.

2.2.1 Methods

Roaming surveys to locate and map the locations of Wedge-tailed Eagle nests were undertaken early in the breeding season on the 17, 18 and 19 September 2019, and within areas previously surveyed (BL&A 2007). The area searched included the wind farm site, Yaloak Estate, and accessible areas from within 5 kilometres of the wind farm.

Roaming surveys were conducted by two Zoologists using all accessible roads within and surrounding YSWF in suitable environs. Field methodologies to locate nests included:

- One Zoologist driving whilst the other scanned for nests using binoculars from the passenger seat.

- Walking along the ridge of one side of a valley and periodically searching in trees on the opposite side of the valley with binoculars and a spotting scope.

Once a nest was detected, observations from a prominent vantage point were made using a spotting scope from approximately 100 metres away in order to reduce disturbance. An observer watched the nest for approximately an hour and recorded observations of any activity of the nest and from adult eagles observed nearby to gain information on habitat use and possible locations of other nests. Nest activity was characterised as:

- Active, if it contained eggs, or if adult eagles were observed incubating (Cherriman 2013).
- Inactive, if the nest presented partial or total collapse (Cherriman 2013).
- Occupied, if it was lined with fresh leaves but contained no eggs/incubating adults (Cherriman 2013).
- Potential for occupation, if it presented a flat top (Wiersma and Koch 2012), the best characteristic for predicting nest activity outside of additional observations fresh chick, leaves, whitewash and prey remains.

Each nest located during searches, including those previously identified by BL&A (2007) and during Year 1 of monitoring, were observed a further four times through the rest of September until the end of October 2019. Any nest observed to be active was observed a further six times from November 2019 until January 2020 to determine if breeding was successful. Observations were made once a fortnight, as required by the BAM Plan.

2.2.2 Estimating reproductive and dispersal capacity

Objectives of the annual report are to assess whether Wedge-tailed Eagle nesting activity and success observed onsite and within the vicinity of YSWF differs substantially from results collected during the pre-construction period or from locations not in the vicinity of wind energy facilities.

Breeders are the individuals that contribute to future generations (Olsen 2005). We have attempted to estimate the mean area associated with each breeding territory (or breeding pairs) for the 2019 breeding season by calculating the density of active nests detected within Yaloak Estate and the YSWF site using nearest-neighbour methods (Foster, A & Wallis, R 2010; Cherriman 2013; Sharp, A, Norton, M, & Marks, A 2016). This method assumes the territory shape to be circular, and calculates the area of a circle with a radius equal to half the average distance between active nests (Foster, A & Wallis, R 2010).

To calculate the distance of active nests to other active nests, we used the ArcGIS Average Nearest Neighbour tool. This tool works by measuring the distance between each feature centroid and its nearest neighbour's centroid location, and then averaging these distances.

The reproductive success of Wedge-tailed Eagles is variable and can be measured in different ways (Olsen 2005). Failure can occur at any stage, but is generally considered to occur where pairs fail to lay or chicks are lost soon after hatching (Olsen 2005). For the purposes of estimating reproductive success and dispersal capacity for the 2019 breeding season, we considered the number of nests that were found to be lined and those in which eggs were laid, in order to measure the subsequent success of young that fledged (Cherriman 2013).

2.3 Assumptions and limitations

Assumptions and limitations relating to the Year 2 monitoring period are as follows:

- Mapping was conducted using hand-held GPS units. The accuracy of this mapping is therefore subject to the accuracy of the GPS units (generally +/- 5 metres) and dependent on the limitations of aerial photo rectification.
- There is a nine year interval between the pre-construction and Year One post-construction period. Biosis acknowledge it is difficult to determine the significance of results in the absence of several years of monitoring prior to construction of YSWF.
- In the pre-construction phase, no activity surveys were conducted during the months of February, April, May and June. As a consequence, these months have been excluded during statistical analysis.
- There is considerable variability in the number of surveys that were undertaken during each month of the pre-construction period. Pre and post-construction data has therefore been compared by calculating the mean number of flights recorded per survey for each month. For example, in August 2009 there were 7 surveys undertaken at site 11 with a total of 16 flights recorded. Therefore, the mean number of flights observed at site 11 in August 2009 was 2.3.
- No flight path data was recorded during the pre-construction period. As a result, it remains necessary to use the instantaneous record of the location where an eagle was first observed for comparisons of pre- and post-construction activity.
- Consistent with Sharp et al. (2016), estimates from our investigations should not be viewed as estimates of the local breeding capacity or population density, because:
  - The large tracts of land adjacent to Yaloak Estate and the YSWF site were not accounted for in our breeding density calculations as we were limited by accessible areas on private and public land within our 5 kilometre search area.
  - There is potential for some nests to be overlooked during ground-based searches due to the undulating terrain and the species preference for selecting nesting trees within these environments.
  - Nests are not necessarily in the centre of territories, thus unlikely to be an accurate reflection of breeding territory size (Olsen 2005).

3. Results

3.1 Temporal and spatial patterns of WTE occurrence within the study area

WTEs were observed in the study area across all months of the post-construction period, with flight observations typically highest in winter and spring (Figure 3).

