ikoala report on Coastal Subsite 1

Bernd Gruber & Aaron Adamack Version 0.33

2017-09-15

This report used the following files and parameters:

Input files:

- Report file name: ikoala report on Southern Tablelands
- Data base: d:/bernd/r/koalaoccupancy/GDA94z55Database2017JUN.accdb
- Study periods file: d:/bernd/r/ikoala/data/periods_coastal.csv
- Study site file: d:/bernd/r/ikoala/data/coastal_1.csv
- Projection: +proj=utm +zone=55 +south +ellps=WGS84 +datum=WGS84 +units=m +no_defs
- max_distance: 250
- resticted: TRUE

Output folder (containing tables, images and maps):

- Results folder: d:/bernd/r/ikoala/results

More than one study period is defined, therefore a detailed report for all sites combinded over all periods and a monitoring ikoala report are produced. For the monitoring report study sites will be projected/moved to sites provided via the study_site file, if they are within the specified in max_distance.

As restricted is switched to **yes**, the detailed report is based on sites as defined by the file:d:/bernd/r/ikoala/data/coastal_1.csv over all periods.

1.) Introduction - Definition of terms and the scope of the report

This is an automatically generated report of koala activity and occurrence for a specified sampling period and region. The terminology and analyses performed within this report are consistent with earlier reports by Phillips & Callaghan (2000), Allen et al. (2009), and Biolink (2011), Gruber & Adamack 2016, 2017).

The report entails the following output:

- Description of sampling area and periods
- Occurrence - determined by the presence or absence of koala faecal pellets at a sampling site for every period
- Activity - the proportion of trees with one or more koala faecal pellets at a sampling site for every period.
- Preference for certain tree species (referred to as ‘strike rate’) - defined as the probability for every period that a faecal pellet is found under a tree of a particular tree species
- If more than one period is defined an analysis on the trend of occurrence between periods is run. The analysis uses a bayesian occupancy modeling approach as detailed in Gruber & Adamack (2016, 2017).

(For more information on terminology, sampling methods and analysis, please, refer to the above mentioned reports)

2. Study area and sampling periods

Data collection at each sampling site consisted of searching the leaf litter within 1 m of the trunks of 30 trees at each sampling site for the presence of koala faecal pellets, identifying each tree's species and measuring its diameter at breast height (DBH). This report is for the study area that has an extent that ranges from -36.7 to -36.61 latitude and from 149.9 to 149.99 longitude.

