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2014 Quota Report

New South Wales Commercial Kangaroo Harvest Management Plan 2012–2016

This report was prepared in November 2013 by the Senior Team Leader Kangaroo Management Program, Office of Environment and Heritage (NSW) North West Branch.

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Contents

Introduction

The New South Wales Office of Environment and Heritage (OEH) and its predecessor agencies have been researching, monitoring and managing the NSW Kangaroo Management Program (KMP) since the 1970s. Throughout this time, adjustments have been made to the survey design, population estimation and method of determining the commercial quota.

This *2014 Quota Report: New South Wales Commercial Kangaroo Harvest Management Plan 2012–2016* gives details of the KMP quotas for the 2014 kangaroo take in accordance with NSW Commercial Kangaroo Harvest Management Plan 2012–2016 (the Plan), which was approved by the Commonwealth Government to start on 1 January 2012. The report includes:

- current population estimates for 2013 and quotas for 2014
- details of trends in:
  - population estimates
  - quotas
  - commercial take data

for red kangaroos, eastern and western grey kangaroos, and wallaroos.

Summary

Table 1 lists the quotas for 2013 and 2014. Table 2 compares the 2014 quotas against the 2013 population estimates and gives the quotas as percentages of those estimates.

Table 1. Quotas for 2013 and 2014

	2014		2013	
	Quota	**Maximum special quota**	**Quota**	**Maximum special quota**
Red kangaroo	761,699	67,209	705,214	62,225
Eastern grey kangaroo	1,334,443	133,444	944,693	94,469
Western grey kangaroo*	277,158	27,791	121,328	12,838
Wallaroo	15,124	1,512	12,515	1,326
Total	**2,388,424**	**229,956**	**1,783,750**	**170,858**

* There is a small population (4,982) of western grey kangaroos in the Narrabri management zone. This is included in the population estimate, but no quota is set for this species in this zone.

Table 2. Population estimates for 2013 and quotas for 2014

	Population estimate 2013	**Quota 2014**	**Quota as per cent of population**
Red kangaroo	4,480,580	761,699	17.0
Eastern grey kangaroo (Western Plains)	6,12,564	946,885	15.0
Eastern grey kangaroo (Central and Northern Tablelands and Southeast NSW)	2,583,720	387,558	15.0
Western grey kangaroo*	1,852,710	277,158	15.0
Wallaroo (Northern Tablelands)	100,825	15,124	15.0
Total	**15,330,399**	**2,388,424**	

* There is a small population (4,982) of western grey kangaroos in the Narrabri management zone. This is included in the population estimate, but no quota is set for this species in this zone.

Table 3 lists the details of the 2013 harvest to 30 September. '%q' is the commercial take as a percentage of the approved quota. '%p' is the commercial take as a percentage of the population estimate.

Table 3. Actual takes to 30 September 2013

Management zone	No.	Eastern grey				Red				Western grey				Wallaroo			
		Quota	Take	%q	%p	Quota	Take	%q	%p	Quota	Take	%q	%p	Quota	Take	%q	%p
Tibooburra	1	8,463	484	6%	1%	159,399	18,167	11%	2%	2,619	241	9%	1%				
Broken Hill	2	13,564	1,619	12%	2%	193,567	39,904	21%	4%	13.138	6,228	47%	5%				
Lower Darling	4	13,239	2,978	22%	3%	50,181	8,639	17%	3%	21,589	4,236	20%	3%				
Cobar	6	17,565	873	5%	1%	42,968	2,015	5%	1%	29,164	1,250	4%	1%				
Bourke	7	48,407	3,721	8%	1%	72,930	10,465	14%	2%	18,630	653	4%	1%				
Narrabri	8	186,514	30,132	16%	2%	63,114	6,504	10%	2%								
Armidale	9	31,017	6,841	22%	3%									6,188	980	16%	2%
Coonabarabran	10	200,410	28,364	14%	2%	60,734	9,691	16%	3%	18,197	320	2%	0%				
Griffith	11	87,068	14,948	17%	3%	62,323	9,126	15%	2%	17,991	1,727	10%	1%				
Glen Innes	13	40,425	6,044	15%	2%									4,829	1,031	21%	3%
Upper Hunter	14	25,125	3,149	13%	2%									1,499	994	66%	7%
Southeast NSW	16	128,835	3,872	3%	0%												
Central Tablelands North	48	91,889	7,469	8%	1%												
Central Tablelands South	49	52,175	6,200	12%	2%												
Total		**944,693**	**116,698**	**12%**	**2%**	**705,214**	**104,511**	**15%**	**3%**	**121,328**	**14,655**	**12%**	**2%**	**12,515**	**3,005**	**24%**	**3%**

Population estimates and survey method used

Full details of the aerial survey methodology used by the KMP are contained in a separate document titled *Population Monitoring Methods for the NSW Kangaroo Management Program* and in individual survey reports for the Northern Tablelands, Southeast NSW and the Central Tablelands. Reports are all available from the KMP's web page at www.environment.nsw.gov.au/wildlifemanagement/KangarooManagementProgram.htm

A brief outline is provided here.

Western Plains

The 2013 survey of the Western Plains started on 3 June and was completed on 9 August. The Western Plains covers an area of approximately 531,000 square kilometres and includes kangaroo m zones 1 to 8, 10 and 12.

The survey was conducted by using well-established techniques. This methodology has been refined on the basis of additional research, but it has remained largely the same since the early 1980s. It involves flying at a predetermined speed and height, with trained observers counting animals within a strip equivalent to 100 metres on the ground. This method provides an observed density, which is then multiplied by species- and habitat-specific correction factors to give a corrected density. The corrected density is then multiplied by the area of each habitat type in each zone to provide population estimates.

