Pilot study of site occupancy and detection probability of the koala (*Phascolarctos cinereus*) in the Lismore Local Government Area, New South Wales.

Jace Emberg

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2015
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Prepared by Jace Emberg

Integrated Project prepared as partial fulfillment of the requirements of the Bachelor of Environmental Science (Natural Resource Management)

Southern Cross University 2015
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Jace Emberg 29/05/2015

(Signed and dated)
Acknowledgements

I firstly would like to acknowledge and thank Dr. Ross Goldingay for his continual enthusiasm, guidance, professional support and assistance with late night surveys.

Particular thanks to my family for whom without their continued love and support this degree would never have occurred. Thanks to my late father Mark Emberg who always showed me the beauty, excitement and fragility of the natural world and encouraged me to seek answers and explore. Thanks to my beautiful mother Debbie Emberg whom has been my rock and support over the entire period of my life and especially my university degree, without both of your love and support I would have achieved none of this.

Finally, thanks to my amazing partner Jenna Calabro for your support and help with all the surveys, your ongoing support throughout my university degree and your constant encouragement and love.

I would also like to acknowledge the Widjabal People of the Bundjalung Nation, Traditional Custodians of the land on which this study was undertaken.
Abstract

The koala (Phascolarctos cinereus) is a significant part of Australian culture and its biodiversity. Threats such as habitat clearance, habitat fragmentation and urbanisation have seen the koala listed as vulnerable in New South Wales. A pilot study was conducted to assess the site occupancy and detection probability of the koala; investigate the accessibility and suitability of possible sites as well as the feasibility of completing a survey like this within the Lismore local government area. Spotlighting occurred on the 16th and 28th of April and the 6th of May across 32 sights spread throughout the study area. Sites needed to fit the criteria: 4ha in area, transects at least 100m long, minimum of 20 primary food trees, minimum of 500m in distance from nearest site. There were 11-14 koalas detected each night with a total of 39 koalas detected. A total of 14 out of the 32 sites produced a koala detection. The software PRESENCE was used to analyse and model the data. The best model found was the statistical model that incorporated no site variables. The probability of detecting koalas at any site was estimated as 0.72 whilst the probability of occupancy at each site was estimated at 0.45, which was slightly higher than the naïve occupancy of 0.44. Recommendations for similar studies include: reassessment of 8 sites undertaken within this study, further investigation into site variables and replication throughout the year to allow for seasonal variation. Continual replication of a similar survey will assist in monitoring Lismore's koala population.

Key words: koala, Phascolarctos cinereus, site occupancy, detection probability, population monitoring, spotlight survey, PRESENCE, Lismore.
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1. Introduction

The koala (*Phascolarctos cinereus*) is a significant part of Australian culture and biodiversity as well as being recognised around the world. Koala numbers dramatically fell with the arrival of the first Europeans to Australia and they are now considered threatened with the real possibility of extinction within certain regions (Lunney, *et al.*, 2014). In the early 1900’s the koala was close to extinction in South Australia [SA] and Victoria, this saw the first intervention and policy in Australia to help restore and save the koala from extinction (DECC 2008). It has now become increasingly accepted that the monitoring of koala populations is a valuable means of evaluating the health and size of the population as well as determining the success or need of management actions (DECC 2008).

The koala is a folivorous, arboreal marsupial which feeds almost exclusively on *Eucalyptus* species of trees (Melzer & Houston 2001; Lunney *et al.* 2014). The koala shows preference for a relatively small amount of *Eucalyptus* species and tends to be found browsing within these trees (Melzer & Houston 2001). These primary *Eucalypt* species vary from region to region, however it is generally accepted that the koala favours trees found to occur on fertile soils. It has been shown that Eucalypt species occurring on these fertile soils contain a higher level of nutrients available to the koala (Moore *et al.* 2004; Moore *et al.* 2005). These specific *Eucalyptus* communities have decreased dramatically since European arrival in Australia and are now severely fragmented (Moore *et al.* 2004; Moore *et al.* 2005; McAlpine *et al.* 2006). Due to this fragmentation of habitat, koalas are now found in increasingly isolated and fragmented habitat (McAlpine *et al.* 2006).

Koala populations in Queensland [QLD], New South Wales [NSW] and the Australian Capital Territory [ACT] are currently listed as vulnerable under the Environment Protection and Biodiversity Conservation Act 1999 [EPBC Act] (NRMMC 2009). The koala is also listed as vulnerable under the NSW Threatened Species Conservation Act 1995 [TSC Act] (OEH 2015). The threat of habitat loss due to land clearing is recognised as a major threat to koala populations throughout Australia. This is also apparent in the Northern Rivers region of NSW where the threat of habitat destruction is thought to be a major influence in the koalas declining population in this area (Lee *et al.* 2010; Lee *et al.* 2013)

The clearing of habitat for urbanisation, agriculture and grazing areas has severely isolated and fragmented the koala’s habitat across the landscape (DECC 2008; Lee *et al.* 2010). As a result of this fragmentation and urbanisation koalas are more susceptible to indirect threats such as car strike, dog attacks and disease. Koalas attempting to disperse between fragmented habitats are more likely to be killed due to these indirect threats, which therefore lead to a reduction of population stability and growth (Lee *et al.* 2010). This isolation and lack of movement between fragmented populations may lead to a reduction in genetic diversity that increases the species susceptibility to disease outbreaks (Lee *et al.* 2010). The protection of remaining koala habitat is critical, however,
the establishment and protection of corridors between these remnants is also crucial as disease is now being recognised as a major threat to the koala.

1.3 Occupancy surveys

Monitoring populations using occupancy surveys (presence/absence) has been an increasing method of tracking wildlife populations over time (Wintle et al. 2005). This can be attributed to the lower costs and time in conducting occupancy surveys in comparison to abundance monitoring programs (Mackenzie et al. 2002; Wintle et al. 2005; Hamer & Mahony 2010).

In abundance surveys where a pre-determined method and survey effort is undertaken, if a species is not observed it is assumed that it is absent from the site. However, if a species is not detected when it is in fact at the survey site a false presence is recorded. This is also true if a species is recorded as being present when it is not, this can occur with survey error or misidentification of species. This is often integrated into the data analysis of surveys so as the amount of false absences and false presences are insignificant (Wintle et al. 2005). Unless the probability of detecting the desired species in a habitat is 1, false absences will occur (Wintle et al. 2005).

If false absences occur with surveys that are directed at impact assessment or population monitoring they may result in inadequate conservation management measures. The estimation of species detectability is useful when undertaking annual population monitoring surveys and impact assessment surveys. Occupancy surveys estimate the number of visits needed to detect a species if it is present at the site as well as estimate the probability of detection from repeat visits to a set of sites.

Occupancy surveys have also been shown to be useful in detecting changes within the target animal’s population (Marsh & Trenham 2008). This can be useful to conservation efforts and for management decisions regarding the target species. They can also be useful if assessing the successfulness of any management decisions put in place.