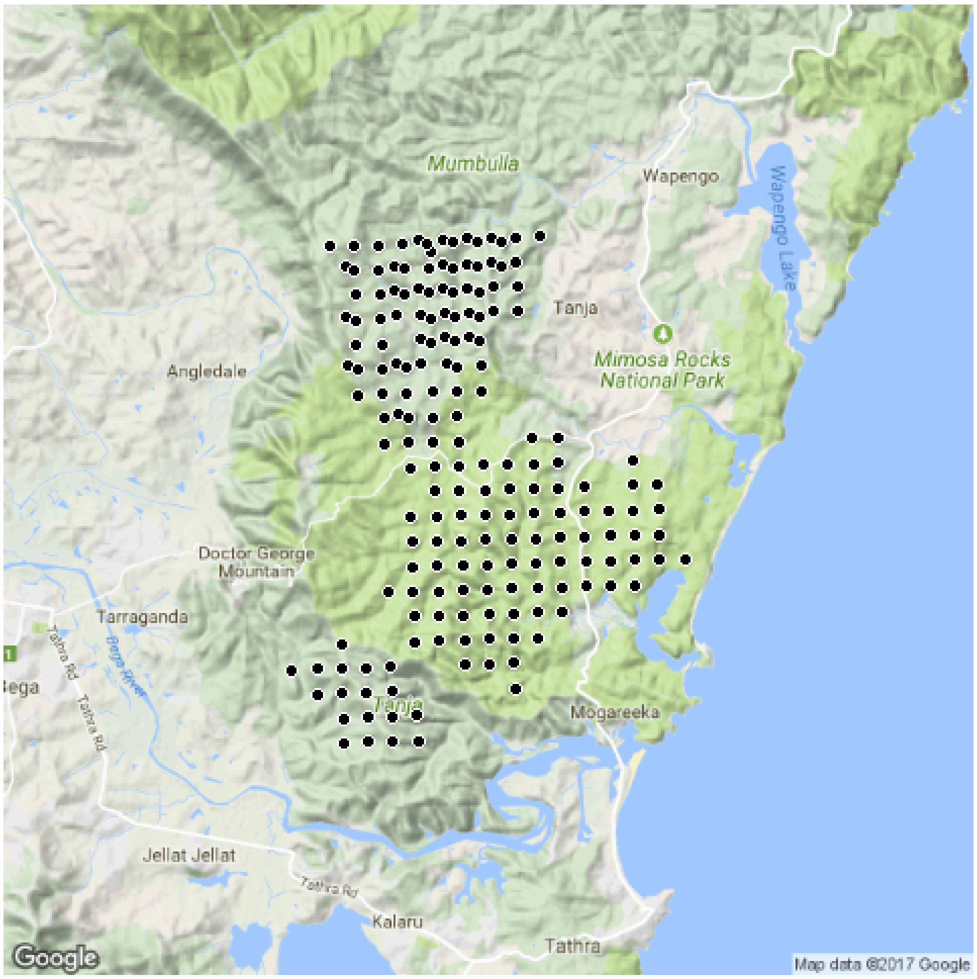


Figure 1: *Study area and sampling sites.*

3.) Occurrences of koalas in the study area

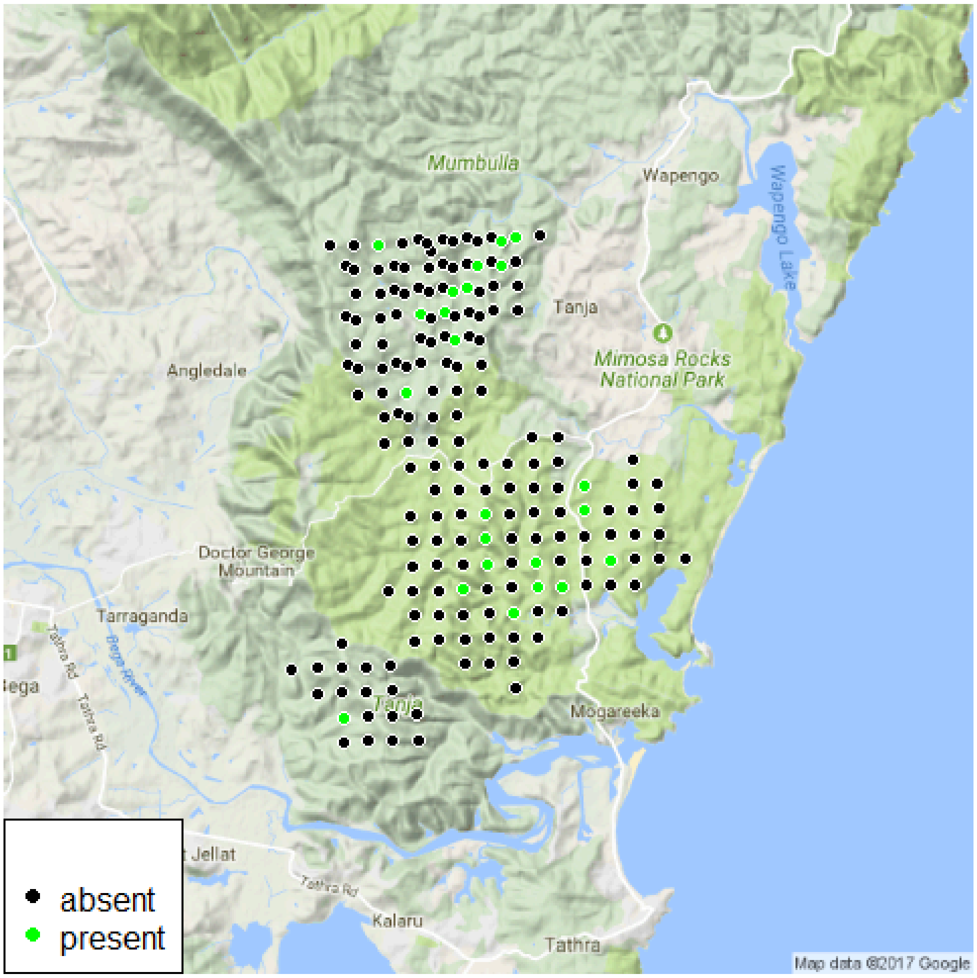


Figure 2: *Presence/absence map of the study area.*

Sampling overview

Table 1: *Summary for occurrence of koalas within the study area*

	Count and proportion
Visited sites	190
Active sites	23 (12.1 %)
Inactive sites	167 (87.9 %)
Examined trees	5642
Active trees	54(1%)
Inactive trees	5588(99%)
Trees at active sites	690(12%)
Trees at inactive sites	4952(88%)

4.) Results - Activity of koalas in the study area

Koala activity at each sampling site was determined by dividing the number of trees with koala faecal pellets under them by the total number of trees at the sampling site (Figure 3). Areas of elevated koala activity are shown using activity contours. Activity contours are analagous to elevation contours - they are derived from the activity values of each sampled site and its 12 nearest neighbours and join points of equal koala activity. The values for activity of koalas in unsampled points (i.e. in between sampling sites) is interpolated using a smoothing function.

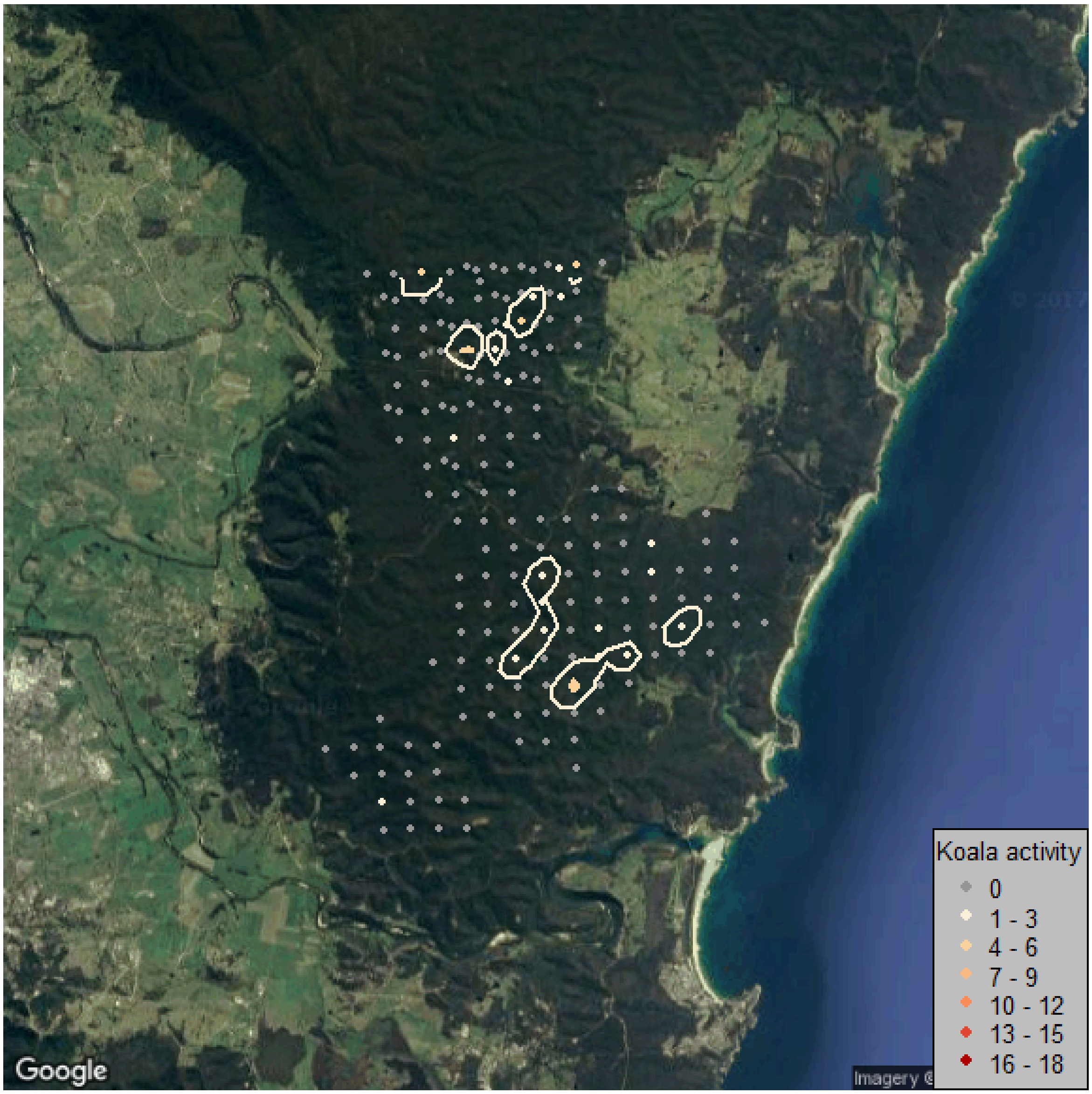


Figure 3: *Site-specific koala activity levels (measured in terms of number of trees with koala faecal pellets)*

4.) Results - Preference of koalas for certain tree species

4.1) Strike rate

Preference of koalas for certain tree species was determined as the probability (strike rate) of finding koala faecal pellets under particular tree species. A summary of strike rates by tree species is provided in Table 2.

In this section, we modified the data analysis methods of Phillips & Callaghan (2000). In their report, Phillips & Callaghan (2000) defined strike rate as the probability that a faecal pellet would be found under a particular tree species and only considered trees at active sites (i.e. the number of trees of species X with one or more faecal pellets divided by the total number of trees of species X at all active sites). Here, we calculated site-specific strike rates for each tree species (i.e. the number of trees of species X with one or more faecal pellets at a site divided by the total number of trees of species X at that site) across all active sites. This enables us to visualise the distribution of strike rates across active sites for a particular species rather than just knowing the mean value of the strike rate for a particular tree species across all active sites.

The distribution of strike rates for each tree species across all active sites is shown in Figure 4 where we overlaid boxplots with dotplots. Dotplots show actual values of strike rates at each site. However, since multiple sites can have the same strike rate, which would not be visible using dotplots only, the boxplots provide additional information about stike rate distribution. The bottom edge of the box corresponds to the lowest 25% of strike rates for a species, the line in the box shows the median (lowest 50%) and the top edge of the box corresponds to the upper 75% of strike rates for a particular tree species. The whiskers at the top and bottom of the box indicate 1.5x the inter-quartile range and the dots outside the range of the whiskers represent outliers (i.e. values beyond 1.5x(the 75% cut-off value - the 25% cut-off value)).

