



Office of  
Environment  
& Heritage

# **Modification of the preliminary map of the likelihood of koalas within NSW**

**For use in Private Native Forestry applications**

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# 1 Contents

List of figures .....	iii
List of tables .....	iv
Summary.....	v
Contents.....	iii
List of figures .....	iv
List of tables .....	iv
<b>1. Introduction .....</b>	<b>1</b>
1.1 Koala export workshop.....	1
<b>2. General issues/points raised.....</b>	<b>2</b>
2.1 Issue 1 – Vegetation mapping .....	2
2.2 Issue 2 – Consistency in the process applied to Crown and private lands.....	2
2.3 Issue 3 - What are we aiming to protect?.....	3
<b>3. Modifying the koala baseline map.....</b>	<b>4</b>
3.1 The cut-off date for data used in the project .....	4
3.2 ‘Other species’ used.....	4
3.3 Filtering data for duplicates .....	5
<b>4. The modified map .....</b>	<b>7</b>
<b>5. Testing the baseline map .....</b>	<b>14</b>
<b>6. Using the koala baseline map .....</b>	<b>17</b>
6.1 Use the map to indicate confidence in koala absence data.....	17
6.2 Use the map to indicate data deficient areas .....	18
6.3 Using the map by itself .....	18
6.4 Using the map in conjunction with vegetation or habitat mapping .....	18
<b>7. Process for updating the koala baseline map .....</b>	<b>19</b>
<b>8. Process for testing other koala models.....</b>	<b>20</b>
<b>9. References.....</b>	<b>21</b>

## 2 List of figures

Figure 1: Koala baseline mapping using the modified underlying dataset .....7

Figure 2: Koala baseline mapping revised 'confidence' using modified underlying data.....8

Figure 3: Koala baseline mapping for KMA1 using the modified underlying dataset.....9

Figure 4: Koala baseline mapping 'confidence' for KMA1 using the modified underlying data.....10

Figure 5: Koala baseline mapping (p-values) and koala activity at SAT points for Coffs Harbour on the north coast of NSW .....15

Figure 6: Confidence in the data for cells in which koalas are absent .....17

## 3 List of tables

Table 1: The number (and percentage) of cells with each estimate of the likelihood of Koalas.....11

Table 2: The number (and percentage) of cells within each confidence category .....11

Table 3: The number (and percentage) of cells with each estimate of the likelihood of Koalas.....12

Table 4: The number (and percentage) of cells within each confidence category .....12

Table 5: Results of the spearman rank correlation tests for the four SAT datasets compared to the koala baseline mapping.....16

Table 6: Example of how the baseline mapping might be used in conjunction with habitat mapping.....18

# 1 Introduction

The NSW Environment Protection Authority (EPA) is currently considering options for how current and future koala distribution and habitat mapping can be better integrated with the regulation of private native forestry (PNF), ensuring consistency and improved protection for koala habitat (NSW Environment Protection Authority, 2013). The NSW EPA engaged the Office of the Environment and Heritage to prepare a baseline map of koala distribution, which is presented in an earlier report (Predavec *et al* 2014).

This current report presents information relating to the update/modification of the preliminary koala baseline mapping resulting from a workshop held in Coffs Harbour on 24 March 2015. It further presents information on how the baseline map can be updated and possibly integrated with the EPA's decision-making process. The information is presented as responses to a series of issues/points raised at, or after, the workshop.

Information presented in the original baseline mapping report (Predavec *et al* 2014) is not repeated here and this report should be read in conjunction with the earlier report.

## 1.1 Koala expert workshop

A koala expert workshop was held in Coffs Harbour on 23 and 24 March 2015. The first day of the workshop was aimed primarily at EPA's response to koalas within Crown lands, although the baseline mapping was briefly discussed. The second day of the workshop covered the preliminary baseline mapping. The attendees at the workshop were:

- Bill Faulkner – EPA – Project manager for the koala baseline mapping project
- Mark Fisher – EPA – Project manager for the koala Crown forestry project
- Rod Kavanagh – Niche Environment and Heritage – Koala expert engaged for the workshop by EPA
- Steve Philips – Biolink - Koala expert engaged for the workshop by EPA
- Andrew Smith – Ecological consultant - Koala expert engaged for the workshop by EPA
- Chris Slade – Ecologist with the Forestry Commission of NSW
- John Turbill – NSW Office of Environment and Heritage (OEH) Coffs Harbour
- Alex Waterworth – EPA – GIS Operator
- Jackie Miles – EPA – Manager EPA Forestry, Technical Policy and Operational Support (Day 1)
- Martin Predavec – OEH – lead author of the original koala baseline mapping report.

## 2 General issues/points raised

This section addresses some of the general issues raised at the workshop. More substantial changes relating to the baseline mapping project are addressed in subsequent sections.

### 2.1 Issue 1 – Vegetation mapping

The point was raised that vegetation mapping should be the primary means of determining koala habitat.

#### **Response**

While it was agreed in principle, it was noted that no suitable and consistent vegetation mapping is available across the State on private lands. It was also noted that there is no intention to produce such a map for the purposes of PNF approvals. Nor is there the ability to require PNF proponents to produce such mapping as part of the assessment and approval process. Notwithstanding the panel's apparent endorsement of vegetation mapping as an appropriate basis for identifying koala habitat generally, it was also suggested that such mapping has poor reliability as an indicator of the habitat value present at any particular site.

### 2.2 Issue 2 – Consistency in the process applied to Crown and private lands

There needs to be consistency between the koala assessment process on Crown (State Forests) and private (PNF) lands.

#### **Response**

While it was agreed in principle, it was noted that there are fundamental differences in the nature of the tenures including:

- On Crown lands the locations of impacts and therefore the areas where koala habitat mapping is required, are known. On private lands the location of impacts is not known until a PNF application is lodged.
- The extent, intensity and frequency of impacts on Crown lands is typically much greater than on private lands.
- The Crown pilot mapping project does involve API mapping of Plant Community Types (PCTs) – on top of existing RN17 Forest Type mapping which is available for virtually all coastal state forest areas (and more historic and lower resolution “Lindsay” type mapping in western areas). It has not been determined if PCT mapping is superior to existing RN17 FT mapping for this purpose. Whether or not PCT mapping is undertaken more broadly will depend on an analysis of its relative costs and benefits which is intended to follow from the pilot project. Such consistent, detailed mapping is not available or proposed for private lands (See Section 2.1).

#### **Action**

Look at opportunities to align the two provisions and where possible develop mapping that can be applied cross tenure.

### 2.3 Issue 3 - What are we aiming to protect?

It was not clear from the two days of discussion as to what is being protected; yet this is an important and fundamental question. On the one hand is potential koala habitat as best represented by a vegetation map or a modelled habitat map (e.g. API vegetation mapping or a habitat model such as MaxEnt). On the other hand is protection of areas where koalas exist currently (e.g. baseline mapping). No direction was given as to what should be the aim.

#### **Response**

To date the Crown pilot project has gone in the direction of combining potential koala habitat and koala occurrence. This is a sensible direction given that vegetation mapping is available (along with additional Plant Community Type (PCT) mapping in pilot project areas) and there are existing records of koala use along with capacity for further assessments to be required. The PNF project has gone in the direction of koala populations. This is considered sensible given the lack of a suitable vegetation layer on the vast majority of private lands. It would be desirable for this to be integrated with a suitable proxy for habitat potential or where available on private lands, suitable higher resolution vegetation mapping.

