

Tweed Coast Koala Study 2021

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Executive summary

The reassessment of the koala population on the Tweed Coast is a three-yearly action of the 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 over time during the operation of the plan. This report details the third koala study since the initial Koala Habitat Study was published in 2011¹.

Surveys were carried out between July and December 2021 and involved resampling a large proportion of sites that were surveyed for the 2011 Koala Habitat Study. Seventy-three sites on Council owned and managed land, private land and Nature Reserve were surveyed using the Spot Assessment Technique, with methods identical to previous surveys.

Fifty-four (54) sites have now been sampled during each of the four monitoring events. When activity levels are compared across years at these sites the number of active sites has decreased from that recorded during the previous monitoring, and is currently approximately equal to that recorded in 2010, and slightly lower than that recorded in 2018. Sites occupied by resident koalas are still substantially fewer than in 2010 at just over half, and slightly lower than recorded in 2018.

Across the Tweed Coast, the distribution of resident koala populations has declined when compared to 2018, but not greatly. Koala activity remains widespread throughout the study area. Currently 30% of the available sampled habitat is occupied by resident koala populations, well below the optimal level of 50%. Some notable localised expansions and contractions have occurred and are worthy of further investigation and prioritised action where possible.

Reestablishment of a resident population to the west of Cudgen Lake has still not occurred, and activity in the south of the Kings Forest Koala Plan of Management (KPoM) area is at its lowest since the monitoring program began. Working with NPWS to identify any additional supporting actions in this area is recommended, and reducing vehicle strike on Clothiers Creek Road remains a priority for recovering the northern extent of the population.

Resident koala occupancy in the Round Mountain Koala Activity Precinct (KAP) has decreased again since 2018 but the total area used by koalas remains widespread.

The Pottsville Wetland continues to support high levels of occupancy and use by koalas, but significant activity has dropped in the Black Rocks KAP. Increased occupancy was recorded within Pottsville Environment Park and a resident population was confirmed within and adjacent to Cudgerie Reserve. The broader Pottsville area remains the most important locality to the Tweed Coast population.

¹ The 2011 Habitat Study (Phillips et al. 2011) details the results of field surveys carried out in 2010.

Connectivity appears good to the north through Pottsville Environment Park to Koala Beach, though large areas of suitable habitat to the north of Koala Beach remain unoccupied.

Food tree plantings continue to be used by koalas and are reaching a size that allows them to be included in the monitoring program. This is recommended where appropriate to be added to the survey design.

Over 600 koala sightings reported by community members indicates that community engagement efforts by Council and partner agencies are being effective. Records include around 50 reports of breeding females from across the Tweed Coast, and the reported rate of vehicle strike remains constant.

The Tweed Coast koala population remains at high risk of extinction. Distribution and activity levels have fluctuated between survey periods over the last 6 years, but occupancy remains extremely low. Efforts to increase available habitat and connectivity and reduce persistent and increasing threats must be continued to support the persistence of this population in the landscape into the future.

Introduction

The Tweed Coast Comprehensive Koala Plan of Management (KPoM) was adopted by Council in 2015. One of the actions of the KPoM is the ongoing monitoring of koala activity (see Section 13 of the plan). 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 Tweed Coast Koala Habitat Study (Phillips et al. 2011) provided a comprehensive overview of the status of the koala population on the Tweed Coast at that time. The resulting KPoM required 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. Reassessment was done in 2015 (five years after the initial study), and again in 2018 (reports available here: www.tweed.nsw.gov.au/koalas). The current study is the fourth assessment of koala activity on the Tweed Coast in this long-term monitoring project.

This assessment focused on the Southern Tweed Coast KMA, located east of the Pacific Highway, between Cudgen and Billinudgel Nature Reserve (Figure 1). 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 current koala distribution and activity levels in the Southern Tweed Coast Koala Management Area.
2. To assess changes in occupancy within the Southern Tweed Coast Koala Management Area over the monitoring period.

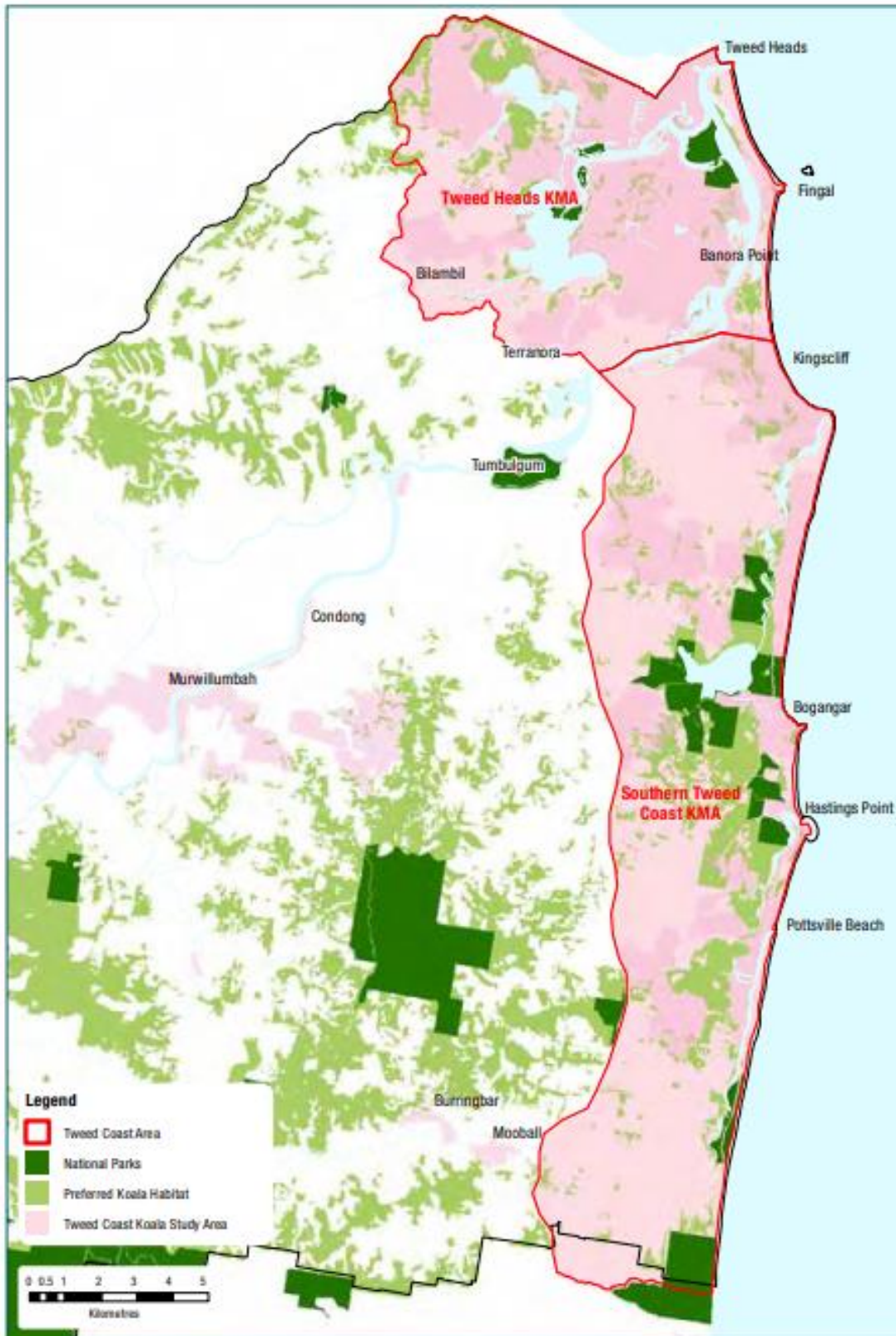


Figure 1 Location of Koala Management Areas (KMA) on the Tweed Coast (Source: Tweed Coast Comprehensive Koala Plan of Management). The current study was done in the Southern Tweed Coast KMA.

