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North Coast Koala Habitat Mapping Pilot

Field Validation and Accuracy Assessment

Prepared for
NSW Environment Protection Agency

17 November 2015

DOCUMENT TRACKING

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Abbreviations

Abbreviation	Description
ELA	Eco Logical Australia Pty Ltd
EPA	NSW Environmental Protection Agency
GPS	Global Positioning System
KFT	Koala Food Tree
NSW	New South Wales
PFC	Projected Foliage Cover

1 Introduction

NSW Environment Protection Authority (EPA) has recently trialled a mapping approach on the North Coast of NSW which aims to capture the distribution of Koala habitat. The project aims to develop an improved method of mapping Koala habitat to better inform decisions regarding threatened species habitat protection in regard to forestry operations.

The trial approach involves relating the cover score of Koala food trees to vegetation mapping. This project aims to determine the accuracy of mapping across four trial areas.

2 Study Area

The study area includes four pilot areas on the North Coast of NSW; Clouds Creek, Maria River, Royal Camp east and Carwong State Forests (Figure 1).
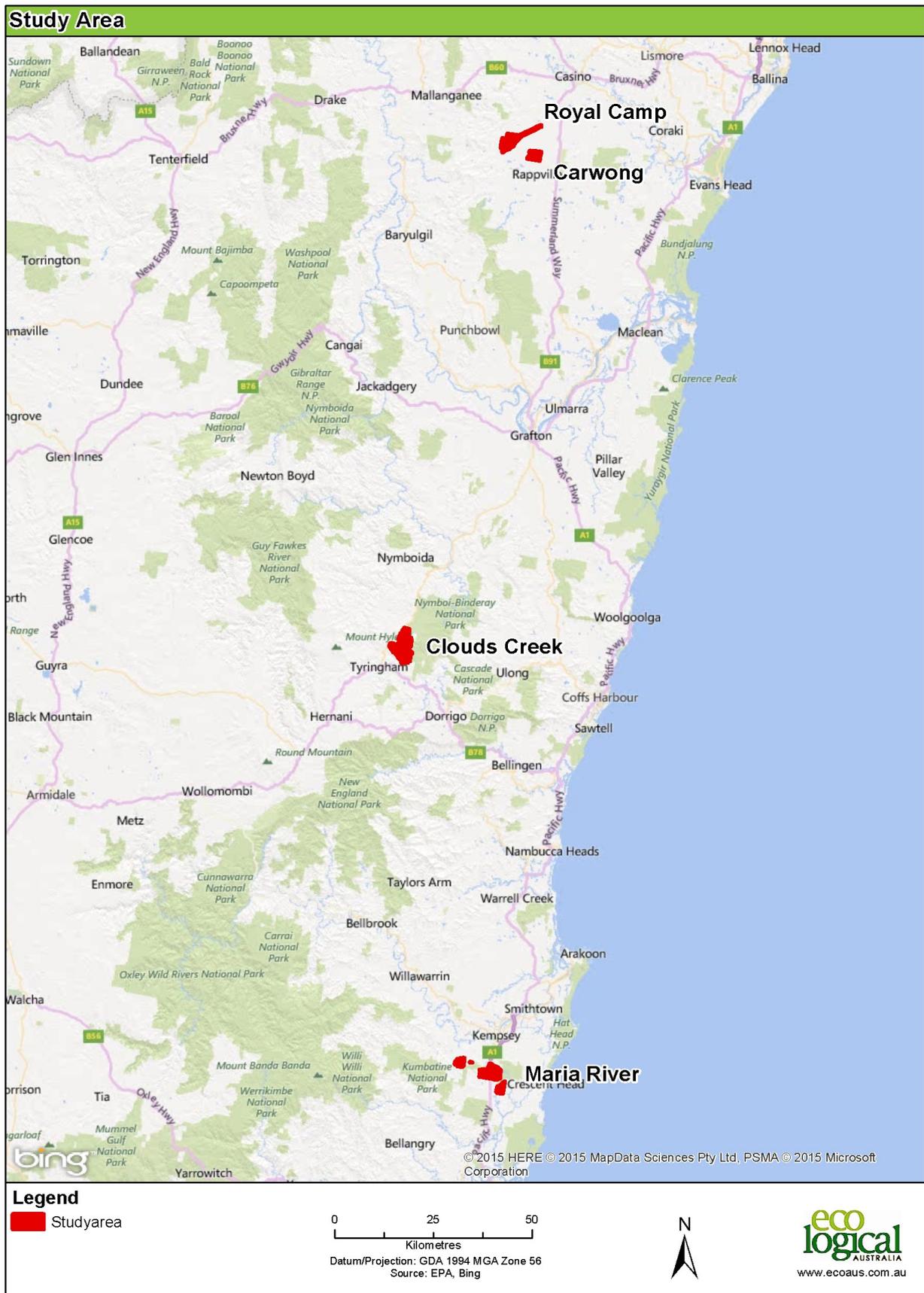
Figure 1: Study area