#### **Action**

There is opportunity to incorporate both datasets and use this as a means of directing koala prescriptions. On private lands a potential habitat map could be developed using MaxEnt or similar (for example the Forestry Corporation of NSW model produced by Brad Law). In line with this, a modification of the koala baseline map could be used to determine the likelihood of koalas. A matrix of potential habitat and koala likelihood could then be used to determine the level of prescription under PNF codes. For example, an area with high potential habitat and high likelihood of koalas should have a higher level of prescription than an area with high potential habitat and low likelihood of koalas. This is discussed further in Section 6 of this report.

### 3 Modifying the koala baseline map

This section reports on modifications to the baseline map and in particular the underlying data.

#### 3.1 The cut-off date for data used in the project

The original baseline map used data from the Atlas of NSW Wildlife with a start date of 1 January 1994. This meant data were used that covered a 20 year range (1994 to 2014) corresponding with the three generation timeframe used by the IUCN to determine if an animal is extinct. The 20 years also corresponded with the generational persistence used in a number of Comprehensive Koala Plans of Management (e.g. Bellingen (OEH 2013), Lismore (Biolink 2011)).

At the workshop discussion focussed on particular datasets that were not included because of the 1994 to 2014 cut-off (e.g. Rod Kavanagh's 1991 survey of the northern forests of NSW (Kavanagh et al 1995) as well as the Comprehensive Regional Assessment surveys). A 1990 cut-off was suggested.

#### Response

The reason put forward for the revised cut-off was the inclusion of specific survey datasets, thereby capturing regionally significant survey events. The cut-off date is important when considering what the map is identifying. If the aim is to look at where current koala populations occur then it is more appropriate to use more recent data (e.g. last three generation of koalas). If the aim is to look at where koalas currently occur, and where they once occurred, then a longer timeframe is more appropriate.

#### Action

Atlas data have been expanded to include all records from 1 January 1990 until 25 March 2015 (date of database search). As well as capturing the data discussed at the workshop, the expanded dates also captured more recent surveys such as the Great Koala Count run by the National Parks Association of NSW.

#### Recommendation

Moving forward, a window of data should be used that is relevant to the question being asked. If the date range expands over time then there is a risk that old data becomes increasingly irrelevant (e.g. areas where koalas once occurred but are no longer present.) Recommend using a 20-year window. In order to generate sufficient data to adequately populate cells this would need to be accompanied by proactive, regular sampling of the subject species.

#### 3.2 'Other species' used

The original baseline map used a suite of 48 other species of mammal to indicate the level of survey effort within a cell (i.e. where people had undertaken surveys but where koalas had not been seen). The concern was raised that the 48 species does not give a suitable measure of survey effort within a cell. It was suggested that the model be rerun using only arboreal mammals.

#### Response

This issue requires further consideration, particularly given that approximately 5000 of the 38,000 koala records come from the 2006 NPWS community survey (Lunney et al 2009). The

community survey data are important on private lands and represent an even greater proportion of records across this tenure. Common species such as kangaroos and echidnas, both of which were included in the community survey, provide good indication of where community surveys were completed. Also, koalas will be observed in many situations that other arboreal mammals will generally not be observed: for example many records of koalas are 'dead on road' and non-arboreal species may be a better indicator of survey in these cases. Reducing the number of 'other species' included in the mapping has the additional effect of increasing the number of cells with 'no data' (see Section 4)

### **Action**

The model has been run using only arboreal mammals as the 'other species'. This included all records of animals within the families *Petauridae* (gliders), *Phalangeridae* (brush-tail possums) and *Pseudocheiridae* (ring-tailed possums). This resulted in eight species being used.

The 'other species' are used as an indication of where survey has been completed and also the level of survey effort. With a perfect dataset, the number of unique observers could be used to give a measure of survey effort (i.e. how many people have looked for arboreal mammals, including koalas). However the Atlas of NSW Wildlife does not consistently record observers, with some observers noted as an individual person and others as a corporation or research group. One of the largest cases where this occurs is with the 2006 Community Wildlife survey where the observer is noted as being '? Unknown'. We therefore used the number of animals observed as an indication of survey effort. In order to test this assumption we were able to replace the Atlas data for the 2006 community wildlife surveys with the original survey data, which includes individual observers (note: these data are not publically available and so cannot be included in the methods for map creation). We then counted the number of unique surveys of arboreal mammals per 10 kilometre cell across NSW. We considered a survey as being observation by an individual observer on an individual date. We tested the correlation of number of surveys against the number of arboreal mammals observed (Spearman rank correlation - SAS Enterprise Guide Version 6.1). There was a significant positive correlation between the number of unique observers and the number of arboreal mammals observed ( $r = 0.82$ ,  $p < 0.0001$ ). This indicates that the number of arboreal mammals observed in a cell is a good indicator of the level of survey effort in a cell.

### **3.3 Filtering data for duplicates**

The Atlas of NSW Wildlife contains many instances of duplicate records. This is particularly the case for records from the Forestry Corporation of NSW and also for the Great Koala Count. There is also an issue of inconsistency in how star searches undertaken under the IFOA are recorded in the Atlas: In some instances the entire star search is recorded as a single entry, while in other instances each tree with evidence of koala activity is recorded as a separate record.

At the workshop it was agreed that further filtering of the Atlas data to account for duplication and star searches should be undertaken.

### **Action**

Data has been filtered for duplication. The filtering completed now includes:

Remove observations made outside of NSW.

Remove data with spatial accuracy greater than 10 kilometres.

Remove data with suspect observation type (e.g. 'beached' koalas).

Remove duplicates (and triplicates) where the same data has been entered multiple times.

These data came mainly from Forest Corporation of NSW and NPA Great Koala Count.

Remove other duplicate data – same species, location and date.

For scat data (observation type code P) remove duplicates of species, person and date. This accounts for the star searches.

