Natural Resources
Kangaroo Island

Kangaroo Island koala population survey 2015

Government of South Australia

PROJECT OFFICER CONTACT DETAILS
Robyn Molsher
Wildlife Program Manager
Natural Resources Kangaroo Island
37 Dauncey Street
Kingscote SA 5223

Phone: (08) 8553 4444
Email: robyn.molsher@sa.gov.au

NATURAL RESOURCES KANGAROO ISLAND CONTACT DETAILS
Regional Director
37 Dauncey Street
Kingscote SA 5223

Phone: (08) 8553 4444
Email: kinrc@sa.gov.au

Version 1.0 August 2017

For bibliographic purposes this paper should be cited as:

Molsher, R. (2017). Kangaroo Island koala population survey 2015. Natural Resources Kangaroo Island, SA.

FRONT COVER IMAGE:
Koala captured for sterilisation, Kangaroo Island, SA

EXECUTIVE SUMMARY

In 1997, the South Australian environment department initiated the Kangaroo Island Koala Management Program (KIKMP) to reduce the island's introduced koala population and prevent over-browsing of native vegetation, which was resulting in the death of significant food trees.

The KIKMP was established with a long-term objective of conserving native vegetation by reducing koala densities to sustainable levels. Sustainable densities were defined as 0.75 koalas/hectare (ha).

In order to evaluate the effectiveness of the KIKMP, an island wide koala population survey is carried out every five years in the native vegetation to estimate the size of the island's koala population. In 2015, the survey counted koalas at 106 fixed monitoring sites in native vegetation and at 19 sites in the recently established commercial blue gum plantations.

The surveys showed that koala densities had increased significantly in the native vegetation since the previous population survey in 2010 and were now above sustainable densities in the high quality habitats. Mean koala densities in these habitats were 1.20 ± 0.17 koalas per ha in 2015 up from 0.73 ± 0.09 in 2010 and 1.07 ± 0.19 koalas per ha in 2006. Mean densities in high quality habitats in 2015, however, were still significantly lower than in the first population survey in 2000 (2.28 koalas per ha) or at the start of the sterilisation program in 1996 (3.30 koalas per ha). Similarly, the maximum density in 2015 was 4.19 koalas per ha, up from 1.76 koalas per ha in 2010 but down from 6.16 koalas per ha in 2000. Koala densities were above the sustainable level at 29% of sites in 2015, an increase from 17% in 2010, and below 36% recorded in 2000.

In 2015, the estimated koala population size in the native vegetation was 25,146 ± 2,646 which is significantly higher than the estimates for 2010 (14,270 ± 759) and 2006 (15,893 ± 1,132) and similar to that estimated in 2000 (26,712 ± 2,923). The population estimate for commercial blue gum plantations was 23,360 ± 3,330 koalas giving an island wide (native vegetation plus plantations) koala population estimate of 48,506 ± 5,976.

The significant increase in the koala population on Kangaroo Island from 2010 to 2015 in the native vegetation was most likely due to a combination of factors including i) the creation of additional koala habitat (commercial blue gum plantations), ii) improved rainfall, and iii) relatively low sterilisation rates 2010-2015 and cessation of translocations in 2010.

While over half the population still occurs at low density (<0.75 koalas per ha), koalas are capable of doubling in size every three years and it is critical that the KIKMP management approach be reviewed and knowledge gaps addressed to prevent further koala increases on the island.

Recommendations for the KIKMP in 2016-17 are to investigate the population dynamics, landscape distribution and density-related impacts of koalas on Kangaroo Island, and to explore new management strategies and tools. Understanding the drivers of the koala population increase on Kangaroo Island and developing a koala spatial model will assist in determining the most effective management strategy and sterilisation targets.

CONTENTS

1. INTRODUCTION

The South Australian Government recognises the koala's (*Phascolarctos cinereus*) national status as an iconic Australian animal and that key sub-populations are declining in distribution and abundance. The koala is listed as vulnerable in Queensland, New South Wales and the Australian Capital Territory. However, in South Australia, koalas are for the most part an introduced species and, in some areas, are considered over-abundant because of their impact on eucalypt tree condition. Kangaroo Island is located 13 km off shore from the Fleurieu Peninsula and 100 km south of Adelaide. It is the third largest island in Australia with a total area of 438,000 ha (140 km long and 55 km wide). Much (47%) of the island's native vegetation remains intact, primarily at the western end.

Koalas were first introduced to Kangaroo Island in the 1920s from French Island in Victoria because of concerns that they were facing extinction on the mainland as a result of hunting and habitat destruction. Numbers expanded rapidly on Kangaroo Island and significant over-browsing impacts in native vegetation were detected in the 1940s. In particular, koala preference for rough-barked manna gum (*Eucalyptus viminalis* ssp. *cygnetensis*), which grows along the river systems, led to this tree species disappearing in some areas, and to visible signs of poor tree health across a broader area (Figure 1). By 1994, the koala population was significantly impacting the health of manna gums at the landscape scale, with over 50% of the canopy of most trees defoliated (Masters et al. 2004).

In 1997, the South Australian Department of Environment and Heritage (now DEWNR- Department of Environment, Water and Natural Resources) initiated the Kangaroo Island Koala Management Program (KIKMP) to reduce the island's koala population to a sustainable level in order to restore native vegetation communities. The program comprises surgical sterilisation of koalas, relocation of koalas from critically damaged areas to the mainland, management of koala habitat and monitoring of koala density and tree condition to evaluate program effectiveness. A population survey is conducted every five years to estimate the island's koala population size.