Mean post-construction WTE flight activities were typically less frequent than pre-construction activities at the majority of monitoring locations (Figure 3). Despite declines, results of the non-parametric Wilcoxon Signed-rank Test found that the median difference in mean WTE flight activities at paired monitoring sites between the pre and post-construction monitoring periods is zero. This indicates that mean WTE flight activity recorded during the post-construction period (Year 1 and Year 2) was not significantly different to that of mean flight activity recorded during the pre-construction period (Z=1244.00, p=0.071).

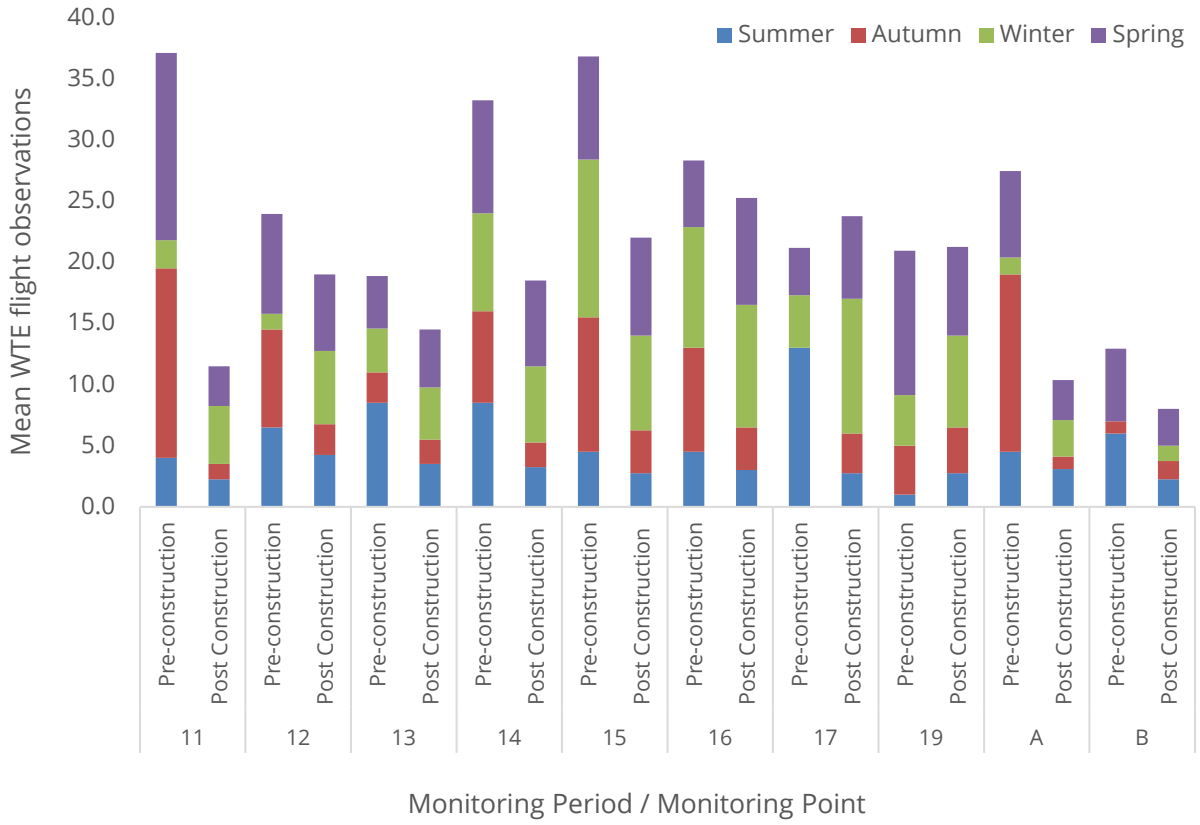


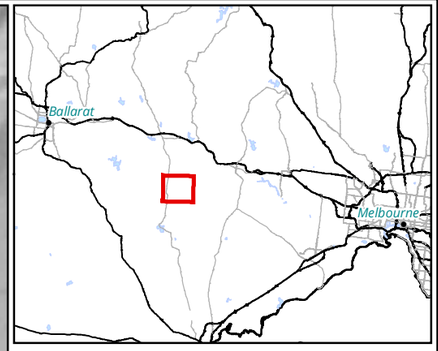
Figure 3 Comparison of pre-construction (2009-2010) and post-construction (Year 1: 2018-2019; Year 2: 2019-2020) mean WTE activity excluding data from February, April, May and June as per section 2.3.

Of the observations recorded, 29% of flights recorded during the post-construction period occurred within 500 metres of monitoring points in comparison to 48% of flights recorded during the pre-construction phase. These results indicate that the majority of WTEs are now being observed at greater distances from the turbines or along the edges of YSWF site.