3 Methods

3.1 Background

The methods used for the Koala habitat accuracy assessment of mapping in the four State Forests were developed in accordance with Chapter 10 "Accuracy Assessment" of the Standards (Sivertsen 2009) to enable appropriate analysis. According to the standards, accuracy assessments must be based on an unambiguous and clearly explained method which is appropriate to the spatial and thematic scales of the product being tested, it should be done according to an equal probability design, it must deliver basic data pertaining to specific site localities, and it should result in the production of an error or confusion matrix using labelling convention detailed in Appendix 8 of the Standards (Sivertsen 2009).

The approach to accuracy assessment employed by Eco Logical Australia (ELA) involved random stratified selection of plots within vegetated areas mapped by the EPA project team. EPA selected target polygons, which were stratified by Koala Habitat class, to be surveyed using a plot based method. On completion of the polygon selection, a field reconnaissance was undertaken to collect diagnostic species information at each plot, with the objective of identifying the actual Koala habitat class at that point.

3.2 Plot Selection

To ensure a reasonable spread of plots across different koala habitat classes, EPA selected target polygons from each class within each pilot area. In addition to the target polygons, EPA selected optional or backup polygons which were only to be sampled if access to the target polygons was not possible. In this case, the replacement needed to have the same Koala habitat code thus the polygons supplied by the EPA were 'blind' coded "W, X, Y or Z". The polygons provided to ELA were further restricted to unique vegetation types to aid the identification of homogeneous areas for the placement of plots (Figure 2).

The mapping provided by the EPA was 'blind', that is Koala habitat class and vegetation type were not included. This was to ensure that EPA's attribution of Koala habitat class to individual polygons would not, or could not, influence the assessment of the Koala habitat class in the field by the ecologist conducting the field validation. Each target polygon was located in the field, a representative area was selected and a plot undertaken.

Target Polygons

Legend

- Target polygon
- Backup target polygon
- State Forest

Royal Camp SF

Carwong SF

Clouds Creek SF

Maria River SF

0   5   10
Kilometres

Datum/Projection: GDA 1994 MGA Zone 56
Source: EPA, LPI

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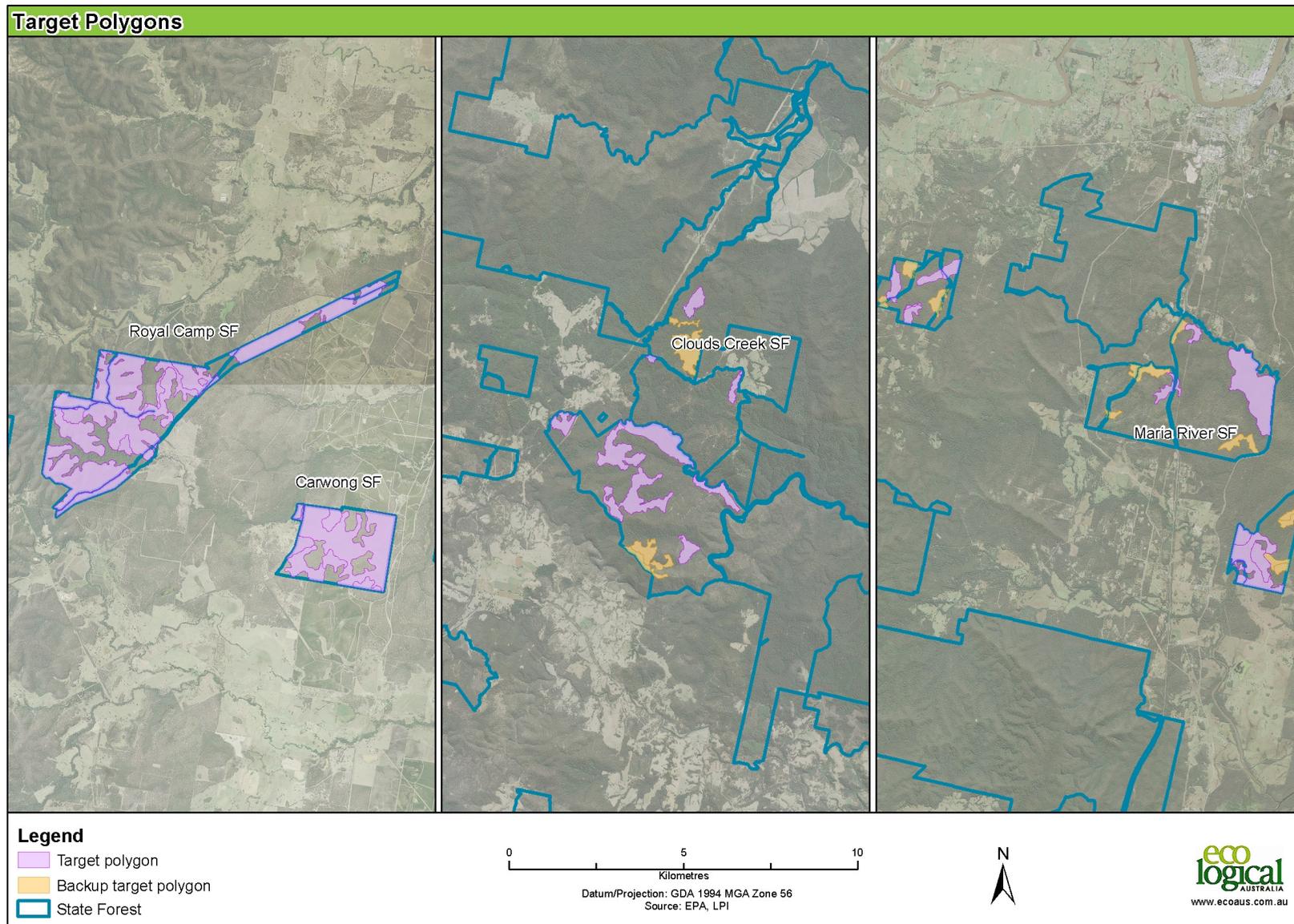
Figure 2: Target polygons

