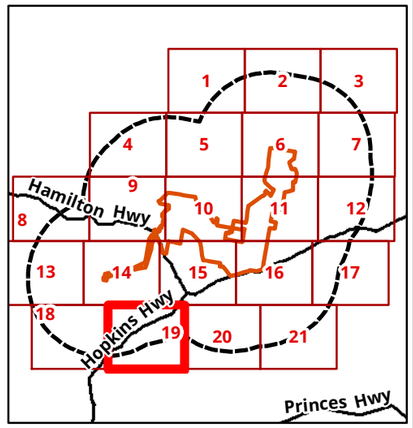

Legend

- Study Area
- 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

Scale: 1:30,000 @ A3

Coordinate System: GDA 1994 MGA Zone 54

N

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Location:P:\16300s\16307\Mapping
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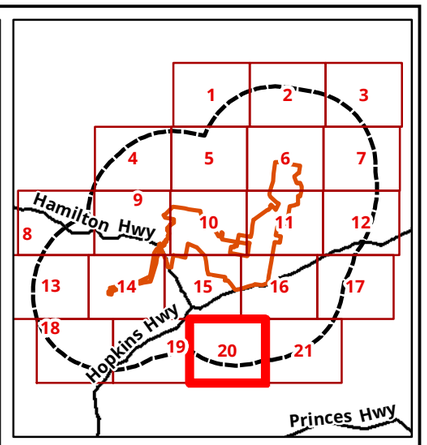
4/1992(1 birds)
1/2002(No count)
1/1984(No count)
1/2002(No count)



Legend

- Study Area
- 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

Scale: 1:30,000 @ A3

Coordinate System: GDA 1994 MGA Zone 54

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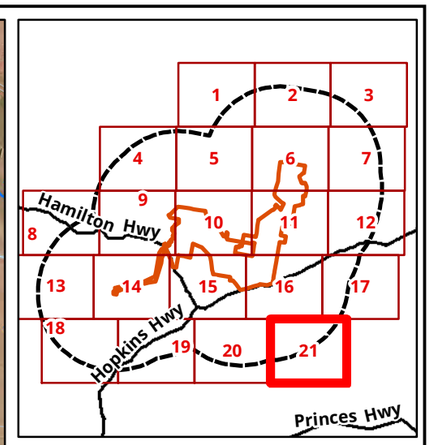

Legend

- Study Area
- 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

Scale: 1:30,000 @ A3

Coordinate System: GDA 1994 MGA Zone 54

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16307_F2_BrolgaRecords

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 3km of the wind farm boundary and four were outside the 3km buffer.

Subsequent ground-truthing of these results within the wind farm and up to 3 km 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 us 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 km 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 Brolga 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 km 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 although the wetland appeared to be suitable for breeding.

The remaining Brolga observations were at a distance greater than 3 km 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 Brolga had been recorded in 2009 (Pair 16, Figure 3a), although breeding has not been confirmed at this site.

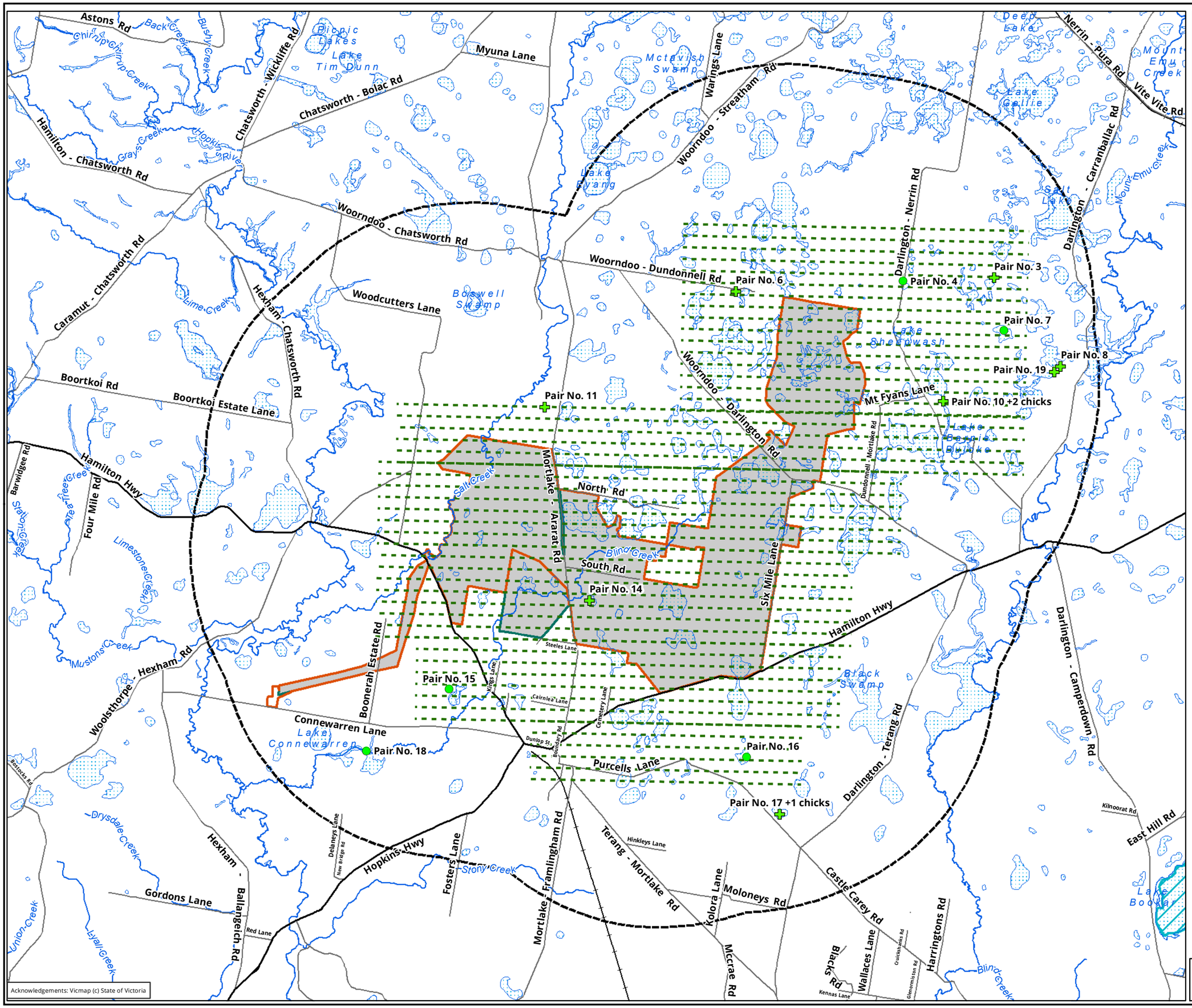

Figure 3a: Mt Fyans Brolga aerial survey results (2009)

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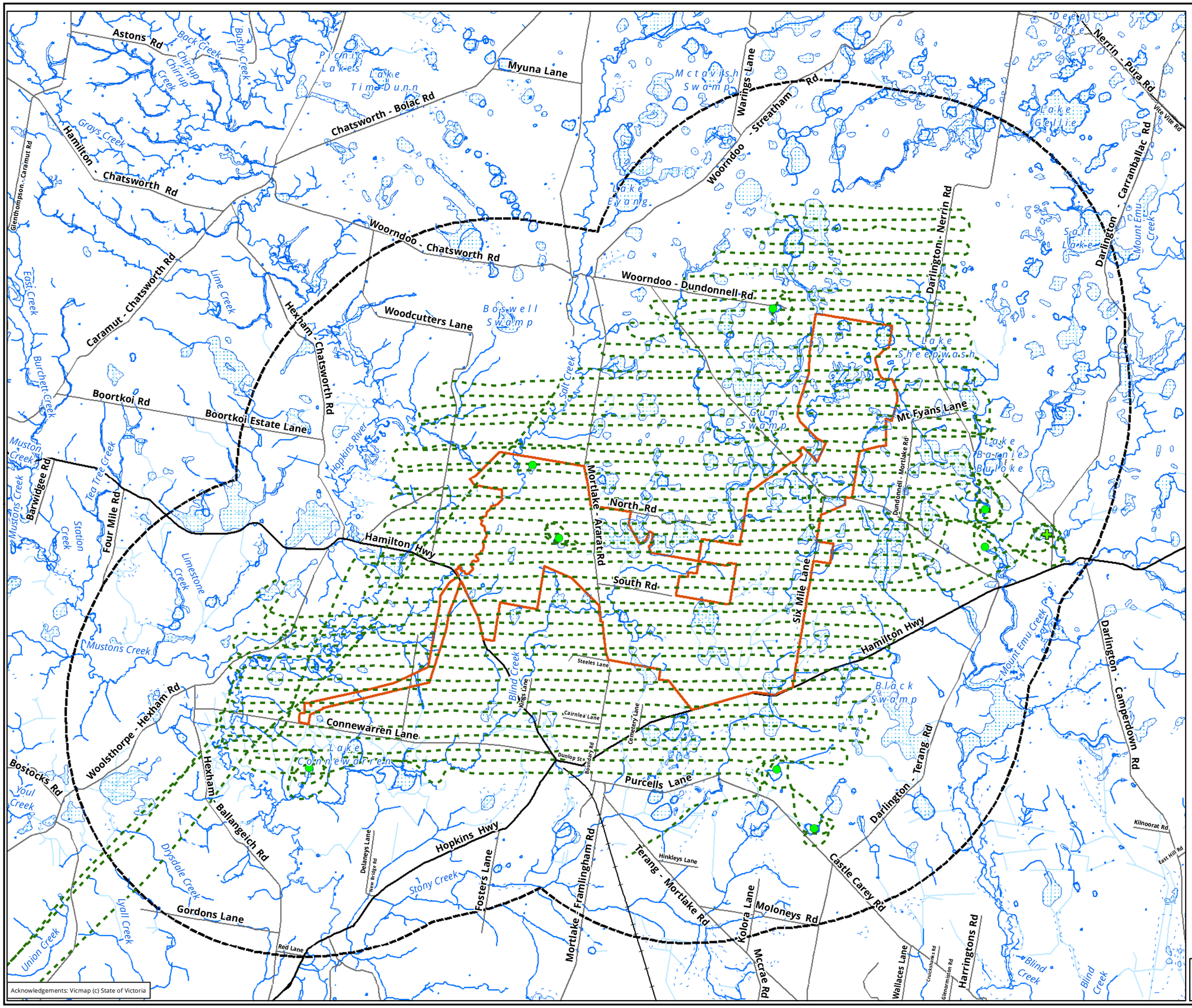

Figure 3b: Mt Fyans Brolga aerial survey results (2014)

0 2 4 6 8

Kilometers

Scale: 1:150,000 @ A3

Coordinate System: GDA 1994 MGA Zone 54

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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 were first observed sitting on a nest on 12 November 2009. Regular observation 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 incubation/brooding. This pair was first observed on 20 October 2009. At this time two chicks were observed, but subsequently 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

During home range observations 39 individual data points were collected, all during the period of incubation/brooding. This pair was first observed during aerial survey sitting on a nest on 12 November 2009. On returning to this pair for home range observations on 3 December 2009 a chick was recorded at-foot with the adults. 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 700m 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 400m 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

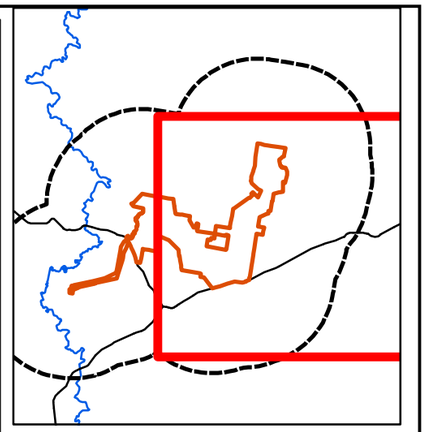
During home range observations 92 individual data points were collected consisting of one during incubation/brooding and 91 post-hatching. This pair was sitting on eggs when first observed on 26 October 2009. They hatched two chicks on 28 October 2009 and the chicks fledged on 18 January 2010 when they 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. Plate 3 below 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 on 27 October 2009. Plate 4 below shows the nest with egg visible while the nest was vacant. 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, 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

- 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

0 1 2 3 4 5

Kilometers

Scale: 1:100,000 @ A3

Coordinate System: GDA 1994 MGA Zone 54

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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 m 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 m 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 (Appendix 2).