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 x 600 metre grid, where possible, to enable uniform and unbiased coverage of the study area.

In the 2015 and 2018 studies, sites were selected for sampling, where possible, where:

- Koala activity was recorded in 2010.
- No koala activity was recorded 2010, but site is located near to a recorded or otherwise known area of koala activity.

The current study attempted to resample as many of the 2015 and 2018 sites as possible. One new site was added for the current study, within road reserve adjacent to land recently dedicated to Council, in Cudgerie Reserve. New sites are aligned as closely to the original sampling grid as possible.

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. Sites located within the Individual Koala Plan of Management (IKPoM) areas at Kings Forest, Koala Beach and Black Rocks were included in the study to provide complete coverage of the study area.

Landholder engagement

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

Consent was obtained from NSW National Parks and Wildlife Service for surveys within Nature Reserve.

Survey method

The GPS coordinates recorded during the previous study were used to navigate to each site. In most cases, the central point of each field site that had been sampled during the previous study was readily found (the centre tree of the site is marked with two flagging tapes and the site number) and this was used as the centre tree for the survey. At times the flagging tape had fallen from the centre tree but could be found following a short search around the base of trees near to the coordinates. For sites where the previously marked centre tree could not be found, the tree closest to the GPS coordinates recorded during the previous study was identified as the “new” centre tree. Degraded flagging tape was replaced.

Field sites were sampled using the Spot Assessment Technique (SAT) methodology of Phillips and Callaghan (2011), the same protocol that was used during the 2011 Habitat Study and all subsequent studies. At each site, an area of one metre out from the base of each of 30 trees was searched for two person-minutes for koala faecal pellets. Each tree was scored for the presence or absence of a faecal pellet detected within the search time. The canopy of each tree was also searched for the presence of a koala. The 30-tree sample consisted of the centre tree and its 29 nearest neighbours.

Each tree was also identified to species where possible, and its diameter at breast height (DBH, measured with a diameter tape at a point 1.4m above the ground) recorded. All trees with at least one stem ≥ 100 mm diameter at breast height, except for tree ferns, palms, and dead trees are included in the sample.

Field sampling was carried out during 24 days between July and December 2021 by a two to four-person team of Council officers and contractors, all of whom were experienced in koala faecal pellet identification, koala survey and tree species identification.

Data analysis

Koala activity

The koala 'activity level' at each site was determined by calculating the percentage of trees in a site that had a faecal pellet detected beneath them within the search time. Activity thresholds developed by Phillips and Callaghan (2011) were used to interpret the activity level at each site. The "East Coast high" koala activity threshold was applied at each site.

The activity level at a site indicates how frequently it is used by koalas in the area. Comparing an activity level against known thresholds indicates whether or not the site forms part of an area currently occupied by a resident koala population. The key measures are detailed below in Table 1.

Table 1 Summary of activity categories and their interpretation. See Phillips and Callaghan (2011) for the justification of these categories.

Activity category	Activity level	Interpretation
Significant activity	$\geq 22.52\%$	Site is regularly used by one or more koalas as part of normal ranging behaviour. These areas are occupied by resident koalas and currently support most of the koala population.
Low activity	$> 0\% - 22.51\%$	Occasional or transitory use of the site by (for example) dispersing animals not yet displaying established home ranging movement patterns.
Inactive	0%	Site 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.

Comparisons of activity across the study area over time were done using the 54 sites that have been sampled during each of the three survey events. Trends in a) the presence of *any* koala activity, and b) the presence of *significant* activity were estimated. The first describes what proportion of available habitat is currently utilised by koalas in any way (either frequently or infrequently), and the second indicates what proportion of habitat is occupied by resident populations, which comprise most of the koala population.

Mapping habitat use by the koala population

Heat maps were produced using the koala activity level recorded at each field site. The heat maps provide a basic visualisation of how koalas are using the landscape across the study area, and ready identification of “hot spots” and “cold spots” of koala presence and absence.

Heat maps were produced using the heat map symbology of ArcGIS Pro, using a radius of 45, and the activity levels at all sites sampled during each of the survey events. Note that the number of field sites is not constant from year to year.

Also note that the heat maps do not account for barriers such as fauna exclusion fencing and major waterways, and do not intend to accurately define the extent of koala presence at a fine scale.

Results

Field sites

Seventy-three (73) field sites were sampled across the Tweed Coast within the Southern Tweed Coast KMA from north of Kings Forest to the Byron Local Government Area (LGA) border and west to the M1, an area of approximately 13,000 ha. Sites were located across all land tenures, and comprised 23 sites on privately-owned land, 29 sites on Council-owned or managed land and 21 sites within Nature Reserve (Table 2, Figure 2).

Table 2 Summary of land tenure associated with field sites.

Tenure	Sites
Private land	23
Council owned/managed	29
Nature Reserve	21
Total	73

Over the four monitoring events, 79 sites have now been sampled on at least two occasions, and 54 sites have been sampled during all four survey events. Two sites that were sampled in 2018 were not sampled during this study due to the presence

of standing water at the site or inability to contact the landholder. One other site was removed from the program due to a lack of food trees at the site.

Within the 73 sites surveyed during the current study, at least 2,190 trees were searched for the presence of koala faecal pellets.

