Woolgoolga to Ballina Pacific Highway Upgrade Phased Resource Reduction for Koala – Wardell Road phase 5 report.

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Cover Photo: Adult male koala, Old Bagotville Road, 23 October 2017.

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1. Introduction

The Woolgoolga to Ballina (W2B) Pacific Highway Upgrade Koala Management Plan (RMS 2016) proposed a staged approach to clearing in two koala hotspots in Section 10 of the upgrade. Koala hotspots were situated at Laws Point and Wardell Road. The staged approach is referred to as 'phased resource reduction' (PRR) and involved the gradual reduction of food resources by ring-barking and collaring trees to facilitate the voluntary movement of koalas by replicating the effects of a severe drought. The PRR method aimed to reduce stress-induced impacts associated with clearing activities by encouraging koalas to move from the clearing area into adjacent habitat. In addition to collaring and ring-barking trees, the project also involved population surveys to monitor koala numbers throughout the PRR process. The purpose of the population monitoring was to monitor and assess the impact of the process on resident koalas and enable implementation of adaptive clearing procedures such that the project-wide goal of zero koala mortalities is achieved (RMS 2016). Other components added to the project included camera monitoring of collared feed trees to record koala response to collaring, inspections of collars for scratch marks, collection and analysis of koala scats collected at hotspots and control sites to monitor cortisol levels, and an additional population survey (Laws Point only).

Due to logistical issues, the PRR program was staged with work commencing at Laws Point in March 2017 and at Wardell Road in May 2017. Staging provided the opportunity to apply lessons learnt at Laws Point to Wardell Road. Sandpiper Ecological (Sandpiper) was contracted by Pacific Complete to implement the PRR program.

The program included five phases (Table 1):

- Phase 1 (Wks 1-3): Tag and map all trees to be collared/ring-barked and undertake six population surveys.
- Phase 2 (Wks 4-5): Collar 40%, ring-bark 20% of trees with continuous canopy to feed trees, ring-bark non-collared trees (DBH 100-300mm), and conduct two population surveys.
- Phase 3 (Wks 6-7): Collar a further 40% of trees, continue ring-barking non-collared trees (DBH 100-300mm), and conduct two population surveys.
- Phase 4 (Wks 8-10): Collar the remaining 20% of trees, finalise ring-barking, and conduct two population surveys.
- Phase 5 (Wks 11-17): Following clearing of the hotspot site undertake eight population surveys.

The following report details the results of phase 5 of the PRR program at the Wardell Road hotspot site. Phase 5 was undertaken between 2 and 29 November 2017. Results of phases 1 to 4 have been reported on previously (see Sandpiper Ecological 2017a, b, c & d). Phase 5 was to include four koala monitoring events spaced over a period of four weeks, commencing immediately after the completion of clearing. As clearing at Wardell Road was staggered (i.e. west side in early October and east side in late October/early November) there was a two week gap between the first and second phase 5 surveys. The following report is the final in the PRR program and includes comment on the success of the program and recommendations for future phased resource reduction programs.

2. Study area

The PRR study area was comprised three sample sites - Laws Point koala hotspot, Wardell Road koala hotspot and Tucki Tucki scat collection control site (Figure 1). Wardell Road and Laws Point are situated in Section 10 of the Woolgoolga to Ballina (W2B) Pacific Highway Upgrade and are

approximately 4km apart. The Section 10 alignment traverses a relatively flat to undulating agricultural valley, which begins north of the Richmond River at Laws Point and runs to the west of the township of Wardell before connecting with the existing Pacific Highway alignment at Coolgardie Road.

Table 1: The Phased resource Reduction schedule applied at the Wardell Road koala hotspot.

Phase	Duration	Dates	Tasks completed
1	66 days	1 May 2017 to 5 July 2017	1. Survey & mark project boundary. 2. Tag and map all trees to be collared & ring-barked. 3. Conduct 3 diurnal and 3 nocturnal population surveys.
2	18 days	10 to 27 July 2017	1. Collar 40% of trees. 2. Ring-bark 100-300mm DBH trees. 3. Ring-bark continuous canopy trees. 4. Conduct 1 diurnal and 1 nocturnal population survey.
3	14 days	28 July – 11 August 2017	1. Collar a further 40% of trees. 2. Conduct 1 diurnal and 1 nocturnal population survey. 3. Discuss options for additional ring-barking with Pacific Complete.
4	12 days	14 to 25 August 2017	1. Collar remaining 20% of trees. 2. Install fence around fig trees 3. Ring-bark additional feed trees and trees around the quad-bike track. 4. Conduct 1 diurnal and 1 nocturnal population survey. 5. Inspect site to assess dieback of ring-barked trees. 6. Download images & inspect collars for scratches.
5	28 Days	2-29 November 2017	1. Undertake 4 diurnal and 4 nocturnal population surveys after completion of clearing.

Wardell Road koala hotspot is located approximately three kilometres west north west of Wardell on the New South Wales north coast. Access to the site is via Wardell Road through RMS acquired land, adjoining private properties, and Hillside Lane. The study site extends for 1.3 kilometres and encompasses chainages 152200 to 153500 of the W2B section 10 upgrade. The survey area includes the subject site – section of W2B alignment between the abovementioned chainages, and study area – vegetation adjoining the subject site that contains eight, 1.3 km long koala survey transects. Vegetation within the Wardell Road hotspot is characterised by a mix of cleared grazing land with scattered remnant trees, planted, regrowth and remnant eucalypts in backyards, and swamp oak forest.

Tucki Tucki was used as a control site for collection of fresh koala scats. Scat collection occurred at two primary locations - Munro Wharf/Tucki Tucki Road and Hazlemount Lane. Tucki Tucki includes a mix of low ridges and floodplain that supports numerous koalas. The area includes numerous feed trees planted within local road corridors adjoining farmland.

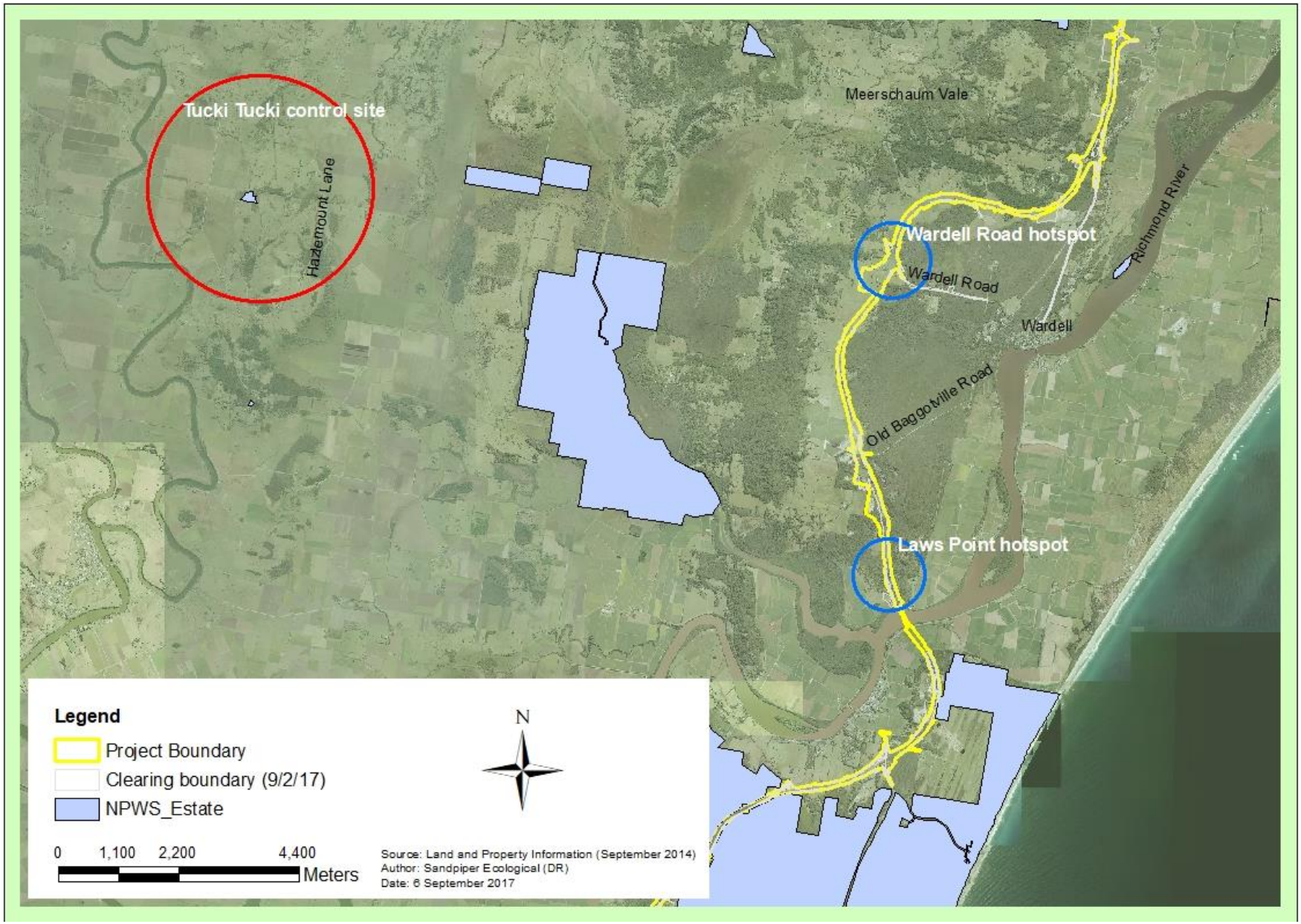


Figure 1: Location of Wardell Road koala hotspot in relation to Laws Point koala hotspot and the Tucki Tucki scat collection control site.

3. Methods

3.1 Method summary phases 1 to 4

3.1.1 Tree collaring

Trees with a Diameter at Breast Height (DBH) of >300mm had 600mm wide collars installed between one and two meters above ground in phases 2 (40%), 3 (40%) and 4 (20%). Collars were made of 1.5mm thick High Density Polyethylene (HDPE). HDPE was used as it is lightweight, has a slippery surface, can withstand punctures, is UV stabilised, and is easy to cut and handle in a field situation. Collar size was determined for each tree by measuring the circumference at 1m (hollow-bearing trees) or 2m (non-hollow-bearing trees) above ground. A three-step ladder was used to install collars at 2m (Plate 1). An additional 100mm was added to each circumference to allow for imperfections in the trunk and to provide a loose fit (Plate 2). Collars were attached using three or four 50-60mm screws. Each tree was inspected for koalas prior to collar installation. Collars were installed loosely around trunks to provide an unstable surface for koalas and enable small scansorial fauna to move up and down trunks. Collaring was undertaken over a period of 44 days between 10 July and 22 August 2017.

Large fig trees were excluded by installing a 1.2m high chicken wire and star picket fence around the perimeter. The fence was situated approximately 100mm above ground and had a single strand of plain wire installed around the base and a 600mm wide strip of HDPE attached to the upper section (Plate 3).

Plate 1: Procedure used to install collars during the Phased Resource Reduction for koalas.

Plate 2: Example of a loosely fitted collar with a gap around the trunk to reduce a koalas grip on the collar and allow small scansorial fauna to access trees.

Plate 3: Combined chicken wire and HDPE fence installed around two clusters of large fig trees that could not be collared.

3.1.2 Ring-barking

All trees with a diameter between 100 and 300mm that did not pose a safety risk to the public / workers, infrastructure (power lines, dwellings, fences) or were within 10m of the Limit of Clearing (LoC) boundary were ring-barked in phase 2. The arborist undertaking ring-barking determined if a tree was safe to ring-bark. Ring-barking was undertaken by Blue Knob Tree Fellas and Sandpiper Ecological and was conducted using a chainsaw and axe. Trees were ring-barked by making two parallel cuts, approximately 100mm apart in the trunk. Bark and sapwood was then removed with an axe. The depth of chainsaw cuts varied depending on trunk diameter. Trees with a DBH between 100 and 200mm had bark only removed, with the sapwood left intact. This was done due to concern

about the stability of trees if sapwood was removed, particularly from tall thin swamp oaks (*Casuarina glauca*). If deemed safe by the arborist an aggressive approach was adopted to ring-barking trees between 200 and 300mm DBH to maximise the likelihood of defoliation with the planned 6-week period between phase 2 and clearing (Plate 4).

Initial (phase 2) ring-barking was undertaken between 18 and 20 July 2017, with follow-up ring-barking of 100-300mm diameter trees on 18 August 2017. The majority of trees were ring-barked in phase 2, with an additional 10 trees, re-assessed by an arborist, and ring-barked in phase 4.

Plate 4: Ring-barking method applied at Wardell road hotspot site. Left = aggressive ring-barking of forest red gum; Right = passive ring-barking of swamp oak.

3.1.3 Continuous canopy trees

The Koala Management Plan specified that 20% of trees that had a continuous canopy to primary and secondary koala feed trees shall be ring-barked in phase 2 (RMS 2016). An assessment of koala feed trees identified seven trees that had continuous canopy to 19 other trees (Table A1, Appendix A). Fifteen connecting trees surrounding three feed trees were either within 10m of the LoC boundary, or had a power-line or dwelling within their fall zone, and were therefore unsuitable to be ring-barked. Two feed trees (and connecting canopy trees) had a DBH <300mm and would therefore be ring-barked anyway. The remaining two feed trees with one connecting tree each equated to 10% of continuous canopy trees within the Wardell Road hotspot site.

Due to the small number of continuous canopy trees available to be ring-barked, and results from Laws Point, which suggested that ring-barking feed trees, in conjunction with collaring, is a suitable means of altering koala behaviour, it was decided to ring-bark as many feed trees as possible within the constraints imposed by infrastructure and the LoC boundary.

3.1.4 Ring-barking koala feed trees

At Wardell Road, all primary koala feed trees that did not have a dwelling, power line, or road within their fall zone, or were within 10m of the LoC boundary were ring-barked. Feed trees with a DBH <200mm had bark only removed and trees with a DBH >200mm had bark and sapwood removed. Expanding ring-barking to include koala feed trees within 10m of the LoC boundary was discussed with Pacific Complete and subsequently rejected prior to completion of phase 4.

3.1.5 Dieback of ring-barked trees

Following completion of phase 4, extent of dieback of ring-barked trees was assessed by randomly sampling 30 ring-barked trees - 10 swamp oak, 10 forest red gum and 10 broad-leaved paperbark. The proportion of the canopy showing evidence of dieback (brown or partially brown leaves) and the degree of ring-barking (sapwood removed or bark only removed) was assessed visually. The survey was undertaken on 6 September 2017, 54 days after completion of ring-barking.

3.1.6 Removal of collars from retained vegetation

Upon completion of clearing, collars were removed from trees within areas of retained vegetation. At Wardell Road this included removal of collars from trees on the west side of the road near chainage 152850.

3.2 Koala population monitoring

3.2.1 Koala surveys

Four paired (diurnal & nocturnal) koala population monitoring surveys were conducted in phase 5 and follow on from the three paired surveys conducted in phase 1 (Sandpiper Ecological 2017a), and one paired sample conducted in each of phases 2, 3, and 4 (Sandpiper Ecological 2017b, c & d). A total of 10 paired monitoring surveys were conducted across the five phases.

