MT FYANS
WIND FARM

APPENDIX H

BROLGA REPORT

BIOSIS

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biosis

Mount Fyans Wind Farm: Brolga Assessment

FINAL REPORT

Prepared for Hydro Tasmania

29 July 2022

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Contents

Summary ..... **V**

1 Introduction **1**

1.1 Project background 1

1.2 Scope of assessment 2

1.3 Location of the study area 2

2 Methods **5**

2.1 Literature and database review 5

2.2 Brolga aerial surveys 6

2.2.1 Aerial surveys - 2009 6

2.2.2 Aerial surveys - 2014 7

2.2.3 Aerial surveys - 2019 7

2.3 Home range analysis 7

2.4 Landowner survey 8

2.5 Additional flocking habitat assessment 8

2.5.1 Flocking survey of Lake Sheepwash 8

2.5.2 Review of potential flocking sites 8

2.6 Additional breeding habitat assessment 9

2.7 Permits 9

2.8 Legislation and policy 10

2.9 Mapping 10

3 Results **11**

3.1 Database review 11

3.1.1 Victorian Biodiversity Atlas (VBA) 11

3.1.2 BirdLife Australia – New Atlas of Australian Birds 17

3.1.3 Southwest Victorian Brolga Flocking Site Database (BFD) 18

3.2 Brolga aerial survey 38

3.2.1 Aerial surveys - 2009 38

3.2.2 Aerial surveys - 2014 38

3.2.3 Aerial surveys - 2019 39

3.3 Brolga home range survey 43

3.3.1 Mount Fyans 43

3.3.2 Penshurst 44

3.4 Home range analysis 46

3.5 Landowner survey 46

3.6 Additional flocking habitat assessment 47

3.6.1 Flocking survey at Lake Sheepwash 47

3.6.2 Review of potential flocking sites ... 47
3.7 Additional breeding habitat assessment ... 48
3.8 Brolga records at a regional scale ... 48
3.9 Cumulative impacts of wind energy developments ... 49
4 Biodiversity Legislation and Government Policy ... 52
4.1 Flora and Fauna Guarantee Act 1988 (FFG Act) ... 52
4.2 Planning and Environment Act 1987 (incl. Planning Schemes) ... 52
4.3 Environment Effects Act 1978 ... 53
4.4 Brolga Guidelines (2012) ... 53
5 Brolga breeding and flocking site constraints ... 55
5.1 Breeding sites ... 55
5.1.1 Turbine-free breeding site buffers ... 56
5.2 Flocking sites ... 56
5.2.1 Turbine-free flocking site buffers ... 57
6 Collision risk and potential offset measures for Brolgas ... 59
Conclusion ... 62
References ... 63
Appendices ... 65

List of Figures

Figure 1 Location of the proposed Mount Fyans wind farm study area ... 4
Figure 2 Historical and database records of Brolga within 10 km of the study area ... 19
Figure 3 Mount Fyans Brolga aerial survey results ... 40
Figure 4 Mount Fyans Brolga home range survey results ... 45
Figure 5 Mount Fyans landowner Brolga survey results ... 50
Figure 6 Cumulative Brolga records for south-west Victoria ... 51
Figure 7 Mount Fyans wind farm consolidated Brolga records and turbine free buffer zones ... 58

Summary

Biosis Pty Ltd was commissioned by Hydro Tasmania to undertake survey and assessment of Brolgas in relation to the proposed Mount Fyans wind farm. The study area is located near the township of Mortlake, approximately 200 kilometres west of Melbourne.

The objective of the study is to identify all potential Brolga breeding and flocking habitats within and adjacent to the proposed wind farm and to then determine any current sites with potential to be impacted by the proposed wind farm. To mitigate potential impacts, appropriate turbine-free buffers will be applied to these sites in accordance with the *Interim Guidelines for the Assessment, Avoidance, Mitigation and Offsetting of Potential Wind Farm Impacts on the Victorian Brolga Population* (*Brolga Guidelines*) (DSE 2012).

The current report includes a comprehensive assessment of Brolgas for the proposed wind farm site from 2009 through to 2019, in accordance with the *Brolga Guidelines* (DSE 2012). The assessment incorporates information on Brolgas from a range of sources, including databases searches, a landowner survey questionnaire, potential Brolga habitat assessment, and survey for Brolgas from the local area. The Brolga investigations also included aerial surveys to locate breeding sites, an analysis of home ranges of breeding pairs, and confirmation of a flocking site at Lake Sheepwash.

The aerial surveys and analysis of several sources of data provides numerous records of Brolgas utilising sites both within and adjacent to the Mount Fyans wind farm study area. By undertaking further analysis of records and assigning turbine free-buffers to breeding and flocking sites, we were able to identify areas of constraint for the proposed Mount Fyans wind energy facility which will enable its design to comply with the *Brolga Guidelines* (DSE 2012).

1 Introduction

1.1 Project background

Biosis Pty Ltd was commissioned in early 2009 by Hydro Tasmania (then Roaring 40's Renewable Energy) to undertake a preliminary desktop assessment in relation to the proposed Mount Fyans wind farm (Biosis 2009), which identified the potential use of the landscape by Brolgas *Grus rubicunda*. In late 2009 Biosis undertook field surveys for Brolgas in relation to the proposed Mount Fyans wind farm. This assessment occurred prior to a number of other flora and fauna assessments of the site (Biosis 2018). Additional surveys were undertaken in 2010, 2013, 2014, 2017, 2018 and 2019 in an attempt to determine the breeding status of Brolgas within the Mount Fyans wind farm study area over time.

The region surrounding the proposed Mount Fyans wind farm is known to support breeding and flocking habitat for Brolgas. The species is listed as threatened under the *Flora and Fauna Guarantee Act* 1988 (FFG) and as and Vulnerable on the *Advisory List of Threatened Vertebrate Fauna in Victoria* (DSE 2013). Several large wetlands and many ephemeral wetlands exist in the local area and there are historical and recent records of the species flocking and breeding at these locations. Regular records of larger numbers of Brolgas are mostly from more permanent wetlands during Brolga flocking seasons, while the number of records of breeding birds appears to be related to ephemeral wetlands that are preferred breeding habitats.

A well-known flocking site occurs at and adjacent to Lake Barnie Bolac (also described as Lake Barnie Buloke), with birds known to utilise resources in the surrounding landscape during the flocking season. Throughout the course of our assessment we have confirmed the use of another site to the north of Lake Barnie Bolac, Lake Sheepwash, as a flocking site.

Examination of database records and discussion with landowners confirms that Brolgas have bred repeatedly in the local area and it is likely that many of these are pairs returning annually to traditional sites. While relatively few records of Brolgas occur within the Mount Fyans wind farm study area, the preliminary assessment identified that, under ideal conditions, there is likely to be an abundance of suitable freshwater marsh breeding habitat in the local area (within 10 kilometres of the study area).

Databases contain records of historical observations of Brolgas from the region. These provide a basis for understanding how the species has utilised the area in past years. In addition to examining historical records of Brolgas from the local area on various databases, additional information was sought via a landowner questionnaire. This provided useful information on sightings of Brolgas on their properties, as well as on the current condition of historically suitable habitat features such as wetlands, and how these have altered over the years.

1.2 Scope of assessment

The objectives of this investigation are to:

- Review Brolga records from relevant databases and other primary sources.
- Report on the results of the landowner survey undertaken by Hydro Tasmania.
- Report on the results of aerial surveys and home range analyses undertaken at Mount Fyans and as part of the proposed Penshurst Wind Farm assessment.
- Report on the results of follow-up aerial surveys for the Mount Fyans study area.
- Identify breeding and flocking sites with potential to be impacted by the proposed wind farm, in accordance with the *Interim Guidelines for the Assessment, Avoidance, Mitigation and Offsetting of Potential Wind Farm Impacts on the Victorian Brolga Population* (*Brolga Guidelines*) (DSE 2012).
- Provide a consolidated map of validated breeding and flocking records relevant to the study area.

1.3 Location of the study area

The study area is located near the township of Mortlake, approximately 200 kilometres west of Melbourne (Figure 1). The study area is approximately 12,625 hectares in area. It is bordered to the south by the Hamilton Highway, to the north by Woorndoo-Dundonnell Road, to the east by Six Mile Lane and Darlington-Nerrin Road and to the west by the Hamilton Highway and Salt Creek. The section of the site between the Mortlake-Ararat Road and Salt Creek was not formally part of the study area in 2009 and hence it was not assessed during the 2009 Brolga survey. Nonetheless, it was included within the 3 kilometre buffer that was flown during the aerial survey in 2014.

The study area is within the Victorian Volcanic Plain Bioregion, and the surface geology is the result of quaternary basalt flows, with small areas of more recent alluvial sediments (derived from basalt) around lakes and waterways. The most recent basalt flows have formed a complex of stony rises, interspersed with low-lying areas and wetlands particularly in the northern section of the study area. Older basalt flows have weathered to a more undulating or flat landscape.

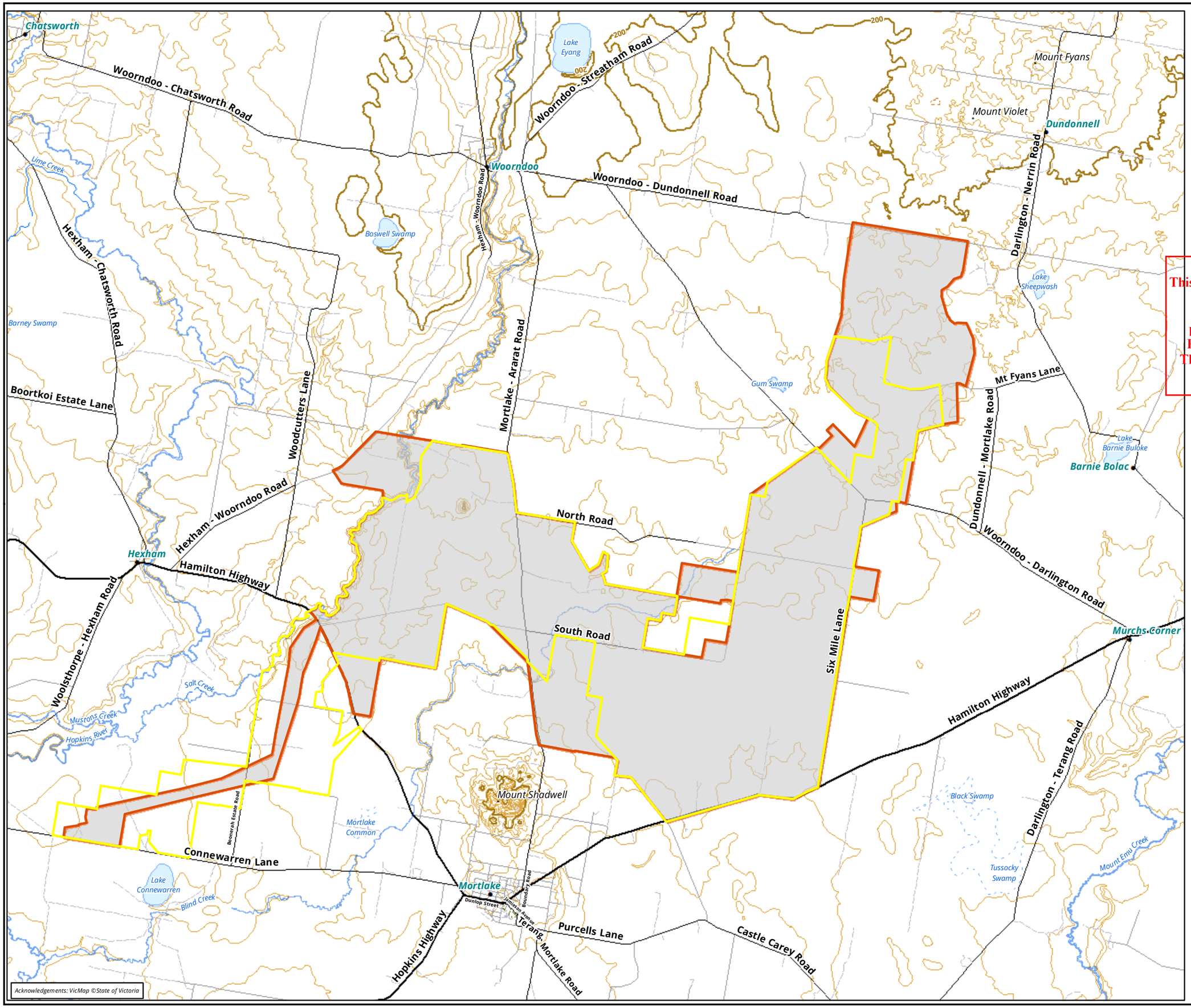
Most of the study area has been cleared of native vegetation and is currently managed for grazing and cropping. Nonetheless, remnant areas still persist within the stony rises, in low-lying areas and associated with depressions and drainage lines. Several roadsides within the area are known to support high-value native grasslands. Very few remnant native trees are present within the main wind farm area (Biosis 2018).

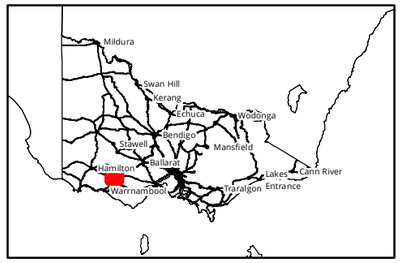
The project boundary includes indicative wind turbine locations, access roads, construction compounds, substations, internal access tracks, underground cables, met masts and works exclusion areas (Figure 2). The project boundary also includes the proposed corridor for a power transmission to connect the wind farm to the electricity grid. This extends from the south-western edge of the wind farm, through an area supporting open River Red-gum woodland and a commercial Blue Gum plantation before terminating at the Mortlake Power Station. The bulk of the transmission line corridor was not assessed as part of 2009 Brolga aerial survey as it was not part of the study area in 2009.

The study area includes the upper reaches of Blind Creek, a number of unnamed tributaries of Stony Creek and Mount Emu Creek, part of Lake Sheepwash and a number of other wetlands and farm dams.

The study area is within the:

- Victorian Volcanic Plain Bioregion
- Hopkins River Basin
- Management area of the Glenelg Hopkins CMA
- Moyne Shire Local Government Area.





Legend

- Study area
- Project boundary

ADVERTISED PLAN

Figure 1 Location of the Mt Fyans Wind Farm study area

0 1 2 3 4 5 Kilometers

N

Scale: 1:100,000 @ A3

Coordinate System: GDA 1994 MGA Zone 54

biosis

Matter: 35163,
Date: 15 February 2022,
Checked by: MV/MSG/KS, Drawn by: SKM, Last edited by: smitchell
Location:P:\35100s\35163\Mapping\35163_21630_F1_Locality

2 Methods

2.1 Literature and database review

A review of historical records of Brolgas within a 10 kilometre radius of the proposed wind farm site was undertaken. The following databases were reviewed:

- The State of Victoria Department of Environment, Land, Water and Planning (DELWP) Victorian Biodiversity Atlas 'VBA_FAUNA25, FAUNA100 & FAUNA Restricted' datasets (downloaded from the VBA on 1 March 2021).
- Southwest Victorian Brolga Flocking Site Database (Ballarat University).
- BirdLife Australia, the New Atlas of Australian Birds (BA Atlas 2012).

A review of each of the database's verification process was undertaken to better understand the level of reliability and accuracy of all records. The records from these sources were collated and examined to remove any duplicates, and to determine/verify those that are considered to be breeding records and those that are considered to be flocking records.

The data from the BA Atlas was included in 2012. From that time, it is our understanding that all BirdLife Australia data (now referred to as Birdata) is incorporated into the VBA. Therefore, from 2012 all Brolga records were obtained from the VBA.

The determination of breeding and flocking records is made in accordance with the definitions specified in the *Brolga Guidelines* (DSE 2012).

Other sources of biodiversity information included:

- Biosis records that are not yet on the VBA.
- Incidental records provided by landowners from the local area.

The following reports were reviewed as part of the assessment:

- *Mount Fyans Wind Farm Due Diligence Ecological Assessment. Report for Roaring 40s Renewable Energy* (Biosis Research 2009).
- *Penshurst Wind Farm: Targeted fauna assessment. Report for RES Australia* (Biosis Research 2011).
- *Mount Fyans Wind Farm: Flora and fauna existing conditions* (Biosis 2021a).
- *Mount Fyans Wind Farm: Targeted surveys and impact assessment* (Biosis 2021b).
- *Brolga Home Ranges: Mount Fyans and Penshurst Combined Sets* (Symbolix 2010).
- *Mount Fyans Wind Farm Brolga Landowner Survey – Summary Report (Hydro Tasmania 2014).*
- *Interim guidelines for the assessment, avoidance, mitigation and offsetting of potential wind farm impacts on the Victorian Brolga population 2011* (DSE 2012) (*Brolga Guidelines*).

The Brolga Recovery Group is a community special interest group operating under the auspices of Birdlife Australia: Ballarat. The Brolga Recovery Group was first contacted in November 2013 to ask if they were able to provide any additional records of Brolga from with 10 kilometres of the study area. Several follow-up requests for data were made between November 2013 and April 2014, however, no additional data has been received to date.

Discussions were held with a number of people who are recorded as observers in the VBA database. Many of these were State Government employed scientists who had conducted research over a long period of time. Brolga data was shared with the ecologists undertaking surveys for the Dundonnell Wind Farm project, undertaken by Brett Lane and Associates (BLA). Staff from BLA provided information on discrepancies between VBA records that were attributed to BLA and records from other sources.

2.2 Brolga aerial surveys

2.2.1 Aerial surveys - 2009

During preliminary investigations in 2009 and in conjunction with survey work on Brolgas in the nearby Penshurst area, discussions were held with Biodiversity Officers for the former Department of Sustainability and Environment (DSE) (now DELWP) to investigate the most appropriate method of assessing Brolgas across broad study areas. It was apparent that rainfall in August/September 2009 had caused many ephemeral wetlands to fill and provide suitable breeding habitat for waterbirds including Brolgas. Due to the large and inaccessible nature of the Penshurst and Mount Fyans study areas it was decided that the most appropriate and rigorous method to assess Brolga occurrence was by means of aerial survey. This included flying over both study areas and out to a buffer of at least a further 3 kilometres.

On 3 and 4 November 2009 a Cessna 172 over-wing airplane was used to fly east-west/west-east transects across the Mount Fyans study area and the 3 kilometre buffer (NB: An earlier aerial survey for the Penshurst site was undertaken on 19-20 October 2009, which included observations for the Mount Fyans study area). Transects were spaced 500 metres apart from north to south. Flight speed was kept as slow as possible at 60-70 knots, while altitude was also kept as low as safely possible at 500 ft. The plane followed pre-determined transects loaded into its on-board GPS system. Two observers were used, one on the front right side, the other on the rear left side. Visual observations were recorded on paper and GPS coordinates taken for clearly identifiable landmark(s). A written description was made of the direction and distance from the landmark to the point of interest. This method required quick response from the observer to obtain as accurate a location as possible. Binoculars (10 x 42) were also used to aid in identification. As required, the aircraft broke from its transect route and circled to permit additional observations prior to resuming transect flight.

Over two subsequent days, one observer working on the ground, attempted to reach and observe as many wetlands as possible from the road network between the 3 kilometre study area survey buffer and the 10 kilometre study area database search buffer. The aerial survey method is the subject of a paper (Veltheim and Venosta in prep) and was used as the basis of the aerial survey method prescribed by DSE (2012).

After reviewing the results of the Penshurst aerial survey further discussion was held with DELWP on 26 October 2009 to propose methods to satisfy the requirements of the *Draft Guidelines for the Assessment of Potential Windfarm Impacts on the Brolga* (DSE 2009) (now the *Interim Guidelines for the Assessment, Avoidance, Mitigation and Offsetting of Potential Wind Farm Impacts on the Victorian Brolga Population* (DSE 2012)). No previous investigation of home ranges used by breeding Brolgas in Victoria had been made at that time. As the Penshurst (and subsequently Mount Fyans) study area was identified as supporting a number of breeding pairs of Brolgas it was decided that a home range analysis would be required to determine the area utilised by pairs of Brolgas involved in successful breeding attempts. Individual breeding sites were expected to differ in the resources they offer to pairs of Brolgas and the requirements of a given breeding pair were also expected to vary through the course of a breeding event from nest-building through to fledging of chicks. For these reasons the study design included establishing home ranges for a representative number of pairs at different

sites and throughout the breeding season to encompass the range of movements expected to occur and that would define the birds' breeding home-ranges. The sizes of home ranges would then be used to inform appropriate turbine-free buffer zones designed to achieve a zero net impact on the Victorian population.

After discussion with DELWP, RES Australia and Roaring 40's Renewable Energy it was decided to share home range data collected across the two wind farm sites to achieve a larger and more robust sample size.

2.2.2 Aerial surveys - 2014

On 8 and 9 October 2014, additional aerial surveys of the Mount Fyans study area were undertaken to provide further data on Brolga breeding pairs within and adjacent to the site. The methods used were consistent with the methods for the 2009 surveys, as outlined above (Section 2.2.1). The purpose of these aerial surveys was to re-confirm previously known breeding sites and identify any new breeding pairs within the study area.

2.2.3 Aerial surveys - 2019

For the purpose of again re-confirming previously known breeding sites and to identify any new Brolga breeding pairs within the study area, aerial surveys of the Mount Fyans study area were undertaken on 30 and 31 October 2109. The methods used remained consistent with the 2009 survey methods as outlined above (Section 2.2.1).

2.3 Home range analysis

Biosis engaged Symbolix to assist with study design and analytical methods. The method used for home range kernel analysis is described in Symbolix (2010a), while the method employed to determine stability of the measurements to increased survey effort (asymptote analysis) is described in Symbolix (2010b). These reports are provided at Appendix 1.

To carry out the home range surveys initially two, and subsequently one, observer visited each breeding Brolga pair at the two study sites as many times as possible from dawn to dusk leaving at least 2 hours between sequential observations to ensure independence of behaviours between one visit and the next. At Penshurst these observations were carried out from 30 November – 4 December 2009, 21 – 24 December 2009, 11 – 15 January 2010 and 18 – 20 January 2010. At Mount Fyans the observations were carried out from 14 – 18 December 2009, 21 – 24 December 2009, 4 – 8 January 2010, 18 – 22 January 2010, 1 – 6 February 2010 and 15 – 18 February 2010. Opportunistic observations of the locations of Brolgas were also noted when moving through the study area during other targeted species surveys throughout October 2009 – March 2010. At Mount Fyans, these opportunistic observations occurred before the home range surveys and were incorporated into the home range analysis. Where a Brolga pair was observed before the study period, follow up observations were carried out at opportunistic times to monitor the pair (e.g. on 12 November 2009 and 3 December 2009).

The data collection method used included visual observation to locate the breeding pair. This location was marked onto a high resolution aerial image by hand and the number of individuals and time of the observation was noted along with a description of the bird(s) behaviour. The location records were considered to be accurate to within metres, particularly once the observer was familiar with the area around the evolving home range. For most pairs, observation was taken by driving through the surrounding area to locate the birds, either within the individual property or from roadsides where these were close enough to observe the birds. Once birds were located the observer then moved out of view as quickly as possible to avoid disturbance or other influence of the

bird(s) behaviour. If the birds were unable to be located at a known breeding site within two hours the search was abandoned and noted as such.

For home range analysis the location data was digitised in the office by hand using digital images of the same aerial imagery used in the field. The observer that gathered the data in the field also entered the digital location, again noting the number of individuals, time and any behaviour described.

Where enough data was collected to describe a stable home range (pairs 1, 2 and 4 at Penshurst and pairs 6, 8, 17 and 19 at Mount Fyans) kernel analysis was undertaken as described in Symbolix (2010a). This data was then used to describe the home range and inform the turbine free buffering process. For failed pairs and previous sites with breeding recorded, Symbolix (2010a) developed the radius of containment approach. This provides a statistical probability, based on previous records for that pair collected during the study that the birds are within a certain radius. This home range analysis and radius of containment principle was independently reviewed by a DELWP biometrics expert at the Arthur Rylah Institute for Environmental Research and DELWP Brolga Biodiversity Officers. After receiving support for this methodology and analysis, Biosis, RES, Roaring 40's Renewable Energy and DELWP met on 26 March 2010 to formulate appropriate turbine free buffers based on the data analysis carried out to that time. Biodiversity Officers at DELWP have subsequently reconfirmed the suitability of the home range assessment methodology on April 2019.

2.4 Landowner survey

Hydro Tasmania, with assistance from Entura and Biosis, conducted a survey of landowners within a 5 kilometre radius of the study area. The survey involved contacting landowners by telephone and conducting six site visits to 42 landowners between 2 May 2013 and 20 March 2014. Further details of the landowner survey are provided in Hydro Tasmania (2014), Appendix 2.

2.5 Additional flocking habitat assessment

2.5.1 Flocking survey of Lake Sheepwash

During the course of our assessments for Mount Fyans it was suggested by DELWP that a dam in the north-east of the study area might be a flocking site. A retired DELWP biologist had made observations of numbers of Brolgas using the site in the past, although these records do not appear in the VBA. The landowner stated that the dam wall had collapsed after heavy rains and that it was unlikely to hold water in the future. Despite this, there were local reports of Brolgas using the dam during March/April 2013.

Biosis conducted surveys over four days from 27-30 May 2013 to confirm that the site was being used by a number of Brolgas as a night roost. One zoologist observed Lake Sheepwash at dawn and dusk to establish if Brolgas were roosting at the site. Where possible, birds were followed in an attempt to establish movements and confirm their return to the roost site.

2.5.2 Review of potential flocking sites

Three additional sites where lager numbers of Brolgas have been reported were also investigated to determine their eligibility as flock roost sites. These three locations are identified as Site A, B and C, as described below. In April 2019, DELWP accepted that these sites are unsuitable flock roost sites as assessed against the *Brolga Guidelines* (DSE 2012).

Site A consists of a wetland to the west of Darlington-Nerrin Road, approximately 1 kilometre west of Lake Barnie Bolac. The wetland contains a very large central drainage line that begins at a large dam

at the Mount Fyans homestead 4 kilometres to the north-west and drains water into Long Dam. The southern boundary of the wetland is formed by a major stony rise ridge.

Site B is a wetland identified south of Woorndoo-Dundonnell Road, approximately 1.5 kilometres west of Lake Sheepwash. As part of the Dundonnell Wind Farm planning process, ecologists periodically recorded a large number of Brolgas foraging around this wetland from February to April 2014.

Site C is a wetland located to the north of Woorndoo-Darlington Road, approximately 1 kilometres east of the intersection between Woorndoo-Darlington Road and Dundonnell-Mortlake Road. The wetland is located just over 2 kilometres south-west of Lake Barnie Bolac. The wetland contains several large and clearly defined drainage channels and a stock dam close to Woorndoo-Darlington Road.

2.6 Additional breeding habitat assessment

During ongoing community consultation, Hydro Tasmania received information about other potential breeding sites within the wind farm study area. In response, additional habitat assessments and on-site monitoring was undertaken by Hydro Tasmania personnel and Biosis ecologists.

Hydro Tasmania personnel conducted observations at a site on Salt Creek off Castle Carey Road (Site 1) to monitor for the presence of Brolgas (Figure 2). To assist with this, a reference site south of Woorndoo-Dundonnell Road (Site 2) was also monitored in conjunction with Site 1 as this was a known breeding site as mapped in Figure 7. At this wetland, a pair of Brolgas (Pair 6) had been observed in November 2009 nesting and with two chicks. Both sites were monitored between 11 July 2017 and 13 June 2018 to ensure the duration of the breeding season was covered. Six observations were undertaken at Site 1 and five observations at Site 2. Site 1, located on Salt Creek, was assessed on 21 May 2018 by a Biosis ecologist. Breeding habitat features including wetland and vegetation condition was documented and assessed for likelihood of supporting a breeding pair of Brolgas.

An additional site was identified as containing potential nest sites and these were assessed on foot by Biosis ecologists for their habitat suitability. This area, Site 3, located in the north of the study area to the east of Mortlake-Ararat Road, was assessed on 19 April 2018 (Figure 2).

2.7 Permits

Biosis undertakes biodiversity assessments detailed hereunder the following permits and approvals, or predecessor authorizations:

- Research Permit/Management Authorisation and Permit to Take/Keep Protected Flora & Protected Fish issued by DELWP under the Victorian *Wildlife Act 1975*, *Flora and Fauna Guarantee Act 1988* (FFG Act), *National Parks Act 1975* and *Crown Land (Reserves) Act 1978* (Permit Number 10008711).
- Approvals 30.17 and 19.18 issued by the Wildlife and Small Institutions Animal Ethics Committee of the Victorian Government Department of Economic Development, Jobs, Transport and Resources (DEDJTR).
- Scientific Procedures Fieldwork Licence issued by DEDJTR's Wildlife and Small Institutions Animal Ethics Committee (Licence Number 20020).

2.8 Legislation and policy

The implications for Brolgas were assessed in relation to the following legislation and policy:

- *Flora & Fauna Guarantee Act 1988* - associated action statements and listing advice.
- *Planning and Environment Act 1987* – specifically Clauses 12.01 and 52.32 in the relevant Planning Scheme.
- *Wildlife Act 1975.*
- *Environment Effects Act 1978.*
- *Interim guidelines for the assessment, avoidance, mitigation and offsetting of potential wind farm impacts on the Victorian Brolga population 2011* (DSE 2012).

2.9 Mapping

Hydro Tasmania supplied aerial photography and site plans.

Mapping in the field was conducted using hand-held (uncorrected) GPS units (WGS84) and aerial photo interpretation. The accuracy of this mapping is therefore subject to the accuracy of the GPS units (generally ± 7 metres) and dependent on the limitations of aerial photo rectification and registration.

Mapping has been produced using a Geographic Information System (GIS). Electronic GIS files which contain our fauna spatial data are available to incorporate into design concept plans. However this mapping may not be sufficiently precise for detailed design purposes.

3 Results

3.1 Database review

The databases that contain historical records of Brolga sightings relevant to the study area include the VBA, BA Atlas and the Southwest Victorian Brolga Flocking Site Database (referred to hereafter as BFD (*Brolga Flocking Database*)).

The VBA, BA Atlas and the BFD are a collection of records of species sightings, obtained either from incidental observations or systematic survey, from a wide range of contributors. With regards to Brolgas, these databases are used as a tool to gain an understanding of where individuals of this species have previously been recorded in the landscape and where current and historical breeding or flocking sites occur.

To provide a general overview of this historical data, Figure 2 includes all Brolga records from these databases. This information was used as a basis to focus on ground habitat assessments, aerial surveys, home range surveys and local landholder consultations to determine where important breeding and flocking sites are located in proximity to the project boundary. This approach is consistent with the Level One and Level Two Assessment Methodology as outlined in the *Brolga Guidelines*.

3.1.1 Victorian Biodiversity Atlas (VBA)

The VBA is an online tool for use by government agencies, environmental consultants, researchers and the public. The atlas, managed by DELWP, is a collection of observations about the distribution and abundance of species in Victoria. The VBA includes all records from previous databases managed by the Department, including the Flora Information System, the Atlas of Victorian Wildlife, the Aquatic Fauna Database and the Victorian Rare or Threatened Population (VROTPop) Database.

Records can be submitted to the VBA by any member of the public who registers as a contributor. The system requires contributors to complete a set of mandatory fields, which starts an automatic verification process for the accuracy of the data (e.g. record is within the accepted range for a species). A panel of experts/specialists for various taxonomic groups is involved in reviewing and verifying new records. The expert review cycle for the VBA is proposed to be undertaken every 3-4 months. The verification process for historical records generally followed the new process, however, with the multiple datasets managed over the years, the review process may not have been consistent (DELWP, *pers. comm*.). Consequently, many old records have limited information, with many observations lacking important information (e.g. breeding records, number of individuals observed) or some fields that are now mandatory.

In mid-2012 the Biodiversity Data Management section of the former DSE advised that up to that point the VBA contained records of survey effort and not just sightings. Contributors would record 'zero', 'null' or 'no record' when they undertook a survey at a location when there were no sightings of the target species. There were numerous ways this was done in the legacy datasets that had been used to create the VBA. The Biodiversity Data Management team recognised this could be misleading to those reviewing the VBA as people were looking at a list or map and expecting it to be a record of actual species sightings, however, these data points show a record of survey effort rather than species sighted.

The VBA consists of two point datasets, categorised based on the level of accuracy of the location of the record. The VBA_FAUNA25 contains the records for which the level of accuracy is less than 500 metres. The VBA_FAUNA100 contains records with an accuracy of 500 meters or greater. For the Mount Fyans Brolga dataset, the stated accuracy of the spatial location of records ranges from 0.005 - 9 kilometres. Older records generally have less accurate locations due to observers relying on maps and grid references when submitting their location details, prior to the widespread use of GPS units. The new system allows for accurate locations provided by GPS units, which lists the accuracy provided by the unit.

There are several other limitations that must be considered when looking at the records within the VBA. It is acknowledged by DELWP that the data may contain errors and omissions. Common errors result from mistakes made when transcribing the information, such as a digit being omitted or entered incorrectly, resulting in the wrong location or incorrect taxon identification number being used. Other errors occur when different common names have been used for one species, the units of measurement or coordinate types differ, or as a result of contributors and data enterers having differing sets of assumptions. Data can also appear skewed for a particular species or region if there has been a greater interest or survey effort at one location or for one species.

For the current version of this report, there are 41 additional Brolga records added to VBA search area since 2018. The majority of the breeding records related to existing or potential breeding wetlands. One breeding record could not be attributed directly to a wetland and did not appear to relate to a nest site. DEWLP were not able to confirm that it had evidence (i.e. a photo) of a nest site associated with this record. Advice from DELWP was to allocate it to the closest potential breeding wetland. Therefore, it was attributed to the known breeding wetland approximately 1 kilometre to the east.

An overview of the Brolga records from the VBA within 10 kilometres of the Mount Fyans study area provides the following information:

- A total of 4455 observations, with dates ranging between 1965 and 2019.
  - *3138 are the result of a GPS tracking survey undertaken between June 2011 and August 2012 (70% of all records).*
  - *689 observations submitted by one contributor (52% of records when excluding the tracking survey).*
  - *108 observations from literature reports.*
  - *41 observations have been added to the VBA search area since 2017.*
- VBA_FAUNA25: 3499 records (precision 0 - 500 metres).
- VBA_FAUNA100: 956 records (precision 500 metres – 9 kilometres).
- 29 observations of Brolgas within the Mount Fyans wind farm study area, including five listed as breeding records.
- 86 observations of flocks of Brolgas numbering ≥ 10 birds.
  - *Largest flock of 100 (estimate) recorded 1.5 kilometres south of Lake Barnie Bolac.*
  - *A flock of 80 Brolgas recorded in 1969 in Darlington.*
  - *Four records from Lack Barnie Bolac, including a flock of 44 recorded in 2000, a flock of 11 recorded in 2001, a flock of 11 recorded in 2008 and a flock of 12 recorded in 2012..*

For the purposes of Figure 2, potential 'flocking' records are shown as observations of ≥ 10 birds (as per the definition used in DSE 2012).

- 3846 records do not include a count of the number of birds observed.
- 790 breeding observations.
  - *Of these breeding records, 677 do not include the number of birds observed; one includes a count of 80 birds.*
  - *There is often no other supporting information with these observations to verify them as 'breeding' records.*
  - *The locations of many of the 'breeding' observations are questionable when they are not associated with a wetland.*
  - *95 records are sourced from literature reports, of which 71 have the date as 1 January of the year recorded, which is assumed to simply be a default in the absence of an actual date record.*

The GPS tracking survey was undertaken as part of the South-West Victoria Brolga Research Project (SWIFFT 2018). This involved researchers fitting 22 Brolgas with transmitters to track their movements and gather data on seasonal movements, dispersal, habitat use, home ranges and survival. It must be noted that the 3138 database records within the VBA are the result of GPS fixes from the transmitters tracking movement of a few individuals. As a result, these records are not shown in Figure 2 as they over-represent individuals when compared with other records shown in the VBA. From information available to date, this research project did not identify any new breeding sites within 10 kilometres of the Mount Fyans study area.