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 m (lower CI 541.7m, upper CI 833.8 m) also has a 300 m buffer around it as agreed with DELWP (Appendix 2). Subsequent discussion with DELWP indicated that using the upper CI of 833.8 m 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 m. In addition, a 300 m disturbance buffer is added to provide a total turbine-free buffer radius of 1133.8 m 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, Appendix 2). The upper CI of 833.8 m of the average was again used as described above and also has a 300 m disturbance buffer around it as agreed with DELWP (Appendix 2). As a consequence, the turbine-free buffer for each of these breeding sites also has a total radius of 1133.8 m.

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 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.

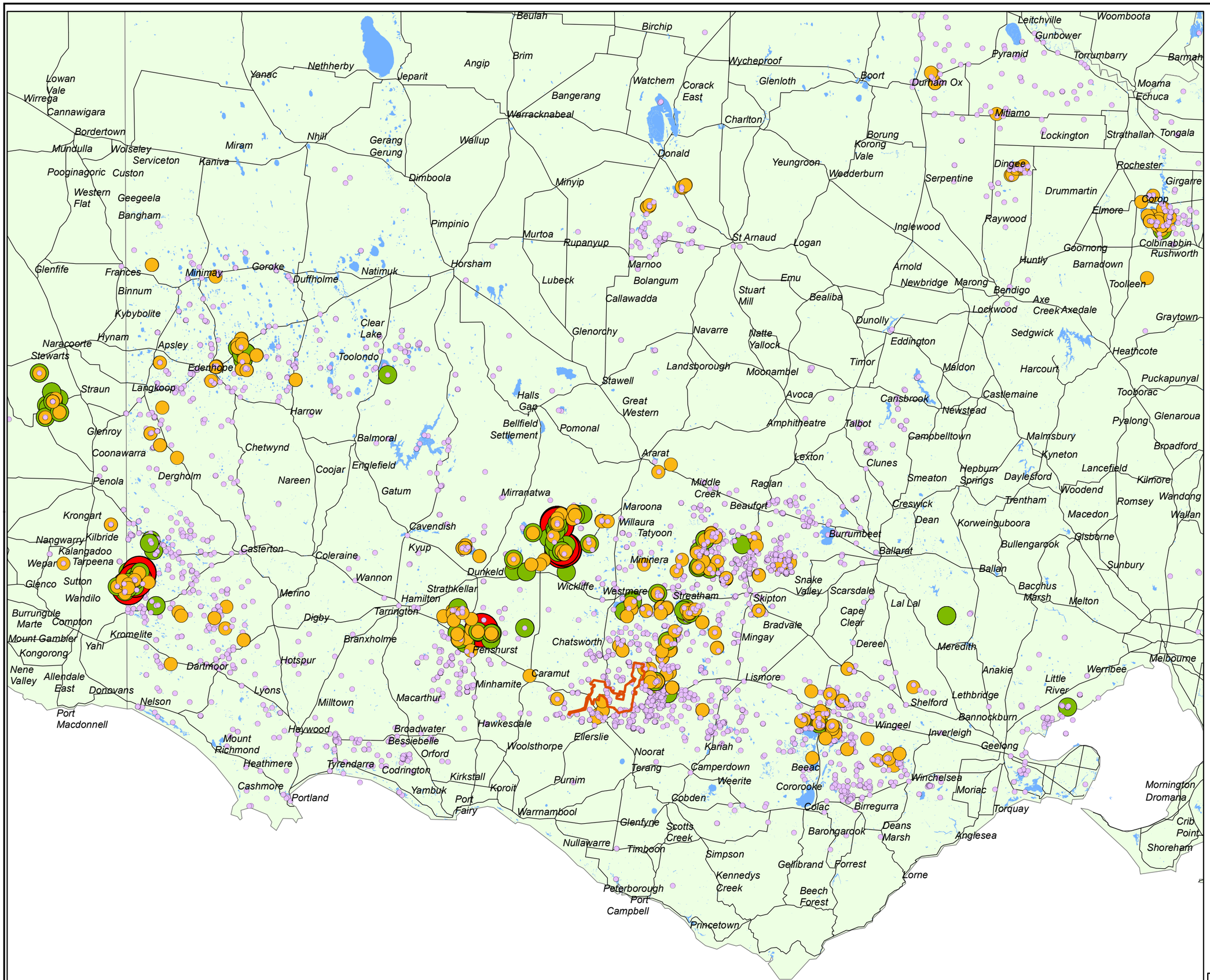
Brolgas were also recorded moving into the surrounding landscape during the day and returning to the roost at night. On this basis and taking into account the reported historical use of the site, the dam meets the definition of a flocking site.

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 4.

3.7 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.



Legend

Brolga numbers

- 1 - 9
- 10 - 50
- 51 - 200
- 200+
- 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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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 1 (DSE 2012).

Table 1 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).

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).

A large number of Brolga records listed as 'breeding' occur within 10 km 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 km 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 m are considered too unreliable to provide confidence in a nest location. Consequently, records from the VBA_100 dataset (>500 m 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 km 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 21 breeding sites are located outside the study area but within 10 km 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 km 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 km. 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 m. 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 km 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).

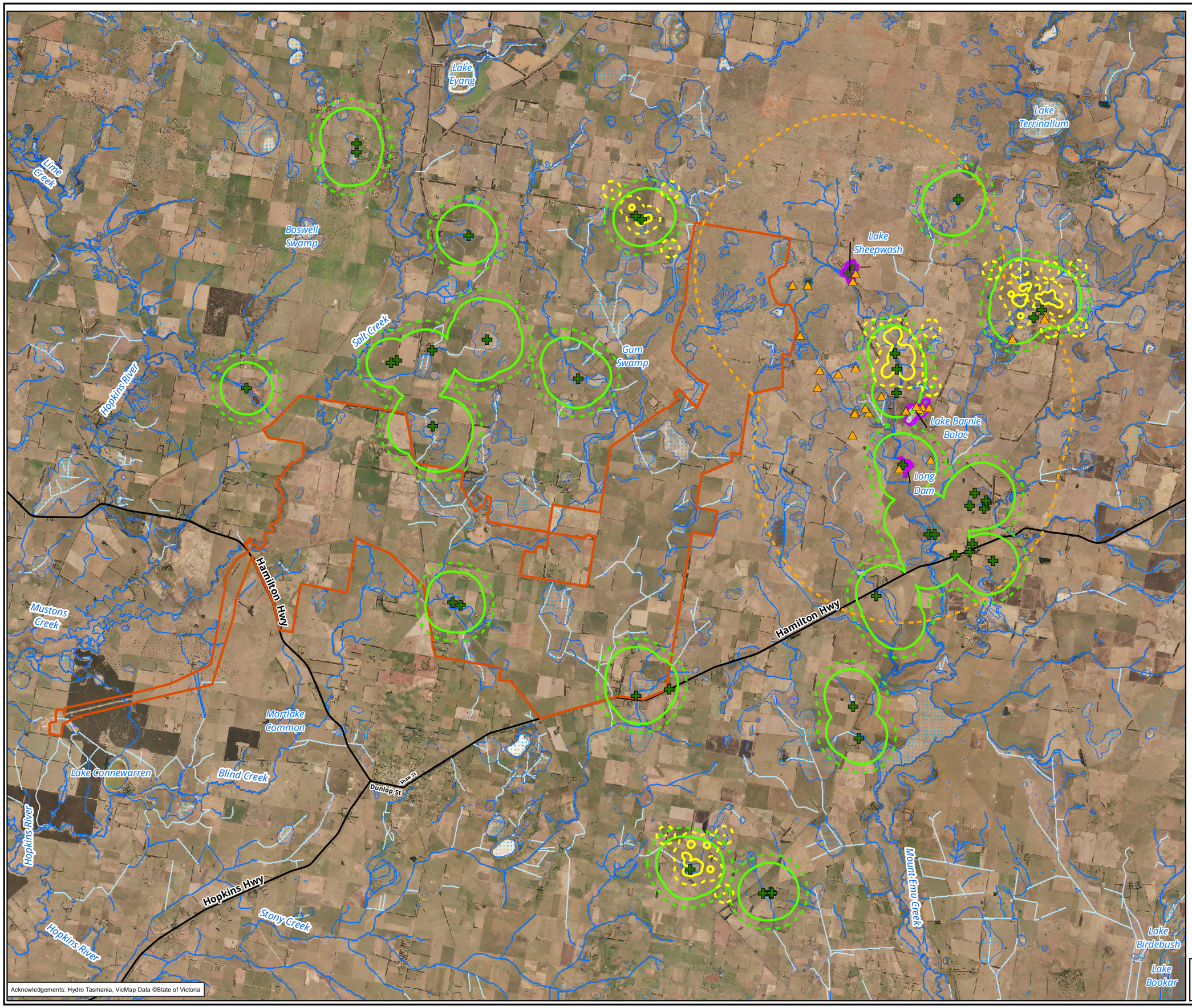
Long Dam is a fresh water spring-fed wetland on private property that adjoins Lake Barnie Bolac to the north. The statutory Planning Panel established to assess the proposed Mortlake Wind Energy Facility in 2010 (DPCD 2010) determined Long Dam to be a potential Brolga flocking site (or part of a complex 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 km 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 km 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 km of study area.

5.2.1 Turbine-free flocking site buffers

The recommendation within the Brolga Guidelines (DSE 2012) is that a 5 km 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 5km turbine-free buffer, as shown in Figure 7.



Legend

- Study area
- 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

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

Ballarat, Brisbane, Canberra, Hobart, Melbourne, Newcastle, Sydney, Wangaratta & Wollongong

Matter: 16307,
Date: 02 February 2017,
Checked by: KS, Drawn by: SKM, Last edited by: smitchell
Location:P:\16300s\16307\Mapping
16307_F7_ConsolidatedRecords

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 km 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 are recommended for these sites, in accordance with the Brolga Guidelines (DSE 2012).

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Appendices

Appendix 1 Symbolix home range reporting

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

Brolga Home Ranges

Mt. Fyans and Penshurst Combined Sets

ISSUE

Version 2.3

30th March, 2010

Submitted to

Biosis Research Pty Ltd

symbolix

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Williamstown North

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Version Control

Doc ID: **BIOHOMER20100210**

Main Author: **Stuart Muir & Michael Reidy**

Path:
C:\SVNStuff\Clients\BIO_Biosis\HOME_HomeRange\Reports\BIO_HOMER_BrolgaHomerangeAnalysis_V2.0_20100210.doc

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

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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 Results

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.

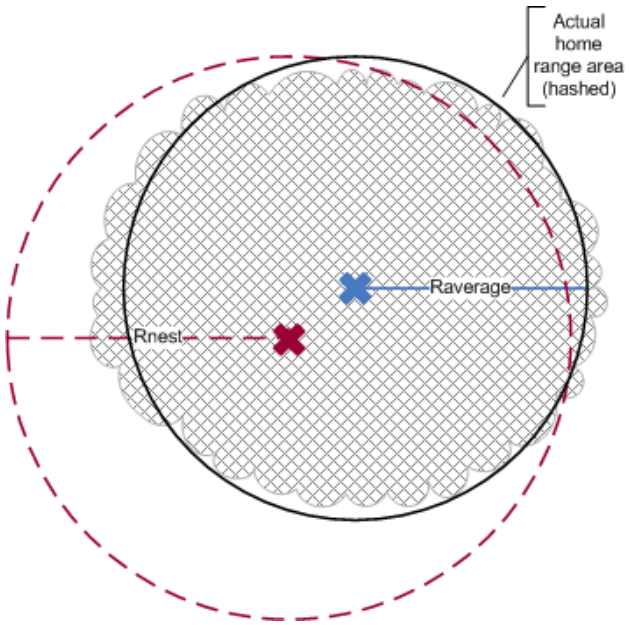

Figure 1: Simple representation of a possible relationship between the radius of containment calculated from the average of all flight points ($R_{average}$) and from the nest site (R_{nest}).