Correction factors are described in detail in *Population Monitoring Methods for the NSW Kangaroo Management Program.* In essence, correction factors are used to account for the fact that not every kangaroo present will be seen by the observers. The proportion of kangaroos observed will depend on the species (because of differences in behaviour among species) and the nature of the habitat (a higher proportion of animals will be observed on open grasslands than in woodland habitats). These correction factors have been derived after several years of research using both helicopter and fixed-wing surveys.

Throughout this document two sets of correction factors have been used to calculate population estimates. Where data are presented for the years before 2001, correction factors for 200-metre-wide survey strips from the work of Cairns and Gilroy (2001) have been applied. For 2001, 2002 and 2003 data (and future years), the most recent correction factors (September 2003) for 100-metre survey strips have been applied. Where appropriate in the tables and figures throughout this document, dark shading has been used to show where the most recent 100-metre correction factors have been used, and light shading where 200-metre correction factors have been applied.

Table 4 shows the current estimated density and population of kangaroos in each of the Western Plains management zones.

Table 4. Red and grey kangaroo population estimates for 2013 for the Western Plains

Management zone	Red kangaroo population estimate	Grey kangaroo population estimate
Tibooburra	903,219 ± 153,972	163,392 ± 31,980
Broken Hill	1,219 ± 188,739	586,534 ± 89,760
Lower Darling	423,518 ± 97,318	486,859 ± 82,476
Cobar	193,738± 64,182	660,596 ± 95,894
Bourke	460,225 ± 106,654	541,622± 122,315
Narrabri	369,861± 118,390	1,874,886± 347,143
Coonabarabran	373,924 ± 116,474	2,071,115 ± 383,366
Griffith	536,580 ± 133,962	1,780,269 ± 482,473
Total	**4,480,580 ± 360,309**	**8,165,273 ± 735,048**

The estimated numbers and densities of red and grey kangaroos in each management zone from 1989 onwards are given in Tables A1 to A8. The population trends for each species are shown in Figures A1 and A2 and Tables A16 to A18 (Appendix A).

Combined red and grey kangaroo population estimates, authorised quotas and actual takes (from 1982 onwards) are shown in graphical form in Figure A3 and in tabular form from 1975 onward in Table A15 (Appendix A). Note that the combined grey kangaroo data in Figure A3 and Table A5 include eastern grey kangaroos in the Northern Tablelands, Central Tablelands and Southeast NSW.

Northern Tablelands

The Northern Tablelands commercial harvest area covers some 51,000 square kilometres and comprises kangaroo management zones 9, 13 and 14. Before 2001, the commercial quota was set on the basis of ground (walked) surveys conducted in 1989–90; the quotas were adjusted annually on the basis of seasonal changes and results from the surveys of neighbouring zones.

The Northern Tablelands was first surveyed by helicopter in 2001, with additional surveys in 2002, then again in 2004 (Cairns 2004). The most recent survey was conducted between 2nd and 13 September 2013, according to a design developed with the help of Distance© software. As helicopter survey techniques are relatively new and still evolving, each survey is redesigned by using information gained from previous surveys and advances in software capability. A full report outlining the design of the survey and analysis of the results is available on the KMP's web page at www.environment.nsw.gov.au/resources/nature/kmp/NT_Report_2011.pdf

Details of the population estimates and commercial takes of wallaroos are given in Table A19 and Figure A7 (Appendix A). Wallaroo population estimates and quotas for each zone are shown in Tables A9a to A11a.

Details of the population estimates and commercial takes of eastern grey kangaroos in all zones are given in Table A17 and Figure A5. Eastern grey population estimates and quotas for each of the Northern Tablelands zones are shown in Tables A9b to A11b.

Table 5 shows the current estimated densities and populations of kangaroos in each of the Northern Tablelands management zones; these data are based on aerial surveys conducted in 2013.

Table 5. Population estimates for 2013 for the Northern Tablelands

Management zone	Zone area (km^2)*	Eastern grey kangaroo			Wallaroo		
		Density (km^{-2})	Population estimate	Quota	Density** (km^{-2})	Population estimate	Quota
Glen Innes	18,449	20.3	374,300	56,145	1.5	28,305	4,246
Armidale	15,809	16.6	263,300	39,495	2.8	45,140	6,771
Upper Hunter	14,004	9.05	126,800	19,020	1.9	27,380	4,107
Total	**48,262**		**764,400**	**114,660**		**100,825**	**15,124**

* 'Zone area' in this table refers only to high- and medium-density strata, excluding the National Park estate, Forests and Reserves, where harvesting is prohibited. Low-density strata were not surveyed.

** Densities have been multiplied by 1.85, as suggested by Cairns (2004).

Southeast NSW

Southeast NSW (kangaroo management zone 16) was surveyed in August and October 2012. About 23% of the total area of the zone is not available for commercial harvest, either because it is reserved for conservation or State Forest or because the terrain is too difficult. These areas are excluded from the survey, which covers approximately 38,500 square kilometres. The population estimate gained from this survey will remain current until the next survey, in 2015. The contractor's report on the results of the survey will be available on the KMP web page when available.

The study area was originally surveyed in 2003 in accordance with a design developed by consultants on the basis of the latest methodologies (Pople, Cairns & Menke 2003). Because of the difficult nature of the terrain, survey using fixed-wing aircraft was not possible and a helicopter was used, as for the Northern Tablelands zones. The consultant's report on the results of the survey was presented with the 2005 Quota Submission and is available from the Kangaroo Management Section (kangaroo.management@ environment.nsw.gov.au).

In accordance with the approval to start a commercial harvest in this zone, a second aerial survey was conducted in September 2006 to provide updated population estimates. The 2006 survey was designed after consideration of the results of the original survey and harvest data and of advances in survey design software. As a result of the redesign, the 2006 survey included greater overall length of survey lines and shorter individual lines, leading to more appropriate coverage of the total area and greater statistical precision. The full report (Cairns 2007) is available from the Kangaroo Management Section (kangaroo.management@environment.nsw.gov.au).