On further assessment of the database records in relation to the study area and in accordance with the Brolga Guidelines, VBA_FAUNA100 records within 3.2 kilometres of the project boundary were analysed.

Overall, there are 101 VBA_FAUNA100 records within 3.2 kilometres of the project boundary. Of these, a total of 80 records were attributed to wetlands as confirmed breeding sites (as shown in Figure 7). Of these 80 records, 62 records represent two sites where multiple observations (from 1969 through to 1999) were by the one observer. The remaining 21 records were not assigned as breeding records due to missing information, no count data, unreliable data, or no nearby wetland. These records are summarised in Table 1.

Table 1 Summary of Brolga breeding records within 3.2 km of the project boundary.

Record date	Location (Longitude)	Location (Latitude)	Count	Source	Rationale
1/01/1984	-38.0652	142.6347	-	Literature Report	No wetland, no count
18/09/2008	-38.0764	142.6472	3	Consultant	No wetland
1/01/1984	-38.0485	142.6514	-	Literature Report	No count data
1/01/1984	-38.0319	142.6514	-	Literature Report	No wetland, no count
11/09/2007	-38.0644	142.6792	-	Literature Report	Further investigation was undertaken, habitat deemed unsuitable (see Table 2, Record ID 120)

Record date	Location (Longitude)	Location (Latitude)	Count	Source	Rationale
1/01/1984	-38.0652	142.7014	-	Literature Report	No wetland, within plantation
1/01/2002	-38.05	142.75	-	Literature Report	Unreliable accuracy, no wetland
11/09/2007	-38.0672	142.7806	-	Literature Report	No wetland, no count
1/01/2002	-38	142.8167	-	Literature Report	Unreliable accuracy (see Table 2, Record ID 976)
1/01/1984	-38.0819	142.8514	-	Literature Report	No count, south of known breeding site
1/01/1984	-38.0485	142.868	-	Literature Report	No wetland, no count
1/01/1984	-38.0652	142.8847	-	Literature Report	No count
1/01/1984	-37.9152	142.9014	-	Literature Report	Close to other known breeding site, no wetland
11/09/2007	-37.9658	142.9094	-	Literature Report	No count
1/01/2002	-38.0667	142.9167	-	Literature Report	No wetland, no count
1/01/1984	-38.0485	142.918	-	Literature Report	No wetland, no count
1/01/1984	-38.0319	142.918	-	Literature Report	No wetland, no count
1/10/2007	-38.0653	142.9214	2	Consultant	No wetland
1/01/1984	-38.0485	142.9347	-	Literature Report	No wetland, no count
1/01/1984	-37.9819	142.9514	-	Literature Report	No wetland, no count
1/01/1984	-37.9652	142.9514	-	Literature Report	No wetland, no count

The veracity of VBA records that may relate to breeding activity were assessed in accordance with the *Brolga Guidelines'* Level Two Assessment Methodology through a combination of:

- Ground based habitat suitability assessments.
- Review of source material when a literature report was a source in the VBA.
- Land owner surveys.
- Aerial observations of habitat suitability during the breeding season.

An overview of the process and key elements for assessing three VBA Brolga records within the project boundary is provided in Table 2 below.

Table 2 Assessment of three VBA Brolga records in accordance with the *Brolga Guidelines*.

Key element	Description
Record ID: 488	
Location	North-western edge of a large salt pan, south of Woorndoo-Darlington Road.
VBA Data	General Observation, Breeding, No Count Map Derived, BLA Report 11/09/2007, Max accuracy 0.9 km.
Desktop Research	The map referred to in the VBA is Figure 9 from the BLA assessment report for the Mortlake Wind Farm (Brett Lane & Associates 2008). The map shows that there are no Brolga observations at this wetland. The closet Brolga observation on the map is approximately 3.5 km to the north-west, however, it is noted that this is ***not*** a breeding site.
Site Assessment	The suitability of the wetland as a potential Brolga breeding site was assessed as part of the targeted survey process. The very shallow lake was observed to have a thin crust of salt over thick black clay. The saline, ephemeral waterbody does not contain vegetation that could be used as breeding site, nor is it suitable as foraging habitat. The waterbody was assessed as unsuitable habitat for a Brolga breeding site.
Landowner Survey	The farm manager who has worked on the property over a 25 year period was surveyed on Brolga observations. The farm manager lived close to the waterbody and did not refer to any sightings of Brolga at the waterbody.
Conclusion	It is likely that the record was allocated to the wrong waterbody during the process of translating information from the BLA report to the VBA. The waterbody was assessed as not providing visible breeding habitat.
Record ID: 976	
Location	South of Manooka Lane.
VBA Data	General Observation, Breeding, No Count Map Derived from Literature Report, Max accuracy 0.9 km.
Desktop Research	The 2002 report could not be identified from the VBA data. The coordinates of the record in the VBA was expressed in decimal degrees of Lat -38 and long 142.816666. To have a 0.9 km level of accuracy a coordinate would be expected to have at least three decimal places. All other VBA Brolga records are expressed to 5-6 decimal places. It is likely that the latitude entry of -38 is a data input error.
Site Assessment	The wetland to the north of the VBA record was assessed during the targeted survey process and again in April 2018. The wetland showed no signs of supporting aquatic plants and contained a very large drainage channel. The ecology and hydrology of the wetland was discussed with the land owner. The wetland was assessed as very poor habitat for breeding and foraging.
Landowner Survey	The landowner has lived in the area for over 40 years and was very familiar with the wetland. He described the construction of a major drainage easement through the wetland down to Blind Creek in the early 1960s. Since that time the

Key element	Description
	land has been used for farming. It does hold water (approximately 10-15 cm deep) for a short time, generally between July and October. The land owner saw a pair of Brolgas at a smaller wet for a short time about 20 years ago. Some years there may be one or two Brolga that fly out after a few days.
Conclusion	Unlike all other VBA Brolga records the latitude used has no decimal places and its accuracy is uncertain. DELWP has advised that 'no count' records relate to sites or surveys where no Brolgas were observed. The adjacent wetland has been drained, and while it holds some water for a limited about of time, it has no aquatic vegetation associated with foraging or breeding and is not considered to be suitable breeding habitat.
Record ID: 120	
Location	North of Connewarren Lane, east of Mortlake Power Station.
VBA Data	General Observation, Breeding, No Count. Map Derived, BLA Report 11/09/2007, Max accuracy 0.9 km.
Desktop Research	The VBA data is derived from a map in a report that was prepared for the Mortlake Wind Farm (Brett Lane & Associates 2008). The report states that within 20 km of the project there were nine confirmed breeding sites as well as another six sightings of Brolga where no breeding was observed. The map shows both nine breeding records as well the sightings. This wetland is shown as a Brolga sighting (i.e. ***not*** a breeding site). It appears that all of the data from the map have been derived as breeding sites in the VBA, even though six of these locations were only Brolga sightings. In 2015 BLA staff advised that they were aware of the incorrect reference to BLA records in the VBA. BLA staff advised that records of Brolga breeding sites from 2007 was shown in full in the 2015 report prepared for the Dundonnell Wind Farm (Brett Lane & Associates 2015). The wetland was not included as a breeding site in the 2015 report for the Dundonnell Wind Farm.
Site Assessment	The suitability of the wetland as a breeding site was assessed via survey undertaken in 2017. The survey classified the vegetation of part of the area as a Plains Grassy Wetland EVC. The wetland showed no signs of holding water or containing aquatic plants that could be used for foraging or nest building for breeding. The stock watering dam to the south of the grassy wetland was not suitable breeding habitat. The grassy wetland was assessed as not providing suitable breeding habitat.
Landowner Survey	The property is owned by Tilt Renewables. The owner is currently constructing a grid connection substation for a wind energy facility on the property. The property manager of the previous land owner was interviewed in 2013 and indicated that the property was used as both a plantation and for grazing. Areas of the grassland can be boggy, but it does not hold water for long periods. A very old drainage channel that ran through the property has been diverted and the area does not receive runoff from the neighbouring property.
Conclusion	The data record has been incorrectly entered into the VBA as a breeding site when the report that it was derived from clarifies that it was a Brolga sighting and not a breeding site. The consulting firm attributed as responsible for the data record in the VBA showed that the wetland was not a breeding site through a report

Key element	Description
	prepared for the Dundonnell Wind Farm (Brett Lane & Associates 2015). The wetland was assessed as not holding water for long periods and does not provide potential Brolga breeding habitat.

3.1.2 BirdLife Australia – New Atlas of Australian Birds

The BA Atlas, managed by BirdLife Australia, is a collection of records on the distribution and abundance of bird species across Australia. The new Atlas has been in operation since 1998 and contains over 7 million bird records. The aim of the Atlas is to collect information on Australian birds, including distribution, abundance and important bird areas, and to use this information to monitor birds for the purpose of conservation, now and into the future.

The records within the Atlas are provided by a broad range of contributors. The Atlas allows anyone to become a contributor, provided they register as an Atlasser through BirdLife Australia. All new Atlassers are provided with a starter kit with instructions on how to participate in the program. When submitting a record a standard form must be completed with mandatory fields such as species, date, time, type of survey and location. The Atlas is focused on structured surveys as well as incidental records. The BA website includes a range of additional information and instructions on how different surveys should be conducted, using prescribed methods such as timed 2-hectare searches and area searches.

A verification process by BirdLife Australia involves an initial check of the location of records to determine if they are within the accepted range for a particular species. A range of local experts are also used to check the validity of records. Similarly to the VBA, there are potential errors and limitations associated with the BA Atlas records. The level of accuracy of location data is provided by three categories: 0 – not given; 1 - <100 metres; 2 - <500 metres. For the Mount Fyans Brolga dataset, the accuracy of the spatial location of records ranges from 0 to 2. Older records that have relied on map coordinates and grid references are less accurate than locations recorded by GPS units. The use of clear survey instructions and information kits assists in reducing errors, however, the potential remains for transcription errors within the data, particularly for location details.

An overview of the Brolga records from the BA Atlas within 10 kilometres of the Mount Fyans study area provides the following information:

- A total of six observations, with dates from between 1991 and 2012.
- Accuracy of records:
  - *One observation with no precision specified.*
  - *Two observations with 0 - 100 metre precision.*
  - *Three observations with0 - 500 metre precision.*
- One observation within the wind farm study area.
- No observations of flocks of Brolgas numbering ≥ 10 birds.
- Two breeding observations.

3.1.3 Southwest Victorian Brolga Flocking Site Database (BFD)

The BFD is a collection of all observations of Brolga from southwest Victoria and southeast South Australia. The intention of the database was for use by the Bird Observers Club of Australia, government departments and researchers (Sheldon 2003). It consists of a compilation of records (from the early 1900s to 2004) from the Victorian Government (formerly Department of Sustainability and Environment), BirdLife Australia Atlas (formerly Birds Australia), the University of Ballarat, and the defunct Friends of the Brolga Group. Consequently, many of the records within the BFD are duplicates of records within the VBA and BirdLife Australia Atlas.

The database was used to generate a list of 29 historical Brolga flocking sites within south-west Victoria, and one site in South Australia. The selection of the flocking sites was based on a set of criteria, including records (with validity) since 1990; more than one year of Brolga records; direct wetland association; one or more records of counts equal to or greater than 10 birds; and Brolgas recorded in more than one month (Sheldon 2004).

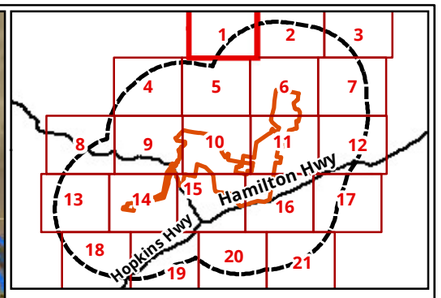
It is noted that although titled as a 'flocking' database, not all sites recorded in the database are flocking sites. As stated in the user manual (Sheldon 2003), any records of Brolga recorded during the flocking season (December to May) have been included in an attempt to avoid excluding any potential flocking records.

Although the intention was to include complete and reliable information, many records omitted data entry for some sections of the survey forms, such as bird count data, habitat parameters and wetland attributes. All records with an acceptably accurate location and year were included. Any records with a significant disparity between the location description and the map reference were rejected. As many of the records were obtained through the state government databases, the verification and accuracy of the records is as outlined in Section 3.1.1. The user manual notes that a validation level for each record is also provided as a level of accuracy, and that location references are cross referenced with known wetlands or feeding sites.

An overview of the Brolga records from the BFD within 10 kilometres of the Mount Fyans study area provides the following information:

- A total of 31 observations, with dates from between 1976 and 2004.
- No observations within the wind farm study area.
- Nine observations of flocks of Brolgas numbering ≥ 10 birds.

Acknowledgements: VicMap BaseMap©State of Victoria



Legend

Study Area 10km buffer

Brolga Flocking Database

Sighting

Victorian Biodiversity Atlas

Sightings

Sighting of ≥10 birds

Figure 2.1 Historical and database records of Brolga within 10km of the Mt Fyans study area

0 300 600 900 1,200 1,500

Metres

N

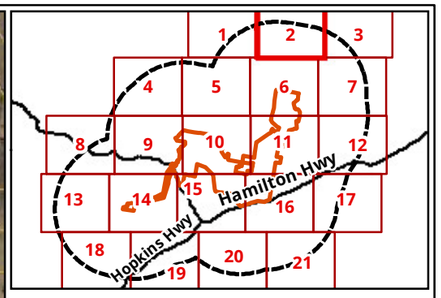
Scale: 1:30,000 @ A3

Coordinate System: GDA 1994 MGA Zone 54

biosis

Matter: 16307,
Date: 28 July 2022,
Checked by: KS, Drawn by: SKM, Last edited by: smitchell
Location: P:\16300s\16307\Mapping\16307_F2_BrolgaRecords.mxd

Acknowledgements: VicMap BaseMap©State of Victoria



Legend

Study Area 10km buffer

Biosis

Sighting <10 birds

Victorian Biodiversity Atlas

Breeding

Sightings

Wetland count 2013/14

Sighting <10 birds

Figure 2.2 Historical and database records of Brolga within 10km of the Mt Fyans study area

0 300 600 900 1,200 1,500

Metres

N

Scale: 1:30,000 @ A3

Coordinate System: GDA 1994 MGA Zone 54

biosis

Matter: 16307,
Date: 28 July 2022,
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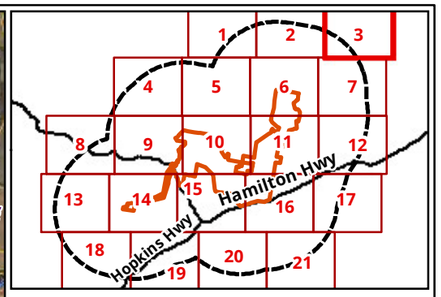

Legend

Study Area 10km buffer

Biosis

- Sighting <10 birds

Brolga Flocking Database

- Sighting

Victorian Biodiversity Atlas

- Breeding
- Sightings
- Sighting of ≥10 birds

Wetland count 2013/14

- Sighting <10 birds
- Sighting of ≥10 birds

Figure 2.3 Historical and database records of Brolga within 10km of the Mt Fyans study area

0 300 600 900 1,200 1,500 N

Metres

Scale: 1:30,000 @ A3

Coordinate System: GDA 1994 MGA Zone 54

biosis

Matter: 16307,
Date: 28 July 2022,
Checked by: KS, Drawn by: SKM, Last edited by: smitchell
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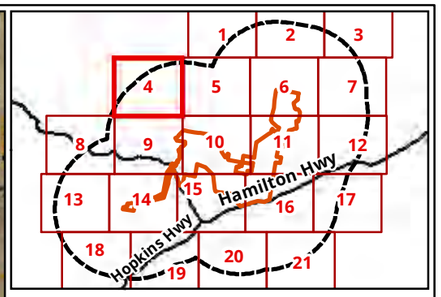

Legend

Study Area 10km buffer

Brolga Flocking Database

Sighting

Victorian Biodiversity Atlas

Breeding

Sightings

Figure 2.4 Historical and database records of Brolga within 10km of the Mt Fyans study area

0 300 600 900 1,200 1,500

Metres

N

Scale: 1:30,000 @ A3

Coordinate System: GDA 1994 MGA Zone 54

biosis

Matter: 16307,
Date: 28 July 2022,
Checked by: KS, Drawn by: SKM, Last edited by: smitchell
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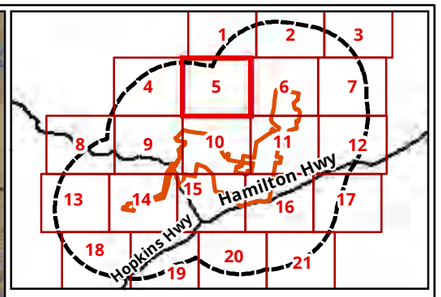

Legend

- Study Area 10km buffer

Brolga Flocking Database

- Sighting

Victorian Biodiversity Atlas

- Breeding
- Sightings

Landholder Brolga records

- Breeding
- Sighting <10 birds
- Sighting of ≥10 birds

Wetland count 2013/14

- Sighting <10 birds

Figure 2.5 Historical and database records of Brolga within 10km of the Mt Fyans study area

0 300 600 900 1,200 1,500 N

Metres

Scale: 1:30,000 @ A3

Coordinate System: GDA 1994 MGA Zone 54

biosis

Matter: 16307,
Date: 28 July 2022,
Checked by: KS, Drawn by: SKM, Last edited by: smitchell
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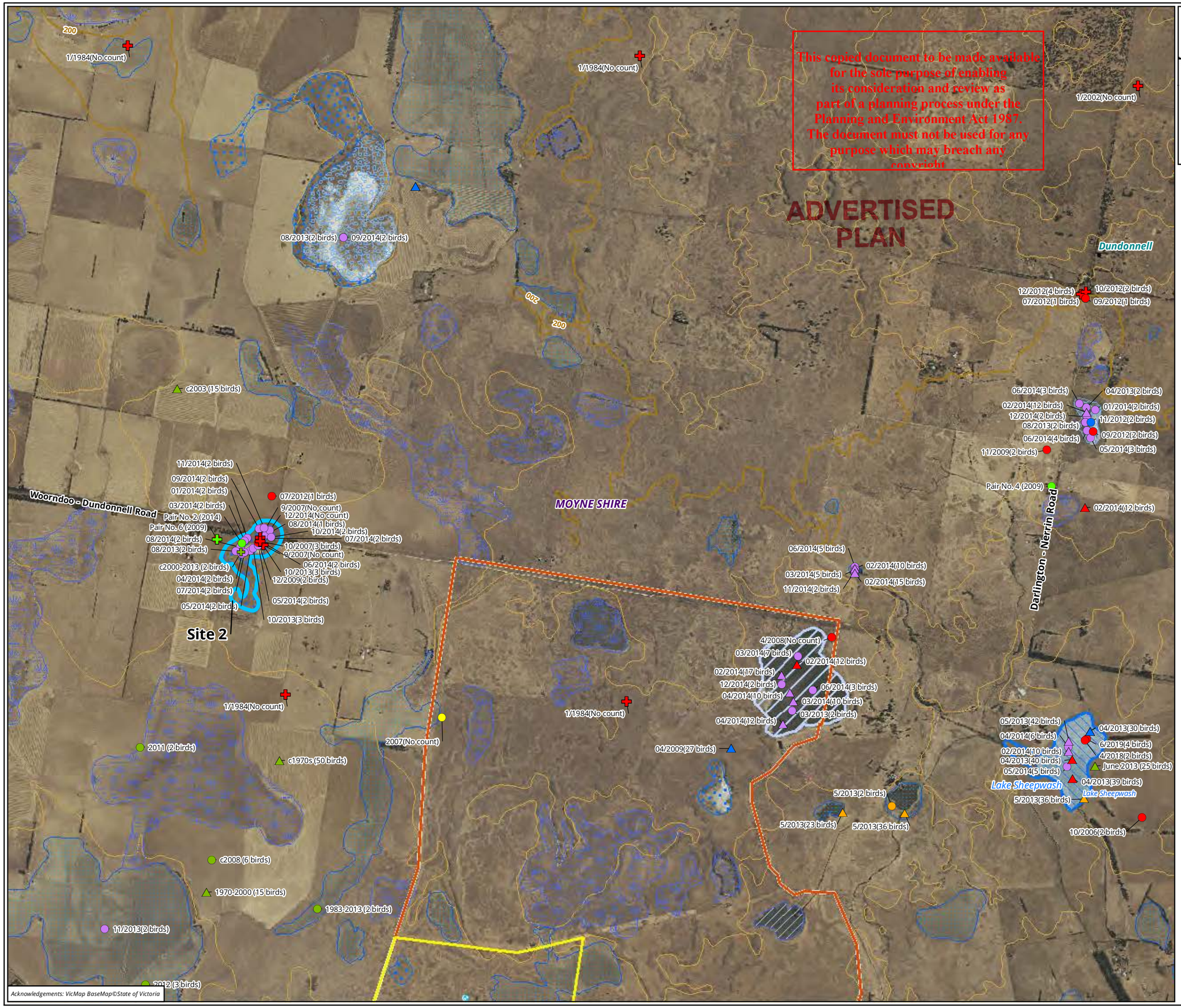

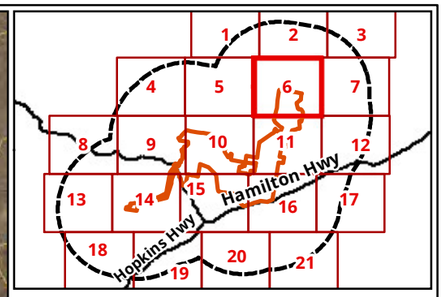

Legend

- Study Area 10km buffer
- Study Area

Biosis aerial survey records

- Nest observed
- No nest observed

Biosis

- Sighting <10 birds
- Sighting of ≥10 birds

Birdlife Australia

- Sighting

Hamish Cumming (2006-2015)

- Sighting <10 birds
- Sighting of ≥10 birds

Victorian Biodiversity Atlas

- Breeding
- Sightings

Landholder Brolga records

- Breeding
- Sighting <10 birds
- Sighting of ≥10 birds

Wetland count 2013/14

- Breeding
- Sighting <10 birds
- Sighting of ≥10 birds
- Additional Brolga habitat sites

Windfarm layout

- Project boundary
- Wind turbine location
- Internal access track
- Underground cable

Figure 2.6 Historical and database records of Brolga within 10km of the Mt Fyans study area

0 300 600 900 1,200 1,500 N

Metres

Scale: 1:30,000 @ A3

Coordinate System: GDA 1994 MGA Zone 54

biosis

Matter: 16307,
Date: 28 July 2022,
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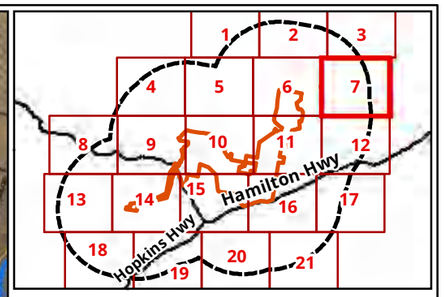

Legend

- Study Area 10km buffer

Biosis aerial survey records

- Nest observed
- No nest observed

Brolga Flocking Database

- Sighting

Victorian Biodiversity Atlas

- Breeding
- Sightings
- Sighting of ≥10 birds

Wetland count 2013/14

- Sighting <10 birds
- Sighting of ≥10 birds

Figure 2.7 Historical and database records of Brolga within 10km of the Mt Fyans study area

0 300 600 900 1,200 1,500 Metres

N

Scale: 1:30,000 @ A3

Coordinate System: GDA 1994 MGA Zone 54

biosis

Matter: 16307,
Date: 28 July 2022,
Checked by: KS, Drawn by: SKM, Last edited by: smitchell
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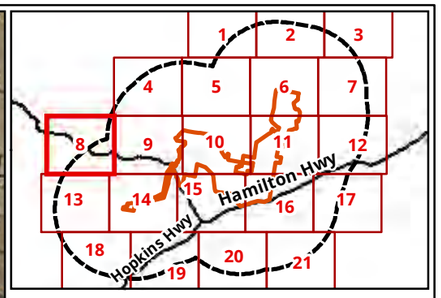

Legend

Study Area 10km buffer

Brolga Flocking Database

Sighting

Victorian Biodiversity Atlas

Breeding

Sightings

Figure 2.8 Historical and database records of Brolga within 10km of the Mt Fyans study area

0 300 600 900 1,200 1,500

Metres

N

Scale: 1:30,000 @ A3

Coordinate System: GDA 1994 MGA Zone 54

biosis

Matter: 16307,
Date: 28 July 2022,
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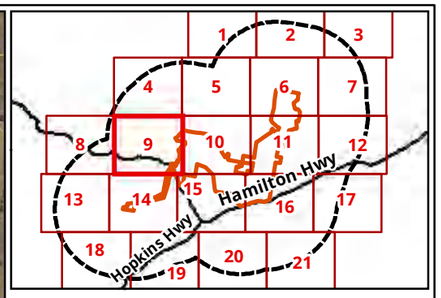


Legend

- Study Area 10km buffer
- Study Area

Birdlife Australia

- Sighting

Brolga Flocking Database

- Sighting

Victorian Biodiversity Atlas

- Sightings

Landholder Brolga records

- Breeding
- Sighting <10 birds
- Sighting of ≥10 birds
- Additional Brolga habitat sites

Windfarm layout

- Project boundary
- Wind turbine location
- Internal access track
- Works exclusion area
- Underground cable
- Indicative transmission route

Figure 2.9 Historical and database records of Brolga within 10km of the Mt Fyans study area

0 300 600 900 1,200 1,500 N

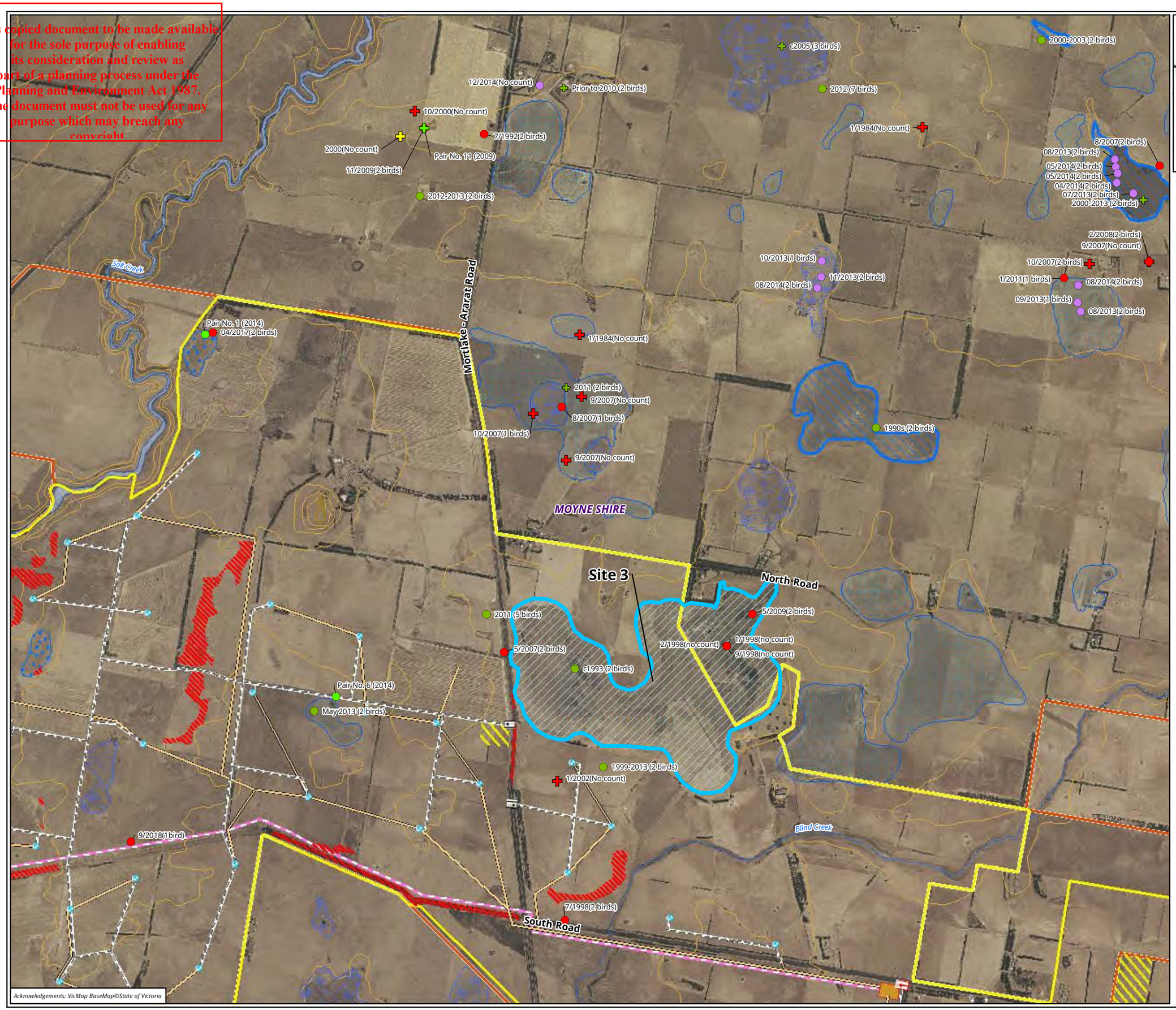
Metres

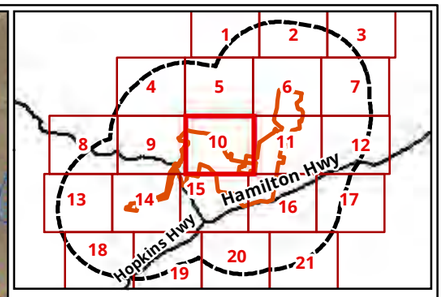
Scale: 1:30,000 @ A3

Coordinate System: GDA 1994 MGA Zone 54

biosis

Matter: 16307,
Date: 28 July 2022,
Checked by: KS, Drawn by: SKM, Last edited by: smitchell
Location: P:\16300s\16307\Mapping\16307_F2_BrolgaRecords.mxd





Legend

- Study Area 10km buffer
- Study Area

Biosis aerial survey records

- Nest observed
- No nest observed

Birdlife Australia

- Breeding

Victorian Biodiversity Atlas

- Breeding
- Sightings

Landholder Brolga records

- Breeding
- Sighting <10 birds

Wetland count 2013/14

- Sighting <10 birds
- Additional Brolga habitat sites

Windfarm layout

- Project boundary
- Wind turbine location
- Internal access track
- Road access - construction stage
- Road access - operating stage
- Construction compound
- Works exclusion area
- Underground cable
- Substation footprint
- Indicative transmission route

ADVERTISED PLAN

Figure 2.10 Historical and database records of Brolga within 10km of the Mt Fyans study area

0 300 600 900 1,200 1,500 N

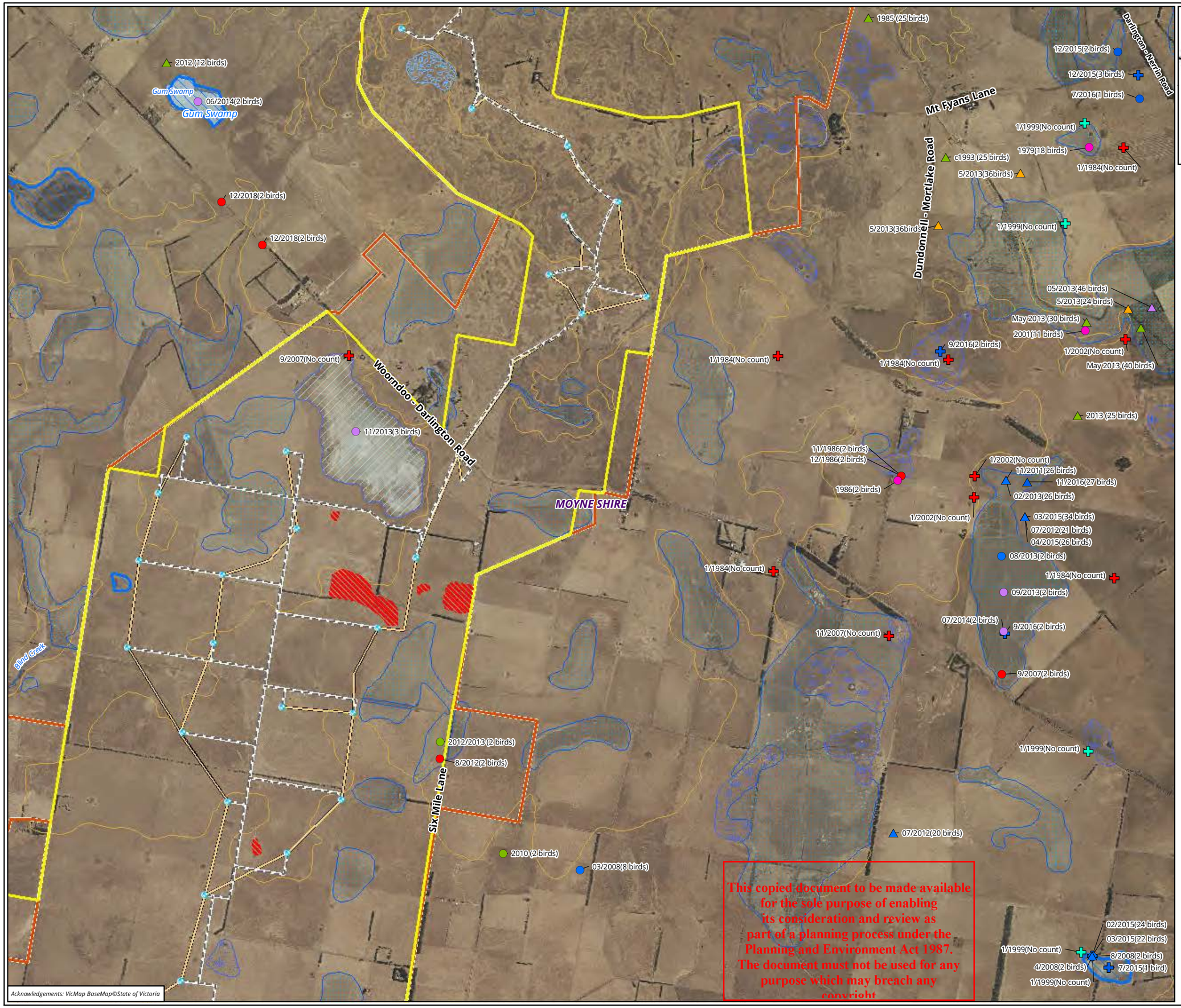
Metres

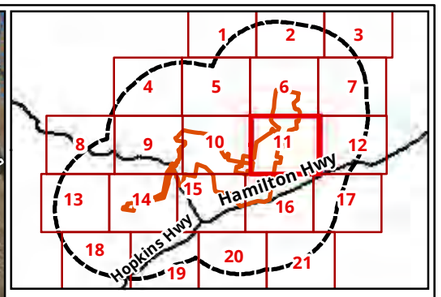
Scale: 1:30,000 @ A3

Coordinate System: GDA 1994 MGA Zone 54

biosis

Matter: 16307,
Date: 28 July 2022,
Checked by: KS, Drawn by: SKM, Last edited by: smitchell
Location: P:\16300s\16307\Mapping\16307_F2_BrolgaRecords.mxd





Legend

- Study Area 10km buffer
- Study Area

Biosis
- Sighting of ≥10 birds

Brolga Flocking Database
- Sighting

Hamish Cumming (2006-2015)
- Breeding
- Sighting <10 birds
- Sighting of ≥10 birds

Hamish Cumming (1969-1999)
- Breeding

Victorian Biodiversity Atlas
- Breeding
- Sightings

Landholder Brolga records
- Sighting <10 birds
- Sighting of ≥10 birds

Wetland count 2013/14
- Sighting <10 birds
- Sighting of ≥10 birds

Windfarm layout
- Project boundary
- Wind turbine location
- Internal access track
- Road access - operating stage
- Works exclusion area
- Underground cable

ADVERTISED PLAN

Figure 2.11 Historical and database records of Brolga within 10km of the Mt Fyans study area