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

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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

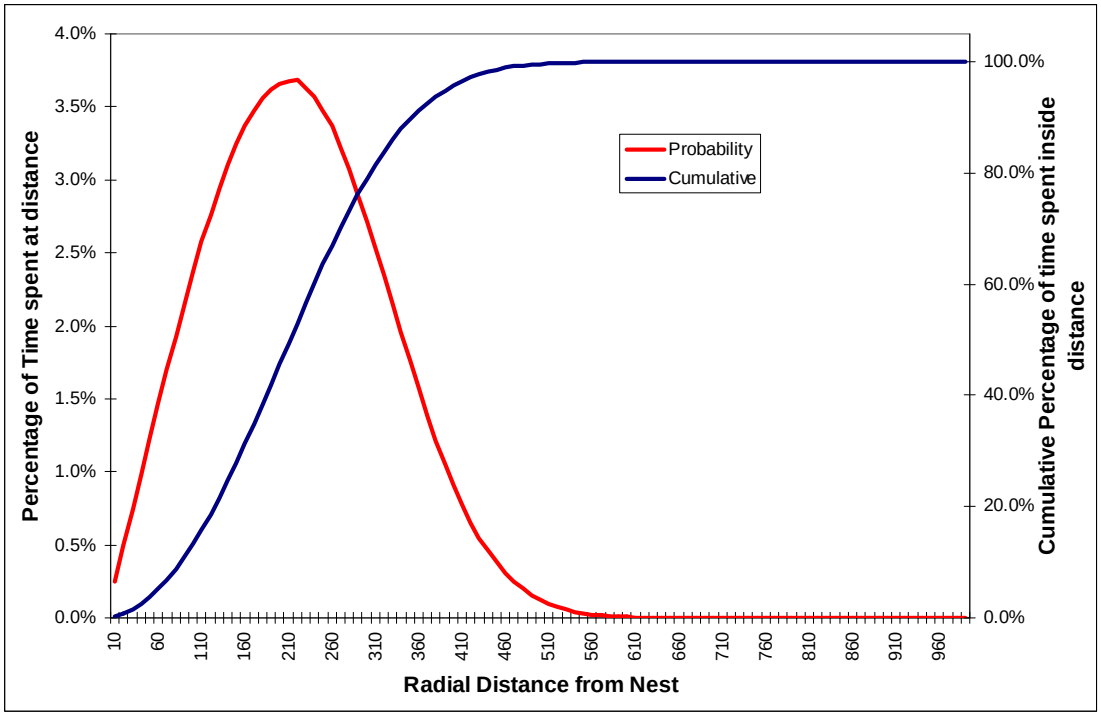

Figure 2: Pair 1 Brooding observations vs radial distance from average point.

A.1.1.2 Pair 1 – Fledging

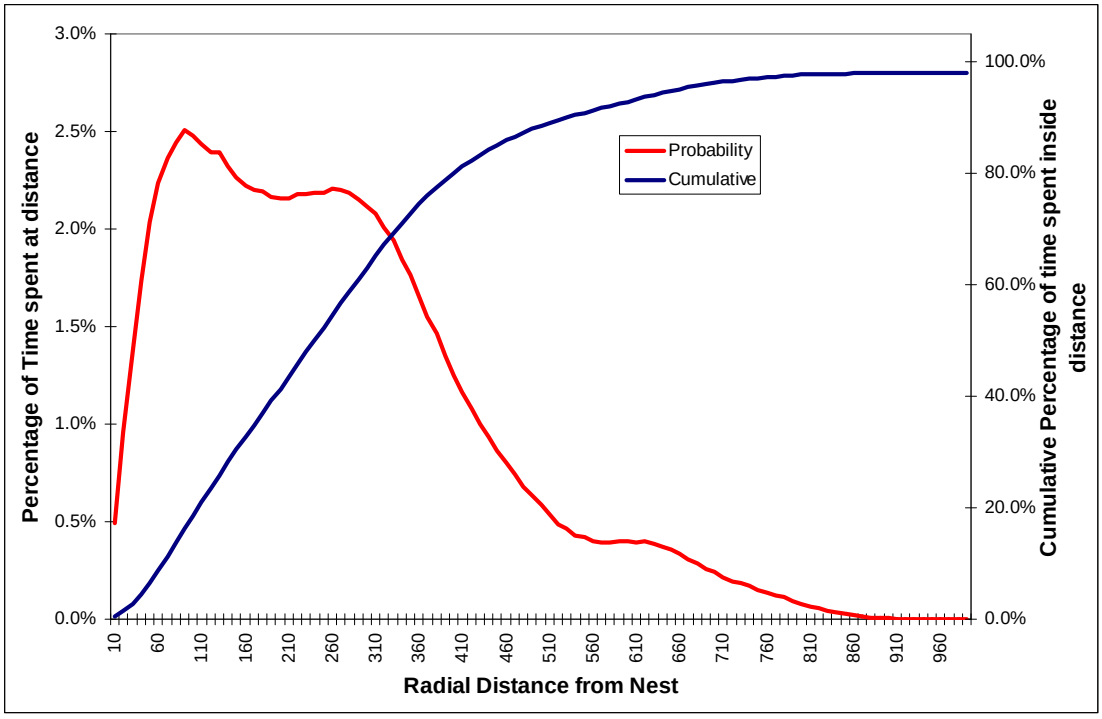

Figure 3: Pair 1 Fledging observations vs radial distance from average point.

A.1.1.3 Pair 1 – All Data

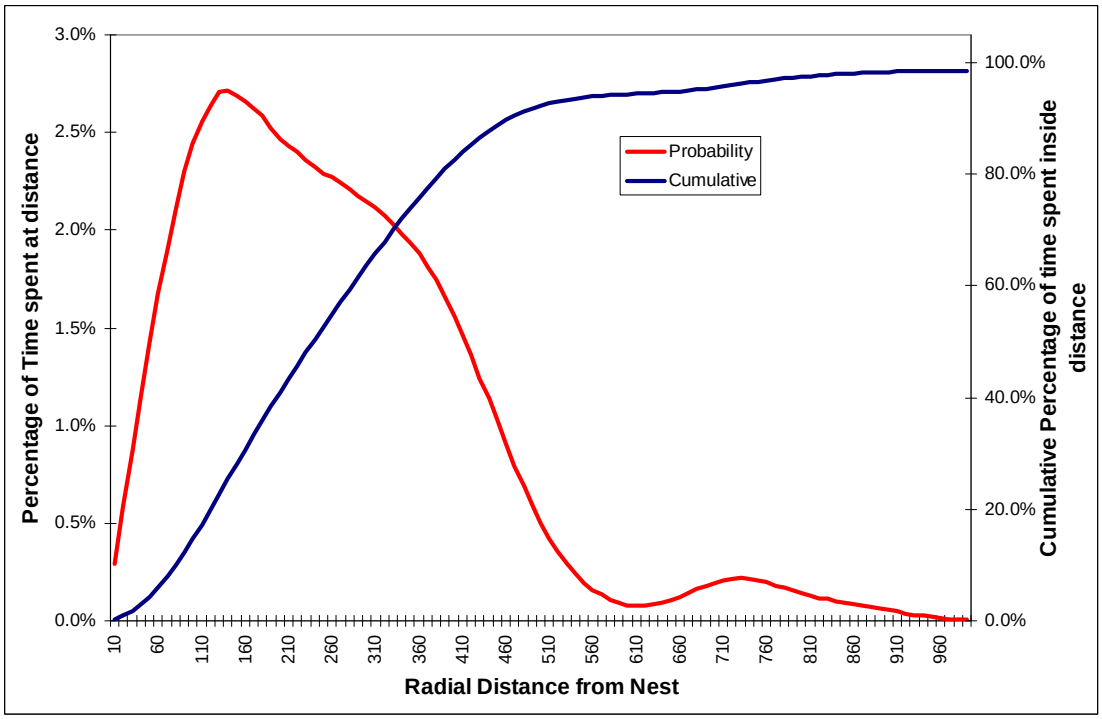

Figure 4: Pair 1 All observations vs radial distance from average point.