Table 2: *Summary of koala activity by tree species for active and inactive sites within the study area. ('N inactive sites' and 'N active sites' = the number of inactive and active sites the species was recorded at respectively; 'N trees at inactive sites' and 'N trees at active sites' = the number of trees of a species recorded at inactive and active sites respectively; 'N trees with faecal pellets' = the number of trees of a species with faecal pellets;and 'Mean strike rate (and standard error)' were calculated from the site-specific strike rate data).*

Tree ID	# of inactive sites	# of active sites	Count at inactive sites	Count at active sites	# of faecal pellets	Mean strike rate	SE
Acac	1	NA	1	NA	0	NA	NA
Acog	3	NA	15	NA	0	NA	NA
Afal	8	1	13	4	0	0	NA
Aimp	1	NA	2	NA	0	NA	NA
Alit	21	NA	115	NA	0	NA	NA
Amea	8	NA	17	NA	0	NA	NA
Angflo	15	3	47	3	0	0	0
Bmyr	1	NA	4	NA	0	NA	NA
Bpop	1	NA	1	NA	0	NA	NA

Cmac	1	NA	14	NA	0	NA	NA
Eagg	7	NA	63	NA	0	NA	NA
Ebau	1	NA	1	NA	0	NA	NA
Ebos	18	3	58	13	0	0	0
Ecyp	9	NA	27	NA	0	NA	NA
Eglo	8	2	52	8	2	0.333	0.083
Elon	25	4	216	36	9	0.462	0.065
Emue	20	3	186	29	1	0.028	0.009
Esie	5	2	27	11	2	0.229	0.044
Esmi	2	NA	2	NA	0	NA	NA
Etri	9	2	24	16	3	0.208	0.015
Excup	3	NA	8	NA	0	NA	NA
Hmac	1	NA	1	NA	0	NA	NA
Nven	1	NA	2	NA	0	NA	NA
Pund	1	NA	4	NA	0	NA	NA

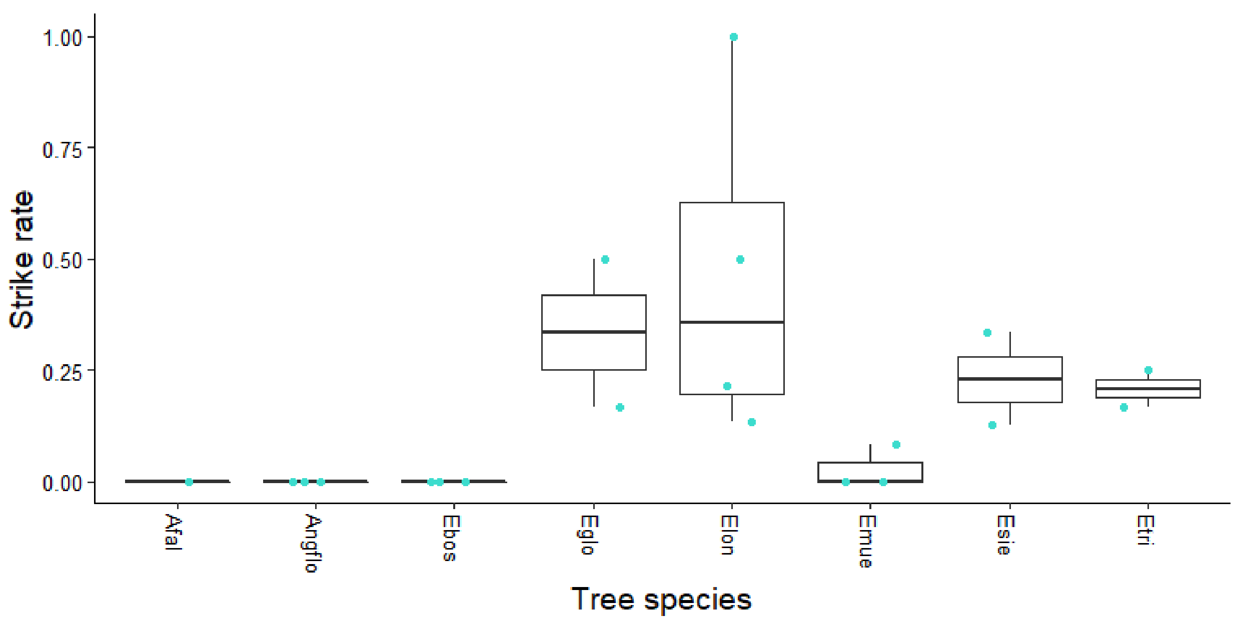


Figure 4: *Boxplots showing the distribution of site-specific strike rates at active sites and dots showing the site-specific strike rates of individual sites.*

4.2) Overall strike rate

We developed a second measure of strike rates to investigate the study's data on tree species selection by koalas, which we call the overall strike rate. The overall strike rate differs from the original strike rate in that it considers all sites, whether or not the site is active (i.e. the number of trees of species X with one or more faecal pellets is divided by the sum of all trees of species X at all visited sites). Overall strike rates for each species are shown in Figure 5. Please, note that the overall strike rate for each species is a single value (i.e. the mean probability across all sites), therefore no distribution is shown in Figure 5. If koalas truly prefer tree species X, the overall strike rate for the tree species (shown above) would be high.

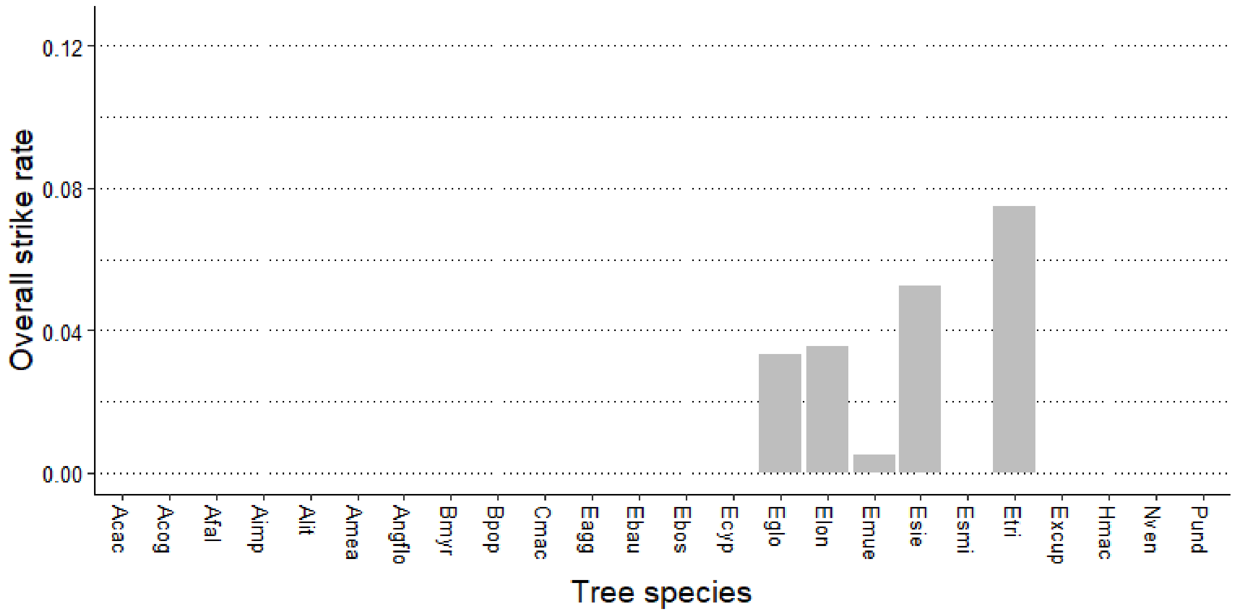


Figure 5: *Overall strike rates for each tree species present at visited sites.*

4.3) Tree species preference

While the overall strike rate helps to determine if koalas are showing a preference for some tree species over others, it does not account for differences in the number of trees of each species. Thus, a tree species with only a few sampled trees, could have a very high overall strike rate with just 1 or 2 trees having faecal pellets. On the other hand, an abundant species would require significant numbers of trees with faecal pellets to have a high overall strike rate, but this is made difficult when koalas are potentially only using a small portion of trees in the region. To account for this problem, we used bootstrap simulations to test whether the observed overall strike rate for a tree species was significantly different from the overall strike rate that would be expected if koalas were choosing trees at random (hereafter referred to as simulated strike rate).