Nocturnal surveys preceded diurnal surveys, which were conducted on the following day. Surveys were completed by one team of three and included one person walking the transect centre line flanked by a person 20m away on each side. Nocturnal surveys were conducted with handheld spotlights (Led Lenser P14) and all personnel were equipped with binoculars for both nocturnal and diurnal surveys. Each 1.3km transect took approximately 30 minutes to complete. The phase 5 population surveys were conducted on 2 and 3, 15 and 16, 21 and 22, and 28 and 29 November 2017. Phase 1 population surveys, at Wardell Road, were conducted on 30 and 31 May, 5 and 6 June, and 3 and 4 July 2017, phase 2 on 26 and 27 July, phase 3 on 9 and 10 August 2017, and phase 4 on 23 and 24 August 2017.

Landowners were contacted within 48 hours of undertaking surveys. One landowner refused permission to access their property from the outset, another refused permission after completion of phase 1, and another after completion of phase 4. This effectively meant that, in phase 5, the northern 650m of transects 1 and 2 could not be traversed. Approximately 100m of each transect contained known koala habitat.

Data recorded during each survey included; date, survey number, observer names, start and end time, temperature range, cloud cover, wind, rain and moon phase. Data collected on each koala observed included: date, time, transect number, coordinates (easting & northing GDA 94), tree species, tree diameter at breast height (DBH), temperature, weather, sex, breeding status, and health (i.e. signs of conjunctivitis or cystitis). Each tree with a koala was marked with flagging tape so it could be re-located the following day.

3.2.2 Scat collection

To support a study being undertaken by Roads and Maritime Services and Sydney University on cortisol levels in koalas, fresh koala scats were collected at Wardell Road (impact site) and Tucki Tucki (control site) following each diurnal survey. At Wardell Road, each tree containing a koala, or where a

koala was recorded the previous night, was revisited and a search conducted for fresh koala scats. Fresh scats were identified by their colour (paler green) and presence of a moist coating. Scats were subsequently collected from the same number, and if possible same sex ratio, of koalas at Tucki Tucki (Figure 2). The Tucki Tucki site was visited on the afternoon following the diurnal koala survey and trees containing suitable koalas were marked. These trees were revisited the following morning and fresh scats collected. Where possible, between five and six scats were collected from each tree and scat collection was conducted during dry weather. The age of scats (i.e. fresh or >1 day old) was noted on the datasheet. Control site scats for the Wardell Road sample were collected from Hazlemount Lane, with one sample collected from Munro Wharf Road (Figure 2).

Data collected at each scat collection site included; location (easting & northing GDA 94), tree species, weather (temperature, cloud cover, rainfall), time since last sunny day, tree size, koala behaviour, koala health, date, and observer. Scats were collected with a toothpick and placed immediately into a Styrofoam block positioned in a plastic container (Plate 5). Scats were then stored in a cool dry location.

Plate 5: Scats being collected at the Tucki Tucki control site.

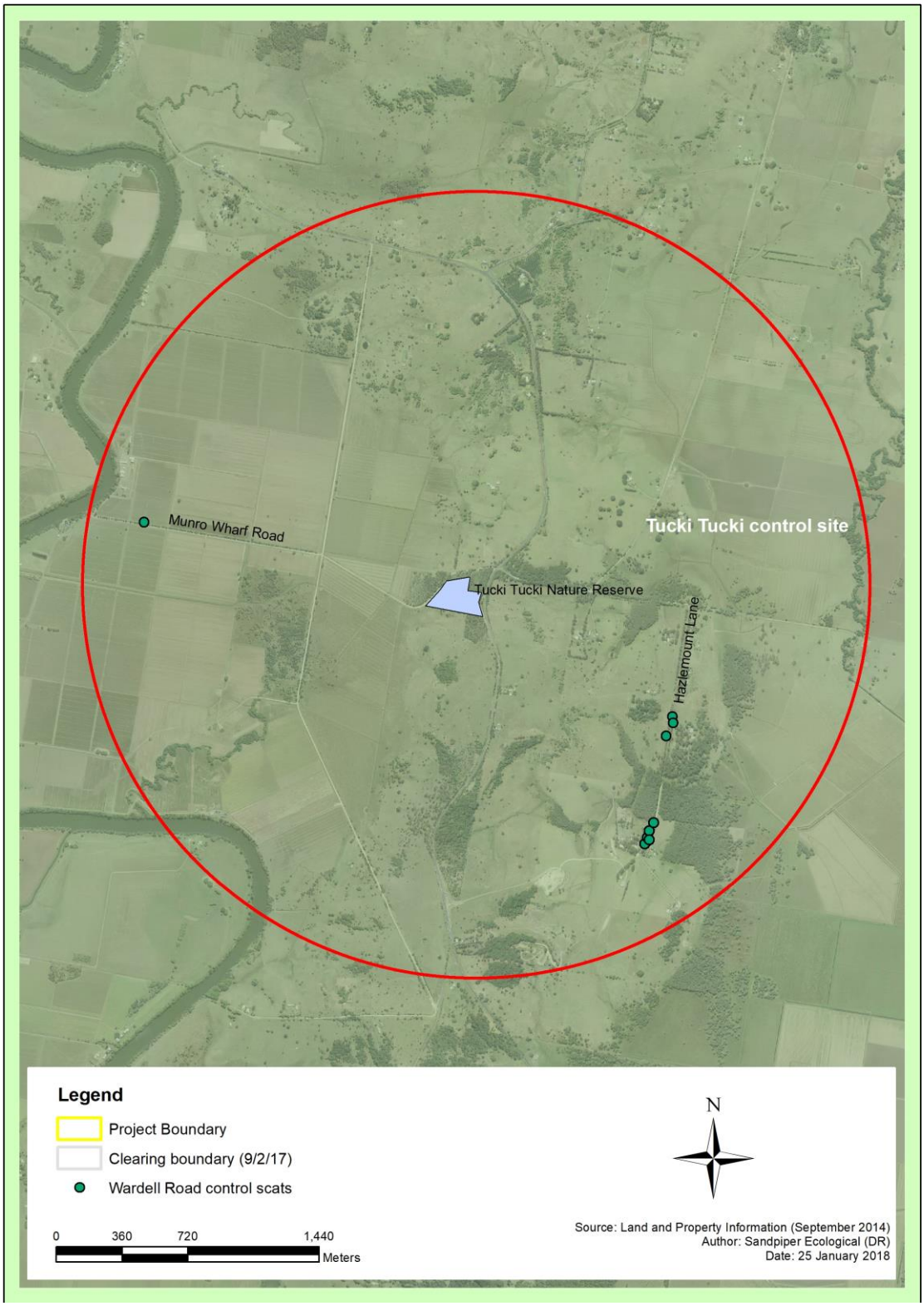


Figure 2: Location of scat sample sites within the Tucki Tucki Control site.

3.3 Camera monitoring

To obtain data on how koalas respond to tree collars six (Scoutguard KG680V) motion-activated infra-red cameras were installed on six trees - four forest red gums and two swamp mahoganies - on 4 August 2017. These trees were in a cluster used by a male koala. Cameras were installed 3-4m above

ground and angled downwards to video koala (& other fauna) interacting with collars. The proximity of feed trees and orientation of cameras enabled more than one tree to be monitored by each camera. Three trees were monitored on both sides and three on one side only. Cameras were set to record 20 seconds of video with a 10 second quiet-period (Plate 6). SD cards and batteries were changed on 25 August and 6 September. The base of each collar on a cluster of feed trees near chainage 152900 was painted to assist in identifying scratch marks. Each collar in the cluster of feed trees near chainage 152900 was inspected for koala scratch marks when changing SD cards/batteries.

Plate 6: Camera installed (left side of tree above collar) on a collared feed tree at Wardell Road. The camera is monitoring use of an adjacent feed tree, which also contains a camera aimed at the tree shown. The bottom of collars on feed trees was painted to assist with identifying scratch marks.

4. Results

4.1 Collaring and ring-barking

A total of 299 trees containing 404 stems were collared during PRR at Wardell (Table 2; Figures 3, 4 & 5; Table A2 & A3, Appendix A). This included 292 non-HBT (Hollow Bearing Tree) and seven HBT's. Six feed trees with a DBH >300mm and 18 with a DBH <300mm were ring-barked, and 38 feed trees were collared (Table 2; Figure 5). No koalas were recorded in trees immediately prior to collaring or ring-barking. Where possible, collaring extended outwards from the centre of the alignment and extended for the entire length of the Wardell Road hotspot area. The total number of trees managed within the Wardell Road hotspot site was 310 (Table 3). Palms were typically not collared or ring-barked, with the exception of three cabbage palms (*Livistona australis*).

Table 2: Number of trees and stems collared and feed trees ring-barked during the PRR program at Wardell Road. * = Includes co-dominant stems; ** = includes 13 trees with a DBH <300mm not included in "Total Trees Managed" tally.

Phase	Total trees managed	Total Trees collared	Non HBT collared	HBT collared	Feed trees collared	Total Stems collared*	Feed trees ring-barked
Two	119 (38%)	114	113	1	6	150	18**
Three	117 (38%)	117	115	2	18	162	0
Four	74 (24%)	68	64	4	14	92	6
Total	310	299	292	7	38	404	24

Table 3: Number of trees marked during phase 1 of the PRR program at Wardell Road.

Phase	Total trees to be managed	Total Stems to be managed	Non HBT	HBT
One	310	413	303	7

4.1.1 Tree dieback

There was considerable variation in the extent of foliage dieback between species of trees ring-barked (Table 4). Dieback of forest red gums and paperbarks was generally rapid and complete (Plates 7 & 8). The tree species with the highest proportion of trees with almost total foliage dieback was broad-leaved paperbark, 100% of trees with 90-100% dieback, followed by forest red gum with 60% of trees with 90-100% dieback. The remaining forest red gums sampled displayed 11-50% dieback (30% of trees sampled), and <10% dieback (10% of trees sampled). No swamp oaks showed evidence of foliage dieback. The 30% of forest red gums that showed 11-50% dieback all had a DBH less than 230mm. Six out of the seven red gums with a DBH >300mm had 90-100% foliage dieback (Table A4, Appendix A).

Table 4: Proportion of canopy dieback recorded in three species of tree at the Wardell Road hotspot. N = 10 for each taxon.

Tree species	% of canopy showing evidence of dieback				
	0	<10	11-50	51-90	91-100
Forest red gum		10	30		60
Broad-leaved paperbark					100
Swamp oak	100				

Plate 7: Dieback of forest red gums: Left = 19 days after ring-barking; Right = 18 days after ring-barking.

Plate 8: Dieback of broad-leaved paperbark (center) and weeping bottlebrush (right) 19 days after ring-barking.

4.2 Camera monitoring

A koala (possible female) was recorded climbing a small (<100mm DBH) tree beside a collared feed tree on 21 September 2017 (Table A5, Appendix A). That was the only evidence of koalas attempting to climb collared feed trees at the Wardell Road hotspot.

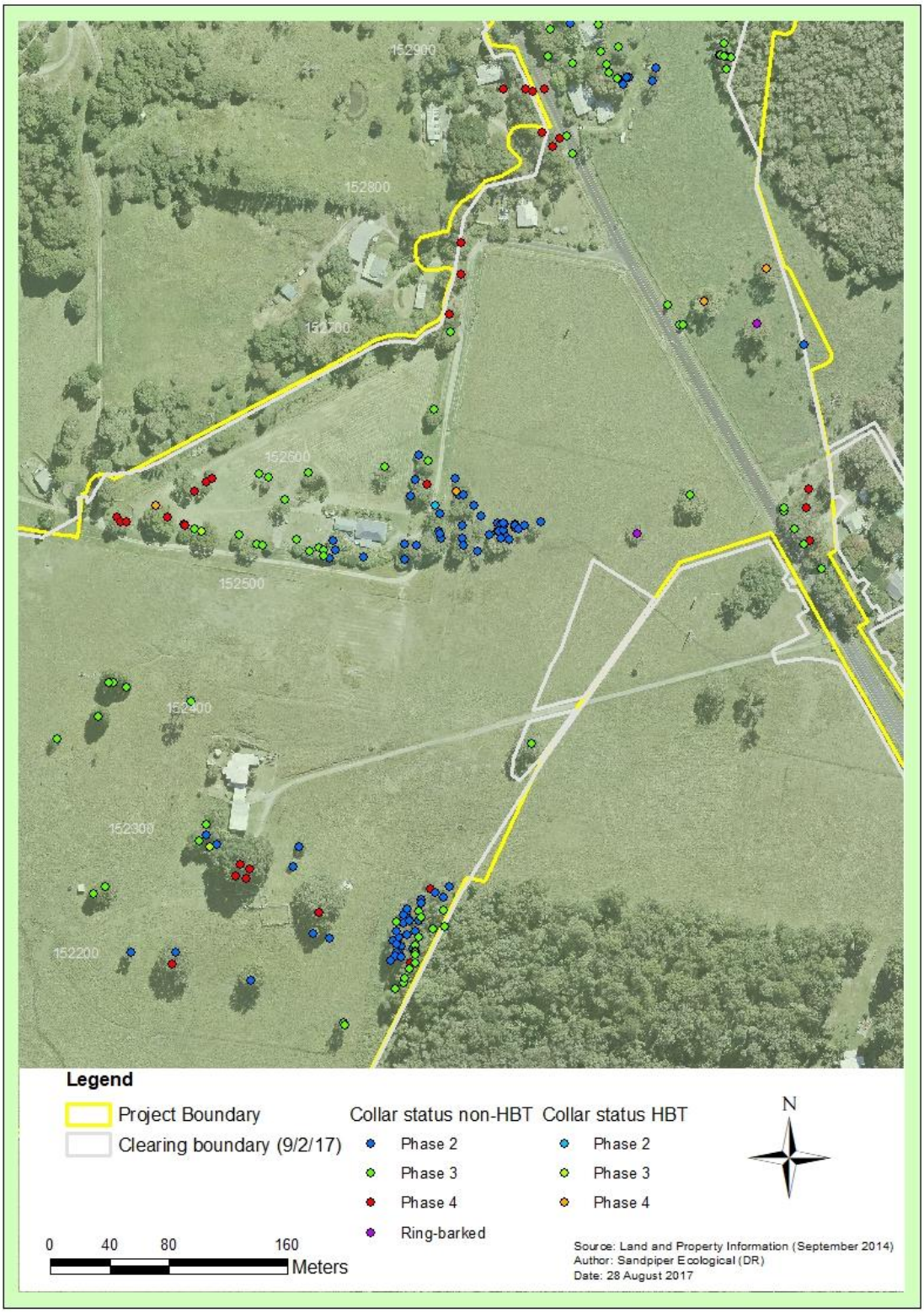
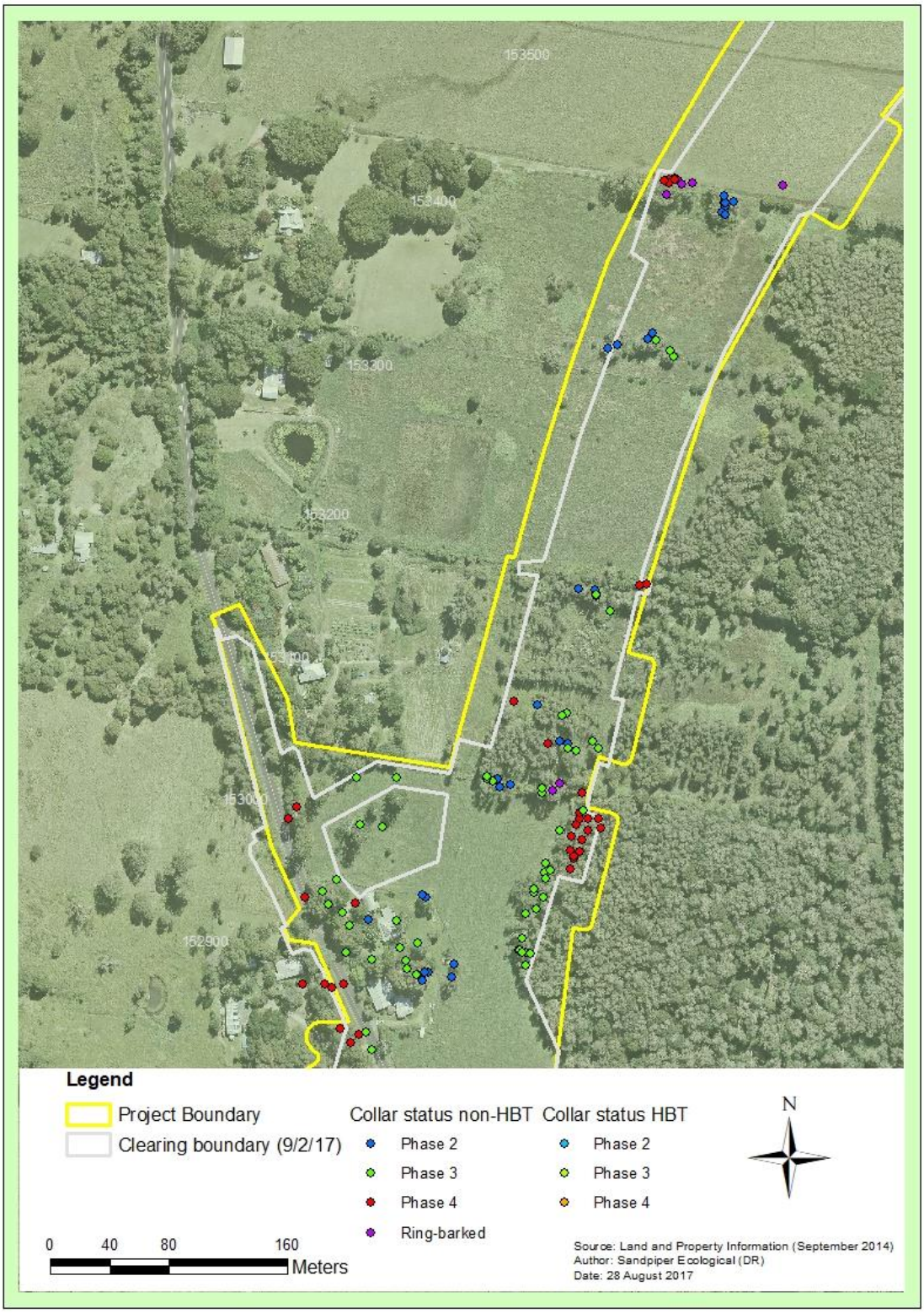