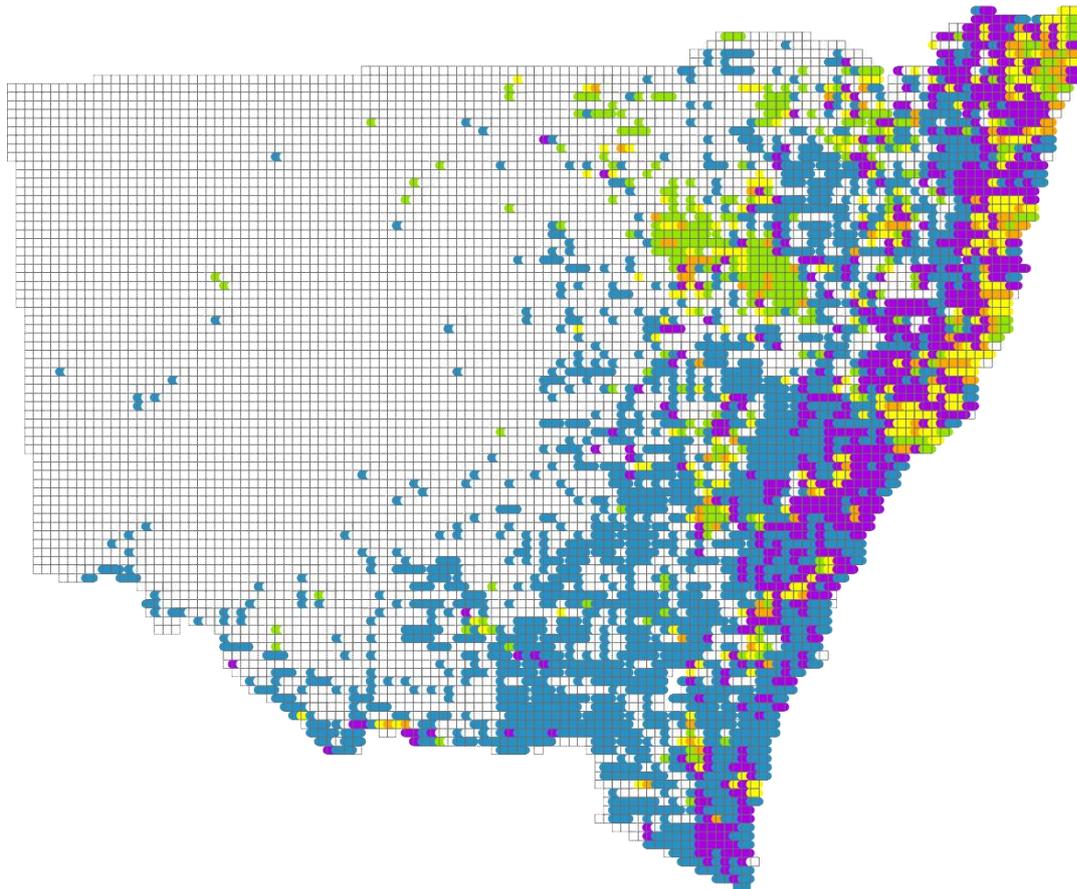
Convert each scat record to one animal (i.e. in the 'number of animals observed' field often the number of scats was recorded).

The filtering was applied to both the koala data and the other species data. The extension of the timeframe that data were sampled (1990 to 2015) resulted in 31,665 koala records, compared to the 21,386 records in the original mapping (1994 to 2014). A similar comparison is not available for 'other species' due to the different species used. For koalas, the filtering resulted in 6795 records being removed from a total of 31,665 records (21.5%). For arboreal mammals (not including koalas) the filtering resulted in 4297 records being removed from a total of 120,386 (3.6%). The large difference between the koalas and arboreal mammals is largely due to the scat searches undertaken for koalas as part of IFOA which were not undertaken for other arboreal mammals.

## 4 The modified map

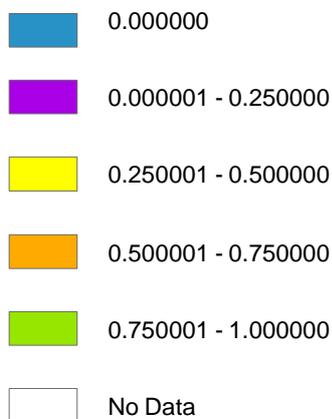
The modified map was created using the filtered data described in Section 3 and using the methods described in the earlier mapping report (ref).

The results of the mapping are shown in Figures 1 and 2 for the state as a whole using 10 km<sup>2</sup> grid cells and in Figures 3 and 4 for Koala Management Area (KMA) 1 using 5 km<sup>2</sup> grid cells.