0 300 600 900 1,200 1,500 Metres

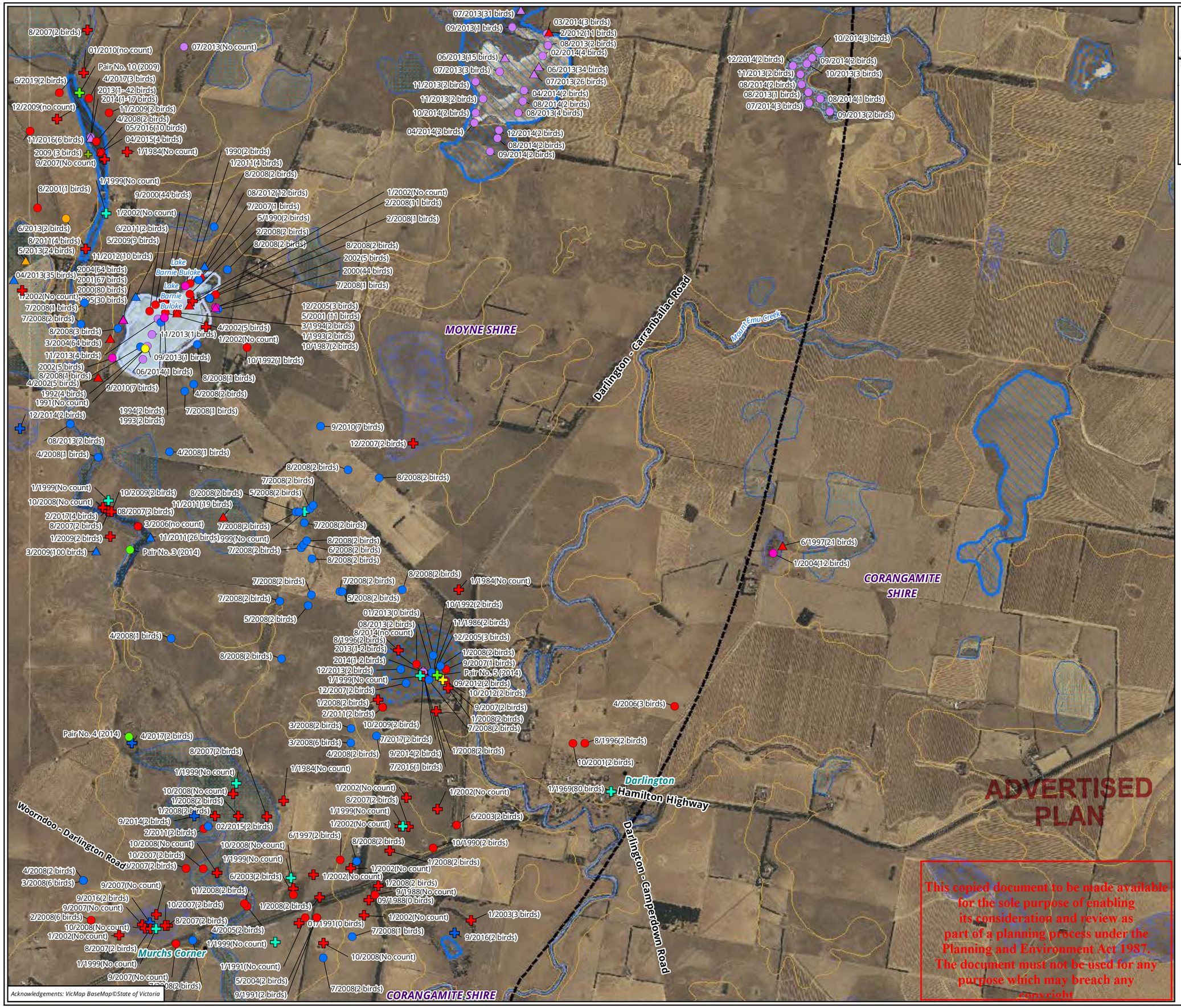
N

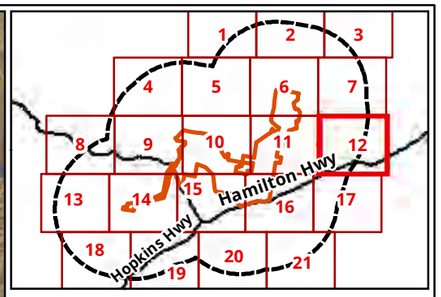
Scale: 1:30,000 @ A3

Coordinate System: GDA 1994 MGA Zone 54

biosis

Matter: 16307,
Date: 28 July 2022,
Checked by: KS, Drawn by: SKM, Last edited by: smitchell
Location: P:\16300s\16307\Mapping\16307_F2_BrolgaRecords.mxd





Legend

- Study Area 10km buffer

Biosis aerial survey records
- Nest observed
- No nest observed

Biosis
- Sighting <10 birds
- Sighting of ≥10 birds

Birdlife Australia
- Breeding
- Sighting

Brolga Flocking Database
- Flocking
- Sighting

Hamish Cumming (2006-2015)
- Sighting <10 birds
- Sighting of ≥10 birds

Hamish Cumming (1969-1999)
- Breeding

Victorian Biodiversity Atlas
- Breeding
- Flocking
- Sightings
- Sighting of ≥10 birds

Landholder Brolga records
- Breeding

Wetland count 2013/14
- Breeding
- Sighting <10 birds
- Sighting of ≥10 birds

Figure 2.12 Historical and database records of Brolga within 10km of the Mt Fyans study area

0 300 600 900 1,200 1,500 N

Metres

Scale: 1:30,000 @ A3

Coordinate System: GDA 1994 MGA Zone 54

biosis

Matter: 16307,
Date: 28 July 2022,
Checked by: KS, Drawn by: SKM, Last edited by: smitchell
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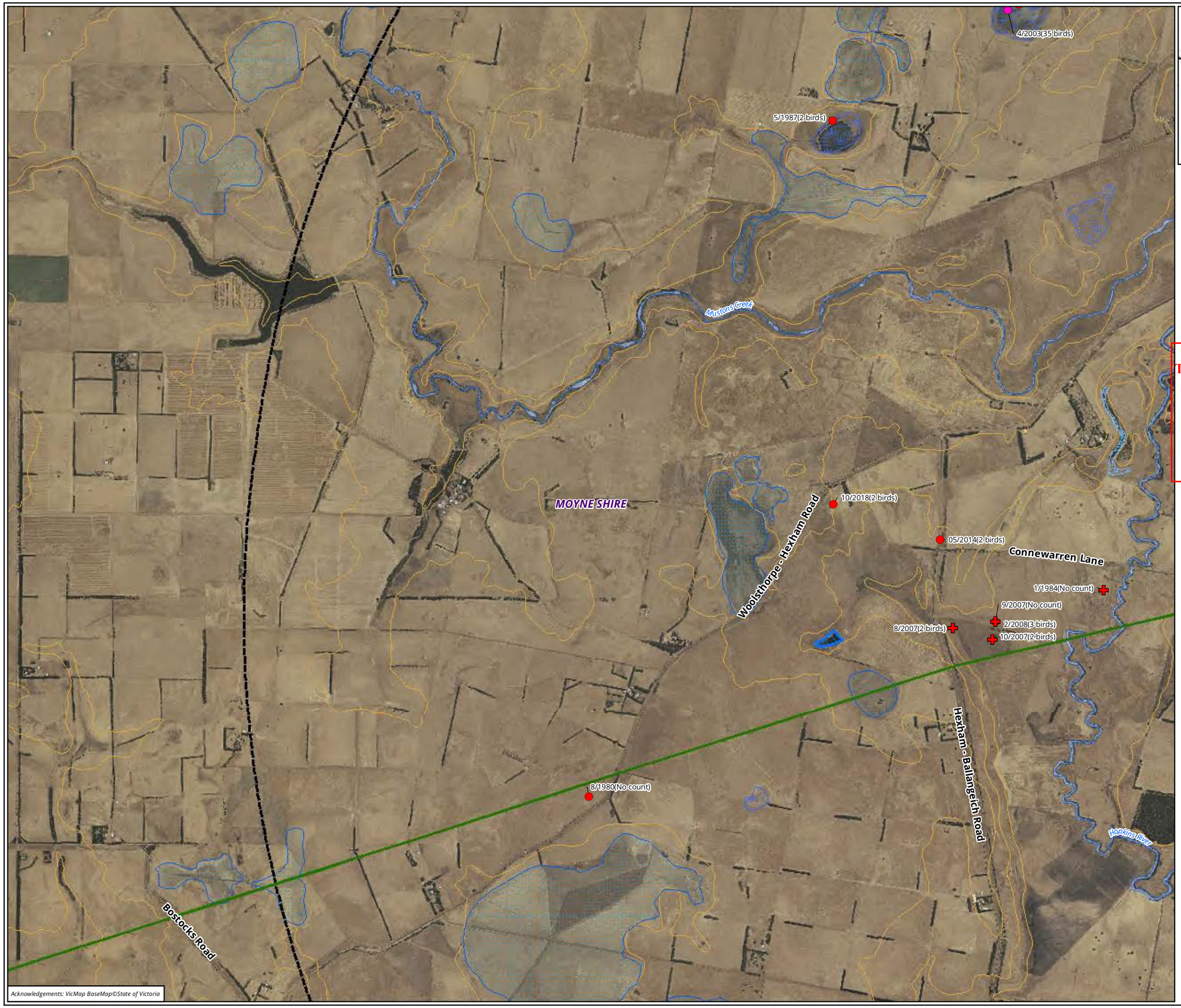
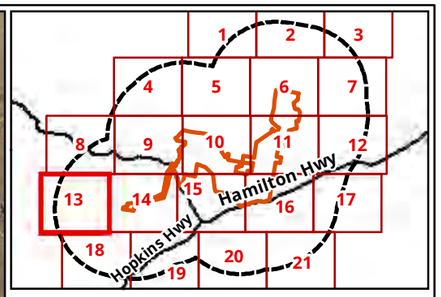




Legend

- Study Area 10km buffer

Brolga Flocking Database

- Sighting

Victorian Biodiversity Atlas

- Breeding
- Sightings
- Existing transmission line 500kV

Figure 2.13 Historical and database records of Brolga within 10km of the Mt Fyans study area

0 300 600 900 1,200 1,500

Metres

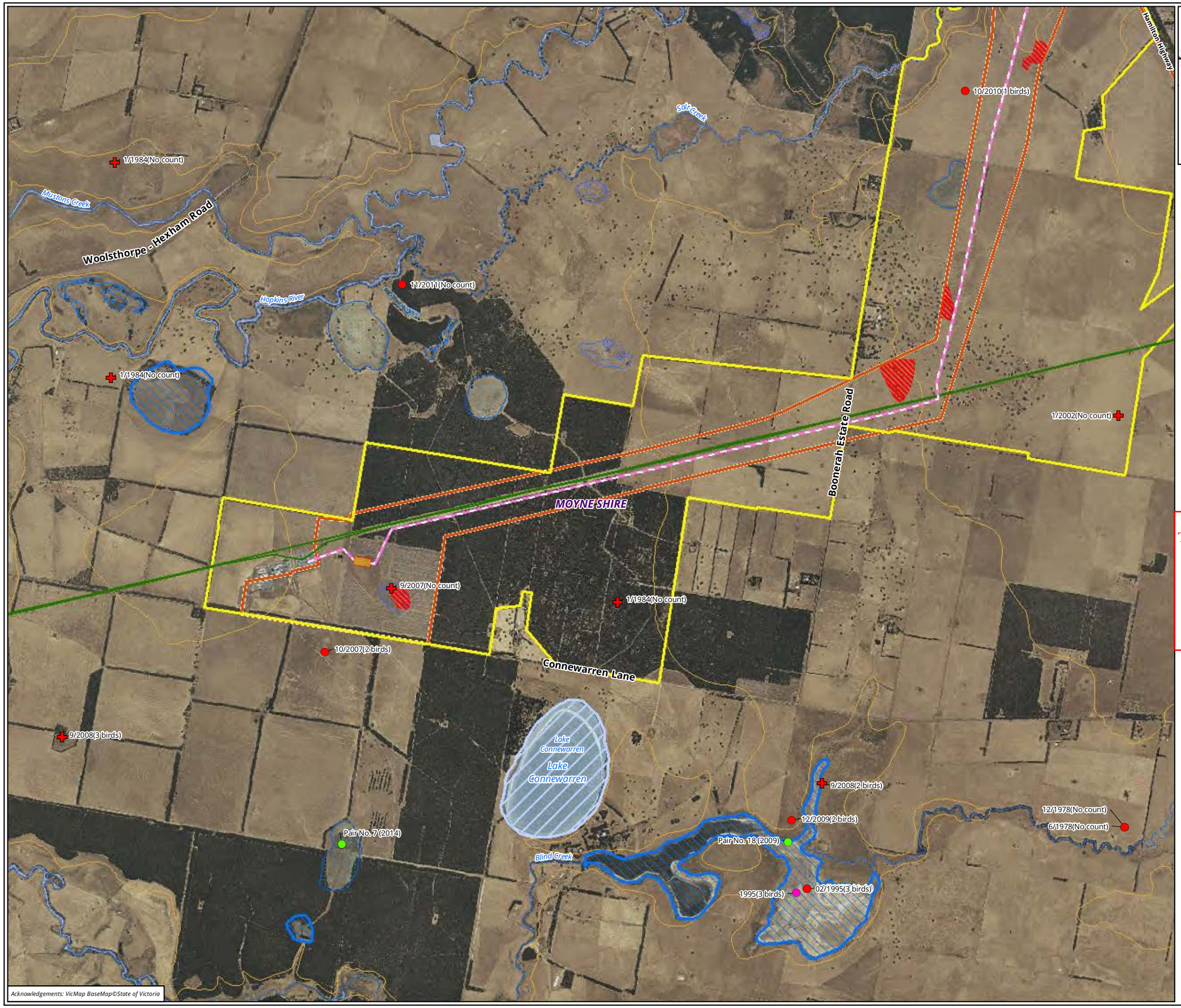
N

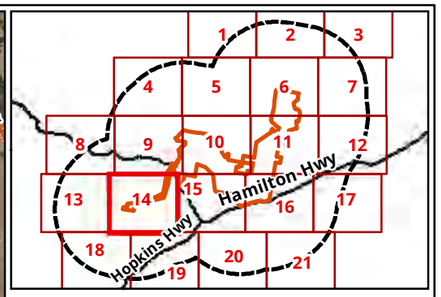
Scale: 1:30,000 @ A3

Coordinate System: GDA 1994 MGA Zone 54

biosis

Matter: 16307,
Date: 28 July 2022,
Checked by: KS, Drawn by: SKM, Last edited by: smitchell
Location: P:\16300s\16307\Mapping\16307_F2_BrolgaRecords.mxd





Legend

- Study Area 10km buffer
- Study Area

Biosis aerial survey records

- No nest observed

Brolga Flocking Database

- Sighting

Victorian Biodiversity Atlas

- Breeding
- Sightings

Wetland count 2013/14

- Sighting <10 birds

Windfarm layout

- Project boundary
- Works exclusion area
- Substation footprint
- Indicative transmission route
- Existing transmission line 500kV

Figure 2.14 Historical and database records of Brolga within 10km of the Mt Fyans study area

0 300 600 900 1,200 1,500

Metres

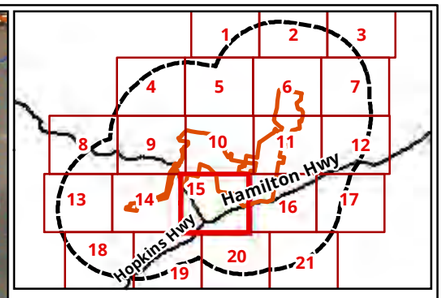
N

Scale: 1:30,000 @ A3

Coordinate System: GDA 1994 MGA Zone 54

biosis

Matter: 16307,
Date: 28 July 2022,
Checked by: KS, Drawn by: SKM, Last edited by: smitchell
Location: P:\16300s\16307\Mapping\16307_F2_BrolgaRecords.mxd



Legend

- Study Area 10km buffer
- Study Area

Biosis aerial survey records

- Nest observed
- No nest observed

Victorian Biodiversity Atlas

- Breeding
- Sightings
- Sighting of ≥10 birds

Landholder Brolga records

- Breeding
- Sighting <10 birds

Windfarm layout

- Project boundary
- Wind turbine location
- Internal access track
- Works exclusion area
- Underground cable
- Existing transmission line 500kV

ADVERTISED PLAN

Figure 2.15 Historical and database records of Brolga within 10km of the Mt Fyans study area

0 300 600 900 1,200 1,500 Metres

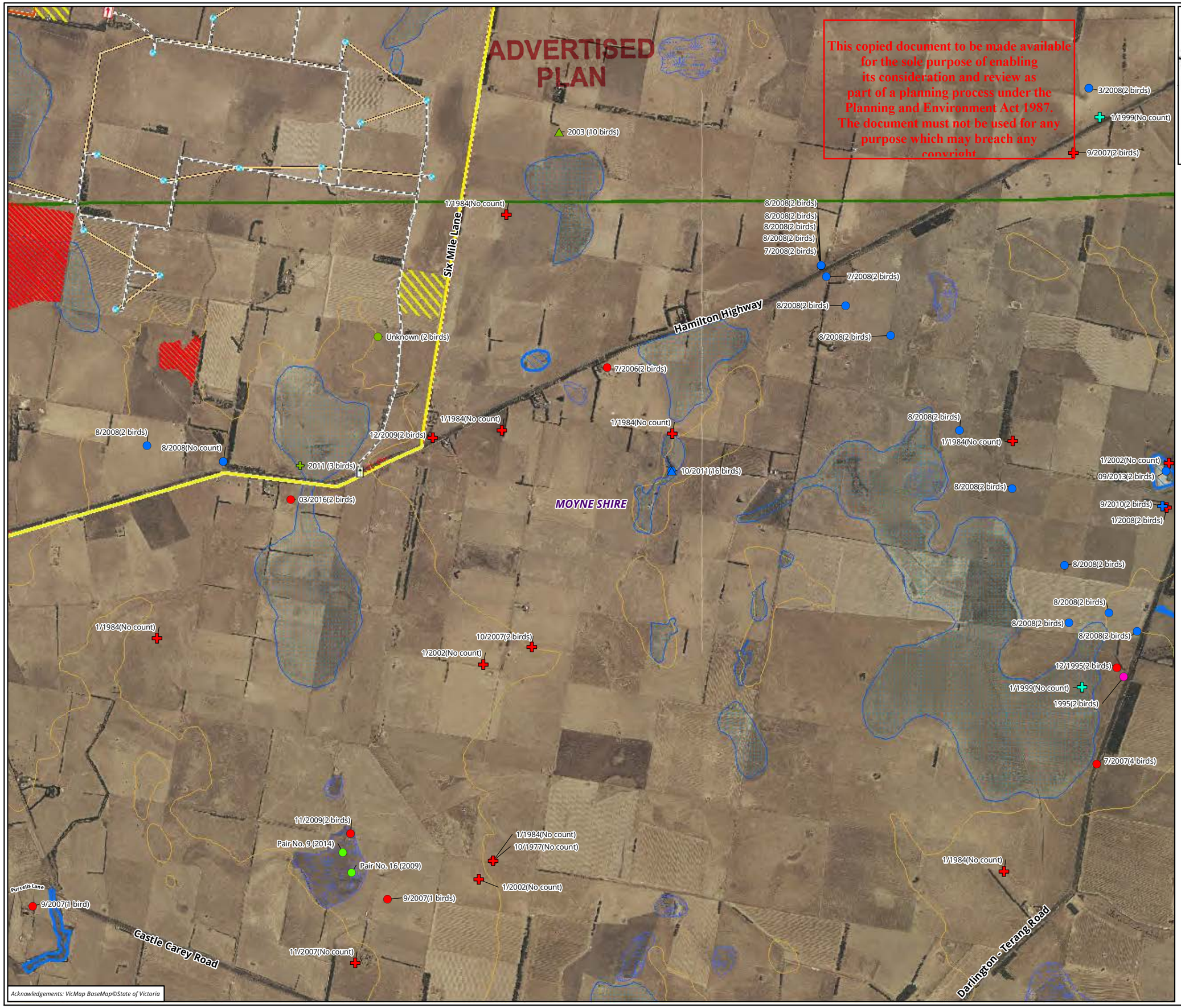
N

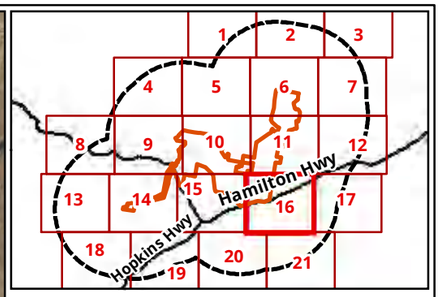
Scale: 1:30,000 @ A3

Coordinate System: GDA 1994 MGA Zone 54

biosis

Matter: 16307,
Date: 28 July 2022,
Checked by: KS, Drawn by: SKM, Last edited by: smitchell
Location: P:\16300s\16307\Mapping\16307_F2_BrolgaRecords.mxd





Legend

- Study Area 10km buffer
- Study Area

Biosis aerial survey records

- No nest observed

Brolga Flocking Database

- Sighting

Hamish Cumming (2006-2015)

- Breeding
- Sighting <10 birds
- Sighting of ≥10 birds

Hamish Cumming (1969-1999)

- Breeding

Victorian Biodiversity Atlas

- Breeding
- Sightings

Landholder Brolga records

- Breeding
- Sighting <10 birds
- Sighting of ≥10 birds

Windfarm layout

- Project boundary
- Wind turbine location
- Internal access track
- Road access - construction stage
- Road access - operating stage
- Construction compound
- Works exclusion area
- Underground cable
- Existing transmission line 500kV

Figure 2.16 Historical and database records of Brolga within 10km of the Mt Fyans study area

0 300 600 900 1,200 1,500 N

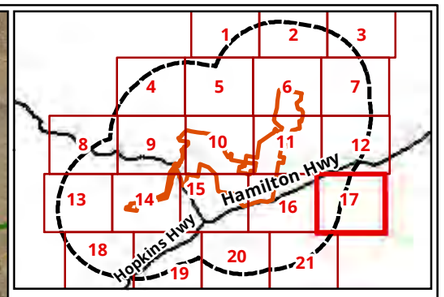
Metres

Scale: 1:30,000 @ A3

Coordinate System: GDA 1994 MGA Zone 54

biosis

Matter: 16307,
Date: 28 July 2022,
Checked by: KS, Drawn by: SKM, Last edited by: smitchell
Location: P:\16300s\16307\Mapping\16307_F2_BrolgaRecords.mxd



Legend

- Study Area 10km buffer

Brolga Flocking Database

- Sighting

Hamish Cumming (2006-2015)

- Breeding
- Sighting <10 birds

Hamish Cumming (1969-1999)

- Breeding

Victorian Biodiversity Atlas

- Breeding
- Sightings
- Existing transmission line 500kV

Figure 2.17 Historical and database records of Brolga within 10km of the Mt Fyans study area

0 300 600 900 1,200 1,500 N

Metres

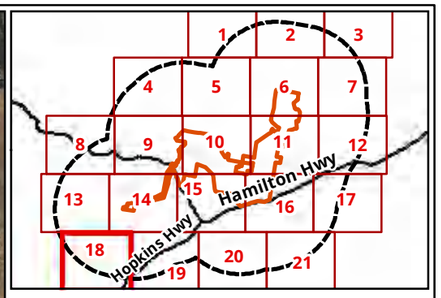
Scale: 1:30,000 @ A3

Coordinate System: GDA 1994 MGA Zone 54

biosis

Matter: 16307,
Date: 28 July 2022,
Checked by: KS, Drawn by: SKM, Last edited by: smitchell
Location: P:\16300s\16307\Mapping\16307_F2_BrolgaRecords.mxd

Acknowledgements: VicMap BaseMap©State of Victoria



Legend

Study Area 10km buffer

Figure 2.18 Historical and database records of Brolga within 10km of the Mt Fyans study area

0 300 600 900 1,200 1,500

Metres

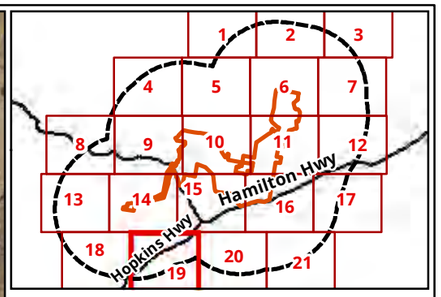
N

Scale: 1:30,000 @ A3

Coordinate System: GDA 1994 MGA Zone 54

biosis

Matter: 16307,
Date: 28 July 2022,
Checked by: KS, Drawn by: SKM, Last edited by: smitchell
Location: P:\16300s\16307\Mapping\16307_F2_BrolgaRecords.mxd



Legend

Study Area 10km buffer

Victorian Biodiversity Atlas

Sightings

Figure 2.19 Historical and database records of Brolga within 10km of the Mt Fyans study area

0 300 600 900 1,200 1,500

Metres

N

Scale: 1:30,000 @ A3

Coordinate System: GDA 1994 MGA Zone 54

biosis

Matter: 16307,
Date: 28 July 2022,
Checked by: KS, Drawn by: SKM, Last edited by: smitchell
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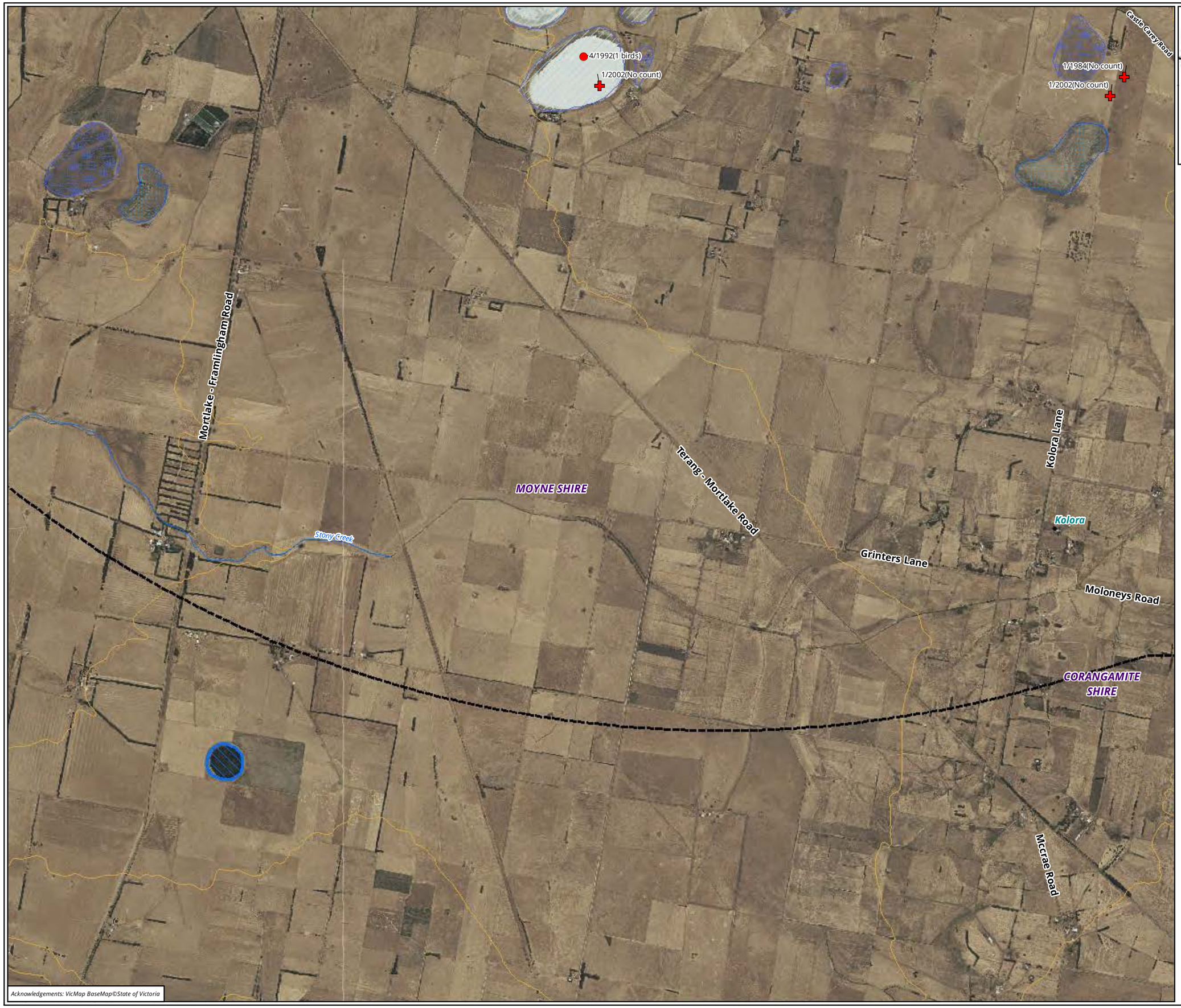
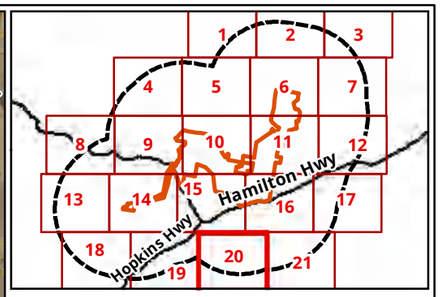




Legend

Study Area 10km buffer

Victorian Biodiversity Atlas

Breeding

Sightings

Figure 2.20 Historical and database records of Brolga within 10km of the Mt Fyans study area

0 300 600 900 1,200 1,500

Metres

N

Scale: 1:30,000 @ A3

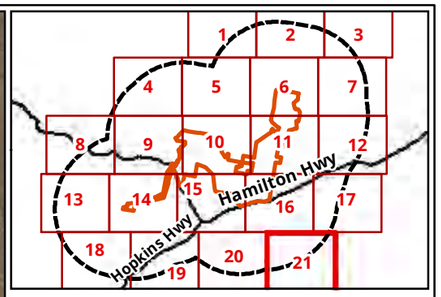
Coordinate System: GDA 1994 MGA Zone 54

biosis

Matter: 16307,
Date: 28 July 2022,
Checked by: KS, Drawn by: SKM, Last edited by: smitchell
Location: P:\16300s\16307\Mapping\16307_F2_BrolgaRecords.mxd

12/2018(2 birds)
9/2007(No count)
2/2008(2 birds)
10/2009(2 birds)
Pair No. 8 (2014)
9/2007(No count)
12/2009(0 birds)
09/2012(2 birds)
8/2007(2 birds)
9/2007(4 birds)
Pair No. 17 (2009)
11/1997(2 birds)
9/2007(No count)
10/2007(2 birds)
4/1993(3 birds)
12/2009(2 birds)
10/2009(2 birds)
1988(6 birds)
12/2009(2 birds)
1993(3 birds)
08/2007(2 birds)
12/2009(2 birds)
12/2009(2 birds)
12/2010(2 birds)
8/2007(2 birds)
9/2007(No count)
MOYNE SHIRE
Darlington - Terang Road
Moloneys Road
CORANGAMITE SHIRE
Castle Carey Road
Glenormiston North
Cruickshanks Road
Harringtons Road
Blacks Road
Wallaces Lane
Glenormiston South
Glenormiston Road
Mount Emu Creek
Terang - Mortlake

Acknowledgements: VicMap BaseMap©State of Victoria



Legend

Study Area 10km buffer

Biosis aerial survey records

- Nest observed
- No nest observed

Brolga Flocking Database

- Sighting

Victorian Biodiversity Atlas

- Breeding
- Sightings

Figure 2.21 Historical and database records of Brolga within 10km of the Mt Fyans study area

0 300 600 900 1,200 1,500
Metres

N

Scale: 1:30,000 @ A3
Coordinate System: GDA 1994 MGA Zone 54

biosis

Matter: 16307,
Date: 28 July 2022,
Checked by: KS, Drawn by: SKM, Last edited by: smitchell
Location: P:\16300s\16307\Mapping\16307_F2_BrolgaRecords.mxd

3.2 Brolga aerial survey

3.2.1 Aerial surveys - 2009

During the 2009 aerial survey 25 Brolgas were observed at 12 locations (Figure 3a). Seven of these were assessed as 'breeding' locations based on the presence of a nest. One of these breeding sites was within the study area, two within 3 kilometres of the wind farm boundary and four were outside the 3 kilometre buffer.

Subsequent ground-truthing of these results within the wind farm and up to 3 kilometres from the wind farm indicated:

- Sites were correct for all breeding locations observed during aerial survey.
- The wetland supporting breeding pair 8 actually had an additional pair (pair 19) nesting within the same wetland (the two sites separated by a rock wall running through the wetland).
- Pair 14 abandoned their nest and did not attempt to breed subsequently. There appeared to be nest site competition occurring within this wetland with Black Swans which subsequently took over the Brolga nest site.

Three of the breeding sites (11, 3 and 17) were on land outside of the study area and Roaring 40s attempted to contact these landowners via the local shire. These efforts did not result in Biosis ecologists gaining access to these properties. Pair 17 was able to be observed clearly from the roadside, so that approach was used in subsequent investigations of that pair.

The landowners of the sites of pairs 6 and 10 had been previously contacted by Roaring 40s and granted access to their properties to observe breeding pairs. Through our access to breeding pairs a PhD student was able to mark several chicks with leg-bands that were subsequently fledged by pairs 10 and 17.

3.2.2 Aerial surveys - 2014

During the 2014 aerial survey 18 Brolgas were observed at nine locations (Figure 3b). Of these, one (Pair 5) was defined as a 'breeding' location based on the direct observation of a Brolga sitting on a nest within the wetland. This observation is from a wetland more than 5 kilometres to the east of the Mount Fyans wind farm study area boundary.

Two Brolga observations from the aerial surveys were within the Mount Fyans wind farm study area (Pair 1 and Pair 6). Pair 1 was within a suitable breeding wetland; however, no nesting was noted. During on-ground ecological field assessments by Biosis the week prior to the aerial survey, it was noted that a pair of Brolgas was in this location near a nest (S. Arber, pers. comm.). Pair 6 was observed within a paddock adjacent to a dam. No nest was visible within the wetland and it did not appear to be suitable for breeding. It is possible that Pair 6 was the same pair of Brolgas observed at the location for Pair 1.

