



## **Tweed Coast Koala Study 2015**

**December 2015**



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## Executive Summary

The reassessment of the koala population on the Tweed Coast is one of the initial actions of the recently adopted Tweed Coast Comprehensive Koala Plan of Management. The aim of this study is to determine current occupancy rates and assess changes in the distribution and levels of koala activity in the five years since the Koala Habitat Study was prepared in 2011.

Surveys were carried out between June and September 2015 and involved resampling a large proportion of those sites surveyed during the Habitat Study, utilising identical methodology. Seventy-two sites on Council owned and managed land, private land and Nature Reserve were surveyed. Records of koala sightings were collated from various sources.

Koala activity remains widespread throughout the study area, however substantially less of the available habitat is currently occupied by resident koala populations than was reported in 2011. Koala activity levels have declined significantly overall, and indicate ongoing decline of the Tweed Coast koala population as a whole. Decline is most notable in the north of the study area, between Kings Forest and Koala Beach, while activity levels and the distribution of resident populations appear stable between Koala Beach and Black Rocks.

The stability of southern populations, ongoing breeding female observations and the use of new food tree plantings by koalas are encouraging. The Tweed Coast koala population however remains at high risk of extinction. As directed by the Tweed Coast KPoM, it is vital that Council and the broader community continue working to reduce threats, and plan for the future expansion of, the koala population to a more sustainable level.

## Introduction

The Tweed Coast Comprehensive Koala Plan of Management (KPoM) lists as one of its initial actions a reassessment of Tweed Coast koala habitat. The Tweed Coast Koala Habitat Study (Phillips et al. 2011) provided a comprehensive overview of the status and threats to the koala population on the Tweed Coast. As stated in the KPoM, ongoing monitoring is essential to:

- ensure that the Plan remains relevant and that planning controls are implemented to achieve the Vision and Aims of the Plan;
- determine the effectiveness of the Plan in achieving the recovery of the Tweed Coast koala population; and
- update and respond to current knowledge on the status of the Tweed Coast koala population.

The KPoM directed an initial reassessment of koalas on the Tweed Coast to be done within 12 months of the Plan's commencement, and ongoing monitoring events at three-yearly intervals thereafter. This assessment focused on the Southern Tweed Coast KMA, located east of the Pacific Highway between Cudgen and Billinudgel Nature Reserve. This area is where the majority of the koala population was

recorded during the Habitat Study, and is therefore the focus of the KPoM's management actions.

## **Aims**

1. To determine changes in the distribution and levels of koala activity within the Southern Tweed Coast Koala Management Area within the last five years.
2. To assess changes in occupancy within the Southern Tweed Coast Koala Management Area.

## **Methods**

### **Site selection**

Field site selection was based on the field sites sampled in 2010 during the Tweed Coast Koala Habitat Study (Phillips et al. 2011). During the Habitat Study, sites were positioned using a 600 m x 600 m grid overlay to enable uniform and unbiased coverage of the study area.

In the 2015 study, sites were selected for sampling on the following basis:

- Active sites (sites where koala activity was recorded) sampled in 2010.
- Inactive sites (where no koala activity was recorded) sampled in 2010, adjacent to modelled metapopulation boundaries. Sampling at these previously unoccupied locations is most likely to detect population expansion, or a shift in distribution should this have occurred.

As directed by the KPoM, an attempt was made to incorporate the majority of sites located within the Koala Activity (KAP) and Koala Linkage Precincts (KLP), whilst working within limitations of time and funding. Additionally, in order to improve on previous knowledge and obtain a more complete understanding of koala distribution, sites located within Individual Koala Plan of Management (IKPoM) areas were also sampled, as were a number of additional sites which were not sampled during the Habitat Study.

### **Landholder engagement**

Where proposed sites occurred on privately-owned land, landholders were sent a letter requesting permission to carry out surveys on their property. A map was sent with the letter indicating the location of the survey sites. Landholders were subsequently contacted by phone to confirm permission and access arrangements. Where permission was not granted or it was not possible to make contact with the landholder, surveys were not carried out on that property.

NSW National Parks and Wildlife Service were consulted with regard to survey within Nature Reserve, and work was carried out under Scientific License.

## Sampling

In most cases, the central point of each field site that had been sampled during the Habitat Study was readily identifiable (due to the centre of the site being marked with flagging tape in 2010). Sites where the previously marked centre tree could not be found were located as close as possible to the identified coordinates. The central tree of each field site was identified with new flagging tape marked with the site number to enable future identification.

All sites were sampled using a protocol identical to that used during the Habitat Study, being the Spot Assessment Technique (SAT) methodology of Phillips and Callaghan (2011). The spot assessment technique uses a 30-tree sample to provide a measure of koala activity based on the presence of koala faecal pellets.

Field sampling was carried out between June and September 2015 by a three-person team of Council Officers, all of whom were experienced in koala faecal pellet identification, koala survey and tree species identification.

## Data analysis

### Koala activity

Koala 'activity' at each site was determined by dividing the number of trees with a koala faecal pellet by the number of trees searched in the site (a minimum of 30). Activity thresholds of Phillips and Callaghan (2011) were used to describe the results of field sites. This threshold allows interpretation of the activity level at each site in order to determine its relative importance to the koala population. The key measures on the east coast are summarised below in Table 1.

**Table 1** Summary of activity categories and their interpretation.

Activity category	Activity level	Interpretation
<b>Significant activity</b>	≥ 22.52%	Site is regularly used by one or more koalas as part of normal ranging behaviour.
<b>Low activity</b>	> 0% - 22.51%	Occasional or transitory use of the site by (for example) dispersing animals not yet displaying established home ranging movement patterns.
<b>Inactive</b>	0%	Site very infrequently used or not used at all by koalas.

The terms "significant activity", "low activity" and "inactive" are used throughout this report to describe the above scenarios.