Since the program began, >12,500 koalas have been sterilised, of which 3,801 have been relocated to the South East of the state where they once occurred naturally (Appendix 1). In 2001, the estimated koala population in native vegetation was 27,000 which was larger and more widespread than previously thought. Management was intensified and subsequent population surveys in 2006 and 2010 estimated that populations had been reduced to ~16,000 and ~14,000, respectively (Molsher et al. 2011).

The aims of the 2015 population survey were to:

1. Update the Kangaroo Island koala population estimate for native vegetation;
2. Estimate koala population size in the recently established blue gum plantations;
3. Determine the proportion of koalas sterilised; and
4. Assess the effectiveness of implemented sterilisation rates to reduce koala numbers.

Figure 1: Koala in over-browsed tree in 2015

2. METHODS

2.1 Study area and site selection

Koala density has been monitored at 26 fixed monitoring sites since the program began in 1996, primarily in the Cygnet River catchment. In 2000, and additional 109 fixed monitoring sites were established across the island to allow a population survey to be carried out every five years. The sites, each of approximately five hectares (ha) in size, were selected randomly across the landscape and stratified by habitat quality and management units (MUs) (Masters et al. 2004, Whisson 2007). Seven MUs were identified based on Kangaroo Island water catchments (Masters 2004, Whisson 2007) (Figure 2).

Suitable vegetation types for koalas on Kangaroo Island occurs over approximately 54,365 ha or 12% of the island area (Masters et al. 2004) (Figure 2). Suitable vegetation subgroups were grouped into three koala habitat classes according to their quality (high, medium, low) as a food source for koalas (Table 1) (Masters et al. 2004). The remaining habitat was considered unsuitable, although koalas are known to occur in these areas from time to time.

Since 1996, koala density and food tree condition have been assessed annually at a subset of these sites in six of the MUs across Kangaroo Island. No monitoring or koala management occurs in the Gantheaume MU, where koala habitat is rare. Access to some monitoring sites is no longer possible, primarily due to landholders prohibiting access or the vegetation impenetrable after fire. The number of sites selected in each MU in the 2015 survey are provided in Table 2.

Commercial Tasmanian blue gum plantations (*Eucalyptus globulus*) are also a known habitat for koalas that have relatively recently become available on the island. These commercial forestry plantations comprise 13,198 ha and were first planted in the 1990s with the majority planted in 2005-06. The trees are estimated to have all become large enough as koala habitat since 2008. In 2015, for the first time, a population size was estimated for the plantations as it was becoming evident that koala numbers were increasing in plantations and were at potentially high densities.

Table 1. Koala habitat classes

Habitat class	Area (ha)	Description
High quality	750 (2%)	Rough-barked manna gum (*Eucalyptus viminalis* ssp. *cygnetensis*), swamp gum (*E. ovata*), river red gum (*E. camaldulensis* var. *camaldulensis*) or South Australian blue gum (*E. leucoxylon* ssp. *leucoxylon*) present as dominant species.
Medium quality	12,909 (23%)	Rough-barked manna gum, swamp gum, river red gum or South Australian blue gum present as secondary species.
Low quality	40,706 (75%)	Brown stringybark (*E baxteri*) or messmate stringybark (*E. obliqua*) present.

2.2 Data collection

The koala monitoring component of the Kangaroo Island Koala Management Project provides information on trends in koala density and distribution. It helps to prioritise areas for management and assists in determining the effectiveness of the sterilisation targets. An island wide population survey of >100 monitoring sites has been conducted approximately every five years in the native vegetation: in 2000, 2006, 2010 and now 2015.

2.2.1 Koala density in native vegetation

Koalas were counted at 106 established monitoring sites (Table 2) primarily (89%) from mid-August to early November 2015. The remainder of sites were counted December 2015 to February 2016. The double count method (i.e. two-count mark-recapture technique; Caughley and Sinclair 1994, Masters et al. 2004) was used at most sites, but single counts were conducted at 12 sites. Double counts involved two observers independently searching a site for koalas. When a koala was seen by either observer, the tree was marked at the base. The other observer determined if a koala was a new sighting or a 'recapture'. In cases where double counts were not possible, koala density was assessed by a single observer who had completed at least 10 surveys using the double count method. A correction factor based on the proportion of koalas seen by each observer during double counts was then applied to each of the single counts to estimate the number of koalas at the site (Duka and Masters 2005). For all sites, site density estimates were derived by dividing the estimated number of koalas by the site area. The sex, presence of dependant young and presence of an ear tag (denoting a sterilised koala) were recorded for each koala.

2.2.2 Koala density in commercial blue gum plantations

In 2015-16, koala density was also assessed at 19 sites in the blue gum plantations and compared to counts in 2010-11 (4 sites), 2011-12 (4 sites), and 2014-2015 (17 sites). Sites were approximately five ha in size. Between two and six observers counted koalas at each site using the single count method described above from 2010-2014. However, in 2015-16 mostly (73%) double counts were used and counts with inexperienced observers removed from the density calculations to improve accuracy for the 2015 population estimate. Mean koala density was calculated by dividing the estimated number of koalas by the site area. The sex, presence of dependant young and presence of an ear tag (denoting a sterilised koala) were recorded for each koala.

Table 2. Number of sites surveyed in native vegetation in the 2015 population survey

Habitat quality	Management Unit						
	Cygnet River and Birchmore Lagoon	Eleanor River and Timber Creek	South-west	North Coast	Rocky River	Dudley Peninsula	TOTAL
High	12	3	0	1	3	5	**24**
Medium	7	6	8	7	3	0	**31**
Low	8	9	10	13	11	0	**51**
TOTAL	**27**	**18**	**18**	**21**	**17**	**5**	**106**

2.2.3. Population estimate

The population estimate (density * area) was calculated in two ways:

i) The first based on stratification by koala habitat class within management unit; and
ii) The second based on stratification of koala habitat class alone.