3.3 Field Assessment

Field reconnaissance was undertaken by Liz Brown in October and November 2015 (Table 1) and involved driving as close to each polygon, then walking to a representative point assisted by software 'Collector for ArcGIS' installed on a mobile device. Each validation plot was defined as a view-shed up to a maximum area of 0.79 ha (50m radius sweep).

Table 1: Field survey dates

Pilot Area	Survey Date
Royal Camp State Forest	2/11/2015
Carwong State Forest	3/11/2015
Clouds Creek State Forest	19/10/2015
Maria River State Forest	20/10/2015

A field validation proforma was provided by EPA (Appendix A) for the fieldwork which recorded the following attributes:

- Location - State Forest Name and Compartment number
- Date
- EPA Site Number
- Recorder
- Coordinates
- Position in quadrat
- Elevation (GPS)
- Base Plot size
- Structure
- Upper stratum cover (Projected Foliage cover, PFC %)
- Upper stratum Height – min and max (m)
- Upper stratum species name, growth form, Koala Food Tree (KFT), PFC (%)
- Total KFT PFC
- Keith Class
- Soil Fertility
- Ground Layer
- Koala evidence
- Plot disturbance > 50%

For the purposes of determining Koala habitat class for this pilot project, EPA provided a list of species to be considered KFTs. It is acknowledged that other species will be foraged and utilised when in association with those listed below;

- Tallowwood (*Eucalyptus microcorys*)

- Swamp Mahogany (*Eucalyptus robusta*)

- Small Fruited Grey Gum (*Eucalyptus propinqua*)

- Forest Red Gum (*Eucalyptus tereticornis*)

- Slaty Red Gum (*Eucalyptus glaucina*)

- Orange Gum (*Eucalyptus bancroftii*)

- Grey Gum (*Eucalyptus biturbinata*)

- Grey Box (*Eucalyptus moluccana*)

The main objective of the validation fieldwork was to ascertain the Koala habitat class occurring at each plot, on the basis of its dominant upper stratum species, presence of KFTs and cover.

3.4 Data Analysis

3.4.1 Field Data Preparation
Following field reconnaissance all plot data was entered into an excel spreadsheet and Koala class was calculated using the following equation.

Koala Class = (total KFT PFC% / upper stratum PFC %)

Koala Class was then grouped into four categories (Table 2) with Class 1 being considered the best or primary Koala habitat.

Table 2: Koala habitat classes

Koala Class	Koala Habitat Class
≥30%KFT	Class 1
>15<30%KFT	Class 2
<15%KFT	Class 3
No local KFT	Non-Habitat

The excel spreadsheet was transferred into a single ArcGIS point layer. This layer included a column in the attribute table for the Koala habitat class.

3.4.2 Accuracy Assessment
The Koala habitat mapping was provided by EPA following completion of the field validation. The plot data were intersected spatially with the mapped polygons to determine the level of Koala habitat

correspondence between polygon and plot data. This was facilitated by constructing a confusion matrix for each area based on the Standards (Sivertsen 2009), comprising a row for each Koala habitat class mapped, and a column for each of the following three classes of correctness (Gopal and Woodcock 1994, Table 3):

1. Absolutely Right: no doubt about the match. Perfect.
   (field and mapped Koala habitat class the same.)

2. Reasonable or Acceptable Answer: May not be the best possible but is acceptable; this does not pose a problem to the user if it is seen on the map. Right.
   (the mapped Koala habitat class not same as observed in the field, but within plus or minus 7.5% of the Koala class, Table 2).