Figure 3: Distribution and status of all trees (DBH >300mm) within the Wardell Road site following implementation of the PRR program.



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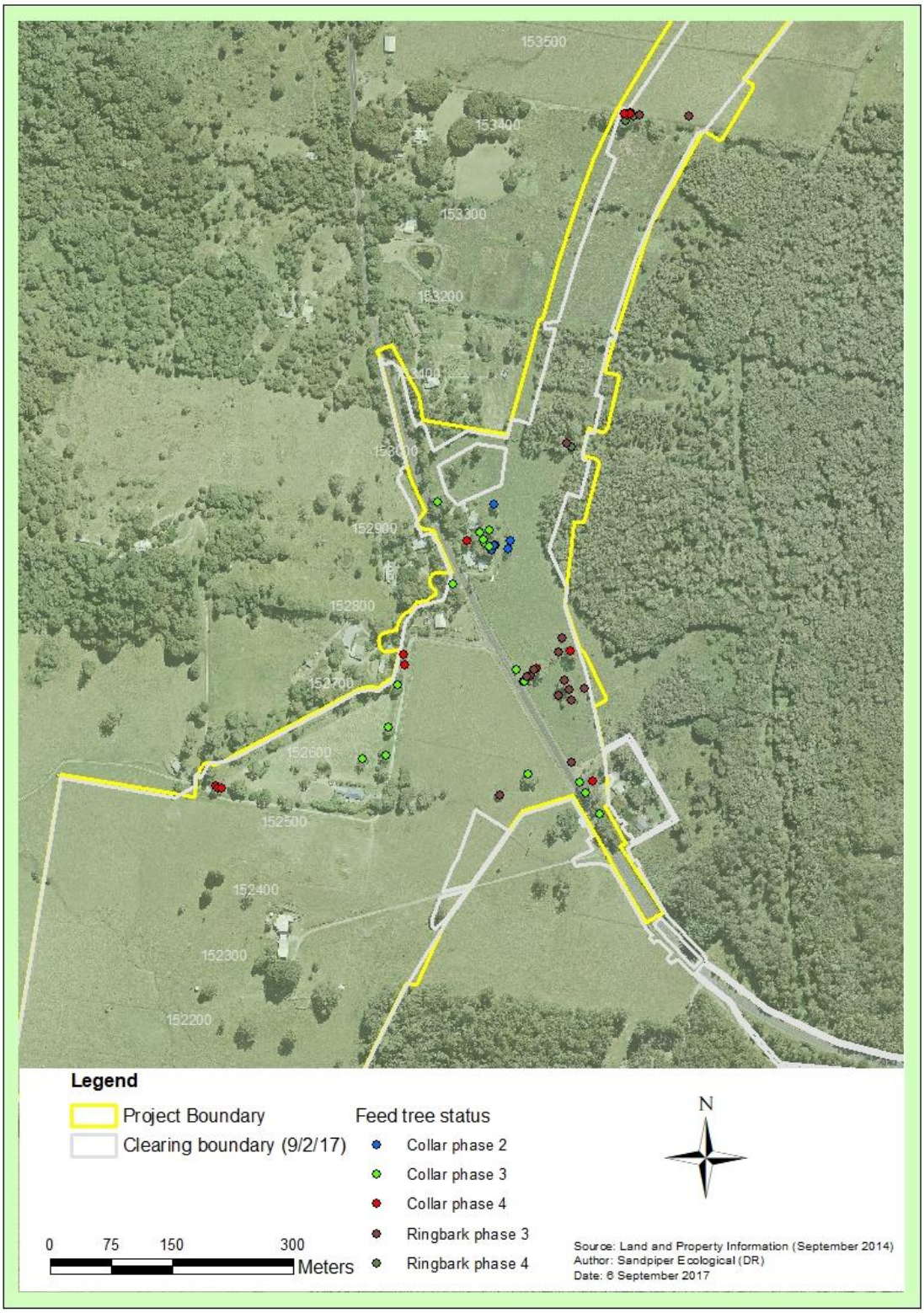

Figure 5: Status of koala feed trees within the Wardell Road hotspot area following implementation of the PRR program.

4.3 Koala population surveys

4.3.1 Koala surveys

Phase 5 koala population surveys were conducted between 2 and 29 November 2017. Three koala records were obtained during phase 5, bringing the total number of koala records at the Wardell Road hotspot to 12 (Table 5). In phase 5, single koalas were recorded on transects 6, 7 and 8 during surveys 7, 8 and 9 respectively (Figure 6). Records included two adult males (15 & 22 November) and a probable adult female (2 November). All individuals had wet and dirty tails (Table A6, Appendix A).

Table 5: Koala records obtained during phase 1 to 5 koala surveys at Wardell Road. Pr = probable identification; po = possible identification.

Date	Record No.	Sex	D/N	Time	T'sect	Phase	Easting	Northing	Tree sp.
30/5/2017	WK1	M (pr)	N	1743	1	One	542533	6798776	Forest red gum
5/6/2017	WK2	F (pr)	N	1739	1	One	542533	6798776	Forest red gum
6/6/2017	WK2.1	F (pr)	D	0945	1	One	542533	6798770	Forest red gum
6/6/2017	WK3	M (pr)	D	0945	1	One	542569	6798777	Forest red gum
3/7/17	WK4	M (pr)	N	1751	1	One	542553	6798770	Narrow-leaved red gum
4/7/17	WK4.1	M (pr)	D	1010	1	One	542540	6798773	Forest red gum
26/7/17	WK5	F (pr)	N	1926	7	Two	542763	6798531	Forest red gum
27/7/17	WK5.1	F (pr)	D	1051	8	Two	542747	6798494	Flooded gum
9/8/17	WK6	F (pr)	N	1933	8	Three	542803	6798541	Forest Red Gum
2/11/17	WK7	F (pr)	N	2200	6	Five	542743	6798648	Forest red gum
15/11/17	WK8	M	N	2044	7	Five	542785	6798603	Broad-leaved paperbark
22/11/17	WK9	M	D	2250	8	Five	542831	6798520	Swamp mahogany

The maximum number of koalas recorded during a single sample (i.e. day or night) in phase 5, one, was broadly consistent with phase 1 (Figure 6). The total number of records obtained in phase 5 (3 records) was half that obtained in phase 1 (6 records). In addition, the mean number of individuals recorded per survey in phase 5 (0.25/survey at day, and 0.5/survey at night) was less than that recorded in phase 1 (1/survey during day and night).

All records occurred in areas where koalas had been recorded in previous surveys with exception of the probable adult female which was recorded in a small (5m tall) forest red gum on the flat east of Wardell Road (Chainage 152700; Figure 8). A cluster of koala records occurred west of the upgrade alignment at approximate chainage 152840, with a second cluster on the east side of Wardell Road at approximate chainage 152600 (Figures 8 & 9). All phase 1 koala records occurred west of Wardell Road with records in Phases 2, 3 and 5 occurring east of Wardell Road (Figures 8 & 9).

At least two koalas (1 male & 1 female) have been recorded in each area. At least two adult females, distinguished by size and health, utilised the study area but it is unknown if the same adult male moved between sites. The absence of concurrent records of a male in both locations and observation of an adult male crossing Wardell Road suggests movement between sites is plausible. The number of koalas using the Wardell Road hotspot during PRR was 3-4 individuals.

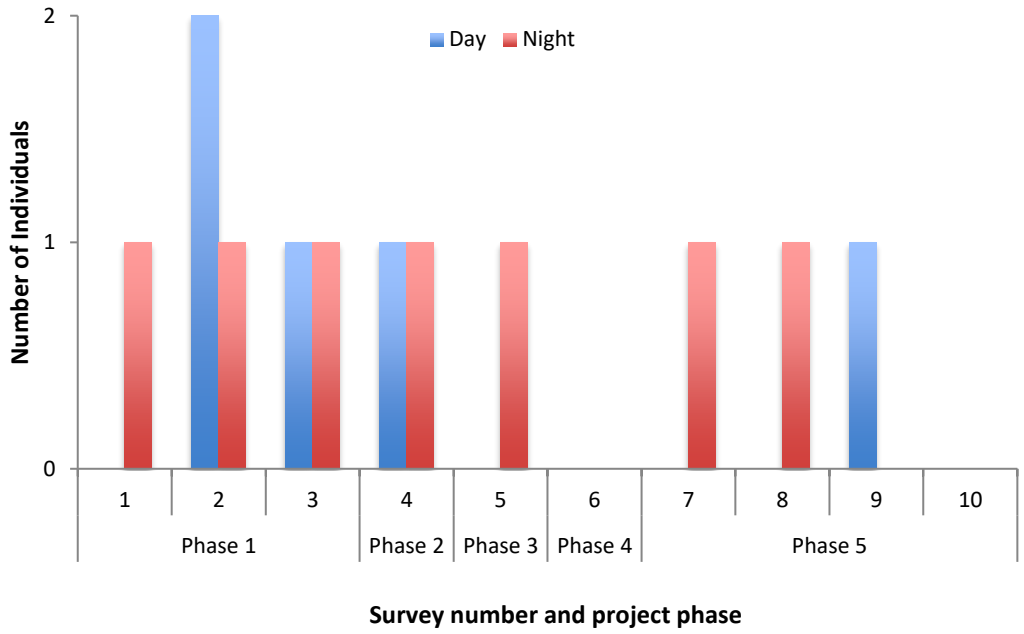

Figure 6: Number of koalas recorded during paired day and night surveys during the PRR program at Wardell Road.

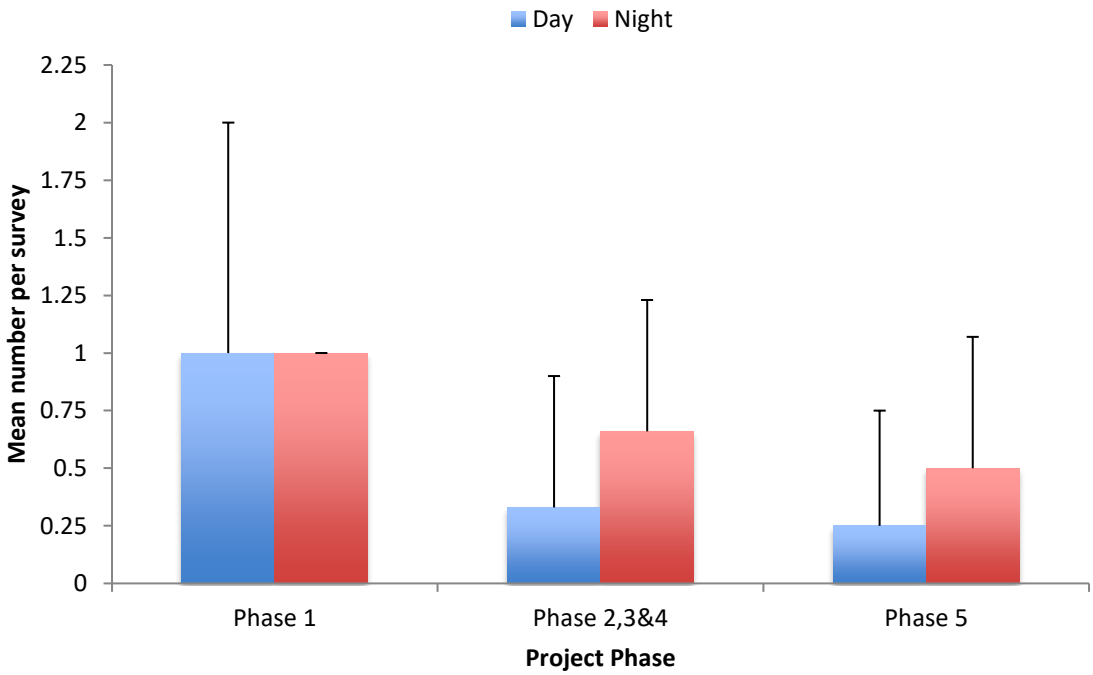

Figure 7: Mean number of koalas recorded during day and night per survey at the Wardell Road hotspot.

The limited point locality data precludes any assessment of home range. Based on field observations it is tentatively suggested that individuals using habitat east of Wardell Road occupy home ranges extending further east into areas of Swamp Forest and Heath. Individuals using habitat west of Wardell Road utilise habitat further west, on the eastern slope of Buckombil Mountain, and immediately east of Wardell Road.