1.4 Population surveys

Numerous studies have been conducted on the koala including that focused on disease (Polkinghorne et al. 2013), genetics (Houlden et al. 1995), distribution (Dique et al. 2004), abundance (Ellis et al. 2013), impacts of threats (DOE 2015), tree and habitat preference (Moore et al. 2004), home ranges (Goldingay & Dobner 2014) as well as translocation (Phillips 1997). This research forms a large basis of information on the koala and has allowed land managers and scientists to formulate appropriate plans and management decisions for the koala. However, there is no nationally recognised standard for estimating koala populations (Melzer et al. 2000). The lack of a standard is due to differing needs of projects and varying locations of koala populations.
A range of techniques is available and utilised, which estimate the abundance and density of koalas depending on the need of the project (Dique et al. 2004). Scat count surveys (Ellis et al. 2013) and community based response surveys (Phillips 1990; Lunney et al. 1997; Harris & Goldingay 2003) are effective methods in providing an index of koala abundance. Count surveys are useful for estimating the abundance of species with high abundances and are quite often used for koala population surveys within small geographical ranges (Dique et al. 2004; Budee 2012; Millard 2012). However, as the koala tends to have relatively low abundances in NSW regions a presence-absence method of interpreting data is another option being utilised to detect and estimate koala site occupancy and the probability of detection (Rhodes et al. 2006).

1.5 Definition of problem

The Lismore Local Government Area [Lismore LGA] contains one of the most significant koala populations in NSW and Australia (Phillips et al. 2000). It is therefore a key area for research, surveys and management of koalas. Previous studies undertaken in this region and other areas have shown koalas are under extreme risk due to rapid urbanisation (DoE 2012; Goldingay & Dobner 2014; McAlpine et al., 2006). The development of previous koala habitat means populations are becoming fragmented and genetic diversity is being lowered. This puts populations at risk from disease and other threats associated with urbanisation (DoE 2012; Goldingay & Dobner 2014; McAlpine et al., 2006).

The Lismore Council has developed a comprehensive koala management plan for the region (Lismore City Council, 2013). However, this plan is mainly directed at clearing controls and the planting of trees in the southeast of the Lismore LGA. Whilst this is important to the management of the koalas, a survey is needed to track the population over a long time period. Many consultants and groups have determined causes that are affecting local koala populations. These groups are responding with community-funded projects such as tree planting days, koala nurseries and free primary koala browsing trees (Friends of the Koala, 2015).

There is currently no data on how the koala population is tracking over time and this is a vital piece of information needed to track the population.

1.6 Aim and objectives

The aim of this study was to conduct a pilot study of the Lismore koala population to determine how readily monitoring could be done and whether an adequate number of survey sites was available without having to resort to venturing onto private property. If effective, this approach to monitoring could be adopted as an annual survey of koala populations around the Lismore Local Government Area in order to establish population trend data that can be used to assist koala management, plans for the LGA.

The aim will be achieved with the following objectives:

- A literature review will be conducted on koala ecology, conservation management plans, occupancy and detection of nocturnal arboreal mammals and relevant survey methods.
• Performing repeat spotlighting surveys of total koala counts to complete statistical analysis of koala populations.
• To use species occupancy software to estimate the probability of detection and the probability of occupancy will be developed.
• Provide recommendations from this study for any future similar studies

2. Literature Review

2.1 Conservation status

Due to varying population size, health and infection prevalence, the koala's listed status is different from to state to state with the koala being listed from vulnerable to secure (see table 1). The koala's populations within QLD, NSW and the ACT are recognised collectively as vulnerable under the EPBC Act (DOE 2015). A recent assessment of the koala's population in Victoria and South Australia by the Department of Environment found the koala to be secure (DOE 2015).

Table 1: The koala's legal status and listings throughout its range within Australia. (Source: NRRMC 2009).

<table>
<thead>
<tr>
<th>State/territory</th>
<th>Legislation</th>
<th>Status of koala</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australian</td>
<td>Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)</td>
<td>Vulnerable in New South Wales, Queensland and the Australian Capital Territory (as of 2012)</td>
</tr>
<tr>
<td>New South Wales</td>
<td>Threatened Species Conservation Act 1995 (TSC Act)</td>
<td>Not listed in Victoria or South Australia</td>
</tr>
<tr>
<td></td>
<td>National Parks and Wildlife Act 1974 (NPW Act)</td>
<td>Vulnerable</td>
</tr>
<tr>
<td>Queensland Australian Capital Territory</td>
<td>Nature Conservation Act 1992</td>
<td>Hawks Nest/Tea Gardens and Pittwater populations listed as endangered</td>
</tr>
<tr>
<td></td>
<td>Nature Conservation Act 1980</td>
<td>Not listed</td>
</tr>
<tr>
<td>Victoria</td>
<td>Wildlife Act 1975</td>
<td>Protected wildlife</td>
</tr>
<tr>
<td></td>
<td>Flora and Fauna Guarantee Act 1988</td>
<td>Not listed</td>
</tr>
<tr>
<td>South Australia</td>
<td>National Parks and Wildlife Act 1972</td>
<td>Protected</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not listed as threatened</td>
</tr>
</tbody>
</table>

2.2 Legislation in NSW

In NSW there are numerous Acts, legislation and initiatives in place statewide and in local government areas. The Threatened Species Conservation Act [TSC Act] and the National Parks and Wildlife Act 1974 [NPW Act] are the umbrella legislation to all other policy and legislation in place within NSW. Along with these there is also the Native Vegetation Act 2003 [NV Act] and the Environment Planning and Assessment Act 1979 [EPA Act] which both contain koala specific legislation. The NV Act prevents broad scale clearing of suitable koala habitat within the koala’s range whilst the EPA Act is the principal planning legislation and includes the environmental planning instrument State Environmental
Planning Policy No. 44 – Koala Habitat Protection [SEPP 44]. The SEPP 44 is directed at the protection of the koala’s habitat on private land through the Comprehensive Koala Plans of Management, which outlines provisions for restoration and rehabilitation of koala habitat.

In the Lismore LGA the council has released The Comprehensive Koala Plan of Management for South-East Lismore [CKPoM]. This plan aims to protect the significant koala population within the southeast of the LGA. The plan contains direction on how to manage threats to the koala and their habitat. It also contains policies and planning provisions on how development is assessed taking into account the conservation principals of the koala. The main goal of the CKPoM is to ensure the koala has viable natural habitat and food with the southeast of the Lismore LGA (LCC 2013).

2.3 Koala populations after European arrival

When Europeans arrived in Australia koala numbers seemed to be low as any incidental sightings were low (Melzer et al. 2000). This was initially accredited to aborigines hunting the koala as well as dingoes preying on the koala. The increase in the koala numbers after European settlement was accredited to the decline in the aboriginal numbers as well as dingoes (Reed & Lunney 1990). However this theory has been disputed and the increase in initial koala numbers has been attributed to Europeans expanding into areas where koala habitat was more favourable (Melzer et al. 2000). Another theory was that an interruption in fire regimes produced more habitat suitable for the koala and helped increase their numbers (Reed & Lunney 1990).