Declines in WTE flight activity within the YSWF site during the post-construction phase may be attributed to one or more of the following:

- Increases in breeding activity within YSWF in Year 2 (see below section), resulting in an increase in territorial behaviour and exclusion of other WTEs over the breeding months.
- Reduction in the availability and abundance of prey from within the site (i.e. Eastern Grey Kangaroos), attributed to the construction of the 1.8 metre fence along the YSWFs southern boundary with the Brisbane Ranges National Park.
- Changes in surrounding land use and climate variability that have occurred during the nine year interval between the pre-construction phase and the Year 1 monitoring period.
- Active avoidance of wind turbines.

No defined directional or seasonal patterns have been observed during the post construction phase. However, most WTE individuals and convocations (groups) were observed near escarpments within YSWF and above the Brisbane Ranges National Park bordering the site to the south (Figure 4 – Figure 7). Such occurrences within these particular areas of the landscape are likely attributed to the regular occurrence of solar thermals, providing uplift and a harvestable supply of energy for movement.



Legend

- Turbine location
- Study area

Winter

- Year 1
- Year 2

Figure 4 Wedge-tailed Eagle flight activity in Winter

0 200 400 600 800 1,000

Metres

N

Scale: 1:25,000 @ A3

Coordinate System: GDA 1994 MGA Zone 55

Acknowledgements: VicMap Basemap©State of Victoria

Matter: 27507, Wedge-tailed Eagle flight activity
Date: 22 October 2020,
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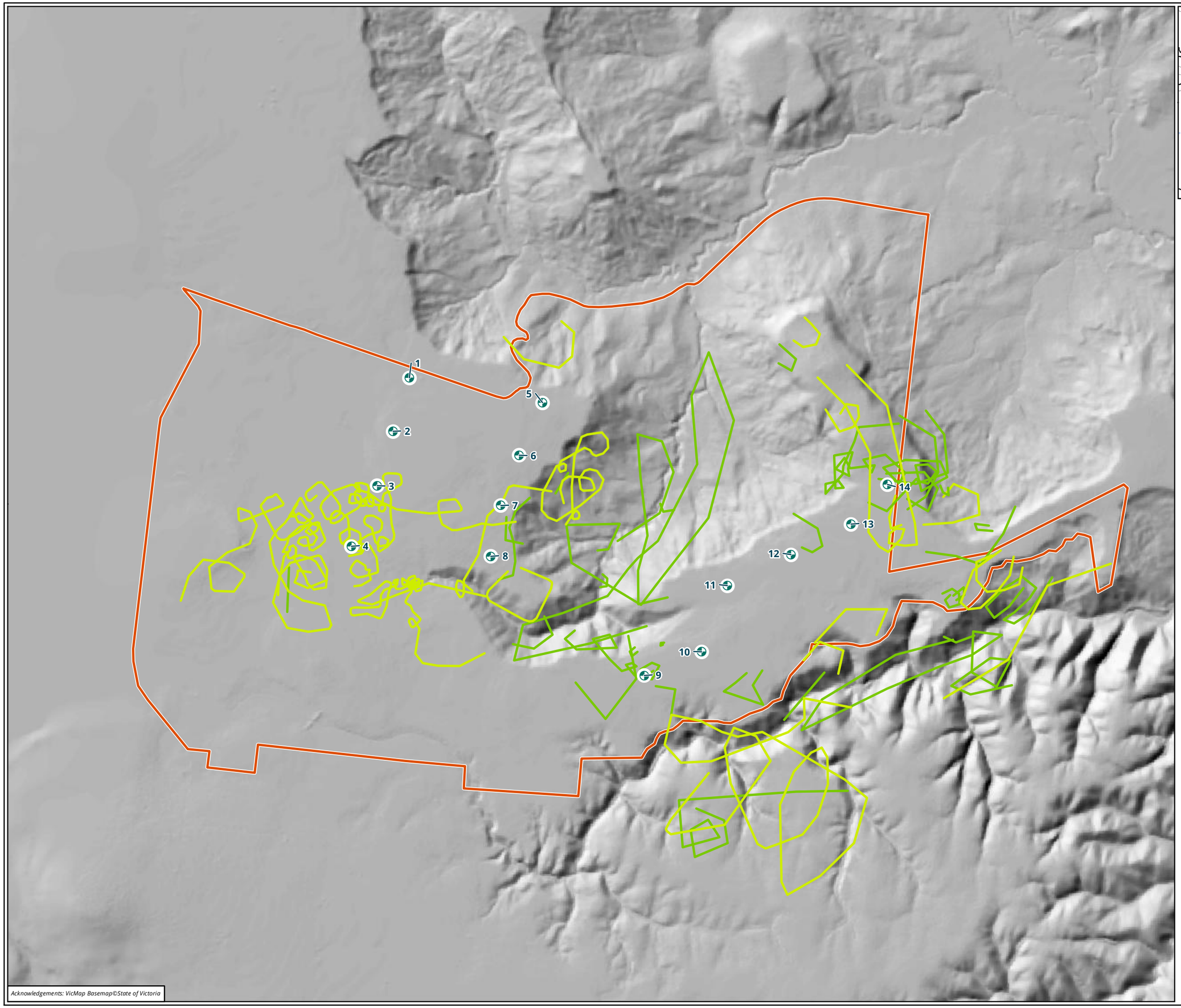