A total of 12 koala records were obtained during the 10 paired (day & night) population surveys (Table 5). Seven records occurred at night, and five during the day. No ear-tagged individuals were recorded. Eight records were of individuals in forest red gum (*Eucalyptus tereticornis*), with one each in narrow-leaved redgum (*E. seeana*), flooded gum (*E. grandis*) and swamp mahogany (*E. robusta*). Four koala records at Wardell Road occurred inside the LoC boundary. All koalas recorded at the Wardell Road hotspot showed signs of disease (i.e. brown or wet bottom and/or conjunctivitis). Weather conditions during each population survey are summarised in Table A7, Appendix A.

4.3.2 Clearing phase koala records

Three koala records were obtained during the clearing phase (Figure 8). Clearing phase surveys consisted of pre-dawn spotlight and early morning pre-clearing surveys immediately prior to each days clearing, and opportunistic observations during habitat tree mark-up, prior to commencement of any clearing. Clearing phase surveys were restricted to the alignment and immediately adjoining forest. The clearing phase koala records are separate to the PRR koala monitoring surveys and have been included to provide additional contextual information. Sandpiper and FoK captured a sick adult female koala east of Wardell Road (chainage 152600) on 21 September 2017. During clearing, an adult male was recorded near the western project boundary (chainage 152800) on 8 and 9 November 2017.

4.3.3 Determining koala health and sex in the field

The aim of koala population monitoring was to gain an understanding of koala abundance and resource utilisation (RMS 2016). Detailed health assessment of individuals was not a component of the monitoring program but following results from Laws Point it was included in all population surveys. Information on unhealthy koalas was provided to Friends of the Koala (FoK) enabling them to undertake health assessments of sick individuals to determine if they needed to be captured and treated.

Acquiring definitive information on koala health and sex in the field is difficult particularly at night when visibility is limited. The posture of sick koalas, which are often curled in a fork, affects the ability to determine sex and distinguish individuals. At Wardell Road all koalas recorded showed obvious signs of disease from phase 1 onwards. Friends of the Koala (FoK) were informed on the location of sick koalas as they were encountered and FoK representatives typically visited landowners to discuss options to trap and treat sick individuals.

4.3.4 Scat Collection

Scats were collected from each koala sighted at the Wardell Road site, with equivalent samples collected from Hazlemount Lane at the Tucki Tucki control site (Tables A7 & A8, Appendix A). Between 3 and 6 scats were collected for each sample and rainfall was recorded 24hrs prior to scat collection on two occasions.

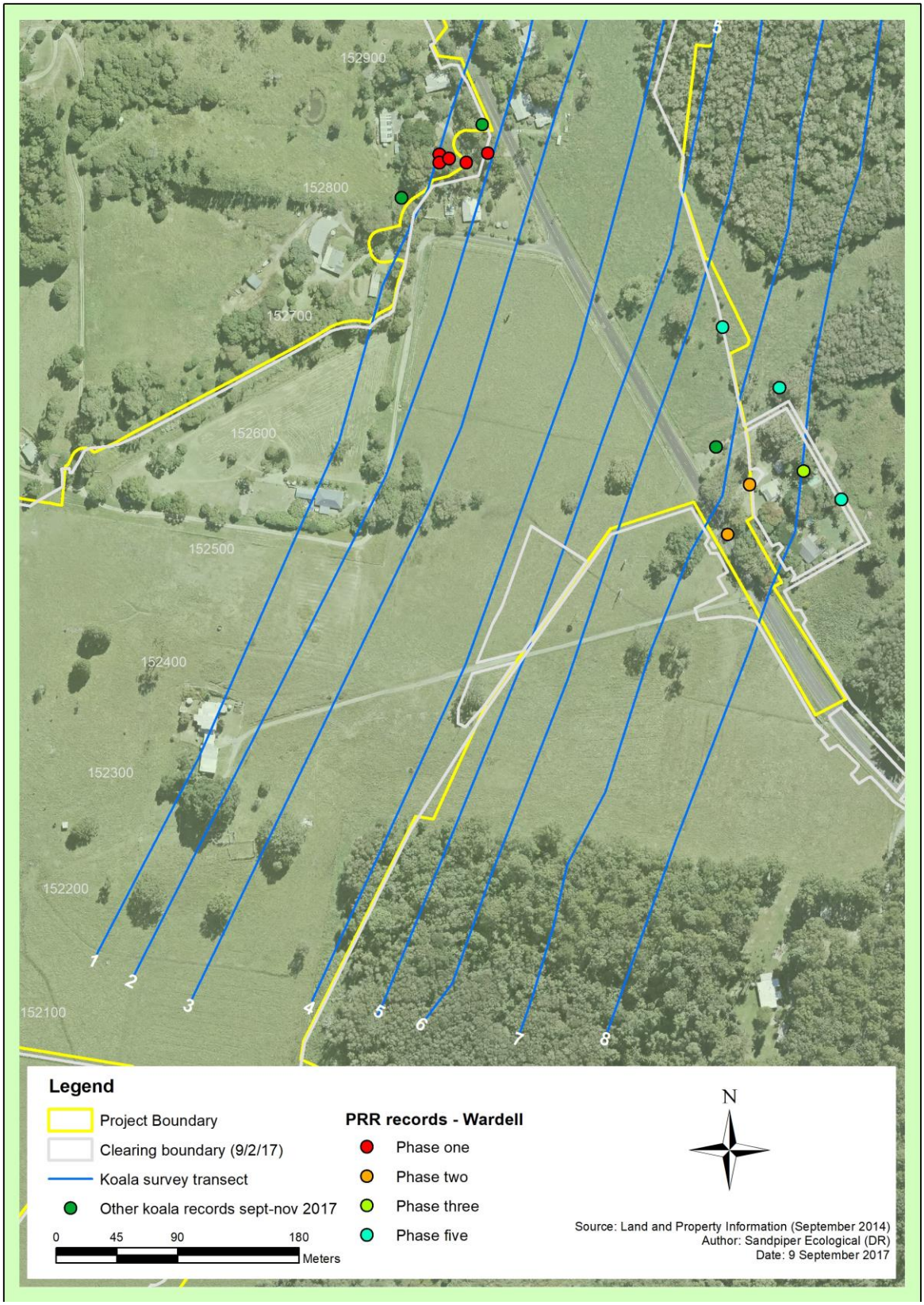

Figure 8: Distribution of koala records for all phases of the PRR program at the Wardell Road hotspot site. Note: no koalas were recorded in phase 4.

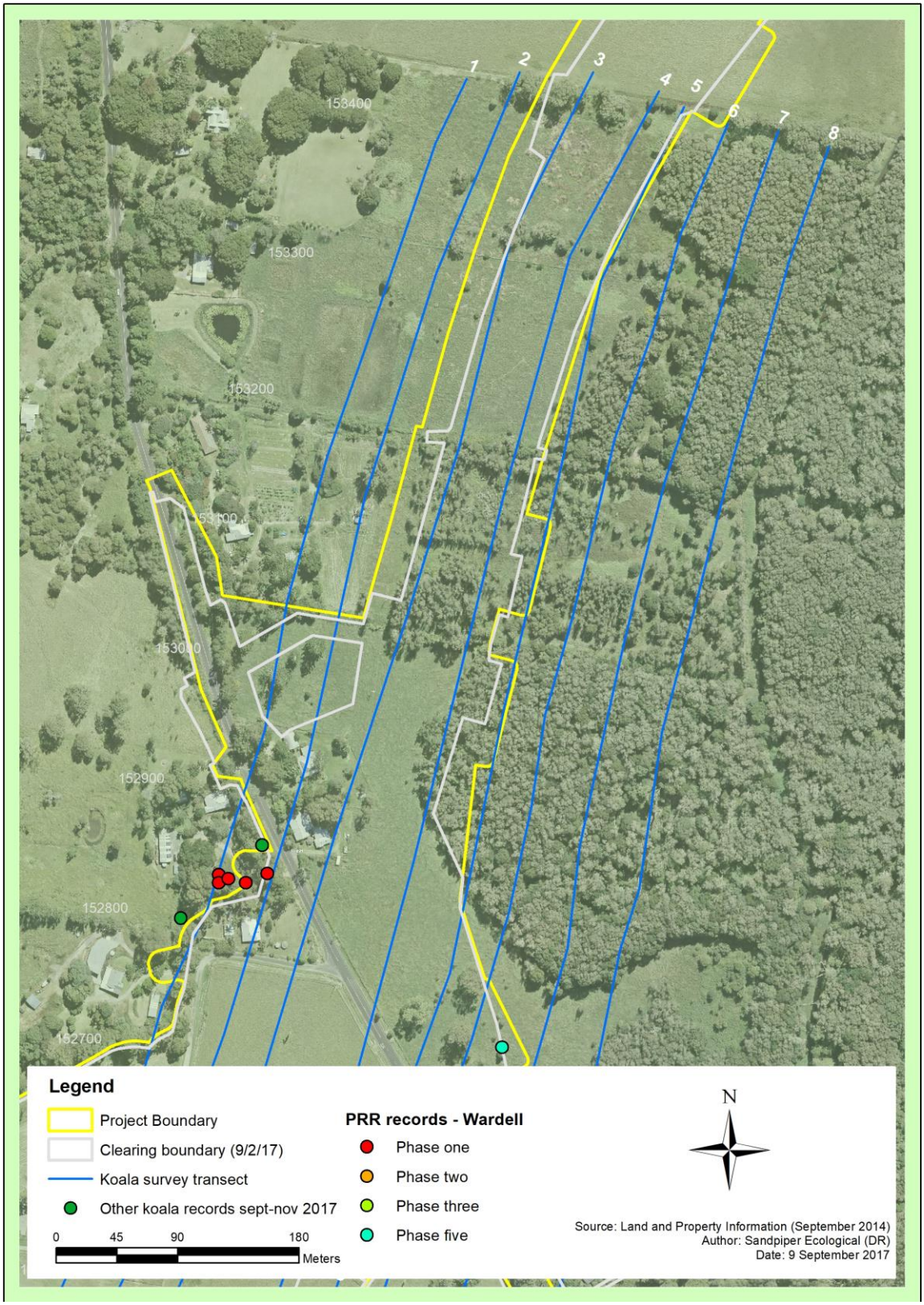

Figure 9: Distribution of koala records for all phases of the PRR program at the Wardell Road hotspot site. Note: no koalas were recorded in phase 4.

5. Discussion

5.1 Clearing

Clearing of the Wardell Road site occurred in two stages. Vegetation southwest of Wardell Road was cleared between 4 and 9 October and vegetation northeast of Wardell Road from 6 to 13 November 2017, with a small area of vegetation trimming occurring on 22 January 2018.

5.2 Koala distribution and occurrence

5.2.1 Individuals removed from the study area

Two koalas, one female and one male, were removed from the Wardell Road study area during the PRR program. The adult female was recorded opportunistically prior to clearing. An initial visual assessment identified external signs of disease and the individual was captured by Sandpiper and FoK and taken into care for a veterinary assessment (M. Mathes pers comm). That individual was subsequently euthanased. A second individual, a young male not recorded during PRR, was captured west of the alignment near chainage 152830 by FoK on 20 December 2017. That individual was euthanased following a veterinary assessment (M. Mathes pers comm). The condition of neither individual was attributable to PRR. The young male had not been recorded in the Wardell Road study area during the PRR program and the adult female displayed outward signs of disease when first observed in Phase 2.

5.2.2 Changes in koala distribution and occurrence

Providing definitive information on koala distribution, abundance and occurrence is challenging as not all individuals could be differentiated and distinguishing sex was at times difficult. Koalas were infrequently recorded in the highway alignment at the Wardell Road hotspot, with 67% of records occurring outside the LoC boundary. Two of the four records inside the alignment occurred immediately prior to clearing and during phase 5, and consisted of female koalas in small (<200mm DBH) forest red gums. All trees used by koalas inside the alignment were situated east of Wardell Road.

No distinct changes in koala distribution were recorded over the sample period with individuals still persisting inside the LoC immediately prior to clearing. Individuals did utilise different trees in phases 4 and 5, with use switching to small (<200mm DBH) ring-barked trees. Small diameter ring-barked trees retained foliage until clearing occurred. The persistence shown by koalas to remain in their home ranges, despite PRR, is likely to be associated with the strong fidelity to feed trees (Whisson *et al.* 2016) and suggests some tolerance to disturbance (Kavanagh *et al.* 2007). Whisson *et al.* (2016) found that koalas moved relatively short distances from their former ranges when faced with a critical food shortage associated with over-browsing. Overlapping home ranges with low levels of overlap in tree use (see Ellis *et al.* 2009) may explain the reluctance of individuals to move away from established territories, particularly in a fragmented landscape.

The small number of known feed trees impacted at Wardell (i.e. six known feed trees and four additional trees with old scats) and the linear nature of clearing for the upgrade means that only some of the feed trees within a home range were affected. Whilst such clearing may still fragment home ranges or remove key feed trees the likelihood that koalas will persist is higher than in cases where clearing is more extensive.

Of the six known feed trees removed two were small saplings (DBH <200mm) that were used only after other feed trees were collared. Monitoring showed limited use of trees inside the alignment and therefore substantial changes in koala distribution were not expected.

One koala, a sick adult female, was recorded in phase 1 only, and the absence of that individual in subsequent phases was not attributed to PRR. The lower abundance of koalas in phase 5 is attributed to removal of one adult female prior to phase 5, the absence of an (unhealthy) adult female recorded in phase 1 only, and restricted access to previously sampled sites properties with known habitat.

Following phase 4, Sandpiper Ecological (2017d) suggested that three koalas constantly utilised the Wardell Road hotspot. Single adult females and males were recorded east (chainage 152600) and west of Wardell Road (chainage 152830). The adult male was suspected of moving between the east and west sides of the road.

5.3 Effect of PRR on koalas at Wardell Road

The principal aim of the PRR program was to reduce stress-induced impacts associated with clearing by encouraging koalas to move from the clearing area into adjacent habitat. Voluntary movement was to be achieved through the staged reduction of food resources. In essence replicating the effects of a severe drought. Collaring trees was an effective way of reducing koala access to trees, however, it did not remove the resource as foliage remained alive and therefore attractive to koalas. In contrast, ring-barking was an effective means of reducing the food resource and more closely resembled drought conditions, albeit occurring at a faster rate than a drought.

Following the success of ring-barking at Laws Point the size of feed trees ring-barked at Wardell Road was increased to include all (feed) trees >100mm DBH. Limitations on ring-barking at Wardell Road (i.e. proximity to the project boundary, infrastructure and tree size) reduced the effectiveness of this technique and did not provide an opportunity to fully assess how broad-scale ring-barking of feed trees would affect koalas.

The PRR program stopped koalas from accessing large feed trees that were collared (Sandpiper Ecological 2018a). Unlike Laws Point, no evidence of repeated visitation to collared feed trees was recorded in those trees monitored at Wardell Road. The absence of repeat visitation to monitored trees suggests they are either used seasonally, or occasionally and emphasises the likely importance of trees outside the alignment.