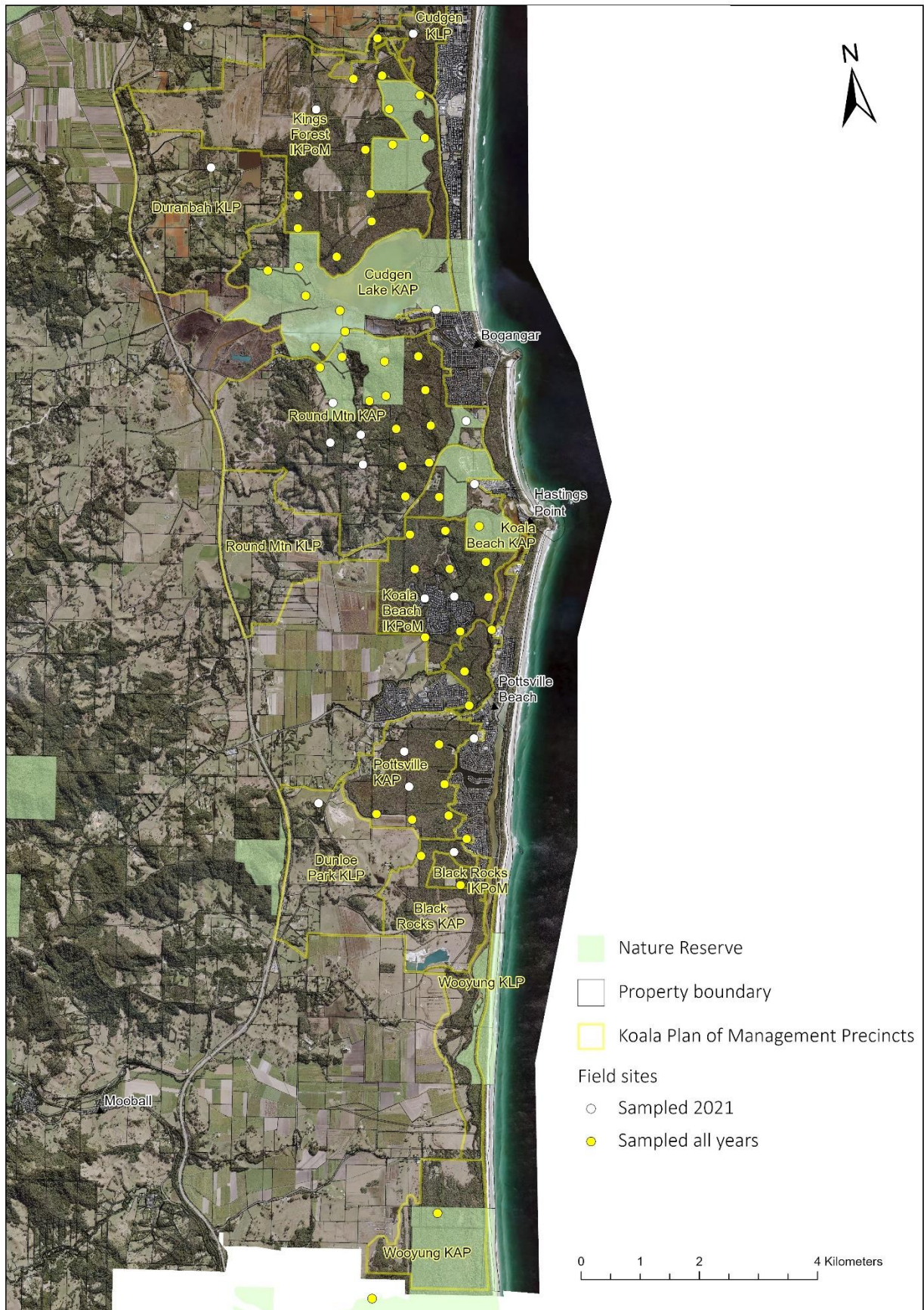


Figure 2 Distribution of field sites across the study area for the 2021 koala study. White points indicate field sites that were sampled in 2021 but have not been sampled during all

other events (but may have been surveyed during 1, 2 or 3 sampling events). Yellow points indicate those that have been surveyed during each of the four survey events, in 2010, 2015, 2018 and 2021. Koala Management Precinct boundaries, as defined in the Tweed Coast KPoM, are also shown.

Koala activity

This study

Koala activity was recorded from 68% (n=50) of the 73 field sites sampled during this study. Of the sites that contained koala activity, 22 sites indicated significant koala activity, indicating regular use by resident koalas (Figure 2).

Koala activity (at least one faecal pellet recorded beneath at least one tree) was recorded from within each of the Koala Activity Precincts, with the exception of Wooyung KAP (Fig 3). Evidence of koala activity was recorded from sites within all land tenures with 18 active sites on private land, 20 sites on Council-managed land and 12 sites in Nature Reserve.

Sites and clusters of sites with significant activity were located in the north of Kings Forest, at Cudgen Nature Reserve south of Cudgen Lake, and at Pottsville, throughout Koala Beach bushland and Pottsville Wetland. These locations are therefore where the majority of the Tweed Coast koala population is located at this point in time.

Comparing koala activity levels since 2010

Fifty-four (54) sites have now been sampled during each of the four monitoring events.

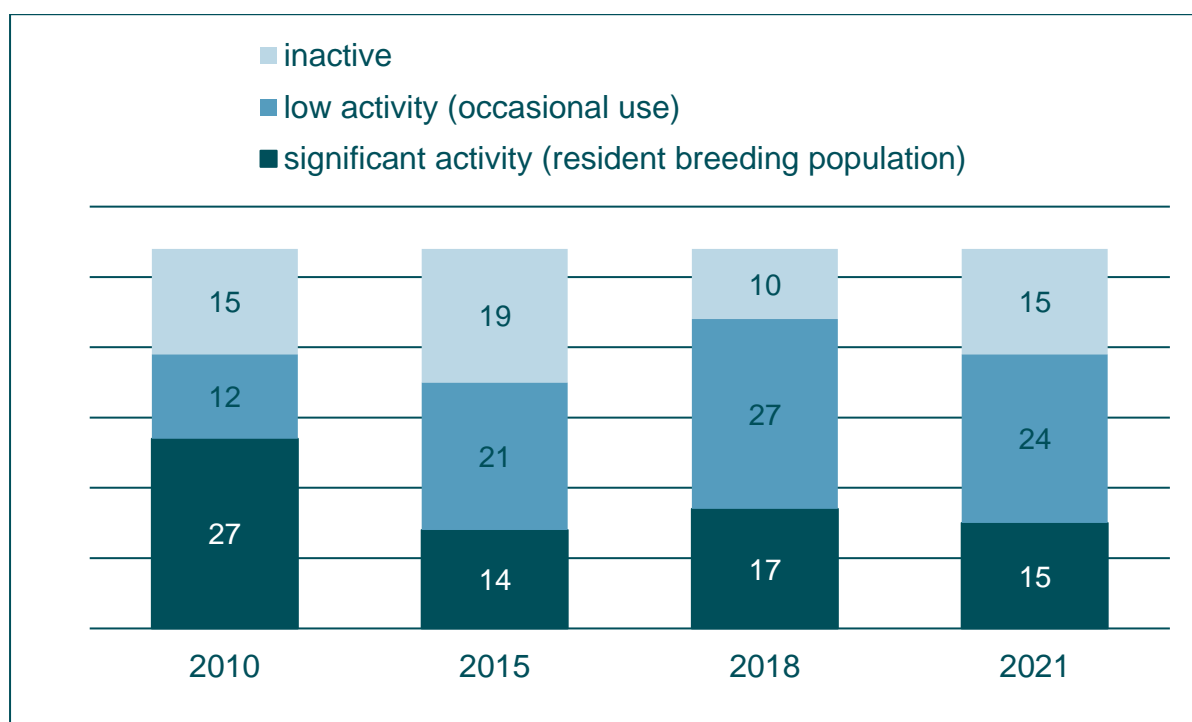
Throughout this period, evidence of koala activity has been found at more than 60% and up to 78% of these sites. During the 2021 study, 72% (n=39) of sites showed evidence of koala activity, which is lower than that recorded in 2018 but higher than the 2010 and 2015 results.

The proportion of sites returning significant activity (28%, n=15) is currently not substantially different from either the 2015 or 2018 levels, but is roughly half of the 2010 result.

Table 3 provides a summary of activity/occupancy data at the 54 field sites sampled during each of the four monitoring events, and Figure 3 provides a graphical illustration of the same data.

Table 3 Comparison of activity levels at 54 field sites sampled during each of four monitoring events.

	2010	2015	2018	2021
Active sites (any evidence of koala activity)	70%	62%	78%	72%
Sites with significant activity (occupied by resident populations)	48%	25%	30%	28%

**Figure 3** Comparison of koala activity levels at 54 sites sampled during all four survey events. Numbers within column sections are the number of sites in that category.

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

Comparing current results with 2018, meaningful positive change in activity levels has occurred at five of the 66 sites sampled on both of those occasions; one site in Pottsville Environment Park that was previously not used by koalas is now used regularly by koalas, and four sites that were previously used infrequently are now occupied by resident koalas. These sites were located at Kings Forest, Round Mountain and Koala Beach.

Negative change (a shift from significant activity to low or no activity) was recorded at 10 sites. These sites were distributed across the study area, located at Kings

Forest, at the northern end of Cudgen Lake KAP, Round Mountain KAP, Pottsville Wetland and Black Rocks KAP.