For each tree species in the study area, we performed a bootstrap simulation with 100,000 permutations. For each set of simulations, we first determined the relative abundance of a tree species across all visited sites (i.e. the number of trees of species X / the number of all trees), the total number of trees with koala faecal pellets present, and the number of trees of species X with faecal pellets present.

For each bootstrap permutation, we generated a random deviate from a binomial distribution which represented the number of strikes assuming koalas choose trees at random. The number of trials was set to the total number of trees with koala faecal pellets present (all tree species), and the probability of a success was set to the proportion of all trees that were trees of species X. As it was possible to generate a random deviate that exceeded the number of trees of a species of interest, if the random deviate exceeded the number of trees of interest we adjusted the random deviate downward to the total number of trees of the species of interest. The random deviate was then converted to simulated strike rate by dividing the random deviate by the total number of trees of species X. Finally, the difference between the observed overall strike rate and the simulated strike rate was determined. After 100,000 permutations were performed, the middle 95% of the distribution of the differences between the observed and simulated strike rates was determined. If the middle 95% of the distribution of differences for a tree species does not include 0, it indicates that koalas are actively avoiding (distribution is below 0) or selecting for (distribution is above 0) a tree species (Figure 6). Bootstrapping is a stochastic process and for tree species that are on the cusp of being positively or negatively selected, their selection status can vary from one set of bootstrap simulations to another. However, by using a high number of replicates, we have reduced the likelihood of that happening.

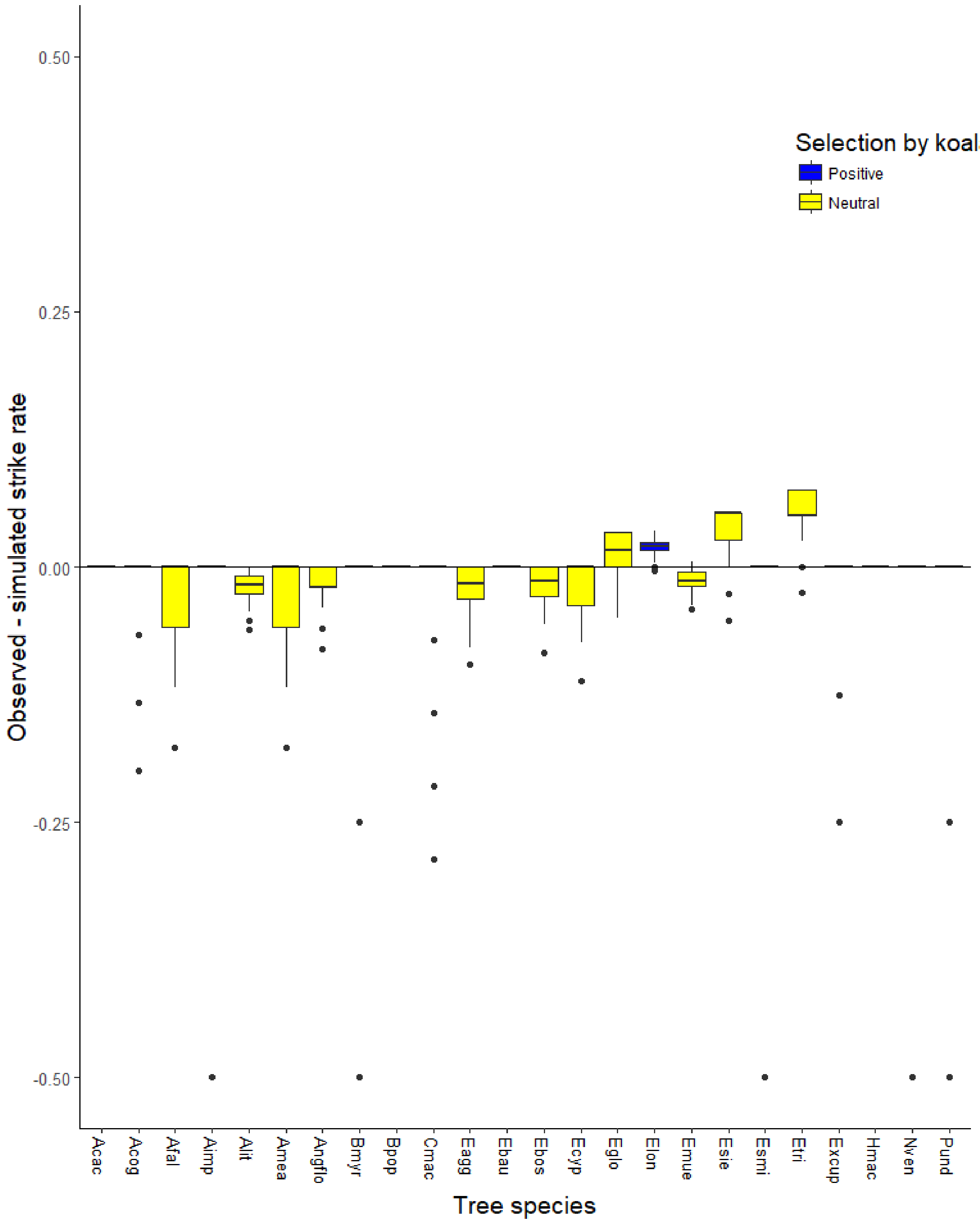


Figure 6: *Distributions of observed - simulated strike rates assuming that koalas choose trees within the study area at random. Distributions whose middle 95% do not include 0 suggest that the tree species is either being positively selected (i.e. the boxplot is above 0 and has a blue fill colour) or negatively selected (i.e. the boxplot is below 0 and has a red fill colour). Boxes for tree species that are being neutrally selected have a yellow fill colour.*

4.4) Tree size preference

In addition to the preference of koalas for tree species, we also investigated the preferences of koalas for different tree sizes. Trees of each individual species were divided into 100 mm DBH intervals (i.e. 100 to 199 mm, 200 to 299 mm, etc.) and the strike rate (i.e. the probability considering active sites only) for each size class for each species was determined. The relationship between tree size and their use by koalas is shown in Figure Figure 7. For each tree species, we performed a weighted linear regression between strike rate and tree size, with each size class weighted by the number of trees (of the species of interest) in the size class. Results for all tree species are shown in Table 3. The R^2 value shows the proportion of the change in strike rate with tree size that can be attributed to tree size. The closer the R^2 value is to 0, the weaker the relationship between tree DBH and koala strike rate for a particular species while the closer the R^2 value is to 1, the more important the role of tree size in the selection of trees by koalas. The slope of the relationship informs us about the overall direction of the relationship. A positive slope value indicates that koalas prefer larger trees than smaller trees of a particular species, whereas negative slope value indicates the opposite. The absolute value for the slope (i.e. how far the slope value is from zero in any direction) tells us about the steepness of the relationship. High absolute value for the slope indicates that there is a large difference in strike rates between size class 1 and size class 2, and size class 2 and size class 3, etc. The p-value provides information about the significance of the observed relationship - in general, only relationships with $p < 0.05$ are considered to be significant, but if regressions are being performed for a large number of trees, a more appropriate significance level is $0.05/N$, where N is the number of regressions performed.