Following the approval of additional commercial harvest zones in the Central Tablelands area, the former Young Rural Lands Protection Board (RLPB) has been incorporated into the Southeast NSW commercial harvest zone, adding an additional 8,884 square kilometres. The survey conducted in September 2009 included this area.

Table 6 shows the current estimated density and population of kangaroos in each of the former RLPBs in the Southeast NSW management zone.

Table 6. Population estimates for 2012 for eastern grey kangaroos in each of the six Rural Lands Protection Board (RLPB) areas comprising the Southeast NSW management zone

RLPB	Area (km^2)	Survey effort (km)	Density (km^{-2})	Population estimate
Goulburn	6,028	405	23.5	108,200
Braidwood	4,284	390	27.1	107,900
Gundagai	6,342	460	21.0	116,800
Yass	5,615	472	23.6	106,500
Cooma	7,271	600	34.5	248,300
Young	8,884	430	31.3	171,200
Total or (average)	**38,424**	**2,757**	**(22.35)**	**858,900**

Details of the population estimates and commercial takes of eastern grey kangaroos in all zones are given in Table A17 and Figure A5. Eastern grey population estimates and quotas for the Southeast NSW zone are shown in Table A12.

Central Tablelands

The initial helicopter survey of the new Central Tablelands management zone was conducted in 2008. It was designed to provide separate population estimates for the Hunter–Mudgee–Merriwa and Central Tablelands areas, allowing the Central Tablelands zone to be managed as either one or two zones. Since its commencement on 1 June 2009, the area has been managed as two zones (Central Tablelands North and Central Tablelands South).

These two zones were surveyed again in September 2011. The survey design incorporated the information gained from the initial survey in the delineation of low-, medium-, and high-population-density strata, allowing for improved precision in the population estimates. The population estimates and densities derived from this helicopter survey are shown in Table 7. The full report is available from the KMP web page: www.environment.nsw.gov.au/resources/nature/kmp/120749KMPCTablelandsRep.pdf

Table 7. Population estimates for 2011 for eastern grey kangaroos in each of the new Central Tablelands commercial harvest zones.

Zone	Area (km^2)	Density (km^{-2})	Population estimate
Hunter–Mudgee (Central Tablelands North)	29,379	20.9	612,590
Central Tablelands South	23,105	15.1	347,830
Total or (Average)	**52,484**	**18.3**	**960,420**

Details of the population estimates and commercial takes of eastern grey kangaroos in all zones are given in Table A17 and Figure A5. Eastern grey population estimates and quotas for the Central Tablelands zone are shown in Tables A13 and A14.

Determination of quotas

Commercial quotas

Annual commercial quotas are set at a proportion of the estimated macropod populations. For the Western Plains, quotas are set at 17 per cent of the estimated red kangaroo population and 15 per cent of the estimated population of eastern grey and western grey kangaroos. For the Northern Tablelands, quotas have been set at 15 per cent for both eastern grey kangaroos and wallaroos. Eastern grey kangaroo quotas for the Southeast NSW and Central Tablelands zones have also been set at 15 per cent. These proportions are specified in the Plan, and any proposal to set a commercial harvest quota above these rates requires specific approval from the Commonwealth.

In light of the population dynamics of red and grey kangaroos and wallaroos and the male bias of the commercial take, quotas set at these levels are considered sustainable in the long term for kangaroo populations. More than 20 years of available data indicate that kangaroo populations harvested at these rates continue to fluctuate primarily in response to seasonal conditions.

As the quota is based on harvesting a proportion of the estimated population, changes in populations are reflected in the quotas. As such, the quotas for 2014 are still considered to be sustainable in the long term.

Low kangaroo populations are further protected by the incorporation of harvest thresholds into the Plan. OEH is required to either reduce or suspend the commercial harvest quotas if the population of a species falls below the threshold in that zone, as determined by aerial surveys. Thresholds have been set on the basis of standard deviations relative to the long-term average population; details are given in Appendix B (Table B1). Using statistical measures rather than arbitrary population size allows for variation between species and climatic zones: for example, red kangaroo populations in the Far West change more rapidly and deviate more from the average than do eastern grey populations in the Northern Tablelands. This variation is reflected in the standard deviation, and hence in the population change that is allowable before harvest reductions or suspensions are implemented.

The wallaroo quota in the Upper Hunter zone was suspended in 2011 following a significant decline between the last two surveys. Under the new threshold calculations, the commercial harvest quota was set at 10% of the population for 2012 and continued at this rate for 2013. The 2013 surveys revealed a 45% increase in wallaroo numbers in the Upper Hunter; therefore, the 2014 quota for the Upper Hunter will be set at 15%.

Special Quotas

A Special Quota for 2014 has been calculated in accordance with the provisions of the Plan and will potentially be available to minimise the number of kangaroos shot under non-commercial licences. The Special Quota will be used only when the commercial quota for a particular kangaroo management zone has been fully issued. This is not a pseudo-commercial quota: its sole purpose is to provide for commercial utilisation of kangaroos that would be shot and left in the field under the normal non-commercial licensing system. As specified in the plan, the use of this quota will depend on one or more of the following:

- consideration of local conditions, including extended periods of rainfall well below average
- Western Lands destocking orders
- kangaroo population trends (based on the 2013 survey if completed). Special quotas will not be considered for zones where the commercial quota has been reduced or suspended because the populations are low.

The maximum number of animals that may be taken under Special Quota provisions in any commercial harvest zone is 5 per cent of the population estimate for that species in that zone. However, across the combined commercial zones, the Special Quota used must not exceed 1.5 per cent of the population estimate for that species. It is not necessarily intended to fully utilise the special quota, unless circumstances justify such action. The Special Quota was last used in 2003.