3. Absolutely Wrong: absolutely unacceptable. Very wrong.
   (the mapped Koala habitat class differs markedly from that sampled in the field).

Table 3: Assignment of correctness class

Mapped Koala Habitat Class	Observed Koala Class (KFT PFC %)	Level of Correctness
Class 1	>=30	1 – Absolutely right
	>=22.5 to 30	2 – Reasonable
	< 22.5	3 – Wrong
Class 2	>=37.5 or < 7.5	3 – Wrong
	>=30 to 37.5 or >=7.5 to 15	2 – Reasonable
	>=15 to 30	1 – Absolutely right
Class 3	>=22.5	3 – Wrong
	>=15 to 22.5	2 – Reasonable
	< 15	1 – Absolutely right

An example of the confusion matrix is shown in Table 4. In this example, 19 of 33 plots are absolutely right and 10 of 33 plots are reasonable, an overall acceptable accuracy of 29/33. Conversely, 4 of 33 plots are absolutely wrong.

Table 4: Example of confusion matrix used for map accuracy assessment

	Level of Correctness (against field NSWVCA type)			
Mapped Koala habitat type	**1**	**2**	**3**	**All**
Map Unit A	5	4	1	10
Map Unit B	11	2	2	15
Map Unit C	3	4	1	8
All	19	10	4	**33**

4 Results

4.1   Plot Distribution

A total of 36 plots were completed within the four pilot areas (Table 5, Figure 3).

Table 5: Allocation of plots to the pilot areas

| Pilot Area	Number of plots
Carwong State Forest	7
Clouds Creek State Forest	9
Maria River State Forest	11
Royal Camp State Forest	9
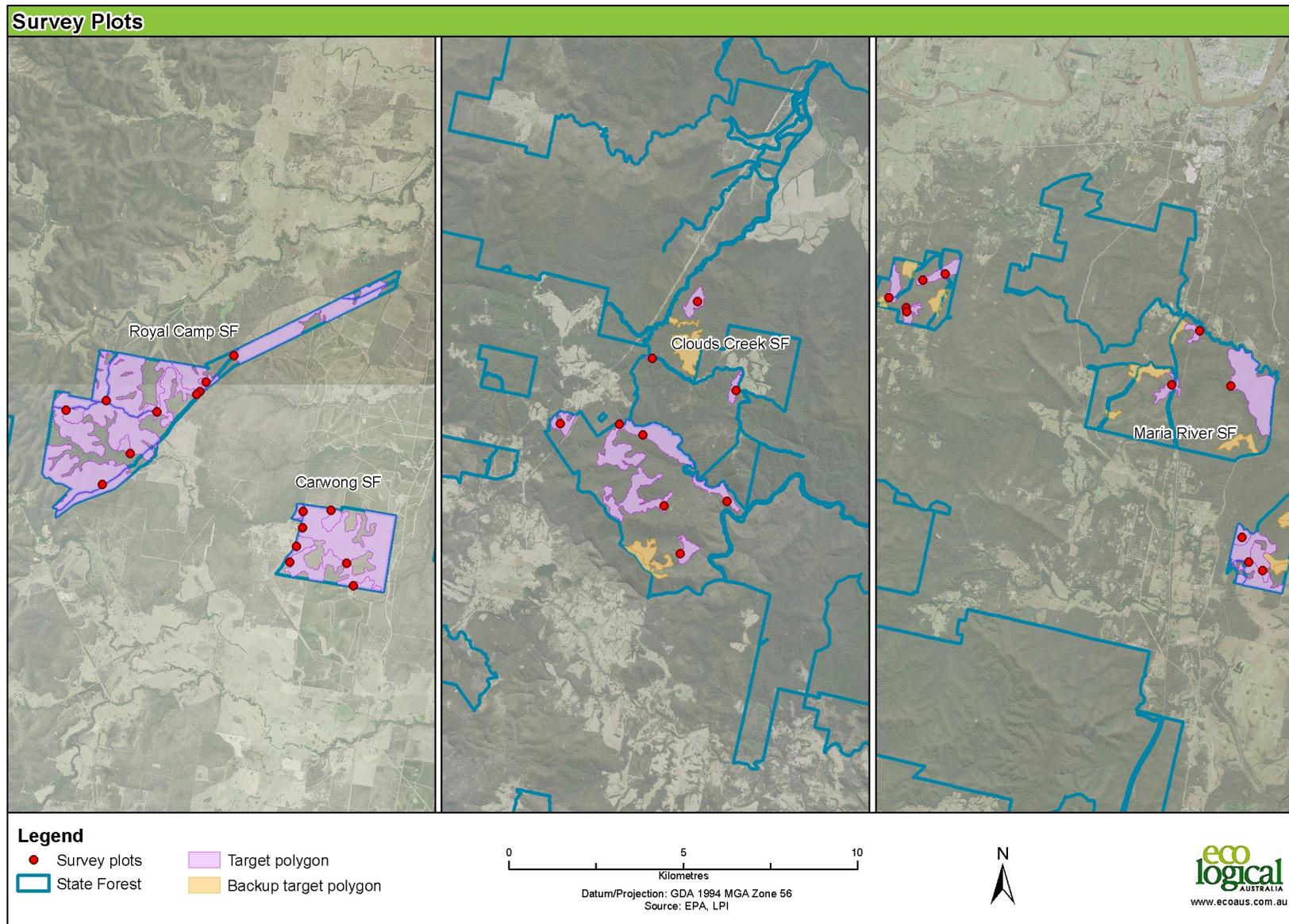
Figure 3: Location of field sampling plots