The first estimate allows for comparisons between MUs, while the second provides an island-wide comparison of koala habitat types. The second estimate was primarily used in comparison between years for consistency. Population size in the native vegetation (54,365 ha) was calculated from surveys at 101 sites (excludes sites in the Dudley MU where koalas are absent). Koala population size in the commercial blue gum plantations (13,198 ha) was calculated from koala density surveys at 19 sites. The total population estimate for the island was calculated by summing the native vegetation and plantation estimates.

Although this population estimate is only an index of relative abundance rather than an absolute number, given a number of constraints, it provides a useful index of change between years. The constraints are that the estimate is extrapolated to the whole island based on site based koala counts in three habitat types and is limited by the current available vegetation mapping and habitat quality model. As well, koalas on the island are regularly observed and caught outside the three defined habitat types such as in very small patches of vegetation, shelter belts, non-native revegetation and roadside vegetation and it is possible that koalas are spreading out into habitats not occupied previously. Therefore, this population estimate is most likely an under-estimation of the absolute number of koalas on Kangaroo Island but it is a useful index of change in relative abundance of koalas between years.

2.3 Data analysis

Sites were grouped according to MU and habitat class (high, medium and low). Descriptive statistics, including mean koala density and percentage of tagged (sterilised) koalas, were calculated for each combination of habitat class and MU. Comparisons in koala density between surveys years were made using t-tests assuming equal variance. Because densities in 2010 and 2006 were similar, pairwise comparisons in koala density were only made between 2015 and 2010 and 2015 and 2000.