Non-commercial culling is available to landholders throughout NSW and occurs even where commercial harvesting is available. Each application must be assessed by an authorised OEH officer before a licence is issued. In the commercial zone, non-commercial licenses are generally requested only when:

- it is not economically viable to take kangaroos commercially
- the commercial kangaroo industry is unable to fulfil the landholder's needs
- management zone commercial quotas are fully utilised.

Trends in populations, quotas and commercial takes

Populations

The majority of commercial harvest areas in NSW received lower than average relative rainfall over the last 12 months; rainfall remained generally below average to well below average across much of the northwest, the central areas of the state and the far west and southwest. Although the last 6 months' relative rainfall was average or better than average across the state, August falls were below average for most of the state. As of October 2013, the state was drought free, although northern NSW had received less than 60% of its long-term average rainfall since January (NSW Department of Primary Industries 2013).

The improved seasonal conditions have resulted in overall population increases across the Western Plains for both eastern grey and western grey kangaroos, of 65 and 116 per cent respectively (about 2,477,709 and 996,818 respectively). However, the increase in red kangaroo populations was marginal, at 8 per cent (332,264). There is marked regional variation.

Over the past 3 years, the commercial harvest areas have received better than average rainfall (Bureau of Meteorology 2013). Kangaroo populations are known to respond to changes in seasonal conditions, and the observed increases are consistent with this rainfall pattern and widespread improvement in food and water resources. Low harvest rates of all species in all zones in 2012 (equivalent to less than 4 per cent of the population) are likely to have contributed to population growth. Movement of animals into NSW ahead of widespread rainfall in other states is also possible.

The Southeast NSW management zone was surveyed in August and October 2012. The survey was interrupted by poor weather and was completed several weeks after the initial transects were flown. Since the previous survey in 2008, the population of eastern grey kangaroos has increased by 31 per cent in response to the above-average rainfall and favourable seasonal conditions.

Red kangaroo

The 2013 red kangaroo population estimate and trends in abundance since 1997 are shown in Table 8. Refer to Figure A1 for trends in red kangaroo abundance on the Western Plains since 1984.

Table 8. Population estimates and trends in abundance for red kangaroo, 1997–2013

Year	Population estimate (millions)	Density (km^{-2})	Trends in abundance (% change from previous year)
2013	4.50 ±0.36	8.47	8
2012	4.15 ±0.31	8.01	4
2011	3.97 ± 0.41	7.39	32
2010	3.01 ± 0.24	5.73	23
2009	2.46 ± 0.17	4.58	–14
2008	2.87 ± 0.21	5.26	14
2007	2.52 ± 0.21	4.44	16
2006	2.18 ± 0.16	4.05	–3
2005	2.24 ± 0.22	4.32	–11
2004	2.51 ± 0.24	4.66	12
2003	2.24 ± 0.16	4.22	–53
2002	4.80 ± 0.39	9.35	–6
2001	5.12 ± 0.34	9.74	*17
2000	4.39 ± 0.40	8.49	–7
1999	4.71 ± 0.44	8.82	–19
1998	5.81 ± 0.61	11.36	10
1997	5.29 ± 0.40	10.01	40

Note: Dark shading has been used to indicate the use of the September 2003 100-m correction factor (CF); light shading indicates the use of a 200-m CF.

* Invalid comparison due to a change in correction factors and survey strip width.

Eastern grey kangaroo

The 2013 grey kangaroo (eastern and western) estimate for the area surveyed by fixed-wing aircraft is 8.2 million (density 15.6 km^{-2}). Refer to Figure A2 for trends in grey kangaroo abundance on the Western Plains since 1984. The relative proportions of eastern and western grey kangaroos in the area surveyed were examined in 2000. Application of these proportions to the 2013 survey gives an eastern grey kangaroo population estimate for the area surveyed by air of 6.3 million (11.7 km^{-2}).

The 2013 eastern grey kangaroo population estimate and trends in abundance on the Western Plains since 1997 are shown in Table 9.

Table 9. Population estimates and trends in abundance for eastern grey kangaroo on the Western Plains, 1997–2013

Year	Population estimate (millions)	Density (km^{-2})	Trend in abundance (% change from previous year)
2013	6.31 ± 0.64	11.74	65
2012	3.83 ± 0.48	7.36	28
2011	3.00 ± 0.44	5.64	20
2010	2.50 ± 0.31	4.70	38
2009	1.81 ± 0.19	3.49	–16
2008	2.15 ± 0.21	3.97	0
2007	2.15 ± 0.27	3.99	0
2006	2.14 ± 0.32	3.92	7
2005	2.00 ± 0.33	3.65	–25
2004	2.66 ± 0.32	5.03	–31
2003	3.83 ± 0.58	7.42	–51
2002	7.80 ± 1.02	15.07	24
2001	6.29 ± 0.72	12.48	*22
2000	5.17 ± 0.57	9.86	6
1999	4.87 ± 0.42	9.43	–6
1998	5.19 ± 0.54	9.91	17
1997	4.43 ± 0.63	8.53	12

Note: Dark shading has been used to indicate the use of the September 2003 100-m correction factor (CF); light shading indicates the use of a 200-m CF.

* Invalid comparison due to a change in correction factors and survey strip width.

The **Northern Tablelands** management zones were surveyed in September 2013. On the basis of this survey, the number of eastern grey kangaroos estimated to be in the Northern Tablelands region is 764,400 (Table 10). The Northern Tablelands region will be surveyed again in 2016.