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

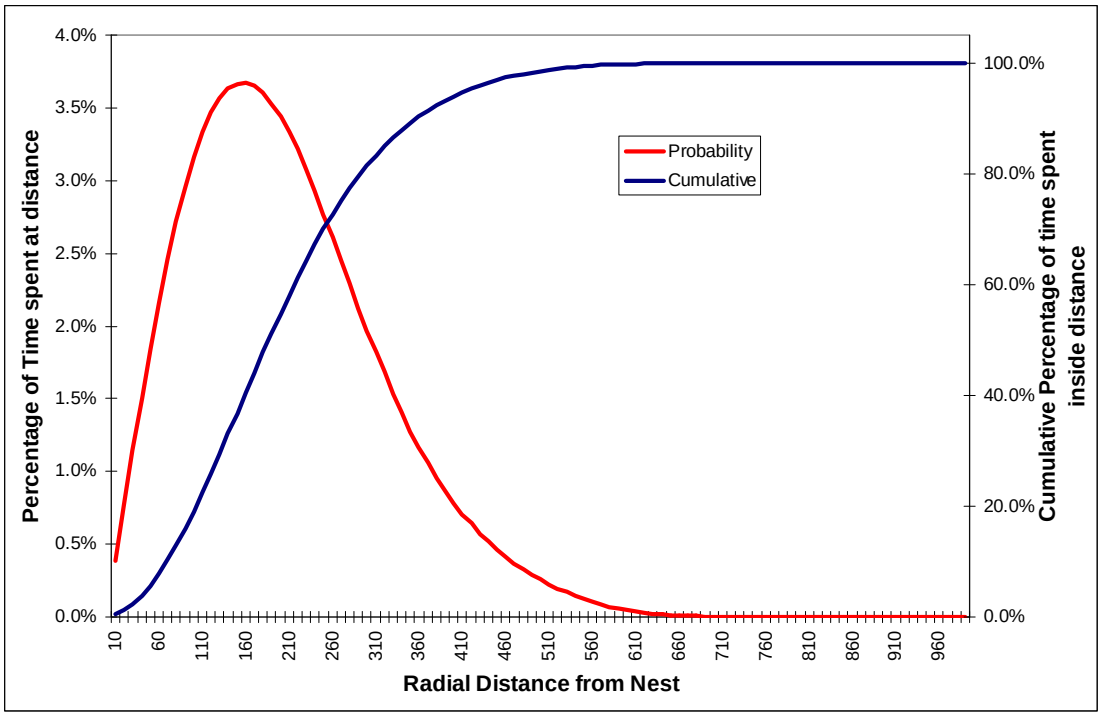

Figure 5: Pair 2 All observations vs radial distance from average point

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

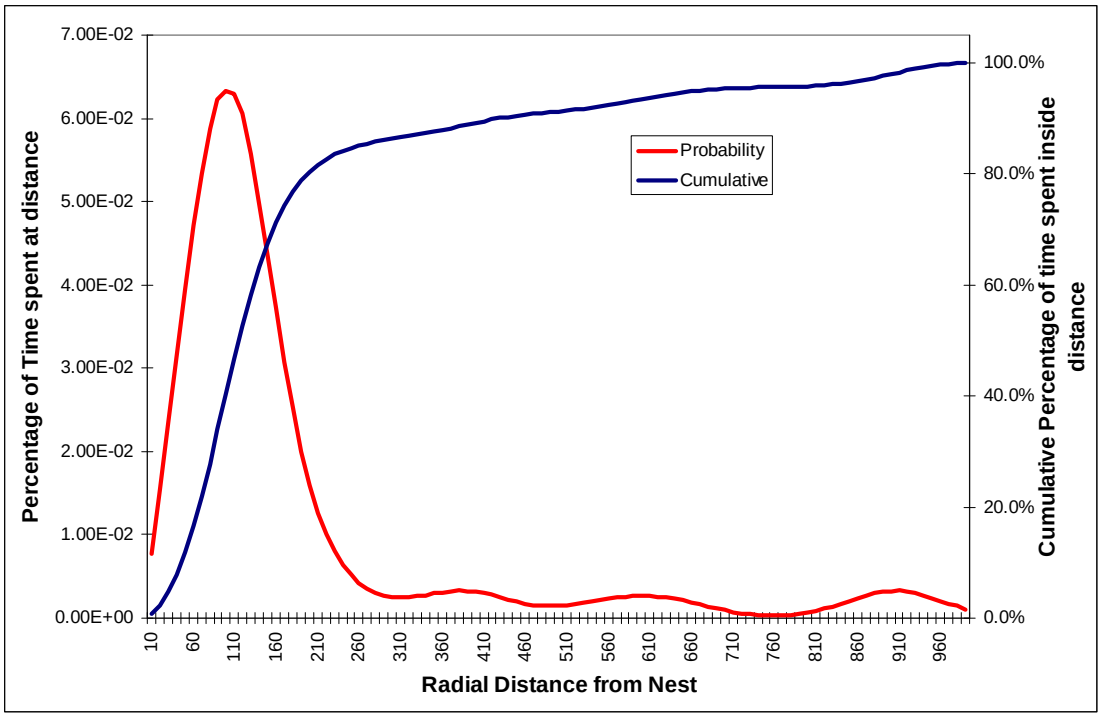

Figure 6: Pair 4 All observations vs radial distance from average point

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

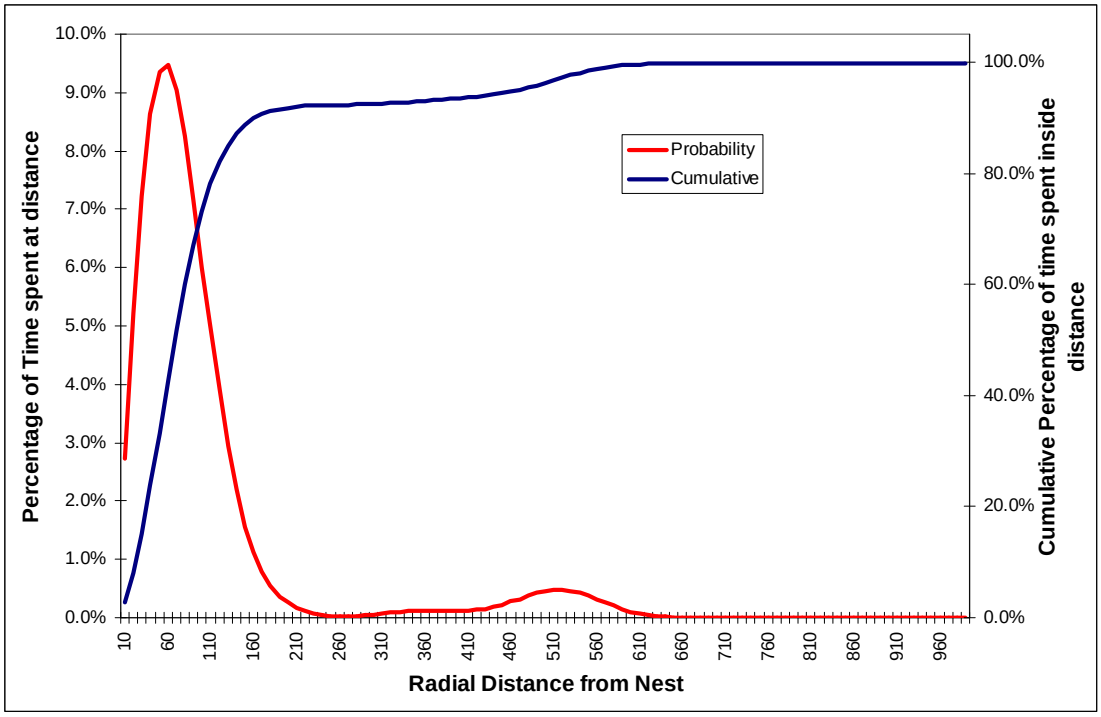

Figure 7: Pair 6 Brooding observations vs radial distance from average point.

A.2.1.2 Pair 6 - Fledging

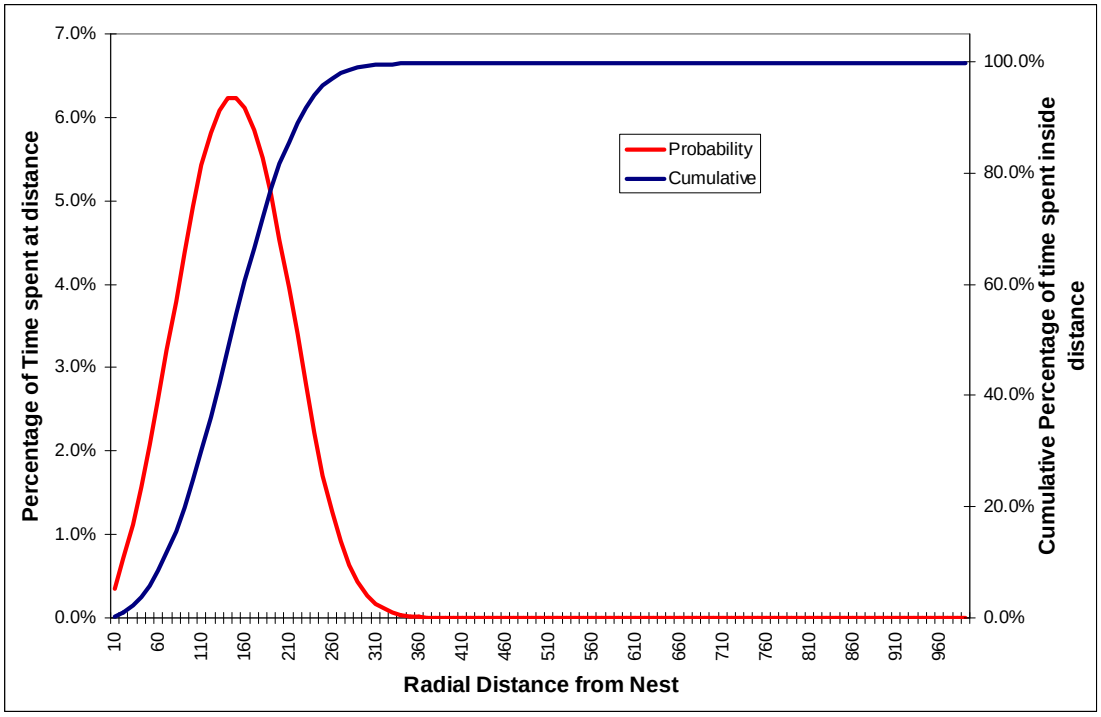

Figure 8: Pair 6 Fledging observations vs radial distance from average point

A.2.1.3 Pair 6 – All Data

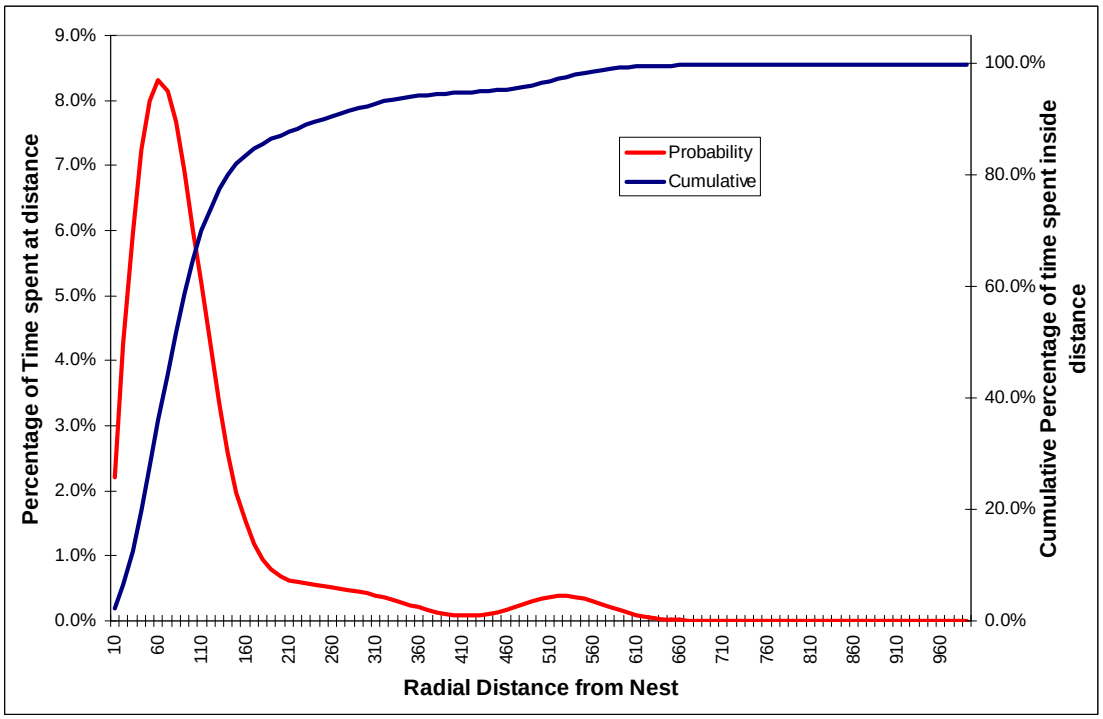

Figure 9: Pair 6 All observations vs radial distance from average point.

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

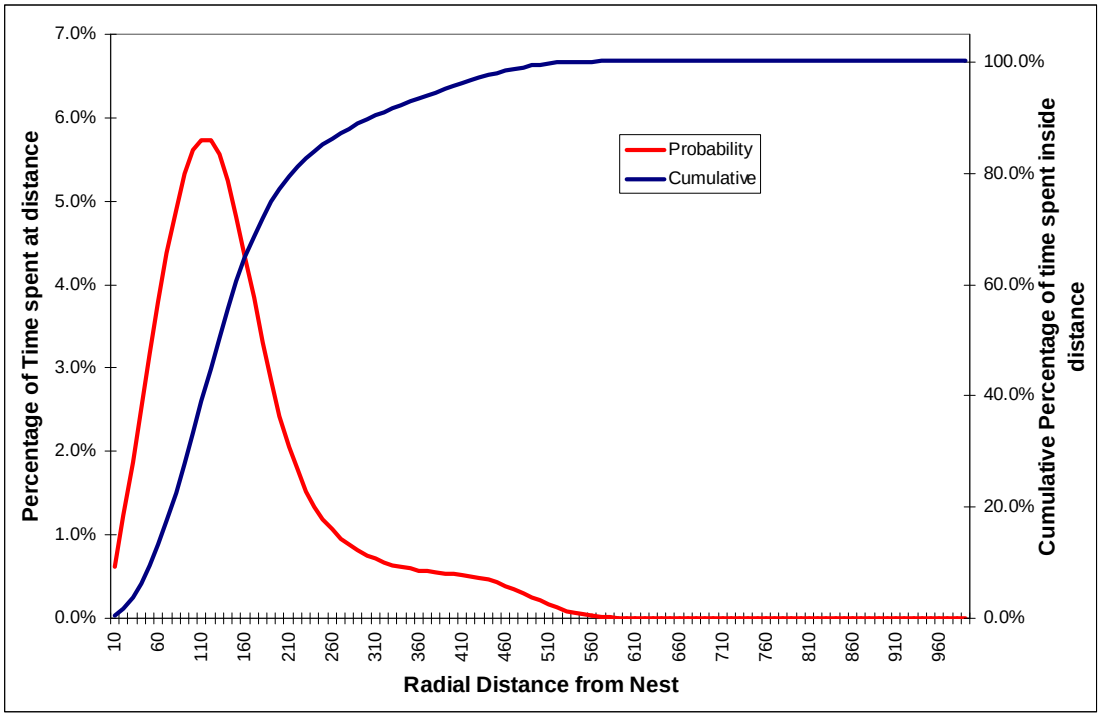

Figure 10: Pair 8 Brooding observations vs radial distance from average point

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)