The late 19th and early 20th century saw koala numbers dramatically decrease, this was credited to a combination of hunting for pelt, clearing of habitat, disease and increased bush fires (Reed & Lunney 1990; Melzer et al. 2000). It is believed that in the early 1900’s several million koalas were killed for their pelts (Phillips 1990). It is also likely large numbers of koalas died due to disease during this time brought on by stresses from habitat clearance and a severe drought during this period (Reed & Lunney 1990). Due to extensive hunting, habitat clearance and a severe drought during this period the koala suffered a monumental population decline that has not recovered to this day (Hume 1990).

2.4 Taxonomy & Identification

The koala is a marsupial, a subclass of mammals and the sole member of the family Phascolarctidae. This makes them unique from any other living marsupial with the wombat being their closest relative (Martin & Handasyde 1995, p. 195–198). The koala is an arboreal marsupial with large ears, a prominent nose and vertical pupils. Koalas have an undeveloped tail hidden by fur, relatively large hands and feet and two opposable digits that aid in climbing and create a powerful grip (Martin & Handasyde 1995, p. 195–198). The koala also varies in size from region to region with QLD koalas weighing on average 6.5 kg and Victorian koalas weighing 12 kg. The male koala is generally larger than the female and generally weighs up to 50% more than the female (Martin &
Handasyde 1995, p. 195–198). Koala pelts range from chocolate brown in the south of Australia to silver grey in the northern regions. It has been suggested that southern and northern koalas are separate sub-species (Martin & Handasyde 1995, p. 195–198) however this has also been disputed and is the topic of current study (Lee et al. 2010).

2.5 Distribution

The koala was historically found to occur in eastern Australia from northeastern QLD to southeastern SA and as far west as the Great Dividing Range (Melzer et al. 2000). The koala is believed to have had a continuous distribution throughout the majority of the eastern coastal region as well as inland QLD and NSW (Melzer et al. 2000). European settlement in has seen the koala’s habitat become severely fragmented and isolated. Habitat clearance, disease, hunting and drought saw the koala’s population decline dramatically and it was estimated that by the 1930′s koalas were present in less than half of their original distribution (Houlden et al. 1995). Only small populations remained in QLD and NSW and it was believed the koala was extinct in Victoria and SA (Phillips 1990; Melzer et al. 2000).

From the 1930s protective legislation and a halt to the hunting of the koala saw it return to fragmented parts of their former distribution within QLD and NSW. A natural recovery program and re-introduction programs has also seen the koala return to former distribution ranges within Victoria and SA and also to areas in the states where it has not been historically recorded (Martin & Handasyde 1999). The koala now has a fragmented distribution through the eastern side of Australia from northeastern QLD to the Eyre Peninsula in SA and west onto the Tablelands as well as west of the Great Dividing Range, see figure 1 (Martin & Handasyde 1999).
Surveys from 1949 suggest that koala populations have disappeared from many regions within NSW particularly in the southern and western parts of their original distribution (Reed & Lunney 1990). The majority of koala populations are now located in isolated habitat within NSW, see figure 2 (Lunney et al. 2014). Koalas are also found to be absent from areas with suitable habitat, which infers the difficulty the koala has of recovery when faced with habitat fragmentation and other threats (Lunney et al. 2014). Significant koala populations in NSW now include Coffs Harbour, Port Macquarie, Port Stephens, Lismore and Tweed Heads (Reed & Lunney 1990). A community-based survey conducted within the Lismore LGA showed that 10% of respondents had weekly sightings of koalas (Harris & Goldingay 2003), which suggests a significant population within the study area.

Figure 1: Current habitat of listed and unlisted koalas

2.5.1 Distribution in NSW

Surveys from 1949 suggest that koala populations have disappeared from many regions within NSW particularly in the southern and western parts of their original distribution (Reed & Lunney 1990). The majority of koala populations are now located in isolated habitat within NSW, see figure 2 (Lunney et al. 2014). Koalas are also found to be absent from areas with suitable habitat, which infers the difficulty the koala has of recovery when faced with habitat fragmentation and other threats (Lunney et al. 2014). Significant koala populations in NSW now include Coffs Harbour, Port Macquarie, Port Stephens, Lismore and Tweed Heads (Reed & Lunney 1990). A community-based survey conducted within the Lismore LGA showed that 10% of respondents had weekly sightings of koalas (Harris & Goldingay 2003), which suggests a significant population within the study area.
Figure 2: The distribution of koalas from a 2006 community based survey within NSW. Each square is 10km² and shows the average occupancy of that section. (Lunney et al. 2009)

2.6 Habitat preference

The koala is found to occupy a variety of eucalypt forests and woodlands including coastal forests, woodlands and riparian communities (Phillips 2000); koalas have also been shown to utilise isolated trees in urban areas and paddocks (Lee et al. 2010). The attributes of the habitat communities directly affect the suitability of the habitat for the koala and a range of factors influence this (Lee et al. 2010; Lunney et al. 2014) include:

- the type of tress present and their size
- vegetation composition
- type of soil and nutrient composition
- climate
- size, location and history of habitat

Whilst koalas tend to use an extensive variety of *Eucalyptus* species (Phillips 2000; Lee et al. 2010; Lunney et al. 2014) it is commonly found that in a koala’s range only a minor number of available *Eucalyptus* species are browsed upon (Phillips 2000; Moore et al. 2004; Moore et al. 2005). The koala has been shown
to browse upon certain non-*Eucalyptus* species opportunistically (Phillips 2000; Moore *et al.* 2005). The most preferred food tree species is often different from region to region and commonly disagreed upon in literature, which indicates a local preference depending on the location of the koala (Moore *et al.* 2004; Moore *et al.* 2005).

In recent studies conducted on Southern Cross University [SCU] Lismore campus four eucalypt species were found to be primarily utilised, these species included the forest red gum (*Eucalyptus tereticornis*), tallow wood (*Eucalyptus microcorys*), flooded gum (*Eucalyptus Grandis*) and swamp mahogany (*Eucalyptus robusta*) (Williams 2011; Buddee 2012;). Millard (2012) showed a strong relationship between koala preference for forest red gum, tallow wood and swamp mahogany species being used predominantly within the SCU Lismore campus. As the SCU Lismore campus is situated within the Lismore LGA it can be inferred that koalas within this region will exhibit similar tree preferences.

![Figure 3: forest red gums found at site 11.](image)

### 2.7 Threats

There are numerous threats to koalas in Australia, NSW and the study area of the Lismore LGA. The major threats impacting upon koalas within the Lismore LGA include habitat loss and fragmentation, disease, urbanisation, overbrowsing and extreme weather events. These will be discussed in more detail in the following sections.
2.7.1 Habitat Clearance & Fragmentation

Habitat clearance and fragmentation was historically the most significant threat that caused the original decline of koala populations within Australia and NSW (Reed & Lunney 1990; Melzer et al. 2000). This is still considered the most serious threat facing koalas in Australia and NSW today (Phillips 1990; Reed & Lunney 1990; Houlden et al. 1995; Melzer et al. 2000). A study on the distribution of koalas in NSW conducted by Reed & Lunney (1990) during 1986-87 found the majority of records were found on private land where they are extremely susceptible to habitat and clearance.