### Legend

**$p$  (Proportion of koala records from all arboreals)**



**Figure 1: Koala baseline mapping using the modified underlying dataset**

Modification of the preliminary map of the likelihood of koalas within NSW

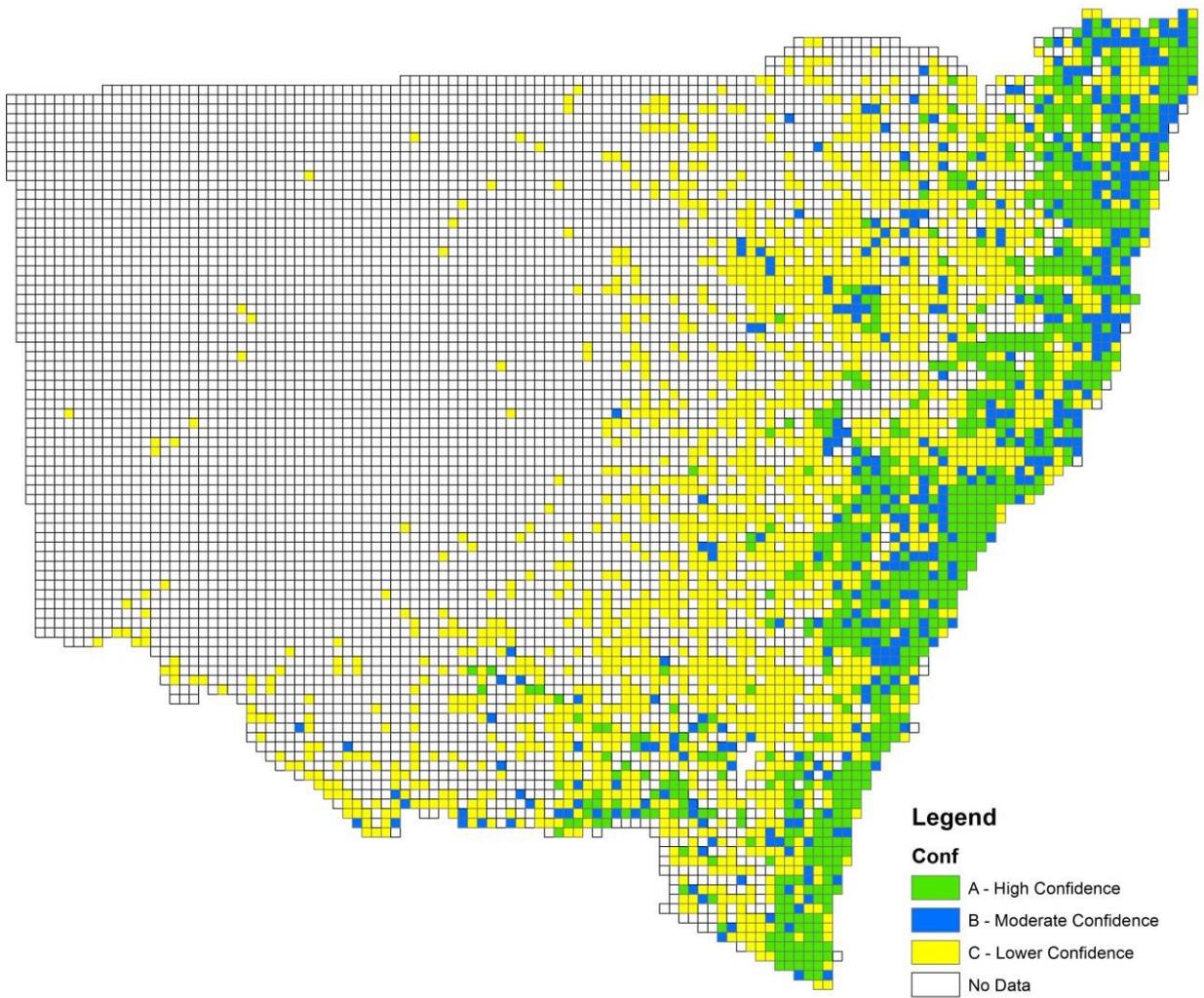
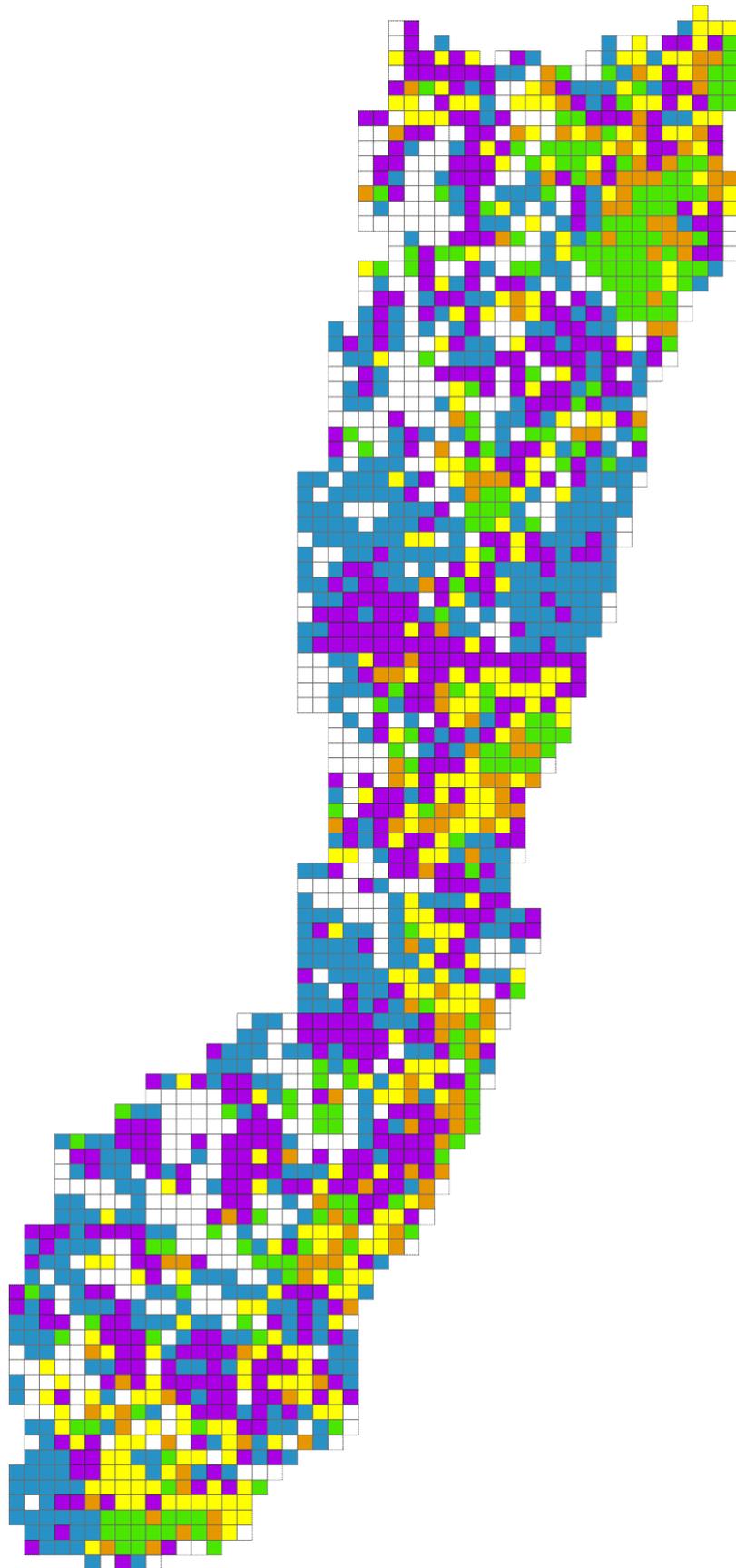
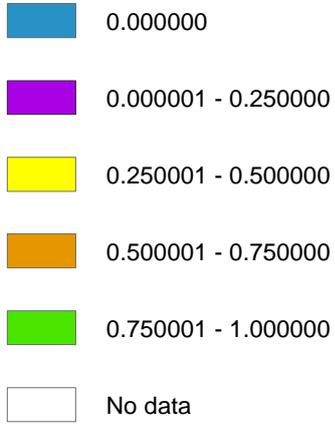


Figure 2: Koala baseline mapping revised 'confidence' using modified underlying data