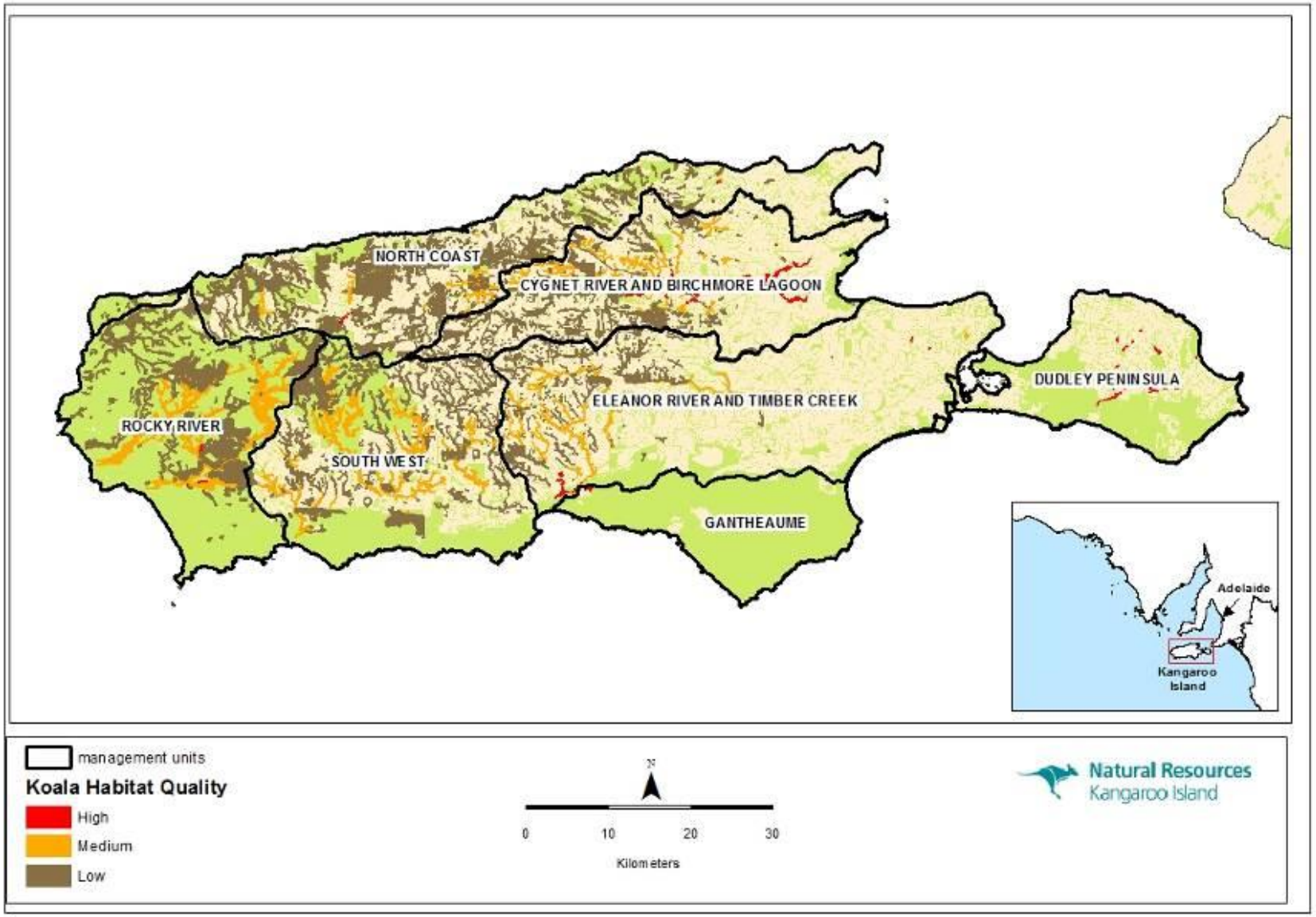

Figure 2. Koala management units and habitat classes

3. RESULTS

3.1 Native vegetation

3.1.1. Koala density

Koala densities in the native vegetation were significantly higher in 2015 than in the previous population survey in 2010 in all habitat classes ($P<0.05$) (Figure 3, Tables 3 and 4) and were now above sustainable densities (i.e. 0.75 koalas per ha) in the high quality habitats (Table 3). Mean koala density in high quality habitats was 1.20 ± 0.17 koalas per ha in 2015 up from 0.73 ± 0.09 in 2010 and 1.07 ± 0.19 koalas per ha in 2006. While densities in high quality habitats have increased since 2010 they are still significantly lower than in 2000 (2.28 ± 0.31 koalas per ha) (Figure 3, Tables 3 and 4). Similarly, the maximum density in 2015 was 4.19 koalas per ha (Appendix 2), up from 1.76 koalas per ha in 2010 but down from 6.16 koalas per ha in 2000.

Overall (habitat classes combined), mean koala density in 2015 was 0.64 koalas per ha, up from 0.36 koalas per ha in 2010 and 0.47 koalas per ha in 2006 and down from 0.83 koalas per ha in 2000 (Table 3). Koala densities were above the sustainable level at 29% of sites in 2015, an increase from 17% in 2010, but below 36% recorded in 2000 (Table 3).

As in previous years, koalas were not observed at sites on the Dudley Peninsula and koala densities were generally lower in low quality habitats compared with medium and high quality habitats (Table 3, Figure 3).

Of the 331 koalas observed in 2015, 58% were female and the remainder were male (35%) or sex unknown (7%). Of the 193 females, 26% were tagged (and therefore sterilised), which was the same as that recorded in 2010, but less than in 2006 (30%) and 2000 (44%) (33 sites only). In 2015, the highest sterilisation rate was in the Cygnet River and Birchmore Lagoon MU low quality habitats (63%) (Appendix 3). Sterilisation rates in the Cygnet River MU since 2000 have increased in the low quality habitats (0 to 63%), declined in the high quality habitats (47% to 31%) and remained similar in the medium quality habitats (48% to 46%).

Dependant young were observed with 36% of unsterilised females in 2015, which is higher than that reported in 2010 (23%) and 2006 (25%) (data not available for the 2000 surveys).

3.1.2 Population size

Population size in the native vegetation was estimated at 25,146 ± 2,646 (s.e.) koalas based on the habitat only stratification (Figure 4, Table 5) which is significantly higher than that estimated in 2006 and 2010 but similar to that estimated in 2000. The population estimate in 2015 when MUs were calculated separately was 17,830 (Appendix 2) (c.f. 10,681 in 2010 and 21,382 in 2000).

Most koalas (29%) during the 2015 surveys were found in the south-west MU (Appendix 2). As in previous years, most koalas (58%) occupied low quality habitat which comprised a large area of the island and where koalas occur at low densities (Appendix 2). Over half the population (60%) occurred below sustainable densities of 0.75 koalas per ha (Appendix 2).

3.2 Commercial blue gum plantations

3.2.1. Koala density

Mean koala density in plantations in 2015 was 1.77 ± 0.25 koalas per ha which was higher than that recorded in the previous year 2014 (0.89 ± 0.23 koalas per ha) (Figure 3). However, counts in 2015 were mostly the more rigorous double counts compared with single counts in 2014 that may have underestimated koala densities (Molsher 2011). Variation in koala densities was high within and between plantations. Sample sizes in 2010 and 2011 were too small to allow a comparison for these years.

Koala density in plantations was higher (1.77 ± 0.25 koalas per ha) than in the high quality native vegetation (1.2 ± 0.17 koalas per ha). The maximum koala density in plantations was 4.70 koalas per ha and in native vegetation was 4.19 koalas per ha.

Of the 158 koalas detected in plantations, 34% were female, 15% male and the sex of the remaining 51% of koalas could not be determined due to the height and structure of plantation trees obstructing a clear view. Of the 54 females observed, only two were tagged and therefore sterilised but again this is probably an underestimate given the difficulty in observing koalas at the top of plantation trees. Dependant young were observed with 52% of the unsterilised females, which is higher than that reported in the native vegetation (i.e. 36%).

3.2.2. Population size

The population estimate for plantations is 23,360 ± 3,330 (s.e.) koalas (n = 19 sites) based on a mean density of 1.77 koalas per ha and area of 13,198 ha (Table 5).

3.3 Island koala population size

The total estimated koala population size for Kangaroo Island (native vegetation plus plantations) in 2015 is 48,506 ± 5,976 (s.e.) (n = 120 sites) (Table 5).