Habitat clearance and fragmentation has been most commonly undertaken on areas with nutrient rich soils, which provide the most valuable and useful habitat to the koala (DECC 2008). This has caused the koala to frequently be occurring in areas of low value habitat, which therefore has a lower carrying capacity and supports a lower density of animals (Moore et al. 2005; DECC 2008).

Due to habitat clearance and fragmentation the koala is now forced to move through areas where they are susceptible to car strikes and dog attacks, see urbanisation section (Goldingay & Dobner 2014). When habitat clearance and fragmentation reduces and in some cases prevents dispersal between koala populations, the number of koalas may decrease due to the coinciding threats of dog attacks, car strikes, predation and stress related disease. The reduction of numbers causes a genetic lowering within the population, which leaves it susceptible to threats such as disease and severe weather (Lee et al. 2010).

2.7.2 Disease

Koala populations within QLD and NSW carry the disease pathogens Chlamydia spp. (DECC 2008). Clinical signs of the disease will be shown in the form of keratoconjunctivitis (pink eye) and urinary tract infections (stained tail) and are usually only expressed when the animal is exposed to outside threats such as poor habitat, competition and predation (DECC 2008; Polkinghorne et al. 2013). Chlamydia weakens koalas and makes them susceptible to death from other threats such extreme weather events (DECC 2008), it will also cause blindness and infertility in extreme and prolonged clinical cases (Polkinghorne et al. 2013).

Whilst Chlamydial disease is commonly described as a non-threatening stress for the lasting survival of the koala (Gordon et al. 1990; Martin & Handasyde 1995; Phillips 2000), it should still be considered a serious threat. Localised extinctions are possible due to a loss of fertility from Chlamydia and reduced recruitment of koalas due to habitat fragmentation.

2.7.3 Urbanisation

Increasing urbanisation into habitat occupied by the koala is placing numerous stresses and threats on the koala. Car strikes, dog attack and pool drowning’s are all associated threats from the effect of urbanisation on koala habitat.
Car Strikes
Car strikes are a significant threat to the koala and can cause death and injury in many areas of their distribution. Starr (1990) showed that 45% of koalas taken into the Port Macquarie koala hospital were car strike victims and similarly Smith (1992) reported car strikes were the main reason for animal deaths and injury within the Gunnedah region (DECC 2008). The koala is extremely susceptible to car strikes within the Lismore LGA as was shown by Goldingay & Dobner (2014) where koalas radio tracked crossed roads between 5-53 times with the Lismore LGA.

Dog Attacks
Dog attacks are a major cause of koala deaths in and around urban areas. Smith (1992) described dog as being the second major cause of koala deaths around the urban region of Gunnedah. Wildlife rescue centres have recorded both female and male deaths by dog attacks and also showed that they are increasingly susceptible if weakened by Chlamydia (Wilkes & Snowden 1998).

Swimming Pools
Koalas have been shown to swim, however when a koala falls into a pool it often cannot pull itself out due to hard slippery edges (DECC 2008). Whilst pools are not a major threat to koalas appropriate management actions should be undertaken if they are within known koala regions.

2.7.4 Overbrowsing

Overbrowsing of food trees by koalas can cause starvation and added stress onto koalas and is caused by koala populations exceeding the carrying capacity (Melzer et al. 2000; Melzer & Houston 2001). This is a problem in certain parts of Victoria and SA however, it is not cited as a major threat in NSW. However, there is the potential for this to occur in certain areas of extreme habitat fragmentation (DECC 2008). Whilst overbrowsing in highly fragmented koala habitat regions is a potential threat, the occurrence of Chlamydia in NSW populations is unlikely to lead to population growth above the carrying capacity (Phillips 1997).

2.7.5 Extreme Weather

Extreme weather events and natural disasters will impact the koala in varying ways depending on the quality and quantity of available habitat. Climate change is expected to increase the severity of natural disasters and extreme weather conditions such as drought, bushfires, heat waves, floods and cyclones (DECC 2008). Gordon et al. (1990) showed that koalas in southwestern QLD lost 63% of their population due to an extreme heat wave and drought during 1979-90. The animals which survived in this case were found close to watercourses in habitat where trees had available water and continued to produce food and shelter, the animals which died were located in sub-prime habitat away from waterways (Gordon et al. 1990).

Studies have shown that koalas will move to more suitable habitat in severe weather events such as droughts and floods (Reed & Lunney 1990). This
highlights the importance of refugia habitat to koalas during time of extreme weather events, however, in many cases fragmentation and isolation makes this difficult or impossible. Extreme weather conditions is not recognised as a major threat to koalas at present as they tend to affect small numbers of koalas (Reed and Lunney 1990). However, with the growing concern of climate change these impacts are expected to increase as well as the affects on koala populations.

3. Methods

3.1 Study area and description

The study area for this survey is the Lismore LGA in the Northern Rivers region of NSW, located at 28°49’ S, 153°18’ E (Figure 4). The Lismore LGA is approximately 1290km² in area with the town of North Woodburn bordering the south, the village of Nimbin and the Nightcap Ranges to the north, Clunes to the east and Bentley to the west (RDA 2014).

![Figure 4: Location of Lismore and the study site (Source: ©2015 Google Earth).](image)

3.1.1 Climate

The climate is subtropical to temperate with mean annual rainfall ranging from 1100mm to 2400mm (BOM 2015). Temperatures are generally mild with mean annual values ranging from 12°C to 28°C throughout the year (BOM 2015).

3.1.2 Geology

The Lismore LGA lays within the Mesozoic Clarence-Moreton Basin, which is generally comprised of lithic, quartz sandstones, siltstones, shales and
conglomerates with Georgica being the dominant soil type (Wells & O’Brien 1994).

3.1.3 Vegetation

Prior to European settlement the ‘Big Scrub Rainforest’ covered the study area. The ‘Big Scrub’ was the largest continuous expanse of lowland sub-tropical rainforest in Australia (Big Scrub Landcare Group, 2015). The rainforest occurred on fertile basalt soils, which originated from Mount Warning in Northern New South Wales. The ‘Big Scrub’ was estimated to cover 75,000 hectares before its clearing with only 556 hectares (0.74%) remaining today in small isolated remnants (Parkes et al, 2012). The ‘Big Scrub’ was cleared by European settlers in the early 20th century for agricultural purposes and logging needs (Parkes et al, 2012). Due to the removal of existing vegetation, biodiversity and vegetation has been altered and the overall ecosystem health reduced (Catterall & Kanowski, 2010). Therefore natural koala habitat is largely fragmented and isolated throughout the study area. The remaining vegetation found in the study area is mainly wet and dry sclerophyll forest and remnant ‘Big Scrub’ rainforest.

3.2 Study Design

The initial objective of the study was to identify approximately thirty sites scattered throughout the Lismore LGA. These sites were to be accessible and able to be spotlighted by two separate survey teams within a single night of spotlighting. This would help to minimise differences in detection that could arise from changes in weather or adverse events. The sites also needed to be easily accessible from a roadside so as minimal travel and setting up time was needed across multiple sites.

3.3 Site Selection

The study sites were spread throughout the Lismore LGA and were determined due site-specific criteria developed from existing literature on the koalas preferred habitat.