Modification of the preliminary map of the likelihood of koalas within NSW

**Legend**

**p (proportion koalas)**



**Figure 3: Koala baseline mapping for KMA1 using the modified underlying dataset**

Modification of the preliminary map of the likelihood of koalas within NSW

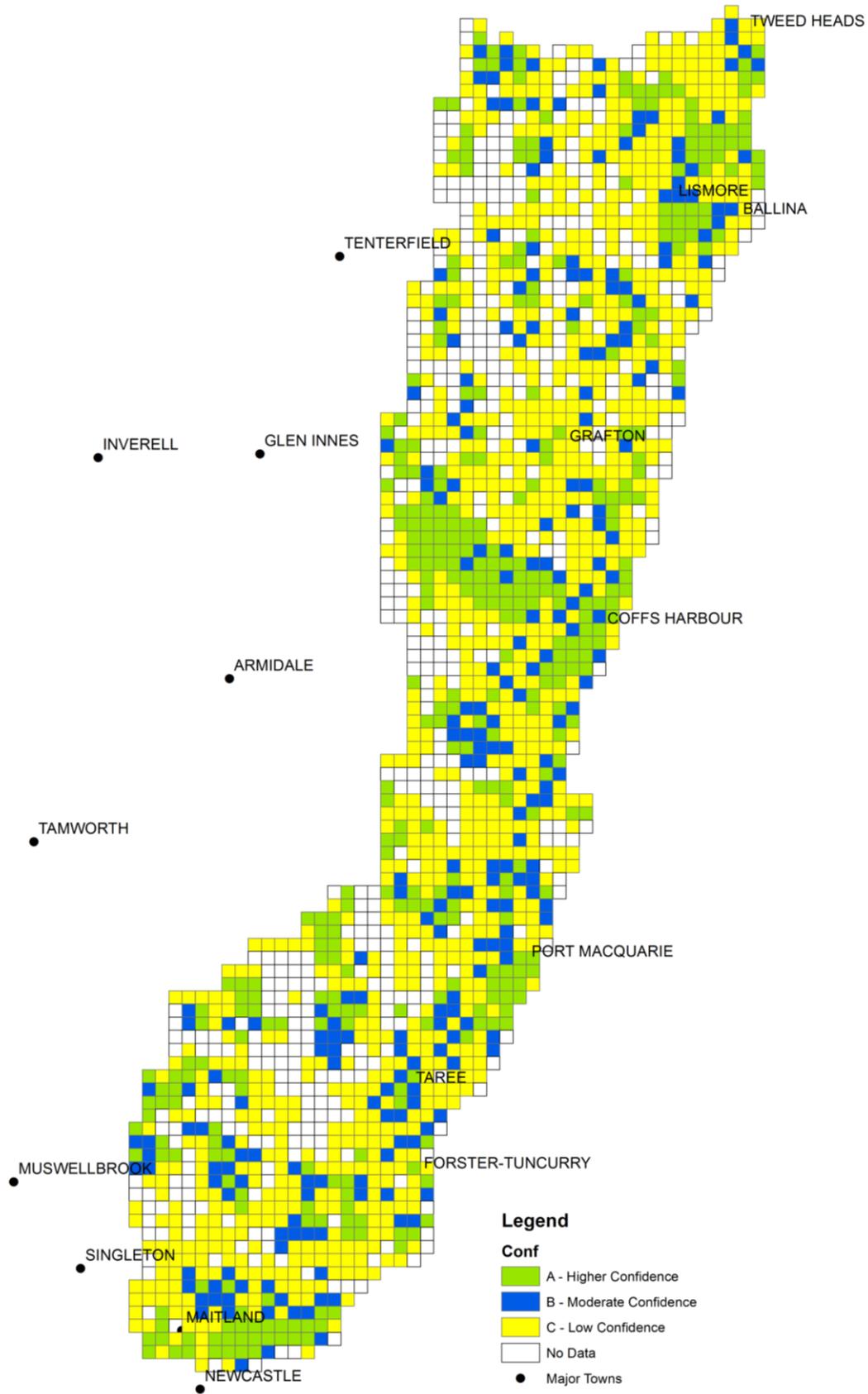


Figure 4: Koala baseline mapping 'confidence' for KMA1 using the modified underlying data.

Modification of the preliminary map of the likelihood of koalas within NSW

The breakdown of the resulting data by KMA is shown in Table 1 (p-values) and Table 2 (confidence categories). For reference and comparisons the breakdown of data in the original mapping (Predavec et al 2014) are shown in Table 3 (p-values) and Table 4 (confidence categories).

**Table 1: The number (and percentage) of cells with each estimate of the likelihood of Koalas (p). Colours correspond approximately with the categories used in the maps in the report. Data are from the modified koala baseline map described in this report.**

Koala Management Area (KMA) at 10 km									KMA1 (5 km)
p	1	2	3	4	5	6	7	State	
0	67 (13%)	122 (40%)	102 (60%)	222 (36%)	466 (55%)	469 (14%)	168 (7%)	1616 (19%)	449 (23%)
0.1	124 (25%)	98 (32%)	46 (27%)	80 (13%)	41 (5%)	14 (0%)	6 (0%)	409 (5%)	150 (8%)
0.2	69 (0.14%)	25 (8%)	3 (2%)	25 (4%)	16 (2%)	19 (1%)	2 (0%)	159 (2%)	145 (8%)
0.3	49 (10%)	12 (4%)	2 (1%)	14 (2%)	14 (2%)	11 (0%)	3 (0%)	105 (1%)	8 (0%)
0.4	48 (10%)	9 (3%)	3 (2%)	7 (1%)	12 (1%)	17 (1%)	0 (0%)	96 (1%)	110 (6%)
0.5	33 (7%)	6 (2%)	1 (1%)	22 (4%)	15 (2%)	25 (1%)	1 (0%)	103 (1%)	124 (6%)
0.6	28 (6%)	5 (2%)	0 (0%)	2 (0%)	3 (0%)	4 (0%)	1 (0%)	43 (1%)	143 (7%)
0.7	23 (5%)	3 (1%)	2 (1%)	7 (1%)	5 (1%)	16 (0%)	1 (0%)	57 (1%)	52 (3%)
0.8	9 (2%)	1 (0%)	0 (0%)	2 (0%)	7 (0%)	6 (0%)	0 (0%)	25 (0%)	71 (4%)
0.9	17 (3%)	2 (1%)	1 (0%)	1 (0%)	4 (0%)	20 (1%)	0 (0%)	45 (1%)	73 (4%)
1	20 (4%)	3 (1%)	3 (2%)	44 (7%)	25 (3%)	139 (4%)	6 (0%)	240 (3%)	17 (1%)
No Data	16 (3%)	21 (7%)	7 (4%)	196 (32%)	236 (28%)	2582 (78%)	2334 (93%)	5392 (65%)	348 (18%)
<b>Total</b>	<b>503</b>	<b>307</b>	<b>170</b>	<b>622</b>	<b>844</b>	<b>3322</b>	<b>2522</b>	<b>8290</b>	<b>1930</b>

**Table 2: The number (and percentage) of cells within each confidence category. Colours correspond with the categories used in the maps in the report. Data are from the modified koala baseline map described in this report using the same cut-off values as in the original mapping.**

Koala Management Area at 10 km									KMA1 (5km)
Confidence	1	2	3	4	5	6	7	State	
A	207 (41%)	141 (46%)	104 (61%)	120 (19%)	135 (16%)	33 (1%)	6 (0%)	746 (9%)	399 (21%)
B	140 (28%)	63 (21%)	20 (12%)	49 (8%)	64 (8%)	39 (1%)	19 (1%)	394 (5%)	255 (13%)
C	140 (28%)	82 (27%)	39 (23%)	257 (41%)	409 (48%)	668 (20%)	163 (6%)	1758 (21%)	928 (48%)
No Data	16 (3%)	21 (7%)	7 (4%)	196 (32%)	236 (28%)	2582 (78%)	2334 (93%)	5392 (65%)	348 (18.0%)
<b>Total</b>	<b>503</b>	<b>307</b>	<b>170</b>	<b>622</b>	<b>844</b>	<b>3322</b>	<b>2522</b>	<b>8290</b>	<b>1930</b>

**Table 3: The number (and percentage) of cells with each estimate of the likelihood of Koalas ( $p$ ). Colours correspond approximately with the categories used in the maps in the report. Data are from the original koala baseline map and are provided for reference and contrast.**

Koala Management Area (KMA) at 10 km									KMA1 (5 km)
$p$	1	2	3	4	5	6	7	State	
0	73 (14.5%)	133 (43.3%)	106 (62.4%)	342 (55.0%)	631 (74.8%)	1151 (34.6%)	539 (21.4%)	2975 (35.9%)	589 (30.5%)
0.1	129 (25.6%)	127 (41.4%)	45 (26.5%)	92 (14.8%)	95 (11.3%)	44 (0.3%)	6 (0.2%)	538 (0.5%)	254 (13.2%)
0.2	101 (20.1%)	28 (0.1%)	7 (0.1%)	49 (0.9%)	25 (0.0%)	58 (0.7%)	3 (0.1%)	271 (0.3%)	269 (13.9%)
0.3	70 (13.9%)	6 (0.0%)	2 (0.2%)	15 (0.4%)	13 (0.5%)	42 (0.3%)	4 (0.2%)	152 (0.8%)	177 (0.2%)
0.4	43 (0.5%)	2 (0.7%)	1 (0.6%)	15 (0.4%)	8 (0.9%)	20 (0.6%)	1 (0.0%)	90 (0.1%)	121 (0.3%)
0.5	26 (0.2%)	2 (0.7%)	3 (0.8%)	12 (0.9%)	6 (0.7%)	37 (0.1%)	1 (0.0%)	87 (0.0%)	93 (0.8%)
0.6	17 (0.4%)	0 (0.0%)	1 (0.6%)	1 (0.2%)	2 (0.2%)	18 (0.5%)	1 (0.0%)	40 (0.5%)	50 (0.6%)
0.7	13 (0.6%)	1 (0.3%)	0 (0.0%)	4 (0.6%)	4 (0.5%)	15 (0.5%)	0 (0.0%)	37 (0.4%)	52 (0.7%)
0.8	11 (0.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (0.4%)	8 (0.2%)	0 (0.0%)	22 (0.3%)	25 (0.3%)
0.9	4 (0.8%)	1 (0.3%)	0 (0.0%)	0 (0.0%)	3 (0.4%)	7 (0.2%)	0 (0.0%)	15 (0.2%)	18 (0.9%)
1	5 (0.0%)	0 (0.0%)	1 (0.6%)	19 (0.1%)	2 (0.2%)	44 (0.3%)	4 (0.2%)	75 (0.9%)	31 (0.6%)
No Data	11 (0.2%)	7 (0.3%)	4 (0.4%)	73 (11.7%)	52 (0.2%)	1878 (56.5%)	1963 (77.8%)	3988 (48.1%)	251 (13.0%)
<b>Total</b>	<b>503</b>	<b>307</b>	<b>170</b>	<b>622</b>	<b>844</b>	<b>3322</b>	<b>2522</b>	<b>8290</b>	<b>1930</b>