### Koala occupancy

Occupancy rates for a) the presence of any koala activity, and b) the presence of significant activity were estimated. The first provides a measure of what proportion of available habitat is currently utilised by koalas in any way, the second indicating what proportion of habitat is occupied by resident populations, comprising the majority of the koala population. In order to do this whilst accounting for the bias introduced by

targeted field site selection, data from a subset of 21 sites were used from the primary sites sampled during the 2011 Habitat Study. These sites were those that were sampled on both occasions, were initially systematically-placed at 1,200 m intervals without regard for any prior knowledge of koala activity and comprise a representative proportion of the primary sites sampled during work for the 2011 Habitat Study. From these sites, occupancy rates were calculated for both this and the previous survey.

#### Modelling metapopulation boundaries

Activity levels at field sites were used to produce a spatial model of indicative boundaries describing the location of resident koala populations. The model was built using the thin plate spline and contour extraction functions of QGIS, assisted by the inclusion of barriers. Barriers are used to reflect the location of existing fauna exclusion fencing and major waterways.

Metapopulation boundary contours identify and predict areas in which field sites recorded significant activity. It should be noted that the boundaries modelled by sampling at this scale are indicative, and identify broad areas within which relatively large 'source' populations exist, rather than the movement patterns of individual animals.

## Results

### The field sites

Seventy two (72) field sites were sampled across the Tweed Coast, including 27 sites on privately-owned land, 27 sites on Council-owned or managed land and 18 sites within Nature Reserves (Table 2, Figure 1). Within these sites, a total of 2,160 trees were searched for the presence of koala faecal pellets.

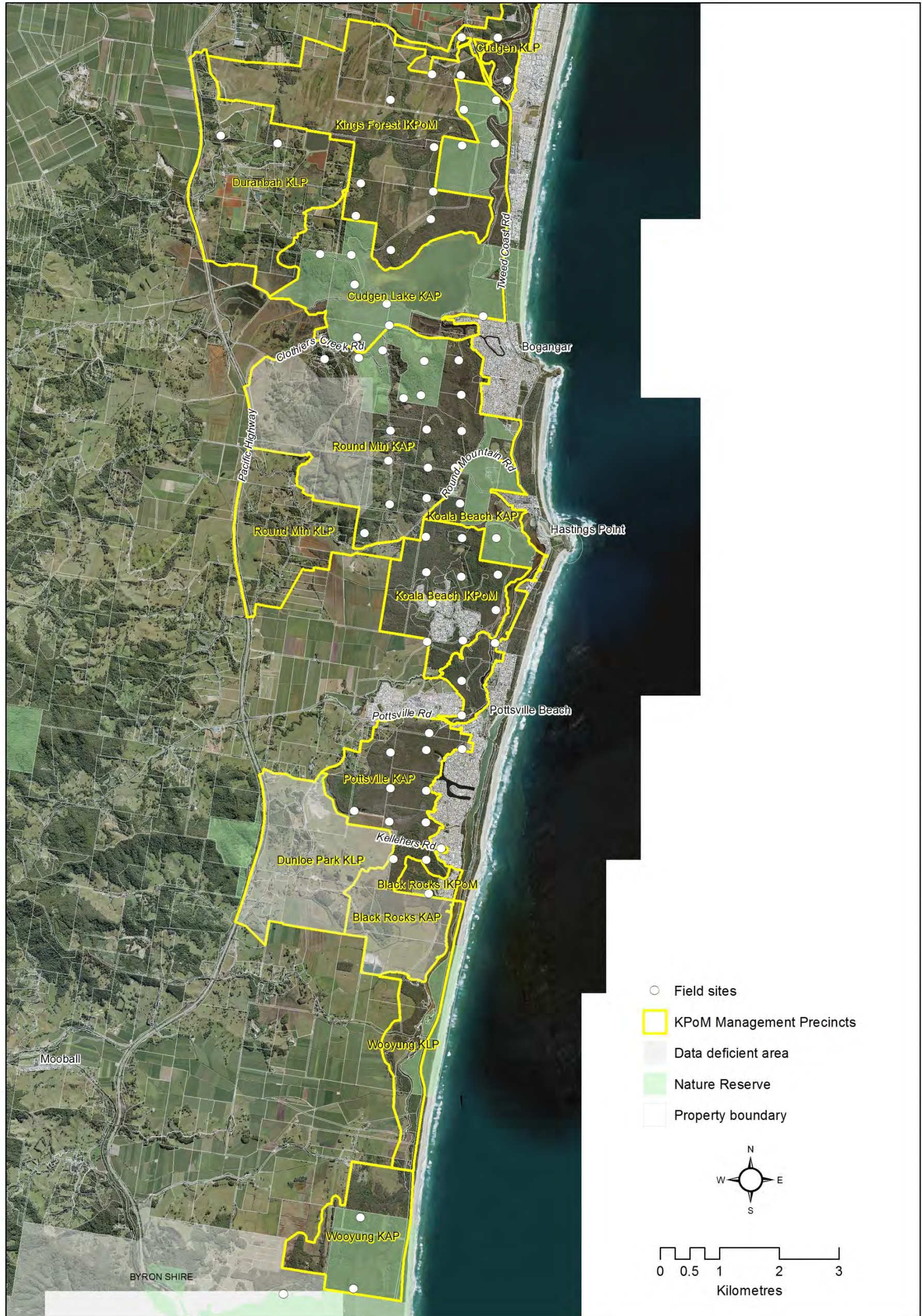
**Table 2** Summary of land tenure associated with field sites.

Tenure	Sites
Private land	27
Council owned/managed	27
Nature Reserve	18
<b>Total</b>	<b>72</b>

Across the Tweed Coast, 61 of the sites that were sampled in 2010 during the 2011 Habitat Study were revisited during this survey, representing 59% of the Habitat Study's original sites within the study area. An additional 11 sites that were not previously visited were added to this survey.

A further 11 field sites were planned on privately owned land, however landholder permission was not provided, and these sites were not visited. These areas are depicted as "data deficient" on Figure 1.





**Figure 1** Distribution of field sites across the study area for the 2015 koala study. Koala Management Precinct boundaries, as defined in the Tweed Coast KPoM, are also shown.