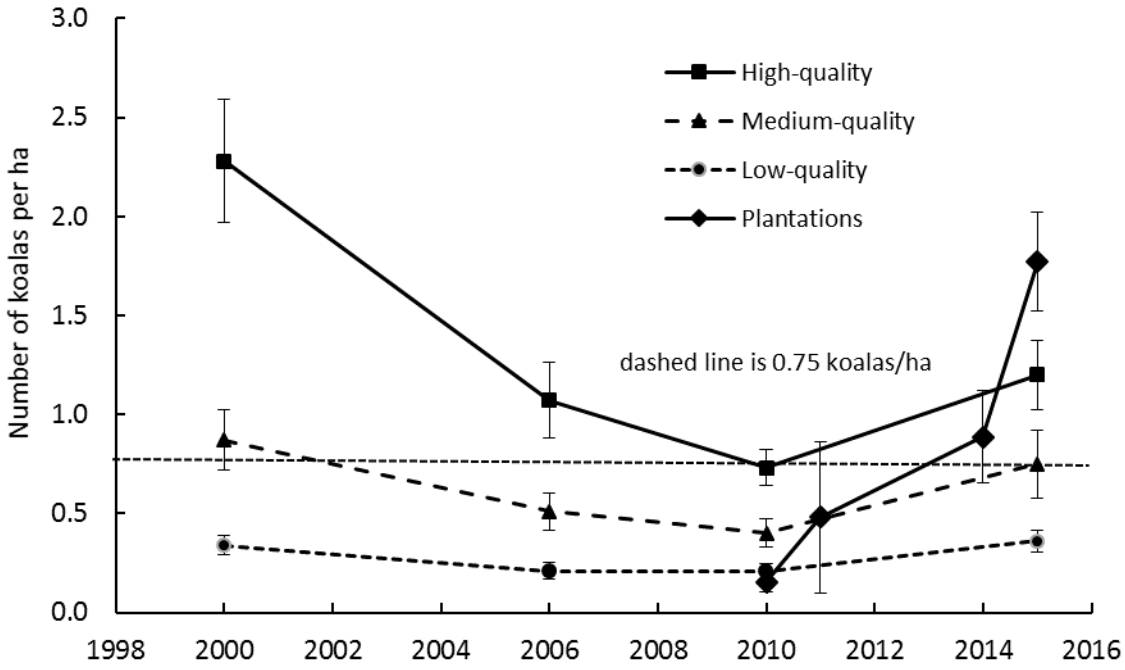

Figure 3. Mean koala density ± SE per habitat class for each population survey

Table 3. Comparison of mean koala densities between population surveys

Management Unit	Koala habitat	No. of sites surveyed in 2015	Area (ha)	Mean koala density (no. per ha)			
				2000	2006	2010	2015
Cygnet River	High	12	613	2.14	0.91	0.87	1.3
	Medium	7	1375	1.09	0.93	0.56	0.96
	Low	8	5018	0.40	0.27	0.29	0.31
	mean			**1.23**	**0.72**	**0.58**	**0.92**
Eleanor/Timber Creek	High	3	99	1.46	1.39	0.47	0.9
	Medium	6	1669	0.51	0.48	0.39	0.78
	Low	9	3081	0.48	0.55	0.29	0.87
	mean			**0.62**	**0.66**	**0.37**	**0.84**
South-west	High	-	0	-	-	-	-
	Medium	9	3989	0.71	0.35	0.15	0.42
	Low	9	7630	0.38	0.24	0.30	0.47
	mean			**0.54**	**0.29**	**0.23**	**0.45**
North Coast	High	1	10	1.74	0.86	0.90	1.06
	Medium	7	670	1.71	0.59	0.64	1.18
	Low	13	14723	0.29	0.07	0.19	0.18
	mean			**0.88**	**0.30**	**0.40**	**0.56**
Flinders Chase	High	3	27	4.85	1.8	0.16	1.15
	Medium	3	5207	0.32	0	0	0.16
	Low	11	10254	0.11	0.09	0.02	0.05
	mean			**0.77**	**0.26**	**0.03**	**0.27**
Overall	High	75	750	2.28	1.07	0.73	1.2
	Medium	140	12,909	0.87	0.51	0.40	0.75
	Low	205	40,706	0.34	0.21	0.21	0.36
	mean			**0.83**	**0.47**	**0.36**	**0.64**
	s.e.			**0.1**	**0.06**	**0.04**	**0.07**
	n			**115**	**108**	**106**	**101**
% sites >0.75 koalas per ha				**36%**	**24%**	**17%**	**29%**

Table 4. Statistical comparison of mean koala densities between 2015 and 2010 for each habitat class

Management Unit	Koala habitat	2015 vs 2010				2015 vs 2000			
		t	df	P (2 tailed)	sig	t	df	P (2 tailed)	sig
Overall	**High**	2.37	35	0.02	yes	-3.09	35	0.003	yes
	Medium	1.98	65	0.05	yes	-0.52	69	0.59	NS
	Low	2.12	100	0.04	yes	0.25	106	0.79	NS

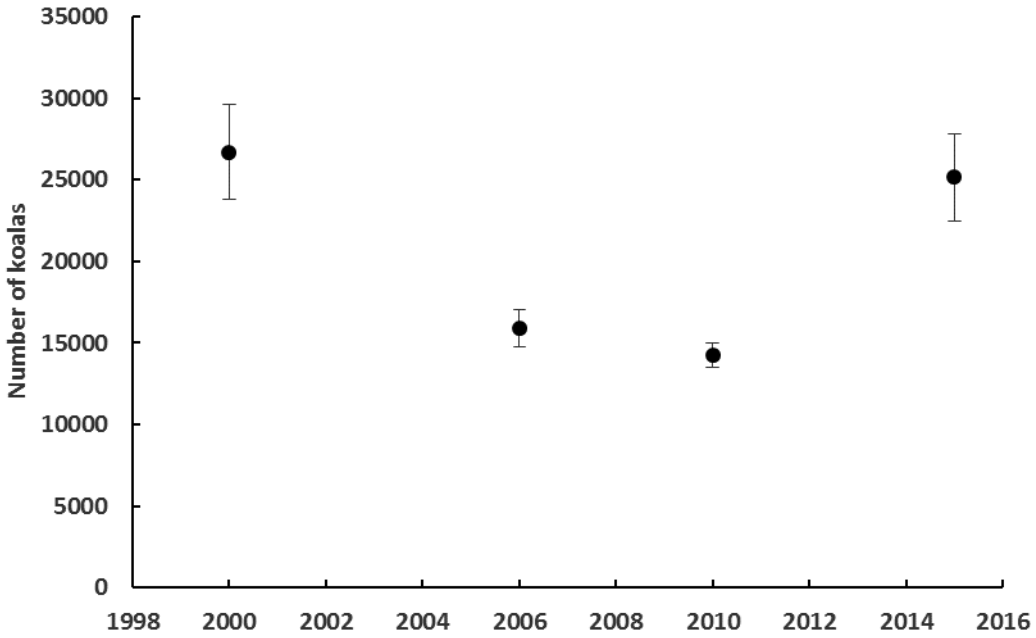

Figure 4. Population estimate and standard error for each koala population survey in native vegetation

Table 5. Kangaroo Island koala population estimate for 2000, 2006, 2010 and 2015.