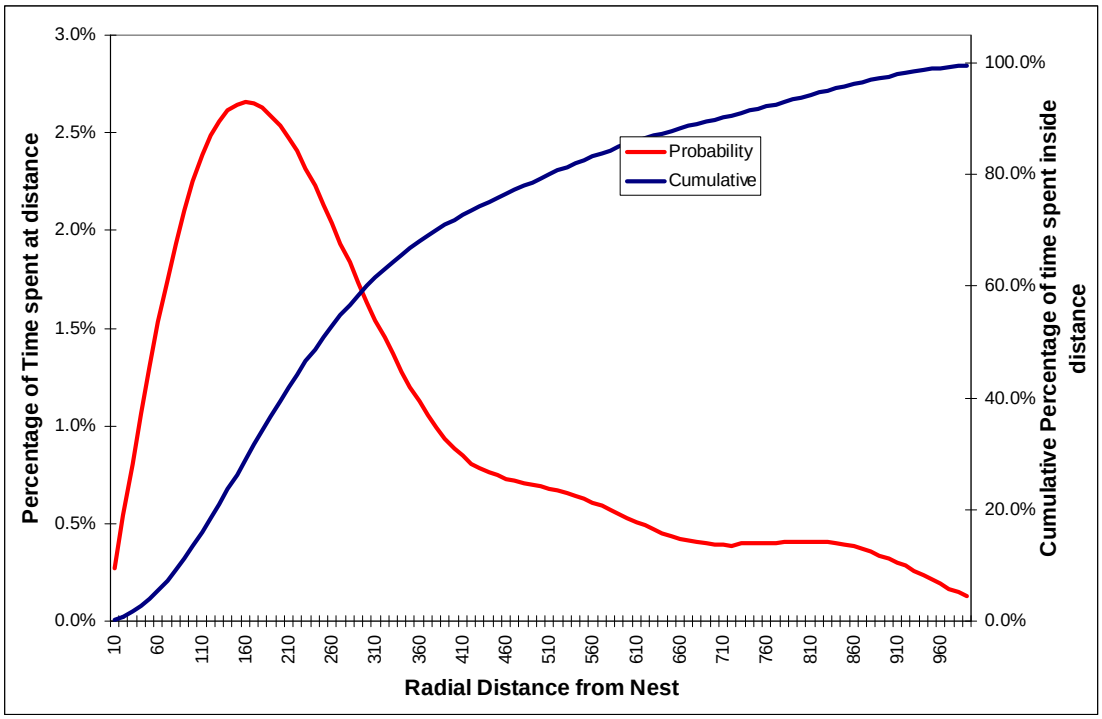

Figure 11: Pair 10 Fledging observations vs radial distance from average point

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

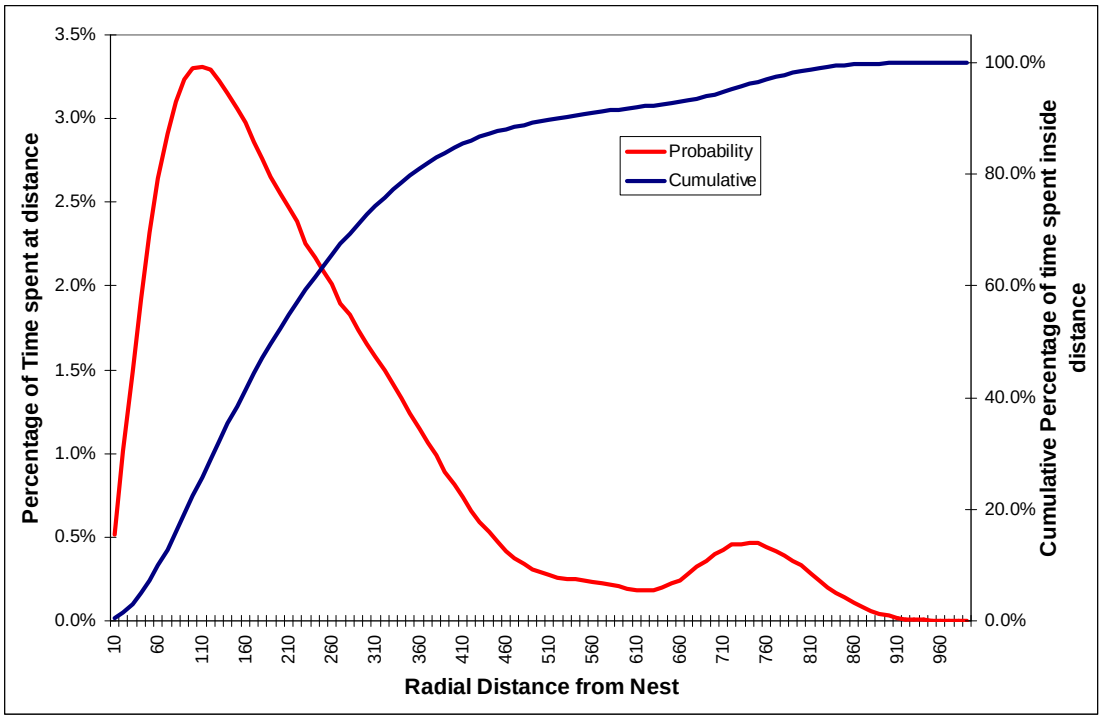

Figure 12: Pair 17 Fledging observations vs radial distance from average point

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

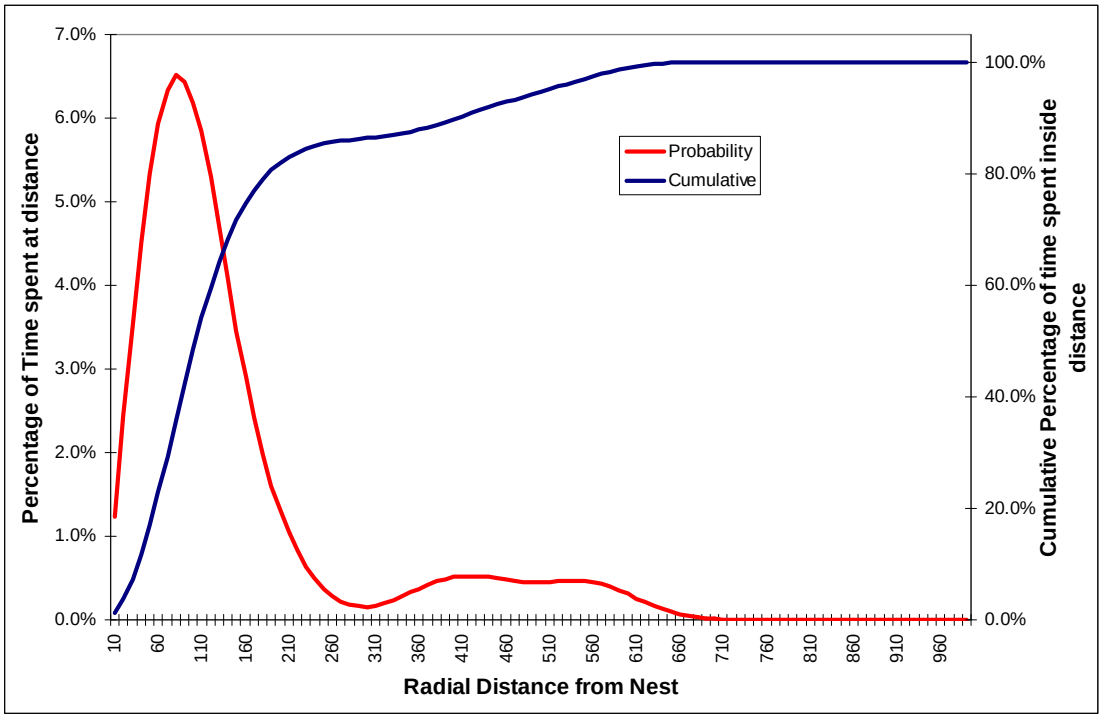

Figure 13: Pair 19 Brooding observations vs radial distance from average point

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

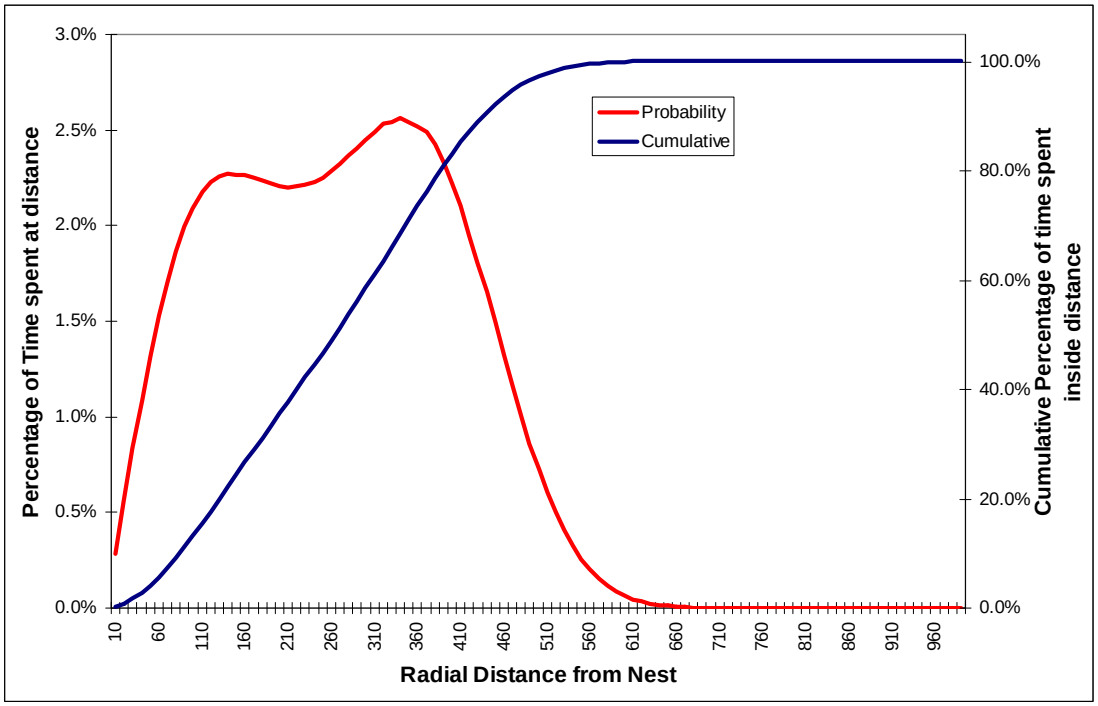

Figure 14: Pair 1 Brooding observations vs radial distance from roost

Pair 1 – Fledging

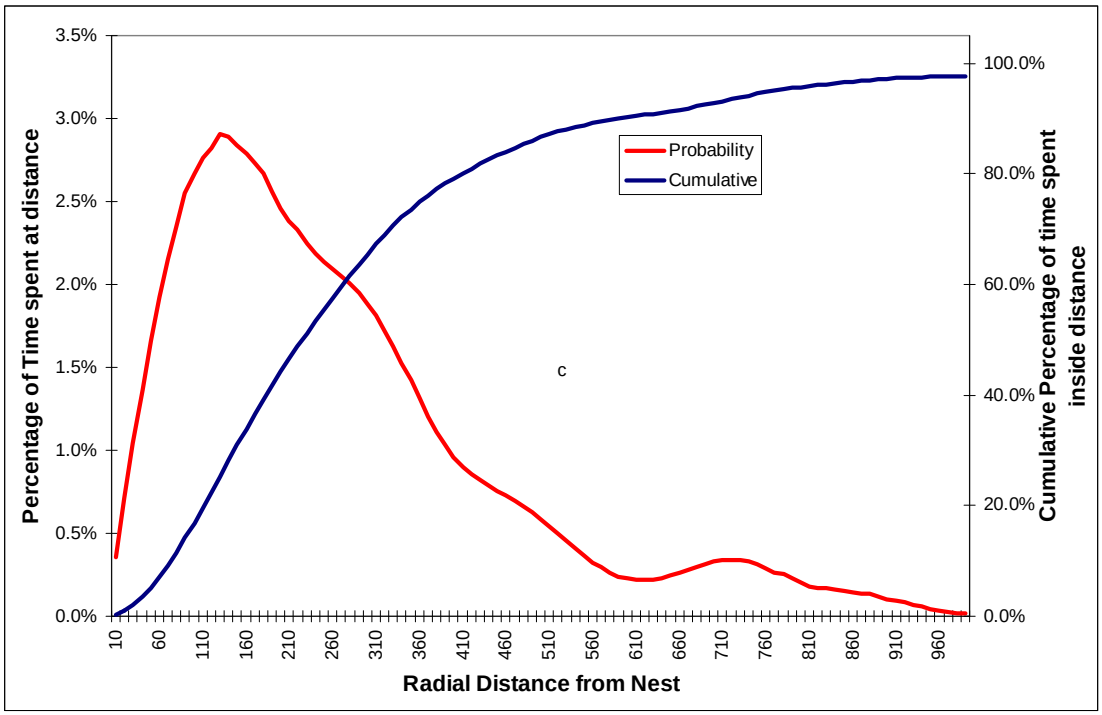

Figure 15: Pair 1 Fledging observations vs radial distance from roost