## Koala activity

### This study

Koala activity was recorded from 44 of the 72 field sites sampled during this study. Activity levels at active sites ranged from 3.33% to 96.67%. Of these “active sites”, 19 returned significantly high activity levels to indicate regular use by resident koalas.

Seven new sites returned evidence of koala activity (4 significant activity, 3 low activity) and four new sites were inactive.

Evidence of koala activity (ie at least one faecal pellet recorded beneath at least one tree) was recorded from sites across all land tenures with 16 sites on private land, 20 sites on Council-managed land and eight sites in Nature Reserves.

### Comparing 2010 and 2015

Sixty one (61) sites were sampled in both this and the previous survey, allowing comparisons of koala activity levels between the two survey periods.

When results of this survey are compared to those reported in the 2011 Habitat Study, activity levels have decreased across the study area. For sites that were active during either of the sampling occasions, and sampled on both ( $n = 49$ ), the mean activity level during this study ( $20.11 \pm 3.51\%$  SE) is significantly lower than that recorded during the Habitat Study ( $33.18 \pm 4.02\%$  SE) ( $t = 3.50$ ,  $48_{df}$ ,  $p < 0.05$ ). It is of note that the mean activity level in 2011 was above the significant activity threshold of 22.52%. The mean activity level for 2015 was below this threshold.

Table 3 provides a comparison of activity data at 61 field sites, and Figure 2 illustrates the distribution of active and inactive sites.

**Table 3** Comparison of results from 61 sites sampled during this and the previous study.

	2010	2015
<b>Number of active sites</b>	44	37
<b>Number of sites with significant activity</b>	30	15
<b>Mean activity level (active sites)</b>	33.18%	20.11%






Whilst activity levels are expected to change over time, change at a particular site is only ecologically meaningful if there is a shift from one activity category to another (eg. From above threshold (significant activity) to below (low activity or inactive), or *vice versa*).

Increases in activity category occurred at seven (11%) of the 61 sites (Table 4), Activity levels at two of these sites indicate current, regular use by resident koalas where low activity was previously recorded. Conversely, a decrease in koala activity

was seen at 24 sites. Seventeen sites (28%) from which significant activity was previously recorded, are currently used only occasionally or not at all by koalas. No change was recorded from a further 18 sites (29%) which were active (13 sites with significant activity and five sites with low activity) during the previous study and remain so. Twelve sites that were inactive during the previous study remained inactive during the current study.

Figure 3 illustrates changes in activity category at each of the field sites between this and the previous study. Figure 4 illustrates the broad distribution and indicative boundaries of current population cells, when compared to those modelled in the 2011 Habitat Study.

**Table 4** Summary of meaningful changes in activity level at resampled field sites. Arrows represent direction of change. Smaller green arrows indicate an increase, either from low activity to significant activity, or from inactive to low activity. Small red arrows indicate a decrease from significant to low activity or from low activity to inactive. Large red arrow indicates a major decrease from significant activity to inactive. Circles represent no change in activity category.

Recorded change		Activity category		Number of sites
		2010	2015	
Increase		Inactive	Low	5
		Low	Significant	2
No change (active)		Low	Low	5
		Significant	Significant	13
Decrease		Significant	Low	12
		Low	Inactive	7
Major decrease		Significant	Inactive	5
No change (inactive)		Inactive	Inactive	12