4.2   Field Assessment

Of the 36 plots surveyed, all were located within the target polygons, none of the backup polygons were sampled. Significant rain fell prior to the last day of field survey at Cawong SF making the tracks un-drivable. Field work was undertaken on foot which limited the time available to select representative plots within the target polygons.

4.3   Data Analysis

Figure 4 shows the distribution of verification plots within the four pilot areas according to the three classes of correctness. The data are summarised in the final row of Table 6 with data for individual pilot areas provided in Table 7.

Of the 36 plots used in this assessment, a total of 7 plots (19%) occupied polygons which matched their field habitat class, 11 plots (31%) occupied polygons with the next closest habitat class and 18 plots (50%) occupied polygons tagged with a quite dissimilar habitat class to that recorded at the plot. Assuming that Level 1 and 2 correctness (absolutely correct and reasonable) satisfies the requirements of accuracy, then the overall accuracy of the Koala habitat mapping was 50%, at least within the spatial domain within which verification plots were selected.

The accuracy figures are based on a direct line comparison. Applying an ecotonal error margin of 10 or 25 metres may increase the over-all accuracy of the mapping products.

Table 6: Confusion matrix for Koala habitat mapping

Mapped Koala Habitat Class		Number of plots within each category of correctness *		
Class Number	Class Name	1	2	3
1 -	Greater than or equal to 30% of upper stratum cover made up by Koala food tree species	4	2	8
2 -	Greater than or equal to 15% and less than 30% of upper stratum cover made up by Koala food tree species	3	5	5
3	Less than 15% of upper stratum cover made up by Koala food tree species	0	4	5
Total	No. Plots	**7**	**11**	**18**

* 1. Absolutely correct   2,. Reasonable   3. Incorrect

It should be noted that drawing conclusions about the accuracy of the mapping, particularly between pilot areas, is problematic given the limited level of sampling (typically only three polygons were sampled for each habitat class within each area). With this in mind, the results for the individual pilot areas indicate that the mapping in Maria River has an accuracy of 73% (assuming that Level 1 and 2 correctness, absolutely correct and reasonable, satisfies the requirements of accuracy), Carwong scored 57%, Clouds Creek 44% and Royal Camp 22%. The confusion matrix for individual pilot areas is provided in Table 7 and the complete confusion matrix in Appendix C.

Table 7: Confusion matrix for Koala habitat mapping (individual pilot areas)

Mapped Koala Habitat Class	Number of plots within each category of correctness *		
Pilot Area	**1**	**2**	**3**
Carwong SF	3	1	3
Clouds Creek SF	2	2	5 -
Maria River SF	2	6	3 -
Royal Camp SF	0	2	7
Total	**7**	**11**	**18**