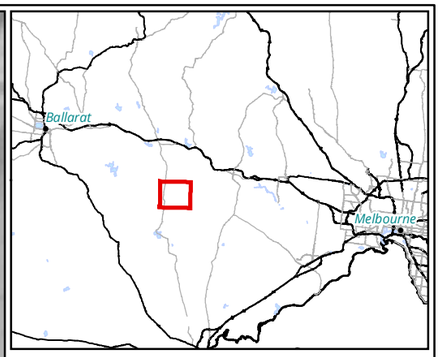

Legend

- Turbine location
- Study area

Spring

- Year 1
- Year 2

Figure 5 Wedge-tailed Eagle flight activity in Spring

0 200 400 600 800 1,000

Metres

N

Scale: 1:25,000 @ A3

Coordinate System: GDA 1994 MGA Zone 55

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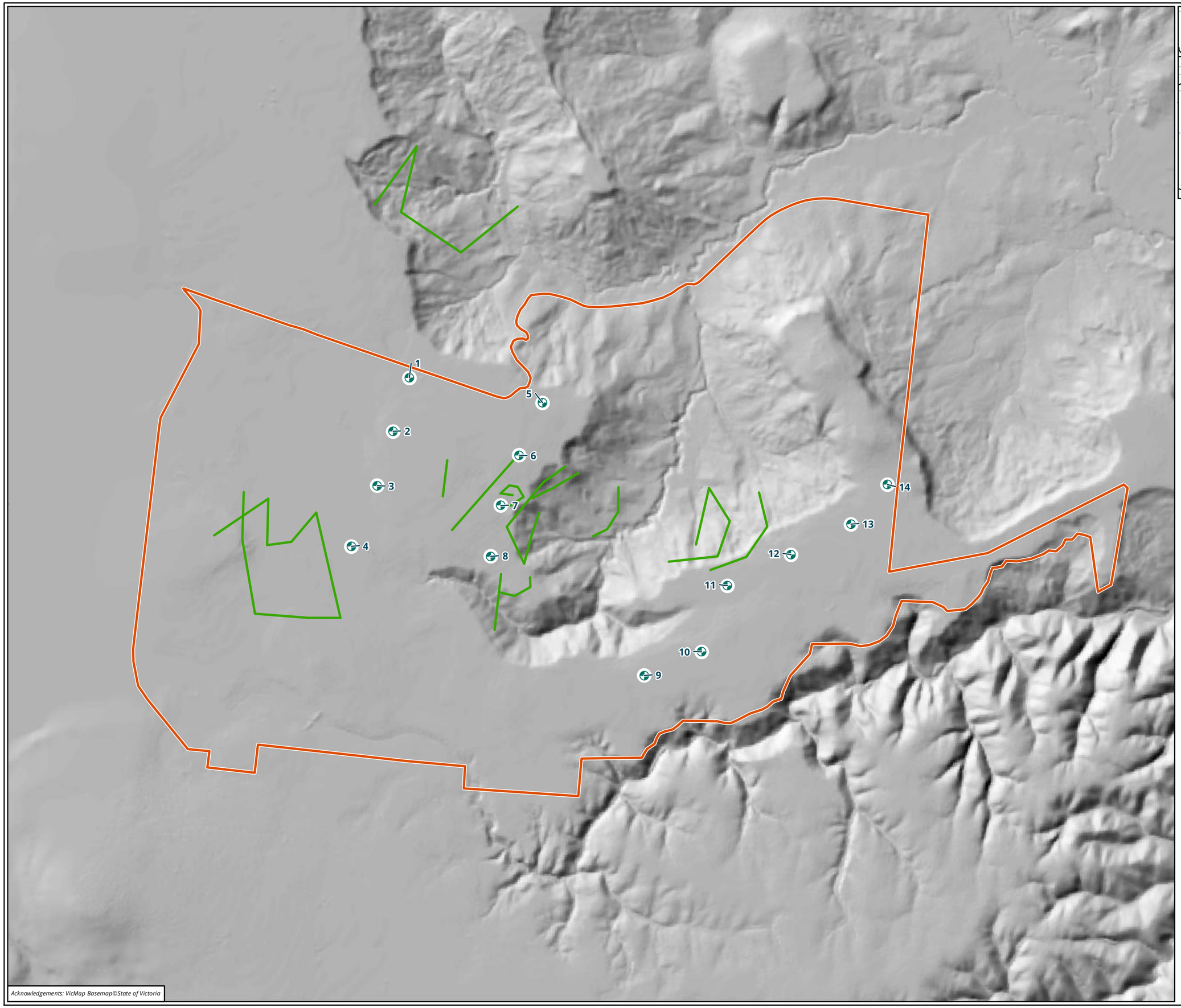