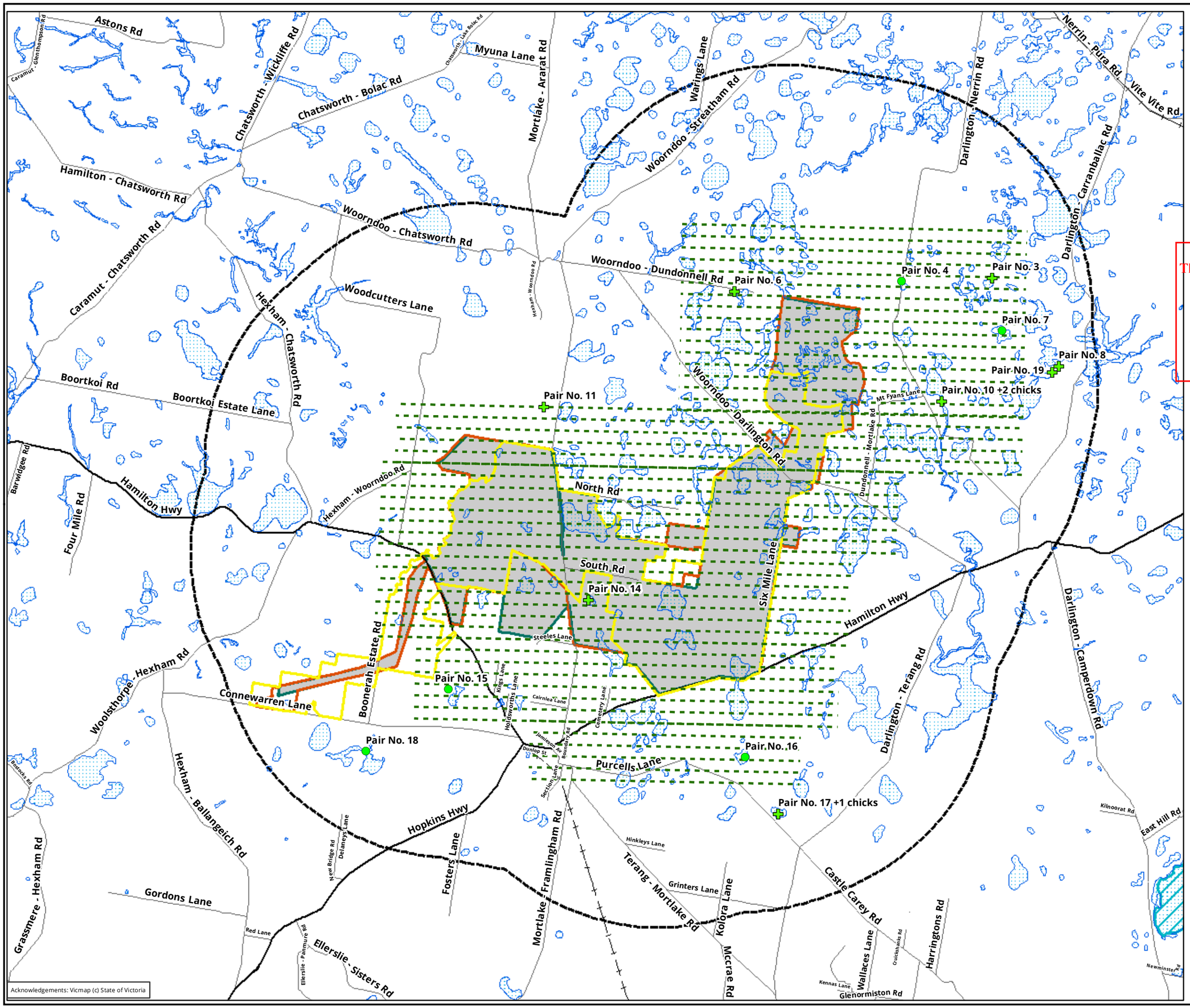
Two Brolga pairs (Pair 2 and Pair 7) were recorded within 3 kilometres of the wind farm boundary. Pair 2 was seen standing next to a nest and moving with the wetland. The nest was in the same location as noted in previous surveys (Pair 6, Figure 3a), although no eggs were visible during the more recent survey. Pair 7 was within a wetland in an open patch within the eucalypt plantation adjacent to a gravel access track. No nest was visible despite the wetland appearing to be suitable for breeding.

The remaining Brolga observations were at a distance greater than 3 kilometres from the Mount Fyans wind farm study area boundary, including Pair 3, Pair 4, Pair 8 and Pair 9. Pairs 3 and 4 were on different sections of Long Dam and could have been the same pair of birds and have moved during the survey. Neither observation was associated with a nest. Pair 8 was within the wetland where breeding had been confirmed in 2009 (Pair 17, Figure 3a). No nest was recorded there during the 2014 aerial survey. Pair 9 was observed within a wetland but no nest was visible. This is the same location where a pair of Brolgs had been recorded in 2009 (Pair 16, Figure 3a), although breeding has not been confirmed at this site.

3.2.3 Aerial surveys - 2019

During the 2019 survey, four Brolgas were observed at two locations, both of which were outside the wind farm study area, but within the buffer area. Both were breeding observations. One observation was of a single bird sitting on a nest (its partner was not observed). The single bird sitting on a nest was at a wetland where the species had not been recorded in previous aerial surveys (Figure 3c). The other observation was of a pair with an unfledged chick. This pair and their chick were at the Mortlake Common, where the species has been recorded in previous aerial surveys.

In addition to the birds observed during the aerial survey, a pair were observed attending (sitting on) a nest near Woorndoo-Dundonnell Road by Matt Gibson (Senior Botanist) on 5 November 2019 (Figure 3c). This is a well-known breeding site located outside the wind farm study area.



Legend

- Project boundary
- Current study area (2017)
- 2009 Study area
- 2009 Study Area 10km buffer
- Aerial survey transects

Brolgas recorded during survey

- Nest observed
- No nest observed

Figure 3a: Mt Fyans Brolga aerial survey results (2009)

0 2 4 6 8

Kilometers

Scale: 1:150,000 @ A3

Coordinate System: GDA 1994 MGA Zone 54

N

Biosis Pty Ltd

Albury, Ballarat, Melbourne, Newcastle, Sydney, Wangaratta & Wollongong

Matter: 16307,
Date: 23 August 2018,
Checked by: KS, Drawn by: SKM, Last edited by: smitchell
Location:P:\16300s\16307\Mapping\16307_F3a_BrolgaAerialSurveys2009

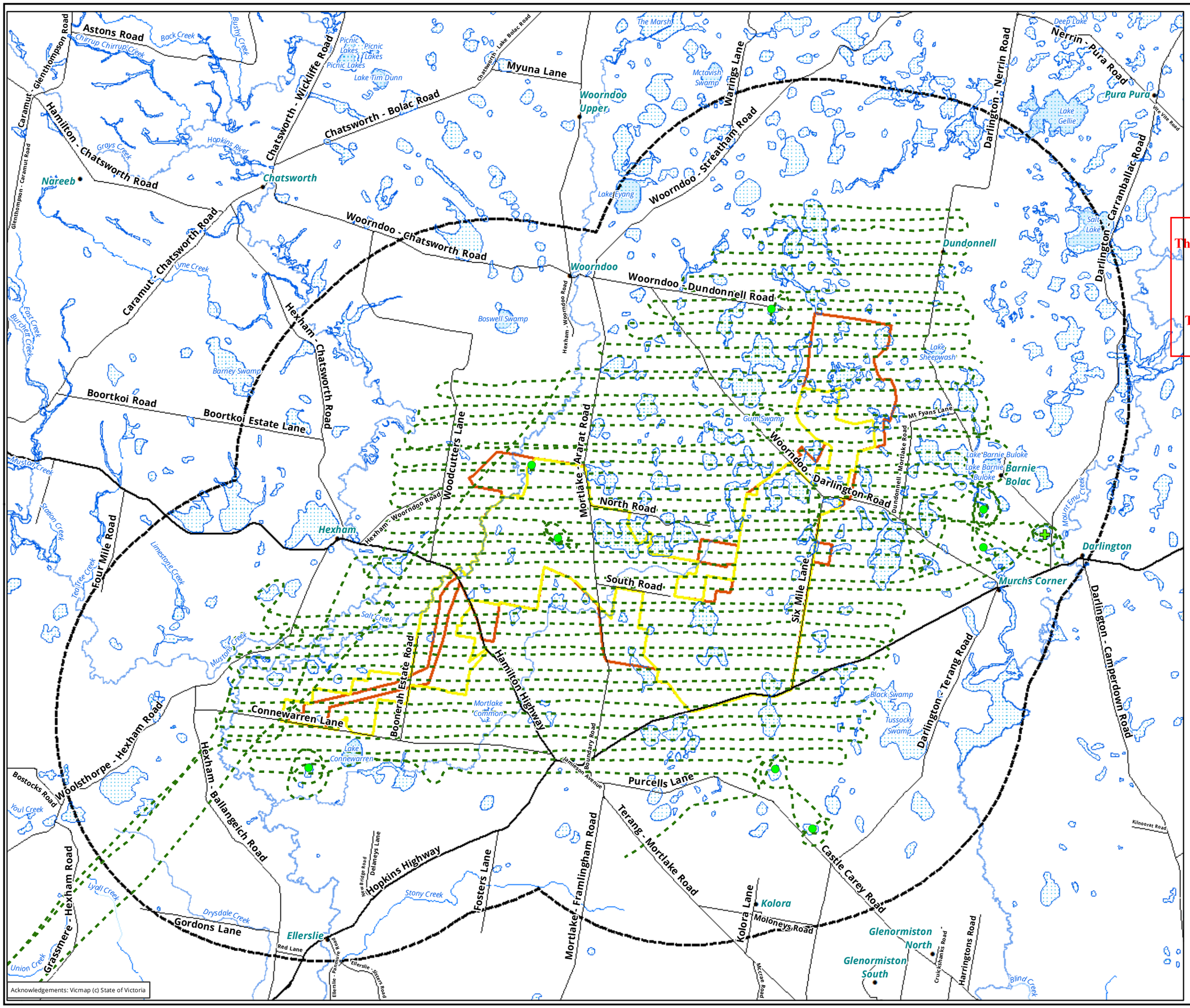
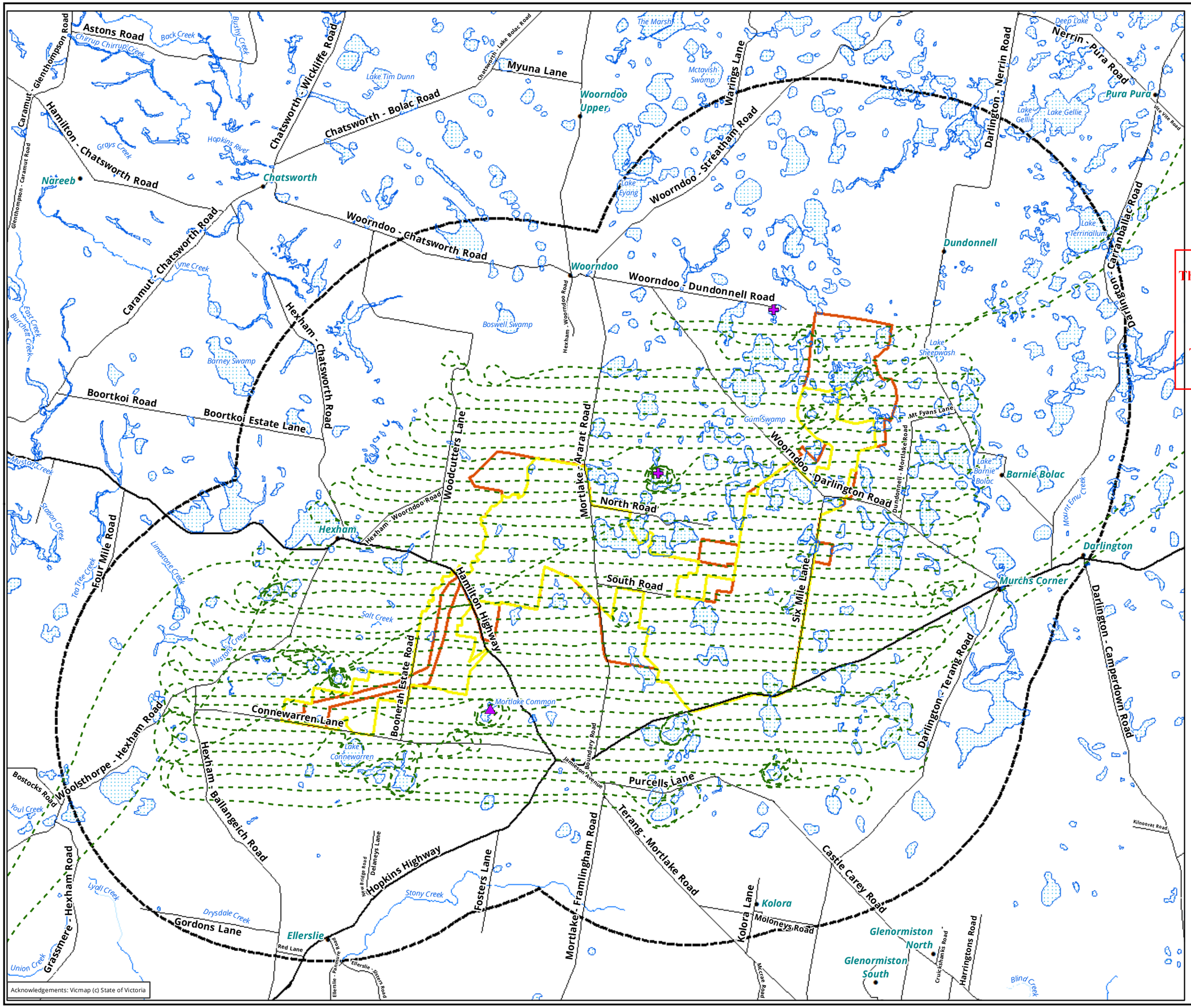


Figure 3b: Mt Fyans Brolga aerial survey results (2014)



Legend

- Project boundary
- Study area
- Study area 10km buffer
- Survey flight path

Brolga recorded during aerial survey 2019

- Nest observed
- Pair observed with chick

Figure 3c Mt Fyans Brolga aerial survey results (2019)

0 1.5 3 4.5 6

Kilometers

Scale: 1:150,000 @ A3

Coordinate System: GDA 1994 MGA Zone 54

N

biosis

Matter: 16307,
Date: 10 February 2022,
Checked by: KS, Drawn by: SKM, Last edited by: smitchell
Location:P:\16300s\16307\Mapping\16307_F3c_BrolgaAerialSurveys2019.mxd

3.3 Brolga home range survey

Home ranges recorded for each Brolga pair at Mount Fyans are shown in Figure 4 and are discussed in detail below.

3.3.1 Mount Fyans

Pair 6

During home range observations 83 individual data points were collected consisting of 67 observation points during the periods of incubation/brooding and 16 points post-hatching. This pair was first observed during an opportunistic observation sitting on a nest on 12 November 2009. Regular observations during November and December 2009 continued to record incubation activity. On 18 January 2010 two chicks were observed. The pair with the two chicks at foot were observed until 22 January 2010. By early February the chicks had disappeared and both adults left the site and were not observed there again after the first week of February 2010. It is assumed that the chicks may have been predated upon. There were three instances where only one of the adult pair could be located.

Pair 8

During home range observations 40 individual data points were collected, all during the period of incubation/brooding. This pair were first observed sitting on a nest on 14 December 2009. During observations over the next seven days the adult on the nest repeatedly rose from the nest upon seeing an approaching observer. Both adults were observed to walk and fly away from the nest on several occasions. The decision was made to abandon observation of this pair due to concerns over disturbance and any impact this may have had on their nesting. The pair was last observed on 4 January 2010 at which point they were still nesting. There were two instances where only one of the adult pair could be located.

Pair 10

During home range observations 49 individual data points were collected, all during the period of post-hatching. This pair was first observed on 20 October 2009 with one chick visible. Two chicks were observed with the pair on 12 November 2009 during an opportunistic observation, however, after this point only one chick remained with the adults. It is assumed the first chick was predated upon. In early January 2010 it became apparent that there was a second pair of Brolgas with a single chick within the same home range as pair 10. Due to inability to distinguish the two pairs and chicks it was assumed that these two pairs had slightly overlapping home ranges. The last home range observation point for pair 10 was recorded on 22 January 2010, however both pairs of birds remained in the area with their chicks until at least March 2010, well past the time of their fledging. It is possible that these pairs remained in the local area as it is also known to be a flocking site. There were no instances where this pair could not be found.

Pair 17

This pair was first observed sitting on a nest on 12 November 2009 during an opportunistic observation. On 3 December 2009 a chick was recorded at-foot with the adults. During the home range observations, 38 individual data points were collected, all during the period of post-hatching. Of these observations a chick was observed with the pair or an individual adult on 35 occasions. The pair was not found at the breeding wetland again after 22 January 2010 when they were last seen there. During subsequent visits to this wetland in February 2010 no Brolgas were observed. On twelve occasions over three days during late January 2010 this pair and chick were unable to be located. On the third day the pair and chick were observed to the north in a paddock 700 metres

away. It was difficult to observe the birds at this site from that distance and it is likely that the pair utilised the northern paddock for foraging. They were subsequently observed foraging at the chick's natal wetland (by then dry) on 21 January 2010. There were two instances where only one of the pair could be located.

Pair 19

During home range observations 36 individual data points were collected, all during the period of incubation/brooding. This pair were first observed sitting on a nest on 14 December 2009. Over the subsequent eight days this pair was observed sitting on a nest. On returning to the site in January 2010 the nest was abandoned and no adults were observed over repeated visits. It is notable that this pair was attempting to nest in the same wetland as pair 8. The pairs were nesting within approximately 400 metres of each other. No interactions between the pairs were observed. There were two instances where only one adult of this pair could be located.

3.3.2 Penshurst

Pair 1

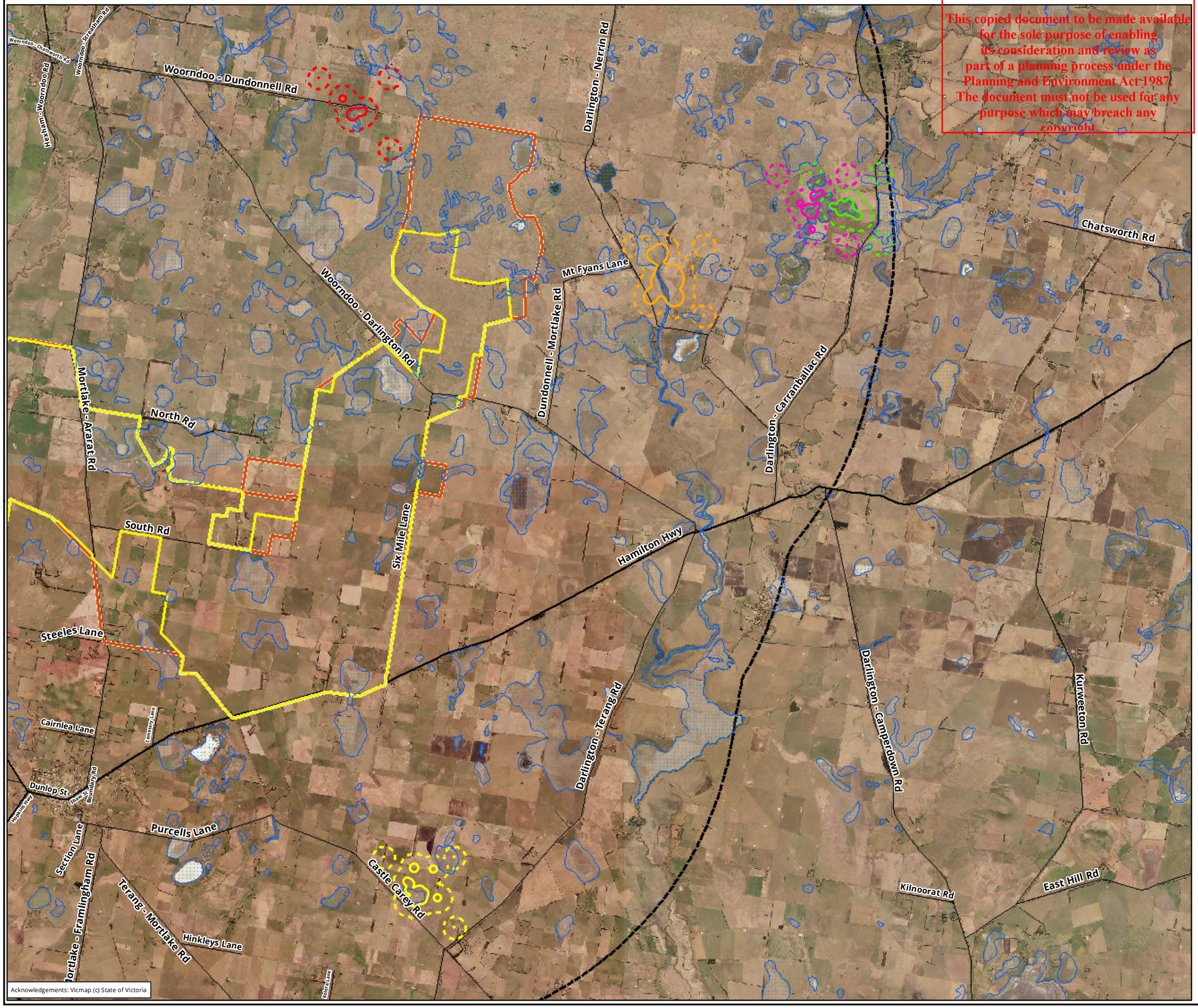
During home range observations 92 individual data points were collected consisting of one during incubation/brooding and 91 post-hatching. This pair was sitting on eggs when first observed during an opportunistic observation on 26 October 2009. They hatched two chicks on 28 October 2009 and the chicks fledged on 18 January 2010 when they were observed flying north-east of Mt Rouse into the distance with both adults. There were no instances where this pair could not be located. The report cover photo shows Pair 1 with two chicks in November 2009.

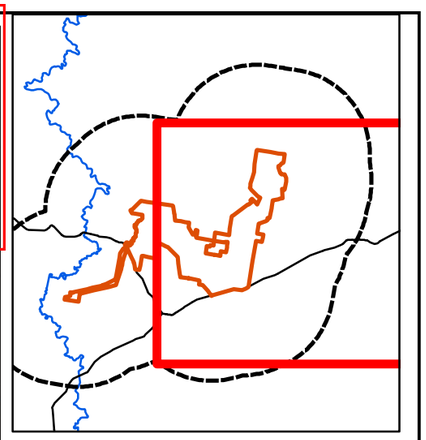
Pair 2

During home range observations 20 individual data points were collected, all during the period of incubation/brooding. This pair were first observed sitting on a nest during an opportunistic observation on 27 October 2009. This nest was abandoned shortly thereafter and this pair had two further unsuccessful attempts at nesting during November. This pair appeared to be competing with Black Swans for nest sites. The pair was not found at the breeding wetland again after 15 December 2009 when they were last observed at the site. There were three instances where only one of the adult pair could be located. During subsequent visits to this wetland in December 2009 and January 2010 Brolgas were observed only on one occasion and were foraging. It is not known if the birds recorded in these latter visits were the same individuals as Pair 2.

Pair 4

During home range observations 36 individual data points were collected, all during the period of incubation/brooding. This pair were first observed sitting, possibly on a nest, during an opportunistic observation on 13 October 2009. It was difficult to establish if a nest was actually present for this pair, however the observed behaviour would indicate that at least one bird was spending time sitting in the same location across multiple observations, which was consistent with incubation activity. There were three instances where only one of the pair could be located. This wetland dried out rapidly during late November and early December and the pair was last observed there on 22 December 2009. During subsequent visits to this wetland in December 2009 and January 2010 no Brolgas were observed.





Legend

- Project boundary
- Study area
- Study area 10km buffer

Brolga home range 99.9% isopleths

- Pair 6
- Pair 8
- Pair 10
- Pair 17
- Pair 19

Brolga hom range 300m buffers

- Pair 6
- Pair 8
- Pair 10
- Pair 17
- Pair 19

Figure 4: Mt Fyans Brolga home range survey results

ADVERTISED PLAN

0 1 2 3 4 5

Kilometers

Scale: 1:100,000 @ A3

Coordinate System: GDA 1994 MGA Zone 54

N

biosis

Matter: 16307,
Date: 10 February 2022,
Checked by: KS, Drawn by: SKM, Last edited by: smitchell
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16307_F4_BrolgaHomeRanges

3.4 Home range analysis

Symbolix (2010a) (Appendix 1) describes the results of the home range survey analysis undertaken for Mount Fyans and Penshurst. On average, the home range for all observed pairs was between 31 and 35 hectares. The average home range is reported as a range is because of uncertainty as to whether 'Pair 10' actually comprised more than one pair.

In order to satisfy the requirements of the *Brolga Guidelines* the home ranges of pairs 6, 8, 10, 17 and 19 at Mount Fyans sites and pairs 1, 2 and 4 at Penshurst sites were used to create specific turbine-free buffers. Analysis of home range data showed that that for 95% of the time, Brolgas will be within 600 metres of the centre of their home range whilst incubating, brooding and rearing fledglings (Symbolix 2010a). As a conservative measure the 99.9% home range was used, rather than the traditionally reported 95% home range. In order to provide an added measure of protection a further 300 metres additional turbine-free buffer was added to the outer perimeter of the home ranges determined by the study. This measure was discussed and agreed with DELWP.

For breeding sites which failed before sufficient data could be collected to assign dimensions of a stable home range, a conservative average radius of containment area was devised to provide a suitable buffer around these sites. The radius of containment is based on data collected from pairs with stable home ranges at Mount Fyans and Penshurst (Symbolix 2010a, Appendix 1). This 99.9% contained average radius of 687.8 metres (lower CI 541.7 metres, upper CI 833.8 metres) also has a 300 metre buffer around it as agreed with DELWP. Subsequent discussion with DELWP indicated that using the upper CI of 833.8 metres would be the most conservative and acceptable approach to satisfying the assessment approach in the *Brolga Guidelines*, resulting in a turbine-free buffer of 833.8 metres. In addition, a 300 metre disturbance buffer is added to provide a total turbine-free buffer radius of 1133.8 metres for each breeding site.

For VBA/DELWP/Birds Australia and other breeding site records, the radius of containment area was also devised to provide a suitable buffer around these sites. The radius of containment is based on data collected from pairs with stable home ranges at Penshurst and Mount Fyans (Symbolix 2010a). The upper CI of 833.8 metres of the average was again used as described above and also has a 300 metre disturbance buffer around it as agreed with DELWP. As a consequence, the turbine-free buffer for each of these breeding sites also has a total radius of 1133.8 metres.

3.5 Landowner survey

The results of the landowner survey are detailed in Appendix 2 and summarized below.

A total of 48 landowners within and surrounding the Mount Fyans wind farm study area were communicated with as part of the Brolga landowner survey. A large number of landowners had reports of Brolgas on their land (Figure 5). Many of the observations consisted of Brolgas being sighted at various locations across the landscape, likely to be associated with general foraging behaviour. Although many reported seeing Brolgas during the breeding season or large groups of Brolgas, most of these observations are not consistent with the definitions of breeding or flocking sites used in the *Brolga Guidelines* (DSE 2012). In particular, where landowners had reported seeing either single or pairs of Brolgas during the breeding season, a breeding site was only identified when a nest, eggs or a chick was observed.

3.6 Additional flocking habitat assessment

3.6.1 Flocking survey at Lake Sheepwash

The surveys completed by Biosis confirmed that Lake Sheepwash was being used by a number of Brolgas as a night roost. The maximum number of Brolga observed roosting overnight was 36 on 30 May 2013. Similar numbers were recorded across the four days spent observing this flock. When roosting at Lake Sheepwash the majority of the flock was observed using the southern end of the wetland. This observation is consistent with advice from the landowner that the dam wall was broken during recent heavy rains, resulting in the lake only filling with water at the southern end at the dam wall.

Brolgas were also recorded moving into the surrounding landscape during the day and returning to the roost at night. On this basis and taking into account the reported historical use of the site, the dam meets the definition of a flocking site.

Figure 2 shows the location of the flocking site observed by Biosis in May/June 2013. The additional observational data of the Brolgas flocking at Lake Sheepwash is included in Appendix 3.

3.6.2 Review of potential flocking sites

The wetland at Site A is directly to the west of Lake Barnie Bolac, which is an established flock roost site with observations in most years since 1990. In May 2013, survey being undertaken by Biosis ecologists observed Brolgas moving from Lake Sheepwash and foraging in the drainage line that runs through the wetland at Site A before returning to Lake Sheepwash (refer to Appendix 3). The landowner also observed this flocking event and foraging behaviour. The landowner observed a second flocking event in April 2013 and indicated that he had seen a flock foraging in the wetland for a period during the day.

There are additional database records that relate to flocking events where groups of Brolgas (36 and 24 birds) were observed foraging at this wetland, however, aerial photos from 2012 show that the wetland does not hold water over summer months.

The Dundonnell Wind Farm Brolga Assessment Report (Oct 2014), states that the wetland was included in annual flocking / breeding surveys held between 1980 and 2002. No flocking records were made as a result of these surveys.

Based on a review of the information for Site A, the hydrology of the wetland is unlikely to support a flock roost site. It is likely that the wetland provides a foraging opportunity for Brolgas who are known to roost at the nearby Lake Sheepwash and Lake Barnie Bolac.

Site B is described as a salt lake with minimal vegetation. During 2014, Brolgas were observed periodically using the wetland as a roost site during the day as well as roosting at Lake Sheepwash during the day and overnight. This group of Brolgas were observed moving around the landscape together and feeding in large numbers on grain trails (used for sheep feeding) approximately 800 metres north and 3 kilometres north-east of the site. It is likely the presence of the grain trails increased the concentration of Brolgas in the area at this time, leading to the wetland being used as a day roost site.

Based on the Brolga Guidelines, the wetland at Site B is not considered to be a flock roost site due to the flocks of Brolgas using the site periodically during the day over a three month period in 2014. It was noted that the flocks using the site during the day would move to other wetlands for nocturnal roosting.

For Site C, a review of the VBA shows five records of flocking events at this location, with three of these events during the flocking season. However, aerial imagery from February 2013, which

coincides with one of the flocking season records, shows that the wetland did not contain water. In addition, aerial imagery from 2012 shows that the wetland did not hold water over the summer months (with the exception of the stock watering dam).

The Dundonnell Wind Farm Brolga Assessment Report (Oct 2014), states that the wetland was included in the annual flocking / breeding surveys between 1980 and 2007. No flocking records were made as a result of these surveys.

Recent discussions with the current landowners has confirmed that there have only been a few sightings at this site over the 10 years they have lived there. The most Brolgas they have observed were 3-4 Brolgas foraging in paddocks in approximately 2016. The landowner also noted that the low-lying areas do not hold water over summer.

As outlined in Section 2.5.2, in April 2019, it was accepted by DELWP that these three sites are unsuitable flock roost sites as assessed against the *Brolga Guidelines* (DSE 2012).

3.7 Additional breeding habitat assessment

Throughout the regular observations of Site 1 and the reference Site 2 undertaken by Hydro Tasmania, there were no observations of Brolga within the wetlands at these sites with no evidence of breeding.

During the habitat assessments of Site 1 and Site 3, Biosis determined that neither of these sites provided the appropriate habitat features suitable for nesting.

Site 1 is located within Salt Creek. There are low-lying flats adjacent to the creek which may at times flood and hold water, but it is unlikely that these areas would provide the hydro period required for successful breeding. The habitat within Salt Creek itself was mostly dense vegetation in the form of reeds. This densely structured habitat was also largely unsuitable for breeding. We are not aware of Brolgas breeding in a creek on the volcanic plain which is known to flow regularly.

At Site 3, two large low-lying areas were examined. These areas would have once been wetlands, however a noticeable drainage line passes through both areas resulting in the current dry conditions. Both areas are dominated by pasture grasses and other weeds, are heavily grazed by stock and showed little sign of supporting aquatic plants. It was determined from the site assessment that these wetland areas may hold water for short periods during wet seasons, however, they are unlikely to hold water long enough for breeding. The north-eastern tip of this wetland complex may hold water for longer periods of time, however, no suitable breeding habitat was identified.

The western landowner for Site 3 was consulted and reported that they had observed Brolgas in the area in the early 1970s, prior to the wetland being drained. While the wetland does hold small amounts of water each year, it is not for long enough periods to support breeding. No nests have been seen in the area.

3.8 Brolga records at a regional scale

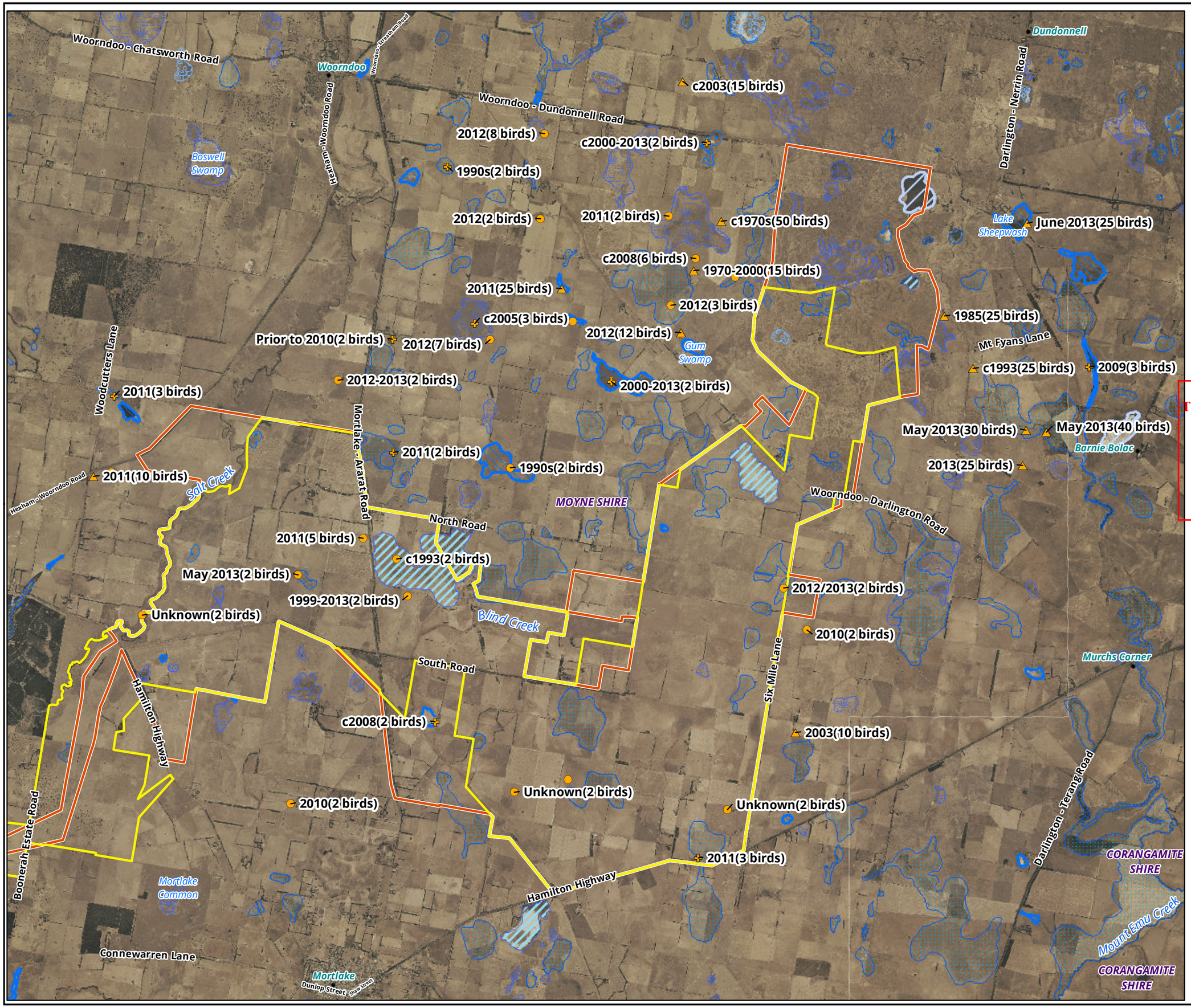
The BFD provides information on historical Brolga flocking sites for south-west Victoria. Sheldon (2004) identified 29 flocking sites (including one site in South Australia) based on a set of criteria similar to those outlined in the *Brolga Guidelines* (DSE 2012). These historical flocking sites are reflected in the number of observations of large groups of Brolgas throughout south-west Victoria and as seen in Figure 6 which includes the cumulative database records from the VBA, BirdLife Australia and BFD.

At the regional scale, Figure 6 highlights where the important flocking sites for Brolgas occur and provides a perspective for the Mount Fyans study area. The flocking sites relevant to the study area include Lake Barnie Bolac, Lake Sheepwash and Long Dam. It is evident that these sites have historically had lower numbers of Brolga compared to some of the other important flocking sites within the region. Sites such as Kaladbro, Penshurst and Willaura have had the most significant numbers of flocking Brolga, with these sites being able to support numbers greater than 200 birds. Other flocking sites near Cressy, Skipton/Streatham and Edenhope also show historical records of flocking numbers greater than 50 birds and several records of flocks between 10 and 50 birds. The large numbers of sightings of between 1 and 9 birds surrounding Mount Fyans, particularly to the north and east, are mostly due to the results of the individual GPS tracking data points from the South-West Victoria Brolga Research Project.

3.9 Cumulative impacts of wind energy developments

The Mount Fyans wind farm has been designed and proposed in accordance with the *Brolga Guidelines.* Its overall objective to avoid a cumulative effect on the Brolga population by direct impacts through collisions with turbines, as well as indirect impacts such as disturbance or barrier effects. This is achieved by the requirement of each individual wind farm to have, 'at minimum, a zero net impact on the Victorian Brolga population'. The *Brolga Guidelines* propose methods such as turbine free buffers and offsets. If an impact does occur, mitigation measures must be taken to ensure that each wind farm achieves a zero net impact. The common application of the *Brolga Guidelines* ensures there is no cumulative impacts to the Victorian Brolga population resulting from multiple wind farms operating in proximity to one another.