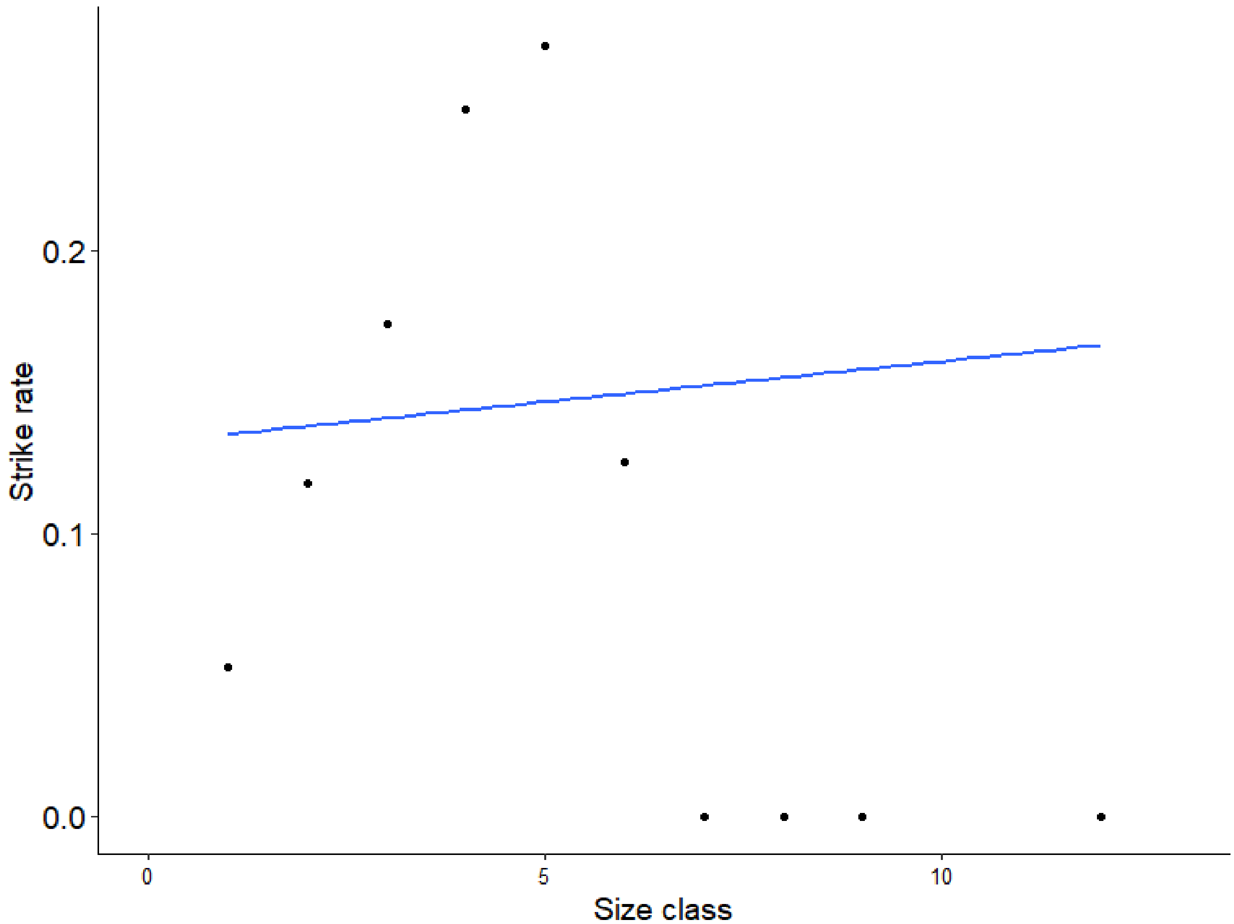


Figure 8: *Relationships between tree size (DBH) and strike rate across all tree species.*

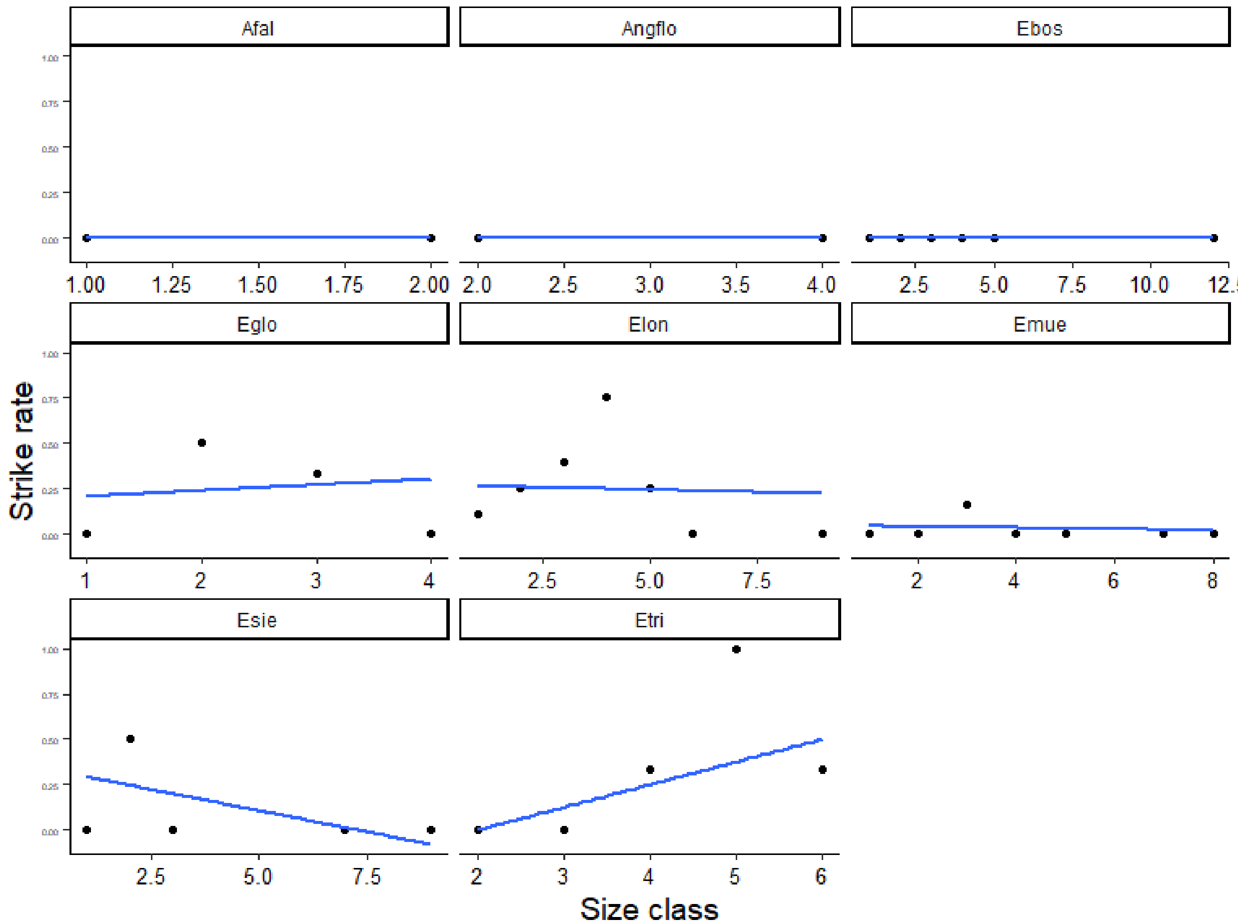


Figure 7: *Relationships between tree size (DBH) and strike rate for each tree species.*

Table 3: *Summary terms for linear regressions of strike rate on tree size for each tree species found at active sites weighted by the number of trees in each size class. Summary terms include the number of trees used in the regression (N), intercept and slope of the regression line, the R2 value and the p-value for the regression.*

Species	N	Intercept	Slope	R-square	p-value
Afal	4	0	0	NA	NA
Angflo	3	0	0	NA	NA
Ebos	13	0	0	NA	NA
Eglo	8	0.1746	0.03175	0.02381	0.8457
Elon	36	0.268	-0.005103	0.002304	0.9186
Emue	29	0.04606	-0.003324	0.01214	0.8141
Esie	11	0.3385	-0.04658	0.1996	0.4506
Etri	16	-0.25	0.125	0.5094	0.1757

5.) Monitorig report

5.1) Monitoring periods and summary tables

Monitoring periods

Definition of monitoring periods

period	region	from	to
1	Bermagui	2005	2009
2	Coastal	2010	2012
3	Coastal	2013	2017

Monitoring area.