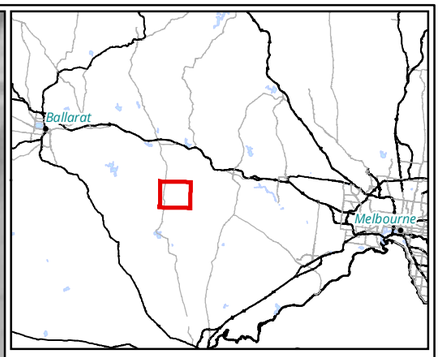

Legend

- Turbine location
- Study area

Summer

- Year 2

Figure 6 Wedge-tailed Eagle flight activity in Summer

0 200 400 600 800 1,000

Metres

N

Scale: 1:25,000 @ A3

Coordinate System: GDA 1994 MGA Zone 55

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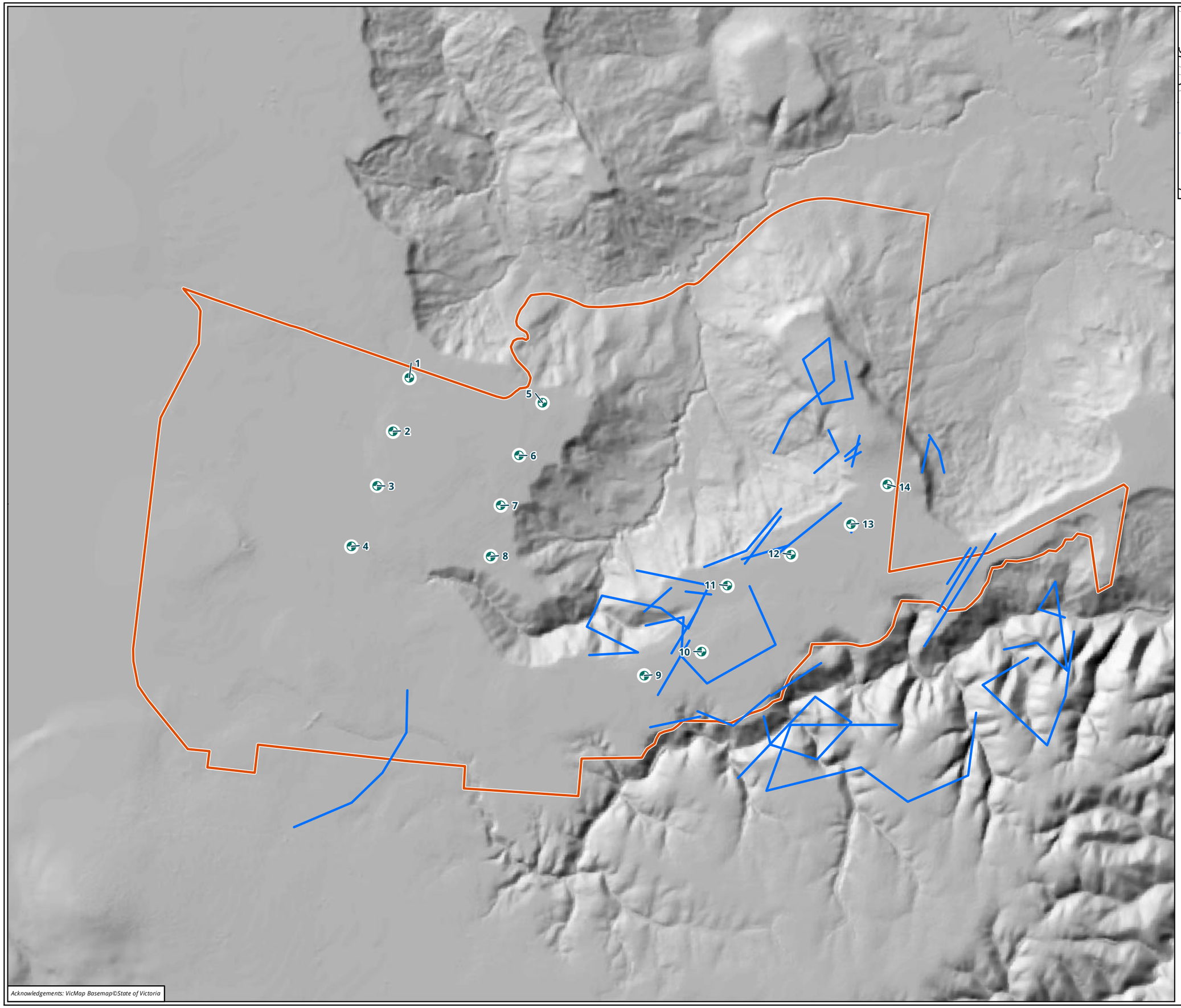

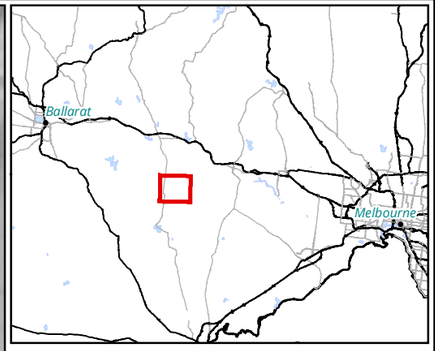

Legend

Turbine location

Study area

Autumn

Year 2

Figure 7 Wedge-tailed Eagle flight activity in Autumn

0 200 400 600 800 1,000

Metres

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Scale: 1:25,000 @ A3

Coordinate System: GDA 1994 MGA Zone 55

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Date: 22 October 2020,
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Consistent with Year 1 of post-construction monitoring, WTE flight activity observed within 500 metres of monitoring points has remained predominantly within rotor-swept height (33.75-126.25 metres) during the post construction period (Figure 8).