Table 10. Population estimates and trends in abundance for eastern grey kangaroo in the Northern Tablelands zones, 2001–2013

Year	Zone	Population estimate	Density (km^{-2})	Trend in abundance (% change from previous survey)
2013	Armidale	263,300	16.6	27
	Glen Innes	374,300	20.3	39
	Upper Hunter	126,800	9.05	–24
	Total	**764,400**		**19**
2010	Armidale	206,780	13.1	46
	Glen Innes	269,500	12.9	14
	Upper Hunter	167,500	11.5	82
	Total	**643,780**		**37**
2007	Armidale	141,610	8.7	–12
	Glen Innes	236,600	11.3	58
	Upper Hunter	92,016	6.3	36
	Total	**470,226**		**24**
2004	Armidale	161,726	10.2	4
	Glen Innes	149,621	8.1	–35
	Upper Hunter	67,499	4.8	–28
2001–2002	**Total**	**378,846**		**–23**
	Armidale	173,109	10.6	N/A
	Glen Innes	221,975	10.6	N/A
	Upper Hunter	95,273	6.5	N/A
	Total	**490,357**		**N/A**

Tables A9b, A10b and A11b show population estimates and quotas for eastern grey kangaroos in the Northern Tablelands management zones from 1993 to 2014.

Before the approval of the commercial harvest zone in **Southeast NSW**, a baseline population estimate was established by using helicopter survey methodology developed in the Northern Tablelands. A second survey was conducted in September 2006 in accordance with the approval; it indicated an increase of 42 per cent in the population since the 2003 survey. The area was surveyed again in 2009, with the addition of the former Young RLPB (Table 11). The trend in abundance is not shown in Table 11, as the areas surveyed in 2006 and 2009 were different.

Since the 2009 survey, populations remained virtually unchanged in the Cooma (decline of 1.8 per cent) and Yass (increase of 6.2 per cent) RLPB areas, but significant increases were recorded elsewhere. In particular, the Young RLPB recorded an increase of 106 per cent (88,100 animals); an increase of this magnitude is likely to be the result of immigration from neighbouring areas in addition to natural increase. Survey redesign may also have contributed.

Table 11. Population estimates and trends in abundance for eastern grey kangaroo in Southeast NSW, 2003–2012

Year	Population estimate	Density (km^{-2})	Trend in abundance (% change from previous survey)
2012	858,900	22.4	31
2009*	655,900	17.1	N/A
2006	415,271	14.07	42
2003	292,455	11.95	N/A

* The 2009 population estimate is for a larger area than in the previous two surveys, as it includes the former Young RLPB. It is therefore inappropriate to consider the difference between the 2006 and 2009 surveys as a trend.

Central Tablelands North and South management zones were surveyed for the first time in 2008 and started operation on 1 June 2009. A second survey was conducted in September 2011, providing some trend information (Table 12). However, the apparent trends should be viewed with caution because of the short survey history in these zones.

Table 12. Population estimates and trends in abundance for eastern grey kangaroo on the Central Tablelands North and South, 2008–2011

Year	Zone	Population estimate	Density (km^{-2})	Trend in abundance (% change from previous survey)
2011	CT North	612,590	20.9	41.5
	CT South	347,830	15.1	–35.1
	Total	**960,420**		**–1.0**
2008	CT North	433,030	14.7	N/A
	CT South	535,600	23.2	N/A
	Total	**968,630**		

CT, Central Tablelands

Western grey kangaroo

The 2013 grey kangaroo (eastern and western) estimate for the area surveyed by fixed-wing aircraft is 8.2 million (average density 15.6 km^{-2}). Refer to Figure A2 for trends in grey kangaroo abundance on the Western Plains since 1984. The relative proportions of eastern and western grey kangaroos in the area surveyed were examined in 2000. Application of these proportions to the 2013 survey gives a western grey kangaroo population estimate for the area surveyed by air of 1.8 million (average density 3.83 km^{-2}).

The 2013 western grey kangaroo population estimate and trends in abundance for the Western Plains since 1997 are shown in Table 13.

Table 13. Population estimates and trends in abundance for western grey kangaroo on the Western Plains, 1997–2013

Year	Population estimate (millions)	Density (km^{-2})	Trend in abundance (% change from previous year)
2013	1.82 ± 0.20	3.83	116
2012	0.86 ± 0.11	1.83	73
2011	0.50 ± 0.07	1.02	–25
2010	0.66 ± 0.08	1.39	–8
2009	0.72 ± 0.08	1.49	–27
2008	0.99 ± 0.10	2.07	36
2007	0.73 ± 0.09	1.55	11
2006	0.65 ± 0.11	1.35	9
2005	0.60 ± 0.09	1.31	–33
2004	0.89 ± 0.11	1.89	–29
2003	1.27 ± 0.26	2.72	–47
2002	2.39 ± 0.30	5.02	18
2001	2.03 ± 0.22	4.53	*13
2000	1.79 ± 0.24	3.86	–14
1999	2.09 ± 0.19	4.50	11
1998	1.88 ± 0.18	3.97	–11
1997	2.11 ± 0.27	4.33	22

Note: Dark shading has been used to indicate the use of the September 2003 100-m correction factor (CF); light shading indicates the use of a 200-m CF.

* Invalid comparison due to a change in correction factors and survey strip width.

Wallaroo

The 2013 wallaroo population estimate and trends in abundance for the Northern Tablelands management zones since 2001–02 are shown in Table 14.

Tables A9a, A10a and A11a show population estimates and quotas from 1993 to 2014.

Table 14. Population estimates and trends in abundance for wallaroo on the Northern Tablelands, 2001–2013.