Criteria Selection

- 4ha in area (can include adjoining habitat)
- Transects at least 100m long
- Minimum of 20 primary food trees
- Minimum 500m in distance from nearest site so as to ensure that sites were independent and animals counted at one site would be unlikely to be the same encountered at any other site.

A preliminary survey of suggested sites had a possible 36 sites to be sampled, full list of sites see appendix. This was reassessed down to 33 suitable sites that met the selection criteria, see figure 5. The sites were separated into northern and
southern sites that were surveyed at the same time by two separate teams. The northern section contained sites 1-16 (figure 6) whilst the southern section contained sites 17-33 (figure 7).

**Figure 5:** Overview of all sites located with the Lismore LGA (Source: ©2015 Google Earth).

**Figure 6:** Northern section of survey area (Source: ©2015 Google Earth).
3.4 Field Surveys

The objective of the surveys was to determine presence or absence of koalas at each site surveyed. Additional data such as primary food trees, total number of trees spotlighted, koala health, koala sex and incidental spotting of other animals were recorded. Although common techniques for estimating populations is scat counts and searching transects with fixed boundaries during the day (Dique et al. 2003), nighttime spotlighting techniques was shown to be a suitable technique by Buddee (2012).

Three spotlighting surveys were conducted and completed on the 16th of April, the 28th of April and the 6th of May. Site 1 (Cowlong Rd. and Palmer Rd.) and site 16 (Lindendal Rd.) were deemed to be unsuitable after the initial spotlighting survey. Site 1 was discontinued after the initial survey and site 16 was changed to a new site at Kadina Park. Site 24 (Henson Rd.) was missed in the initial survey due to an error and was then surveyed in the following two surveys.

Survey teams met at Southern Cross University Lismore Campus where spotlighting equipment was collected just before dark on the allotted day. Spotlighting was conducted by the same two observers (Jace Emberg and Ross Goldingay) along with assistance from volunteers (Jenna Calabro, Leif Emberg). 50 watt spotlighting torches, binoculars, cameras, maps and data recording sheets (Appendix C) were used each survey. Sites were either determined as transects or patch areas and were surveyed accordingly. Trees along each transect were surveyed from different angles to maximize detection of koalas. An allotted time of ten minutes was given to spotlight each site to maximise the number of trees spotlighted. However, at some sites containing numerous trees
less time was needed to complete an appropriate search.

At each site the following data were recorded: number of primary food trees, total number of trees, number and age of koalas present, sex of koala (if observable), health of koala (if observable), weather conditions and general comments including incidental spotting of other animals. The time spent at each site was also recorded along with the type and size of the moon for the evening. Spotlighting took on average 5.2 hours each night combined effort by both teams. Starting and finishing times varied each survey due to darkness coming earlier each sequential survey. Spotlighting was generally conducted between 6-11pm each night.

3.5 Data analysis

The data was analysed using the program Presence (version 5.7; USGS Patuxent Wildlife Research Centre). This data analysis program uses maximum likelihood methods to estimate the probability of detection and the probability of occupancy (Hamer & Mahoney). I used the single-season occupancy model to determine whether any habitat variables (see Table 2) influenced occupancy by koalas.

3.5.1 Habitat variables

Habitat variables (site co-variates) were composed to evaluate six possible assumptions related to the koalas within the study area. The choice of variables used were based upon the results of similar koala studies and included: number of primary food trees at each site, total number of trees at each site, size of vegetation at site, configuration of site, traffic volume, size of adjoining road to site size and time (see Table 2) (Millard 2012; Goldingay & Dobner 2014; Ellis et al. 2013). If variables were found to be influential this data could be used to determine suitability of sites for inclusion in future monitoring.

Table 2: Variables recorded at each site.

<table>
<thead>
<tr>
<th>Site covariate</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>Number of primary food trees spotlighted at each site</td>
</tr>
<tr>
<td>Total</td>
<td>Total number of trees spotlighted at each site</td>
</tr>
<tr>
<td>habitat-size</td>
<td>Size of vegetation at site. 1=&lt;2ha, 2=2-4ha, 3=&gt;4ha</td>
</tr>
<tr>
<td>configuration</td>
<td>Configuration of site. 1=Thin strip of habitat, 2=Broad patch of habitat</td>
</tr>
<tr>
<td>traffic</td>
<td>Traffic volume. 1=low, 2=medium, 3=heavy</td>
</tr>
<tr>
<td>lanes</td>
<td>Adjoining road to site size. 1=2 lanes of traffic, 2=4 lanes of traffic, 0=other</td>
</tr>
</tbody>
</table>

primarya=primary food trees of koala: forest red gum, tallow wood, flooded gum, swamp mahogany.
volumebysubjective observation of the amount of traffic flow next to each site by survey
participants during each survey.

\[ \text{sites with no adjoining road side or sites located next to dirt/rural roads.} \]

3.5.2 Detection & modeling

A detection history was compiled for each site that consisted of 0 (absent) or 1
(present) for the three survey occasions (Appendix x). Models were constructed
and compared using Akaike’s Information Criterion [AIC]. These models included
various combinations of the site variables or where no variable was included.
Detection was allowed to vary over time or was held constant. Models were
ranked by AIC from lowest to highest. Interpretation was based on the difference
in AIC value (\( \Delta \text{AIC} \)) between the top ranked model and the next model. Where
\( \Delta \text{AIC} \) was <2, models were considered to be very similar in explanatory ability. If
\( \Delta \text{AIC} \) was >2 then they differed significantly.

4. Results

The spotlighting surveys detected 11-14 koalas during each survey period (Table
3). Overall, koalas were detected at 14 of the 32 transect sites. One or two
juveniles accompanying an adult female were detected each survey, with four
being detected across all transects. One to three koalas were observed in each
survey with obvious signs of *Chlamydia* with a total of six koalas detected shown
to be portraying signs of *Chlamydia*. Koalas were detected in tallow woods,
swamp mahogany, forest red gums, spotted gums as well as unidentified trees.

**Table 3:** Number of koalas sighted at 33 sites around Lismore LGA on three nights in 2015.
Koalas were scored for indicators of sex, chlamydia and for the tree species occupied.

<table>
<thead>
<tr>
<th></th>
<th>16\textsuperscript{th} April</th>
<th>28\textsuperscript{th} April</th>
<th>6\textsuperscript{th} May</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Female</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Juveniles</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Unknown</td>
<td>8</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Clinical signs of <em>chlamydia</em></td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Trees utilised</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forest red gum</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Tallow wood</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Swamp mahogany</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Spotted gum</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Unknown</td>
<td>5</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Total Koalas</td>
<td>14</td>
<td>14</td>
<td>11</td>
</tr>
</tbody>
</table>
4.1 Modeling results

The probability of detection (p) could either be constant or vary across survey occasions. I tested a constant model (p(.)) and a time-varying model (p(t)), see Table 4 for constant model and appendix X for full model results. Koala detection could be influenced by prevailing weather conditions or moon phases. These varied across each survey so therefore a time-varying model was ran to assess the \( \Delta \text{AIC} \) between these two models and was found to be 3.06 \([p(.)-p(t)]\). The output from the model showed: \( p(.) \) [AIC=98.49], \( p(t) \) [AIC=95.43].