There is no evidence to suggest that the PRR program simulated a drought effect and forced koalas to leave the Wardell site, with one koala recorded in the alignment (in an un-collared tree) shortly before clearing. It is likely that frequency of visitation and time spent in the alignment was reduced by PRR, resulting in minor changes in habitat use. The effect of the PRR program on koala habitat use was most likely buffered by the removal of an adult female prior to clearing, absence of the sick adult female recorded in phase 1 and only occasional use of most feed trees in the treatment area. Absence of two koalas from an area used by 3-4 individuals would have reduced browsing pressure on remaining trees and therefore stress on koalas. Use of small diameter trees following collaring indicates that PRR affected tree use, however, the effect of such a change on koala stress is unknown. Scat sample size at Wardell Road was insufficient to enable statistical analysis of Feacal Cortisol Metabolites (FCM) across project phases (Hogg *et al.* 2018).

Due to the strong association koalas have with individual trees the impact of PRR will largely depend on the importance of individual trees collared/ring-barked as opposed to the overall number of trees

treated. This effect was obvious at Laws Point where repeat visitation was recorded to a subset of trees monitored (Sandpiper Ecological 2018). Understanding the importance of individual trees to resident koalas would assist in planning and staging tree collaring and ring-barking.

The effectiveness of PRR should be viewed in the context of tree clearing as the impetus for PRR was to reduce the impact of clearing on koalas and particularly the risk of mortality during clearing. Although koalas were still using the PRR site shortly before clearing no individuals occurred inside the clearing area on the day of clearing. Whilst this result cannot be solely attributed to PRR it is likely that PRR reduced the time koalas spent in the LoC and therefore reduced the risk of injury. Nonetheless, best practice pre-clearing surveys provide a high probability of detecting koalas if present, particularly in fragmented habitat such as occurred at Wardell Road.

6. Summary and recommendations

6.1 Summary

Key summary points from the PRR program at Wardell Road include:

1. During the PRR program at Wardell Road 299 trees were collared, including 38 feed trees, 24 feed trees were ring-barked, 20 koala population surveys were conducted, 12 koala records were obtained, and 19 koala scat samples collected.
2. The program was successful in stopping koalas from accessing large trees in the LoC. Small ring-barked feed trees had low rates of dieback and remained accessible up to clearing. At least two of these trees were used by koala.
3. Collaring of feed trees was not a suitable way to change koala habitat use in the short-term.
4. The intent of PRR was to cause a gradual reduction in food availability by progressively collaring trees from the centre of the alignment to the edges. This was not achieved due to the patchy distribution of feed trees, and the strong fidelity to individual trees. Using the methods applied in this study progressive reduction in food availability would be feasible only if feed trees were evenly distributed across the treatment area and individual koalas utilised a subset of these trees evenly. The patchy distribution of feed trees and strong fidelity to individual trees meant that collaring, in some cases, resulted in the immediate loss of an individual koalas foraging habitat inside the treatment area. Greater flexibility in the selection of trees to be collared with reference to koala records obtained in early project phases would have resulted in a more gradual loss of habitat. In the context of habitat loss, the immediate effect of collaring a preferred feed tree is comparable to clearing that tree, albeit without the risk of mortality.
5. Treatment of trees during PRR occurred over a period of five weeks, which is substantially faster than a severe drought.
6. If applied as the primary treatment, ring-barking has merit as a means of changing koala habitat use. For ring-barking to mirror drought conditions it should be applied in such a way as to cause gradual dieback over a period of weeks or months. Progressive ring-barking of individual trees may be a means of achieving such an outcome.
7. Restrictions on ring-barking within 10m of the LoC constrained the ability to fully assess the effectiveness of that technique.
8. The PRR program would have increased energy expenditure and reduced energy intake of those koalas whose preferred feed trees were treated. The effect on koalas at Wardell was most likely influenced by the extent to which koalas utilise trees in the treatment area.
9. Removal of a sick female from the study population and absence of a second sick individual after phase 1 would have buffered the effect of PRR on remaining individuals.
10. There is no evidence that the PRR program affected koalas that did not utilise habitat inside the LoC.

11. Additional baseline data on koala habitat use, health, and sex would have improved the ability to identify impacts as PRR progressed.
12. Nocturnal surveys were slightly more successful in detecting koalas than daytime surveys, although it was often more difficult to sex individuals and assess health at night.
13. PRR should be considered in the context of alternative methods such as, robust pre-clearing surveys, as applied during the W2B project.
14. The combination of koala population surveys and cortisol metabolite concentration analysis provide an effective means of monitoring the effect of PRR on koalas, however, the sample size at Wardell was insufficient for analysis.

6.2 Recommendations

1. Installation of collars on trees as a means of changing habitat use by free-ranging koalas requires careful consideration before it is applied elsewhere. Collaring is effective in excluding koalas from individual trees and, in the context of vegetation removal, may be a feasible means of excluding koalas from specific, isolated, trees or small patches of habitat. However, it does have the potential to cause additional energy expenditure if koalas repeatedly visit collared trees. If applied to a larger area of habitat the collaring schedule should be guided by baseline data on feed tree distribution and koala habitat use and may not be suitable if the subject area is the primary source of feed trees. The final phase of collaring should occur shortly (<2 weeks) before clearing. In the context of phased resource reduction collars are less suitable than ring-barking.
2. In the context of tree clearing, tree collars would be an efficient means of excluding koalas from small areas of habitat, thereby reducing the risk of mortality during clearing, if installed on all trees in the week prior to clearing.
3. Phased Resource Reduction using staged and progressive ring-barking may be a suitable way to change koala habitat use prior to clearing. Ring-barking needs to be comprehensively applied to a treatment site to fully determine its suitability. Staged implementation of ring-barking is recommended, and ring-barking should be applied to achieve gradual dieback over several weeks. This may be achieved by progressively ring-barking trees over a period of time.
4. Treatment (collaring and ring-barking) of trees during PRR should occur over a longer duration (i.e. minimum of 4-6 months) to reduce the effect of immediate habitat loss.
5. Collect additional baseline data on koala health and habitat use prior to implementing PRR. By understanding how koalas utilise the impacted habitat (i.e. which are the preferred feed trees and how are these trees used daily & seasonally) PRR can be applied in a more targeted manner and abrupt loss of important feed trees avoided.
6. A combination of koala population surveys and faecal cortisol metabolite analysis should be used in future PRR to monitor effects on koalas.
7. Collaring and ring-barking trees does not negate the need for robust pre-clearing surveys that include as a minimum pre-dawn spotlighting and post-dawn surveys.

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Appendix A – Field data

Table A1: Primary feed trees with continuous canopy trees at the Wardell Road hotspot.

Feed Tree number	Species	Easting	Northing	Notes
KF1	Forest red gum	542793	6799366	C261; trees are within 10m of LoC
	Forest red gum			C263
	Forest red gum			C264
	Forest red gum			C265
	Forest red gum			C266
	Forest red gum			C267
	Forest red gum			C268
	Forest red gum			C269
	Forest red gum			C252
KF 2	Forest red gum	542830	6799356	C260; nth end
	Broad-leaved paperbark	542820	6799364	C258
KF 4	Forest red gum	542618	6798826	C173; trees have power lines within fall zone
	Swamp mahogany			C169
	Swamp mahogany			C170
	Forest red gum			C174
	Forest red gum			C175
	Fig			C172
	Forest red gum			C171
KF 5	Forest red gum	542625	6798878	C179
	Cabbage palm			C180
KF 8?	Forest red gum	542713	6798640	Two trees east Wardell rd flats.
	Forest red gum			Understorey tree
KF 9?	Forest red gum	542734	6798626	Two trees east Wardell rd flats.
	Forest red gum			Understorey tree
KF10?	Forest red gum	542742	6798535	C156; trees within front yard of 1243 Wardell Road
	Liquid amber			C157

Table A2: Collared trees identified in the Wardell Road study area. Decimals (i.e C6.1) indicate co-dominant stems.

Date	Observer	Tree number	Species	Easting	Northing	DBH (mm)	Circumference (m)	Collar Status
15.5.17	DR & SR	C1	Forest red gum	542712	6798660	1444	4.54	Ring-barked
15.5.17	DR & SR	C6	Forest red gum	542631	6798518	499	1.57	Ring-barked
15.5.17	DR & SR	C6.1				315	0.99	Ring-barked
15.5.17	DR & SR	C6.2				372	1.17	Ring-barked
15.5.17	DR & SR	C6.3				236	0.75	Ring-barked
15.5.17	DR & SR	C9	Broad-leaved paperbark	542492	6798277	963	3.02	Phase 4
15.5.17	DR & SR	C49	Broad-leaved paperbark	542478	6798227	445	1.4	Phase 4
15.5.17	DR & SR	C49.1				256	0.8	Phase 4
15.5.17	DR & SR	C57	Ficus watkinsoni	542360	6798286	1022	3.21	Phase 4
15.5.17	DR & SR	C58	Ficus watkinsoni	542367	6798284	2500	7.85	Phase 4
15.5.17	DR & SR	C59	Ficus watkinsoni	542369	6798291	3700	11.62	Phase 4
15.5.17	DR & SR	C60	Ficus watkinsoni	542363	6798294	3400	10.68	Phase 4
15.5.17	DR & SR	C63	Strangler fig	542416	6798261	3100	9.74	Phase 4
15.5.17	DR & SR	C66	Strangler fig	542317	6798226	1646	5.17	Phase 4
25.5.17	DR & ZE	C82	Swamp mahogany	542280	6798529	600	1.88	Phase 4
25.5.17	DR & ZE	C83	Swamp mahogany	542280	6798529	310	0.86	Phase 4
25.5.17	DR & ZE	C84	Swamp mahogany	542282	6798526	250	0.77	Phase 4
25.5.17	DR & ZE	C85	Swamp mahogany	542286	6798526	433	1.34	Phase 4
25.5.17	DR & ZE	C86	White mahogany	542314	6798529	735	2.31	Phase 4
25.5.17	DR & ZE	C87	Tuckeroo	542325	6798524	485	1.52	Phase 4
25.5.17	DR & ZE	C88	Mango	542326	6798523	310	0.97	Phase 4
25.5.17	DR & ZE	C88.1				370	1.16	Phase 4
25.5.17	DR & ZE	C90	Pink bloodwood	542332	6798546	108	3.4	Phase 4
25.5.17	DR & ZE	C91	Hoop pine	542340	6798553	475	1.5	Phase 4
25.5.17	DR & ZE	C92	Mango	542344	6798555	430	1.35	Phase 4
25.5.17	DR & ZE	C118	Moreton bay fig	542504	6798666	1258	3.96	Phase 4
25.5.17	DR & ZE	C119	Tallowwood	542512	6798693	460	1.44	Phase 4
25.5.17	DR & ZE	C120	Cadagi	542512	6798715	445	1.4	Phase 4
25.5.17	DR & ZE	C122	Grey Ironbark	542489	6798551	1010	3.18	Phase 4
26.5.17	DR & SR	C129.1				280	0.88	Phase 4
26.5.17	DR & SR	C129.2				178	0.56	Phase 4
27.5.17	DR & ZE	C158	Liquid amber	542748	6798513	728	2.28	Phase 4
27.5.17	DR & ZE	C160	Forest red gum	542746	6798535	1043	4.5	Phase 4
27.5.17	DR & ZE	C163	Silky oak	542747	6798548	308	0.97	Phase 4
27.5.17	DR & ZE	C172	Lilly pilly	542619	6798826	485	1.53	Phase 4
27.5.17	DR & ZE	C197	Swamp oak	542722	6798897	317	1	Phase 4
27.5.17	DR & ZE	C198	Broad-leaves paperbark	542725	6798904	330	1.04	Phase 4
27.5.17	DR & ZE	C199	Swamp oak	524726	6798911	355	1.12	Phase 4
27.5.17	DR & ZE	C200	Swamp oak	542725	6798906	295	0.93	Phase 4
27.5.17	DR & ZE	C201	Broad- leaved paperbark	542722	6798910	380	1.2	Phase 4
27.5.17	DR & ZE	C202	Swamp oak	542723	6798919	372	1.16	Phase 4
27.5.17	DR & ZE	C204	Broad-leaved paperbark	542729	6798909	295	0.95	Phase 4
27.5.17	DR & ZE	C205	Swamp oak	542730	6798917	456	1.44	Phase 4

Date	Observer	Tree number	Species	Easting	Northing	DBH (mm)	Circumference (m)	Collar Status
27.5.17	DR & ZE	C206	Broad-leaved paperbark	542734	6798923	345	1.08	Phase 4
27.5.17	DR & ZE	C207	Swamp oak	542726	6798927	340	1.07	Phase 4
27.5.17	DR & ZE	C208	Swamp oak	542729	6798931	343	1.08	Phase 4
27.5.17	DR & ZE	C208.1				390	1.22	Phase 4
27.5.17	DR & ZE	C208.2				399	1.25	Phase 4
27.5.17	DR & ZE	C209	Broad-leaved paperbark	542734	6798931	300	0.95	Phase 4
27.5.17	DR & ZE	C209.1				235	0.74	Phase 4
27.5.17	DR & ZE	C210	Broad-leaves paperbark	542741	6798931	280	0.87	Phase 4
27.5.17	DR & ZE	C211	Swamp oak	542743	6798925	323	1.02	Phase 4
27.5.17	DR & ZE	C212	Broad-leaved Paperbark	542729	6798935	390	1.22	Phase 4
27.5.17	DR & ZE	C212.1				300	0.95	Phase 4
27.5.17	DR & ZE	C212.2				225	0.71	Phase 4
27.5.17	DR & ZE	C214	Broad-leaved paperbark	542730	6798949	250	0.78	Phase 4
27.5.17	DR & ZE	C214.1				148	0.48	Phase 4
27.5.17	DR & ZE	C214.2				180	0.57	Phase 4
27.5.17	DR & ZE	C214.3				340	1.08	Phase 4
27.5.17	DR & ZE	C214.4				144	0.45	Phase 4
27.5.17	DR & ZE	C224	Swamp oak	542707	6798982	321	0.98	Phase 4
27.5.17	DR & ZE	C229	Forest red gum	542715	6798955	388	1.25	Ring-barked
27.5.17	DR & ZE	C230	Forest red gum	542710	6798950	572	1.8	Phase 4
27.5.17	DR & ZE	C236	Swamp oak	542684	6799011	345	1.1	Phase 4
27.5.17	DR & ZE	C236.1				275	0.87	Phase 4
27.5.17	DR & ZE	C243	Sieber's paperbark	542774	6799090	437	1.37	Phase 4
27.5.17	DR & ZE	C244	White bottlebrush	542769	6799089	350	1.1	Phase 4
27.5.17	DR & ZE	C252	Forest red gum	542787	6799354	468	1.47	Phase 4
27.5.17	DR & ZE	C260	Forest red gum	542866	6799360	454	1.43	Ring-barked
27.5.17	DR & ZE	C261	Forest red gum	542793	6799365	571	1.79	Phase 4
27.5.17	DR & ZE	C262	Forest red gum	542805	6799362	549	1.73	Ring-barked
27.5.17	DR & ZE	C263	Forest red gum	542795	6799363	333	1.05	Phase 4
27.5.17	DR & ZE	C264	Forest red gum	542798	6799361	394	1.24	Phase 4
27.5.17	DR & ZE	C265	Forest red gum	542791	6799364	313	0.98	Phase 4
27.5.17	DR & ZE	C266	Forest red gum	542789	6799364	327	1.03	Phase 4
27.5.17	DR & ZE	C267	Forest red gum	542789	6799362	284	0.89	Phase 4
27.5.17	DR & ZE	C268	Forest red gum	542793	6799364	417	1.31	Phase 4
27.5.17	DR & ZE	C269	Forest red gum	542786	6799363	193	0.61	Phase 4
12.7.17	GM & SR	C270	Hoop pine	542537	6798939	725	2.28	Phase 4
12.7.17	GM & SR	C271	Hoop pine	542532	6798931	982	3.08	Phase 4
12.7.17	GM & SR	C277	Broad-leaved paperbark	542543	6798878	382	1.2	Phase 4
12.7.17	GM & SR	C277.1				460	1.4	Phase 4
12.7.17	GM & SR	C277.2				384	1.2	Phase 4
12.7.17	GM & SR	C283	Hoop pine	542577	6798874	896	2.81	Phase 4
12.7.17	GM & SR	C284.1				340	1.07	Phase 4
12.7.17	GM & SR	C284.2				300	0.94	Phase 4
12.7.17	GM & SR	C284.3				430	1.35	Phase 4
19.7.17	BT & ZE	C288	Forest red gum	542574	6798780	350.00	1.10	No collar
19.7.17	BT & ZE	C289	Flooded gum	542574	6798780	350.00	1.10	No collar