For Mount Fyans wind farm, Brolga disturbance has been addressed through the application of turbine-free buffers on all confirmed breeding and flocking sites. Similarly, the 'barrier effect' of Brolga not flying between flock roost sites in order to avoid turbines is not considered to be a significant risk. A number of flock roost sites exist to the north, north-east and east of the Mount Fyans study area such as Lake Barnie Bolac, Lake Sheepwash, Lake Terrinalum, Lake Gellie and Chinaman Swamp. Brolga flying between these flock roost sites will not encounter turbines associated with the Mount Fyans project.



Legend

- Project boundary
- Study area

Landholder Brolga records

- Breeding/nest site
- Sighting
- Sighting ≥10 birds

DELWP Wetlands

- 2 - Freshwater meadow
- 3 - Shallow freshwater marsh
- 4 - Deep freshwater marsh
- 5 - Permanent open freshwater
- 6 - Semi-permanent saline
- 7 - Permanent saline
- 99 - No Category

Figure 5: Mt Fyans landowner Brolga survey results

0 0.8 1.6 2.4 3.2 4

Kilometers

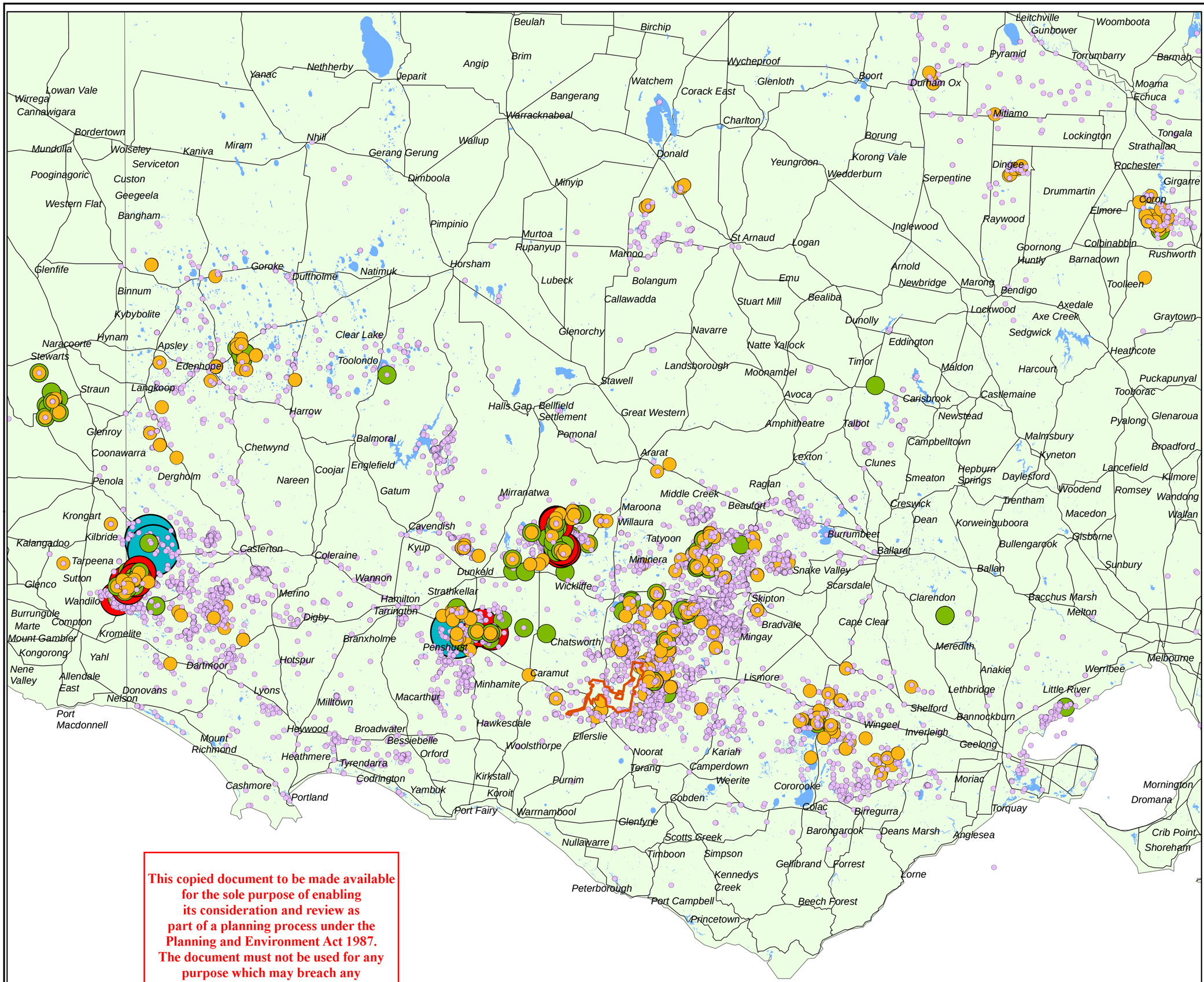
Scale: 1:80,000 @ A3

Coordinate System: GDA 1994 MGA Zone 54

N

biosis

Matter: 16307
Date: 10 February 2022,
Checked by: KS, Drawn by: JMS, Last edited by: smitchell
Location:P:\16300s\16307\Mapping
16307_F5_LandholderBrolgaRecords



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Legend

Brolga numbers

- 1 - 9
- 10 - 50
- 51 - 200
- 201 - 500
- 500+
- Study area

Figure 6: Cumulative Brolga records for south-west Victoria

0 10 20 30 40 50

Kilometers

Scale: 1:1,200,000 @ A3

Coordinate System: GDA 1994 MGA Zone 54

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Biosis Pty Ltd

Albury, Ballarat, Melbourne, Newcastle, Sydney, Wangaratta & Wollongong

Matter: 16307,
Date: 27 July 2018,
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16307_F6_Regional_overview

4 Biodiversity Legislation and Government Policy

This section provides a summary of the key biodiversity legislation and government policy relevant to the Brolga within Victoria.

Where available, links to further information are provided. This section does not describe the legislation and policy in detail and guidance provided here does not constitute legal advice.

4.1 Flora and Fauna Guarantee Act 1988 (FFG Act)

The FFG Act is the key piece of Victorian legislation for the conservation of threatened species and communities and for the management of potentially threatening processes. It provides a list of threatened plant and animal species, ecological communities and potentially threatening processes for Victoria. All listed items under the FFG Act must have an Action Statement prepared following their listing. Action Statements provide background information on the species, list the threatening processes affecting the species, and provide medium to long-term management actions with the objective of conserving the species.

The Brolga is listed as 'threatened' under the FFG Act and an Action Statement has been prepared for the species. The FFG Act is not responsible for wind farm approvals, however, development of the proposed wind farm must have regards to the management actions outlined in the Action Statement for the Brolga.

Link for further information: http://www.depi.vic.gov.au/environment-and-wildlife/threatened-species-and-communities/flora-and-fauna-guarantee-act-1988

4.2 Planning and Environment Act 1987 (incl. Planning Schemes)

The *Planning and Environment Act 1987* controls the planning and development of land in Victoria, including wind farm projects, and provides for the development of planning schemes for all municipalities. Individual municipalities are responsible for the assessment and approval of proposed wind farms. Two of the key clauses within Victorian planning schemes that relate to biodiversity considerations for wind farm proposals are summarised below:

- Clause 12.01 (Biodiversity) outlines the requirement that Action Statements prepared under the FFG Act must be considered in the planning and approvals process. It also includes a strategy for habitat conservation that must also be considered at the planning stage.
- Clause 52.32 (Wind Energy Facilities) outlines the requirement that potential impacts from a proposed wind farm must have consideration of the natural environment and systems. In particular, a wind farm application must include an assessment of its likely impacts on any species that is listed under the FFG Act or *Environment Protection and Biodiversity Conservation Act 1999*.

4.3 Environment Effects Act 1978

The *Environment Effects Act* 1978 establishes a process to assess the environmental impacts of a project. If applicable, the Act requires that an Environment Effects Statement (EES) be prepared by the proponent. The EES is submitted to the Minister for Planning and enables an assessment of potential environmental effects of the proposed development.

The general objective of the assessment process is *to provide for the transparent, integrated and timely assessment of the environmental effects of projects capable of having a significant effect on the environment* (DSE 2006).

The 'Ministerial Guidelines for Assessment of Environmental Effects under the Environment Effects Act 1978' (DSE 2006) provide a range of criteria that can be used to determine whether an EES may be required for a project. These criteria relate to individual potential environmental effects and a combination of (two or more) potential environmental effects.

However, the ministerial guidelines are not binding, and the decision as to whether an EES is required is ultimately at the discretion of the Minister for Planning.

4.4 Brolga Guidelines (2012)

The *Interim Guidelines for the Assessment, Avoidance, Mitigation and Offsetting of Potential Wind Farm Impacts on the Victorian Brolga Population 2011* (*Brolga Guidelines*) (DSE 2012) have been prepared by State government and the Brolga Scientific Panel, consisting of experts on the Brolga and impacts on avifauna associated with wind farms.

The *Brolga Guidelines* were first introduced in draft format in 2009 (DSE 2009). This document was updated and expanded upon to produce the document published in 2011 (DSE 2011). The current version of the *Brolga Guidelines* includes minor amendments and was published in February 2012 (DSE 2012).

The *Brolga Guidelines* were prepared in response to the potential risks posed by the wind industry in Victoria on the south-west population of Brolgas. They provide a framework to manage direct and cumulative impacts by individual and multiple wind farms proposed and approved throughout the Brolga's range. The main objective of the *Brolga Guidelines* is to have a zero net impact on the population of Brolgas within Victoria, facilitated through an appropriate assessment and approvals process.

The *Brolga Guidelines* define Brolga breeding site and flock roost sites (flocking sites) by providing a set of criteria that can be applied to known records. By clearly defining a breeding or flocking site, these important locations can be protected through the application of turbine-free buffers. The *Brolga Guidelines* (DSE 2012) provide the following definitions of breeding and flocking sites:

- **Breeding site:** The nest of a Brolga breeding pair and the perimeter of the surrounding wetland. Also includes wetlands with pervious records of Brolga nests from any relevant information source. A wetland remains a breeding site provided it has not been permanently drained and/or planted with trees. Wetlands that have been ploughed can still be breeding sites providing the wetland retains some level of filling.
- **Flock roost site:** A permanent or ephemeral wetland known to be utilised by a Brolga flock for nocturnal roosting. Specifically, the flock site should meet ***all three*** criteria listed in Table 3 (DSE 2012).

Table 3 Criteria for identifying a Brolga flock roost site (table sourced from DSE 2012)

Criteria	Justification
More than one year of recording.	To ensure the selection of traditional and regularly used sites.
One or more records of counts equal to or greater than 10 birds.	To include sites which have been used often or traditionally by flocking Brolgas. The assumption is made that if more than 10 birds are recorded on a wetland, flocking behaviour is likely.
Recorded in more than one month.	To include sites where Brolgas Flock for periods greater than one day or one week, i.e. to include sites used traditionally for the majority of the flocking or non-breeding season.

For the purposes of this report, our assessment of Brolga flocking sites has been undertaken in accordance with the criteria outlined above. Our interpretation of the *Brolga Guidelines* (2012) is that the intent of the definition of a flock roost site is for the protection of large flocks that regularly use a wetland for roosting for the majority of the flocking season, in order to assess potential impacts on these sites and provide mitigation measures to minimise and avoid impacts (i.e. through the use of appropriate buffers). Quantitative compliance with the criteria is required but is not sufficient to determine the presence of a flock roost site. Further assessment is generally required to determine that the definition of a flock roost site is met.

In Victoria, the non-breeding season for Brolgas occurs in summer and autumn (DSE 2003). During this time, it can be expected that groups of Brolgas will flock together and move between waterbodies for the purpose of foraging. Occasionally groups of Brolgas may roost at a nearby waterbody for a period of time. In doing so, Brolgas can regularly move up to 3 kilometres from the flock roosting wetland but may move up to 5 kilometres (Herring 2005). Hence, the 5 kilometres buffer has been applied around flock roost sites to avoid Brolgas using surrounding wetlands.

During foraging activities away from the flock roost site, Brolgas can gather in large groups at roost sites at permanent or ephemeral freshwater or saline wetlands (including dams, swamps, etc.) to rest day or night. They will generally return to a flock roost sites to roost nocturnally.

For a wetland to be classified a flock roost site it must possess a unique combination of suitable roosting habitat of deep freshwater marshes and permanent freshwater or saline open water and have a close proximity to suitable feeding habitat (Sheldon 2004). A flock roost site holds water for the majority of the summer and autumn flocking period and as Brolgas generally return to traditional flock roost sites each year the wetland should possess long term historical records of its use by large numbers of brolgas for nocturnal roosting during the flocking season. A wetland that has counts of ten or more Brolgas over several years and over several months within a year is a good indicator of a potential flock roost site, however, these sites require further qualitative analysis to confirm actual use by Brolgas.

The approach to survey and assessment of Brolgas at Mount Fyans began prior to the release of the initial *Brolga Guidelines*. Subsequent to this, the approach has always been in compliance with the version of the *Brolga Guidelines* available at the time. As the *Brolga Guidelines* have been updated and evolved over time, the approach to Brolga survey and assessment for Mount Fyans has responded to these changes accordingly.

5 Brolga breeding and flocking site constraints

The objective of this assessment is to compile and consolidate the available information and data on Brolgas relevant to the Mount Fyans wind farm study area, and to determine the breeding and flocking sites with potential to be impacted by the proposed wind farm. In accordance with the *Brolga Guidelines*, appropriate buffers are applied to breeding and flocking sites based on a set of justifiable criteria. The process for determining the buffers for breeding and flocking sites is outlined below and a consolidated map showing the sites relevant to the study area is provided in Figure 7.

5.1 Breeding sites

As outlined in section 4.4, a Brolga breeding site is defined by the *Brolga Guidelines* as 'the nest of a Brolga breeding pair and the perimeter of the surrounding wetland' (DSE 2012). Paired Brolgas establish breeding territories that typically consist of a nest constructed on a vegetated platform within a shallow herb-dominated or sedge-dominated freshwater wetland and the associated foraging areas adjacent to the breeding wetland (DSE 2003). Clutches of usually two eggs are laid in the large nest mounds constructed from vegetation sourced from the surrounding wetland. As a long-lived species, Brolga pairs can return to defend breeding territories for many years (DSE 2003).

A large number of Brolga records listed as 'breeding' occur within 10 kilometres of the Mount Fyans wind farm study area. As outlined in Section 3.1 many of the historical records within the databases have a varying degree of accuracy. In consideration of assigning breeding sites as defined by the *Brolga Guidelines*, the accuracy and reliability of these database records in respect to the study area must also be considered at a reasonable level. Therefore, to confidently assign appropriate protection measures for breeding sites, the following parameters have been applied to the current and historical breeding records for Brolgas with the aim of providing a consolidated and justified dataset for breeding sites within 10 kilometres of the study area:

- Breeding sites confirmed through aerial and home range surveys are included.
- Breeding observations from the VBA_25 dataset are included as they provide reasonable certainty in a breeding site.
- Historical records/observations with an accuracy margin of greater than 500 metres are considered too unreliable to provide confidence in a nest location. Consequently, records from the VBA_100 dataset (>500 metres accuracy) are omitted.
- Any duplicates across the databases have been removed to avoid confusion and potential over-representation of a particular site.
- Nesting sites identified by landowners are only included where a nest, eggs or chicks were directly observed.

The consolidated dataset for breeding sites within 10 kilometres of the Mount Fyans wind farm study area is displayed in Figure 7. It consists of three sites where the breeding buffers are within or overlap the boundary of the study area. A further 24 breeding sites are located outside the study area but within 10 kilometres of the study area boundary.

5.1.1 Turbine-free breeding site buffers

Turbine-free buffers are assigned to Brolga breeding sites to avoid significant impacts posed by the wind farm on the likelihood of successful reproduction. The buffers assigned to breeding sites are applied to the boundary of the wetland for which the breeding record/observation applies. This allows for variation in the actual location of where the nest may be located within the wetland from one breeding season to another.

The *Brolga Guidelines* state that "turbine-free buffers should be designed to remove any significant impact on Brolgas within their breeding and non-breeding home ranges" (DSE 2012, p 11). Consequently, the *Brolga Guidelines* outline the general recommendation that a 3.2 kilometres radius turbine-free buffer be applied to breeding sites to meet the objectives of reducing impacts.

The *Brolga Guidelines* also allow that, where detailed data has been collected to determine actual home range size(s) of Brolga breeding pairs, that information can be used to determine applicable turbine-free buffers, rather than applying the generic distance of 3.2 kilometres. Consequently, the home range analysis data collected for Mount Fyans and Penshurst proposed wind farm sites was used to assign the turbine-free breeding buffers for Mount Fyans, in accordance with the *Brolga Guidelines* and in consultation with DELWP. As outlined in Section 3.4, the total turbine-free buffer assigned to each breeding site has a total radius of 1133.8 metres. The turbine-free buffers for the consolidated set of breeding records is shown in Figure 7.

5.2 Flocking sites

Outside of the breeding season, Brolgas flock at large, permanent wetlands where they forage and roost communally. The flocking season generally occurs from December to June in southern Australia (Sheldon 2004). The *Brolga Guidelines* (DSE 2012) require that a turbine free buffer of 5 kilometres must be used around flocking sites to protect the species while flocking. There can be hundreds of Brolga congregating simultaneously at flocking sites, where they make daily movements to and from foraging, loafing and drinking areas. Sheldon (2004) reports that the majority of the Victorian Brolga population is usually found at 4-6 sites during the flocking season. This makes flocking sites potentially more risky within proximity of potential wind energy sites due to the larger number of individuals and number of flights that may occur.

Brolga are known to flock in the region at Lake Barnie Bolac (Sheldon 2004). Although there are records of high numbers of Brolga flocks at Lake Barnie Bolac, this site has generally received smaller flocks than some of the other major flocking sites within south-west Victoria. Historically, the sites that have been known to support the largest numbers of Brolga consistently during the flocking season include Willaura, Penshurst, Kaladbro and the Cressy region (Sheldon 2004; King 2008).

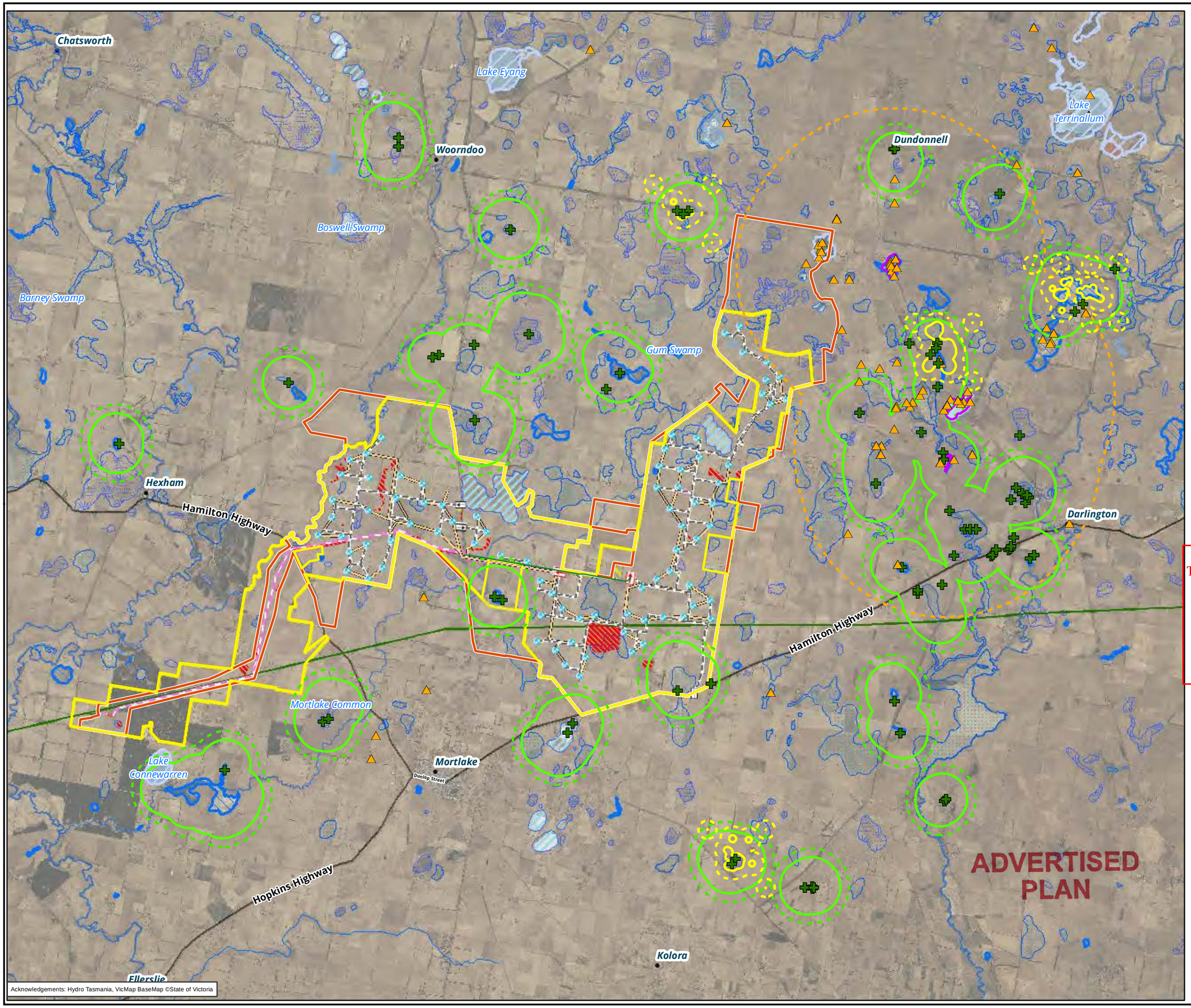
Long Dam is a fresh water spring-fed wetland on private property that adjoins Lake Barnie Bolac to the north. The statutory Planning Panel established to assess the proposed Mortlake Wind Energy Facility in 2010 (DPCD 2010) determined Long Dam to be a potential Brolga flocking site (or part of a complex of wetland flocking sites) due to records from the land owner and the permanency of the water within the wetland. The Panel then considered that a turbine within 3.5 to 5 kilometres of Long Dam could present a significant risk to Brolgas. Therefore, as part of the Mount Fyans wind farm, Long Dam is considered to be a Brolga flocking site.

The surveys undertaken by Biosis in 2013 confirmed that Lake Sheepwash is used as a flock roost site by Brolgas. Additional advice from DELWP concurs that this has been the case in the past at this location.

In summary, the Brolga flocking sites within 10 kilometres of the Mount Fyans wind farm study area include Lake Barnie Bolac, Long Dam and Lake Sheepwash (Figure 7). Analysis of the databases records and observations from the landowner survey found no additional sites that meet the criteria of a flock roost site, as defined by the *Brolga Guidelines*, within 10 kilometres of study area.

5.2.1 Turbine-free flocking site buffers

The recommendation within the *Brolga Guidelines* (DSE 2012) is that a 5 kilometres radius turbine-free buffer from flock roost sites will adequately meet the objectives of avoiding and minimising impacts on non-breeding habitats. To satisfy the *Brolga Guidelines* for the Mount Fyans wind farm site, Lake Barnie Bolac, Long Dam and Lake Sheepwash will need to be buffered accordingly using a 5 kilometres turbine-free buffer, as shown in Figure 7.



Acknowledgements: Hydro Tasmania, VicMap BaseMap ©State of Victoria

Legend

- Study area
- Project boundary
- Breeding record
- Sighting of ≥10 birds
- Flocking site
- Turbine free flocking buffer
- Turbine free breeding buffer
- Disturbance buffer
- Home range buffer
- Home range disturbance buffer

Proposed Windfarm layout

- Project boundary
- Wind turbine indicative location
- Internal access track
- Road access - construction stage
- Road access - operating stage
- Construction compound
- Works exclusion area
- Underground cable
- Substation footprint
- Indicative transmission route
- Existing transmission line 500kV

Figure 7: Mt Fyans wind farm consolidated Brolga records and turbine free buffer zones

0 1 2 3 4 5

Kilometers

Scale: 1:120,000 @ A3

Coordinate System: GDA 1994 MGA Zone 54

N

Biosis Pty Ltd

Albury, Ballarat, Melbourne, Newcastle, Sydney, Wangaratta & Wollongong

Matter: 16307,
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16307_F7_ConsolidatedRecords

6 Collision risk and potential offset measures for Brolgas

Biosis has evaluated the potential for undertaking turbine and powerline collision risk modelling and population viability analysis (PVA) for Brolgas at Mount Fyans Wind Farm. This evaluation was discussed in detail with officers of DELWP at a meeting in Geelong on 18 July 2018.

Collision risk modelling has been used as a component of impact assessment for a number of wind energy facilities within the Victorian distributional range of Brolgas. Collision risk modelling offers a quantified consideration of possible numbers of Brolgas that might be involved in collisions on the basis of explicit information about the number, layout, dimensions, rotor-speed and other aspects of turbines, and the routes and dimensions of powerlines, along with explicit inputs for the numbers and behaviours of the birds and their flights. The process, as outlined under Level Three of the *Brolga Guidelines* (DSE 2012), is to use the results of collision risk modelling as inputs to PVA. The PVA component provides an indication of the likely effect on the Victorian population of Brolgas (measured as altered extinction risk) and indicates the number of Brolgas that might be required to be added to the population in order to compensate for any losses due to collisions. Previous wind farms that have followed this process have used it to determine compensatory measures aimed at improving survivorship and productivity within the Brolga population. As per the *Brolga Guidelines* (DSE 2012), these mechanisms are intended to ensure that each wind farm achieves a zero net impact on the Brolga population.

In such previous assessments a number of informed assumptions have been used to quantify the frequency and heights of Brolga flights for use as input values to collision risk modelling. This has been because, whilst it may be possible to document Brolga flights near centres of their activities such as breeding and flocking locations, it is not feasible to obtain representative measures of their flights across the general landscape away from such locations. Even at centres of their activity, Brolgas may rarely fly and it is notable that in the study of breeding home ranges detailed above for Mount Fyans, there were 394 observations of Brolgas but they included only one instance of Brolgas in flight. The turbine layout for Mount Fyans Wind Farm has been designed to explicitly avoid breeding and flocking sites and turbine-free buffers around breeding wetlands are integral to its design.

We note that collision risk modelling is a quantitative mathematical approach used to provide estimates of potential risk. In the situation at Mount Fyans Wind Farm we do not have an empirical basis for a number of Brolga flights that could be used as valid inputs to collision risk modelling.

No natural flights that would create a collision risk were recorded during substantial fieldwork documenting Brolga breeding home ranges for the Mount Fyans project or while following flight paths during activity at nearby flocking sites. During home range investigations Pair 8 were seen to walk and make several flights away from the nest. These were very short and low movements near to the nest. These flights were considered to be responses to the presence of an observer and for this reason further visits to that pair were discontinued. We do not consider it appropriate to include such 'forced' flights as part of an input to the collision risk modelling.

For the Mount Fyans Wind Farm, Biosis considered how to estimate collision risk and the question of whether it is appropriate to run the mathematical model for scenarios that lack any empirical basis for Brolga flights.

In Biosis' view, and with the reputation of our model also in mind, Biosis determined it was not appropriate to run the model without a defensible value for the key input for number of Brolga flights. Biosis has previously adopted the same position for other species where a low number of flights were recorded at various wind farms and have considered the number of records was insufficient to provide an appropriately representative value for use in our model.

Without an empirical value for numbers of Brolga flights as an essential input parameter, we conclude that there is no basis for collision risk modelling as means to estimate collision risk for Brolgas at Mount Fyans Wind Farm site.

This situation and position was discussed at the meeting with DELWP on 18 July 2018. While collision risk for Brolgas at Mount Fyans Wind Farm cannot be quantified by means of collision risk modelling, some residual collision risk may still exist. It was proposed to DELWP that a straightforward method to determine an appropriate level of compensatory offset measures for Mount Fyans Wind Farm is to draw this from other wind farms that have used collision risk modelling and PVA for that purpose. As a consequence, a review was undertaken. It checked for the results of collision risk modelling (combined for the risks of collisions with both turbines and new overhead powerlines) for other wind farms that are within the distribution of Brolgas in Victoria. Some of these have been approved while others have not proceeded. Stockyard Hill, Dundonnell and Golden Plains wind farms have been approved since the *Brolga Guidelines* came into operation in 2012 and for those wind farms a Level Three assessment under the *Brolga Guidelines* was required.

Table 4 provides collision risk results for Brolgas for five wind farms. For each wind farm the table details the total number of turbines; collision risk modelling projections at 95% avoidance rate assessed as a per-turbine per-annum rate and for the rate for the entire proposed wind farm. The table also sets out the average number of Brolga mortalities over a projected 25-year life of each wind farm that would be required to be offset by recruitment into the Victorian population to compensate for projected losses.

Table 4 Collision risk modelling results for Brolgas for five wind farms in western Victoria (95% avoidance rate)

Wind farm	Number of turbines	CRM projected collision rate per-turbine per annum	CRM projected collision rate entire wind farm per annum	CRM total projected collisions over 25 years	Equates to average of one replacement Brolga per:
Mortlake East	46	0.0024	0.11	2.7	9.3 years
Penshurst	223	0.0012	0.27	6.8	3.7 years
Stockyard Hill	149	0.0006	0.09	2.3	10.7 years
Dundonnell	96	0.0039	0.38	9.5	2.6 years
Golden Plains	228	0.0008	0.19	4.6	5.4 years

The information set out in Table 4 is drawn from collision risk modelling undertaken for three wind farms by Biosis using the Biosis collision risk model and for two wind farms by BLA using the Band/BLA model. There are differences between these models that may have influenced their respective results, but we present them here at face value. Results are also influenced by the various sizes of turbines at these wind farms and the number of Brolgas and their variable utilisation of the wind farms.

Results of turbine collision risk modelling for each of these wind farms were provided for a range of potential avoidance rates. Avoidance rate is a measure of the capacity of a bird to avoid a potential collision. A 90% avoidance rate means that a bird will fail to avoid a collision in one of every ten flights towards a turbine, while 99% avoidance rate means that a bird will fail to do so in one of every 100 flights towards a turbine. Overseas experience with other species of cranes indicates that collisions are very rare events (Derby *et al.* 2013; Nagy *et al.* 2013). Monitoring for bird carcasses at multiple wind farms spanning more than 15 years has not detected any Brolga fatalities (Moloney *et al.* 2019) and DELWP (2020) note that there is no evidence of Brolga collisions with wind turbines. Collision risk modelling for each of the five wind farms provided results for a range of avoidance rates between 90% or 95% and 99%. Here we have referred to the predictions made for

those projects at 95% avoidance rate. This provides consistency across the projects, noting that for Stockyard Hill, the lowest avoidance rate modelled was 95% and that the planning Panel Report for Dundonnell Wind Farm referred to results at 95% avoidance rate. We consider 95% avoidance – a rate at which one in 20 flights towards a turbine will not avoid collision - to be reasonable but may represent an overestimate of risk for Brolgas.

In order to consider the likely rate at which Brolga collisions might occur at Mount Fyans Wind Farm, we have used the rates projected for the five wind farms in Table 4 and applied them for 81 turbines as proposed for Mount Fyans Wind Farm. The results are provided in Table 5.

Table 5 Application of collision risk modelling results for Brolgas for five wind farms to Mount Fyans Wind Farm (81 turbines)

Wind farm	CRM per-turbine projected collision rate per annum	CRM per-turbine projected collisions p. a. x 81 turbines	CRM total projected collisions over 25 years	Equates to average of one Brolga mortality per:
Mortlake East	0.0024	0.19	**4.9**	5.1 years
Penshurst	0.0012	0.10	**2.4**	10.3 years
Stockyard Hill	0.0006	0.05	**1.2**	20.6 years
Dundonnell	0.0039	0.32	**7.9**	3.2 years
Golden Plains	0.0008	0.06	**1.6**	15.4 years

We recognise there are limitations to this approach however it does offer an indicative range of rates at which Brolga fatalities might occur at Mount Fyans Wind Farm. Using this approach it would seem reasonable to expect that over the life of a wind farm with 81 turbines conservation measures designed to add five Brolgas (i.e. more than the mean of the values calculated for five wind farms in Table 5) to the Victorian population would be likely to replace possible collisions. It should also be noted that if experience at the operational wind farm demonstrates that this number is inappropriate then adaptive management will still permit measures to be taken to provide an appropriate offset.

Experience at Victorian wind farms to-date suggests that collisions by Brolgas are rare events and at the time of writing, there have been no confirmed mortalities of Brolgas due to collisions at currently operating wind energy facilities in Australia and thus the processes described here takes a precautionary approach on the premise that a level of this risk does exist.

Concepts for offsetting of potential losses of Brolgas for previously approved wind farms include restoration of an appropriate hydrological regime to otherwise suitable breeding wetlands that have been historically drained; legal protection of sites through on-title agreements or covenants; suitable fencing to exclude grazing and trampling by stock; and, revegetation with appropriate wetland plants. Burial of single-strand overhead powerlines that represent a collision risk to Brolgas at key sites such as the immediate vicinity of flocking sites and reduction of foxes at breeding sites may also offer methods to increase Brolga numbers for the purposes of offsetting wind farm losses.

It is recommended that a strategy or program that gives effect to offset requirements for Mount Fyans Wind Farm should be established through the permit condition compliance process. All such efforts will require systematic monitoring to determine their efficacy.

Conclusion

The proposed Mount Fyans wind farm is located within the range for Brolgas within south-west Victoria. Consequently, several records for breeding and flocking have been reported within 10 kilometres of the Mount Fyans wind farm study area. These records have been examined and consolidated by a database review, landowner surveys, aerial surveys, a home range analysis, and on-ground assessments to provide a current set of Brolga breeding and flocking sites with potential to be impacted by the proposed wind farm. To mitigate these potential impacts, appropriate turbine-free buffers have been considered and are recommended for these sites, in accordance with the *Brolga Guidelines* (DSE 2012). Significant effort has been made by Hydro Tasmania throughout the design of the project to avoid proposing turbines within areas that may pose higher risk to Brolga collision, such as the Lake Sheepwash flocking site.

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Appendices

Appendix 1 Symbolix home range reporting

A1.1 Brolga Home Ranges: Mount Fyans and Penshurst Combined Sets (Symbolix 2010a).

ADVERTISED PLAN

Brolga Home Ranges

Mt. Fyans and Penshurst Combined Sets

ISSUE

Version 2.3

30th March, 2010

Submitted to

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Version	Status	Date	Approved for release	Issued to	Copies	Comments
0.1	Draft	9/02/2010	internal	Internal	1e	For comment
0.9	Review	9/2/2010	Internal			Quality Assurance check
1.0	Issue	11/2/2010	E.Stark	Mark Venosta	e	Issued
2.0	Issue	17/2/2010	E.Stark	Mark Venosta	e	Incorporating client comments and with additional appendix detailing home range measured from average point.
2.1	Issue	17/3/2010	E.Stark	M.Venosta	E	Added 99.9% containment radii result
2.3	Issue	30/4/2010	E.Stark	M.Ventosa /N.Harvey	E	Fixed table & format errors

Approved for Release: **30/4/2010**

Signed Date

Limitation: This Report has been prepared in accordance with the scope of services described in communications between Symbolix Pty Ltd and Biosis Research Pty Ltd. Any findings, conclusions or recommendations only apply to the aforementioned circumstances and no greater reliance should be assumed or drawn by Biosis Research Pty Ltd. Furthermore, the report has been prepared solely for use by Biosis Research Pty Ltd and Symbolix Pty Ltd.