Koalas have maintained regular use of 14 sites between 2018 and 2021, and a further 16 sites maintained occasional use status. Eleven sites that were inactive during the previous study remained inactive during the current study.

A table of activity levels at each site during each survey event is provided at Appendix 1. Changes in the distribution and intensity of koala activity over time can also be seen in Figure 5.

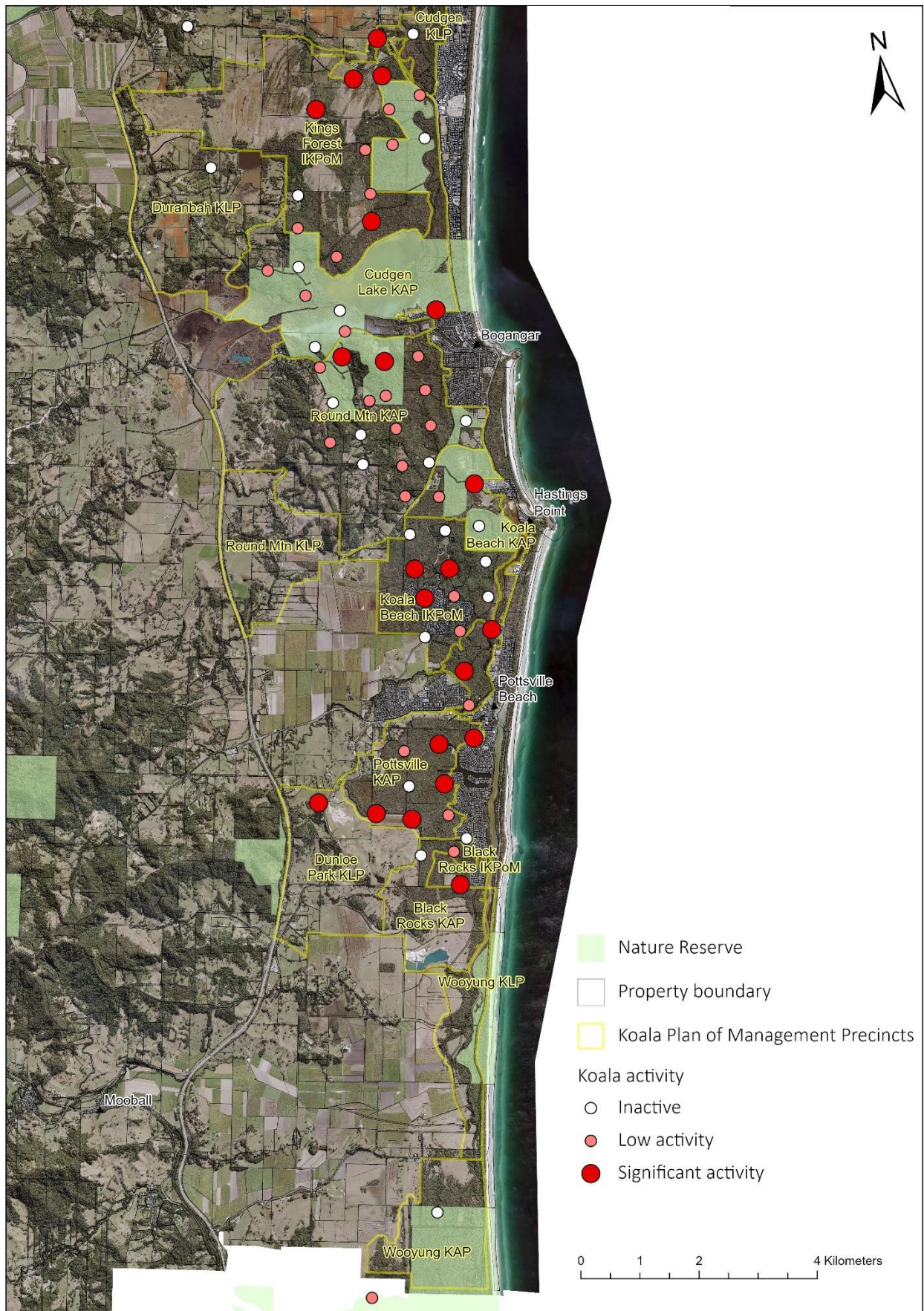


Figure 4 Distribution of koala activity at field sites sampled during the 2021 study.

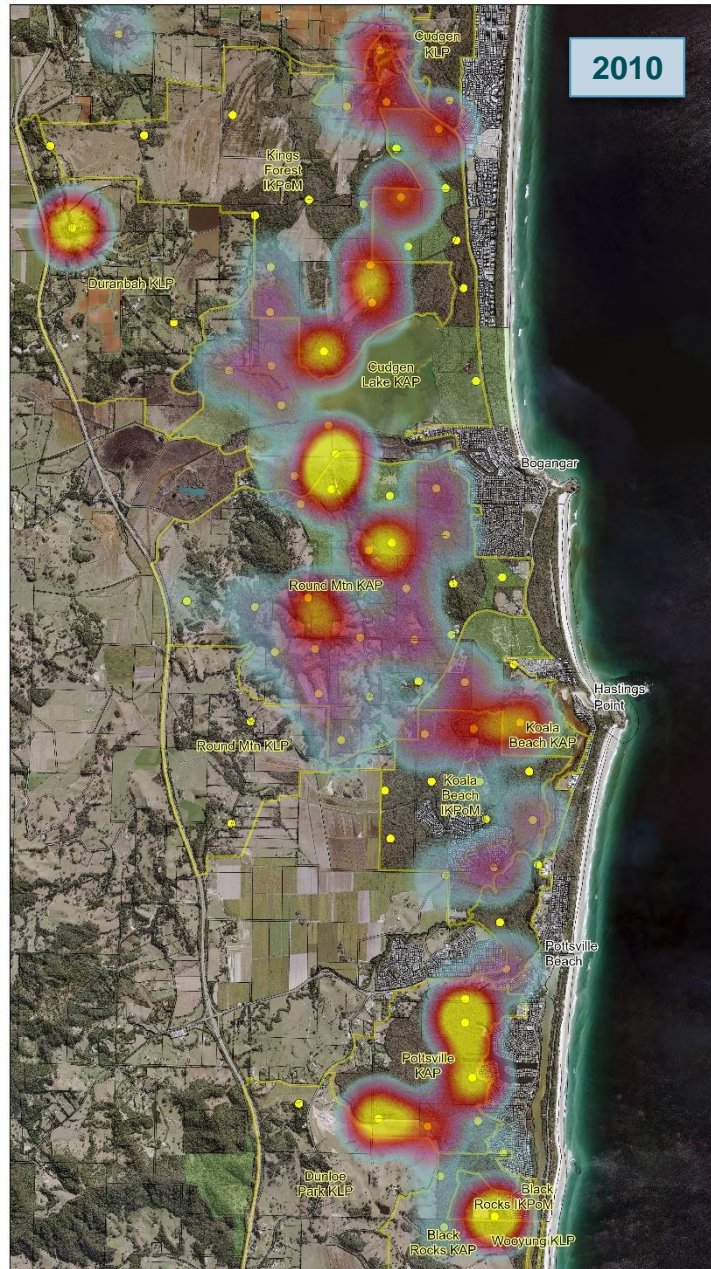


Figure 5a Heat maps representing the relative level of koala activity at each field site during each of the sampling events.

Left: 2010, right: 2015.

Hotter colour indicates higher activity (blue is coolest, yellow is hottest).