	Koala population estimates			
Population survey year	**2000**	**2006**	**2010**	**2015**
Population estimate-native vegetation	26,712	15,893	14,270	25,146
standard error	2,923	1,132	759	2,646
no. sites	115	108	105	101
% sites > 0.75 koalas per ha	36%	24%	17%	29%
% change since previous population survey	n/a	-41%	-10%	76%
Population estimate – blue gum plantations	n/a	n/a	n/a	23,360
standard error				3,330
no. sites				19
Population estimate - total	as for native vegetation	as for native vegetation	as for native vegetation	**48,506**
standard error				**5,976**
no. sites				**120**

4. DISCUSSION

The koala population on Kangaroo Island increased significantly in 2015 (by 77%) compared to the previous population survey in 2010 with densities now above the sustainable density of 0.75 koalas per ha in high quality habitats (1.20 koalas per ha). Nevertheless, densities in 2015 in high quality habitats were still lower than those recorded during the first population survey in 2000 (2.28 koalas per ha) and at the start of the koala program in 1996 (3.30 koalas per ha) (Molsher 2015). Similarly, the maximum koala density at a site in 2015 has halved since the beginning of the program, falling from 9.4 in 1996 to 4.1 koalas per ha in 2015. Thus although koala numbers have increased significantly across the island in the last five years they are not as high as in 2000 or at the start of the program and over half the population occurs at sustainable densities (0.75 koalas per ha).

Koala densities in 2015 on Kangaroo Island are similar to other southern koala populations at Mt Eccles National Park and less than those recorded on French Island and at Cape Otway (Table 6).

Table 6. Koalas densities (number per ha) in southern Australia

Location	Year	Mean density	Maximum density	Range	Reference
Kangaroo Island, South Australia	2015	0.64 ± 0.07	4.19	0.05 - 1.3	This report
Mt Eccles National Park, south –west Victoria	2011 2014 2016	0.65 ± 0.08 0.54 0.93 ± 0.08	2.17		Wood 2011 Ramsey et al. 2015 Wood 2016
French Island, Victoria	2013	8.4 ± 1.9	24.2	2.2 - 24.2	Lee 2013
Cape Otway, Victoria	2011 2013	10.1 ± 1.2 18.4 ± 2.5	-	-	Whisson et al. 2016

The koala population estimate for native vegetation in 2015 was 25,146 koalas (± 2,646), up from 14,270 koalas (± 759) in 2010 and similar to 26,712 koalas (± 2,923) estimated in 2000. Additionally, if the estimated koala population in the newly established Tasmanian blue gum plantations is added then a new koala population estimate of 48,506 ± 5,976 is obtained for the island. While there are constraints in estimating population size in this way (discussed earlier) and this estimate is most likely an under-estimation of the absolute number of koalas, it is a useful index of change in relative abundance between years.

Koala densities, rather than population estimates, are more useful for targeting areas for koala management as are not extrapolated across vegetation types and provide site based counts. A spatial population model that incorporates recent vegetation data would improve the accuracy of the population estimate for the island and is currently being developed.

While the decline in koala numbers from 2000 to 2006 to 2010 may have been attributed in part to some of the koalas moving out of the native vegetation and into the newly established commercial blue gum plantations from 2008, it is unlikely that this was the sole reason for the koala declines in 2010 as the plantations are primarily located at the western end of the island which is > 50 km from some of the monitoring sites. This distance is greater than the distance koalas usually move on the island (Carlyon 2013, Louter 2017).

Increases in koala numbers between 2010 and 2015 were not uniform across the island with varying trends in different MUs. Possible factors influencing the koala population trajectory on the island are:

i) Habitat/food - an additional 13,000 ha of blue gum plantations available since 2008

ii) Rainfall - last drought 2006 and good rainfall since then

iii) Sterilisation and translocation effort variable

iv) Combination of above factors

These factors are discussed below.

i) Habitat/food

Tasmanian blue gum plantations can support high density koala populations where they co-occur (e.g. Hynes 2014). On Kangaroo Island, densities in plantations have continued to increase since monitoring began in 2010 with an estimated mean density of 1.77 koalas per ha ± 0.25 in 2015, up from 0.89 koalas per ha ± 0.23 in the previous year. This is more than twice the sustainable density (0.75 koalas per ha) for native vegetation and higher than densities recorded in high quality native vegetation (1.20 koalas per ha ± 0.17), indicating that the plantations are a preferred habitat for koalas on the island. The maximum koala density recorded in the plantations was 4.70 koalas per ha which was lower than the maximum recorded in plantations in south-west Victoria (5.86 koalas per ha n = 20 sites) where densities ranged from 0 to 5.86 koalas per ha (mean 0.76 ± 0.11 koalas per ha) (Hynes 2014).