Table of Contents

1 Results 2
1.1 Contributory pairs and meta-information 2
1.2 A general home range area for brolgas at Mt Fyans and Penshurst 3
1.3 Radii of Containment 3
1.3.1 Results 5
1.3.2 Implications 6
2 References & Further Reading 7
Appendix A: Additional Data and Visual Aids A-1
A.1: Penshurst (Pair 1) A-2
A.1.1: Pair 1 ..... A-2
A.1.2: Pair 2 ..... A-4
A.1.3: Pair 4 ..... A-5
A.2: Mt Fyans (Pair 6, 8, 17 & 19) A-6
A.2.1: Pair 6 ..... A-6
A.2.2: Pair 8 ..... A-8
A.2.3: Pair 10 ..... A-9
A.2.4: Pair 17 ..... A-10
A.2.5: Pair 19 ..... A-11
Appendix B: Additional Calculations – Nest as Locus point B-12
B.1: Penshurst (Pair 1) B-13
B.1.1: Pair 1 (Nest Based Radius) B-13
B.2: Mt Fyans (Pair 6, 8, 17 & 19) B-15
B.2.1: Pair 6 ..... B-15
B.2.2: Pair 8 ..... B-17
B.2.3: Pair 17 ..... B-18
B.2.4: Pair 19 ..... B-19

List of Figures

Figure 1: Simple representation of a possible relationship between the radius of containment calculated from the average of all flight points ($R_{average}$) and from the nest site (R_{nest}). 4

Figure 2: Pair 1 Brooding observations vs radial distance from average point. A-2

Figure 3: Pair 1 Fledging observations vs radial distance from average point. A-3

Figure 4: Pair 1 All observations vs radial distance from average point. A-3

Figure 5: Pair 2 All observations vs radial distance from average point A-4

Figure 6: Pair 4 All observations vs radial distance from average point A-5

Figure 7: Pair 6 Brooding observations vs radial distance from average point. A-6

Figure 8: Pair 6 Fledging observations vs radial distance from average point A-7

Figure 9: Pair 6 All observations vs radial distance from average point. A-7

Figure 10: Pair 8 Brooding observations vs radial distance from average point.....A-8

Figure 11: Pair 10 Fledging observations vs radial distance from average point A-9

Figure 12: Pair 17 Fledging observations vs radial distance from average point ...A-10

Figure 13: Pair 19 Brooding observations vs radial distance from average point...A-11

Figure 14: Pair 1 Brooding observations vs radial distance from roost B-13

Figure 15: Pair 1 Fledging observations vs radial distance from roost B-14

Figure 16: Pair 1 All observations vs radial distance from roost B-14

Figure 17: Pair 6 Brooding observations vs radial distance from nest B-15

Figure 18: Pair 6 Fledging observations vs radial distance from nest B-16

Figure 19: Pair 6 All observations vs radial distance from nest B-16

Figure 20: Pair 8 Brooding observations vs radial distance from nest B-17

Figure 21: Pair 17 Fledging observations vs radial distance from nest B-18

Figure 22: Pair 19 Brooding observations vs radial distance from nest.....B-19

List of Tables

Table 1 : Contributory observations to the Area Calculations (Areas in ha). For each site and pair, we record the area containing 50%, 90%, 95% and 100% of the home range. We also report the kernel bandwidth employed in the calculation. 2

Table 2 : Area and Confidence intervals (in hectares) for a general home range area 3

Table 3 : Areas and Confidence intervals on home range area (in hectares), after Splitting Pair 10 into two components 3

Table 4: Details of the central point for radius determination 4

Table 5: Radius of Containment (95% and 99.9%) with confidence interval (average central point) 5

Table 6 : Radius of 95% Containment, with Confidence interval (nest/roost as central point) 5

Table 7: Radius of 95% Containment, with Confidence interval (average central point) 5

Table 8 : Radius of Containment, treating Pair 10 as two Components (nest/roost as central point) 6

Summary

Biosis Research has been commissioned to provide, for their client, an assessment of the ranges Brolga (*Grus Rubicunda*) utilise during brooding and fledging. Ultimately these findings are to be submitted to the Department of Sustainability and Environment (DSE) to assess potential impacts of developments upon this species.

To facilitate this, Symbolix were engaged to establish a modelling platform that is capable of using a variety of techniques and tools to determine these ranges, commonly referred to as Home Ranges.

The techniques used are published versions of kernel methods and related techniques (Odum & Kuenzler, 1955). This work validates and extends that presented in Symbolix (2009a), where a third party package (Calhome) was used to determine initial estimates of the home ranges.

Asymptotic analysis (Haines, et al., 2006) has also been employed to determine stability of the measurements to increased survey effort (see Symbolix 2009b for discussion and results).

This report produces traditional values (in hectares) of the amount of land used by the pairs, collected across a number of sites via a data sharing arrangement.

It determines that the traditional home range measure (95% of total area) is between 31 and 35 hectares. The slight variation comes from the treatment of pair 10, as there was uncertainty as to whether this was one pair or two.

The ultimate application of this data is in assigning buffer regions around brolga habitat. For this reason, we also provide a new measure (albeit through traditional techniques) that gives us the ***radius of containment***. This value is determined as the distance that the birds are contained within for a given percentage of time.

While the traditional approach of determining a home range area is appropriate for individual sites, it may not provide adequate generality for creating broad policy concerning buffers. To inform policy development, the radius of containment provides a more general representation of the asymmetrical and complex geometry of the physical home range.

We find that for 95% of the time, Brolgas will be within 600 metres of the centre of their home range whilst brooding and fledging.

1.1 Contributory pairs and meta-information

The brolga study consists of two sites: Penshurst and Mt Fyans. The calculation of the Home Range uses a kernel integration method (Worton, 1989), using a Gaussian Kernel.

Site	Pair		50%	90%	95%	100%	Bandwidth
Penshurst	Pair 1	All	8.9	44.8	63.1	164.6	84.0
		Brooding	16.3	42.9	49.8	113.5	113.0
		Fledging	4.7	38.4	56.7	157.1	84.0
	Pair 2	All	11.2	36.0	46.9	129.4	129.0
	Pair 4	All	1.6	5.4	6.9	121.4	75.0*
Mt Fyans	Pair 6	Brooding	1.1	4.1	6.1	53.5	69.0†
		Fledging	3.7	11.8	14.5	40.4	69.0†
		All	1.2	4.4	8.5	56.1	69.0†
	Pair 8	Brooding	1.6	8.8	16.3	68.7	75.0*
	Pair 10	Fledging	10.7	60.0	86.7	232.4	126.0
	Pair 17	Fledging	3.6	23.8	36.1	123.2	73.0
	Pair 19	Brooding	1.5	7.4	11.1	91.2	75.0*

Table 1 : Contributory observations to the Area Calculations (Areas in ha). For each site and pair, we record the area containing 50%, 90%, 95% and 100% of the home range. We also report the kernel bandwidth employed in the calculation.

We also report the bandwidth, or diffusion parameter, that is integral to kernel methods. We employ the LSCV (Least Squares Cross Validation) technique to determine the optimal parameter (Worton, 1989).

The contributions of each pair to seasonal behaviour are identified from the associated metadata. We define Fledging season data as corresponding to all records where a chick was known to be on site. Before this, the data is classified as Brooding. If a pair's status is unclear, then the data is included under the generic "All" classifier only.

Note that we have marked Pair 10 as an outlier. It is identified in the metadata as potentially being two pairs, with difficulty in identifying individual contributions.

More details on individual pair data is outlined in Appendix A: and Appendix B: below.

* For three pairs (Pair 4, Pair 8 and Pair 19) LSCV fails. In this case, a generic value of 75 metres was employed.

† For Pair 6 we employed the value determined for the combined set (all data associated with Pair 6) as, once separated into Brooding and Fledging contributions, the LSCV became unstable.

1.2 A general home range area for brolgas at Mt Fyans and Penshurst

To combine the individual pair findings and provide a general rule governing the home range area of brolgas in this study, we have combined all the pairs and measured the average values, along with the window that covers 95% of the observations. These results are presented in Table 2, below.

	95% Area	C.I.	100% Area	C.I.
All	34.4	(9.9 , 58.8)	124.7	(77.2 , 172.2)
Brooding	26.1	(0.4 , 51.8)	91.5	(53 , 130.1)
Fledging	48.1	(15 , 81.3)	138.3	(51.7 , 224.9)

Table 2 : Area and Confidence intervals (in hectares) for a general home range area

If we look at the data records behind Pair 10, we have evidence that there are actually two pairs contributing to this home range. Although the data cannot be split, we can assume an extra contributory pair in the assessment of the average. This produces Table 3, below.

	95% Area	CI	100% Area	CI
All	30.6	(14.9 , 46.2)	110.9	(84.3 , 137.4)
Brooding	26.1	(0.4 , 51.8)	91.5	(53 , 130.1)
Fledging	40.1	(25.2 , 55.1)	115.2	(72.4 , 158.1)

Table 3 : Areas and Confidence intervals on home range area (in hectares), after Splitting Pair 10 into two components

1.3 Radii of Containment

The preceding area assessments, although traditional, do not necessarily aid in the establishing of general policy regarding the prescription of safe buffers. There is no accounting for the complexity of the shape of the range that contributes to this area.

To portray a measure of this, we have determined the probability that the birds are within a certain radius (as opposed to an area).

This necessarily requires a locus point to be specified as the origin[‡].

[‡] The radius of containment from some r=0 point of origin is formally defined as the radius containing the cumulative distribution function out to some level (typically 95% or higher). The cumulative distribution function ($F(r)$) is determined by numerically integrating the probability density function ($f(r,\theta)$), i.e.

$$F(r) = \int_{r'=0}^{r} \int_{\theta=0}^{2\pi} f(r',\theta) r' dr' d\theta .$$

To offer maximum information to facilitate management decisions, we present two variations on this measurement:

1. As a default, we have used the **average of all recorded positions of the pair as the central locus point**.
2. For comparison (and where available) we have **used nest or roost coordinates**. For these distance calculations, Table 4 shows the centroid used to determine the radius of containment values

Site	Pair	Central Position
Penshurst	Pair 1	Roost
	Pair 2	Average
	Pair 4	Average
Mt Fyans	Pair 6	Nest
	Pair 8	Nest
	Pair 10	Average
	Pair 17	Nest
	Pair 19	Nest

Table 4: Details of the central point for radius determination

Figure 1 shows a simple representation of the possible difference arising from the different locus point chosen. Note that the real relationship is complicated by the non-circular form of the home range area.

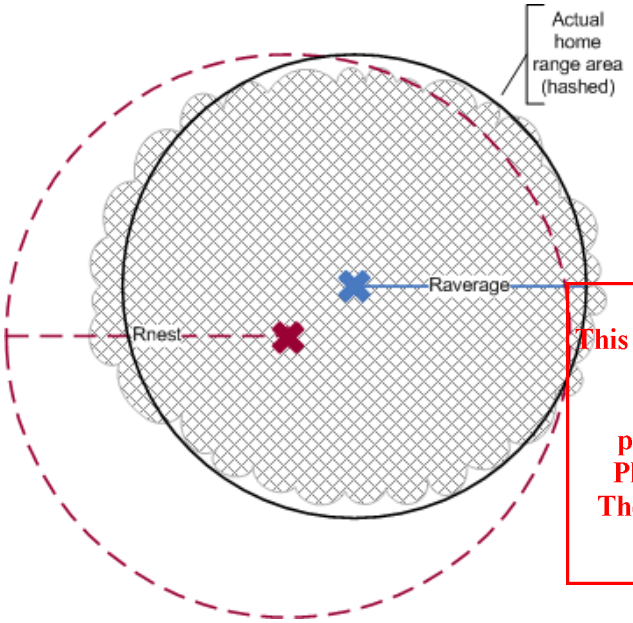

Figure 1: Simple representation of a possible relationship between the radius of containment calculated from the average of all flight points ($R_{average}$) and from the nest site (R_{nest}).

1.3.1 Results

Table 5 shows the radius of containment for the group of brolgas under study. This is the radius that contains 95% of the home range. We also present the confidence interval for these values.

	95% Contained (m)	C.I. (m)	99.9% Contained (m)	C.I. (m)
All	577.6	(441 , 714.1)	773.8	(620.6, 926.9)
Brooding	434.2	(369.8 , 498.6)	590.0	(522.5, 657.5)
Fledging	572.3	(277.6 , 867)	726.0	(403.4, 1048.6)

Table 5: Radius of Containment (95% and 99.9%) with confidence interval (average central point)

For comparison, we repeat the calculation using nest or roosting sites where available:

	95% Contained	CI
All	616.6	(463.4 , 769.8)
Brooding	474.6	(424.2 , 525.0)
Fledging	654.5	(334.9 , 974.1)

Table 6 : Radius of 95% Containment, with Confidence interval (nest/roost as central point)

A simple inspection of Table 5 and Table 6 shows that the radius of containment reduces when the average location is used as the central point. This is due to the distribution of the activity of the brolga, relative to the nest.

If the activity and range is perfectly symmetrical in all directions around the nest then there would be no difference whether the nest location or the average location is used. However, if the activity is not spatially balanced then the radius of containment will increase, and so capture areas that have zero-activity levels (see Figure 1).

The use of an average location reduces this effect as it serves to partially spatially balance the home range.

As with the Home range area assessments, it is more than merely conceivable that Pair 10 consists of two, confounded pairs. We repeat the derivations separating Pair 10 into two contributions, to realise Table 7.

	95% Contained (m)	C.I. (m)	99.9% Contained (m)	C.I. (m)
All	513.4	(411 , 615.8)	687.8	(541.7, 833.8)
Brooding	434.2	(369.8 , 498.6)	590.0	(522.5, 657.5)
Fledging	476.9	(292 , 661.8)	605.0	(380.8, 829.2)

Table 7: Radius of 95% Containment, with Confidence interval (average central point)

Again, for completeness, we present the results, using the nest/roosting site as the central locus:

	95% Contained	CI
All	548.1	(417.1 , 679.0)
Brooding	474.6	(424.2 , 525.0)
Fledging	545.4	(297.6 , 793.2)

Table 8 : Radius of Containment, treating Pair 10 as two Components (nest/roost as central point)

1.3.2 Implications

If we take a simple area formed by the radius of containment, we can see that it is a larger area than the Home Range values reported above. This is a direct effect of the complexity of the home range being captured by the radius of containment.

For example the radius within which the Brolga are contained for 95% of the time is, from Table 7, 514 Metres. This corresponds to a disc of 83 ha, considerably more than the 30.6 ha of Table 3. This increase is due to the necessary inclusion of un-used space in the radius measure.

This implies that the radius of containment produces a more conservative estimate of the home range buffer than a simple, traditional area calculation. It is, however, free from the individual effects inherent to the hectare assessment of home range, and is potentially less susceptible to seasonal effects.

2 References & Further Reading

Odum, E. and Kuenzler, E. 1955, *Measurement of Territory and Home range size in Birds,* Auk, Vol 72, pp 128.

Haines, et al. 2006. *A Method for determining Asymptotes of Home range Area Curves*, pp489-498 in Cederbaum et al, Gamebird 2006.

Symbolix, 2009a. *Brolga Home Range.* Letter to Biosis Research, Ref: Bio1209HomC, Dated 18/12/2009.

Symbolix, 2009b. *Survey Effort - Brolga Home Range.* Letter to Biosis Research, Ref: Bio1209HomB, Dated 17/12/2009.

Worton. 1989. *Kernel Methods for Estimating the Utilization Distribution in Home-Range Studies*, *Ecology*, Vol. 70, No. 1. (Feb., 1989), pp. 164-168.

Worton 1989, *Optimal Smoothing Parameters for Multi-variate Fixed and Adaptive Kernel Methods*, *J.Statist.Comput.Simul*, Vol 32, pp 45-57.

Appendix A: Additional Data and Visual Aids

We include the following as a working appendix to highlight particular behaviours and ranging distances. Each site comprises a brief description of pertinent points extracted from the survey meta-data, and curves that show the probability distributions of the range.

The Red curves are probability distributions in one dimension, showing the likelihood of the bird being at any radius from the origin. The Blue curves identify the cumulative probability, i.e. the likelihood of being within that distance from the origin.

For all the calculations below, the radius of containment is calculated using the average of all flights as the central point. Additional calculations using the nest or roost are given in Appendix B:

Two dimensional Probability distributions have been supplied digitally.

A.1: Penshurst (Pair 1)

A.1.1: Pair 1

Pair 1 was split either side of the 18th December 2009 (as suggested by M. Venosta, Biosis Research (*pers. comm.*). Thus all flights pre-18th December was considered to be within the Brooding season, and all flights after this date were considered to be within the Fledging season.

The combined dataset had total of 92 points. The brooding period consists of 36 and Fledging period contains 56. The nest point was taken from the associated metadata.

LSCV was used to determine the most appropriate smoothing length for use with the kernel selected. Due to the nature of the data the LSCV method failed to return a value for Pair 1 fledging data, so the bandwidth calculated for the brooding season was applied to both.

A.1.1.1 Pair 1 – Brooding

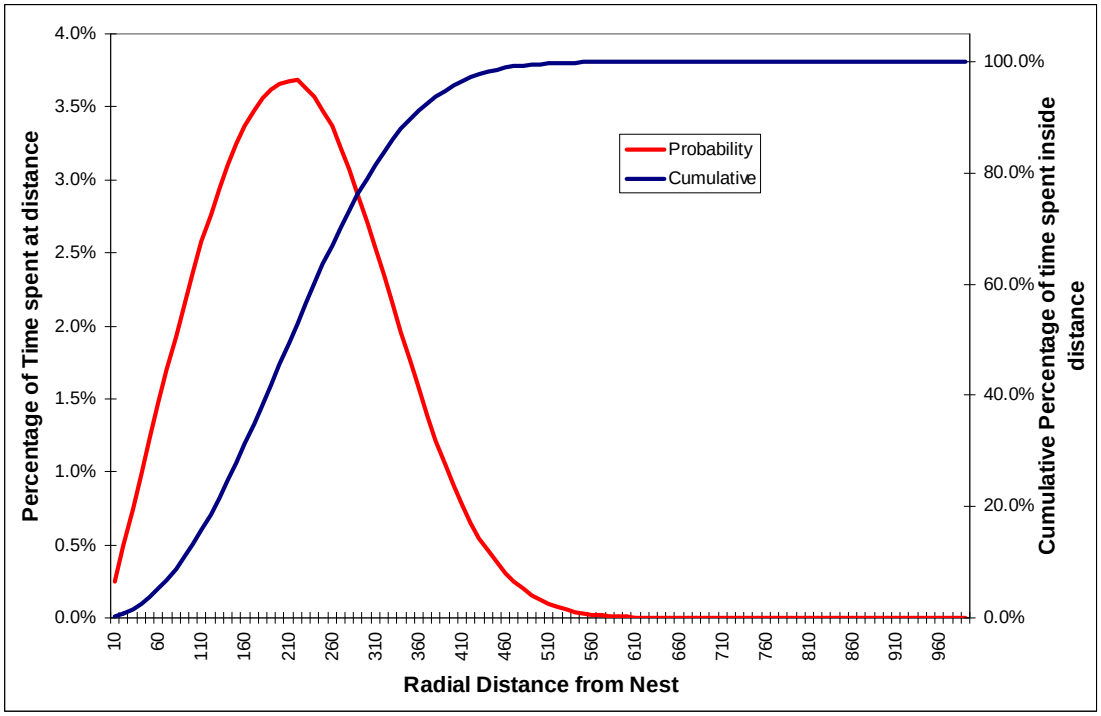

Figure 2: Pair 1 Brooding observations vs radial distance from average point.

A.1.1.2 Pair 1 – Fledging

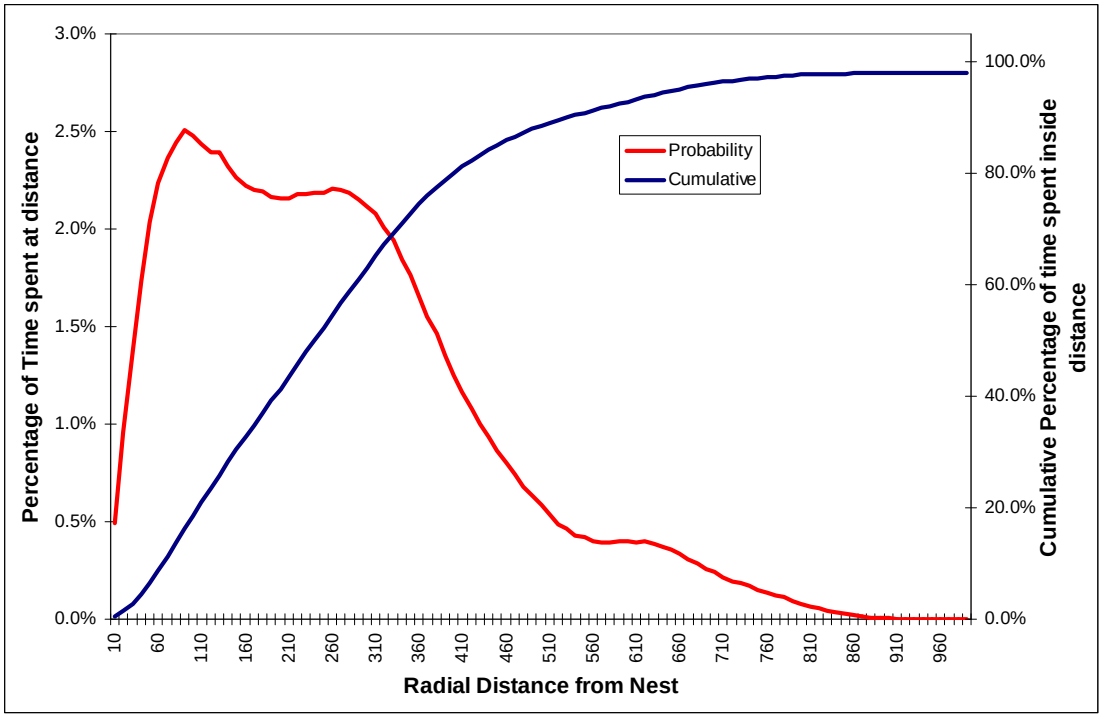

Figure 3: Pair 1 Fledging observations vs radial distance from average point.

A.1.1.3 Pair 1 – All Data

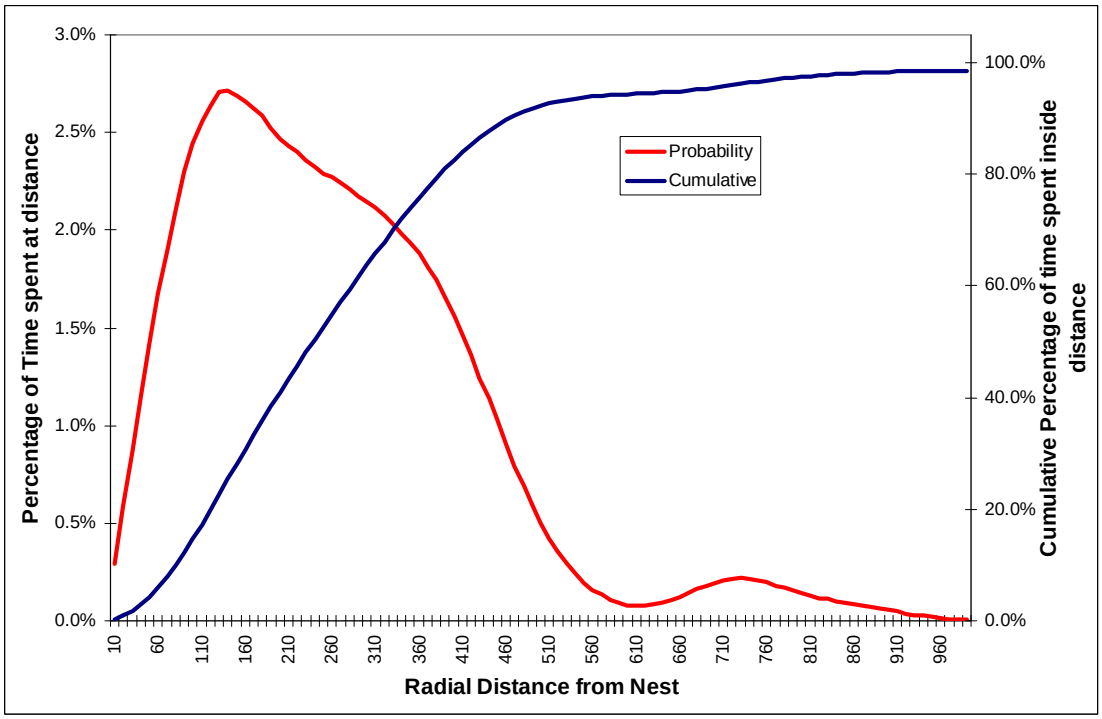

Figure 4: Pair 1 All observations vs radial distance from average point.

A.1.2: Pair 2

Pair 2 was a failed pair, they did not produce a chick and, after 20 observation data points, actually left. The central point for the home range calculation was taken as the average of all points. Hence we are not able to carry out calculations for separate activities and we only show the full set below.

A.1.2.1 Pair 2 – All Data

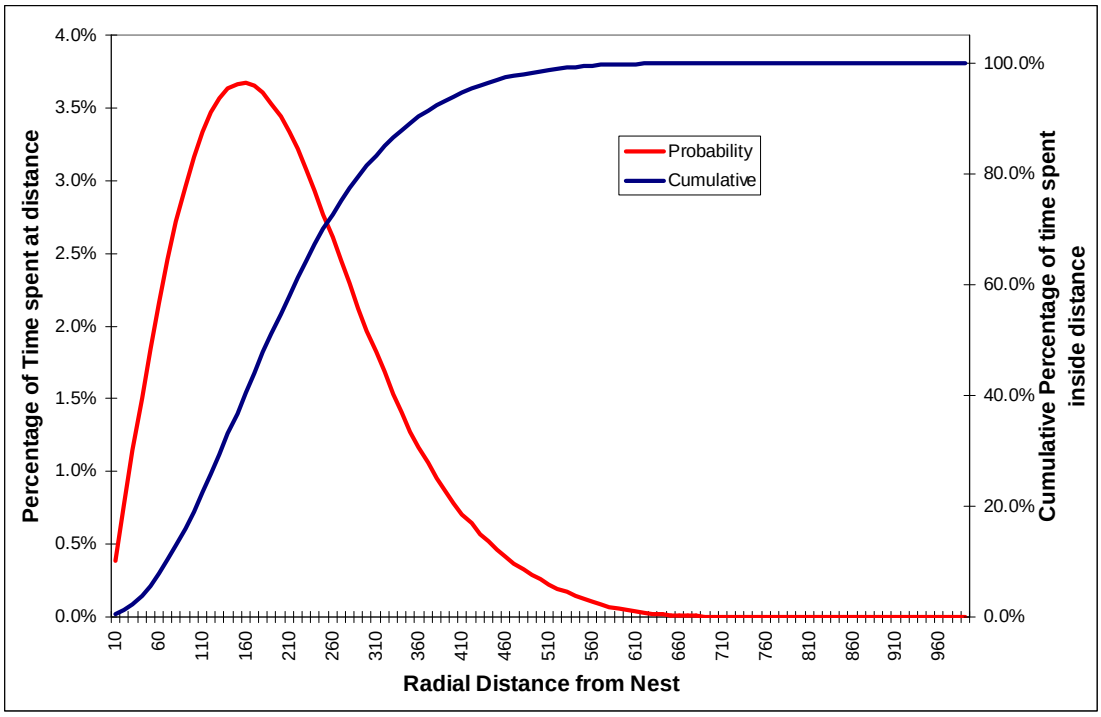

Figure 5: Pair 2 All observations vs radial distance from average point

A.1.3: Pair 4

Pair 4 appears to be atypical, in that they are rarely in close proximity to each other. Even at night, they were often observed at large distances apart.

A total of 36 points were recorded for this pair. The nest location was taken as average of all points.

This dataset was 'trimmed' of data collected in October, as this was noted as preceding the building of a nest, and consists of large ranging movements South of the road. The birds subsequently returned to this area, and these points are included in the home range. Only the points preceding the nest construction were excluded from the analysis.

LSCV was used to determine the most appropriate smoothing length for use with the kernel selected. It's important to note that due to the nature of the data for pair 4 this method did NOT select an appropriate smoothing length. Therefore, a generic value of 75 metres was used.

A.1.3.1 Pair 4 – All Data

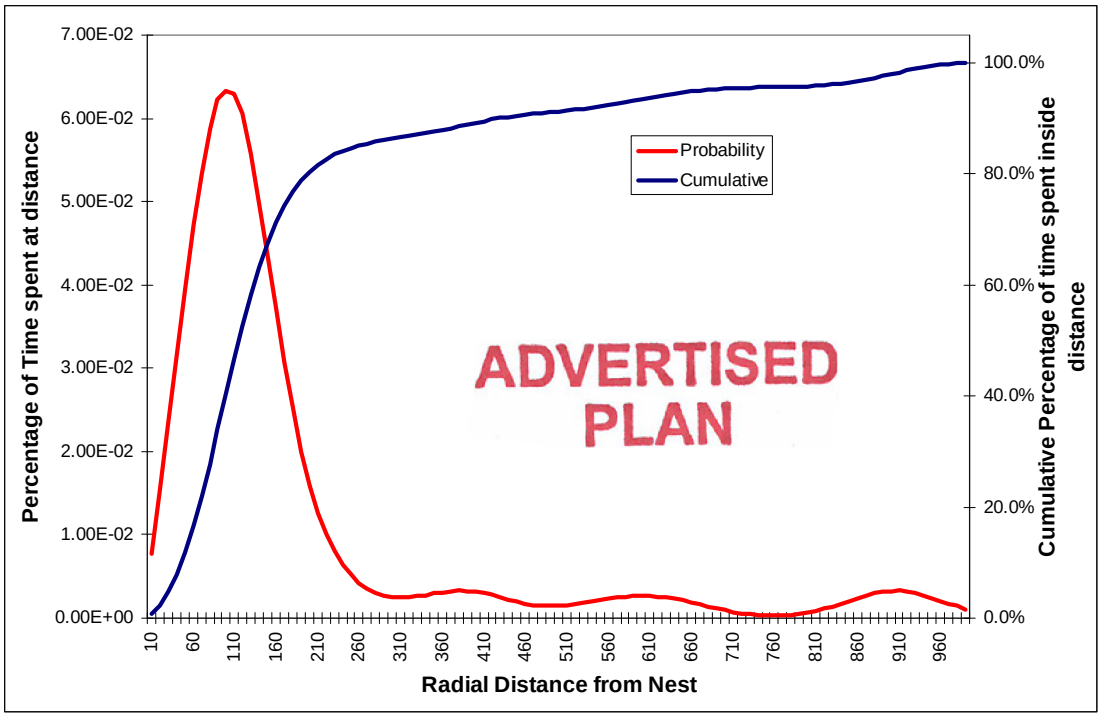

Figure 6: Pair 4 All observations vs radial distance from average point

A.2: Mt Fyans (Pair 6, 8, 17 & 19)

Pair 6 was split into brooding and fledging based on the 'appearance' of a chick in the metadata. All points prior to the first mention of the chick are treated as brooding, all points including and after the first mention of the chick were treated as fledging.

LSCV failed to determine an appropriate smoothing length for the brooding and All data, so the one from fledging was applied.

A total of 83 points were divided into 67 brooding and 16 fledging.

A.2.1: Pair 6

A.2.1.1 Pair 6 – Brooding

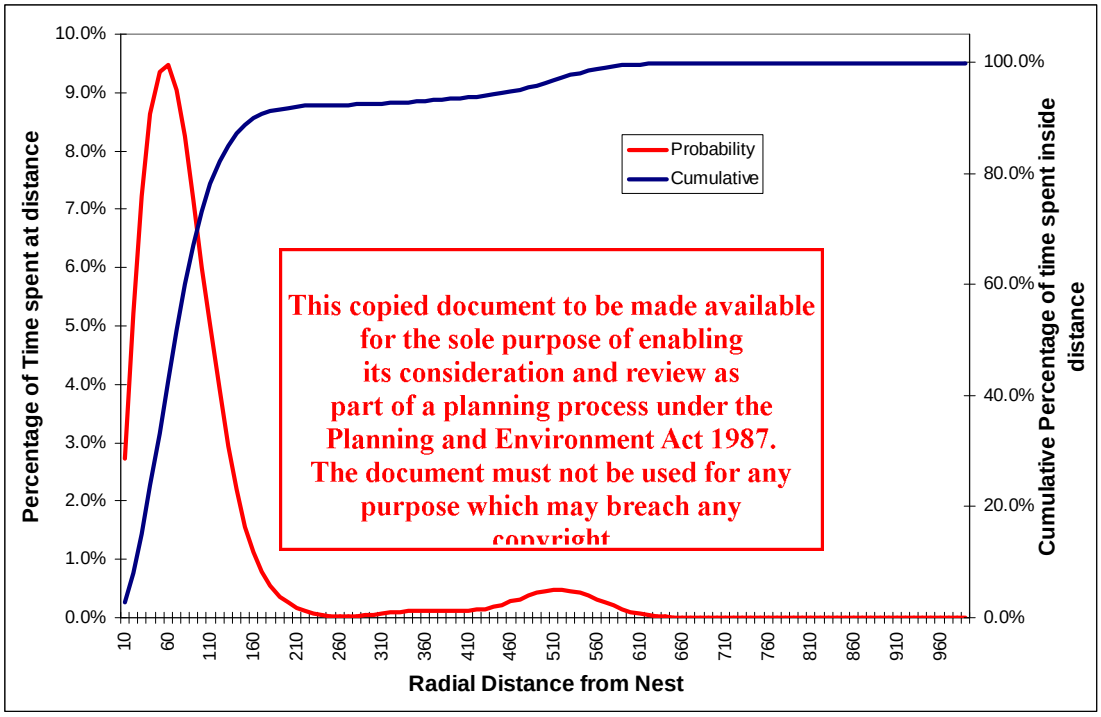

Figure 7: Pair 6 Brooding observations vs radial distance from average point.