Figure 8 Comparison of pre-construction (2009-2010) and post-construction (Year 1: 2018-2019; Year 2: 2019-2020) mean WTE flight height within 500 metres of monitoring points (excluding data from February, April, May and June of as per section 2.3).

3.2 Wedge-tailed Eagle breeding behaviour and success

During spring 2019:

- One new Wedge-tailed Eagle nest was detected within the search area.
- 8 Wedge-tailed Eagle nests previously detected during surveys undertaken in 2006, 2009 and 2018 were re-visited during the 2019 roaming surveys.
- Three nests previously detected in 2006 and 2009 (Nest #7, Nest #8 and Nest #11) were unable to be detected during the 2019 searches, and may have completely degraded during the nine year interval since nest monitoring was last undertaken in 2009.

Of the 8 Wedge-tailed Eagle nests revisited:

- One was determined to be active, based on the observation of an incubating adult.
- Two were determined to be abandoned, based on the nest's partial or total collapse.
- Five were determined to have potential for occupation, based on the presence of a flat top (Wiersma, J & Koch, A 2012), the best characteristic for predicting occupation outside of additional observations of fresh leaves, whitewash and prey remains.

Fortnightly monitoring of both the active nest (Nest #4) and those determined to have potential for occupation (Nest #1-3, Nest #9-10) detected a further two active nests (Nest #3 and Nest#9). The locations and activity of the new nest and those previously re-visited during the 2019 breeding season are provided in Figure 9 and Table 3 below.

Table 3 2019 Wedge-tailed Eagle nest characteristics and activity

Nest No.	Year Detected	Tree species	2019 Activity	Year(s) Active	Distance to nearest active nest	Distance to nearest turbine	2019 Young Hatched	2019 Young Fledged
Nest #1	2006	*Eucalyptus* sp.	Occupied	-	73 m	525 m	-	-
Nest #2	2006	*Eucalyptus* sp.	Occupied	-	64	497 m	-	-
Nest #3	2006	*Eucalyptus* sp.	Active	-	2380 m	434 m	1	1
Nest #4	2006	Pine sp.	Active	2006, 2009	2380 m	530 m	1	1
Nest #5	2018	*Eucalyptus* sp.	Abandoned	-	3675 m	3860 m	-	-
Nest #6	2006	*Eucalyptus* sp.	Abandoned	2006, 2009	3154 m	4359 m	-	-
Nest #7	2006	NA	NA	-	NA	NA	-	-
Nest #8	2006	NA	NA	-	NA	NA	-	-
Nest #9	2019	*Eucalyptus* sp.	Active	-	8437 m	7553 m	1	Unknown
Nest #10	2006	*Eucalyptus* sp.	Occupied	-	3503 m	6504 m	-	-
Nest #11	2006	NA	NA	2006, 2009	NA	NA	-	-

Some nests with the potential for occupation (Nest #1 and #2) were found to be clustered around nests determined to be active (Nest #3), and thus are probably the alternative/disused nests of that pair (Silva and Croft 2007). The decent condition of Nest #10 suggests the presence of an additional occupied territory of a pair that may have not attempted to breed in 2019. Wedge-tailed Eagle nests detected within the search area

were also predominantly found in large emergent Eucalypts associated with slope habitat where they are sheltered from winds (Cherriman 2013).

One of the active nests was located in Yaloak Estate (Nest #9), approximately 8.4 kilometres north of the YSWF site. Monitoring of this nest and its single chick ceased in early December 2019 due to concerns from the managing landholder regarding its remote location and the property's increasing risk of fire during the summer months. It is therefore unknown whether this chick fledged successfully from its nest.

The two remaining active nests (Nest #3-4) were located within the YSWF site at a distance of 2380 metres apart and 400-500 metres from turbines (Table 3). These nests were monitored for activity between November 2019 and January 2020. Both nests were observed to contain a single chick that was recorded to have successfully fledged as of January 2020 (Plate 1 and Plate 2). In each case, juveniles of each nest were observed flying and/or perched within the site.