**Table 4: The number (and percentage) of cells within each confidence category. Colours correspond with the categories used in the maps in the report.**

Koala Management Area at 10 km									
Confidence	1	2	3	4	5	6	7	State	KMA1 (5km)
A	259 (51.5%)	209 (68.1%)	115 (67.6%)	81 (13.0%)	197 (23.3%)	44 (1.3%)	12 (0.5%)	917 (11.1%)	706 (36.6%)
B	149 (29.6%)	52 (16.9%)	24 (14.1%)	92 (14.8%)	180 (21.3%)	134 (4.0%)	40 (1.6%)	671 (8.1%)	290 (15.0%)
C	84 (16.7%)	39 (12.7%)	27 (15.9%)	376 (60.5%)	415 (49.2%)	1266 (38.1%)	507 (20.1%)	2714 (32.7%)	683 (35.4%)
No Data	11 (2.2%)	7 (2.3%)	4 (2.4%)	73 (11.7%)	52 (6.2%)	1878 (56.5%)	1963 (77.8%)	3988 (48.1%)	251 (13.0%)
<b>Total</b>	<b>503</b>	<b>307</b>	<b>170</b>	<b>622</b>	<b>844</b>	<b>3322</b>	<b>2522</b>	<b>8290</b>	<b>1930</b>

The modified underlying data and the restriction of 'other species' to arboreal mammals has resulted in an overall shift in the distribution of  $p$ -values towards the higher end (i.e. towards  $p = 1$ ). This is expected since  $p$  is calculated as the proportion of records in a cell that are koalas and restricting the 'other species' to arboreal mammals reduces the overall number of records. The change in the data has also resulted in a higher percentage of cells with no

records ('no data') increasing to 65% of cells across the state compared to 45% of cells in the original map. The increase is particularly pronounced in KMA7 where the percentage of cells with no data has increased to 93% compared to 78% in the original map.

We compared the p-values in cells using the two datasets (original and modified) and using the 10-km cells across the state. Comparison was made using a Spearman rank correlation (SAS Enterprise Guide Version 6.1). Only cells that had data present in both maps were included. There was a significant correlation between the p-values using the two different dataset ( $r=0.89$ ,  $p<0.0001$ ). The correlation coefficient increased slightly when considering only those cells that had 'high confidence' in the original report ( $r= 0.91$ ,  $p<0.0001$ ).

## 5 Testing the baseline map

The original baseline map was tested against published koala habitat mapping (OEH 2014) and the study concluded there was broad agreement between koala likelihood of occurrence mapping and the locally derived koala habitat mapping. It goes on to state that given the inherent differences between the two mapping methods it would be unrealistic to expect perfect concurrence.

The workshop participants recommended that the baseline mapping be compared with an independent survey method and it was recommended that Spot Assessment Technique (SAT) surveys (Phillips and Callaghan 2011) are used for the comparison.

Four sets of SAT data were available and suitable to use at the scale of a local government area.

1. Coffs Harbour: These data were collected by OEH in 2011 as part of a LGA –scale study of changes in koala population (Lunney et al *in review*).
2. Port Macquarie: These data were collected by Steve Phillips and contributed to the preparation of the Comprehensive Koala Plan of Management.
3. East Kempsey: These data were collected by Steve Phillips and contributed to the preparation of the Comprehensive Koala Plan of Management.
4. Bellingen: These data were collected by OEH and contributed to the preparation of the Comprehensive Koala Plan of Management (OEH 2013).

Importantly, the comparison SAT data are not included in the Atlas of NSW Wildlife and therefore are a measure of koala activity independent of the baseline koala map derived from the Atlas data.

For each SAT point the p-value from the koala baseline map was determined using ArcMap (version 10.1). For each cell that contained SAT sites the tree data were summed to provide an overall level of koala activity for that cell (taken as the proportion of trees searched that showed evidence of koalas including actual koalas, scats or scratches). The distribution of baseline mapping cells (10 kilometres) and SAT points within Coffs Harbour are shown in Figure 5 as an example.

A Spearman rank correlation was calculated between koala activity derived from the SAT data and the underlying koala baseline map p-value. The correlation was calculated using all cell data and then repeated using only those cells that had a high confidence level in the baseline mapping. Data from the four LGAs were analysed as a group and then separately.

The analysis shows that there is a strong positive relationship between the koala baseline mapping and the activity level of koalas shown by the SAT data. This pattern holds generally at both the 10 kilometres and 5 kilometres grid level and using all data and only the high confidence level cells (Table 5). It appears that the correlations are not significant when the N value is less than 10 (see Bellingen in Table 5). This pattern is generally consistent across all four LGAs tested.

There is no expectation of a perfect correlation given that the two datasets are derived in very different ways: The baseline mapping represent the likelihood of koalas based on 25 years of data, whereas the SAT data represent a snapshot in time. However the strong and significant correlations suggest that the baseline map does provide a good index of koala occurrence.