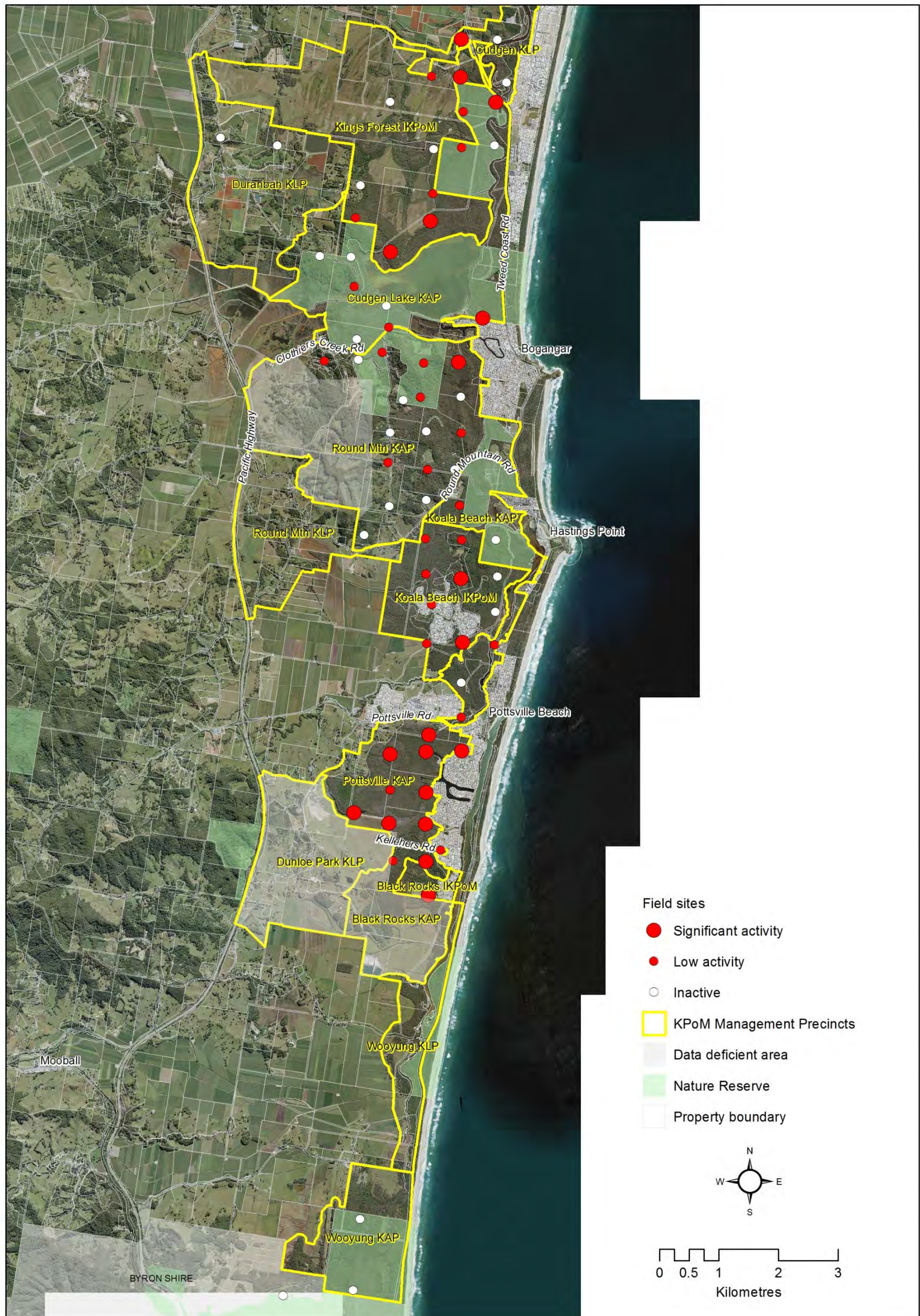
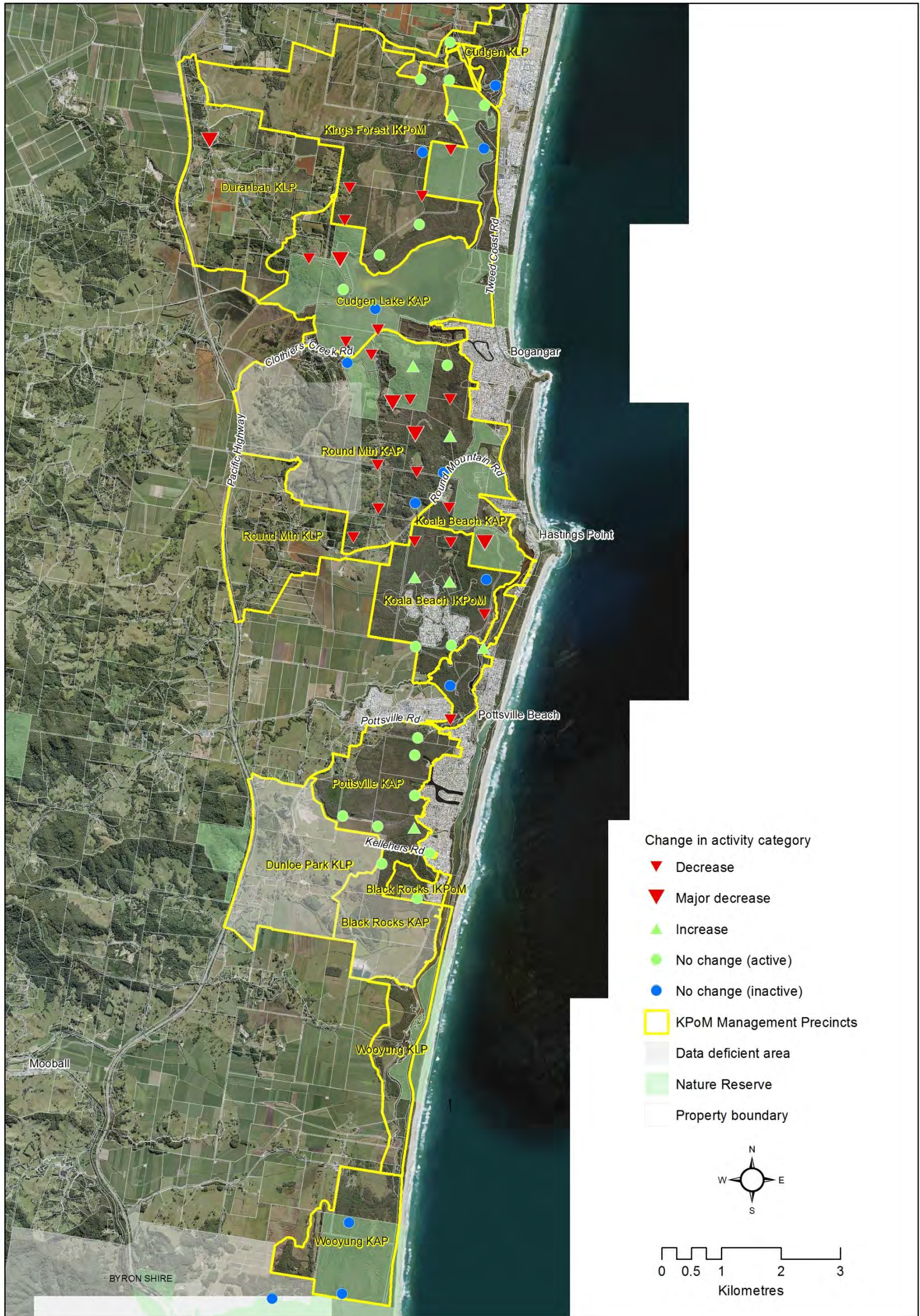