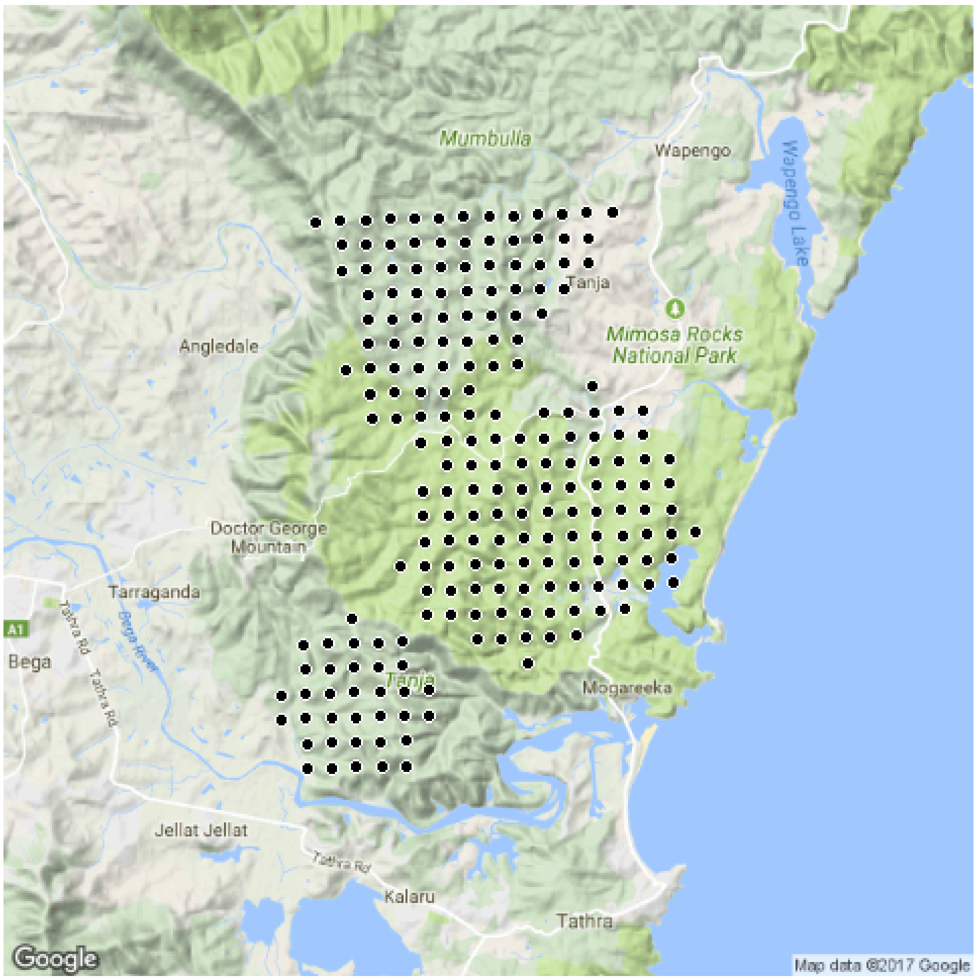


Figure 9: *Monitoring area. The monitoring area is defined by the sites listed in file: d:/bernd/r/ikoala/data/coastal_1.csv and consists of 211 sites.*