Commercial blue gum plantations have become significant habitat for koalas on the island and the presence of back-young indicates the population is breeding in plantations and are not transient individuals. Koalas are not managed in plantations because the difficulties in climbing plantation trees given the thin structure of trunks and limbs and the focus of KIKMP resources in native vegetation. Koalas in plantations on the island are likely to continue to breed up and disperse into neighbouring native vegetation. Future harvesting of the plantation trees may also potentially increase the population in the native vegetation as koalas move into the surrounding area and needs to be managed appropriately.

ii) Rainfall

The decline in koala densities between 2001 and 2010, may have been due in part to the drought conditions that prevailed in 2006 followed by below average rainfall in the region in 2007 and 2008. This may have decreased the quality of the food for koalas or contributed to direct mortalities. Drought is known to reduce koala breeding on Kangaroo Island (Carlyon 2013). Thus, the improved rainfall conditions after 2008 may have promoted koala survival and breeding and contributed to the population increase observed between 2010 and 2015. This is supported by the higher incidence of unsterilised koalas with back-young in 2015 (36% of females) compared to 23% in 2010 and 25% in 2006.

iii) Sterilisation and translocation effort variable

The 2006 drought period also coincided with intensification of the sterilisation program where high numbers of koalas were sterilised and translocated which would have further contributed to the population decline between 2000 and 2010. Sterilisation targets in 2005-06 (n = 1533 koalas) and 2006-07 (n = 1790 koalas) were a lot higher compared with the 400-500 koalas that were sterilised each year for 2010-2015. When the sterilisation target was reduced in 2010 and translocations ceased, primarily due to resource constraints, the reduction in the sterilisation target was considered appropriate given the koala population had significantly reduced from 27,000 koalas in 2000 to 14,000 in 2010 and the program was entering a maintenance phase.

Overall, 26% of female koalas observed in 2015 were sterilised, which was the same as that recorded in 2010, but less than that recorded in 2006 (30%) and 2000 (44%) (33 sites only).

Delean et al. (2013) recommend that the sterilisation rate needs to be at least 55% to stop the population from increasing. However, over half the population occurs below the estimated sustainable level (< 0.75 koalas per ha) where overbrowsing doesn't usually occur. Sterilisation needs to be targeted outside these areas where koala densities are high.

Combination of above factors

The reduced sterilisation rate, cessation of translocations and improved rainfall since 2010 has been further exacerbated by an increasing number of landholders prohibiting access to their properties for koala management in recent years for a variety of reasons. This potentially allows pockets of koalas to breed up and disperse into neighbouring vegetation. In 2015, 13 properties restricted access for monitoring or management compared with two properties during the last population survey in 2010. The three most common (78%) reasons for prohibiting access for management were: 1) anti-government sentiments; 2) likes having koalas around e.g. for tourism; and 3) the Koala Program is a waste of time and money and it would be better to shoot them. Of the 35 properties currently prohibiting access, 21 (60%) were prohibited in the last five years.

It is likely that all factors described above have contributed to the increase in the koala population on the island but their relative importance is unknown. Understanding the causes of the increase in koala numbers is important for preventing future increases and developing the most appropriate management strategy.

Conclusion

The significant increase in the koala population on Kangaroo Island from 2010 to 2015 was most likely due to a combination of factors including i) the creation of additional habitat (commercial hardwood plantations) ii) improved rainfall and iii) relatively low sterilisation rates 2010-2015 and cessation of translocations in 2010. While over half the population still occurs at low density (<0.75 koalas per ha), koalas are capable of doubling in size every three years (Martin 1997) and it is critical that the KIKMP management approach be reviewed and knowledge gaps addressed to prevent further population increases.

Recommendations

Recommendations for the KIKMP in 2016-17 will be to investigate the population dynamics, landscape distribution and density-related impacts of koalas on Kangaroo Island, and to explore management strategies and tools. Understanding the drivers of the koala population increase and filling knowledge gaps will assist in determining the most effective management strategies and allow more confidence in predicting sterilisation targets.

Key research questions are:

1. Quantify the relative importance of the different factors affecting koala density so that a long term strategy for the KIKMP can be developed.
2. Improve confidence in the koala population estimate by incorporating land cover maps, habitat information and koala movement data into a spatial model.
3. Determine the relationship between koala density and tree condition for manna gum, SA blue gum, stringybark and red gum communities and confirm that 0.75 koalas per ha is a sustainable koala density for all koala food species on the island.
4. Explore all available koala management options and determine feasibility for use e.g. hormone implants and drones.
5. Seek funding to expand the sterilisation program and target areas where koala densities have increased above sustainable densities or where overbrowsing has reduced tree condition.