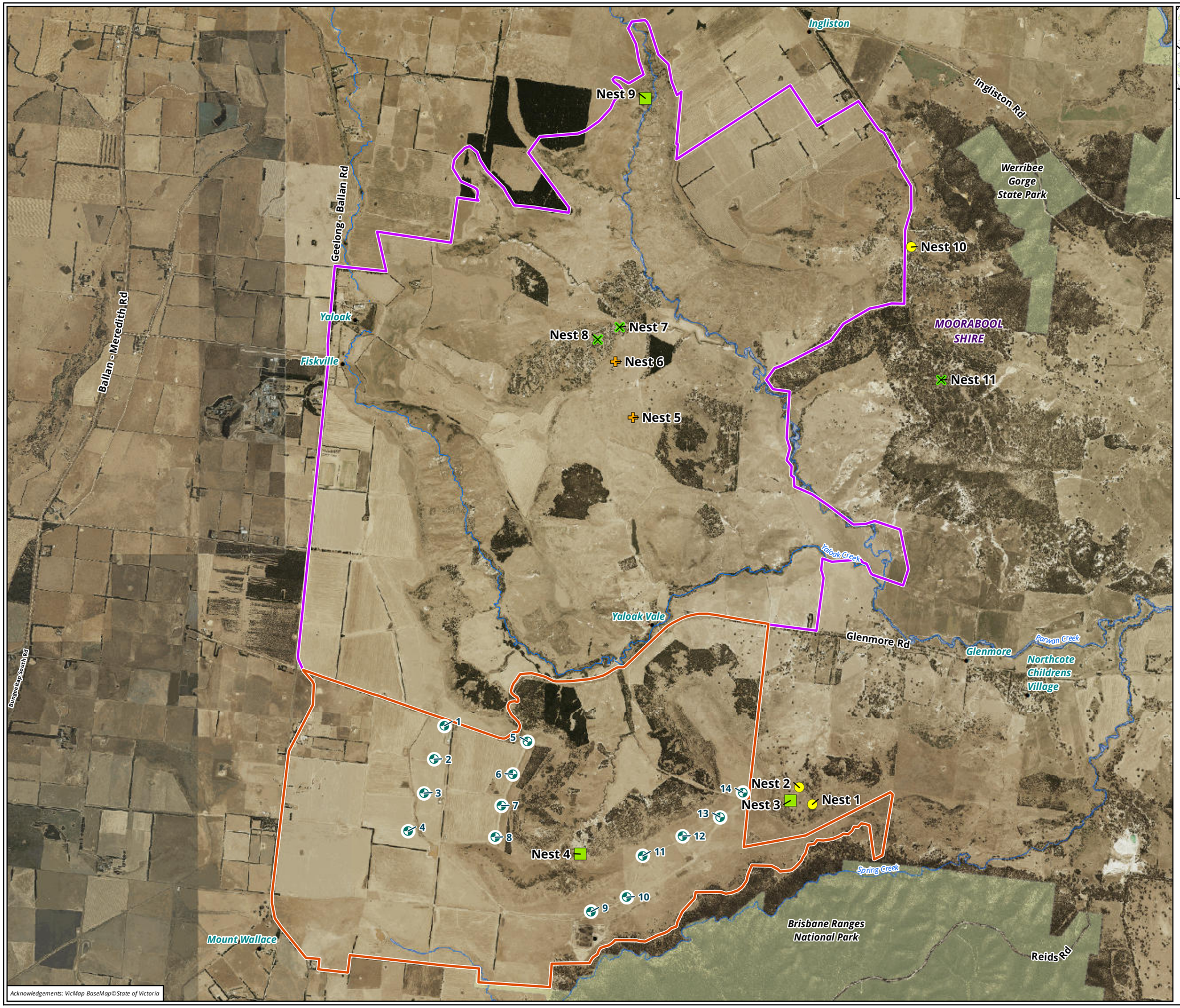
Breeding success, for nests where the outcome was known (*n*=2), averaged 1.0 for young fledged per attempt in which eggs were laid in 2019. This estimate for breeding productivity takes into account that no other nests were identified during winter 2019 that were found to have been lined (occupied) during monitoring and thus assumes that the number of nonbreeding pairs was not underestimated (Cherriman 2013). These results are higher than those recorded for pairs in recent studies in Perth, Western Australia (Cherriman 2013) and in Fleurieu Peninsula, South Australia (Rowe, Brinsley, & Dennis 2017), but consistent with that of the mainland population breeding average (Olsen 2005).

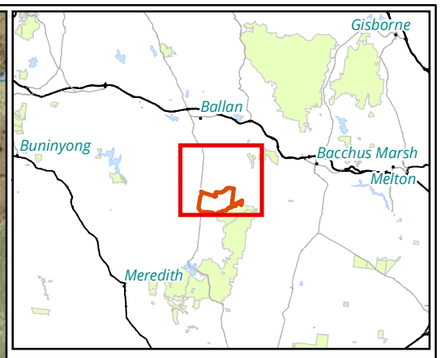
Whilst no active nests were detected during Year 1 of post-construction monitoring, the detection of three active nests during the 2019 breeding season is consistent with the detection of three active nests during pre-construction surveys undertaken in 2006 and 2009. The average distance between active nests during the 2019 breeding season was 4.4 kilometres (2.4-8.4 km, *n*=3), giving a calculated core breeding density of one pair per 15.21 square kilometres (4.52-55.41km^2). These nearest-neighbour distances are within range of results previously reported for Wedge-tailed Eagles near to Bacchus Marsh, where the average distance between active nests was found to be 4.7 kilometres (4-5.5 km, n = 5) and the core breeding territory size averaged 17.6 square kilometres (12.6-23.8 km^2).