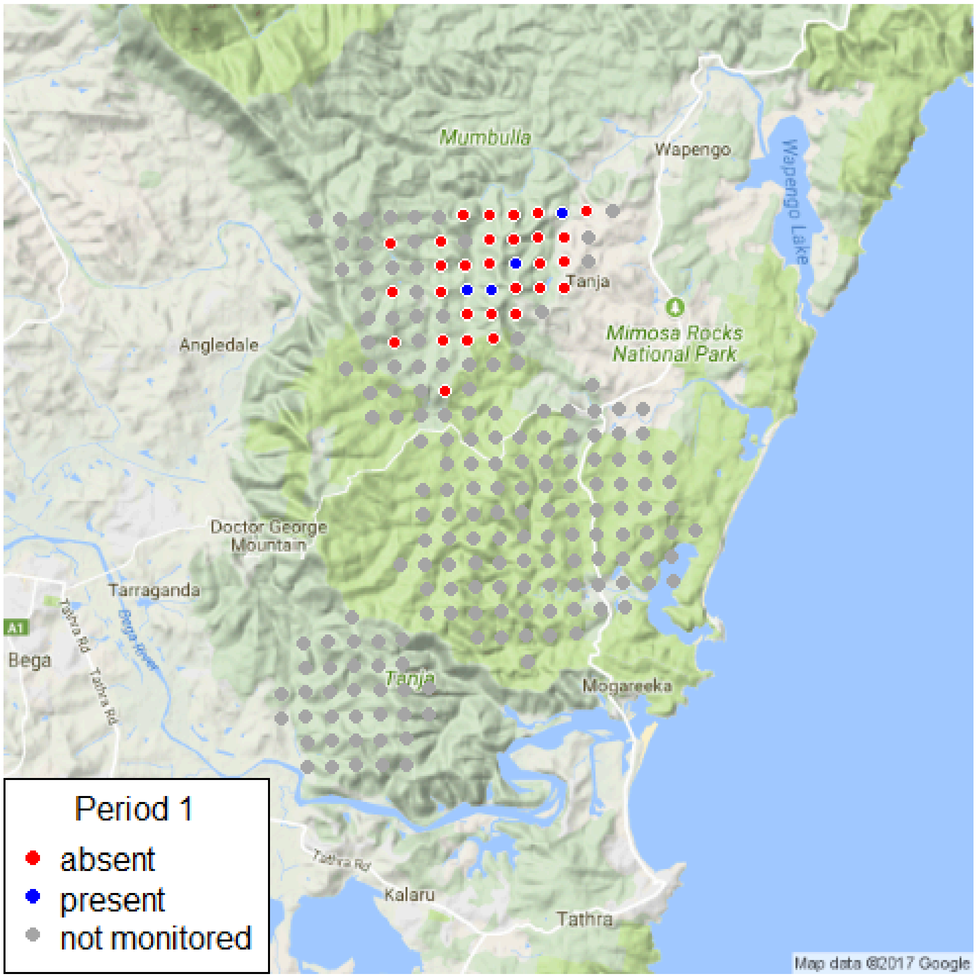
5.2 Summary tables per period

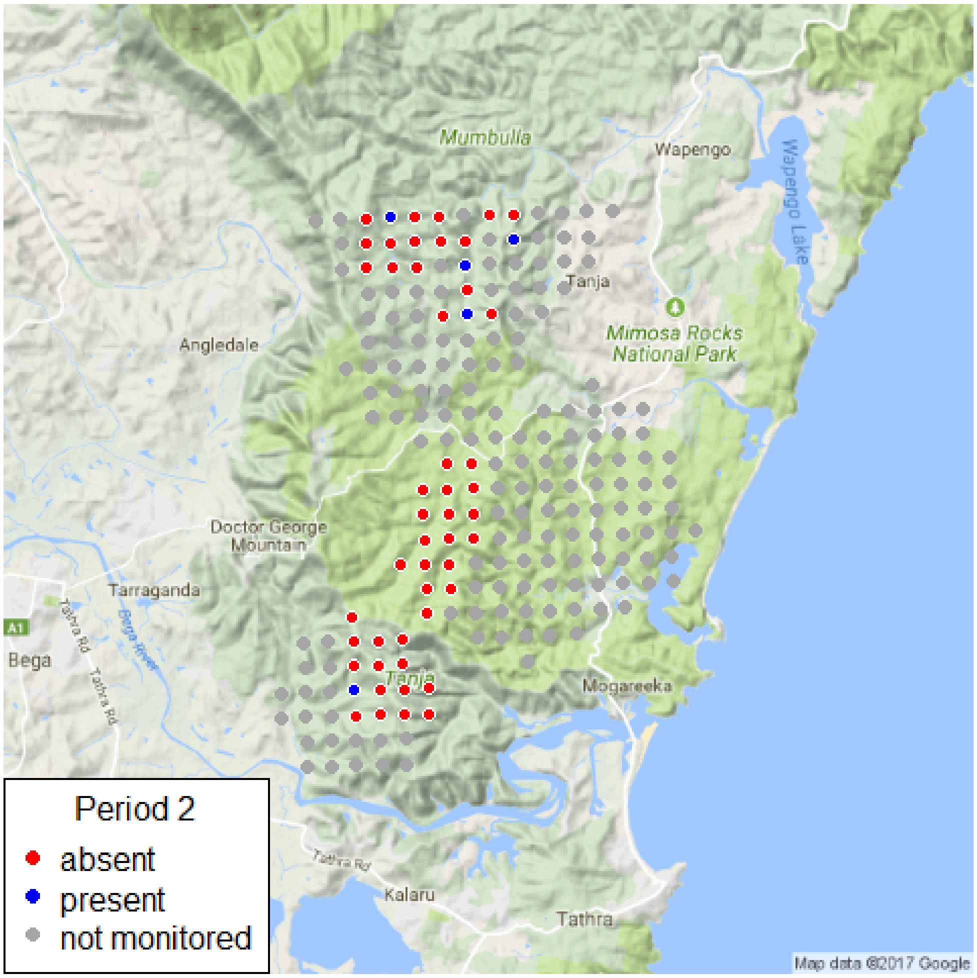
Table 4: *Summary of occurences of koalas per study period within the monitoring site. Please note that sites within 250 were moved to corresponding monitoring sites. Sites visited more than once during a period were combinded into one observation.*

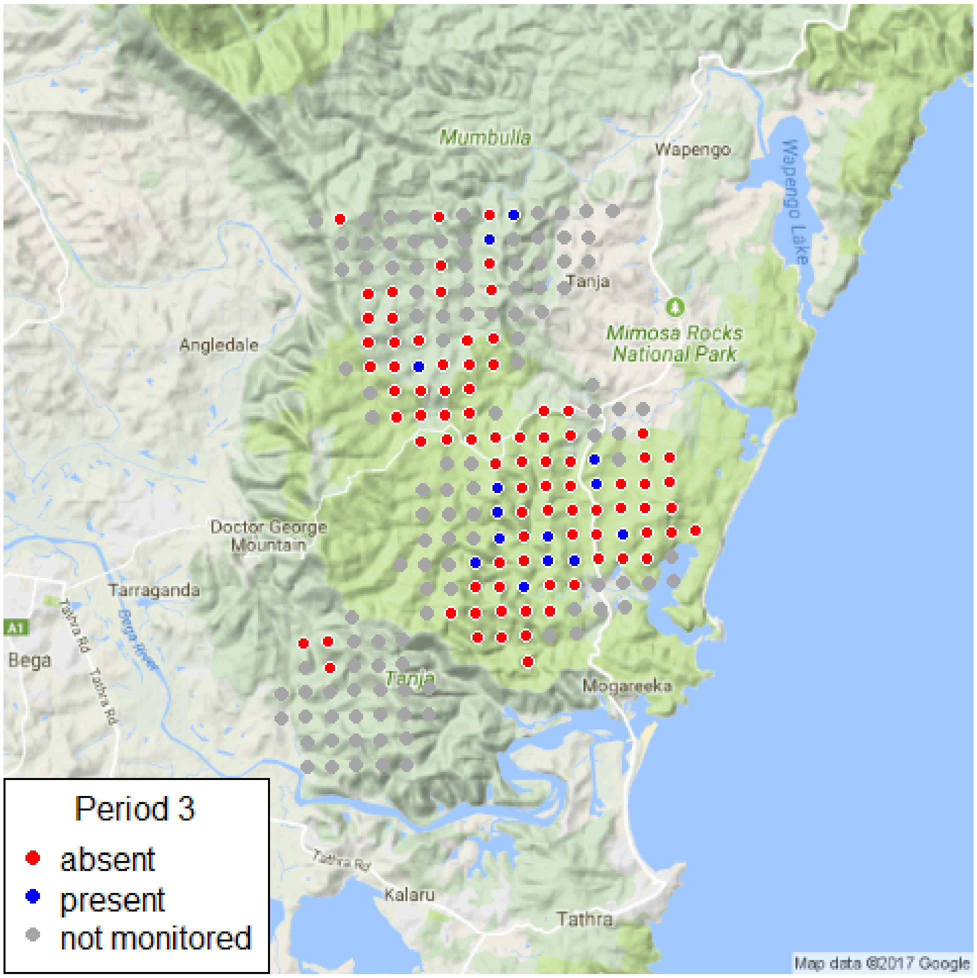
	Period 1	Period 2	Period 3
absent	29	47	85
present	4	5	14
not monitored	178	159	112
Sum	211	211	211

Table 5: *Percentage of occurrences of koalas per study period*

	Period 1	Period 2	Period 3
absent [%]	88	90	86
present [%]	12	10	14
Sum	100	100	100


Mumbulla
Wapengo
Wapengo Lake
Tanja
Mimosa Rocks
National Park
Angledale
Doctor George
Mountain
Tarraganda
A1
Bega
Tathra Rd
Bega River
Tanja
Mogareeka
Tathra Rd
Kalaru
Tathra
Map data ©2017 Google
Period 1
absent
present
not monitored


Mumbulla
Wapengo
Wapengo Lake
Tanja
Mimosa Rocks
National Park
Angledale
Doctor George
Mountain
Tarraganda
Tathra Rd
Bega River
A1
Bega
Tanja
Mogareeka
Tathra Rd
Kalaru
Tathra
Map data ©2017 Google
Period 2
absent
present
not monitored



5.3 Estimated occupancy over time and probability of detection

A Bayesian-based occupancy modelling approach was used to estimate site occupancy. Site occupancy is analagous to to the proportion/percentage of sites that are active, but accounts for imperfect detection of koala activity. Two parameters are estimated using this approach. The first is *psi*, the proportion of sites that are occupied adjusted for imperfect detection and *p*, the probability of detection given that koala faecal pellets are present. To obtain our estimate of *p*, we treat each actual site visit as three repeated visits with 10 trees being searched as a part of each repeated visit. This step is required as the estimation of *p* requires temporally repeated visits to the same sight with the assumption that there is no change in population size or activity levels between visits. We have performed testing with varying numbers of trees being visited during the repeat visits and have found that it has only limited effects on the estimate of *p*