Modification of the preliminary map of the likelihood of koalas within NSW

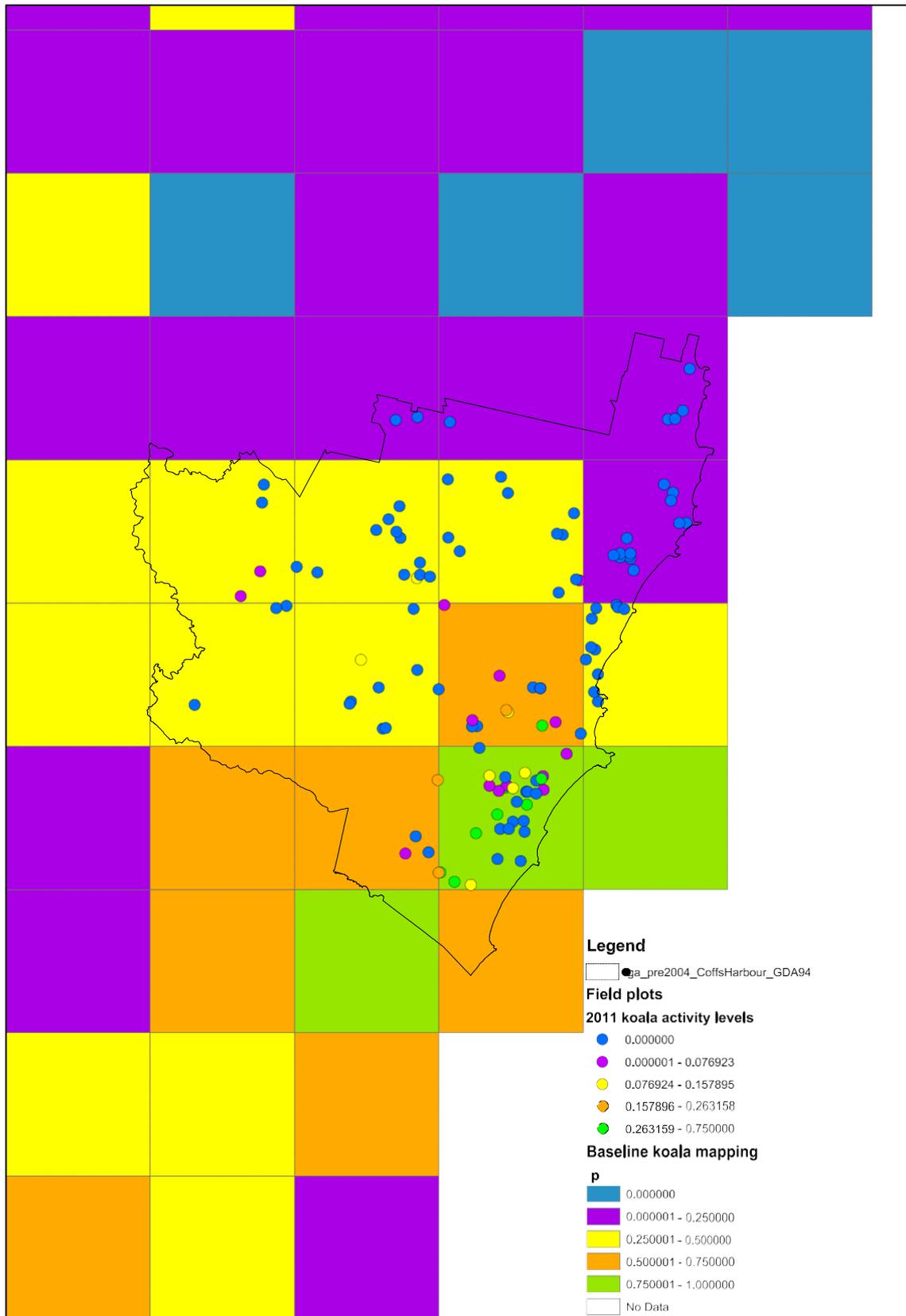


Figure 5: Koala baseline mapping (p-values) and koala activity at SAT points for Coffs Harbour on the north coast of NSW

**Table 5: Results of the spearman rank correlation tests for the four SAT datasets compared to the koala baseline mapping. Numbers in bold are statistically significant.**

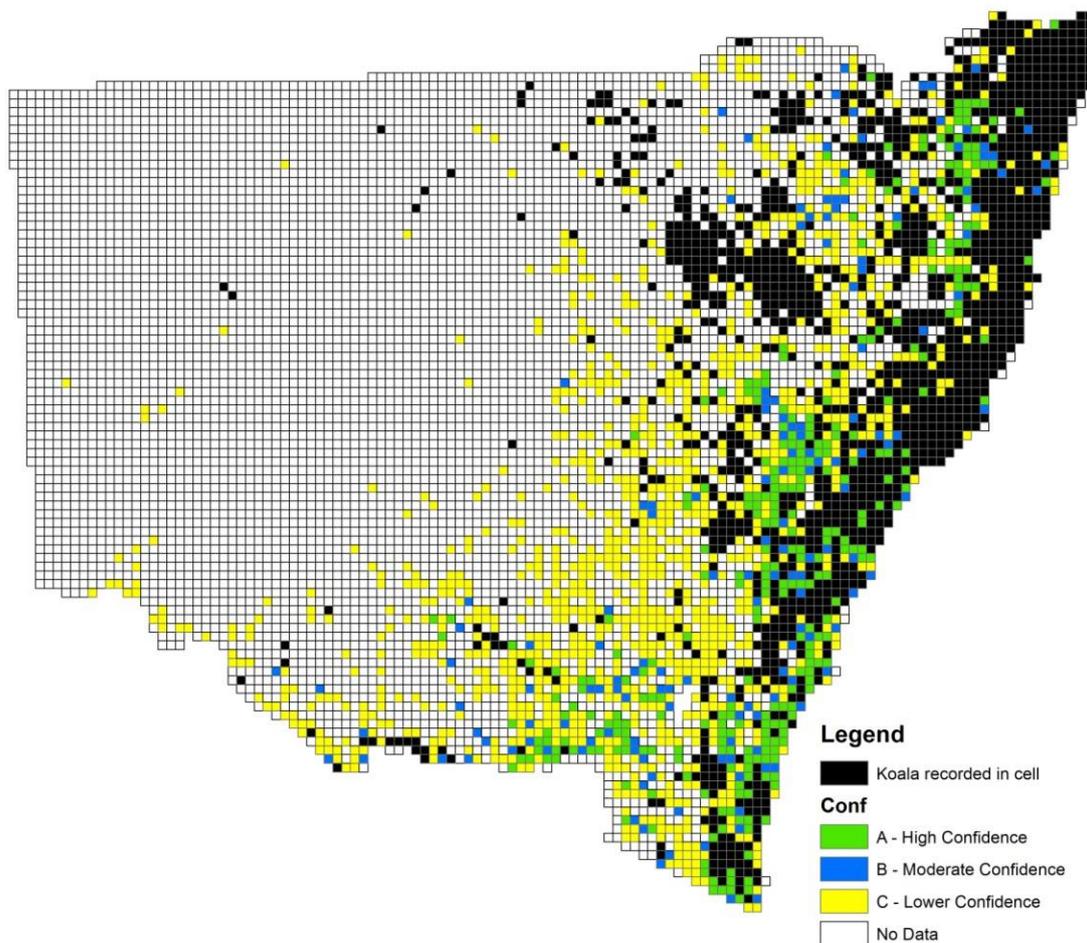
LGA	Number SAT sites	Grid Cell Size	Confidence	N (cells)	r	p
All 4 LGAs	902	5km	All	174	<b>0.404</b>	<b>&lt;0.0001</b>
		5km	High	59	<b>0.5</b>	<b>&lt;0.0001</b>
		10km	All	76	<b>0.425</b>	<b>0.0001</b>
		10km	High	38	<b>0.58</b>	<b>0.0001</b>
Bellingen	134	5km	All	19	<b>0.686</b>	<b>0.0012</b>
		5km	High	6	0.2	0.704
		10km	All	8	0.455	0.257
		10km	High	4	0.8	0.2
Coffs Harbour	119	5km	All	32	<b>0.53</b>	<b>0.0018</b>
		5km	High	17	<b>0.743</b>	<b>0.0006</b>
		10km	All	13	<b>0.673</b>	<b>0.0117</b>
		10km	High	10	<b>0.9317</b>	<b>&lt;0.0001</b>
East Kempsey	109	5km	All	29	<b>0.5269</b>	<b>0.0033</b>
		5km	High	5	<b>-0.335</b>	<b>0.5811</b>
		10km	All	15	<b>0.6798</b>	<b>0.0053</b>
		10km	High	4	0.6325	0.368
Port Macquarie	540	5km	All	94	<b>0.3073</b>	<b>0.0026</b>
		5km	High	31	<b>0.6189</b>	<b>0.0002</b>
		10km	All	40	<b>0.3665</b>	<b>0.200</b>
		10km	High	20	<b>0.591</b>	<b>0.006</b>

## 6 Using the koala baseline map

The baseline koala map can be used in a number of different ways, some of which are discussed in this section.