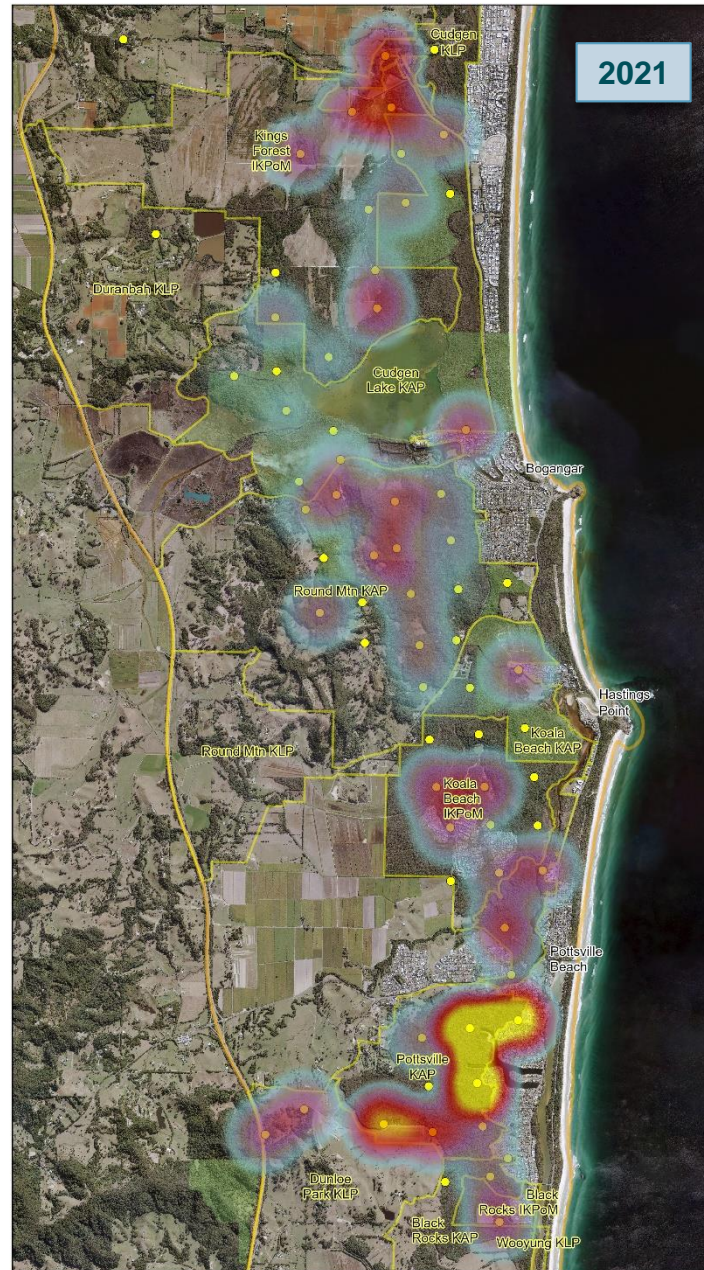
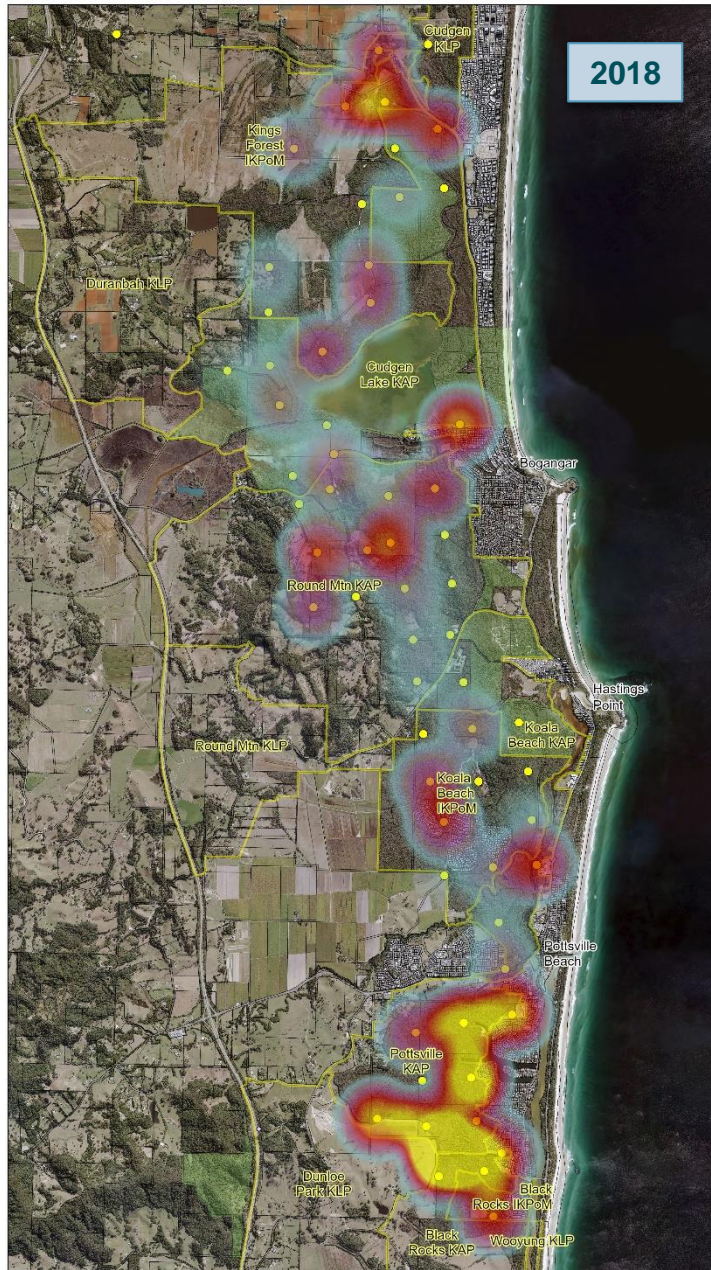


Figure 5b Heat maps representing the relative level of koala activity at each field site during each of the sampling events.

Left: 2018, right: 2021.

Hotter colour indicates higher activity (blue is coolest, yellow is hottest).

- Field sites
- Property boundary
- Nature Reserve
- Koala Plan of Management Precincts

0 0.5 1 2 Kilometers

Koala sightings

Within the Tweed Coast KPoM area, 618 records of koala sightings have been reported to the public databases in the three years 2019 to 2021. The reporting rate continues to rise, with around 150 more sightings than reported in the three years previous. Though sightings were reported year-round, the majority (>50%) were reported during the Spring months. Records were obtained from public and Council officer reports (reported through Council's online sightings tool, to the Atlas of Living Australia), Friends of the Koala Inc., Currumbin Wildlife Hospital, Atlas of Living Australia, and NSW Government's BioNet.

Records of koala sightings remain widely distributed throughout the study area, with sightings remaining clustered around the key locations: Kings Forest, the eastern portion of Clothiers Creek Rd, Koala Beach, Pottsville Environment Park, and Pottsville Wetlands (Figure 6).

At least 48 sightings of breeding females (female koalas with either pouch young or back young visible) have been reported over the last three years. Breeding females are reported frequently within the Pottsville Environment Park and along the western edge of Pottsville wetland. Breeding females were also seen at the northern end of Pottsville Road, on the northern and western edges of the urban area at Bogangar, at Forest Hill, Terranora and Bilambil.

While it is outside of the main area examined by this report, there has been a notable increase in sightings in the Bilambil and Terranora areas, within and adjacent to the Tweed Heads Koala Management Area (see inset Figure 6).