Year	Zone	Population estimate	Density (km^{-2})	Trend in abundance (% change from previous survey)
2013	Armidale	45,140	2.8	9
	Glen Innes	28,305	1.5	–12
	Upper Hunter	27,380	1.9	83
	Total	**100,825**		**14**
2010	Armidale	41,255	2.5	9
	Glen Innes	32,190	1.5	0
	Upper Hunter	14,985	1.0	–67
	Total	**88,430**		**–23**
2007	Armidale	37,859	2.3	–58
	Glen Innes	32,184	1.5	–43
	Upper Hunter	44,923	3.1	–27
	Total	**114,966**		**–44.8**
2004	Armidale	89,787	5.7	158
	Glen Innes	56,657	3.1	–56
	Upper Hunter	61,660	4.4	7
	Total	**208,104**		**5.8**
2001–02	Armidale	34,744	2.1	N/A
	Glen Innes	128,323	6.1	N/A
	Upper Hunter	57,762	4.0	N/A
	Total	**220,829**		**N/A**

Quotas

Quotas have been set at the same percentages of the population estimates for several years. These proportions are specified in the Plan. On the basis of the population dynamics of the species and the selectivity of kangaroo harvesters for male kangaroos, these quotas are considered to be sustainable in the long term.

The Plan includes low population thresholds below which the commercial quota is either reduced or suspended, depending on the magnitude of the decline relative to historical fluctuations. The thresholds are based on standard deviations, which are statistical measures that indicate how much a population varies from its average over time. For the purposes of setting quotas, quotas on populations that are between 1.5 and 2 standard deviations below their long-term averages are calculated at a reduced rate of 10 per cent, whereas quotas on populations that are two or more standard deviations below their averages are suspended.

This contrasts with the previous plan, which specified one threshold for each species in each zone and was based on recent historical low populations, without any consideration of natural fluctuations. For populations that fell below their respective thresholds, the commercial harvest quotas were suspended.

Red kangaroo

The quota for 2014 of 761,699 represents 17 per cent of the population estimated by aerial survey, as specified in the Plan. None of the zone populations of red kangaroos is below the threshold at which the quota must be reduced or suspended.

Eastern grey kangaroo

The quota for 2014 of 946,885 for the Western Plains represents 15 per cent of the population estimated by aerial survey—the maximum commercial quota specified in the Plan.

The quota for 2014 of 114,660 for the Northern Tablelands region represents 15 per cent of the estimated population of 764,400 derived from aerial surveys in 2013.

The Southeast NSW quota is 128 835, which represents 15 per cent of the population estimate of 858,900 derived from aerial surveys in 2012.

The quotas for Central Tablelands North and Central Tablelands South are 91,889 and 52,175 respectively, which represent 15 per cent of the population estimates derived from aerial surveys in 2011.

The combined 2014 eastern grey quota is 1,334,443.

Western grey kangaroo

The quota for 2014 of 277,906 represents 15 per cent of the population estimated by aerial survey. The maximum commercial quota specified in the Plan is 15 per cent.

Wallaroo

In 2004, the quotas for wallaroos in the Northern Tablelands were changed from 5 per cent to 15 per cent of the population estimate as a result of the more rigorous scientific basis to survey and estimation methodologies. For the 2014 quota, this value will remain at 15 per cent for the Armidale, Glen Innes and Upper Hunter zones, in accordance with the Plan.

The 2014 quota is 15,124 for the Northern Tablelands.

Commercial takes

Species:	Red Kangaroo *(Macropus rufus)*
	Eastern grey kangaroo *(Macropus giganteus)*
	Western grey kangaroo *(Macropus fuliginosus)*
	Wallaroo *(Macropus robustus robustus)*
Extent:	Commercial zone
Frequency:	Continuous
Methodology:	Collection and compilation of returns from licensed Harvesters, Registered Premises and Wholesalers
Data:	Species, sex, group weight and location taken (property)

In 2008 the minimum carcase weight requirement increased from 12 to 14 kilograms for carcases dressed for pet food processing, and from 13 to 15 kilograms for carcases dressed for human consumption processing. Because of the size difference between male and female wallaroos in particular, this requirement almost eliminates females from the harvest, as they are generally too small to meet the carcase weight requirement. The impact on the other harvested species is less pronounced. In all cases the average carcase weights for the period 1 January 2013 to 30 September 2013 (average 24 kilograms) were similar to those

reported for 2012 (average 24 kilograms) and well above the long-term average (average 21 kilograms) (1999–2012).

Red kangaroo

Harvester returns for 2012 indicated that 84 per cent of red kangaroos taken were males. For the year to 30 September 2013, harvester returns reported a male bias of 92 per cent, which is well above the long-term average (1999–2012) of 71 per cent.

The actual takes of red kangaroos are shown against the authorised quotas in Table A16 and Figure A4.

The *average* take as a proportion of the authorised quota from 2000 to 2012 was 55.5 per cent.

Eastern grey kangaroo

Harvester returns for 2012 indicate that 79.6 per cent of eastern grey kangaroos taken were males. For the year to 30 September 2013, harvester returns reported a male bias of 89.5 per cent, higher than the long-term average (1999–2012) of 70.9 per cent.

The actual takes of eastern grey kangaroos are shown against the authorised quotas in Table A17 and Figure A5.

The *average* take as a proportion of the authorised quota from 2000 to 2012 was 65 per cent.

Western grey kangaroo

Harvester returns for 2012 indicate that 82 per cent of western grey kangaroos taken were males. For the year to 30 September 2013, harvester returns recorded a male bias of 88.9 per cent, well above the long-term average (1999–2012) of 68.3 per cent.

The actual takes of western grey kangaroos are shown against the authorised quotas in Table A18 and Figure A6.

The *average* take as a proportion of the authorised quota from 2000 to 2012 was 51.1 per cent.

Wallaroo

Harvester returns for 2012 indicate that 97.3 per cent of wallaroos taken were males. For the year to 30 September 2013, harvester returns recorded a male bias of 98.2 per cent, well above the long-term average (1999–2012) of 89.6 per cent.

The actual takes of wallaroos are shown against the authorised quotas in Table A19 and Figure A7.