### 6.1 Use the map to indicate confidence in koala absence data

One possible use of the map is to take the presence of koalas as a simple binomial yes/no based on the presence of one or more records within a cell. The assessment of confidence in the data are then focussed only on those cells in which a koala has not been recorded. This is shown across the State with 10 kilometres grid cells in Figure 6.



**Figure 6: Confidence in the data for cells in which koalas are absent. The presence of koalas is shown as a single category.**

This use of the map would in many ways be similar to the current provisions for the koalas under the PNF Codes of Practice (outside of mapped core koala habitat under an approved CKPoM), which places restrictions on logging on sites that either have a koala record or that are within 500 metres of a koala record. Where the map would provide an improvement on the current procedure is that it allows a level of confidence in the extent of data to be added to the cells in which koalas have not been recorded and to direct where further work should be undertaken.

A quick inspection of Figure 6 suggests that this use of the map is likely to be of limited use given that almost all cells within KMA1 have at least one koala record (only 83 cells out of

503 in KMA1 have no koalas). This use does not take advantage of the data available for cells in which koalas have been recorded.

## 6.2 Use the map to indicate data deficient areas

An extension of the use outlined in Section 6.1 is to use the cell confidence levels across all cells, regardless of whether or not koalas are present (refer to Figure 2). The confidence levels can be used to direct future field survey towards areas where the most benefits could accrue or to help refine models that include absence data (i.e. are they likely true absences). The map can be used in this manner in addition to using it to assist in setting prescriptions (see Sections 6.3 and 6.4).

## 6.3 Using the map by itself

A method was proposed in the original report for using the baseline map to determine the level of prescription. This leant heavily on further survey (or expert opinion) in areas with low confidence. This method is not repeated here and reference should be made to the earlier document (Predavec et al 2014). Cut-off levels for both the likelihood value and the confidence value categories should be determined with expert input.

## 6.4 Using the map in conjunction with vegetation or habitat mapping

The method described in the earlier report and Section 6.3 can be expanded if vegetation mapping or habitat mapping is available. In this situation a decision matrix can be developed with the likelihood of koalas being present on one axis and the suitability of habitat on the second axis (Table 6). Cells with low confidence or no data would either need to be dealt with before data are applied to the matrix or else can be factored in as shown in Table 6. The level of prescription should take into consideration what is likely to be protected. The example shown in Table 6 could be simplified to have less categories (e.g. a 2 x 2 matrix).

**Table 6: Example of how the baseline mapping might be used in conjunction with habitat mapping**

		<b>Koala Baseline mapping</b>			
		<b>Likelihood of koalas (high confidence cells)</b>			<b>Low confidence cells</b>
		<b>High</b>	<b>Medium</b>	<b>Low</b>	
<b>Habitat suitability</b>	<b>High</b>	Prescription level 1	Prescription level 2	Prescription level 3	Assume High likelihood or else collect more data to increase confidence
	<b>Medium</b>	Prescription level 2	Prescription level 3	Prescription level 4	
	<b>Low</b>	Prescription level 3	Prescription level 4	Prescription level 5	

## 7 Process for updating the koala baseline map

The koala baseline map can, and should, be updated on a regular basis as new data become available. An update every two years is likely to be sufficient or on an as needs basis.

It is recommended that each new iteration of the map is based on a moving search window with a fixed length of time rather than an expanding window. It should be recognised, however, that a moving fixed window of time may result in a reduction in both the likelihood of koalas and the confidence in the data, and such changes will need to be dealt with depending on how the map is used.

1. Complete an Atlas of NSW Wildlife search ([www.bionet.nsw.gov.au/](http://www.bionet.nsw.gov.au/)). The search can either be incremental or a complete new search for the search timeframe window. Maintain a separate spreadsheet for koalas and then another for all arboreal mammals (including koalas).
2. Filter/modify the data so as to:
  - a. Remove observations made outside of NSW.
  - b. Remove data with spatial accuracy greater than 10 kilometres.
  - c. Remove data with suspect observation type (e.g. 'beached' koalas).
  - d. Remove duplicates (and triplicates) where the same data has been entered multiple times.
  - e. Remove other duplicate data – same species, location and date.
  - f. For scat data (observation type code P) remove duplicates of species, person and date. This accounts for the star searches.
  - g. Convert each scat record to one animal (i.e. in the 'number of animals observed' field often the number of scats was recorded).
3. Import the filtered data into ARC GIS as point data.
4. Use a 'clean' State\_10km\_grid or KMA1\_5km grid file (i.e. a file that doesn't have any animal data included). Using ArcGis and the 'spatial join' function, join the point layer (either koalas or all arboreals) to the relevant grid layer. Select 'sum' from the summarising options. The important field to be summed is the "number of animals observed' field. This will give a new field of the number of animals observed per cell. The join function will create a new shape file in ArcGis.
5. Open the database file (.dbf) associated with the newly created shapefile in Excel. Ensure that the data are sorted by increasing CellID. Copy the new data to the relevant columns in the 'Koala Baseline Mapping\_Calculations sheet.xls' file. This file contains columns for current data and additional data and separate spreadsheets for the 10km and 5km (KMA1) grids. If the database searches are totally new and all inclusive then use on the current or new columns (not both). If the dataset searches are incremental then use both the current and additional columns. Both spreadsheets will calculate the likelihood and binomial confidence intervals based on the data that you enter.
6. Select all data in a sheet and copy and paste special (values only) to a new workbook. Save the workbook to your computer.
7. In ArcGIS use the 'Attribute join' function to join the newly saved data to the relevant clean grid cell shape file.

## 8 Process for testing other koala models

EPA are considering a number of different models relating to koalas in addition to the baseline mapping discussed in this report. These include:

- A MaxEnt model completed by Brad Law of the Forestry Corporation of NSW
- A Boosted Tree Regression Model completed by Allen McIlwee of EPA Coffs Harbour.

All three models are quite different from each other in how they are run and in particular what they model (e.g. koala presence or potential koala habitat). Prior to any testing of the models, the nature of the modelled output should be clearly identified.

There is no absolute measure of koala abundance and distribution against which the models can be tested. However SAT data does provide a spatial estimate of koala activity against which the models can be tested, in a manner similar to testing the baseline mapping in Section 5. The SAT data used in Section 5 of this report are not included in the Atlas of NSW Wildlife and therefore can be considered an independent dataset for the comparison.

## 9 References

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