The statistical model that incorporated no site variables was ranked as the top model (Table 4). The next best model (variable of habitat-size) had a \( \Delta \text{AIC} \) of 1.21, which suggests the two models do not differ greatly. When comparing the Akaike weight of the top model, 0.283 and the next best model, 0.155 it can be seen that the top model has 1.8 times more support.

The probability of detecting koalas at a site was estimated as 0.72 for each occasion. The probability of occupancy of koalas at each site was estimated at 0.45, slightly more than the naïve occupancy of 0.44.

**Table 4: Model selection results from Presence**

A single-season model was used to estimate the probability of occupancy (\( \Psi \)) and the probability of detection (p) on the detection of koalas within the Lismore LGA. Models are ranked using the Akaike’s Information Criterion (AIC) See Table 2 for full description of habitat variables.

<table>
<thead>
<tr>
<th>Model</th>
<th>AIC</th>
<th>( \Delta \text{AIC} )</th>
<th>w</th>
<th>Model likelihood</th>
<th>K</th>
<th>-2log-likelihood</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \Psi(.)\ p(.) )</td>
<td>95.43</td>
<td>0.00</td>
<td>0.283</td>
<td>1.0000</td>
<td>2</td>
<td>91.43</td>
</tr>
<tr>
<td>( \Psi(\text{habitat-size})\ p(.) )</td>
<td>96.64</td>
<td>1.21</td>
<td>0.155</td>
<td>0.5461</td>
<td>3</td>
<td>90.64</td>
</tr>
<tr>
<td>( \Psi(\text{traffic})\ p(.) )</td>
<td>96.94</td>
<td>1.51</td>
<td>0.133</td>
<td>0.4700</td>
<td>3</td>
<td>90.94</td>
</tr>
<tr>
<td>( \Psi(\text{configuration})\ p(.) )</td>
<td>97.31</td>
<td>1.88</td>
<td>0.111</td>
<td>0.3906</td>
<td>3</td>
<td>91.31</td>
</tr>
<tr>
<td>( \Psi(\text{Total})\ p(.) )</td>
<td>97.36</td>
<td>1.93</td>
<td>0.108</td>
<td>0.3810</td>
<td>3</td>
<td>91.36</td>
</tr>
<tr>
<td>( \Psi(\text{lanes})\ p(.) )</td>
<td>97.39</td>
<td>1.96</td>
<td>0.106</td>
<td>0.3716</td>
<td>3</td>
<td>91.41</td>
</tr>
<tr>
<td>( \Psi(\text{Food})\ p(.) )</td>
<td>97.41</td>
<td>1.98</td>
<td>0.105</td>
<td>0.3716</td>
<td>3</td>
<td>91.41</td>
</tr>
</tbody>
</table>

\( \Psi = \text{occupancy (psi)}, \ p = \text{detection} \)

AIC = corrected Quasi-Akaike’s Information Criterion

\( \Delta \text{AIC} = \text{AIC} - \text{minimum AIC} \)

w = Akaike weight

K = number of parameters
5. Discussion

The assessment and estimation of occupancy and detection probability are fundamental when monitoring a species population across time (MacKenzie 2002; Pellet & Schmidt 2005). Successfully estimating both occupancy and detection probability needs good survey design and data analysis (Hamer & Mahony 2010). The detection probability of 0.72 with this study provides some confidence in reliably detecting koalas within the Lismore LGA. This initial pilot study may have particular relevance in any future annual surveys studied in this manner. The data could be compared across years with some confidence, however this study has also helped show areas with which improvements can be made.

Site variables have been shown to affect the influence of occupancy in previous studies (Ellis et al.). However, the variables measured and used within this study did not have a major influence on occupancy. If a good site variable was identified throughout this study it is possible that the estimations would be improved. At present the data is suggesting that our minimum requirements used throughout this study were appropriate and variables were not having a significant effect. In future studies it is recommended that further effort and time is set aside for recording more variables at sites to confirm or disprove this.

5.1 Disease

Overall the results showed only 13% (5 out of 39) koalas detected throughout this study were showing signs of Chlamydia see figure 8. Two koalas were showing signs of keratoconjunctivitis (dull/no eye shine) whilst three koalas were showing signs of cystitis (dirty tail). This is lower than previous studies undertaken in the Lismore LGA and neighbouring regions where incidences of disease were reported more frequently (Faulks 1991; Melzer et al. 2000).
5.2 Future Recommendations

Koalas were detected at 14 out of the 32 sites throughout the study period. However, it is recommended that for any future studies following a similar format to this that the following sites be re-evaluated:

- Site 3 (Richmond Hill Road), Site 27 (Cook Road), Site 32 (Paffs Lane) – these sites did not produce a koala sighting throughout the survey and may need to be removed due to their fragmented vegetation and lack of connectivity with other sites.
- Site 8 (Northcott Drive) – this site did not produce a koala sighting throughout the survey and may need to be removed due to its positioning on land for sale.
- Site 18 (Rous Road), Site 22 (Tregeagle Road), Site 23 (Graham Road), Site 31 (Baxter Lane) - these sites did not produce a koala sighting throughout the survey and may need to be removed due to their dominance of non primary trees.

The other sites producing non-results fit all the selection criteria for the site selection and are recommended to be included in future studies.

5.3 Limitations of study

Spotlighting was deemed an effective method in detecting koalas throughout this survey. However, on several occasions it was noted koalas were detected incidentally as the animal was facing away and no eye shine was detected. Koalas
with signs of keratoconjunctivitis were also found to have much duller eye shine and could record a false absence.

Whilst this study was a pilot study and should be regarded as a baseline for future studies more replications of spotlighting nights would be recommended for future surveys over a longer time period. Surveys were conducted over three nights over three weeks due to time constraints and weather conditions. Ideally the surveys would have been spread of further time periods and had more replication.

6. Conclusion

This pilot study undertaken throughout the Lismore LGA has given a good reference for future studies of a similar nature. Koalas were detected at 14 out of the 32 sights surveyed with a total of 39 koalas being detected overall. The study showed a low detection rate of 13% of animals showing clinical signs of Chlamydia. A total of four juvenile koalas were spotted with females, which indicates there is a good fertility rate. Overall the occupancy probability was 0.45 and the detection probability was 0.72, which provides some confidence in the ability of comparing this data across years.

The Lismore koala population is a significant one for NSW and Australia and continued monitoring of the population should be continued to ensure koalas are managed appropriately. This study has determined a good number of appropriate sites within the Lismore LGA, which produced some promising results. It is recommended that similar studies to this be undertaken which include the revisions: reassessment and replacement of the aforementioned sites; a detailed investigation and analysis of variables at each site; replication of this study at different times of the year to account for seasonal variation and an implementation of an ongoing annual survey. It is hoped that this study will help to assist in the implementation of an ongoing population-monitoring program within Lismore that will help to protect and conserve a significant species of Australia.
7. References


major limiting factors. *Biology of the koala* 14(1) 85-95.


LCC (2013). Comprehensive Koala Plan of Management for south-east Lismore. Lismore City Council, Lismore, NSW.