The *average* take as a proportion of the authorised quota from 2000 to 2012 was 53.6 per cent.

Proposed changes to quotas

For 2014, OEH does not propose to set quotas that are higher than those specified in the Plan.

No adjustments are proposed to quotas for eastern grey or red kangaroos in any of the management zones. The Upper Hunter zone wallaroo quota is currently set at 10 per cent, but in response to the 2013 surveys it will revert to 15 per cent for 2014.

New commercial harvest ones

No new commercial harvest zones are proposed for commencement in 2014.

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Appendix A. Tables and Figures

Notes to the tables that follow:

- Dark shading indicates the use of 100-m correction factors from September 2003; light shading indicates 200-m correction factors for surveys of the Western Plains zones using fixed-wing aircraft, as described in the section on 'Population estimates and survey method used'. Correction factors do not apply to helicopter surveys.
- '% Population' refers to the actual take as a proportion of the *previous* year's population estimate, on which the quota is set.
- Where a quota has been set for only one of the two species of grey kangaroo, the population given includes both species.
- Where quota adjustments have been implemented during 2013, these are *not* reflected in the following tables. Full details of adjustments will be given in the Annual Report for 2013.
- Management zones that are surveyed by helicopter are surveyed on a 3-yearly cycle. Population estimates remain the same for the intervening period.

Kangaroo management zone no. 1: Tibooburra

Table A1a. Red kangaroo

Average density (kangaroos/km^2)		16.42			
Area in km^2		54,848			
Standard deviation		6.78			
Year	**Population**	**Density**	**% Change**	**Quota**	**% Population**
1990	1,004,500	18.3	–10.6	161,900	14.4
1991	1,468,600	26.8	46.2	149,200	14.9
1992	845,000	15.4	–42.5	337,800	23.0
1993	1,230,319	22.4	45.6	135,200	16.0
1994	1,103,648	20.1	–10.3	221,457	18.0
1995	1,078,399	19.7	–2.3	139,300	12.6
1996	1,009,295	18.4	–6.4	141,100	13.1
1997	1,673,668	30.5	65.8	132,800	13.2
1998	1,576,827	28.7	–5.8	190,900	11.4
1999	925,897	16.9	–41.3	104,570	6.6
2000	927,889	16.9	0.2	107,300	11.6
2001	1,389,398	25.3	49.7	106,200	11.4
2002	754,013	13.7	–45.7	229,200	16.5
2003	420,721	7.7	–44.2	124,700	16.5
2004	487,004	8.9	15.8	71,523	17.0
2005	629,502	11.5	29.3	82,791	17.0
2006	361,586	6.6	–42.6	107,015	17.0
2007	432,096	7.9	19.5	61,470	17.0
2008	606,518	11.1	40.4	73,456	17.0
2009	560,706	10.2	–7.6	103,108	17.0
2010	636,038	11.6	13.4	95,320	17.0
2011	621,124	11.3	–2.3	108,126	17.0
2012	937,643	17.10	51.0	105,591	17.0
2013	903,279	17.10	–3.7	159,399	17.0
2014				153,557	17.0

Table A1b. Grey kangaroo

Average density (kangaroos/km^2)		2.35			
Area in km^2		54,848			
Standard deviation		1.53			
Year	**Population**	**Density**	**% Change**	**Quota**	**% Population**
1990	83,400	1.5	48.7	7,400	13.2
1991	55,500	1	–33.5	11,000	13.2
1992	45,900	0.8	–17.3	8,900	16.0
1993	136,489	2.5	197.4	7,803	17.0
1994	162,375	3	19.0	34,122	25.0
1995	150,510	2.7	–7.3	8,653	5.3
1996	151,515	2.8	0.7	10,460	6.9
1997	274,399	5	81.1	7,185	4.7
1998	356,751	6.5	30.0	12,410	4.5
1999	212,896	3.9	–40.3	36,300	10.2
2000	209,231	3.8	–1.7	16,350	7.7
2001	242,312	4.4	15.8	18,100	8.7
2002	184,093	3.4	–24.0	41,700	17.2
2003	73,098	1.3	–60.3	31,000	16.8
2004	72,890	1.3	–0.3	10,965	15.0
2005	52,605	1	–27.8	10,933	15.0
2006	59,034	1.1	12.2	7,891	15.0
2007	64,222	1.2	8.8	8,855	15.0
2008	93,058	1.7	44.9	9,633	15.0
2009	92,905	1.7	–0.2	13,959	15.0
2010	37,781	0.7	–59.3	951	1.0
2011	51,214	0.9	35.6	0	0.0
2012	73,882	1.35	44.3	7,153	14.0
2013	163,392	2.98	121.2	11,082	15.0
2014				24,509	15.0

Kangaroo management zone no. 2: Broken Hill

Table A2a. Red kangaroo

Average density (kangaroos/km^2)		12.54			
Area in km^2		90,845			
Standard deviation		3.5			
Year	**Population**	**Density**	**% Change**	**Quota**	**% Population**
1990	1,654,100	18.2	19.7	203,700	14.7
1991	1,480,900	16.3	–10.5	252,600	15.3
1992	1,031,700	11.4	–30.3	263,900	17.8
1993	1,205,576	13.3	16.9	160,785	15.6
1994	1,059,378	11.7	–12.1	148,568	12.3
1995	1,477,215	16.3	39.4	125,732	11.9
1996	1,100,017	12.1	–25.5	174,059	11.8
1997	1,785,627	19.7	62.3	120,768	11.0
1998	1,437,241	15.8	–19.5	223,480	12.5
1999	1,358,991	15	–5.4	203,800	14.2
2000	959,482	10.6	–29.4	191,175	14.1
2001	1,487,845	16.4	55.1	143,000	14.9
2002	1,121,294	12.3	–24.6	220,200	14.8
2003	584,448	6.4	–47.9	166,950	14.9
2004	925,845	10.2	58.4	99,356	17.0
2005	538,956	5.9	–41.8	157,394	17.0
2006	725,035	8	34.5	91,622	17.0
2007	1,092,982	12.0	50.7	123,256	17.0
2008	1,190,299	13.1	8.9	185,807	17.0
2009	809,665	8.9	–32.0	202,351	17.0
2010	855,368	9.4	5.6	137,643	17.0
2011	1,079,052	11.9	26.2	145,413	17.0
2012	1,138,627	12.5	5.5	183,439	17.0
2013	1,219,455	13.4	7.1	193,567	17.0
2014				207,307	17.0