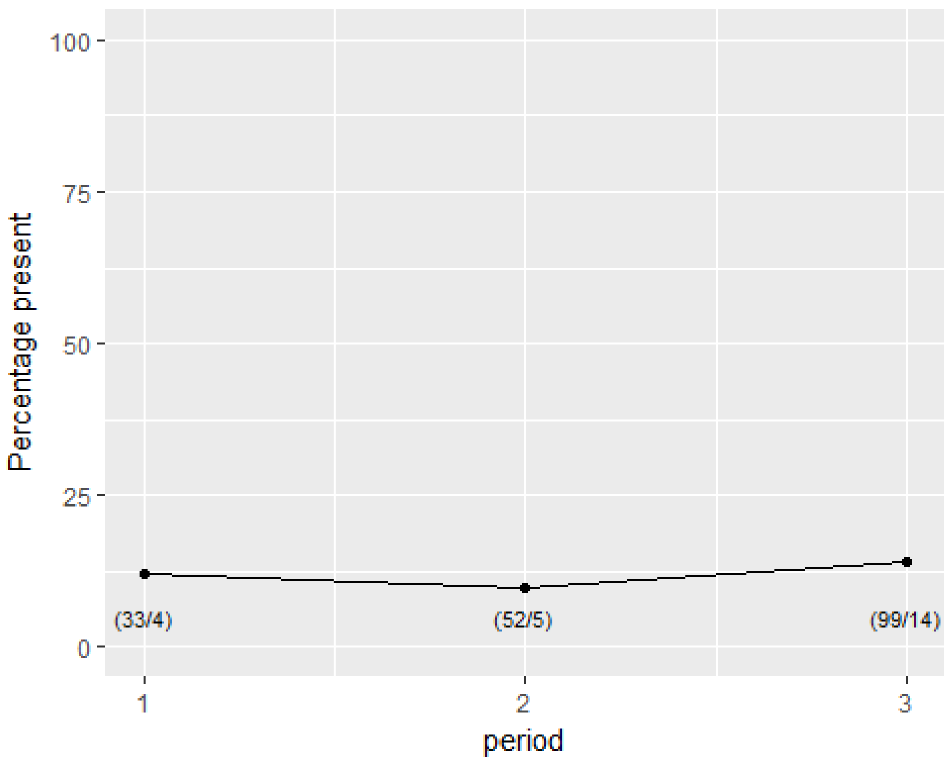


Figure 10: *Percentage of occupied sites over periods*

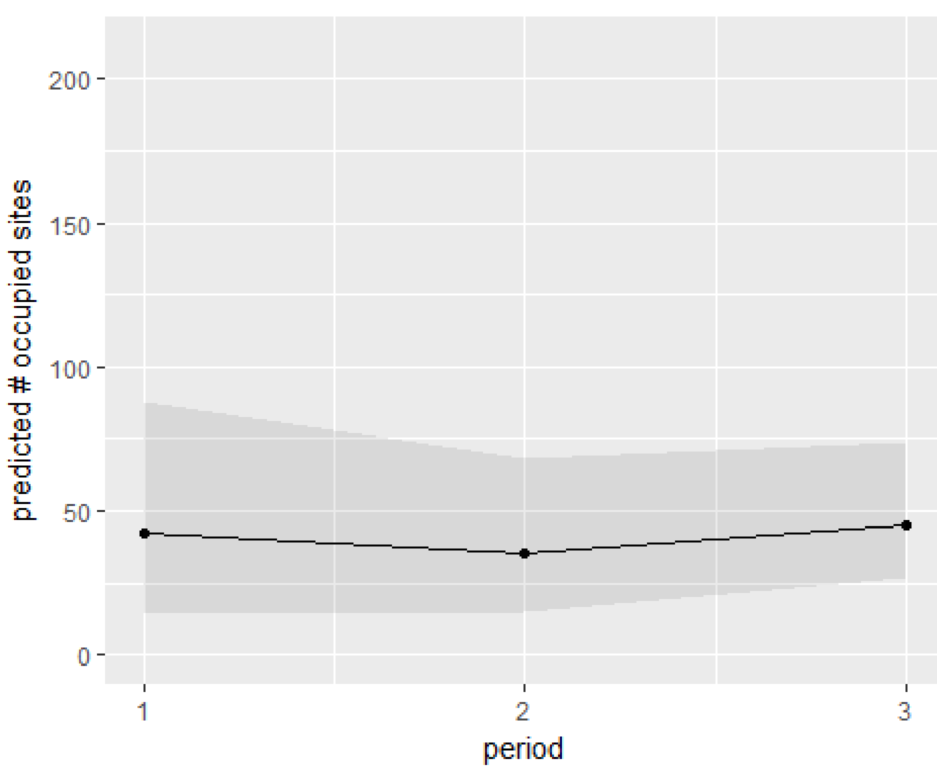


Figure 11: *Predicted number of sites occupied over periods (out of a total of 211 sites)*

Table 6: *Summary output of occupancy model.*

	mean	sd	2.5%	97.5%
occupancy rate[1]	0.203	0.095	0.066	0.425
occupancy rate[2]	0.174	0.069	0.068	0.332
occupancy rate[3]	0.219	0.062	0.121	0.364
# occupied sites[1]	42	19	14	88
# occupied sites[2]	35	14	15	68
# occupied sites[3]	45	12	27	74
detection probability at a site (30 trees)	0.715	0.104	0.482	0.886
colonisation rate[1-2]	0.17	0.091	0.04	0.376
colonisation rate[2-3]	0.179	0.09	0.031	0.39
extinction rate[1-2]	0.219	0.197	0.006	0.737
extinction rate[2-3]	0.432	0.278	0.018	0.953
probability of increase[1-2]	0.406	0.491	0	1
probability of increase[2-3]	0.737	0.44	0	1

6.) List of Tree Species

Table 7: *List of tree IDs used in this report and corresponding scientific and common names.*

Tree ID	Scientific name	Common name
Acac	Unidentified acacia	Unidentified acacia
Acog	Acacia cognata	Narrow-leaf bower wattle
Afal	Acacia falciformis	Hickory wattle
Aimp	Acacia implexa	Lightwood
Alit	Allocasuarina littoralis	Black she-oak
Amea	Acacia mearnsii	Black wattle
Angflo	Angophora floribunda	Rough-barked angophora
Bmyr	Backhousia myrtlefolia	Grey myrtle
Bpop	Brachychiton populneus	Kurrajong
Cmac	Corymbia maculata	Spotted gum
Eagg	Eucalyptus agglomerata	Blue-leafed stingybark
Ebau	Eucalyptus baueriana	Blue box
Ebos	Eucalyptus bosistoana	Coastal grey-box
Ecyp	Eucalyptus cypellocarpa	Monkey gum, Mountain grey gum
Eglo	Eucalyptus globoidea	White stringybark
Elon	Eucalyptus longifolia	Woollybut
Emue	Eucalyptus muelleriana	Yellow stringybark
Esie	Eucalyptus sieberi	Silvertop ash
Esmi	Eucalyptus smithii	Gully peppermint
Etri	Eucalyptus sideroxylon subb tricarpa	Ironbark
Excup	Exocarpus cuppressiformis	Native cherry
Hmac	Hakea macraeana	Macrae’s hakea
Nven	Notalea venosa	Mock olive
Pund	Pittosporum undulatum	Pittosporum

7.) References

Allen CD, Saxon M and McDougal K (2010). Koala surveys in the coastal forests of the Bermagui-Mumbulla area: 2007-09 - An interim report. NSW Office of Environment and Heritage PO Box 656 Merimbula NSW 2548.

Biolink, (2011). Tweed Coast Koala Habitat Study. Report to Tweed Shire Council. Biolink Uki, NSW. Elith, J., Leathwick, J. R. and Hastie, T. (2008), A working guide to boosted regression trees. Journal of Animal Ecology, 77: 802-813.

Gruber, B., Eckel, K., Everaars, J., Dormann, C.F. (2011). On managing the Red mason Bee (*Osmia bicornis*) in apple orchards. Apidologie 42: 564 - 576.

Lechowicz MJ. (1982). The sampling characteristics of electivity indeces. Oecologia 52: 22-30

Tulau, M.J. (1994). Soil Landscapes of the Cooma 1: 100,000 Sheet Report. Department of Conservation and Land Management incorporating the Soil Conservation Service of NSW, Sydney.