B.1.1.2 Pair 1 – All Data

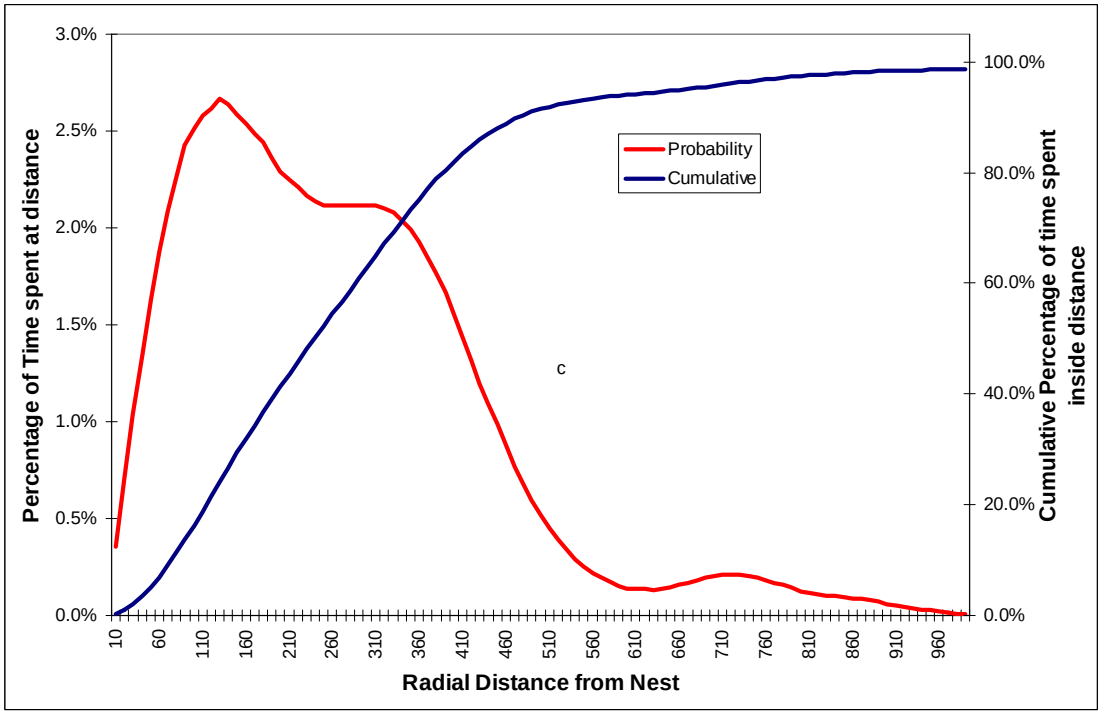

Figure 16: Pair 1 All observations vs radial distance from roost

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

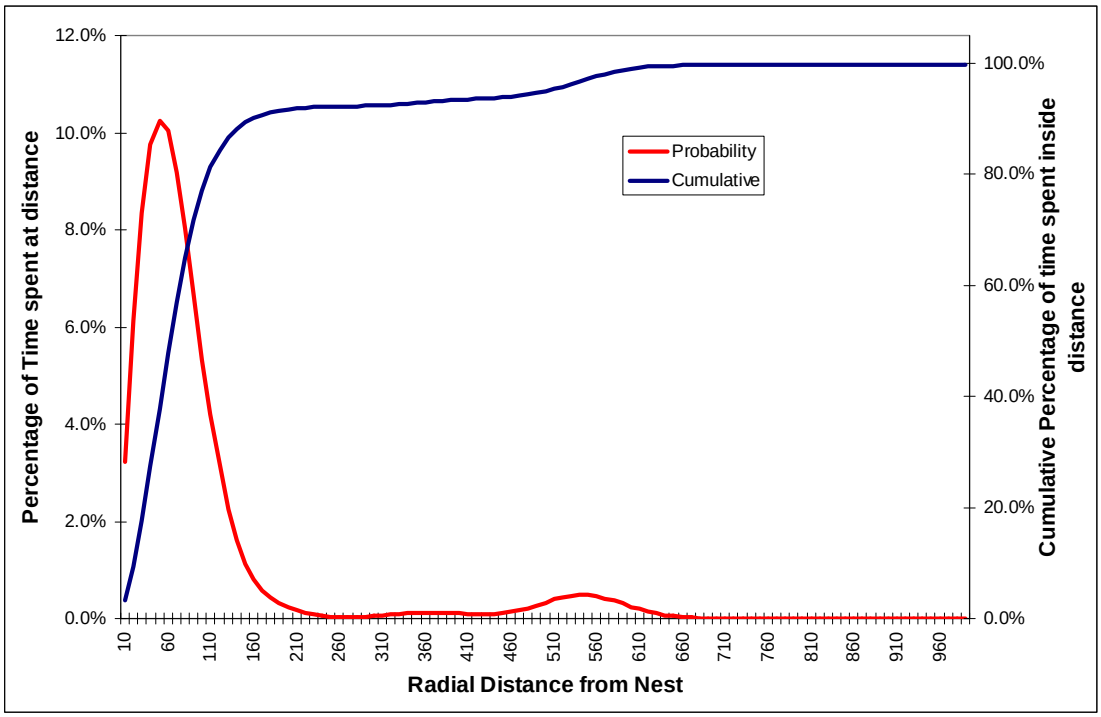

Figure 17: Pair 6 Brooding observations vs radial distance from nest

B.2.1.2 Pair 6 Fledging

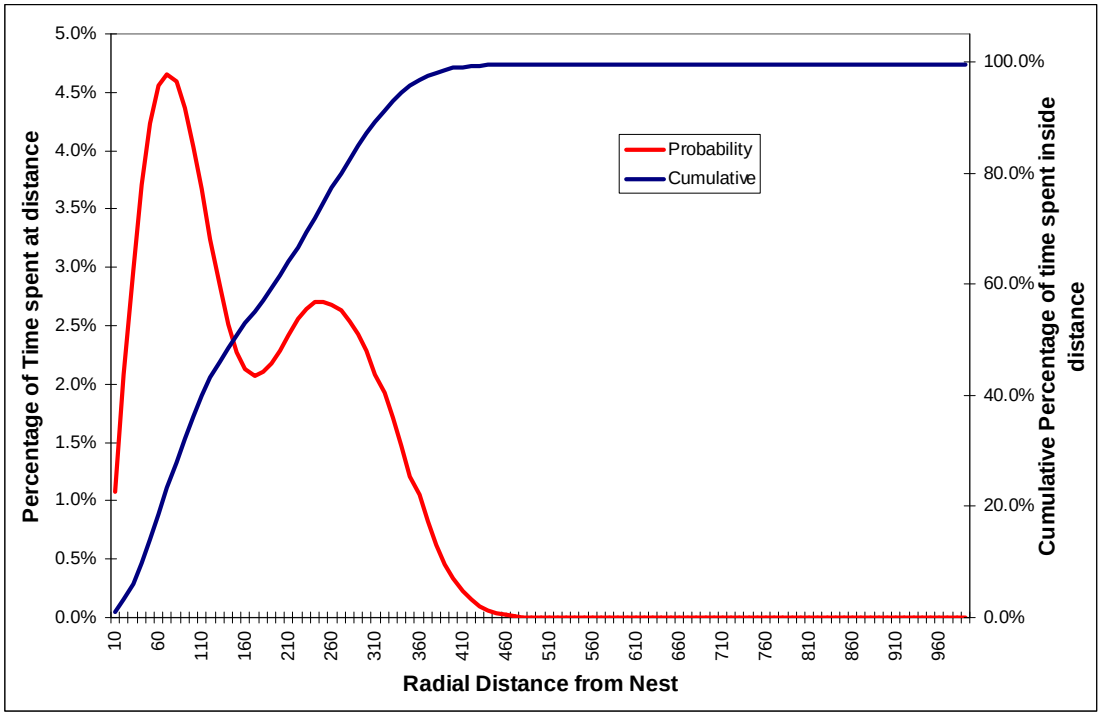

Figure 18: Pair 6 Fledging observations vs radial distance from nest

B.2.1.3 Pair 6 All

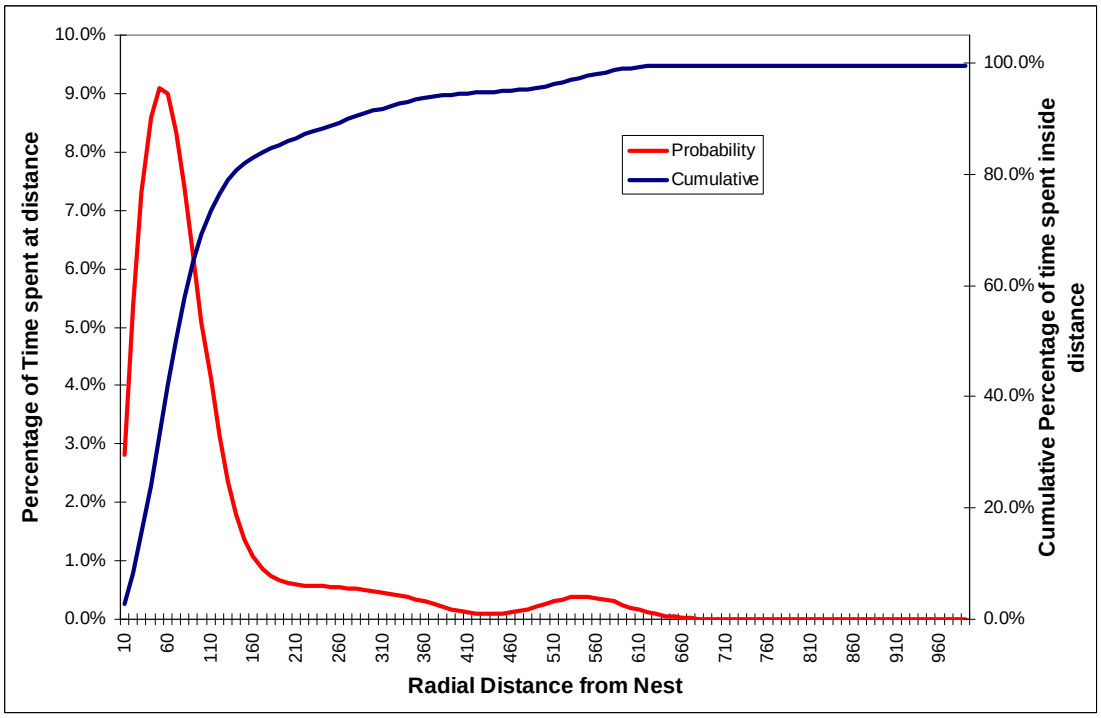

Figure 19: Pair 6 All observations vs radial distance from nest

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)

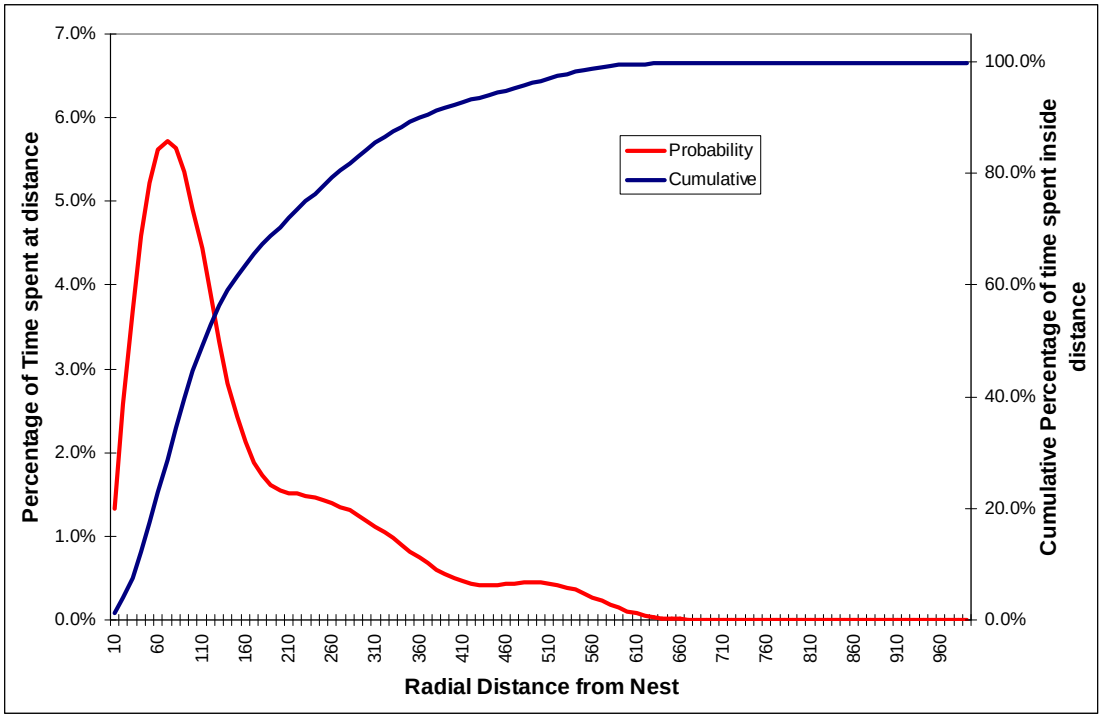

Figure 20: Pair 8 Brooding observations vs radial distance from nest

B.2.3: Pair 17

B.2.3.1 Pair 17 Fledging (All)