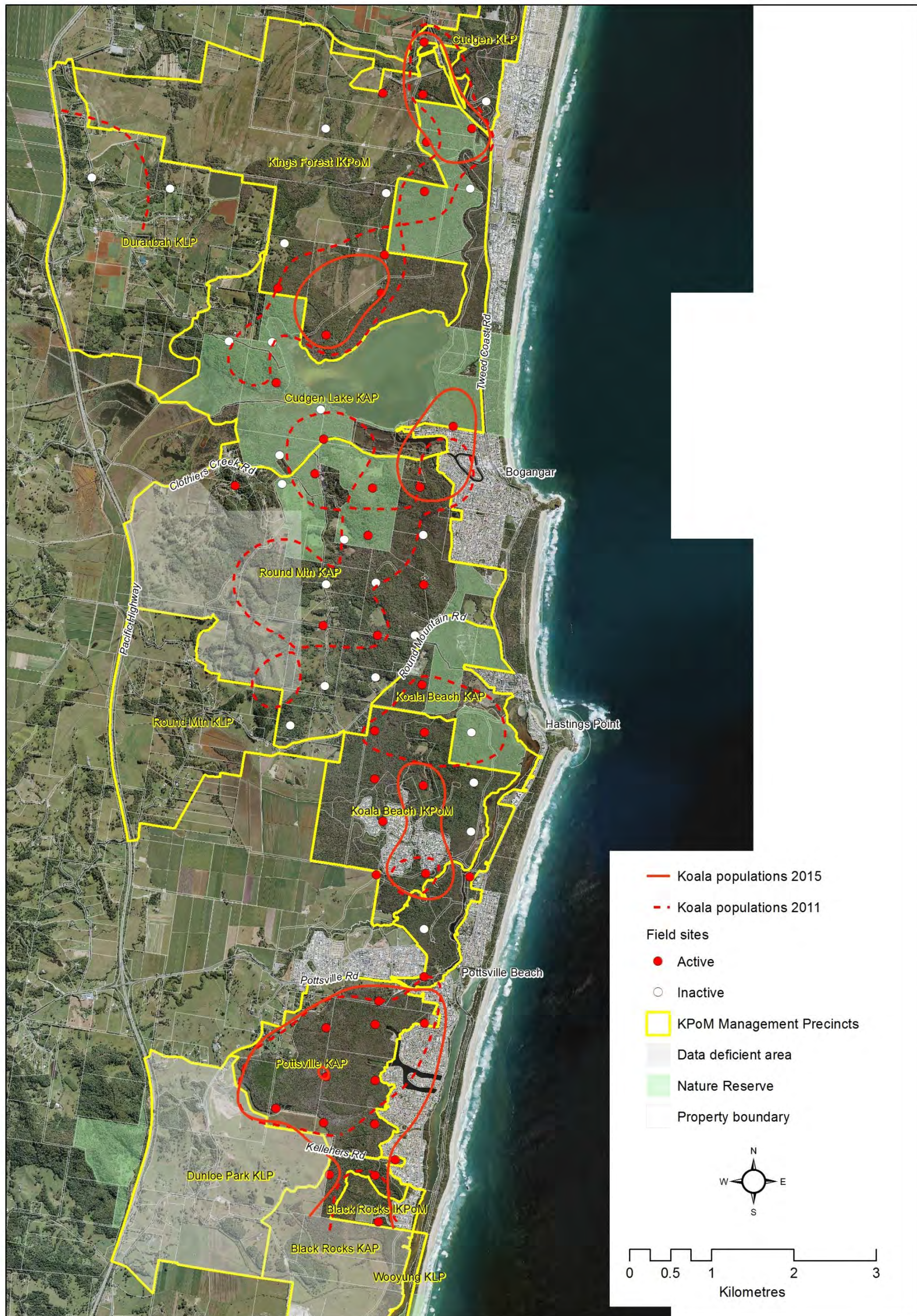
Figure 2 Distribution of koala activity at field sites sampled during the 2015 study.





**Figure 3** Changes in activity category recorded at each of the field sites sampled in both 2011 and 2015.





**Figure 4** Indicative population boundaries modelled using the results of 2015 (solid line) and 2011 (dashed line) koala studies, showing changes in the distribution of resident koala populations.



## Occupancy

When they were sampled in 2010, 10 of the 21 sites (48%) returned evidence of koala activity. Eleven of these sites (52%) were active in 2015 (Table 5).

Only three (14%) of these sites returned significant activity in 2015; half the proportion used by resident populations in 2010 (28%, n = 6). These data indicate that the amount of habitat occupied by resident populations has reduced by approximately half since the previous survey, whilst occasional use by koalas still occurs throughout a similar proportion of habitat to that recorded in 2010.

**Table 5** Summary of koala occupancy rates across the study area (n = 21 field sites).

	2010	2015
<b>Occupancy (any use)</b>	48%	52%
<b>Occupancy (significant activity)</b>	28%	14%

## Koala sightings

Within the study area, 322 records of koalas have been reported to or obtained by Council between January 2010 and September 2015. Records were obtained from a number of sources, including the public, Council technical staff, NSW Office of Environment and Heritage's BioNet Atlas, Friends of the Koala Inc. and Council's remote monitoring cameras.

Records of koala sightings are widely distributed throughout the study area, but sparse in the north and no records were obtained from south of Black Rocks (Figure 5). The majority of sightings occurred along Clothiers Creek Rd, Koala Beach, Pottsville and Black Rocks. Females with joeys have been sighted from a number of locations including Forest Hill, Bogangar, Koala Beach, Pottsville Wetlands and Black Rocks.

These records include a number of sightings of females with either pouch, back or semi-independent young, as well as sightings resulting from vehicle strike, other causes of death and rescues of diseased and injured animals. It is important to note that sightings data is not systematically collected, inevitably contains multiple sightings of the same animals, and is biased towards more densely human-populated areas.