A.2.1.2 Pair 6 - Fledging

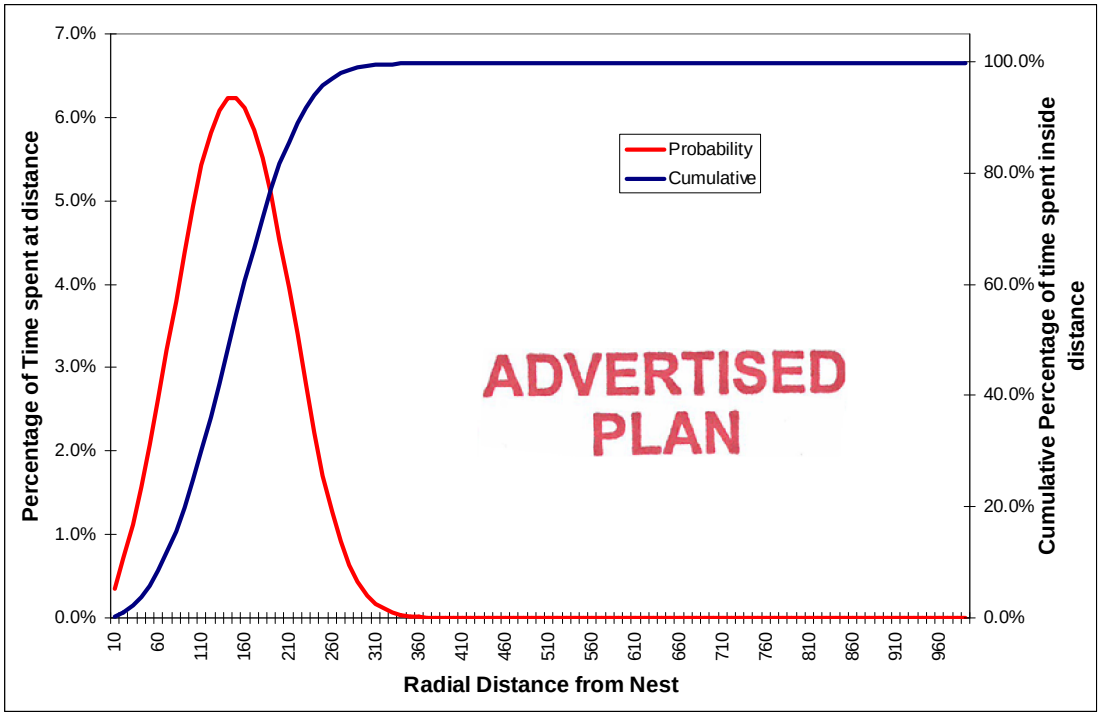

Figure 8: Pair 6 Fledging observations vs radial distance from average point

A.2.1.3 Pair 6 – All Data

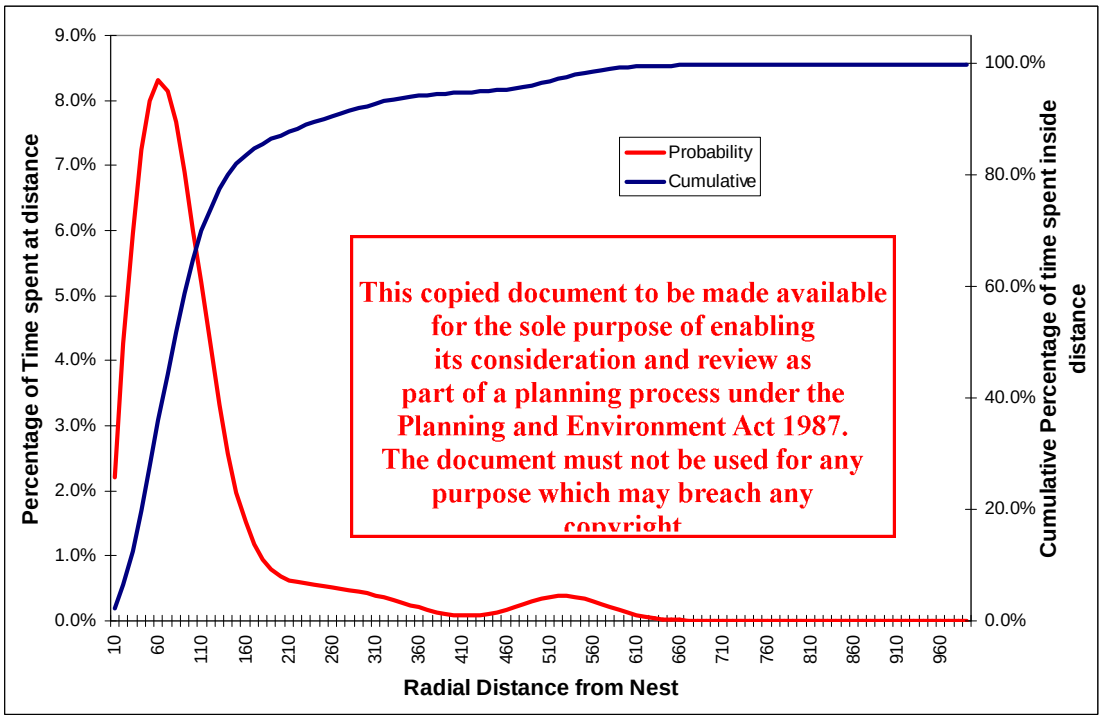

Figure 9: Pair 6 All observations vs radial distance from average point.

A.2.2: Pair 8

LSCV was not able to determine an appropriate smoothing length, as such the smoothing length was 'locked' at 75m.

There was no mention of the presence of a chick with Pair 8 and as such all observations were treated as brooding, which gave a total of 40 observations.

A.2.2.1 Pair 8 - Brooding

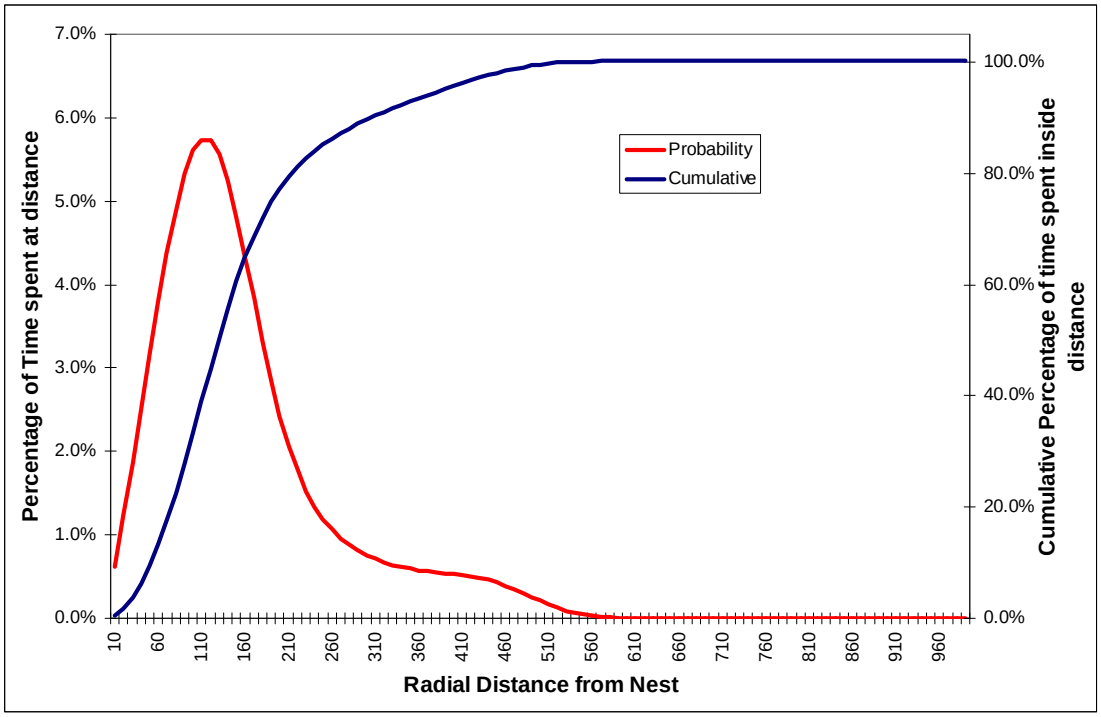

Figure 10: Pair 8 Brooding observations vs radial distance from average point

A.2.3: Pair 10

Pair 10 is now known to be at least two pairs of brolgas, indistinguishable in the dataset. It is assumed that these two pairs have home ranges which overlap slightly. This can be seen in the results which show a much larger home range than the other pairs. The nest was taken as the average of all points. Set consists of 49 observations. As the first observation contained information about a chick it is assumed that all datapoints are to be considered as fledging, thus giving no brooding data for Pair 10.

A.2.3.1 Pair 10 Fledging (All)

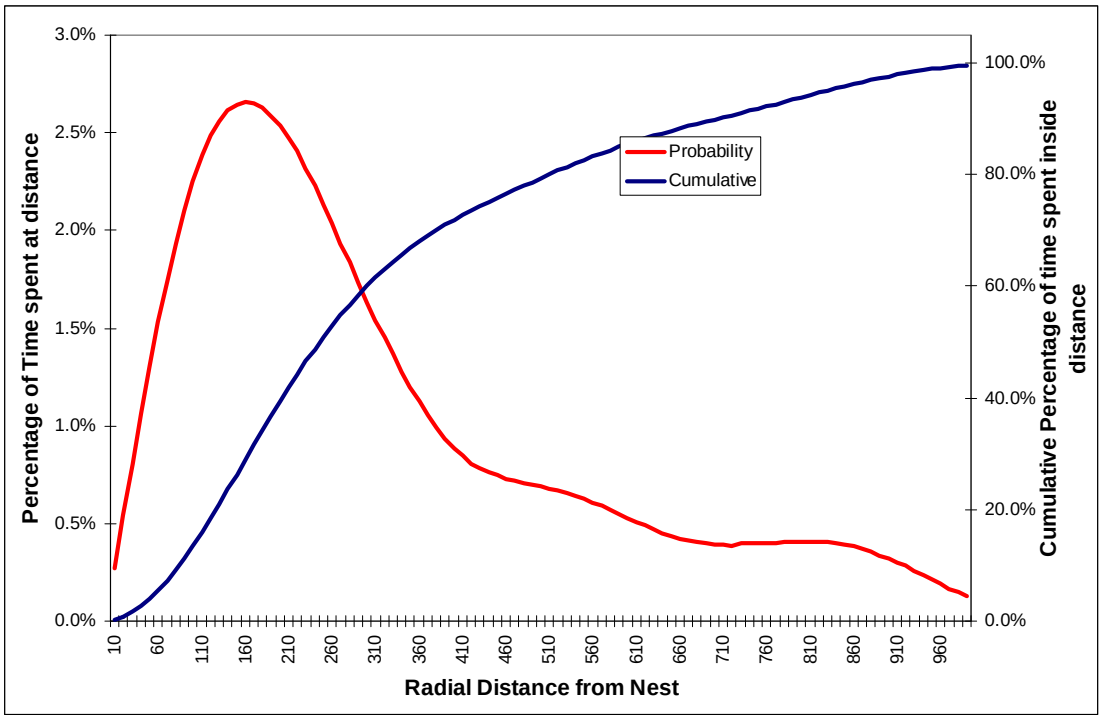

Figure 11: Pair 10 Fledging observations vs radial distance from average point

A.2.4: Pair 17

The data set consists of 39 records. As with pair 10, the first observation record includes information on the presence of a chick, as such all observations were classified as fledging, which gives no records for brooding.

A.2.4.1 Pair 17 - Fledging

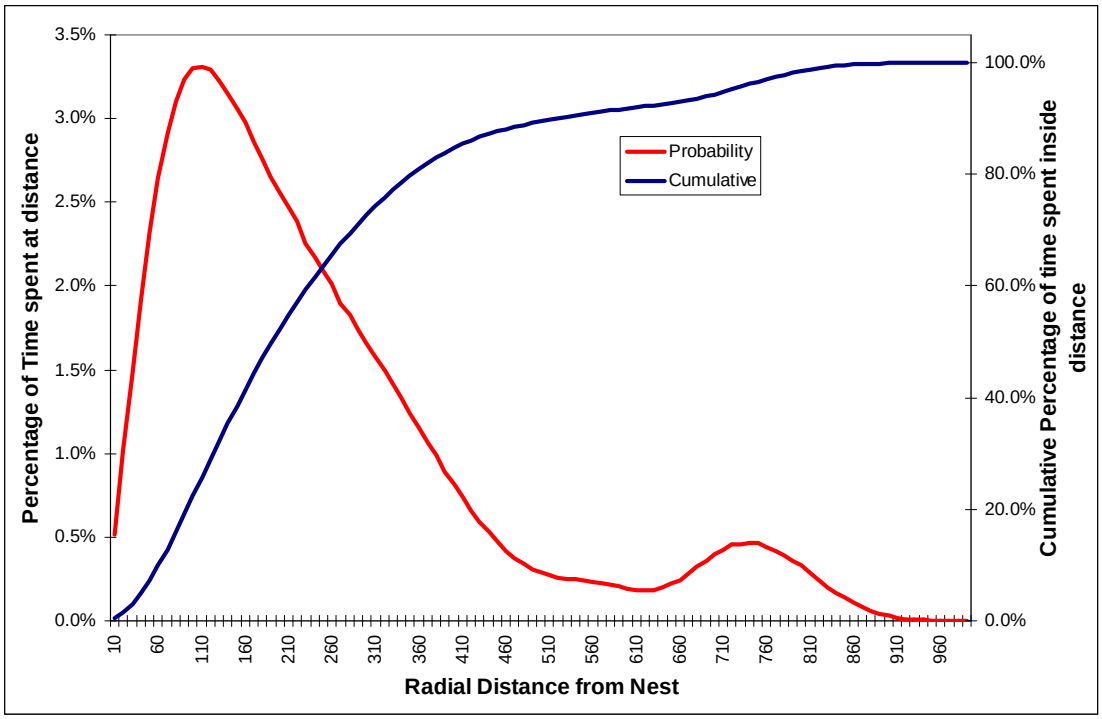

Figure 12: Pair 17 Fledging observations vs radial distance from average point

A.2.5: Pair 19

LSCV would not converge; as such a default diffusion of 75 metres was used.

As with pair 8, there was no mention of a chick in the notes, so all data was classified as brooding. A total of 36 points were available for Pair 19.

A.2.5.1 Pair 19 - Brooding

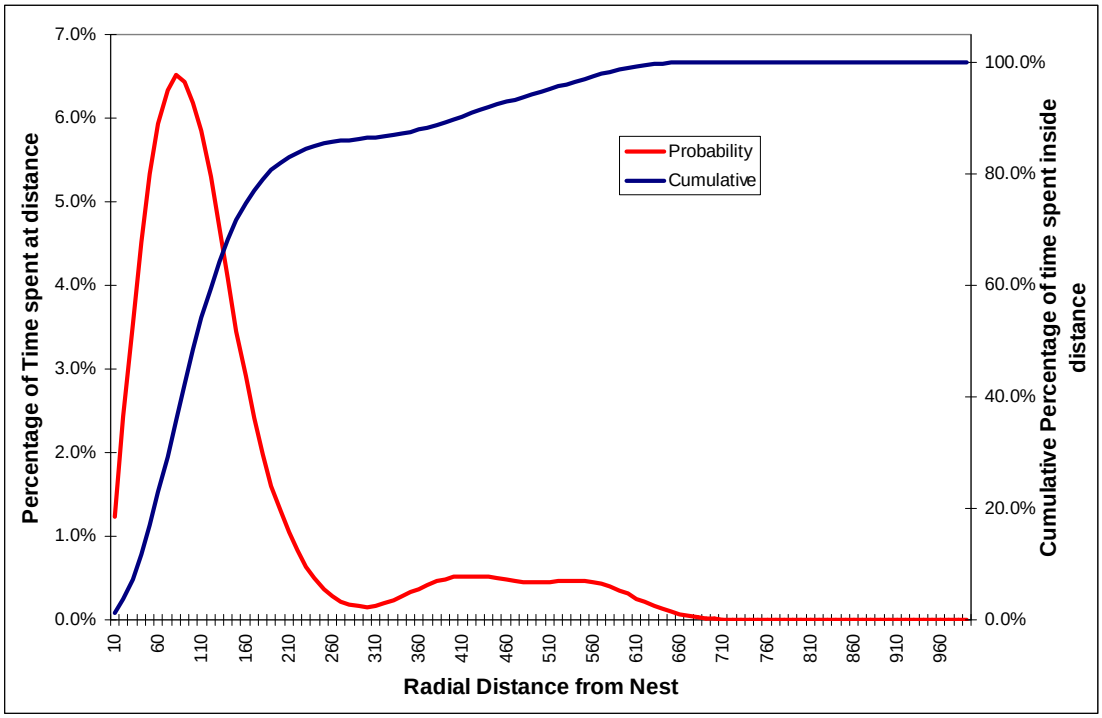

Figure 13: Pair 19 Brooding observations vs radial distance from average point

Appendix B: Additional Calculations – Nest as Locus point

In Appendix A:, the home range calculations were performed based on the average position of all flights recorded.

These sets were then re-run using not the average co-ordinates but the nest or roost coordinates contained in each set, for comparison.

Please note that pairs 2, 4 and 10 have not been presented below as there was no nest or roost position evident in the notes.

B.1: Penshurst (Pair 1)

B.1.1: Pair 1 (Nest Based Radius)

All of the temporal splitting and smoothing length used previously were preserved.

B.1.1.1 Pair 1 - Brooding

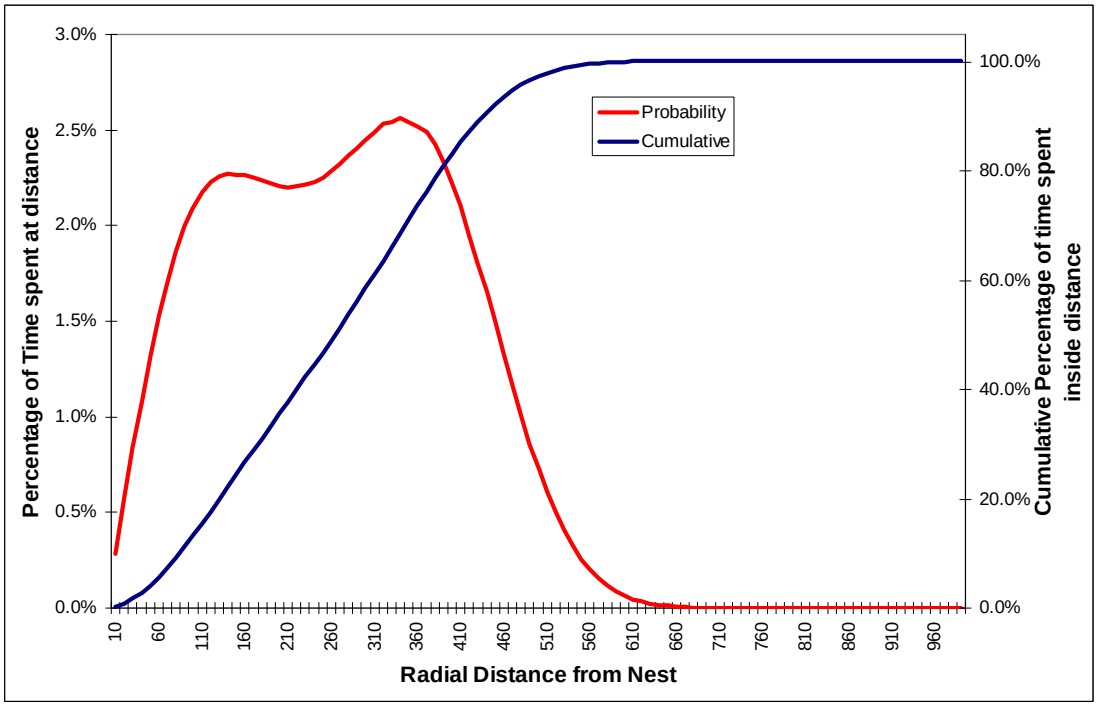

Figure 14: Pair 1 Brooding observations vs radial distance from roost

Pair 1 – Fledging

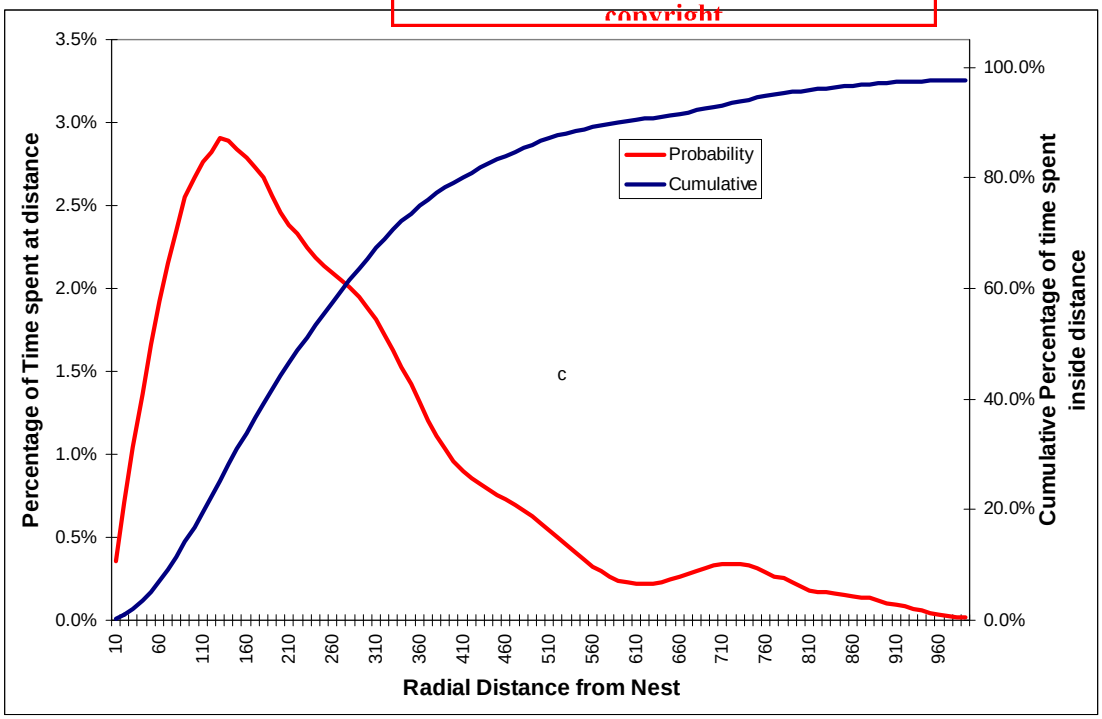

Figure 15: Pair 1 Fledging observations vs radial distance from roost

B.1.1.2 Pair 1 – All Data

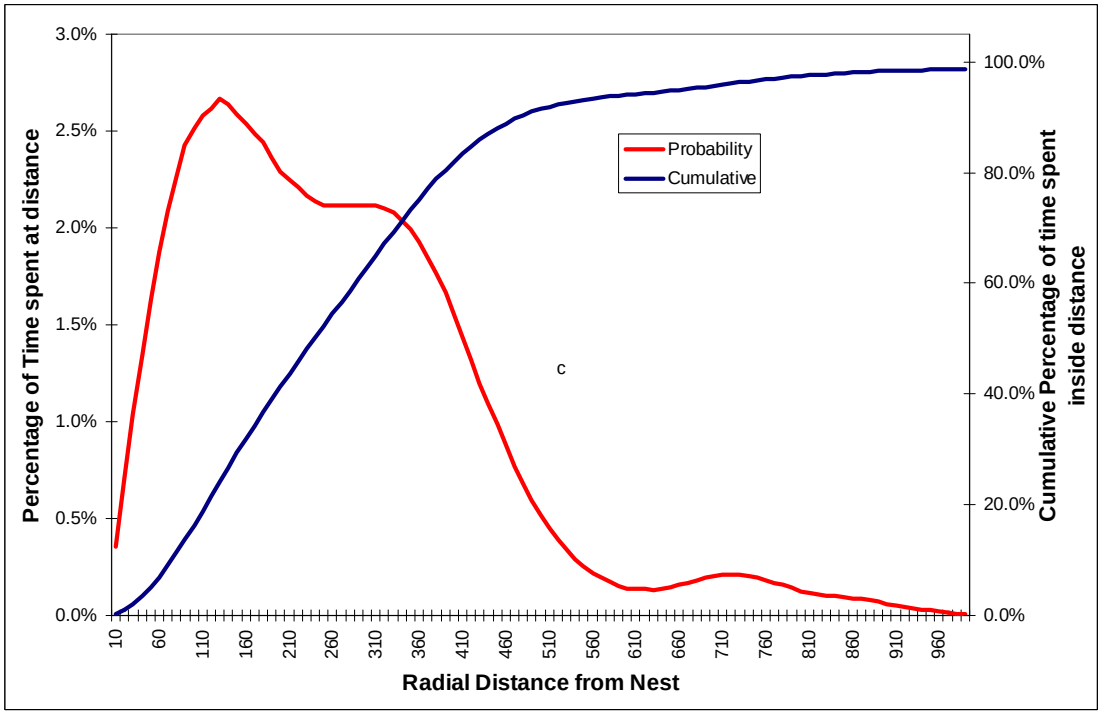

Figure 16: Pair 1 All observations vs radial distance from roost

B.2: Mt Fyans (Pair 6, 8, 17 & 19)

B.2.1: Pair 6

As with Penshurst, the following charts are presented based on the same smoothing length and temporal splits as those from Appendix A:. The nest location was taken from the associated metadata

B.2.1.1 Pair 6 Brooding

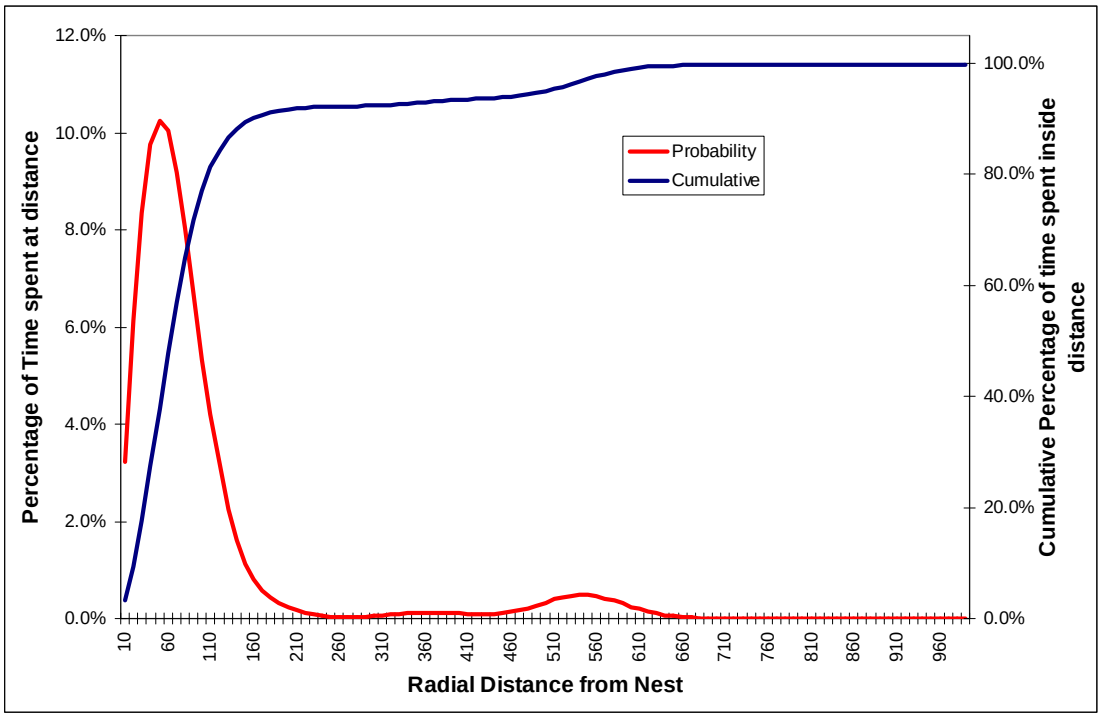

Figure 17: Pair 6 Brooding observations vs radial distance from nest

B.2.1.2 Pair 6 Fledging

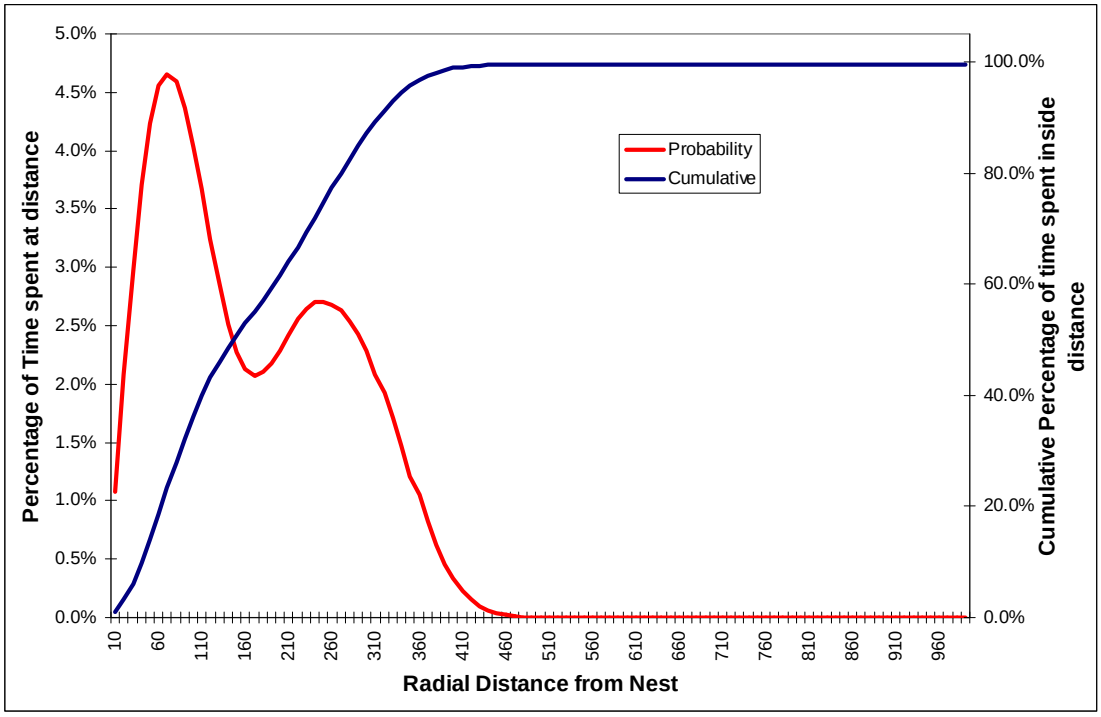

Figure 18: Pair 6 Fledging observations vs radial distance from nest

B.2.1.3 Pair 6 All

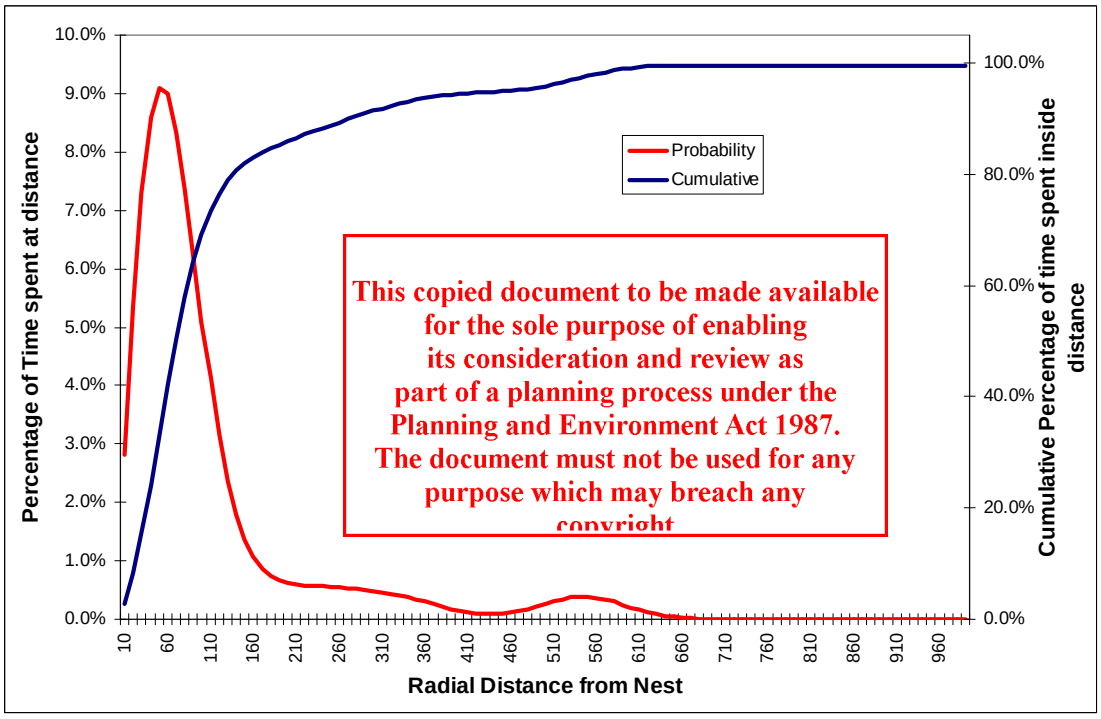

Figure 19: Pair 6 All observations vs radial distance from nest

B.2.2: Pair 8

The location for the nest was taken from notes on the original observations.

B.2.2.1 Pair 8 Brooding (All)

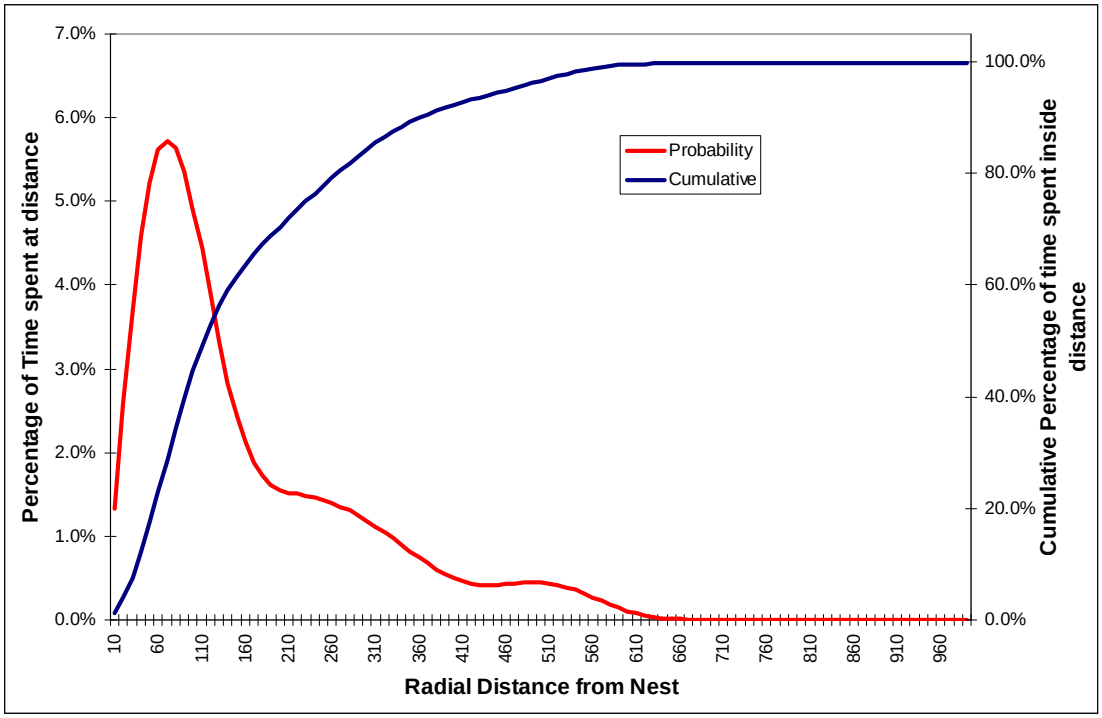

Figure 20: Pair 8 Brooding observations vs radial distance from nest

B.2.3: Pair 17

B.2.3.1 Pair 17 Fledging (All)

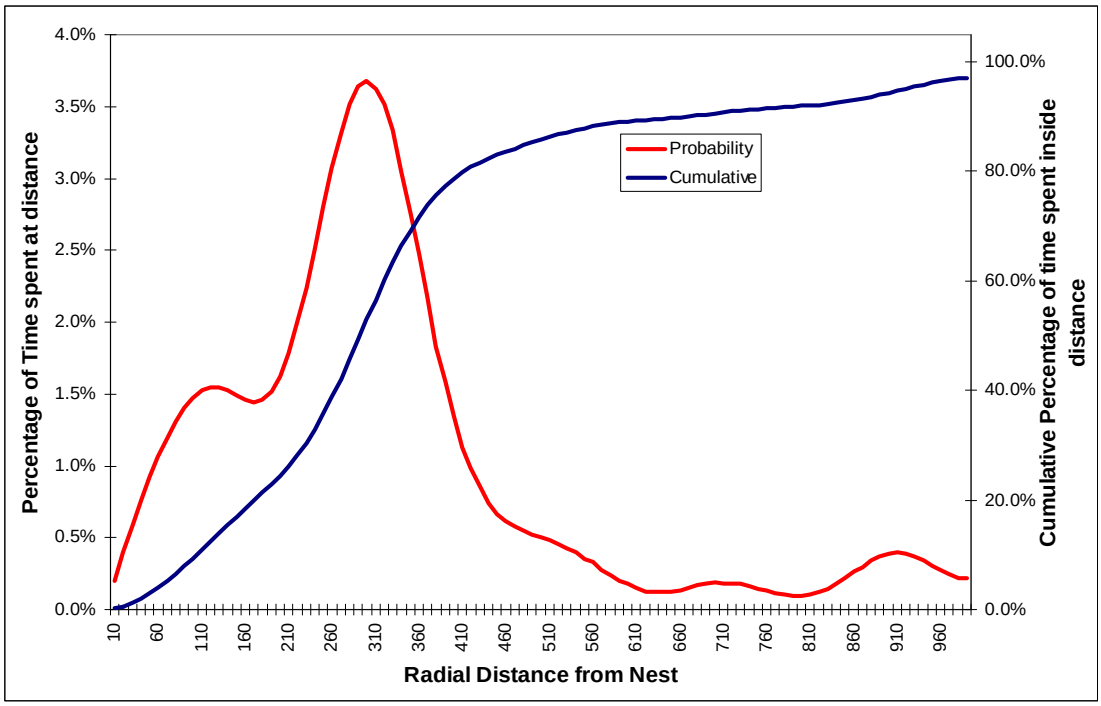

Figure 21: Pair 17 Fledging observations vs radial distance from nest

B.2.4: Pair 19

The location of the nest for pair 19 was taken from the notes

B.2.4.1 Pair 19 Brooding (All)

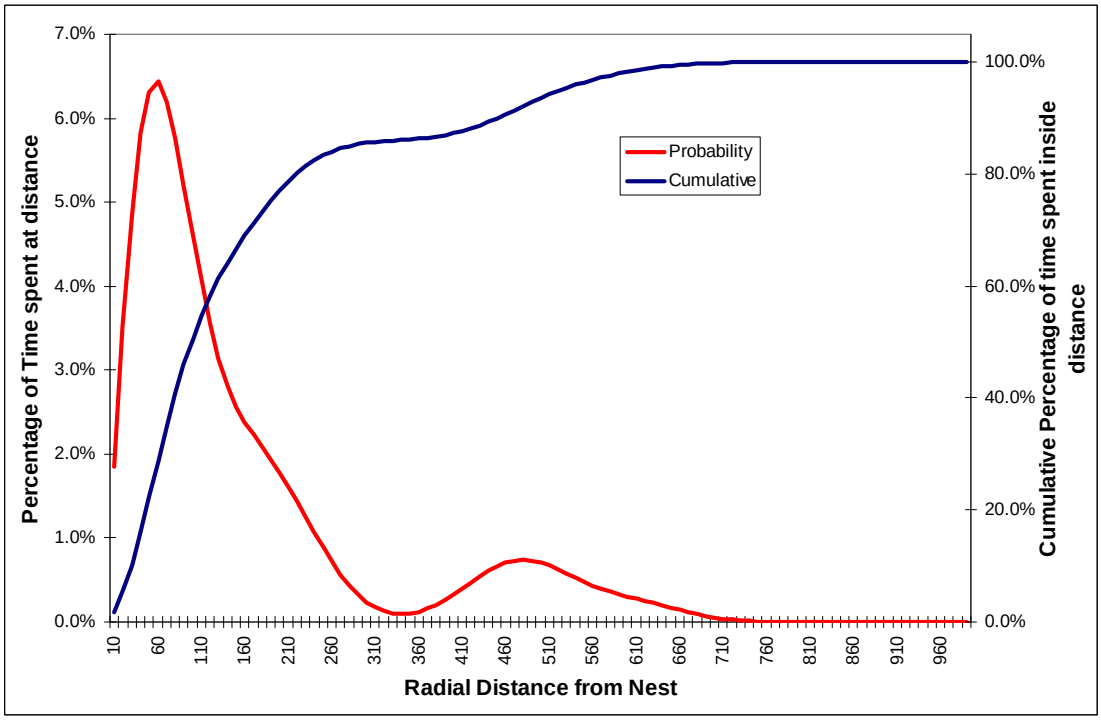

Figure 22: Pair 19 Brooding observations vs radial distance from nest

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A1.2 Homerange Asymptote Analysis (Symbolix 2010b).