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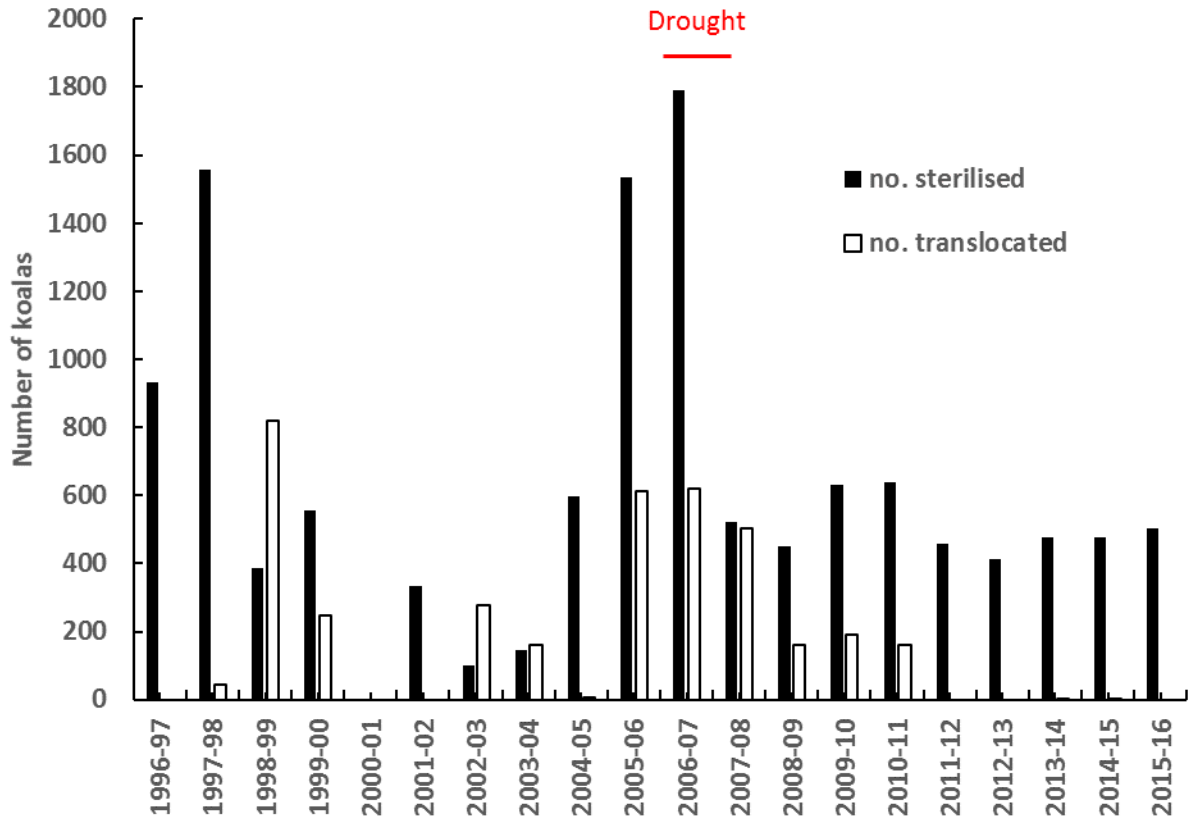
ACKNOWLEDGEMENTS

We sincerely thank the numerous landholders who allowed access to their properties to monitor koalas. Thanks also to the 2015-16 KIKMP field staff: Andrew Schofield, Torran Welz, Dave Dowie, Julia Greenfield, Brodie Philp, Andrew Collis, Venetia Bolwell and Mike Barth who conducted the koala surveys.

APPENDICES



Appendix 1. Numbers of koalas sterilised and translocated on Kangaroo Island 1996-2015

Appendix 2. Koala density (number per ha) and population estimate for 2015

Management Unit	Koala habitat quality	Area (ha)	No. sites	Mean density (no. per ha) ± SE	Maximum density (no. per ha)	Population estimate	% of total koalas
Cygnet River and Birchmore Lagoon	High	613	12	1.30 ± 0.25	2.98	796	
	Medium	1375	7	0.96 ± 0.40	2.94	1320	
	Low	5018	8	0.31 ± 0.11	0.75	1555	
	TOTAL MU	**7,006 (12%)**	**27**			**3,671**	**21%**
Eleanor River and Timber Creek	High	99	3	0.90 ± 0.39	1.64	89	
	Medium	1669	6	0.78 ± 0.26	1.62	1302	
	Low	3081	9	0.87 ± 0.17	1.99	2680	
	TOTAL MU	**4,849 (9%)**	**18**			**4,071**	**23%**
South-west	High	0	0	-	-	-	
	Medium	3989	9	0.42 ± 0.16	1.15	1,675	
	Low	7630	9	0.47 ± 0.11	0.85	3,586	
	TOTAL MU	**11,619 (21%)**	**18**			**5,261**	**29%**
North Coast	High	10	1	1.06	1.06	10	
	Medium	670	7	1.18 ± 0.56	4.19	791	
	Low	14,723	13	0.18 ± 0.05	0.60	2,650	
	TOTAL MU	**15,403 (29%)**	**21**			**3,451**	**19%**
Rocky River	High	27	3	1.15 ± 0.26	1.57	31	
	Medium	5207	3	0.16 ± 0.09	0.32	833	
	Low	10,254	11	0.05 ± 0.04	0.38	512	
	TOTAL MU	**15,488 (29%)**	**17**			**1,376**	**8%**
	OVERALL TOTAL (MUs separately)					**17,830**	
Overall	High	750	19	1.20 ± 0.17		899	4%
	Medium	12,909	32	0.75 ± 0.17		9,658	38%
	Low	40,706	50	0.36 ± 0.06		14,589	58%
	OVERALL TOTAL (habitats separately)	**54,365**	**101**			**25,146 ± 2,646**	

Appendix 3. Proportion of koalas sterilised in 2015

Management Unit	Koala habitat quality	Total no. females observed	% females sterilised
Cygnet River and Birchmore Lagoon	High	52	31
	Medium	24	46
	Low	8	63
TOTAL for MU		**84**	**38%**
Eleanor River and Timber Creek	High	9	22
	Medium	14	29
	Low	24	13
TOTAL for MU		**47**	**19%**
South-west	High	-	-
	Medium	12	17
	Low	15	20
TOTAL for MU		**0**	**19%**
North Coast	High	4	50
	Medium	17	12
	Low	5	0
TOTAL for MU		**26**	**15%**
Rocky River	High	8	0
	Medium	0	-
	Low	1	0
TOTAL for MU		**9**	**0%**
TOTAL for MU OVERALL		**193**	**26%**