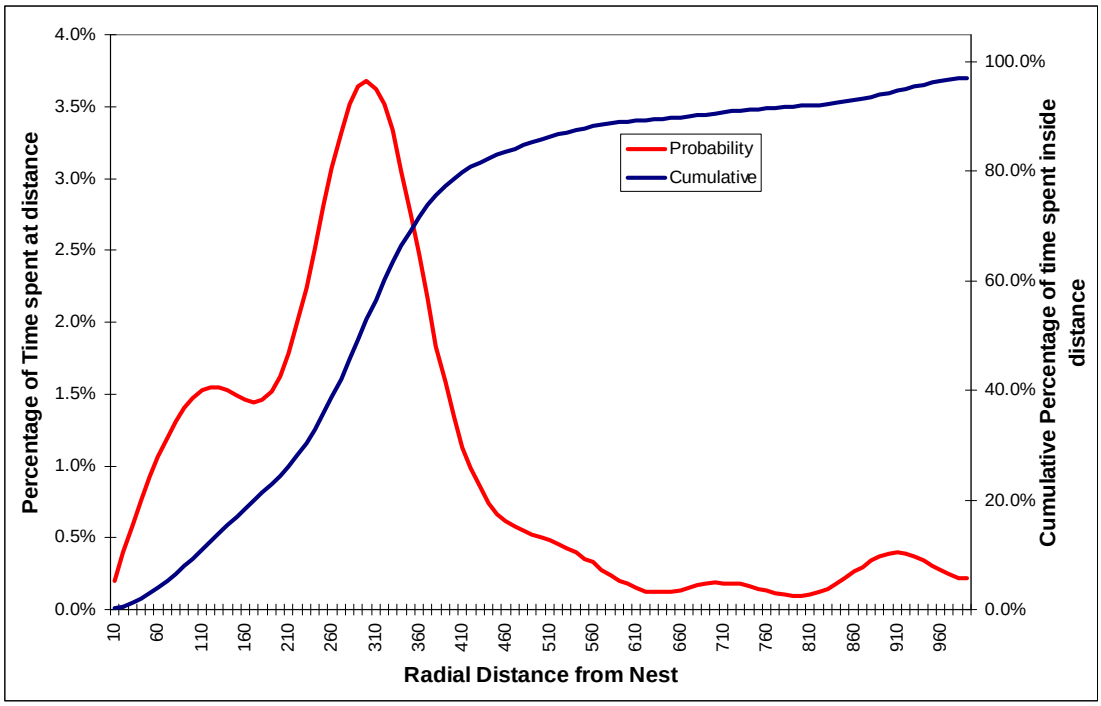

Figure 21: Pair 17 Fledging observations vs radial distance from nest

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)

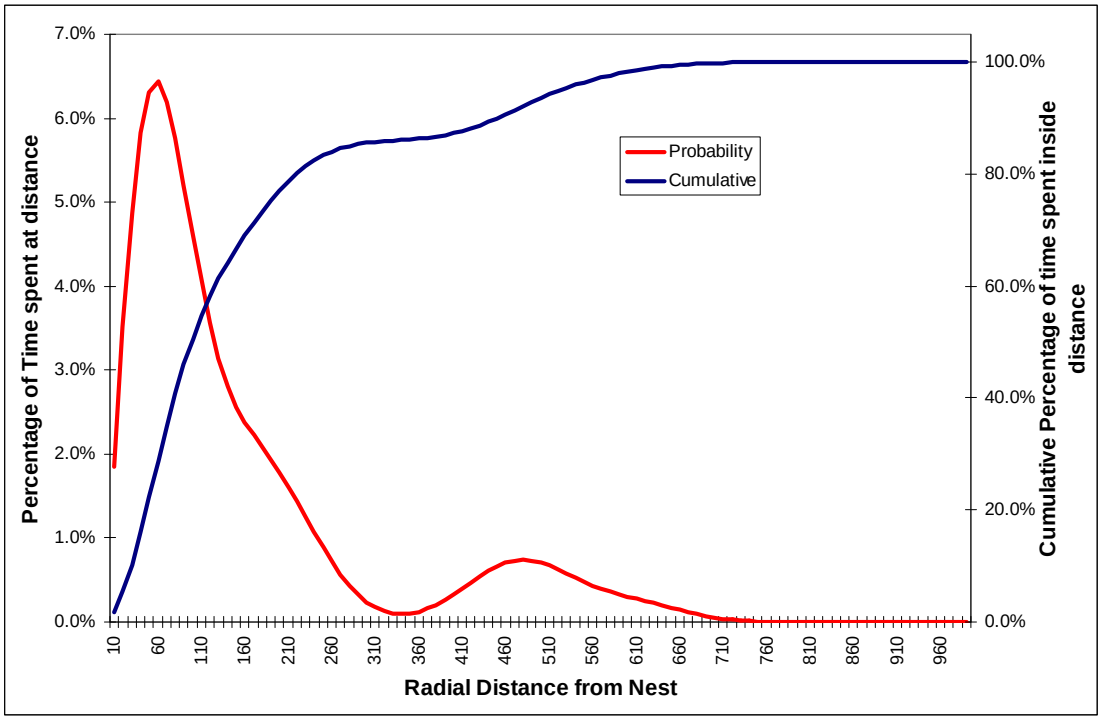

Figure 22: Pair 19 Brooding observations vs radial distance from nest

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

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

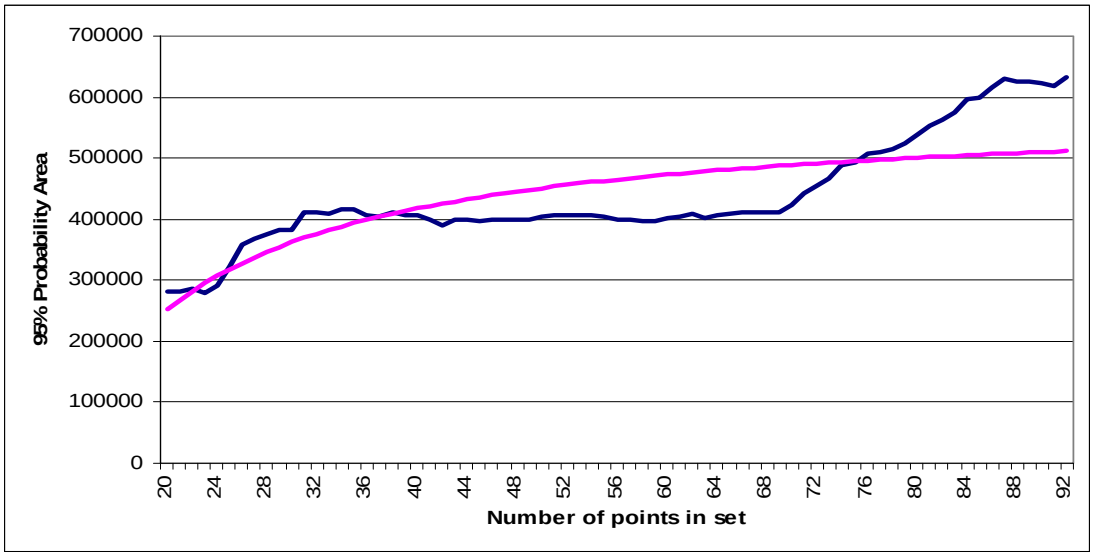


Figure 1: Pair 1 All Data Asymptote

- 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)