Roads

Friends of the Koala and Atlas of Living Australia records include 11 reports of vehicle strike in the Southern Tweed Coast Koala Management Area between 2019 and 2021. Six of these occurred on the M1; at Sleepy Hollow, Cudgera Creek, Crabbes Creek and Chinderah. Two reports of vehicle strike were received from Tweed Coast Road; at Kings Forest and Casuarina, and four on Clothiers Creek Road, Bogangar.

The number of reported² vehicle strikes is similar to the previous reporting period (there were 11 reports in the September 2015 - December 2018 period).

It is of note that reports of sightings of koalas and koala vehicle strike have increased in the Tweed Heads Koala Management Area, particularly in the Terranora area. At least 7 vehicle strikes were reported between 2019 and 2021, mostly occurring on Terranora Rd.

Dog attack

No reports of dog attack have been made within the Tweed Coast KPoM Study Area in the reporting period, and only one has been reported in the Tweed as a whole. This is lower than the three reports during the last monitoring period, however it is well known that dog attacks go largely unreported and do not provide a good indication of the level of threat. A map of all³ koala records (rescues and sightings) is provided in Figure 6. Note that koala records are not collected systematically, and therefore do not present reliable information about where koalas are, in areas of low human population or visitation.

² Note that it is likely that not all vehicle strikes are reported, and the actual number is almost certainly higher.

³ Note that koala records are not collected systematically, and therefore a higher number of records is usually reported from areas of higher human population or visitation. A lack of koala records does not necessarily indicate a lack of koalas in this data.



Figure 6 Koala sightings reported between January 2019 and December 2021. Inset: Tweed Heads KMA, including Terranora, Bilambil, Banora Point and Cobaki areas. Source: Atlas of Living Australia, Friends of the Koala, NSW DPE.

Key outcomes & discussion

Management precincts

The distribution of current koala activity and some discussion of changes over time for individual precincts within the KPoM area are provided below. Refer to Figures 4 and 5 for spatial context.

Kings Forest IKPoM

Little change in the intensity or distribution of koala activity was observed in the Kings Forest area since the previous survey. Resident koalas continue to occupy an area in the north of the Kings Forest IKPoM area, and occupancy continues to extend into adjacent private landholdings to the north.

The sites in the south of Kings Forest returned lower activity than in past surveys. The previous survey returned evidence that a small population was occupying the area between Cudgen Paddock and Cudgen Lake (represented by three adjacent sites of significant activity), however this area of use has contracted to only a single site of significant use and two sites where low activity was recorded. The current level of use in that area is considerably lower than has been recorded in any previous surveys, and is concerning, as it suggests that there is unlikely to be a stable resident population currently present between Kings Forest and Clothiers Creek Road.

Cudgen KLP

Suitable habitat is limited within this precinct, and only a single survey site was sampled during this period. No koala activity was detected at this site however anecdotal information confirmed that koalas were still using this property, accessed via the underpass under Tweed Coast Rd.

Cudgen Lake KAP

Cudgen Lake KAP encompasses Cudgen Nature Reserve to the west of Cudgen Lake, wraps around the lake to the south and extends to the north to Nature Reserve on the eastern boundary of Kings Forest. Eleven field sites are located within Cudgen Lake KAP.

Activity in the Cudgen Lake KAP was lower than previously recorded. A single site on the northern edge of Bogangar's urban area returned significant activity, as it has in previous surveys. This indicates that a breeding aggregation of koalas continues to occupy this habitat, which was confirmed by neighbouring landholders who reported sightings of a female with back young in August 2021 to staff members during field work.

Koala activity to the west of Cudgen Lake was limited to three sites of low activity, indicating only occasional use by koalas, in a pattern similar to that recorded during 2015 surveys, and lower than that seen in 2018, when it appeared that an increase in use may have indicated the beginning of reestablishment. Along with the low activity recorded in the south of the Kings Forest precinct, this year's result is of concern and warrants investigation of potential causes and actions to improve the likelihood of koalas re-establishing in this area.

Koala sightings and vehicle strikes continue to be reported from Clothiers Creek Rd, confirming continued occupancy and movements in the vicinity of the road.

Round Mountain (KAP, KLP)

Round Mountain KAP is located south of Clothiers Creek Road, extending to Round Mountain Road, and together with Round Mountain KLP, extends west to the M1.

The 2015 koala study noted that the substantial population that occupied much of the precinct during 2010 had largely disappeared. The subsequent 2018 study detected significant koala activity at four sites, and low activity at a large proportion of sites that returned zero activity during 2015, suggesting that a reconnection between populations at Round Mountain and Koala Beach may be re-establishing. The current study returned significant activity at two sites, again with a large proportion of the remaining sites being utilised occasionally, indicating a shift back to lower occupancy while still being used widely by koalas.

Access to field sites on private land in the western portion of Round Mountain KAP and KLP remains unreliable; alternative sites should be considered in this area for subsequent surveys to improve the completeness of data collection in this area.

Koala Beach KAP and IKPoM

Koala activity remains present within these management areas, with the distribution of significant and low activity shifting over time. The current survey detected significant activity at four sites, compared to two during the previous survey, though one of those sites in the north of the KAP was not surveyed in 2018. The other three significant use sites were located to the north of the Koala Beach development, within bushland managed under the Koala Beach IKPoM.

Four sites across an area of approximately 50 ha between Koala Beach and Round Mountain returned no koala activity. These sites are located in high quality koala habitat and returned only evidence of low use during the 2018 surveys. This ongoing reduction and lack of occupancy requires further investigation.

Pottsville KAP, Black Rocks KAP, Black Rocks IKPoM

The sites with the most frequent and highest levels of recorded use on the Tweed Coast continue to occur within the Pottsville KAP. The majority of field sites within the Pottsville Wetland returned significant koala activity, as they have done in all previous surveys.

Two field sites within the Pottsville Environment Park returned significant koala activity, where only one of these had done so in the 2018 survey, indicating an increase in use of this habitat by resident koalas. Consistent reporting of sightings of breeding females confirms this.

Only one site returned significant koala activity within the Black Rocks KAP and Black Rocks IKPoM areas, indicating a substantial reduction in use of that small area by the resident population. A similar distribution pattern was recorded in 2010. Previous surveys have seen koala activity at all four sites, and significant activity at three.

Dunloe Park KLP

The addition of a new monitoring site in the north of the Dunloe Park KLP, and resampling of a site within the now Council-managed Cudgerie reserve has confirmed the presence of a resident population in that area, immediately east of the M1 land bridge.

No survey data is available for the remainder of the southern portion of Black Rocks KAP and the Dunloe Park KLP. It is known that koalas occur within these areas, however the status and distribution of koalas in those management precincts thus remains largely unknown. The potential for establishing new field sites in alternative locations should be examined prior to the 2024 survey.

Wooyung KAP

No koala activity was recorded at the single site visited within Wooyung KAP, and the other was inundated at the time of survey. One site adjacent to and south west of the Wooyung KAP (within Byron LGA) returned low koala activity.

Koala population status

The results of this study indicate that the koala population on the Tweed Coast remains fragmented and sparsely distributed across the study area. Localised expansions and contractions in the areas that are occupied by koalas are evident when the distribution of koala activity is compared across years as illustrated in the heat maps presented above. For the Tweed Coast as a whole, there has been a slight decline in the distribution of resident populations across the study area since the previous survey in 2018, and some notable localised changes; both expansions and contractions in the occupied area.

The set of 54 permanent field sites on the Tweed Coast have now been surveyed on four separate occasions between 2010 and 2021. These sites provide good coverage of the available, well-connected koala habitat in the study area, are located regularly throughout the landscape, and so provide a sound sample from which to examine trends over time. The trend over the last three monitoring events indicates that the population appears generally steady, with small fluctuations from year to year.