9. Acronyms

CKPoM - The Comprehensive Koala Plan of Management for South-East Lismore
EPA Act – Environmental Protection Act
EPBC Act – Environmental Protection and Biodiversity Act
Lismore LGA – The Lismore Local Government Area
NPW Act – National Parks and Wildlife Act 1974
NSW – New South Wales
NV Act - Native Vegetation Act 2003
QLD - Queensland
SA – South Australia
SCU – Southern Cross University
SEPP 44 - State Environmental Planning Policy No. 44 – Koala Habitat Protection
TSC Act - The Threatened Species Conservation Act 1995
VIC – Victoria
8. Appendices

Appendix A. List of sites and description surveyed throughout the study.

Site Selection

**Site 1** - Cowlong Rd & Palmer Rd (Previously K31)
- Good access and parking, quiet road
- Good selection of eucalyptus
- Flagged

**Site 2** - Cowlong Rd
- Approximately 500 metres from Bruxner Hwy
- 200 metre transect of eucalypt trees along cowlong road on both sides of the road

**Site 3** - Richmond Hill Rd (Previously K30)
- Approximately 200 metres from Bruxner Hwy
- Transect of trees along road some spread out > 20 eucalypt trees in transect

**Site 4** - James Rd (Previously K35)
- 250m north of Eucalypt Grove
- 200m+ transect of eucalyptus along both sides of the road

**Site 5** - Alphadale Rd and Bruxner Hwy (Previously K28)
- Access via road into old cemetery
- Dispersed eucalypt trees behind old cemetery and along access road
- > 20 eucalypt trees in section easily accessible

**Site 6** - Bruxner Hwy (Previously K29)
- Approximately 1km past Cowlong Rd turnoff
- Busy road but some good parking off road on grass
- Good selection of eucalyptus trees over private fence in a transect

**Site 7** - Windsor Ct (Previously K36)
- Good selection of eucalyptus trees near parking spot
- Section of eucalypt trees through the park up the street

**Site 8** - Northcott Drive
- > 20 eucalypt trees able to be accessed behind three vacant blocks downhill from the road

**Site 9** - Clifford Park
- Line of eucalypt trees at the back of the sports field
- Easy parking in the car park and short walk to trees

**Site 10** - Robinsons Lookout
- Section of eucalypt trees at the top of Robinson's lookout
- Gate may be shut and locked after hours, short walk from gate to access tree at the top of the lookout

**Site 11** - Amaroo Place
- Section of > 20 eucalypt trees around old cemetery site
- Access is via parking on Amaroo Place

**Site 12** - Rifle Range Road
- Corner of Rifle Range Rd and Industry Dr
- On SCU campus next to the koala hospital
- Numerous eucalypt trees in this corner

**Site 13** - Flametree Drive
- Access via Flametree Dr
- Eucalypt trees behind houses down side road and also down Casuarina Dr

**Site 14** - Captain Rous Park
- Entry via Hamley Rd
- Various eucalypt trees within the park

**Site 15** - City View Drive
- Access via the large water storage tank
- Eucalypt trees behind tank and to the side

**Site 16** - Lindendale Road
- Access is north off Skyline Rd
- Transect of smaller eucalypt trees here > 20

**Site 17** - Skyline Road 1
- Access is north off Skyline Rd
- Transect of smaller eucalypt trees here > 20

**Site 18** - Rous Road
- Transect of eucalypt trees approximately 400m from Molly's Grass Rd.

**Site 19** - East Skyline Road
- Transect of eucalypt trees along the road approximately 400m
- Broken into two sections 100m apart

**Site 20** - Skyline Road South
- Transect towards the end of skyline road south
- Numerous eucalypt along side of road

**Site 21** - Connor Road
- Numerous eucalypt trees approximately 300m from end of road
- Some trees far off road but should be able to spotlight at least 20 trees here

**Site 22** - Treggeagle Road
- Opposite 559 Treggeagle Rd.
-100m transect of eucalypt trees which extends further back into property, >20 trees

Site 23 – Graham Road
- Windbreak of eucalypt trees bordering farm and eucalypt bush land
- Approximately 1.4km from Tucki Rd. turnoff

Site 24 – Henson Road
- Eucalypt trees extending down driveway which appears as Faulkner road on GPS
- Should be able to spotlight 20+ trees without going onto private property
- Approximately 900m from Tucki Rd.

Site 25 – Greannan Road
- Good transect of trees along road
- Transect approximately 1km from Tucki Rd.

Site 26 – Robson Road
- 500m south of Tregeagle road
- Transect along road

Site 27 – Cook Road
- 200m south of Tucki Rd.
- Scattered eucalypt trees which should be able to spotlight 20+ eucalypt trees in this section

Site 28 – Wyrallah Road
- Approximately 400m south of Tucki Rd.
- Transect 300m along border of property

Site 29 – Tucki Tucki nature reserve
- Access via Wyrallah Rd.
- Enter via the Tucki Tucki nature reserve access road, numerous eucalypt trees in large patch here

Site 30 – Wyrallah Road
- Approximately 1km north of Tuckurimba Rd.
- Eucalypt trees on side of road in long transect

Site 31 – Baxter Lane
- Access via Tuckurimba Rd.
- Eucalypt trees in patches and transects along the start of Baxter lane
- Scattered eucalypt trees in this section

Site 32 – Paffs Lane
- Approximately 1km from Tuckurimba Rd.
- Eucalypt trees off side of road a little distance (<100m)
- Should be able to spotlight 20 trees here

Site 33 – Tuckean Island Road
- Approximately 700m from Dungarubba Rd.
- Transect of eucalypts approximately 200m along the road
Appendix B. OH&S fieldwork safety risk assessment completed form.

School of Environment, Science and Engineering
Fieldwork Safety Risk Assessment

The purpose of this form is to ensure field work planning accounts for hazard identification and risk management. It is also a record of important information you may need if an incident occurs. Therefore, the content of this form must be reviewed with all field workers before leaving and must be taken into the field with you.

This form must be approved by the Head of School before work commences. Allow 7 days for approval.

1. Name of Fieldwork Leader or Unit Assessor (Who is the person in charge on-site):
   Name: Dr. Ross Goldingay
   Contact No.: 0488074126
   SCU Email: ross.goldingay@scu.edu.au

2. Description of Fieldwork
   Night time spotlighting survey of koalas in and around the greater Lismore area.
   Does the fieldwork involve:
   - [ ] Diving
   - [ ] Boating
   - [ ] Off-road or 4W Driving

3. Site information

<table>
<thead>
<tr>
<th>Site Location &amp; Address</th>
<th>Contact details of Owner/Manager of field site</th>
<th>Permit number (if required)</th>
<th>Date/s of visit/s²</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 separate survey sites.</td>
<td>Public land</td>
<td>15/4/15-15/5/15</td>
<td></td>
</tr>
</tbody>
</table>

4. List all fieldwork personnel and relevant qualifications and training³

<table>
<thead>
<tr>
<th>Name</th>
<th>Qualification, Training, Proficiency</th>
<th>Licence/ID number and expiry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ross Goldingay</td>
<td>&gt;25 years' experience in wildlife surveys. First Aid certificate</td>
<td>7113XX; 2! Feb 2020 HLTFA301C-121:908</td>
</tr>
<tr>
<td>Jace Embreg</td>
<td>1 semester training in wildlife surveys</td>
<td>89516796; 2! Jun 2019</td>
</tr>
<tr>
<td>Jenna Calebro</td>
<td>Will be supervised</td>
<td></td>
</tr>
<tr>
<td>Leif Embreg</td>
<td>Will be supervised</td>
<td></td>
</tr>
</tbody>
</table>

5. Emergency Communications⁴

Who do you contact in an emergency?