*   1. Absolutely correct   2,. Reasonable   3. Incorrect
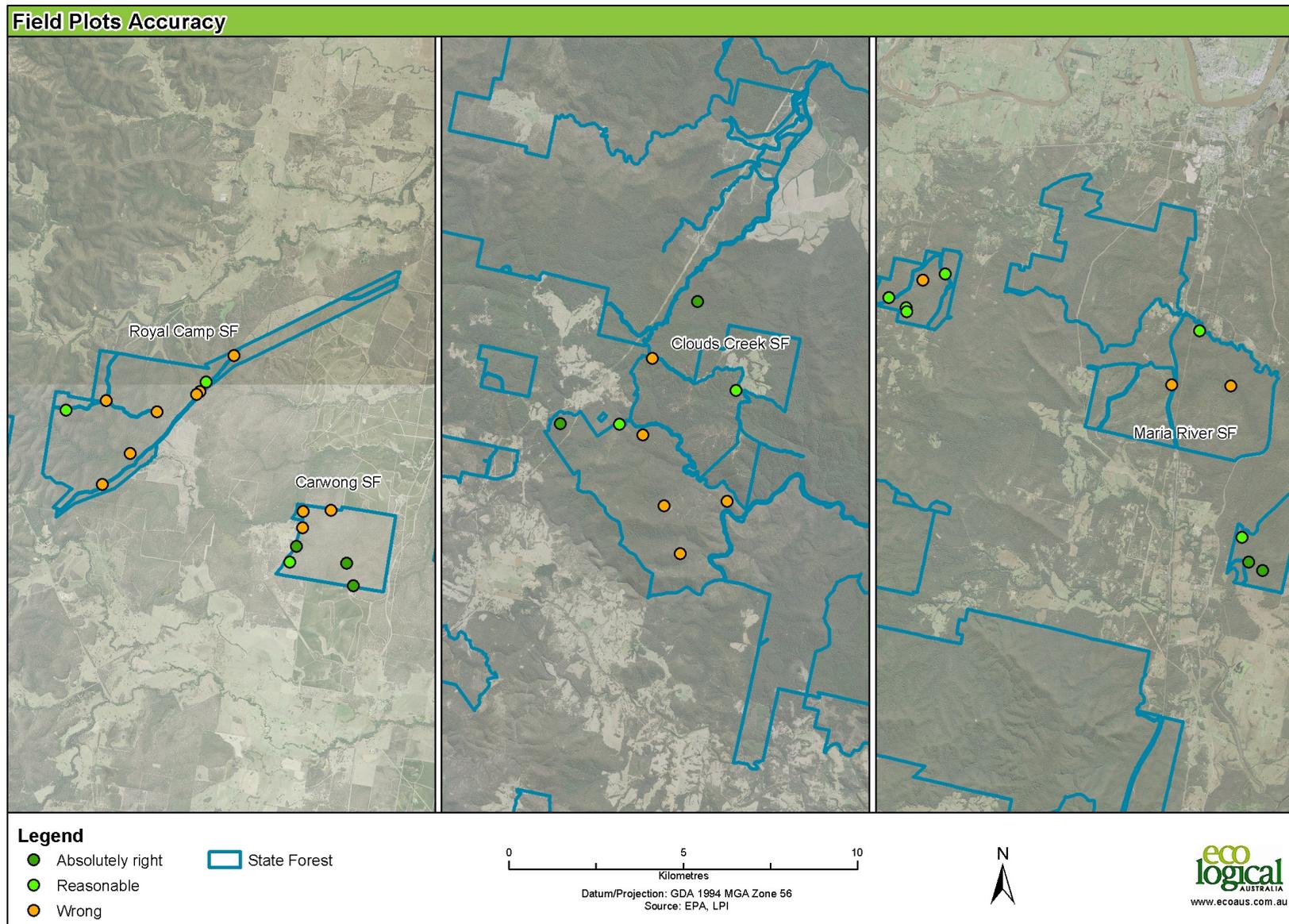
Figure 4: Field plots classified into accuracy classes

5 Discussion

The accuracy assessment undertaken in this project finds the following in relation to the accuracy of the pilot Koala habitat mapping:

- An overall map accuracy of 50% from the application of the confusion matrix which assumed that Level 1 and 2 correctness (absolutely correct and reasonable) satisfies the requirements of accuracy. This value (50%) should be used as the basis of reporting accuracy in relation to the pilot Koala habitat map.
- An exact match for 19% of plots (where the habitat class recorded at the field plot matched the type recorded within the map unit within which the plot was located).

The 50% level of map accuracy obtained in this analysis indicates that the pilot project is of insufficient standard to be rolled out across the region. The level of exact matches (19%) would suggest that the ability to differentiate between the three habitat classes is limited.

Map accuracy would be improved by simplifying the classification so that it better services the mapping process yet still addresses community needs for a Koala habitat map. Similarly recalibrating the KFT cover thresholds used to calculate the four habitat classes could be investigated as a potential way to improve map accuracy.

While drawing conclusions form a limited number of sample points is not recommended, it was noted that the accuracy for the different pilot areas differed greatly (e.g. Maria River 73%, Royal Camp 22%) indicating the diversity of habitat that Koalas utilise and difficulty in mapping such variation.

References

Gopal, S. and Woodcock, C. (1994). Theory and methods for accuracy assessment of thematic maps using fuzzy sets. *Photogrammetric Engineering and Remote Sensing.* 60(2): 181 – 188.

Sivertsen, D (2009) *Native Vegetation Interim Type Standard*. Department of Environment, Climate Change and Water NSW, Sydney.