Currently, resident koalas are present in approximately 30% of the koala habitat on the Tweed Coast. This remains well below the ideal level for a healthy koala population, which is thought to be around 50% (Phillips et al 2011). The occupied areas remain small and unconnected, and therefore highly susceptible to localised impacts that are likely to have significant effects on the population as a whole.

Outside of and adjacent to the areas occupied by resident koalas, the area of koala habitat being used occasionally or transiently has also fluctuated, but again not substantially so. The level of occasional use in 2021 again falls between that of the 2015 and 2018 surveys. Collectively, the number of these sites being used by koalas at any frequency is similar to that recorded in 2010 when making direct comparison of activity levels at these sites.

The 2011 Habitat Study stressed that the koala occupancy level on the Tweed Coast was sub-optimal at that time, meaning that there was a large proportion of habitat on the Tweed Coast that was suitable for koalas but was not occupied (regularly used) by resident koalas.

The 2015 koala study reported a further dramatic decline in the area of habitat occupied by resident populations, at approximately half of that previously reported. Since then, while there have been no further dramatic declines, there has been no considerable recovery either.

The Tweed Coast koala population remains in a poor situation, still highly susceptible to well-known threats, particularly stochastic events such as high-intensity wildfire and ongoing vehicle and dog-related mortality. Much of the available koala habitat remains unoccupied due to low numbers and apparent difficulty establishing residency in new locations. Identifying any external factors that are contributing to the lack of occupancy or effective connectivity may assist in prioritising recovery actions.

Continued progress on the restoration and creation of koala habitat has been made since the previous reporting period. The program continues to work towards the KPOM target of providing sufficient habitat area and quality available for population expansion in the longer term. Koalas are known to be using these areas which would suggest that the capacity of the Tweed Coast habitat to house an expanding population is increasing. Formal monitoring of koala use of habitat plantings is proposed to be incorporated into the 2024 survey.

A note on occupancy

Koala “occupancy” describes the amount (usually described as a percentage) of the sampled area where koalas are present. Two types of “occupancy” are presented in the results of this report.

The first type of occupancy is use of habitat by koalas at any level, be it occasional or frequent. Occasional use can be usually the result of dispersing or transient animals or infrequent use of habitat outside a resident animal’s normal home range.

The second and more useful measure is occupancy by resident koala populations. Resident koala populations are made up of a group of koalas that occupy a fairly stable area of habitat. These groups are strongly organised by social structure, and once established, generally occupy the same area for the duration of their lives. The breeding females of the population live within these groups, and their offspring ideally both maintain these occupied areas as well as produce the offspring that will go on to recolonise currently unoccupied areas.

Occupancy of resident koalas in a population is the more meaningful indicator as it relates to the majority of the koala population at any given time.

Results of this long-term monitoring program reinforce that koala recovery is a long-term goal that will be dependent on reducing mortality and improving connections between current resident populations.

Recommendations

Recent research (Camus et al. 2022) has shown that in the Northern Rivers, management should not focus on one single action, but that a combination of actions will result in the greatest likelihood of successful recovery. The Tweed Coast KPoM provides this comprehensive set of management actions and it is recommended that the implementation of the KPoM continues. Other guiding documents working alongside the KPoM include the Tweed Coast Koala Fire Management Plan and the Northern Rivers Regional Koala Conservation Strategy and implementing the relevant actions of each on the Tweed Coast will assist in recovering the population.

The following specific recommendations are also offered as they relate to matters highlighted by the current study:

- Reduce the incidence of vehicle strike on Clothiers Creek Road. This is vital to maintain and improve connectivity between the northern and southern portions of the koala population and to allow the northern portion of the population to recover and persist.
- Habitat retention, creation and connectivity must be improved within the KPoM's Koala Activity and Linkage Precincts. The upcoming review of the Tweed Coast KPoM should consider whether current development provisions are effective and adequate to provide for future individual movement and population expansion.
- The results of this and the preceding studies should be used to inform prioritisation of management actions in the upcoming review of the Tweed Coast CKPoM.
- Identify and investigate any habitat-related issues or other threats that may be restricting occupancy in Cudgen Nature Reserve to the west of Cudgen Lake. Council should work with NSW National Parks and Wildlife Service to do this.
- Continue to provide information on vehicle strike and maintenance requirements as needed to NSW Government and TfNSW and continue advocacy for improving koala vehicle strike mitigation along key sections of the M1.
- Continue to monitor distribution and occupancy of the Tweed Coast Koala population using methods consistent with those described in this report. Where relevant, the monitoring program should also respond to opportunities to obtain further insights offered through collaboration with researchers, government and through use of emerging technologies.
- Determine current koala distribution and activity levels in the Tweed Heads KMA. Design monitoring for incorporation into the existing regular program.
- Incorporate new field sites located in koala habitat planting and restoration sites in locations where they fit the survey design.
- Determine the utility of retaining long-term inactive sites and remove from survey design where appropriate.

- Continue to build on the success to date of the Tweed Coast koala habitat restoration program and work towards the goal of creating and restoring sufficient habitat to sustain a viable koala population in the long term.
- Continue to collaborate at a regional scale and cross-border, on education, engagement, research, conservation planning and regional population recovery actions.

Limitations

Access

Access to privately-owned land to carry out survey work is the largest limitation to data collection during this study, and the sites to which access is granted will vary between sampling events. This does not affect the overall interpretation of the results of the study, as its influence is limited to a small proportion of the study area and sufficient sites tend to be available to provide adequate coverage of the study area.

Population size

Population size is a measure that is easily understood and communicated. For very small populations however, such as the koala on the Tweed Coast, the sample size and survey effort required to provide statistically robust data is prohibitively large and uneconomical on an ongoing basis. Rather than draw conclusions from insufficient data, or expend those substantial resources, this study does not attempt to provide an estimate of population size but focuses on collecting data that is comparable over time with previous surveys. The methods and data described herein provide adequate detail to inform ongoing management and report on population trends.

Alternative technologies are being tested and utilised to inform various aspects of koala population monitoring throughout the region and the state. As directed by the KPoM, Council is continuing to partner with research institutions and governments to take advantage of any developments in this area that may improve the efficiency and accuracy of population surveys.

Acknowledgements

Council thanks the Tweed Coast landholders who kindly provided access to their property for survey work, and National Parks and Wildlife Service for consent to work on Nature Reserve. Assistance with field work was provided by Grant Brierley, Rhonda James, Georgina Jones, Adam McArthur, Amalia Pahlow and Sandy Pimm. Thank you to Friends of the Koala for provision of koala records and information about dog attack and vehicle strike.