<table>
<thead>
<tr>
<th>Emergency Contact</th>
<th>Numbers</th>
<th>Contact times</th>
<th>Incidents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency Services</td>
<td>000-land line or mobile 112-mobile only</td>
<td>Anytime</td>
<td>Accident or emergency - provide directions on how to get to site</td>
</tr>
<tr>
<td>SCU Security</td>
<td>02 6620 3333</td>
<td>Anytime</td>
<td>Accident or emergency</td>
</tr>
<tr>
<td>GESE Office</td>
<td>02 6620 3650</td>
<td>Office hours only</td>
<td>Accident, emergency, breakdown</td>
</tr>
<tr>
<td>Technical officer</td>
<td>02 6620 3721</td>
<td>Office hours only</td>
<td>Breakdown, or equipment failure</td>
</tr>
<tr>
<td>Graeme Palmer</td>
<td>0419 031 138</td>
<td>After hours</td>
<td>All</td>
</tr>
</tbody>
</table>

How do we contact you in the field?

<table>
<thead>
<tr>
<th>Means of Communication</th>
<th>Contact Name</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile</td>
<td>Jace Embreg</td>
<td>0431285310</td>
</tr>
<tr>
<td>Mobile</td>
<td>Leif Embreg</td>
<td>0448881574</td>
</tr>
<tr>
<td>Mobile</td>
<td>Jenna Calebro</td>
<td>0439444666</td>
</tr>
<tr>
<td>On-site landline</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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6. Transport - Give details of vehicle/s to be used to get to site
   - University vehicle
   - Bus
   - Private vehicle

   Drivers Licence No: 60516786
   Vehicle registration: 603KEK
   CTP Policy No: 7564783

   Third Party Property/Comprehensive Insurance Policy No: 7564783

   Drivers Licence No: 7113XX
   Vehicle registration: AO11BE
   CTP Policy No: RIA809365480

   Third Party Property/Comprehensive Insurance Policy No: MOT319105924

   Drivers Licence No: 
   Vehicle registration: 
   CTP Policy No: 

   Third Party Property/Comprehensive Insurance Policy No: 

7. Who will you notify of your time of departure and return?
   Name: Thea van de Mortel
   Phone: 0429939382

8. Risk Assessment: Additional research specific hazards are to be added to the list below

   The fieldwork leader is obliged to ensure participants are aware of the information contained in this assessment

<table>
<thead>
<tr>
<th>Hazard Identification</th>
<th>Initial Risk Rating</th>
<th>Risk Reduction Procedures</th>
<th>List PPE Required</th>
<th>Final Risk Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic accident</td>
<td>2</td>
<td>Apply caution when driving.</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Trips, slips and falls</td>
<td>4</td>
<td>Correct footwear and PPE worn in the field. Care taken whilst walking in field. Walk slowly along uneven ground with extra care.</td>
<td>Closed in shoes.</td>
<td>5</td>
</tr>
<tr>
<td>Hit by car when walking along roadside</td>
<td>2</td>
<td>High visibility vest worn at all times when outside of the car. Keep well away from the road during survey.</td>
<td>High visibility vest</td>
<td>3</td>
</tr>
<tr>
<td>Snake bite</td>
<td>3</td>
<td>Most field work will be done at night so the possibility of encountering snakes is minimal.</td>
<td>First aid kit</td>
<td>4</td>
</tr>
<tr>
<td>Insect bites and/or leeches</td>
<td>4</td>
<td>Apply insect repellent and wear long sleeves and long pants.</td>
<td>Insect repellent, long sleeves and trousers</td>
<td>5</td>
</tr>
<tr>
<td>Cold stress</td>
<td>5</td>
<td>Wear appropriate clothing.</td>
<td>Jackets and trousers</td>
<td>6</td>
</tr>
</tbody>
</table>

9. List any additional health precautions and/or special requirements
   N/A
10. Declarations and Signatures
Please obtain signatures of all field workers (researchers and/or demonstrators)

<table>
<thead>
<tr>
<th>Field work leader and field workers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name: Ross Goldingay</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Field workers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name: Jace Emberg</td>
</tr>
<tr>
<td>Name: Jenna Calabro</td>
</tr>
<tr>
<td>Name: Leif Emberg</td>
</tr>
</tbody>
</table>

Attached additional form if necessary.

Nominated contact person
I agree to act as the nominated person for the above field work activities and agree to notify the appropriate person if the fieldwork leader fails to report in at the appropriate time.

| Name: Ross Goldingay | Signature: | Date: 10 April 2015 |

Dive Officer – Not applicable

Research or Academic Supervisor/Unit Assessor
I am satisfied that the field worker/s has/have been informed of the risks associated with this work and that the safety precautions in place are adequate.

| Name: Ross Goldingay | Signature: | Date: 10 April 2015 |

Head of School
As required by the University Safety Policy, I approve/do not approve the work described on this form.

| Name: Amanda Ratchett | Signature: | Date: 4/15/15 |

Checklist for Fieldwork Leader / Technical staff to be completed before leaving

- Head of School approval has been obtained
- First aid officer and location of first aid kit have been reviewed
- Communication methods, emergency contacts and location of this document have been reviewed. A person has been nominated to record your departure and return.
- The fieldwork leader has informed all participants of the safety risks and remedial actions relating to the fieldwork. All required PPE has been included.
- Participants have been invited to advise staff or other group members of any special medical conditions or requirements
- Participants have been requested to advise staff if unable to swim or consider themselves to be lacking in confidence as a swimmer for the given field activities
- Research/collecting permits current and on-site

Name: __________________ ______ Signature: __________________ Date: __________
(Name and signature of Fieldwork Leader once above checklist has been performed)
10. Declarations and Signatures
Please obtain signatures of all field workers (researchers and/or demonstrators)

### Field work leader and field workers

<table>
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<tbody>
<tr>
<td>Ross Goldingay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jace Emborg</td>
<td></td>
<td>10/4/15</td>
</tr>
<tr>
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### Dive Officer – if applicable

I acknowledge a dive proposal has been prepared and approved for the above fieldwork. I am satisfied all members of the fieldwork party have the necessary skills and qualifications for the proposed work.

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### Research or Academic Supervisor/Unit Assessor

I am satisfied that the field workers have been informed of the risks associated with this work and that the safety precautions in place are adequate.

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### Head of School

As required by the University Safety Policy, I approve/do not approve the work described on this form.

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**Checklist for Fieldwork Leader / Technical staff to be completed before leaving**

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(Name and signature of Fieldwork Leader once above checklist has been performed)

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