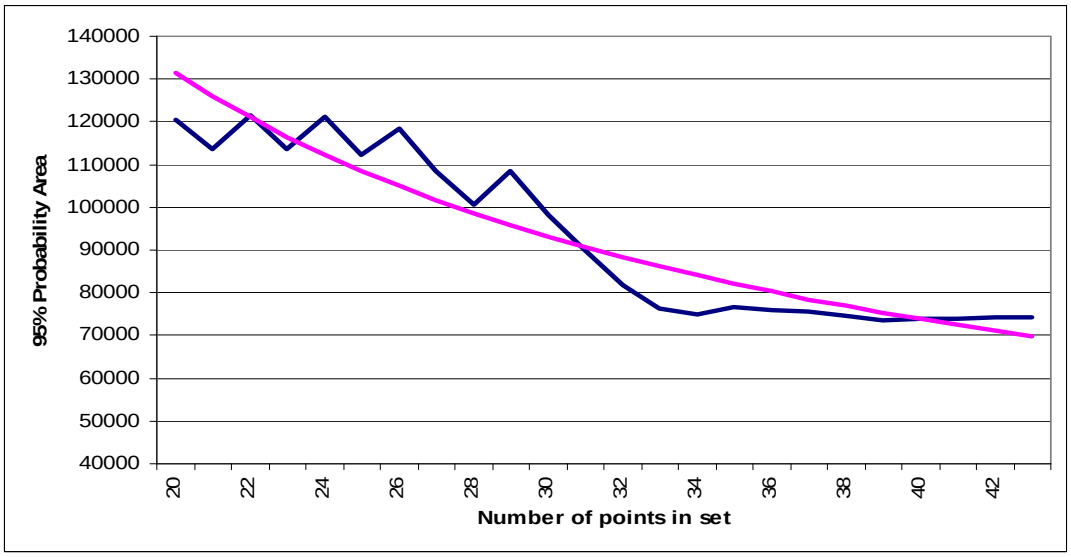


Figure 2: Pair 4 All Data Asymptote

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

Mortlake Asymptotes

Pair 6 Brooding

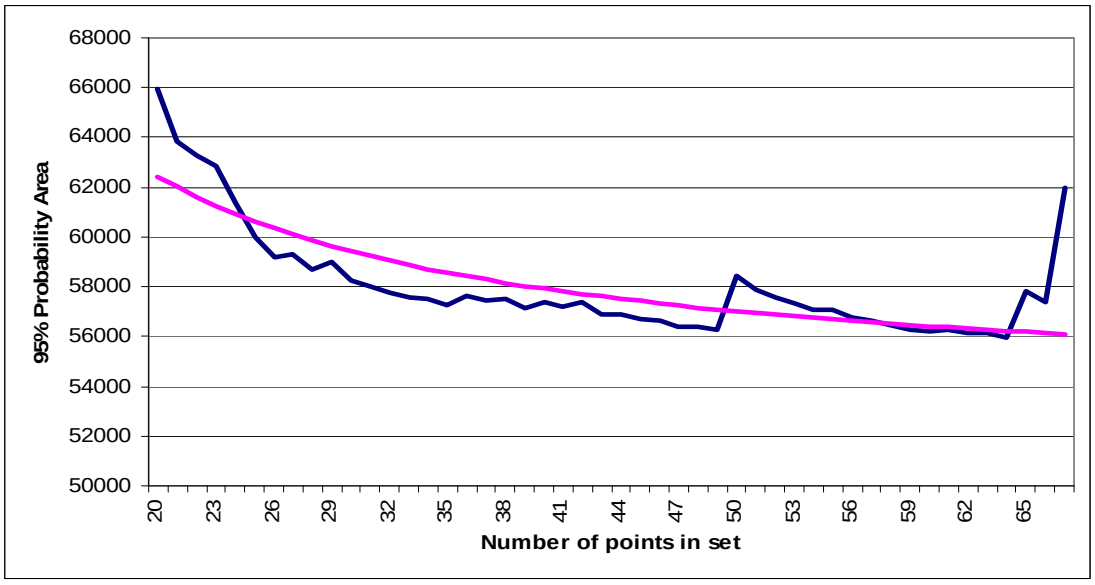


Figure 3: Pair 6 Brooding Asymptote

- 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

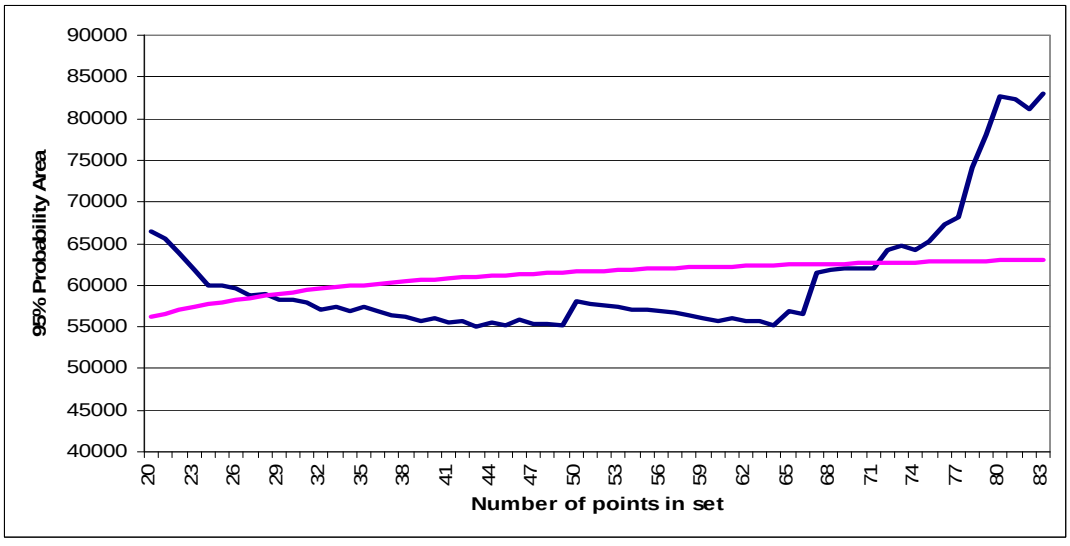


Figure 4: Pair 6 All Data Asymptote

- 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

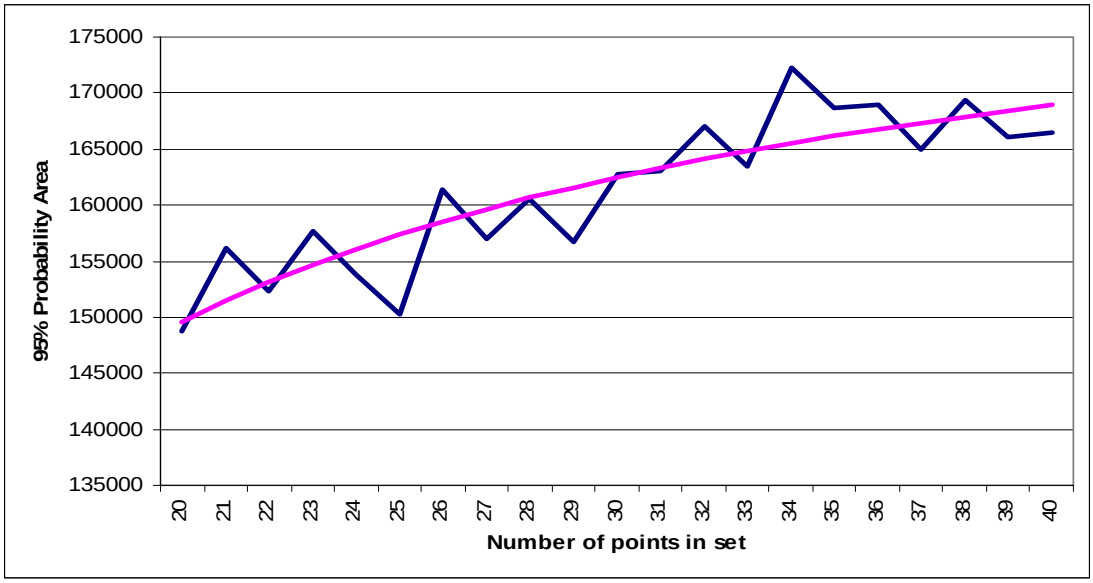


Figure 5: Pair 8 Brooding Asymptote

- 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

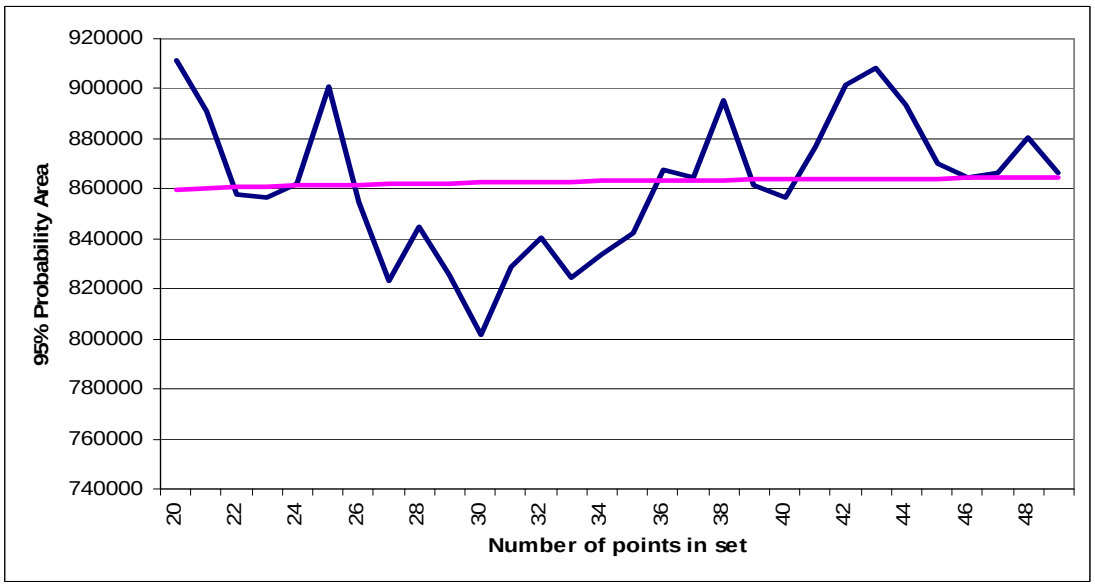


Figure 6: Pair 10 Fledging Asymptote

- 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

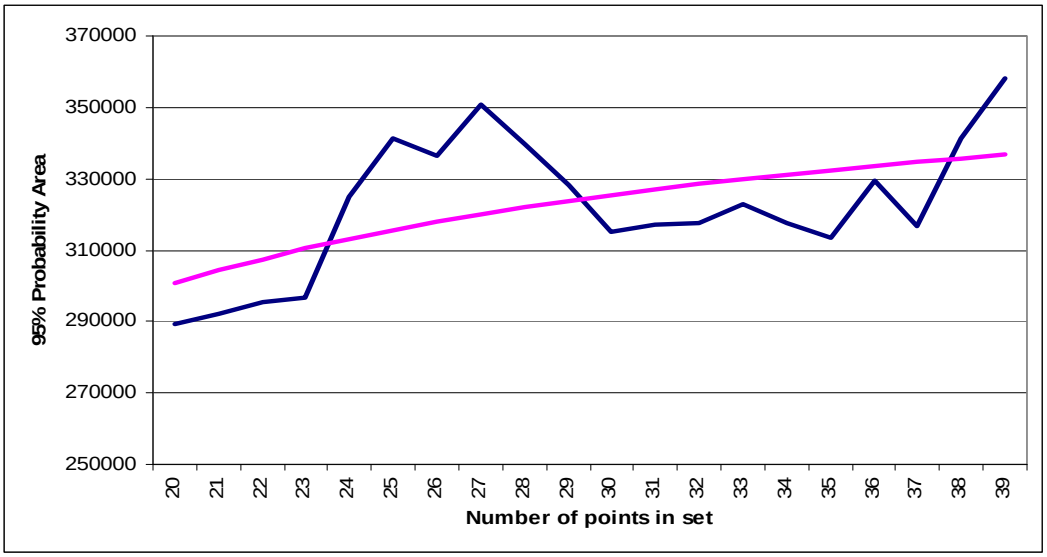


Figure 7: Pair 17 Fledging Asymptote

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

Pair 19 Brooding

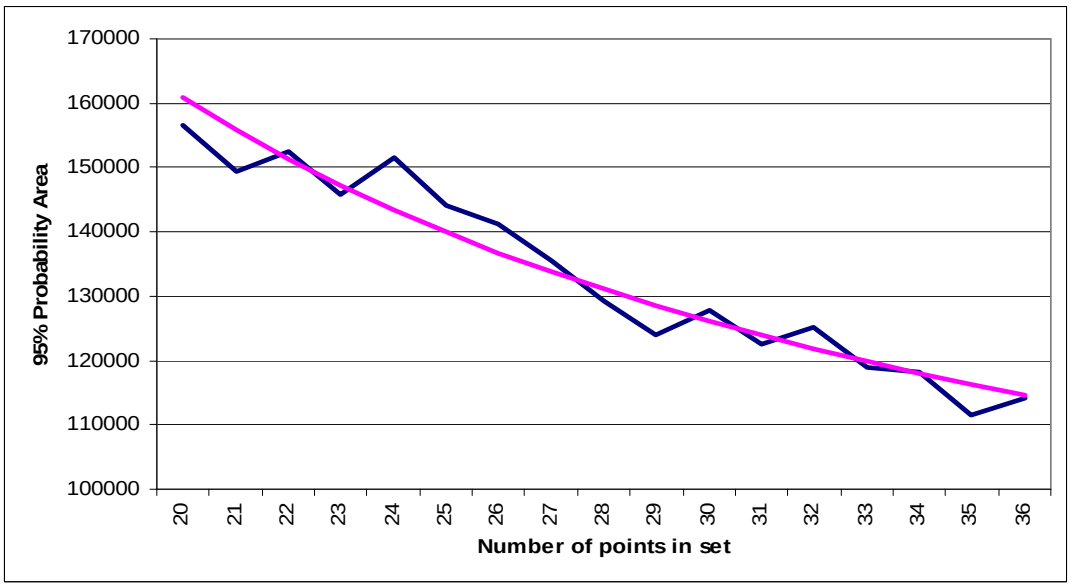


Figure 8: Pair 19 Brooding Asymptote

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

Appendix 2 Meeting Minutes - DELWP/Hydro Tasmania/RES Australia and Biosis

Minutes of Brolga Home Range Analysis Meeting
Friday 26th March 2010 at Biosis Research Melbourne Office

Attendees
Simon Kerrison, RES Australia (Proponent)
Clint Purkiss, Roaring 40s Renewable Energy (Proponent)
Mark Venosta, Biosis Research (Senior Consultant Zoologist)
Nathan Garvey, Biosis Research (Consultant Zoologist)
Ian Smales, Biosis Research (Senior Consultant Zoologist)
Richard Hill, (Senior Biodiversity Officer) Department of Sustainability and Environment

Background

A meeting was set up by RES Australia Pty Ltd, Roaring 40s Pty Ltd and Biosis Research Pty Ltd with the Department of Sustainability and Environment to discuss the data collected from a Home Range Analysis of breeding Brolgas undertaken on both proponent's potential wind farm sites in South West Victoria.

Biosis Research Pty Ltd was commissioned as a specialist consultant by RES Australia Pty Ltd and Roaring 40s Renewable Energy Pty Ltd to undertake breeding Brolga surveys on both of their potential wind farm sites. In October 2009 an aerial flight and subsequent ground truthing indicated that breeding Brolgas were present on both sites. Intensive surveys were then undertaken from November 2009 – March 2010 to determine each breeding pair's home range. During this timeframe a number of breeding nests failed on both sites, this resulted in RES Australia Pty Ltd and Roaring 40s Renewable Energy Pty Ltd entering into a data sharing agreement to combine data sets.

This data set was analysed using a kernel integration method to determine the average home range of the successful breeding Brolga's on both sites. This data is to be used to develop buffers around the successful, failed and past breeding nests on both prospective wind farm sites to achieve the objectives of the draft Brolga Guidelines in relation wind farms.

The aim of the meeting was to introduce this data to Richard Hill of the DSE and to agree buffer shapes and distances around the breeding sites.

In the meeting the following was agreed by the attendees;

- For the breeding sites which were surveyed throughout the whole breeding season, and whereby sufficient data was collected to achieve a stable home range size, the 99.9% home range will be used to develop buffer zones. Beyond this shape, there will be an additional 300m buffer which wind turbine generators will not be allowed to encroach.
- For breeding sites which 'failed' before sufficient information was collected to determine their home range, an area of containment calculation will be used as an indication of appropriate home range size during breeding. The area of containment will be the 99.9% radius of containment for birds where sufficient data was collected. This radius of containment will be used to buffer pairs where sufficient data was not obtained for reasons listed above. This average distance is 687.8m. Beyond this distance will also be an additional 300m buffer on which wind turbine generators will not be allowed to encroach. For the sites where the nests had failed, the central point of these radii of containment will be the likely nest site as determined during observations. Beyond this distance will also be an

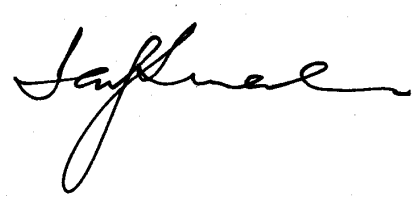
additional 300m buffer which wind turbine generators will not be allowed to encroach.

- For AVW/DSE records of previous Breeding Brolga sites on the wind farm sites, the average radius of containment, (687.8m) derived from the home range analysis will be used to buffer these locations. Beyond this distance will also be an additional 300m buffer which turbines will not be allowed to encroach.
- Within all buffer zones, wind turbines will be prohibited
- Within all buffer zones, other wind farm infrastructure, such as access tracks will be allowed, but the design of the infrastructure must take into consideration the location of the Brolga nests and the timing of the breeding season to minimise any potential impact.
- Within the buffer zones, overhead power lines will be required to be marked in a manner designed to increase their visibility to Brolgas and be located in areas which will result in there being minimal disturbance to the Brolga population.
- The DSE agree that the shared data set that was collected during the 2009/2010 Brolga Breeding season by Biosis Research, the AVW records and also recorded local Brolga information from landowners, will be sufficient information to support a wind farm planning permit application.

All parties signing below agree that the minutes above are a true and accurate reflection of what was agreed.

Mark Venosta
Senior Consultant Zoologist

Nathan Garvey
Consultant Zoologist



Ian Smales
Senior Consultant Zoologist

Appendix 3 Hydro Tasmania Brolga landowner survey

A3.1 Mount Fyans Wind Farm Brolga Landowner Survey – Summary Report (Hydro Tasmania 2014)

Appendix 4 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 A4.1. 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 3km 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).