Appendix A Field Validation Proforma

EPA Modified RAPID Koala Habitat FIELD SURVEY FORM – _____ *Koala Habitat survey*

Location: State Forest Name:					Compartment No. :		
Date		EPA Site No.		Recorder(s)			
AMG grid reference (if not using fulcrum)	zone	datum	Easting		Northing	Position in quadrat	Elevation(GPS)
Base Plot size	50m radius sweep						

NVIS Level V (within 0.79 ha circle)

Structure
Regeneration (>50%)
Mature and Over Mature (>50%)
Mixed (50:50)

Upper stratum Cover (PFC %)

Upper stratum Height (m)	
Min	Max

Stratum	Growth form	Species name	KFT (yes/no)	PFC % for each species
Upper	Tree			
Upper				
Upper				
Upper				
Upper				
Total KFT PFC%				
Koala Class (total KFT PFC% / upper stratum PFC %)				

Growth form: T=tree, M=mallee tree,
Cover %(PFC): <1,1,2,3,4,5, 10,15,20,25,30,35%

Rapid Koala Habitat assessment

Keith Class	Wet Sclerophyll				Dry Sclerophyll	
Soil Fertility	Fertile				Infertile	
Ground Layer	Shrub	Grass	Rainforest	Fern	Heath	Sedge
Koala Habitat Class	Class 1 (≥30%KFT)	Class 2 (>15<30%KFT)	Class 3 (<15%KFT)		Non Habitat (no Local KFT)	
Koala Evidence	Sight				Scat	

Plot Disturbance >50%

Logging
Fire
Weeds
BMAD
Other

Koala Pilot Food Trees *(other species will be foraged and utilised when in association with those listed below, however, for the purposes of determining koala habitat classification, only the following will be assessed)*

MODULE 1: Rapid Koala Habitat Assessment

Koala Pilot Food Trees *(other species will be foraged and utilised when in association with those listed below, for the purposes of determining koala habitat classification, only the following will be assessed until utilisation data from SAT surveys provides data to support food tree listing)*

1.   Tallowwood (*E. microcorys*)

2.   Swamp Mahogany (*E.robusta*)

3.   Small Fruited Grey Gum (*E.propinqua*)

4.   Forest Red Gum (*E.tereticornis*)

5.   Slaty Red Gum (*E. glaucina*)

6.   Orange Gum (*E.bancrofti*)

7.   Grey Gum (*E.biturbinata*)

8.   Grey Box (*E.moluccana*)

MODULE 1: Rapid Koala Habitat Assessment

Appendix B Field Data

Site Number	Recorder	State Forest	Date	Zone	Datum	Easting	Northing	GPS Elevation	Base Plot Size	Upper Cover	Total KFT	Koala Class	Habitat Class	Mapped Likely Koala Habitat	Accuracy Class
MR9	Liz Brown	Maria River SF	20/10/2015	56	GDA94	482,900	6552720	35	50m radius	10	0	0	3	Koala Class 1	3
CC3	Liz Brown	Clouds Creek SF	19/10/2015	56	GDA94	461,058	6659680	700	50m radius	20	1	5	3	Koala Class 1	3
MR2	Liz Brown	Maria River SF	20/10/2015	56	GDA94	475,653	6555297	92	50m radius	10	2	20	2	Koala Class 1	3
CC5	Liz Brown	Clouds Creek SF	19/10/2015	56	GDA94	460,337	6661660	687	50m radius	20	2	10	3	Koala Class 1	3
C5	Liz Brown	Carwong SF	3/11/2015	56	GDA94	494,172	6787966	55	50m radius	10	2	20	2	Koala Class 1	3
RC8	Liz Brown	Royal Camp SF	2/11/2015	56	GDA94	488,423	6789579	90	50m radius	15	3	20	2	Koala Class 1	3
RC4	Liz Brown	Royal Camp SF	2/11/2015	56	GDA94	489,190	6790770	101	50m radius	15	3	20	2	Koala Class 1	3
RC2	Liz Brown	Royal Camp SF	2/11/2015	56	GDA94	490,428	6791339	93	50m radius	15	3	20	2	Koala Class 1	3
MR7	Liz Brown	Maria River SF	20/10/2015	56	GDA94	485,776	6547613	25	50m radius	10	3	30	1	Koala Class 1	1
CC7	Liz Brown	Clouds Creek SF	19/10/2015	56	GDA94	461,702	6665511	793	50m radius	10	4	40	1	Koala Class 1	1
CC9	Liz Brown	Clouds Creek SF	19/10/2015	56	GDA94	462,929	6663059	793	50m radius	20	5	25	2	Koala Class 1	2
C7	Liz Brown	Carwong SF	3/11/2015	56	GDA94	494,627	6786461	89	50m radius	20	11	55	1	Koala Class 1	1
MR1	Liz Brown	Maria River SF	20/10/2015	56	GDA94	476,271	6555496	85	50m radius	35	10	29	2	Koala Class 1	2
C6	Liz Brown	Carwong SF	3/11/2015	56	GDA94	494,815	6785825	83	50m radius	15	10	67	1	Koala Class 1	1
RC5	Liz Brown	Royal Camp SF	2/11/2015	56	GDA94	487,728	6791088	128	50m radius	10	0	0	3	Koala Class 2	3
CC2	Liz Brown	Clouds Creek SF	19/10/2015	56	GDA94	461,588	6658358	705	50m radius	20	1	5	3	Koala Class 2	3
MR8	Liz Brown	Maria River SF	20/10/2015	56	GDA94	485,374	6547824	8	50m radius	10	3	30	1	Koala Class 2	1
C2	Liz Brown	Carwong SF	3/11/2015	56	GDA94	493,186	6786939	69	50m radius	10	3	30	1	Koala Class 2	1
MR4	Liz Brown	Maria River SF	20/10/2015	56	GDA94	475,213	6554493	80	50m radius	35	5	14	3	Koala Class 2	2
MR11	Liz Brown	Maria River SF	20/10/2015	56	GDA94	483,617	6554285	33	50m radius	35	5	14	3	Koala Class 2	2
C4	Liz Brown	Carwong SF	3/11/2015	56	GDA94	493,373	6787928	53	50m radius	10	5	50	1	Koala Class 2	3
RC1	Liz Brown	Royal Camp SF	2/11/2015	56	GDA94	490,596	6791616	88	50m radius	15	5	33	1	Koala Class 2	2