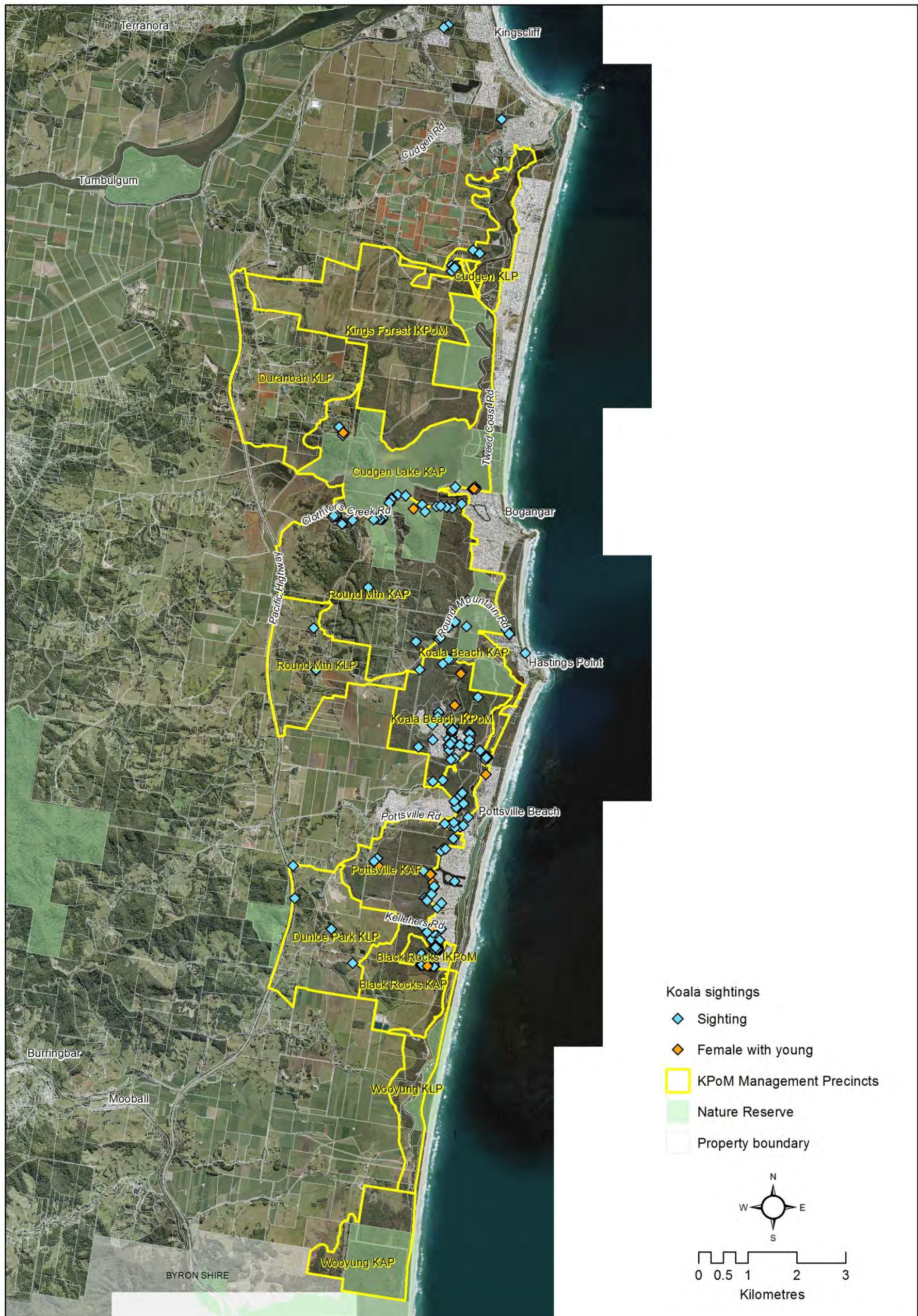


Figure 5 Koala records between January 2010 and September 2015.



## Key outcomes & discussion

The results of this study indicate that the koala population on the Tweed Coast has continued to decline in the five years since the previous survey. This conclusion is supported by the key outcome of this study that there has been a substantial reduction in the area occupied by resident koala populations, demonstrated by a reduction in koala activity levels across much of the northern part of the study area, when compared to the previous study.

### Occupancy

“Occupancy” describes the proportion of a sampled area where the target species is present. One of the main outcomes from the 2011 Habitat Study was that there was a large proportion of habitat suitable for koalas that was not regularly used (occupied) by koalas.

Two measures of occupancy are presented in the results of this report. The first is usage of habitat by koalas at any level, be it occasional or frequent. The second and more useful measure is occupancy by resident populations. This measure describes the trend as it relates to the majority of the koala population and can be assessed against simple benchmarks.

In terms of areas that are subject to *any* koala use (whether occasional or frequent), the occupancy rate of 52% in this study is not different to the 48% estimated using the results of the previous study. This means that koala activity, in its broadest sense, is still present within a similar proportion of the habitat that was occupied by resident populations as observed in 2010.

The difference is that the activity now occurring in these areas is infrequent and/or transient. According to the analysis above, areas supporting *resident populations* (that is, areas supporting the majority of the koala population; animals occupying stable home ranges and breeding females) appear to have substantially contracted in the northern part of the study area. Data collected during the 2011 Habitat Study resulted in an estimated occupancy rate for resident populations of approximately 30% within the area of interest in this study. The current occupancy rate, estimated at 15%, is approximately half that of the previous survey's estimate.

It has been suggested (Phillips et al. 2011, Hopkins and Phillips 2012) that an occupancy rate of 50% is optimal for koala populations on the east coast. This means that at any one time, 50% of the available habitat is occupied by resident koala populations.

The Habitat Study spoke broadly of the sub-optimal occupancy rate across the Tweed Coast as a result of a relatively recent decline. The results of this study suggest that the trend of decline is continuing, and that koala populations on the Tweed Coast continue to exist at an occupancy rate that is well below the optimal level of 50%. As a result, populations are highly susceptible to ongoing and well-known threats, particularly stochastic events such as wildfire that have the potential to significantly impact small and fragmented sub-populations.

## Management precincts

It is clear when examining activity levels at individual field sites that the northern portion of the study area is responsible for the majority of the decline. Much of the habitat in the Duranbah, Cudgen Lake and Round Mountain areas appears to now be only occasionally used by koalas, when previously these areas were used by resident animals as part of their normal ranging behaviour. Conversely, activity levels have remained relatively stable in the Koala Beach, Pottsville and Black Rocks areas when compared to those recorded in 2010. These results are discussed briefly below in terms of individual management precincts, as defined by the KPoM and illustrated in the figures above.