Date	Observer	Tree number	Species	Easting	Northing	DBH (mm)	Circumference (m)	Collar Status
19.7.17	BT & ZE	C290	Spotted gum	542579	6798785	345.00	1.10	No collar
19.7.17	BT & ZE	C291	Swamp oak	542579	6798785	291.00	0.90	No collar
19.7.17	BT & ZE	C292	Swamp oak	542567	6798789	295.00	0.94	No collar
19.7.17	BT & ZE	C293	Swamp oak	542569	6798819	338.00	1.05	No collar
19.7.17	BT & ZE	C294	Swamp oak	542561	6798817	415.00	1.31	No collar
19.7.17	BT & ZE	C295	Swamp oak	542556	6798819	373.00	1.17	No collar
19.7.17	BT & ZE	C296	Flooded gum	542556	6798819	450.00	1.41	No collar
19.7.17	BT & ZE	C297	Tipuana tipu	542541	6798819	582.00	1.83	No collar
15.5.17	DR & SR	C4	Camphor Laurel	542744	6798646	545	1.7	Phase 2
15.5.17	DR & SR	C8	Broad-leaved paperbark	542504	6798279	555	1.74	Phase 2
15.5.17	DR & SR	C10	Broad-leaved paperbark	542485	6798270	561	1.76	Phase 2
15.5.17	DR & SR	C11	Tuckeroo	542485	6798268	350	0.95	Phase 2
15.5.17	DR & SR	C12	Broad-leaved paperbark	542500	6798272	314	0.99	Phase 2
15.5.17	DR & SR	C13	Broad-leaved paperbark	542495	6798275	356	1.12	Phase 2
15.5.17	DR & SR	C17	Strangler fig	542484	6798256	480	1.5	Phase 2
15.5.17	DR & SR	C22	Broad-leaved paperbark & strangler fig	524480	6798254	480	1.5	Phase 2
15.5.17	DR & SR	C22.1				450	1.41	Phase 2
15.5.17	DR & SR	C24	Broad-leaved paperbark	542476	6798258	346	1.09	Phase 2
15.5.17	DR & SR	C24.1				262	0.82	Phase 2
15.5.17	DR & SR	C25	Broad-leaved Paperbark	542473	6798260	310	0.97	Phase 2
15.5.17	DR & SR	C26	Broad-leaved paperbark	542476	6798264	403	1.26	Phase 2
15.5.17	DR & SR	C27	Broad-leaved paperbark	542473	6798254	368	1.16	Phase 2
15.5.17	DR & SR	C27.1				282	0.89	Phase 2
15.5.17	DR & SR	C28	Broad-leaves paperbark	542477	6798256	395	1.24	Phase 2
15.5.17	DR & SR	C29	Broad-leaved paperbark	542481	6798249	369	1.16	Phase 2
15.5.17	DR & SR	C30	Broad-leaved paperbark	542476	6798246	550	1.73	Phase 2
15.5.17	DR & SR	C34	Broad-leaved paperbark	542469	6798242	432	1.36	Phase 2
15.5.17	DR & SR	C35	Broad-leaved paperbark	542469	6798240	352	1.11	Phase 2
15.5.17	DR & SR	C36	Broad-leaved paperbark	542470	6798245	301	0.94	Phase 2
15.5.17	DR & SR	C37	Broad-leaved paperbark	542472	6798238	465	1.46	Phase 2
15.5.17	DR & SR	C38	Broad-leaved paperbark	542466	6798242	501	1.56	Phase 2
15.5.17	DR & SR	C39	Broad-leaved paperbark	542469	6798249	580	1.82	Phase 2
15.5.17	DR & SR	C40	Broad-leaved paperbark	542469	6798240	438	1.38	Phase 2
15.5.17	DR & SR	C41	Broad-leaved paperbark	542480	6798237	313	0.99	Phase 2
15.5.17	DR & SR	C43	Broad-leaved paperbark	542470	6798234	313	0.99	Phase 2
15.5.17	DR & SR	C44	Broad-leaved paperbark	542469	6798234	325	1.02	Phase 2
15.5.17	DR & SR	C45	Broad-leaved paperbark	542468	6798232	350	1.1	Phase 2
15.5.17	DR & SR	C46	Broad-leaved paperbark	542465	6798229	632	1.98	Phase 2
15.5.17	DR & SR	C46.1				395	1.24	Phase 2
15.5.17	DR & SR	C47	Broad-leaved paperbark	542472	6798231	462	1.45	Phase 2
15.5.17	DR & SR	C56	White mahogany	542370	6798215	1411	4.43	Phase 2
15.5.17	DR & SR	C61	Wavy pittosporum	542399	6798292	386	1.21	Phase 2
15.5.17	DR & SR	C62	Stag	542403	6798306	474	1.49	Phase 2
15.5.17	DR & SR	C64	Camphor laurel	542423	6798244	540	1.7	Phase 2
15.5.17	DR & SR	C65	Cheese tree	542412	6798247	443	1.39	Phase 2

Date	Observer	Tree number	Species	Easting	Northing	DBH (mm)	Circumference (m)	Collar Status
15.5.17	DR & SR	C67	Tuckeroo	542319	6798234	307	0.97	Phase 2
15.5.17	DR & SR	C68	Unid sp.	542289	6798234	501	1.57	Phase 2
16.5.17	DR & SR	C71	Cypress pine	542347	6798307	818	2.57	Phase 2
16.5.17	DR & SR	C72	Cypress pine	542340	6798314	435	1.37	Phase 2
25.5.17	DR & ZE	C105	Mango	542423	6798501	291	0.92	Phase 2
25.5.17	DR & ZE	C105.1				260	0.81	Phase 2
25.5.17	DR & ZE	C105.2				307	0.98	Phase 2
25.5.17	DR & ZE	C106	Mango	542427	6798507	224	0.69	Phase 2
25.5.17	DR & ZE	C106.1				205	0.68	Phase 2
25.5.17	DR & ZE	C106.2				200	0.63	Phase 2
25.5.17	DR & ZE	C107	Mango	542426	6798513	222	0.7	Phase 2
25.5.17	DR & ZE	C107.1				370	1.17	Phase 2
25.5.17	DR & ZE	C107.2				357	1.12	Phase 2
25.5.17	DR & ZE	C107.3				230	0.71	Phase 2
25.5.17	DR & ZE	C107.4				320	1.01	Phase 2
25.5.17	DR & ZE	C108	Mango	542446	6798502	255	0.8	Phase 2
25.5.17	DR & ZE	C108.1				420	1.32	Phase 2
25.5.17	DR & ZE	C108.2				460	1.45	Phase 2
25.5.17	DR & ZE	C108.3				207	0.65	Phase 2
25.5.17	DR & ZE	C109	Mango	542474	6798500	275	0.87	Phase 2
25.5.17	DR & ZE	C109.1				264	0.82	Phase 2
25.5.17	DR & ZE	C109.2				267	0.82	Phase 2
25.5.17	DR & ZE	C109.3				208	0.65	Phase 2
25.5.17	DR & ZE	C109.4				232	0.73	Phase 2
25.5.17	DR & ZE	C109.5				230	0.72	Phase 2
25.5.17	DR & ZE	C109.6				365	1.14	Phase 2
25.5.17	DR & ZE	C110	Mango	542474	6798511	387	1.22	Phase 2
25.5.17	DR & ZE	C110.1				315	0.99	Phase 2
25.5.17	DR & ZE	C111	Grey Ironbark	542482	6798510	1015	3.18	Phase 2
25.5.17	DR & ZE	C112	Mango	542478	6798543	440	1.38	Phase 2
25.5.17	DR & ZE	C113	Mango	542481	6798554	380	1.2	Phase 2
25.5.17	DR & ZE	C115	Mango	542484	6798571	288	0.9	Phase 2
25.5.17	DR & ZE	C115.1				217	0.68	Phase 2
25.5.17	DR & ZE	C115.2				195	0.62	Phase 2
25.5.17	DR & ZE	C115.3				246	0.78	Phase 2
26.5.17	DR & SR	C123	Grey Ironbark	542497	6798519	788	2.47	Phase 2
26.5.17	DR & SR	C124	Forest oak	542499	6798515	420	1.32	Phase 2
26.5.17	DR & SR	C125	White mahogany	542498	6798518	425	1.34	Phase 2
26.5.17	DR & SR	C125.1				428	1.34	Phase 2
26.5.17	DR & SR	C126	White mahogany	542498	6798531	679	2.13	Phase 2
26.5.17	DR & SR	C127	Camphor Laurel	542508	6798555	305	0.96	Phase 2
26.5.17	DR & SR	C127.1				230	0.72	Phase 2
26.5.17	DR & SR	C127.2				190	0.6	Phase 2
26.5.17	DR & SR	C128	Cupaniopsis spp	542511	6798544	399	1.25	Phase 2
26.5.17	DR & SR	C129	Camphor Laurel	542514	6798544	335	1.06	Phase 2
26.5.17	DR & SR	C130	White mahogany	542521	6798537	381	1.2	Phase 2

Date	Observer	Tree number	Species	Easting	Northing	DBH (mm)	Circumference (m)	Collar Status
26.5.17	DR & SR	C131	Pink bloodwood	542513	6798523	620	1.94	Phase 2
26.5.17	DR & SR	C131.1				354	1.11	Phase 2
26.5.17	DR & SR	C131.2				283	0.89	Phase 2
26.5.17	DR & SR	C132	White mahogany	542513	6798515	685	2.15	Phase 2
26.5.17	DR & SR	C133	White mahogany	542514	6798510	634	2	Phase 2
26.5.17	DR & SR	C134	White bottlebrush	542523	6798506	576	1.81	Phase 2
26.5.17	DR & SR	C135	Broad-leaved paperbark	542531	6798517	700	2.16	Phase 2
26.5.17	DR & SR	C136	Broad-leaved paperbark	542537	6798519	420	1.32	Phase 2
26.5.17	DR & SR	C137	Pink bloodwood	542526	6798530	489	1.54	Phase 2
26.5.17	DR & SR	C138	Broad-leaved paperbark	542537	6798525	392	1.23	Phase 2
26.5.17	DR & SR	C139	Broad-leaved paperbark	542539	6798524	490	1.54	Phase 2
		C139.1				328	1.03	Phase 2
26.5.17	DR & SR	C140	Broad-leaved paperbark	542542	6798524	387	1.22	Phase 2
26.5.17	DR & SR	C141	Broad-leaved paperbark	542542	6798517	353	1.11	Phase 2
26.5.17	DR & SR	C142	Broad-leaved paperbark	542538	6798519	233	0.74	Phase 2
26.5.17	DR & SR	C143	Broad-leaved paperbark	542538	6798519	243	0.77	Phase 2
26.5.17	DR & SR	C144	Broad-leaved paperbark	542545	6798514	330	1.04	Phase 2
26.5.17	DR & SR	C145	Broad-leaved paperbark	542539	6798515	430	1.35	Phase 2
26.5.17	DR & SR	C146	Broad-leaved paperbark	542541	6798520	310	0.98	Phase 2
26.5.17	DR & SR	C147	Broad-leaved paperbark	542542	6798524	290	0.92	Phase 2
26.5.17	DR & SR	C148	Broad-leaved paperbark	542542	679853	238	0.75	Phase 2
26.5.17	DR & SR	C149	Broad-leaved paperbark	542541	6798525	302	0.95	Phase 2
26.5.17	DR & SR	C150	Broad-leaved paperbark	542549	6798524	320	1.01	Phase 2
26.5.17	DR & SR	C151	Broad-leaved paperbark	542549	6798522	435	1.37	Phase 2
26.5.17	DR & SR	C152	Broad-leaved paperbark	542549	6798523	330	1.04	Phase 2
26.5.17	DR & SR	C153	Broad-leaved paperbark	542551	6798521	257	0.81	Phase 2
26.5.17	DR & SR	C154	Broad-leaved paperbark	542555	6798523	484	1.52	Phase 2
26.5.17	DR & SR	C155	Pink bloodwood	542566	6798526	423	1.33	Phase 2
27.5.17	DR & ZE	C167	Forest red gum	542642	6798824	430	1.36	Phase 2
27.5.17	DR & ZE	C168	Forest red gum	542644	6798833	367	1.16	Phase 2
27.5.17	DR & ZE	C169	Swamp mahogany	542622	6798822	287	0.91	Phase 2
27.5.17	DR & ZE	C170	Swamp mahogany	542626	6798827	340	1.07	Phase 2
27.5.17	DR & ZE	C174	Forest red gum	542624	6798827	723	2.27	Phase 2
27.5.17	DR & ZE	C179	Forest red gum	542625	6798878	465	1.46	Phase 2
27.5.17	DR & ZE	C180	Cabbage palm	542622	6798880	315	0.99	Phase 2
27.5.17	DR & ZE	C217	Swamp oak	542682	6798954	299	0.95	Phase 2
27.5.17	DR & ZE	C218	Swamp oak	542675	6798953	344	1.09	Phase 2
27.5.17	DR & ZE	C219	Swamp oak	542673	6798958	274	0.86	Phase 2
27.5.17	DR & ZE	C220	Swamp oak	542673	6798958	375	1.18	Phase 2
27.5.17	DR & ZE	C225	Swamp oak	542715	6798984	350	1.1	Phase 2
27.5.17	DR & ZE	C226	Swamp oak	542721	6798982	300	0.95	Phase 2
27.5.17	DR & ZE	C235	Swamp oak	542700	6799008	290	0.91	Phase 2
27.5.17	DR & ZE	C239	Swamp oak	542740	6799082	355	1.11	Phase 2
27.5.17	DR & ZE	C240	Swamp oak	542740	6799084	345	1.09	Phase 2
27.5.17	DR & ZE	C241	Swamp oak	542739	6799086	284	0.89	Phase 2
27.5.17	DR & ZE	C242	Black wattle	542728	6799087	294	0.92	Phase 2