Site Number	Recorder	State Forest	Date	Zone	Datum	Easting	Northing	GPS Elevation	Base Plot Size	Upper Cover	Total KFT	Koala Class	Habitat Class	Mapped Likely Koala Habitat	Accuracy Class
CC1	Liz Brown	Clouds Creek SF	19/10/2015	56	GDA94	457,967	6661845	845	50m radius	30	5	17	2	Koala Class 2	1
C1	Liz Brown	Carwong SF	3/11/2015	56	GDA94	492,990	6786500	66	50m radius	20	7	35	1	Koala Class 2	2
C3	Liz Brown	Carwong SF	3/11/2015	56	GDA94	493,356	6787469	59	50m radius	20	10	50	1	Koala Class 2	3
MR5	Liz Brown	Maria River SF	20/10/2015	56	GDA94	475,235	6554384	90	50m radius	30	10	33	1	Koala Class 2	2
RC3	Liz Brown	Royal Camp SF	2/11/2015	56	GDA94	490,322	6791255	85	50m radius	20	10	50	1	Koala Class 2	3
MR3	Liz Brown	Maria River SF	20/10/2015	56	GDA94	474,698	6554753	105	50m radius	5	1	20	2	Koala Class 3	2
MR6	Liz Brown	Maria River SF	20/10/2015	56	GDA94	485,141	6548523	25	50m radius	10	2	20	2	Koala Class 3	2
CC6	Liz Brown	Clouds Creek SF	19/10/2015	56	GDA94	459,650	6661924	685	50m radius	15	3	20	2	Koala Class 3	2
CC4	Liz Brown	Clouds Creek SF	19/10/2015	56	GDA94	462,845	6659902	650	50m radius	30	12	40	1	Koala Class 3	3
RC6	Liz Brown	Royal Camp SF	2/11/2015	56	GDA94	486,587	6790806	137	50m radius	25	5	20	2	Koala Class 3	2
RC7	Liz Brown	Royal Camp SF	2/11/2015	56	GDA94	487,617	6788697	110	50m radius	25	6	24	2	Koala Class 3	3
RC9	Liz Brown	Royal Camp SF	2/11/2015	56	GDA94	491,399	6792368	69	50m radius	15	5	33	1	Koala Class 3	3
MR10	Liz Brown	Maria River SF	20/10/2015	56	GDA94	484,594	6552781	25	50m radius	40	10	25	2	Koala Class 3	3
CC8	Liz Brown	Clouds Creek SF	19/10/2015	56	GDA94	460,500	6663827	865	50m radius	30	10	33	1	Koala Class 3	3

Appendix C Confusion Matrix

Mapped Koala Habitat Class		Number of plots within each category of correctness *		
Pilot Area	Class Number	1	2	3
Carwong SF	1	2	0	1
Carwong SF	2	1	1	2
Carwong Total	No Plots	**3**	**1**	**3**
Clouds Creek SF	1	1	1	2
Clouds Creek SF	2	1	0	1
Clouds Creek SF	3	0	1	2
Clouds Creek Total	No Plots	**2**	**2**	**5**
Maria River SF	1	1	1	2
Maria River SF	2	1	3	0
Maria River SF	3	0	2	1
Maria River Total	No Plots	**2**	**6**	**3**
Royal Camp SF	1	0	0	3
Royal Camp SF	2	0	1	2
Royal Camp SF	3	0	1	2
Royal Camp Total	No Plots	**0**	**2**	**7**
Total	No. Plots	**7**	**11**	**18**

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