### Kings Forest IKPoM

Koala activity remains widespread throughout the eastern portion of the Kings Forest IKPoM area and adjacent Cudgen NR. Overall activity levels have declined, and the previously modelled contiguous area of significant activity has contracted to two smaller cells, within which activity levels are similar to those recorded previously. The northern cell straddles Depot Road and extends south into Cudgen NR. The southern cell is associated with a large area of swamp sclerophyll forest between the Cudgen Paddock and Cudgen Lake. Active low use sites occur to the north, west and southwest of this cell.

### Cudgen KLP

No activity was recorded in within the southern portion of the Cudgen KLP. Limited field sampling was undertaken in this area, and suitable habitat is currently limited in the KLP.

### Cudgen Lake KAP

Of the seven sites sampled in Cudgen Lake KLP, only one returned significant activity. This is illustrated by one small population “cell” on the northwestern edge of the Bogangar urban interface, which is bisected by Clothiers Creek Road. A sighting of a breeding female koala within this population cell during field work confirms its significance.

Modelling reported in the 2011 Habitat Study showed population cells stretching around the southwestern and northwestern extent of the lake, whilst not necessarily meaningfully connected. It now appears that a further retraction of these populations has occurred in that area, with low activity remaining at only two of the active sites from 2010. Notably, declines in koala activity were recorded from a number of sites within Cudgen Nature Reserve, as well as those on other land tenures. A number of recent koala sightings in the vicinity of Clothiers Creek Road confirm the continued presence of resident koalas in the area, however the results of the field survey indicate that these animals likely currently occur in patchily distributed and small aggregations.

### Round Mountain (KAP, KLP)

With the exception of the single area of significant activity in the northeast, the current survey suggests that the substantial population occupying much of the Round Mountain KAP during the previous survey is no longer present. Low activity was recorded at a number of sites during the current survey, indicating that koalas still occur throughout the KAP, however use is largely transient, or areas of significant activity are reduced to an extent not detectable by this study.

The Habitat Study noted the irregular shape of the metapopulation boundary in 2011, suggesting that it was reflective of historical disturbance, including fragmentation of habitat and wildfire. It would appear that the influence of these impacts, or their combination with



continued road strike on Clothiers Creek and Round Mountain Roads have continued to exert pressure on this population, resulting in the most notable decline within the study area.

It should be noted that no survey data was available for much of the western portion of the Round Mountain management precincts. The status of any koala populations in these areas remains unknown, however koala sightings are occasionally reported in the vicinity.

#### Koala Beach KAP and IKPoM

Koala activity remains present within these management areas, however the results of this study indicate a shift in the location of the major resident populations. Four field sites indicated decreasing activity levels in the north (the southern portion of Cudgen NR and bushland south of Heath Road) when compared to the 2011 study. Conversely, a number of sites immediately to the north and south of the residential development area appear to have seen an increase in use or are maintaining similar activity levels.

The results of the current study generally reflect the most recent results of more detailed survey work that is undertaken within the Koala Beach IKPoM area on a regular basis. This work has recorded ongoing persistence, shifts in the location of population cells and overall decline in activity levels.

#### Pottsville KAP, Black Rocks KAP, Black Rocks IKPoM

A large and contiguous resident population continues to persist in the Pottsville KAP, associated with habitat in the Pottsville Wetland. Whilst the population modelling suggests that connectivity remains limited between the Pottsville Wetland and Pottsville Environment Park to the north, significant activity recorded at a new site south of Kellehers Rd and an increase in activity level in the southeast of the wetland indicate that resident populations are occupying a large proportion of the contiguous habitat between the wetland and the Black Rocks sports field, as well as continuing to occupy habitat surrounding the sports field. These two areas currently appear to be well connected, where previous modelling indicated a separation of the main populations occupying the two areas.

No decline was recorded at any of the sites revisited during this survey, indicating some stability in this part of the population. This result is particularly encouraging given the wildfire that occurred in the Pottsville Wetlands on 25-26 December 2014, approximately seven months prior to the survey. Records of koalas including breeding females have been reported to Council from the vicinity of the wetlands, rural properties to the west of the wetlands, Pottsville Waters residential area and habitat surrounding the Black Rocks sports field.

#### Dunloe Park KLP

It is known that koalas occur within the southern portion of Black Rocks KAP and the Dunloe Park KLP, however no survey data is available for the majority of these areas. The status of koalas in those management precincts thus remains largely unknown. As directed by the Tweed Coast KPoM, it is important that connectivity is improved within this area in order to provide for future population expansion and east-west movement.

#### Wooyung KAP

No koala activity was recorded within Wooyung KAP, despite considerable search effort not limited to three formal field sites within and adjacent to Billinudgel NR. Occasional koala records are obtained from the area. As directed by the Tweed Coast KPoM, it is important

that habitat in this area remains available and is improved in order to provide for future population expansion and north-south movement.

### **Future prognosis**

The continued reduction in occupancy and general decline in activity levels throughout the northern part of the study area indicates that the situation remains severe for the Tweed Coast koala population. It is possible that the lingering influence of fire and habitat fragmentation and is being reflected in the Cudgen Lake and Round Mountain areas. In particular, the barrier created by habitat collapse following peat fires west of Cudgen Lake is potentially creating a significant impediment to dispersal. Considering the low fecundity of koalas in general and ongoing mortality due to vehicle strike, and disease, it would be expected that the koala population in these areas struggles to maintain occupancy, let alone establish itself in new, previously unoccupied habitat.

There is clearly an ongoing need to continue and increase efforts to work with key stakeholders including NSW National Parks and Wildlife Service to improve conditions in the northern part of the study area. Further reducing the threats on remaining animals and improving habitat quality will be key to the koala population's persistence.

Evidence of breeding females throughout the study area, continued regular sightings of healthy koalas and the relative stability of the koala population in the Pottsville and Black Rocks area are all encouraging indicators of the population's potential for persistence and recovery. In the five years since the Habitat Study, considerable progress has been made on the restoration and creation of koala habitat, which aims to provide habitat of sufficient area and quality available for population expansion in the longer term. Evidence of koalas using new plantings suggests that the potential exists for existing populations to expand into new areas of habitat.