Date	Observer	Tree number	Species	Easting	Northing	DBH (mm)	Circumference (m)	Collar Status
27.5.17	DR & ZE	C247	Broad-leaved paperbark	542748	6799250	295	0.92	Phase 2
27.5.17	DR & ZE	C247.1				200	0.63	Phase 2
27.5.17	DR & ZE	C249	Broad-leaved paperbark	542778	6799260	978	3.06	Phase 2
27.5.17	DR & ZE	C250	Broad-leaved paperbark	542775	6799256	770	2.42	Phase 2
27.5.17	DR & ZE	C251	Broad-leaved paperbark	542754	6799252	1097	3.45	Phase 2
27.5.17	DR & ZE	C253	Broad-leaved paperbark	542827	6799346	430	1.35	Phase 2
27.5.17	DR & ZE	C253.1				345	1.09	Phase 2
27.5.17	DR & ZE	C253.2				362	1.14	Phase 2
27.5.17	DR & ZE	C254	Broad-leaved paperbark	542826	6799348	400	1.25	Phase 2
27.5.17	DR & ZE	C254.1				300	0.93	Phase 2
27.5.17	DR & ZE	C255	Broad-leaved paperbark	542825	6799342	310	0.98	Phase 2
27.5.17	DR & ZE	C255.1				450	1.4	Phase 2
27.5.17	DR & ZE	C255.2				435	1.36	Phase 2
27.5.17	DR & ZE	C256	Broad-leaved paperbark	542827	6799348	302	0.95	Phase 2
27.5.17	DR & ZE	C257	Black wattle	542827	6799340	270	0.85	Phase 2
27.5.17	DR & ZE	C258	Broad-leaved paperbark	542826	6799353	680	2.14	Phase 2
27.5.17	DR & ZE	C259	Broad-leaved paperbark	542833	6799349	780	2.46	Phase 2
12.7.17	GM & SR	C284	Ficus sp.	542586	6798863	327	1.03	Phase 2
18.7.17	BT & ZE	Add	Stag	NR	NR	NR	NR	Phase 2
18.7.17	BT & ZE	Add	Stag	NR	NR	NR	NR	Phase 2
15.5.17	DR & SR	C5	Forest red gum	542667	6798544	795	2.49	Phase 3
15.5.17	DR & SR	C5.1				477	1.5	Phase 3
15.5.17	DR & SR	C5.2				448	1.4	Phase 3
15.5.17	DR & SR	C5.3				385	1.21	Phase 3
15.5.17	DR & SR	C7	Grey Ironbark	542560	6798376	1100	3.45	Phase 3
15.5.17	DR & SR	C14	Pink bloodwood	542500	6798263	428	1.35	Phase 3
15.5.17	DR & SR	C15	Broad-leaved paperbark & strangler fig	542501	6798252	495	1.55	Phase 3
15.5.17	DR & SR	C16	Broad-leaved paperbark	542484	6798262	300	0.94	Phase 3
15.5.17	DR & SR	C16.1				305	0.97	Phase 3
15.5.17	DR & SR	C16.2				398	1.25	Phase 3
15.5.17	DR & SR	C16.3				248	0.78	Phase 3
15.5.17	DR & SR	C16.4				219	0.69	Phase 3
15.5.17	DR & SR	C16.5				178	0.56	Phase 3
15.5.17	DR & SR	C18	Strangler fig	542485	6798258	290	0.9	Phase 3
15.5.17	DR & SR	C19	Strangler fig	542485	6798258	449	1.41	Phase 3
15.5.17	DR & SR	C20	Swamp box	542493	6798250	360	1.12	Phase 3
15.5.17	DR & SR	C21	Broad-leaved paperbark	542484	6798245	575	1.8	Phase 3
15.5.17	DR & SR	C23	Broad-leaved paperbark	542469	6798255	560	1.76	Phase 3
15.5.17	DR & SR	C31	Broad-leaved paperbark	542481	6798239	373	1.17	Phase 3
15.5.17	DR & SR	C32	Broad-leaved paperbark	542481	6798235	374	1.18	Phase 3
15.5.17	DR & SR	C33	Broad-leaved paperbark	542481	6798234	301	0.95	Phase 3
15.5.17	DR & SR	C42	Broad-leaved paperbark	542481	6798233	339	1.07	Phase 3
15.5.17	DR & SR	C48	Broad-leaved paperbark	542481	6798227	466	1.46	Phase 3
15.5.17	DR & SR	C50	Ficus spp	542477	6798223	575	1.8	Phase 3
15.5.17	DR & SR	C51	Swamp box	542473	6798214	385	1.21	Phase 3

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15.5.17	DR & SR	C52	Swamp box	542474	6798217	322	1.01	Phase 3
15.5.17	DR & SR	C53	Swamp box	542468	6798210	427	1.35	Phase 3
15.5.17	DR & SR	C54	Broad-leaved paperbark	542433	6798187	797	2.5	Phase 3
15.5.17	DR & SR	C55	Broad-leaved paperbark	542434	6798185	627	1.97	Phase 3
15.5.17	DR & SR	C69	Camphor Laurel	542264	6798274	384	1.2	Phase 3
15.5.17	DR & SR	C70	Camphor Laurel	542272	6798279	1012	3.18	Phase 3
16.5.17	DR & SR	C73	Cypress pine	542335	6798310	550	1.73	Phase 3
16.5.17	DR & SR	C73.1				365	1.15	Phase 3
16.5.17	DR & SR	C74	Mango	542340	6798321	370	1.17	Phase 3
16.5.17	DR & SR	C75	Grey Ironbark	542330	6798404	714	2.24	Phase 3
16.5.17	DR & SR	C76	Camphor Laurel	542286	6798414	550	1.73	Phase 3
16.5.17	DR & SR	C77	Camphor Laurel	542275	6798417	389	1.22	Phase 3
16.5.17	DR & SR	C77.1				381	1.2	Phase 3
16.5.17	DR & SR	C78	Camphor Laurel	542277	6798417	500	1.57	Phase 3
16.5.17	DR & SR	C78.1				562	1.76	Phase 3
16.5.17	DR & SR	C79	Camphor Laurel	542274	6798417	499	1.57	Phase 3
16.5.17	DR & SR	C80	Camphor Laurel	542267	6798394	515	1.62	Phase 3
16.5.17	DR & SR	C80.1				460	1.44	Phase 3
16.5.17	DR & SR	C80.2				675	2.12	Phase 3
16.5.17	DR & SR	C80.3				673	2.11	Phase 3
16.5.17	DR & SR	C81	Tuckeroo	542239	6798379	418	1.31	Phase 3
25.5.17	DR & ZE	C89	Mango	542332	6798521	335	1.06	Phase 3
25.5.17	DR & ZE	C93	Eucalyptus spp	542362	6798517	355	1.12	Phase 3
25.5.17	DR & ZE	C94	White Mahogany	542374	6798511	945	2.97	Phase 3
25.5.17	DR & ZE	C95	White mahogany	542378	6798510	443	1.39	Phase 3
25.5.17	DR & ZE	C96	Broad-leaved paperbark	542376	6798558	320	1.02	Phase 3
25.5.17	DR & ZE	C97	Broad-leaved paperbark	542382	6798556	380	1.2	Phase 3
25.5.17	DR & ZE	C98	African tulip	542409	6798559	380	1.19	Phase 3
25.5.17	DR & ZE	C99	Blackbutt	542393	6798541	517	1.65	Phase 3
25.5.17	DR & ZE	C100	Mango	542401	6798514	728	2.29	Phase 3
25.5.17	DR & ZE	C101	Mango	542410	6798506	400	1.26	Phase 3
25.5.17	DR & ZE	C101.1				271	0.85	Phase 3
25.5.17	DR & ZE	C102	Mango	542416	6798508	516	1.62	Phase 3
25.5.17	DR & ZE	C103	Mango	542419	6798507	477	1.5	Phase 3
25.5.17	DR & ZE	C104	Mango	542419	6798503	510	1.6	Phase 3
25.5.17	DR & ZE	C114	Swamp mahogany	542461	6798563	525	1.64	Phase 3
25.5.17	DR & ZE	C116	Tallowwood	542494	6798602	550	1.73	Phase 3
25.5.17	DR & ZE	C117	Tallowwood	542505	6798654	560	1.76	Phase 3
25.5.17	DR & ZE	C121	Forest red gum	542490	6798567	754	2.36	Phase 3
27.5.17	DR & ZE	C156	Forest red gum	542756	6798494	285	0.9	Phase 3
27.5.17	DR & ZE	C156.1				280	0.87	Phase 3
27.5.17	DR & ZE	C156.2				225	0.72	Phase 3
27.5.17	DR & ZE	C157	Liquid amber	542744	6798511	166	0.54	Phase 3
27.5.17	DR & ZE	C157.1				185	0.59	Phase 3
27.5.17	DR & ZE	C159	Forest red gum	542738	6798521	242	0.76	Phase 3
27.5.17	DR & ZE	C159.1				180	0.57	Phase 3

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27.5.17	DR & ZE	C161	Forest red gum	542731	6798533	245	0.76	Phase 3
27.5.17	DR & ZE	C162	Blueberry ash	542731	6798535	231	0.73	Phase 3
27.5.17	DR & ZE	C164	Forest red gum	542652	6798673	208	0.66	Phase 3
27.5.17	DR & ZE	C164.1				203	0.63	Phase 3
27.5.17	DR & ZE	C165	Forest red gum	542660	6798659	160	0.51	Phase 3
27.5.17	DR & ZE	C166	Forest red gum	542662	6798659	136	0.43	Phase 3
27.5.17	DR & ZE	C171	Forest red gum	542612	6798830	795	2.5	Phase 3
27.5.17	DR & ZE	C173	Forest red gum	542618	6798826	720	2.26	Phase 3
27.5.17	DR & ZE	C175	Forest red gum	542611	6798835	408	1.28	Phase 3
27.5.17	DR & ZE	C176	Forest red gum	542607	6798844	530	1.67	Phase 3
27.5.17	DR & ZE	C177	Hoop pine	542605	6798862	900	2.82	Phase 3
27.5.17	DR & ZE	C178	Forest red gum	542619	6798847	560	1.76	Phase 3
27.5.17	DR & ZE	C181	Broad-leaved paperbark	542692	6798832	290	0.91	Phase 3
27.5.17	DR & ZE	C181.1				345	1.09	Phase 3
27.5.17	DR & ZE	C182	Broad-leaved paperbark	542687	6798842	497	1.55	Phase 3
27.5.17	DR & ZE	C183	Broad-leaved paperbark	542688	6798842	185	0.59	Phase 3
27.5.17	DR & ZE	C183.1				220	0.7	Phase 3
27.5.17	DR & ZE	C183.2				204	0.64	Phase 3
27.5.17	DR & ZE	C184	Broad-leaved paperbark	542692	6798841	233	0.7	Phase 3
27.5.17	DR & ZE	C184.1				297	0.93	Phase 3
27.5.17	DR & ZE	C184.2				277	0.87	Phase 3
27.5.17	DR & ZE	C185	Swamp oak	542695	6798840	230	0.72	Phase 3
27.5.17	DR & ZE	C185.1				274	0.87	Phase 3
27.5.17	DR & ZE	C185.2				370	1.16	Phase 3
27.5.17	DR & ZE	C186	Swamp oak	542690	6798841	394	1.24	Phase 3
27.5.17	DR & ZE	C187	Swamp oak	542690	6798850	335	1.04	Phase 3
27.5.17	DR & ZE	C188	Swamp oak	542692	6798867	352	1.1	Phase 3
27.5.17	DR & ZE	C189	Swamp oak	542699	6798870	565	1.78	Phase 3
27.5.17	DR & ZE	C190	Swamp oak	542698	6798881	413	1.3	Phase 3
27.5.17	DR & ZE	C191	Swamp oak	542704	6798878	510	1.6	Phase 3
27.5.17	DR & ZE	C192	Broad-leaved paperbark	542698	6798884	390	1.23	Phase 3
27.5.17	DR & ZE	C193	Broad-leaved paperbark	542705	6798895	340	1.23	Phase 3
27.5.17	DR & ZE	C193.1				170	0.55	Phase 3
27.5.17	DR & ZE	C193.2				189	0.59	Phase 3
27.5.17	DR & ZE	C194	Broad-leaved paperbark	542706	6798891	330	1.04	Phase 3
27.5.17	DR & ZE	C195	Broad-leaved paperbark	542709	6798896	518	1.63	Phase 3
27.5.17	DR & ZE	C195.1				408	1.28	Phase 3
27.5.17	DR & ZE	C196	Broad-leaved paperbark	542706	6798901	510	1.6	Phase 3
27.5.17	DR & ZE	C203	Swamp oak	542715	6798923	397	1.25	Phase 3
27.5.17	DR & ZE	C213	Broad-leaved paperbark	542731	6798937	380	1.2	Phase 3
27.5.17	DR & ZE	C213.1				330	1.04	Phase 3
27.5.17	DR & ZE	C215	Swamp oak	542703	6798949	170	0.54	Phase 3
27.5.17	DR & ZE	C215.1				340	1.06	Phase 3
27.5.17	DR & ZE	C215.2				263	0.83	Phase 3
27.5.17	DR & ZE	C215.3				210	0.67	Phase 3
27.5.17	DR & ZE	C216	Hoop pine	542703	6798952	320	1	Phase 3

Date	Observer	Tree number	Species	Easting	Northing	DBH (mm)	Circumference (m)	Collar Status
27.5.17	DR & ZE	C221	Swamp oak	542670	6798957	338	1.07	Phase 3
27.5.17	DR & ZE	C222	Swamp oak	542666	6798958	334	1.05	Phase 3
27.5.17	DR & ZE	C223	Swamp oak	542666	6798960	300	0.94	Phase 3
27.5.17	DR & ZE	C227	Swamp oak	542721	6798979	350	1.1	Phase 3
27.5.17	DR & ZE	C227.1				228	0.72	Phase 3
27.5.17	DR & ZE	C227.2				250	0.79	Phase 3
27.5.17	DR & ZE	C228	Swamp oak	542726	6798977	350	1.09	Phase 3
27.5.17	DR & ZE	C231	Swamp oak	542741	6798979	414	1.3	Phase 3
27.5.17	DR & ZE	C232	Swamp oak	542737	6798984	317	1	Phase 3
27.5.17	DR & ZE	C233	Swamp oak	542720	6799003	297	0.93	Phase 3
27.5.17	DR & ZE	C233.1				260	0.81	Phase 3
27.5.17	DR & ZE	C234	Swamp oak	542717	6799001	307	0.96	Phase 3
27.5.17	DR & ZE	C234.1				224	0.7	Phase 3
27.5.17	DR & ZE	C237	Black wattle	542749	6799072	542	1.7	Phase 3
27.5.17	DR & ZE	C238	Swamp oak	542740	6799083	354	1.11	Phase 3
27.5.17	DR & ZE	C245	Camphor Laurel	542792	6799244	480	1.51	Phase 3
27.5.17	DR & ZE	C246	Broad-leaved paperbark	542790	6799248	312	0.98	Phase 3
27.5.17	DR & ZE	C248	Broad-leaved paperbark	542780	6799255	645	2.03	Phase 3
27.5.17	DR & ZE	C248.1				485	1.51	Phase 3
12.7.17	GM & SR	C272	Hoop pine	542578	6798959	922	2.9	Phase 3
12.7.17	GM & SR	C273	Hoop pine	542580	6798927	1045	3.28	Phase 3
12.7.17	GM & SR	C274	Hoop pine	542595	6798926	530	1.66	Phase 3
12.7.17	GM & SR	C274.1				295	0.94	Phase 3
12.7.17	GM & SR	C275	Hoop pine	542605	6798959	907	2.85	Phase 3
12.7.17	GM & SR	C276	Blackbutt	542564	6798890	694	2.18	Phase 3
12.7.17	GM & SR	C278	Tallowwood	542555	6798882	595	1.87	Phase 3
12.7.17	GM & SR	C279	Hoop pine	542559	6798873	703	2.21	Phase 3
12.7.17	GM & SR	C280	Hoop pine	542568	6798868	490	1.94	Phase 3
12.7.17	GM & SR	C280.1				410	1.28	Phase 3
12.7.17	GM & SR	C280.2				552	1.74	Phase 3
12.7.17	GM & SR	C281	Lemon-scented gum	542573	6798859	630	1.98	Phase 3
12.7.17	GM & SR	C282	M. quinquenervia	542571	6798841	485	1.52	Phase 3
12.7.17	GM & SR	C282.1				188	0.6	Phase 3
19.7.17	BT & ZE	C285	Hoop pine	542588	6798775	530.00	1.65	Phase 3
19.7.17	BT & ZE	C285.1	Hoop pine			615.00	1.94	Phase 3
19.7.17	BT & ZE	C286	Hoop pine	542584	6798787	700.00	2.20	Phase 3
19.7.17	BT & ZE	C287	Hoop Pine	542584	6798787	465.00	1.46	Phase 3
2.8.17	DR & ZE	C288	Forest red gum	542588	6798836	260	NR	Phase 3
2.8.17	DR & ZE	C288.1				315	NR	Phase 3
1.8.17	DR & ZE	Add	Palm			80	NR	Phase 3
1.8.17	DR & ZE	Add	Palm			100	NR	Phase 3
1.8.17	DR & ZE	Add	Palm			85	NR	Phase 3
2.8.17	DR & ZE	Add				100	NR	Phase 3

Table A3: Habitat trees identified in the Wardell Road study area. s = small (10-50mm); m = medium (51-150mm); l = large (151-300mm); vl = very large (>300mm).