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Appendix 1 – Field sites - koala activity and location

Site	Activity level (%)				Location	
	2010	2015	2018	2021	Easting	Northing
TC002	0	-	-	-	550771	6850008
TC003	0	0	33.3	10	552005	6849966
TC004	0	0	0	-	553180	6850031
TC005	0	-	-	-	549408	6851181
TC006	0	-	-	-	550922	6851114
TC008	0	0	0	0	553299	6851227
TC011	0	-	-	-	551965	6852451
TC018	0	-	-	-	554404	6853657
TC031	3.85	16.7	36.7	0	554652	6857428
TC032	0	-	-	26.7	552224	6858252
TC034	76.9	96.7	90.0	96.7	554388	6858404
TC038	23.3	70.0	-	-	554444	6859369
TC043	10.7	16.7	3.33	0	554412	6860912
TC044	0	10.0	43.3	26.7	555555	6860873
TC046	0	-	-	-	551892	6861895
TC048	0	10.0	30.0	30	554391	6862080
TC049	0	0	0	0	555602	6862028
TC051	0	-	-	-	552296	6863105
TC052	23.3	-	-	-	553169	6863328
TC053	0	0	6.67	6.67	554412	6863330
TC054	0	-	-	23.3	555409	6863428
TC056	3.57	-	-	-	551721	6864674
TC057	58.8	-	26.7	20	553269	6864386
TC058	23.3	0	13.3	16.7	554407	6864459
TC059	0	-	-	0	555605	6864429
TC062	0	0	0	10	553268	6865666
TC063	0	6.67	13.3	30	554376	6865624
TC067	16.7	3.33	16.7	6.67	553195	6866899
TC069	0	-	-	-	555607	6866866
TC071	0	-	-	-	552025	6868084
TC072	23.3	10.0	3.33	13.3	553259	6868024
TC073	47.6	23.3	23.3	30	554483	6867985
TC074	0	-	-	-	555609	6868019
TC075	86.7	0	-	-	550951	6869402
TC077	0	-	-	-	553191	6869250
TC078	0	0	0	6.7	554529	6869201
TC079	0	0	0	0	555558	6869270
TC080	0	-	-	-	550818	6870439
TC081	0	-	-	-	551980	6870413
TC082	0	-	-	-	553090	6870509
TC083	10.0	6.67	33.3	30	554509	6870428
TC084	0	0	0	-	555756	6870330

Site	Activity level (%)				Location	
	2010	2015	2018	2021	Easting	Northing
TC086	13.8	-	0	0	551832	6871681
TC094	0	-	-	-	555951	6873301
TC095	0	-	-	-	556723	6872818
TC106	0	-	-	-	554354	6875149
TC107	0	-	-	-	555473	6875453
TC110	3.85	-	-	-	548422	6876436
TC115	0	-	-	-	554413	6876332
TC116	0	-	-	-	555611	6876500
TC117	0	-	-	-	546035	6877605
TC118	0	-	-	-	547458	6877415
TC120	0	-	-	-	549661	6877418
TC121	0	-	-	-	550833	6877532
TC125	0	-	-	-	555362	6877664
TC129	0	-	-	-	548419	6878838
TC130	0	-	-	-	550774	6878748
TC134	0	-	-	-	555507	6878860
TC135	0	-	-	-	545993	6879979
TC136	0	-	-	-	547348	6880075
TC137	0	-	-	-	548877	6880339
TC139	0	-	-	-	550283	6879366
TC140	0	-	-	-	551975	6880047
TC142	0	-	-	-	554390	6880023
TC143	0	-	-	-	555603	6880090
TC144	0	-	-	-	545853	6881236
TC145	0	-	-	-	546978	6881286
TC146	0	-	-	-	548382	6881279
TC148	0	-	-	-	550705	6881131
TC149	0	-	-	-	551888	6881244
TC150	0	-	-	-	553178	6881237
TC151	20.0	-	-	-	554345	6881090
TC153	0	-	-	-	545990	6882616
TC155	0	-	-	-	548645	6882309
TC156	0	-	-	-	549665	6882094
TC157	0	-	-	-	550853	6882462
TC159	0	-	-	-	553110	6882275
TC160	0	-	-	-	554399	6882352
TC162	0	-	-	-	546014	6883638
TC163	0	-	-	-	547310	6883718
TC164	0	-	-	-	548468	6883953
TC165	3.57	-	-	-	549459	6883544
TC169	0	-	-	-	554374	6883581
TC171	0	-	-	-	547185	6884919
TC172	0	-	-	-	548383	6884813
TC201	50.0	63.3	66.7	43.3	553777	6857887
TC202	3.85	43.3	20.0	20	554391	6857864

Site	Activity level (%)				Location	
	2010	2015	2018	2021	Easting	Northing
TC204	90.9	80.0	76.7	96.7	554406	6859077
TC205	14.3	0	-	-	553376	6862730
TC206	11.1	0	-	-	553785	6863208
TC207	10.0	-	-	-	552705	6863907
TC208	23.3	-	-	-	553198	6863880
TC209	29.0	3.33	-	0	553769	6863928
TC210	27.6	3.33	6.67	16.7	554437	6863813
TC211	0	0	3.33	0	554875	6863821
TC212	11.1	-	-	-	552538	6864489
TC214	0	3.33	3.33	3.3	554989	6864439
TC216	25.0	0	13.3	16.7	554010	6864990
TC217	55.0	6.67	41.9	20	554317	6865052
TC218	17.2	0	3.33	10	554985	6865041
TC219	19.3	0	3.33	3.33	552623	6867406
TC220	23.3	0	6.66	0	553144	6867396
TC221	70.6	38.7	30.0	6.7	553803	6867495
TC223	9.68	0	10.0	0	553313	6868639
TC224	0	-	-	-	555002	6868615
TC225	48.0	20.0	20.0	10	554514	6868457
TC300	50.0	26.7	36.7	43.3	554996	6871038
TC301	40.7	33.3	58.6	43.3	554981	6870413
TC302	0	20.0	0	10	555018	6869832
TC303	45.8	40.0	43.3	20	555583	6869990
TC304	0	-	-	-	553875	6869353
TC305	50.0	13.3	10.0	13.3	554999	6869231
TC306	0	-	-	-	555603	6868613
TC307	0	0	0	0	553734	6866574
TC308	20.0	0	3.33	0	553236	6866030
TC309	91.7	10.0	16.6	10	553778	6866219
TC310	58.8	6.67	13.3	23.3	553665	6865792
TC311	26.6	30.0	33.3	13.3	554944	6865622
TC312	28.1	20.0	3.33	3.3	554976	6863223
TC313	26.7	13.3	0	0	554400	6862657
TC314	43.5	6.67	16.7	0	555004	6862638
TC315	58.3	0	0	0	555573	6862686
TC316	0	-	-	-	553815	6862039
TC317	7.40	33.3	0	30	554985	6861994
TC318	0	-	-	-	553801	6861444
TC319	0	-	-	3.3	554994	6861526
TC320	20.0	0	6.67	0	555568	6861427
TC321	27.6	36.7	13.3	20	555017	6860920
TC323	0	0	6.67	33.3	555001	6860248
TC324	22.6	10.0	16.7	10	554994	6859664
TC325	83.3	73.3	66.7	63.3	553188	6858049
TC326	7.40	10.0	19.3	0	553832	6857255

Site	Activity level (%)				Location	
	2010	2015	2018	2021	Easting	Northing
TC327	7.40	-	-	-	553806	6856627
TC328	100	70.0	46.7	26.67	554425	6856680
TC1501	-	0	0	0	555612	6871034
TC1502	-	0	20.0	26.7	553801	6869999
TC1503	-	0	0	0	551904	6869259
TC1505	-	13.3	0	-	552693	6865645
TC1507	-	0	40.0	0	553401	6865038
TC1508	-	0	0	0	553802	6864440
TC1509	-	6.67	36.7	23.3	554487	6861562
TC1510	-	43.3	33.3	16.7	553812	6859051
TC1511	-	53.3	66.7	80	554994	6859105
TC1512	-	20.0	0	0	553871	6858413
TC1514	-	36.7	50.0	16.7	554387	6857219
TC1517	-	61.3	56.7	30	555350	6866368
TC1518	-	-	-	26.7	551734	6858129

Note:

Datum: GDA.

“-“ indicates site not sampled.