ADVERTISED PLAN

Homerange Asymptote Analysis

Symbolix Pty Ltd.

Internal Memo Prepared for Biosis Research Pty Ltd

26th November, 2010,

Version 2.0 Issue

This memo presents the asymptotic values for all data under all pairs observed at Penshurt and Mortlake. The data was analysed using the kernel methods developed for this project and they replace the previous analysis (letter dated 19/1/2010) which used manual calculations and much less data.

Notes on Asymptotes

The figures presented below were generated for all datasets where more than 20 points were available. This leads to the exclusion of Pair 2 (20 points) and Pair 6 Fledging (16 points).

The available data was sorted chronologically and the first 20 points were passed through the home range platform to generate a 95% probability area. The next data point was added and the process re-run, this continued until the entire dataset for that pair and season (where applicable) was exhausted.

We find that

- For all pairs able to be analysed, an adequate number of data points was collected
- Inspection of the curves can indicate a change from brooding to fledging periods.

The data used to generate these images has been included in the accompanying archive file.

All areas are presented in square metres.

Penshurst Asymptotes

Pair 1 All data - Fledging

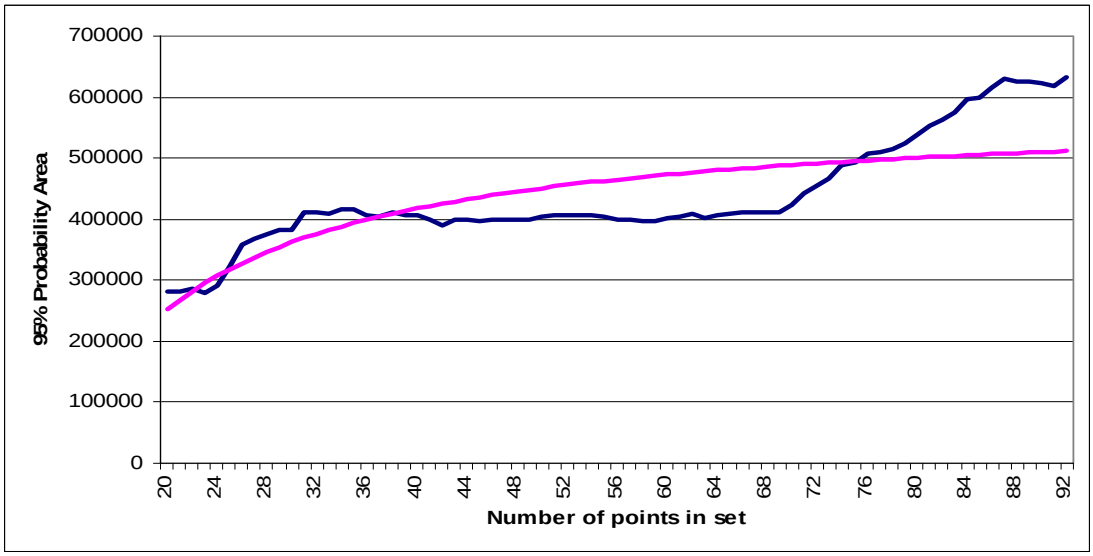


Figure 1: Pair 1 All Data Asymptote

- As chicks were noted at the start of observations all data is considered post-hatching/fledging. This includes a total of 92 individual data points

Pair 4 all (no distinction in stages)

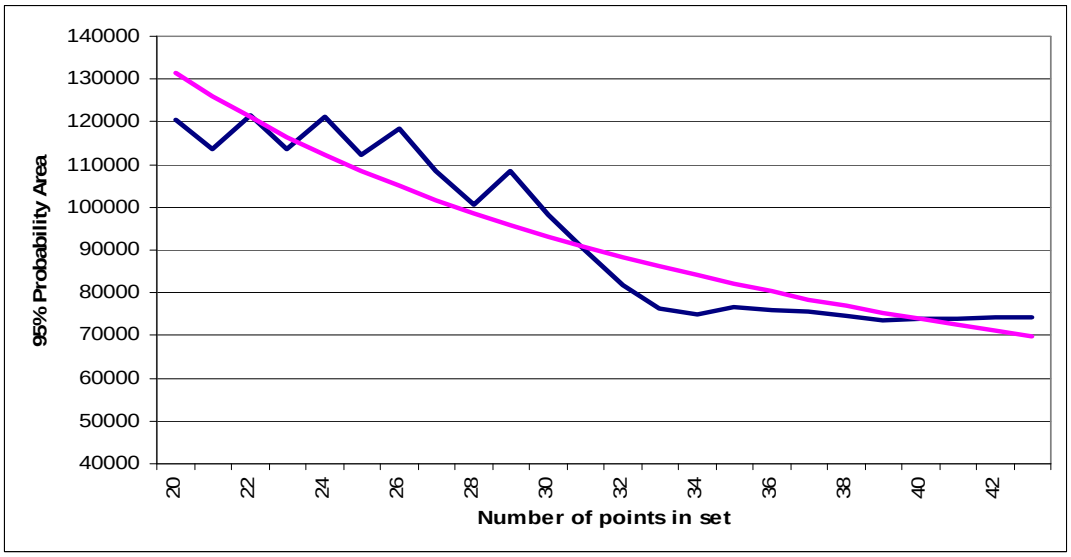


Figure 2: Pair 4 All Data Asymptote

- Uses all data for pair 4 as no notes were made on the different seasons.

Mortlake Asymptotes

Pair 6 Brooding

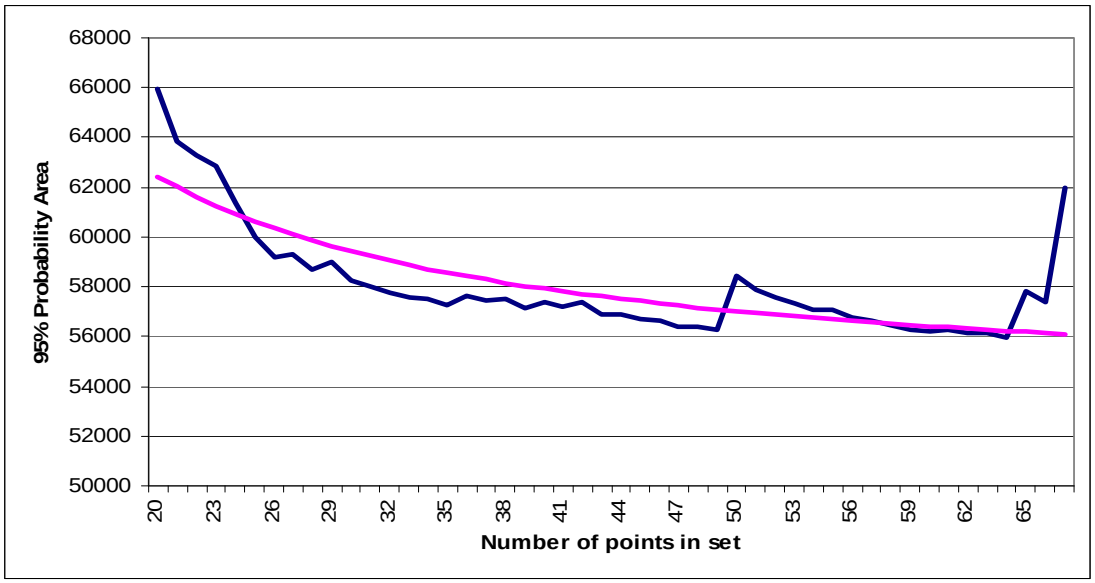


Figure 3: Pair 6 Brooding Asymptote

- Uses the 67 data points prior to the first metadata record noting a chick.
- The last three points show a clear change in behaviour which may indicate that the chick was present and influencing behaviour without being directly observed.

Pair 6 All Data

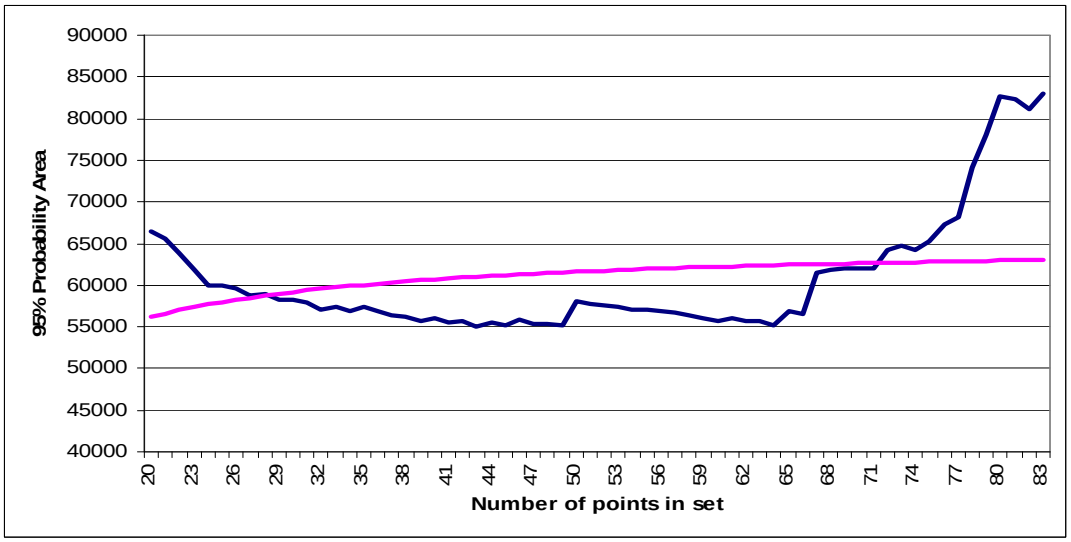


Figure 4: Pair 6 All Data Asymptote

- Uses both the brooding and the fledging data to give a total of 83 points. Again, note the jump in area, most likely representing an undetected chick, and corresponding change in roaming behaviour.

Pair 8 Brooding data

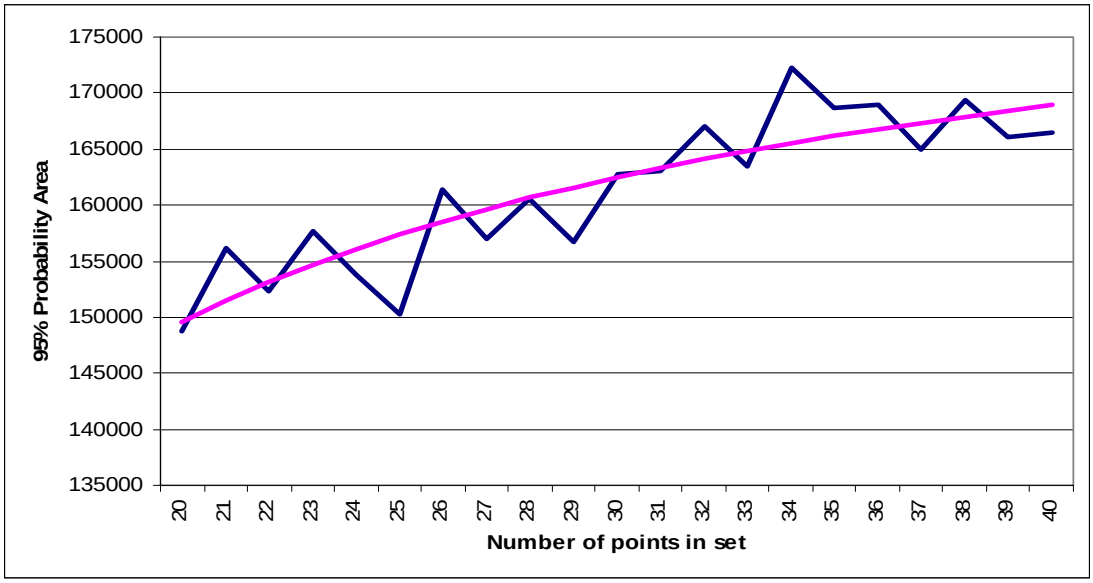


Figure 5: Pair 8 Brooding Asymptote

- There was no mention of a chick in the metadata so all pair 8 data was considered to be brooding. Total data was 40 points.

Pair 10 Fledging

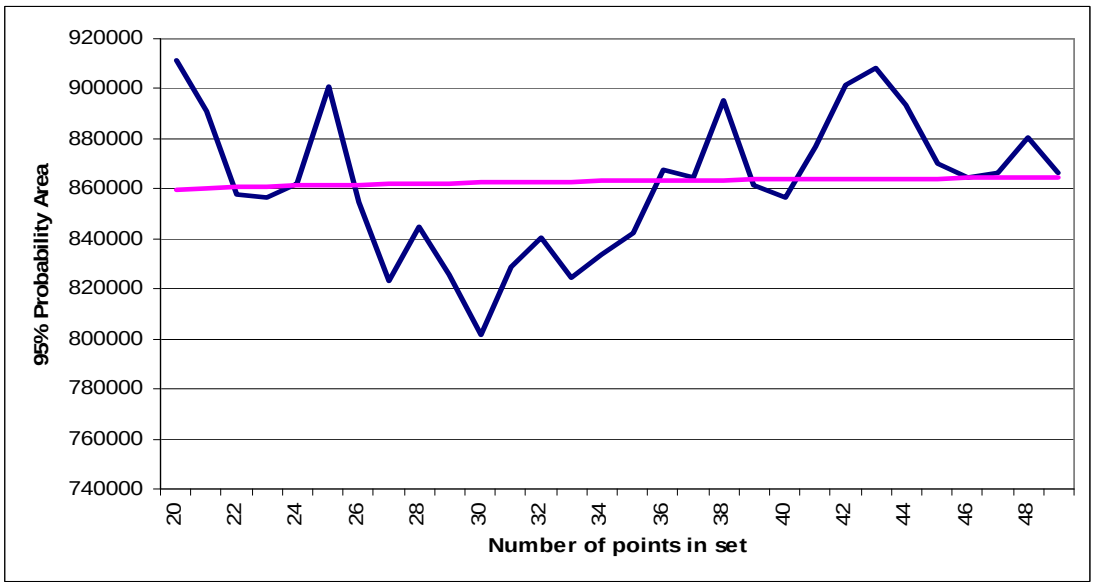


Figure 6: Pair 10 Fledging Asymptote

- This pair contains data from at least 4 birds (2 pairs), with no clear distinction between the two, the data was analysed as being a single pair. 49 points in total.
- A chick was noted in the first observation as such all data was considered fledging.

Pair 17 Fledging

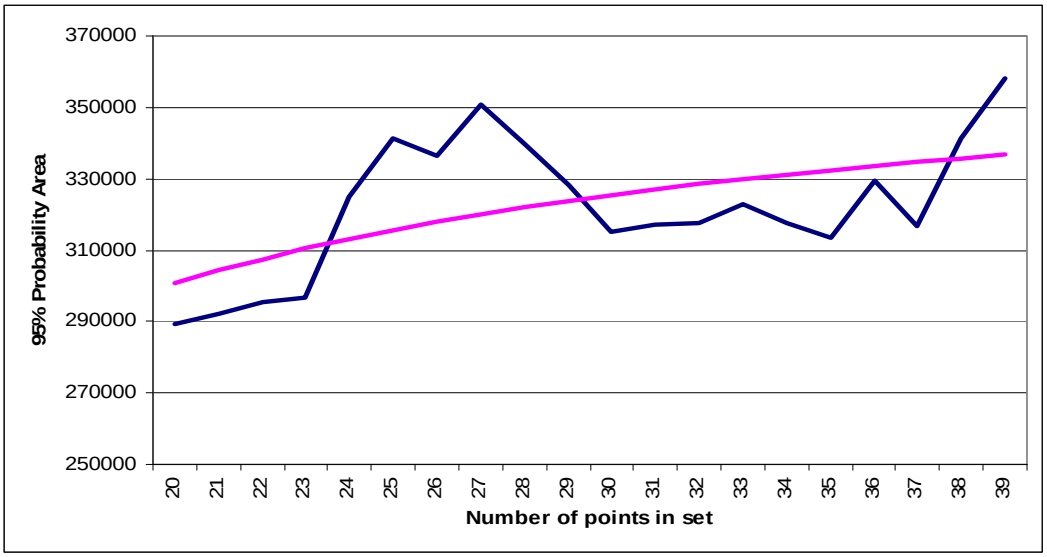


Figure 7: Pair 17 Fledging Asymptote

- A chick was noted in the first observation, as such all data was considered fledging. A total of 39 data points.

Pair 19 Brooding

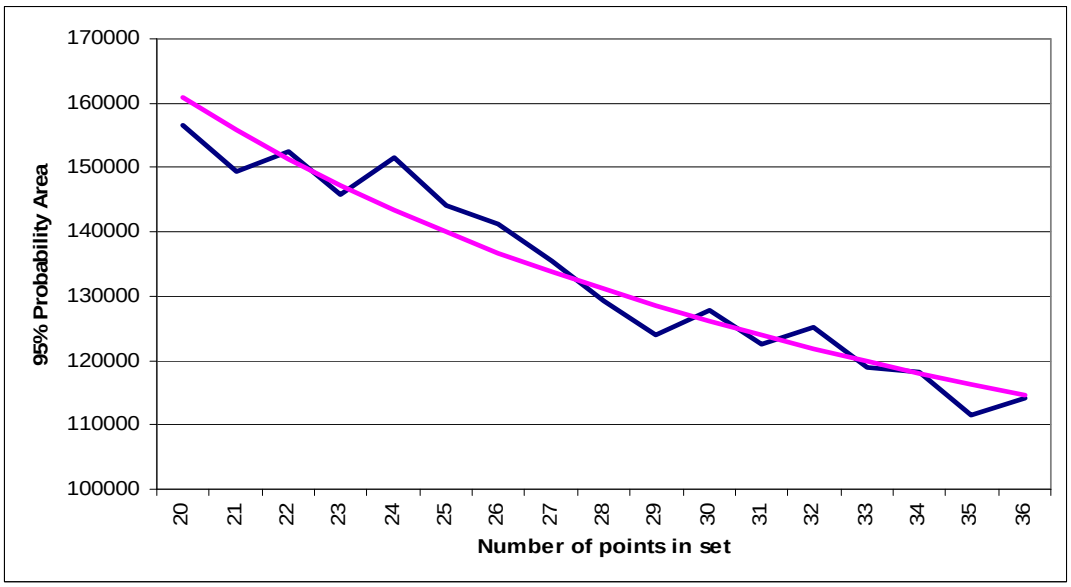


Figure 8: Pair 19 Brooding Asymptote

- No chick was mentioned in the notes, as such all 36 points were treated as brooding.

Appendix 2 Hydro Tasmania Brolga landowner survey

A2.1 Mount Fyans Wind Farm Brolga Landowner Survey – Summary Report (Hydro Tasmania 2014)

Mount Fyans Wind Farm

Brolga Landowner Survey - Summary Report

Introduction

The purpose of this research was to further understand the historical movement of 'threatened' Victorian Brolga from landowner sightings within the region of the proposed Mount Fyans Wind Farm. To do this a landowner survey was conducted in a 5km region of the proposed wind farm boundary. Landowners provided useful information into both sightings of Brolgas and the state of wetlands on their properties.

Method

Landowners within a 5km radius of the proposed wind farm site were considered as part of the survey area.

Initially, each landowner was identified through a title search and called by phone and introduced to the proposed wind farm development – its status, size and location. They were then asked if they had time to meet face to face to answer some questions about Brolgas and Wetlands on their property.

The Survey questions were designed around the specifications of the Interim guidelines for the Assessment, Avoidance, Mitigation and Offsetting of the Potential Wind Farm Impacts on the Victorian Brolga Population, 2011.

To assist with site specific information, a hard copy aerial map (size A3) of each property was taken to each landowner meeting to identify Brolga sightings and wetland information.

The following questions were asked as part of the survey to each landowner:

> *How long have you lived on/owned this property? How many and where are the wetland areas on your property (use map)? When and how long do wetlands hold water for and what is the depth/drainage structure now and historically?*

Are you able to identify a Brolga? Have you seen Brolga/Brolgas on your property? If so, how many did you see? When did you see them? How long did they stay? What were they doing? Where did you see them (use map)?

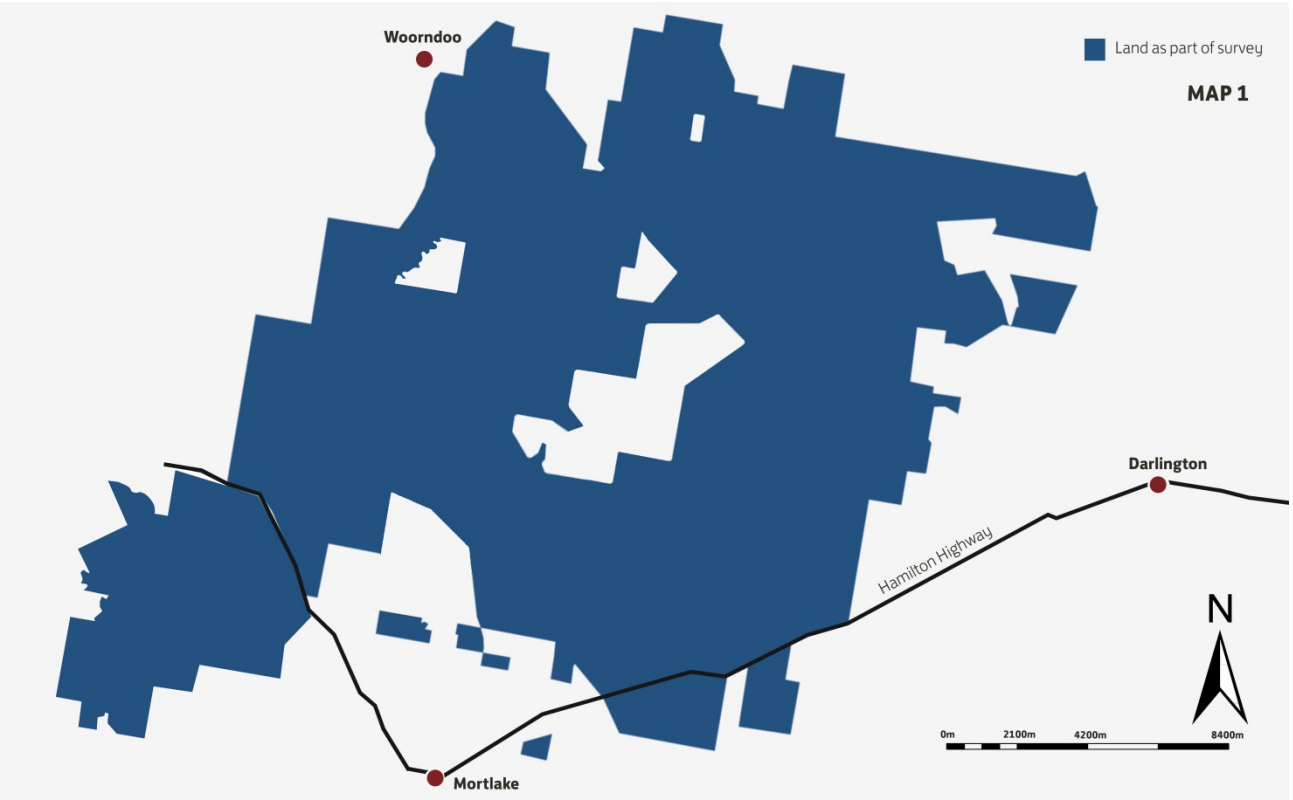
If sightings were suggestive of nesting/breeding or flocking behaviour further questions were asked for clarification:

Do you have photos of the brolgas? Did you see the nest and are its remains still there? Did you see any young brolgas (chicks)? If so, for how long? Did anyone else observe the flocking roost site or breeding site?

The survey was carried out by Chris Bury (Hydro Tasmania), with assistance from Natalie Lukies (Entura), Katrina Sofo (BIOSIS) and Daniel Bennett (Entura). The Survey included 7 site visits to the region which took place between 02/05/2013 and 20/03/2015.

Survey snapshot

- 57 landowners and property managers within and surrounding the proposed wind farm area have been talked to as part of the Brolga Survey (map 1).
- 49 landowners were met face to face.
- Five landowners answered questions on the phone about Brolgas
- Three landowners were not interested in talking or meeting to discuss brolgas (this land is excluded from map 1).
- All but one landowner was able to identify a Brolga and had seen them foraging in the region at some point.



Map 1. Land covered during the Brolga Landowner Survey

Key Brolga findings

- 10 Brolga breeding sites were observed by landowners within the study region (map 2).
- One flocking site was also identified within the study region (map 2)
- Most of the observations/sightings made by landowners did not relate to 'flocking sites' or 'breeding sites' as defined in the 2011 DSE Interim Guidelines. Rather these sightings were other activities, typically – a brolga/brolgas foraging across the land for short periods of time over dry land.

Map 2. Landowner observations - brolga flock roost site and breeding sites.

Appendix 3 Brolga survey data for Lake Sheepwash

The following table includes observation data of Brolga at Lake Sheepwash (and nearby) recorded by Biosis from 27 May 2013 to 14 June 2013. General movement observations were made and foraging activity was noted.

Table A3.1. Brolga survey data for Lake Sheepwash (and nearby) during May and June 2013.

Date	Time	Location	Count	Activity	Movements/observations
27-May-13	3:00	Darlington-Nerrin Rd 3 km N of Mount Fyans Volcanic Reserve	2	Foraging	Two birds located on a low dam wall 400 m W of the road.
27-May-13	4:00	Darlington-Nerrin Rd south of Mortlake-Mount Fyans Lane	2	Foraging	Two birds located in paddock W of the roadway.
27-May-13	4:10	Darlington-Nerrin Rd	2	Foraging	Two birds located in paddock 200 m W of the roadway.
27-May-13	5:55	Lake Sheepwash (Darlington-Nerrin Rd)	2	Foraging	Two birds present on wetland wading in the shallows.
27-May-13	5:59	Lake Sheepwash (Darlington-Nerrin Rd)	28	Flocking	28 birds flew from the SSW and alighted in the wetland, joined other birds located there.
28-May-13	6:45	Lake Sheepwash (Darlington-Nerrin Rd)	32	Flocking and foraging	32 birds feeding in shallow.
28-May-13	8:00	Lake Sheepwash (Darlington-Nerrin Rd)	4	Movement	Four birds departed and flew SW over Mount Fyans (Stradbroke).
28-May-13	8:02	Lake Sheepwash (Darlington-Nerrin Rd)	4	Movement	Four birds departed due west to Mount Fyans.
28-May-13	8:04	Lake Sheepwash (Darlington-Nerrin Rd)	23	Movement	Birds flew as one large group at about 30-40 m height. Two birds peeled off and flew east.
28-May-13	8:08	Lake Sheepwash (Darlington-Nerrin Rd)	2	Movement	Two birds flew low over paddocks heading ENE at a height of 20-30 m.

Date	Time	Location	Count	Activity	Movements/observations
28-May-13	8:10	Lake Sheepwash (Darlington-Nerrin Rd)	-	-	Birds were heard calling from Lake sheepwash but could not be located.
28-May-13	8:27	Darlington-Nerrin Rd	2	Foraging	Two birds were located to the west of the Darlington-Nerrin Rd close to where the pair was located previous afternoon.
29-May-13	6:40	Lake Sheepwash (Darlington-Nerrin Rd)	-	Movement	Birds at flocking site moving south at the flocking site .
29-May-13	6:50	Lake Sheepwash (Darlington-Nerrin Rd)	32	Foraging	32 birds collected at the southern end of the wetland. Several birds are calling from Mount Fyans Homestead area.
29-May-13	7:40	Lake Sheepwash (Darlington-Nerrin Rd)	28	Movement	Birds moved off in a large group at about 30 m in height.
29-May-13	7:42	Lake Sheepwash (Darlington-Nerrin Rd)	3	Movement	Birds flew SW over Mount Fyans at about 20 m height.
29-May-13	7:45	Lake Sheepwash (Darlington-Nerrin Rd)	2	Movement	Birds flew SW over Mount Fyans at about 20 m height.
29-May-13	8:15	Lake Sheepwash (Darlington-Nerrin Rd)	2	Movement	Last pair to leave wetland and would appear to be the same pair as left previously in the same direction.
29-May-13	8:40	Darlington-Nerrin Rd	24	Foraging	Birds feeding in a damp paddock just off the corner of the Neerin- Darlington Rd (located about 300 m SW of the roadway.
29-May-13	8:45	Darlington-Nerrin Rd	2	Foraging	Two birds located in paddock 200 m W of the roadway.
29-May-13	10:13	Hamilton Highway	2	Foraging	Two birds located 400 m S of the highway in a swampy area adjacent to a large brackish wetland (4 km E of Mortlake).
29-May-13	11:20	Darlington-Nerrin Rd	24	Foraging	The group of 24 birds observed in the morning have moved 400-500 m W from where they were earlier location to approximately 800 m W of the Nerrin-Darlington Rd. Birds foraging in a drainage line.
29-May-13	16:45	Darlington-Nerrin Rd	2	Foraging	Two birds located 300 m W of the Nerrin-Darlington Rd just north of the bend heading towards Lake Barnie Bolac.

Date	Time	Location	Count	Activity	Movements/observations
29-May-13	16:50	Darlington-Nerrin Rd	2	Foraging	Two birds located in paddock 200 m W of the roadway (same location as the two previous days)
29-May-13	16:55	Darlington-Nerrin Rd	2	Movement	Two birds located 300 - 400 m E of the Nerrin-Darlington Rd. Birds took off and flew over road and joined two others in paddock to W.
29-May-13	17:35	Lake Sheepwash (Darlington-Nerrin Rd)	32	Movement	Birds flew in low (20-30 m) in two groups close together.
30-May-13	6:40	Lake Sheepwash (Darlington-Nerrin Rd)	36	Foraging	Birds trumpeting ansd calling. Moving S along wetland.
30-May-13	6:40	Lake Sheepwash (Darlington-Nerrin Rd)	-		Birds heard calling from Mount Fyans homestead (not visible).
30-May-13	7:49	Lake Sheepwash (Darlington-Nerrin Rd)	23	Foraging	Birds headed W in a broken group (3-5-15) to the old "tip" area.
30-May-13	7:51	Lake Sheepwash (Darlington-Nerrin Rd)	12	Movement	Birds headed W in a large group.
30-May-13	8:20	Lake Sheepwash (Darlington-Nerrin Rd)	2	Foraging	Two birds flew low in the direction of ENE.
30-May-13	8:30	Mount Fyans Homestead	34	Foraging	Most birds moved off in a large broken group. Five birds remain on site.
30-May-13	9:16	Darlington-Nerrin Rd	2	Foraging	Two birds located W of the roadway.
30-May-13	9:20	Darlington-Nerrin Rd	2	Foraging	Two birds located 200 m W of the roadway (similar positoining to Monday afternoon).
30-May-13	9:35	Mount Fyans Homestead	3	Foraging	Three birds flew SW.
30-May-13	9:35	Mount Fyans Homestead	2	Foraging	Two birds remain feeding at the Mount Fyans homestead dam.
30-May-13	9:45	Mortlake -Mount Fyans Lane	26	Foraging	Birds feeding in a large flock on stock grain approximately 800 m S of the laneway.
30-May-13	16:17	Mortlake -Mount Fyans Lane	26	Foraging	Birds feeding in a large flock on stock grain about 800 m SW of the laneway.

Date	Time	Location	Count	Activity	Movements/observations
30-May-13	17:43	Lake Sheepwash (Darlington-Nerrin Rd)	32	Movement	Birds flew in low (20-30 m) in one large group.
31-May-13	6:35	Lake Sheepwash (Darlington-Nerrin Rd)	36	Movement	Most birds moved S on the wetland. Two birds remained at the northern end.
31-May-13	7:45	Lake Sheepwash (Darlington-Nerrin Rd)	36	Foraging	All birds located S of the Mount Fyans homestead on the S side of the dam bank.
31-May-13	8:02	Mount Fyans Homestead	36	Movement	Birds flew SSW over Mount Fyans and appeared to travel 3-4 km.
31-May-13	9:32	Mortlake -Mount Fyans Lane	36	Foraging	Birds feeding in a large flock approximately 100 m E of lane.
04-Jun-13	11:30	Six Mile Lane	2	Foraging	Two birds adjacent to Six Mile Lane (1 km S of the junction with North Rd).
13-Jun-13	17:35	Lake Sheepwash (Darlington-Nerrin Rd)	4	Movement	Two birds flew in from W over Mount Fyans and the other two birds from the NE.
14-Jun-13	7:25	Lake Sheepwash (Darlington-Nerrin Rd)	4	Movement	Four birds flew low to the E and NE.
14-Jun-13	8:45	Darlington-Nerrin Rd	2	Foraging	Two birds located 300 m off the road just north of the 90 degree bend heading towards Lake Barnie Bolac.
14-Jun-13	13:30	Darlington-Carranbul Rd	2	Foraging	Two birds located adjacent to the E side of the roadway (3 km north of the locality of Pura Pura).