Tree no.	Tree Species	Easting	Northing	DBH (m)	Circumf (m)	Branch	Trunk	Spout	Collar status
H1	Cypress pine	542342	6798306	0.66	2.09		1m		Phase 3
H2	White mahogany	542306	6798537	1.26	3.95	1m, 1s	1l		Phase 4
H3	White mahogany	542337	6798519	0.79	2.48		1m		Phase 3
H4	White mahogany	542495	6798537	1.07	3.37	1s, 4m	2s, 2m		Phase 2
H5	White mahogany	542509	6798546	0.42	1.31	1s	2s		Phase 4
H6	Forest red gum	542677	6798675	1.00	3.14	1s	1term		Phase 4
H7	Forest Red Gum	542714	6798662	1.30	4.08	2s, 2m			Phase 4

Table A4: Data collected from 30 trees ring-barked during phase 2 and phase 4 of the PRR program at Wardell Road. Trees were sampled on 6/9/17, 54 days after being ring-barked. BS = bark & sapwood; BO = bark only.

Tree sp.	Number	Easting	Northing	DBH	Ring bark extent	Proportion canopy dead %	Comments
Forest red gum	C261	542793	6799365	565	BS	90	
Forest red gum	C262	542805	6799362	542	BS	95-100	
Forest red gum	C263	542795	6799363	330	BS	90	
Forest red gum	C264	542798	6799361	392	BS	90	
Forest red gum	C229	542726	6798955	375	BS	95-100	
Forest red gum	C230	542719	6798955	588	BS	0-5	
Forest red gum	H7	542716	6798664	1300	BS	100	
Forest red gum	NA	542724	6798652	228	BS	15	
Forest red gum	NA	542724	6798652	153	BS	15	
Forest red gum	NA	542704	6798624	223	BS	15	
Swamp oak	NA	542706	6799027	137	BO/BS	0	
Swamp oak	NA	542709	6799028	193	BS	0	
Swamp oak	NA	542732	6799030	165	BS	0	
Swamp oak	NA	542730	6799002	235	BO	0	
Swamp oak	NA	542696	6798980	181	BS	0	
Swamp oak	NA	542700	6798983	230	BS	0	
Swamp oak	NA	542724	6798959	182	BO	0	
Swamp oak	NA	542722	6798933	219	BS	0	
Swamp oak	NA	542726	6798881	135	BO	0	
Swamp oak	NA	542691	6798889	141	BO	0	
Broad-leaved paperbark	NA 1.1	542717	6798946	215	BS	70	Codominant
	1.2			173	BS	95-100	
	1.3			213	BS	95-100	
Broad-leaved paperbark	NA 2.1	542718	6798903	165	BS	95-100	Codominant
	2.2			225	BS	5-10	
Broad-leaved paperbark	NA	542733	6798916	183	BS	90	
Broad-leaved paperbark	NA	542733	6798916	205	BS	90	
Broad-leaved paperbark	NA	542728	6798900	235	BS	95-100	
Broad-leaved paperbark	NA	542732	6798892	196	BS	95-100	
Broad-leaved paperbark	NA	542732	6798892	155	BS	95-100	
Broad-leaved paperbark	NA	542715	6798902	231	BS	95-100	
Broad-leaved paperbark	NA 3.1	542457	6798578	194	BS	100	Codominant
	NA 3.2			215	BS	100	
Broad-leaved paperbark	NA	542536	6798529	153	BS	100	

Table A5: Video footage recorded from cameras installed at six collared feed trees at the Wardell Road hotspot.

Download date	Tree no	Date	Time	Species	Confidence	Movement description	Record No.
25/08/17	C173	10/08/17	1838	Cat	D	PB	31
25/08/17	C173	10/08/17	2225	Dog	D	PB	34
25/08/17	C173	12/08/17	0422	Cat	D	PB	47
25/08/17	C173	16/08/17	0424	Cat	D	PB	52
25/08/17	C173	19/08/17	0437	Cat	D	PB	253
25/08/17	C173	20/08/17	0001	Cat	D	PB	293
25/08/17	C169	10/08/17	2216	Dog	D	PB	9
25/08/17	C169	10/08/17	2222	Dog	D	PF	10
25/08/17	C174	16/08/17	0423	Cat	D	PB	75
6/09/17	C168	29/08/17	0436	Cat	D	PB	45
6/09/17	C168	29/08/17	2052	Dog x 2	D	PB	47
6/09/17	C174	29/08/17	0434	Cat	D	PB	61
6/09/17	C174	29/08/17	2050	Dog	D	PB	71
9/10/17	C174	14/09/17	2113	Fox	D	PB	254
9/10/17	C174	15/09/17	1822	Cow	D	PB	293
9/10/17	C174	17/09/17	2029	Dog	D	PB	350
9/10/17	C174	17/09/17	2102	Dog	Pr	PF	352
9/10/17	C174	18/09/17	0947	Pheasant coucal	D	PF	361
9/10/17	C174	21/09/17	0426	Koala	D (F Pr)	Climbing down small tree beside Swamp mahogany	389
10/10/17	C173	7/09/17	2254	Cow	D	PB	24
10/10/17	C173	14/09/17	2310	Cow	D	PB	199
10/10/17	C173	15/09/17	2136	Cow	D	PB	213
10/10/17	C173	17/09/17	2031	Dog	D	PB	316
10/10/17	C173	17/09/17	2105	Cow	D	PB	317
10/10/17	C169	14/09/17	0337	Cat	D	PB	330
10/10/17	C169	14/09/17	2309	Cow	D	PF	381

Table 5 Key	
TCR	Touches Collar Retreats
AT	Approaches Tree
PB	Pass in Background
PF	Pass in Foreground
Po	Possible (50-75% certainty)
Pr	Probable (75-90% certainty)
D	Definite (90%+ certainty)

Table A6: Health of koalas recorded at Wardell Road during the PRR program.

Date	Record No.	Easting	Northing	Tree sp.	DBH	Health
30/5/2017	WK1	542533	6798776	Forest red gum	600	Dry, stained
5/6/2017	WK2	542533	6798776	Forest red gum	600	stained
6/6/2017	WK2.1	542533	6798770	Forest red gum	310	Wet, stained
6/6/2017	WK3	542569	6798777	Forest red gum	300	Wet, stained
3/7/17	WK4	542553	6798770	Narrow-leaved red gum	600	View obscured, bum stained
4/7/17	WK4.1	542540	6798773	Forest red gum	400	View obscured, some bum stain
26/7/17	WK5	542763	6798531	Forest red gum	1400	Dirty bum
27/7/17	WK5.1	542747	6798494	Flooded gum	750	Dirty bum
9/8/17	WK6	542803	6798541	Forest red gum	600	Dirty bum
2/11/17	WK7	542743	6798648	Forest red gum	150	Wet & dirty bottom
15/11/17	WK8	542785	6798603	Broad-leaved paperbark	600	Wet & dirty bottom
22/11/17	WK9	542831	6798520	Swamp Mahogany	300	Wet & dirty bum, clear eyes

Table A7: Weather conditions during Phase 2 koala population surveys at the Wardell Road hotspot. N = night; D = day; Mlb = moves large branch; Msb = moves small branch.

Date	Survey No.	Observers (T'sects)	Start	End	Temp Range	Cloud %	Wind	Rain	Moon	Comments
30/5/2017	1-N	BT,NP, SR	1730	2056	14-17	10	Nil	Fine	1/4	Fine
31/5/2017	1-D	NP, SR, MJ	1202	1530	16-19	nil	Mlb	fine	1/4	fine
5/6/2017	2-N	BT, GM, SR	1722	2059	12-16	15	Msb	Fine, cool	2/4	Fine, cool
6/6/2017	2-D	BT, GM, DR	0927	1308	17-20	10	Msb	Fine	2/4	Fine
19/6/2017	3N	NP, ZE, MJ	1730	2030	Abandoned, paddock flooded			Showers		
3/7/17	3N	NP, GM, SR	1725	2115	17-19	10-80	MLB	Fine, LS	2/4	Fine, then light shower, warm
4/7/17	3D	GM, SR, ZE	945	1330	21-22	0	Nil	Fine	N/A	Fine
26/7/17	4N	BT MJ SJ	1730	2055	14-17	0	Msb	Fine	2/4	
27/7/17	4D	BT MJ SJ	941	1248	28-20	0	Msb	Fine	2/4	
9/8/17	5N	NP, GM, ZE	1800	2139	7-14	0	Msb	Fine	4/4	
10/8/17	5D	NP, GM, ZE	900	1245	1-12	0	Nil	Fine	0	
23/8/17	6N	DR, MJ, SR	1800	2200	21-19	0	MSBsw	Fine		Fine, smoke
24/8/17	6D	DR, MJ, ZE	845	1230	18-25	60	MSB	Fine		Rain forecast
2/11/17	7N	DR, MJ, ZE	1950	2250	21-23	Nil	RL	Fine, clear	4/4	During clearing
3/11/17	7D	DR, MJ, SM	1100	1400	26-27	25	MSB	Fine		
15/11/17	8N	BT, OT, SJ	1925	2300	20	50	MSB	Fine		After clearing
16/11/17	8D	BT, OT, SJ	1030	1330	24	25	RL	Fine		
21/11/17	9N	NP, SJ, ZE	NR	NR	NR	NR	NR	NR		After clearing
22/11/17	9D	NP, SJ, SM	NR	NR	NR	NR	NR	NR		
28/11/17	?N	GM, SR, SJ	2000	2245	18-20	80	MSB	Fine	1/4	After clearing
29/11/17	?D	GM, SR, SJ	1000	1245	23-26	90	MSB	Fine < 12hrs		

Table A8: Koala scat collection location data. HZMT = Hazlemount Lane.

Collection Date	Record No.	Impact/ Control	Time	T'sect/ Location	Easting	Northing	Tree sp.
31/5/2017	WK1	I		1	542533	6798776	Forest red gum
2/6/2017	WC1	C	915	Hazelmount	531901	6798489	Tallow wood
6/6/2017	WK2	I	1325	1	542533	6798776	Forest red gum
6/6/2017	WK3	I	1325	1	542569	6798777	Forest red gum
6/6/2017	WC2	C	830	Hazelmount	532008	6799069	Flooded gum
6/6/2017	WC3	C	900	Hazelmount	531891	6798479	Flooded gum
4/7/17	WK4	I	1345	1	542549	6798784	Small-leaved red gum
5/7/17	WC4	C	735	Hazelmount	531904	6798512	Forest red gum
27/07/17	WK5	I	1320	7	542763	6798531	Forest red gum
28/07/17	WC5	C	900	Hazelmount	531915	6798549	Swamp mahogany
10/8/17	WK6	I	1340	8	542803	6798541	Forest red gum
11/8/17	WC6	C	815	Hazelmount	531916	6798500	Forest red gum
3/11/17	WK7	I	1400	6	542741	6798662	Forest red gum
6/11/17	WC7	C	935	Munro Wharf	529150	6800241	Forest red gum
16/11/17	WK8	I	1110	7	542785	6798603	Broad-leaved paperbark
17/11/17	WC8	C	900	Hazlemount Lane	532043	6799175	Tallowwood
22/11/17	WK9	I	1100	8	542831	6798520	Swamp Mahogany
28/11/17	WCadd1	C	930	Hazlemount lane	532046	6799140	Tallowwood
27/11/17	WCadd2	C	915	Hazlemount	531940	6798595	Tallowwood

Table A9: Koala scat collection weather and health data. HZMT = Hazlemount Lane; M = male; F = female; po = possible; ? = unsure.

T'sect/ Location	DBH	Temp at collection	Weather at collection	Rainfall (collection period)	Sex	Breeding	Health	Comments (activity; ear tag?)
1	600		fine	nil	M?	No		
HZMT	450	12	Fine	Nil	M	No	Healthy, clear eyes	Large male, healthy
1	600	20.5	fine	nil	F?	No	Wet, stained	
1	300	20.5	Fine	Nil	M?	No	Wet, stained	
HZMT	300	12	Fine	nil	M?	?	Dry	
HZMT	380	14	fine	nil	M?	?	Dry	
1	600	24	Fine	Nil	M?	?	Dirty bum	
HZMT	650	9	Fine	Nil	F?	?	Healthy	
7	1400	19	fine	nil	F?	?	Dirty bum	
HZMT	500	9	fine	nil	F?	?	Dirty bum	
8	600	23	Fine	Nil	F?	?		Moved overnight. Not found. Scats older than 24hrs.
HZMT	1000	10	Fine	Nil	M	?	Healthy	Moved over night. Scats older than 24hrs
6	150	27	Fine	Nil	F?	No	Dirty tail	Moved overnight
Munro Wharf	400	22	Fine and windy	10mm over night	?	No	Healthy	
Tran 7	600	24	Fine	Nil	M	No	Wet & dirty bottom	
HZMT	450	20	Cloudy	Nil	M?	No	Healthy	
Tran 8	300	24	Showers and windy	Yes	M	No	Wet dirty bum, clear eyes	In back yard next to private residence.
HZMT	450	22	Cloudy	Nil	?	No	NR	
HZMT	450	20	Cloudy	Nil	F?	No	Healthy	