Whilst there is an annual breeding season, it is common for reproductive rates to vary considerably between years, largely influenced by rainfall effecting the abundance and availability of prey species and/or age distribution of the population (Sharp, A, Norton, M, & Marks, A 2016). Annual rainfall was higher in 2019 (664mm) in comparison to 2018 (575mm), with the most significant differences noted during the months of May (148.6mm) and June (157.4mm) (Bureau of Meteorology 2020); which coincides with the beginning of the Wedge-tailed Eagle breeding season. These increases in rainfall at the beginning of the breeding season, may have triggered the nesting season observed in 2019.

Plate 1 **Photo taken on 28 October 2019 of chick sitting in Wedge-tailed Eagle Nest #4 (Figure 9). Direction of sunlight impacted on ability to take clear photo through the spotting scope.**

Plate 2 **Photo taken on 28 October 2019 of chick sitting in Wedge-tailed Eagle Nest #3 (Figure 9).**





Legend

Wedge-tailed Eagle nests

- Active nest
- Occupied
- Abandoned
- Could not locate
- Yaloak South Wind Farm
- Turbine location
- Yaloak Estate

Figure 9 Year 2 Wedge-tail Eagle nest Locations

0 410 820 1,230 1,640

Metres

N

Scale: 1:40,000 @ A3

Coordinate System: GDA 1994 MGA Zone 55

biosis

Matter: 30298,
Date: 22 October 2020,
Checked by: ERB, Drawn by: SKM, Last edited by: smitchell
Location: P:\30200s\30298\Mapping\30298_F9_WTE_monitoring.mxd

4. Discussion and conclusion

Mean post-construction WTE flight activities were typically less frequent than pre-construction activities at the majority of monitoring locations. However, consistent with previous iterations of monitoring, statistical comparisons found no significant differences in mean WTE flight activity between pre- and post-construction of YSWF following Year 2 of monitoring.

Estimations of the distances between the observer and WTEs were found to have increased during the post-construction period, indicating that the majority of WTEs are now being observed at greater distances from the turbines or along the edges of the site. Observational declines of WTEs from directly within YSWF may be explained by one or more of the following:

- An increase in breeding activity within the site increasing territorial behaviour during Year 2.
- A reduction in resource availability due to the construction of the kangaroo exclusion fence along YSWFs southern boundary with the Brisbane Ranges National Park.
- Changes in surrounding land use and climate variability that have occurred during the nine year interval between pre and post construction monitoring.
- Active avoidance of wind turbines.

Whilst no defined directional or seasonal patterns have been observed during the post-construction phase, most WTE individuals and convocations were typically observed soaring near escarpments within YSWF and above the Brisbane Ranges National Park, where they are likely to rely on solar thermals for uplift.

Flight heights of WTEs observed within 500 metres of monitoring points remain predominantly within rotor-swept height (33.75-126.25 metres) and consistent with trends observed during the pre-construction period. No trends in WTE flight height behaviours observed during the post-construction monitoring phase (Year 1 and 2) may therefore be attributed to the construction and operation of YSWF.

Whilst no active nests were detected during Year 1 of post-construction monitoring, the detection of three active nests during the 2019 breeding season is consistent with the detection of three active nests during pre-construction surveys undertaken in 2006 and 2009. The average distance between active nests during the 2019 breeding season was 4.4 kilometres (2.4-8.4 km, *n*=3), giving a calculated core breeding density of one pair per 15.21 square kilometres (4.52-55.41km^2). These nearest-neighbour distances are within range of results previously reported for Wedge-tailed Eagles near to Bacchus Marsh, where the average distance between active nests was found to be 4.7 kilometres (4-5.5 km, n = 5) and the core breeding territory size averaged 17.6 square kilometres (12.6-23.8 km^2).

The two active nests within the YSWF site were located 400-500 metres from turbines. The proximity of active nests to turbines, comparable nest activity results to the pre-construction period and similar breeding densities to Bacchus Marsh suggest that turbine presence is not a deterrent for nesting birds.

Whilst there is an annual breeding season, it is common for reproductive rates to vary considerably between years, largely influenced by rainfall effecting the abundance and availability of prey species and/or age distribution of the population (Foster, A & Wallis, R 2010; Sharp, A, Norton, M, & Marks, A 2016). Annual rainfall was higher in 2019 (664mm) in comparison to 2018 (575mm), with the most significant differences noted during the months of May (148.6mm) and June (157.4mm) (Bureau of Meteorology 2020); which coincides with the beginning of the Wedge-tailed Eagle breeding season. These increases in rainfall at the beginning of the breeding season, may have triggered the increase is nesting observed in 2019 in comparison to 2018.

The BAM Plan sets the reasonable measure of breeding success as approximately one fledgling per nest in which eggs are laid. Breeding success, for nests where the outcome was known (*n*=2), averaged 1.0 for young fledged per attempt in which eggs were laid in 2019. This estimate for breeding productivity takes into account that no other nests were identified during winter 2019 that were found to have been lined during monitoring and thus assumes that the number of nonbreeding pairs was not underestimated (Cherriman 2013). Nest activity recorded during the 2019 breeding season therefore meets the standard for breeding success outlined in the BAM Plan.

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