Despite the above, there remains a real possibility that the Tweed Coast koala population will decline to extinction within the next few decades. It is also the case that due to the koala's basic biology, ongoing threats and the compounding effects of small populations, a time lag will exist and further decline will be recorded before an upward trend is detected, even if recovery is already underway. Recording such a change, should it occur, is likely to take a number of koala generations.

### **Population size**

The Habitat Study estimated the population size of koalas on the Tweed Coast at between 25 and 267 animals (95% confidence interval). Whilst the best estimate of population size was given as 144 animals, it must be recognised that the variation around that estimate was large ( $\pm 120$  animals), which makes meaningful future comparisons problematic, and potentially open to misinterpretation.

As illustrated by the above example, the smaller the population, the more difficult it becomes to estimate its size using sampling methods. For very small populations, the sample size and survey effort required to provide statistically robust data becomes prohibitively large and uneconomical on an ongoing basis.

Rather than draw conclusions from insufficient data, or expend unnecessarily substantial resources this study has not attempted to provide an estimate of population size. Whilst

population size is a measure that is easily understood and communicated, the other measures described herein provide more detailed, statistically robust and site-specific detail on trends in the population. The analysis of activity levels and distribution provided by the techniques used in this study is an efficient and effective tool for monitoring change.

In order to provide this useful dimension to future surveys, it is recommended that alternative survey methods that may improve the efficiency and accuracy of obtaining abundance estimates be explored.

## Limitations

As described above, knowledge gaps continue to exist in areas where access to privately owned land was not provided, thus it is not possible to determine the status of koala populations in the western portion of the Round Mountain KAP and parts of Black Rocks KAP and Dunloe Park KLP. Whilst not ideal, this does not affect the overall interpretation of the results of the study. Further information about these areas will be gathered during the master planning process associated with the development of the proposed urban release areas.

## Recommendations

The Tweed Coast KPoM provides a comprehensive set of management actions for addressing the key threats and encouraging population recovery in the short- and long-term. In general, it is recommended that the implementation of the KPoM continues, and is appropriately responsive to the status of the population.

- In the short to medium term, it remains vital to continue working to reduce the key threats of vehicle strike, wildfire and dog attack on the population. It should be recognised that the success of much of this requires a behavioural change from the broader community. It is recommended that Council continues to implement the actions in the plan, with a key focus on community engagement.
- Particular attention to threat mitigation in the north of the Tweed Coast is necessary, requiring effort from all key stakeholders.
- It remains important to maintain and build upon the quality and amount of suitable habitat in order that it is available for expansion and eventual support of a viable population in the long term.
- In implementing the plan, Council should remain open to considering novel and emerging management approaches should they arise.
- It is recommended that monitoring of distribution and occupancy of koala populations continues on a regular basis, using methods consistent with those described in this report, and as directed by the KPoM.
- As directed by the KPoM, this initial reassessment should be expanded to obtain current data on the status of koalas in the Tweed Heads KMA, address knowledge gaps and include community-based survey.



- Council should continue to work with the State Government and Universities to explore the utility of new and emerging technologies for improving the efficiency and accuracy of population abundance estimates.

## References

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## Appendix 1 – Field site locations and activity levels 2015

Site	Activity	Easting	Northing	Site	Activity	Easting	Northing
TC003	0.00	552003	6849963	TC305	13.33	554999	6869231
TC004	0.00	553180	6850034	TC307	0.00	553735	6866574
TC008	0.00	553293	6851229	TC201	63.33	553773	6857884
TC031	16.67	554652	6857428	TC202	43.30	554394	6857870
TC034	96.67	554399	6858405	TC204	80.00	554400	6859084
TC038	70.00	554444	6859369	TC205	0.00	553376	6862730
TC043	16.67	554408	6860909	TC206	0.00	553785	6863208
TC044	10.00	555548	6860879	TC209	3.33	553775	6863936
TC048	10.00	554389	6862076	TC210	3.33	554427	6863824
TC049	0.00	555607	6862027	TC308	0.00	553236	6866017
TC053	0.00	554406	6863312	TC309	10.00	553774	6866212
TC058	0.00	554408	6864464	TC310	6.67	553663	6865792
TC062	0.00	553268	6865666	TC311	30.00	554835	6865625
TC063	6.67	554373	6865619	TC312	20.00	554965	6863228
TC067	3.33	553195	6866899	TC313	13.30	554393	6862661
TC072	10.00	553243	6868035	TC314	6.67	555001	6862636
TC073	23.30	554483	6867990	TC315	0.00	555573	6862686
TC075	0.00	550951	6869402	TC317	33.30	554985	6861992
TC078	0.00	554526	6869200	TC320	0.00	555566	6861432
TC079	0.00	555558	6869270	TC321	36.67	555014	6860915
TC083	6.67	554509	6870428	TC323	0.00	554997	6860249
TC084	0.00	555752	6870339	TC324	10.00	554992	6859663
TC211	0.00	554883	6863822	TC325	73.33	553188	6858051
TC214	3.33	554992	6864440	TC326	10.00	553834	6857253
TC216	0.00	554013	6864982	TC328	70.00	554439	6856674
TC217	6.67	554319	6865066	TC1501	0.00	555612	6871034
TC218	0.00	554985	6865046	TC1502	0.00	553803	6869992
TC219	0.00	552623	6867406	TC1503	0.00	551906	6869260
TC220	0.00	553144	6867396	TC1505	13.33	552693	6865645
TC221	38.70	553805	6867477	TC1508	0.00	553799	6864439
TC223	0.00	553316	6868636	TC1509	6.67	554498	6861562
TC225	20.00	554514	6868457	TC1510	43.30	553804	6859044
TC300	26.67	554996	6871043	TC1511	53.30	554993	6859105
TC301	33.33	554981	6870413	TC1512	20.00	553867	6858426
TC302	20.00	555018	6869832	TC1514	36.67	554384	6857217
TC303	40.00	555572	6869993	TC1517	61.30	555352	6866366