Table A2b. Grey kangaroo

Average density (kangaroos/km^2)		5.95			
Area in km^2		90,845			
Standard deviation		3.35			
Year	**Population**	**Density**	**% Change**	**Quota**	**% Population**
1990	465,100	5.1	87.7	37,100	15.0
1991	449,700	5	–3.3	81,600	17.5
1992	457,500	5	1.7	102,900	22.9
1993	1,071,541	11.8	134.2	106,642	23.3
1994	660,124	7.3	–38.4	81,954	7.6
1995	1,291,048	14.2	95.6	50,450	7.6
1996	704,719	7.8	–45.4	118,800	9.2
1997	840,578	9.3	19.3	59,687	8.5
1998	711,846	7.8	–15.3	62,650	7.5
1999	645,471	7.1	–9.3	79,160	11.1
2000	730,421	8	13.2	71,650	11.1
2001	723,937	8	–0.9	71,600	9.8
2002	982,041	10.8	35.7	101,000	14.0
2003	263,796	2.9	–73.1	138,000	14.1
2004	251,867	2.8	–4.5	39,569	15.0
2005	174,358	1.9	–30.8	37,780	15.0
2006	216,474	2.4	24.2	26,154	15.0
2007	281,904	3.1	30.2	32,471	15.0
2008	439,369	4.8	55.9	42,286	15.0
2009	366,677	4.0	–16.5	65,905	15.0
2010	241,831	2.7	–34.0	55,002	15.0
2011	179,320	2.0	–25.8	36,275	15.0
2012	221,803	2.4	23.7	21,382	11.9
2013	586,534	6.5	164.4	26,702	12.0
2014				87,980	15.0

Kangaroo management zone no. 4: Lower Darling

Table A3a. Red kangaroo

Average density (kangaroos/km^2)		5.31			
Area in km^2		56,460			
Standard deviation		2.15			
Year	**Population**	**Density**	**% Change**	**Quota**	**% Population**
1990	349,400	6.2	34.2	34,800	13.4
1991	377,600	6.7	8.1	49,700	14.2
1992	399,200	7.1	5.7	86,800	23.0
1993	268,066	4.7	–32.8	95,808	24.0
1994	555,979	9.8	107.4	42,890	16.0
1995	402,592	7.1	–27.6	75,768	13.6
1996	385,844	6.8	–4.2	55,900	13.9
1997	493,302	8.7	27.9	73,117	18.9
1998	315,945	5.6	–36.0	75,000	15.2
1999	364,651	6.5	15.4	39,910	12.6
2000	221,468	3.9	–39.3	54,300	14.9
2001	279,185	4.9	26.1	36,820	16.6
2002	468,072	8.3	67.7	40,900	14.6
2003	197,864	3.5	–57.7	69,200	14.8
2004	166,340	2.9	–15.9	33,637	17.0
2005	124,665	2.2	–25.1	28,278	17.0
2006	113,119	2	–9.3	21,193	17.0
2007	188,018	3.3	66.2	19,230	17.0
2008	251,731	4.5	33.9	31,963	17.0
2009	185,450	3.3	–26.3	42,794	17.0
2010	193,931	3.4	4.6	31,527	17.0
2011	186,473	3.3	–3.8	32,968	17.0
2012	295,180	5.2	58.3	31,700	17.0
2013	423,518	7.5	43.5	50,181	17.0
2014				71,998	17.0

Table A3b. Grey kangaroo

Average density (kangaroos/km^2)	8.34
Area in km^2	56,460
Standard deviation	4.77

Year	Population	Density	% Change	Quota	% Population
1990	445,800	7.9	79.6	39,700	16.0
1991	696,900	12.3	56.3	75,800	17.0
1992	573,900	10.2	–17.6	188,163	27.0
1993	1,091,834	19.3	90.2	134,293	23.4
1994	1,050,128	18.6	–3.8	207,448	19.0
1995	880,562	15.6	–16.1	88,660	8.4
1996	609,376	10.8	–30.8	91,124	10.3
1997	620,029	11	1.7	59,340	9.7
1998	497,977	8.8	–19.7	54,150	8.7
1999	663,487	11.8	33.2	59,100	11.9
2000	362,692	6.4	–45.3	70,750	10.7
2001	454,782	8.1	25.4	44,600	12.3
2002	512,465	9.1	12.7	69,300	15.2
2003	336,387	6	–34.4	78,300	15.3
2004	306,466	5.4	–8.9	50,458	15.0
2005	110,876	2	–63.8	45,970	15.0
2006	220,666	3.9	99.0	16,631	15.0
2007	226,569	4.0	2.7	33,100	15.0
2008	367,220	6.5	62.1	33,985	15.0
2009	215,420	3.82	–41.3	55,083	15.0
2010	231,585	4.1	7.5	32,313	15.0
2011	98,973	1.75	–57.3	34,738	15.0
2012	232,187	4.1	134.6	3,259	3.3
2013	486,859	8.6	109.7	34,828	15.0
2014				73,029	15.0

Kangaroo management zone no. 6: Cobar

Table A4a. Red kangaroo

Average density (kangaroos/km^2)		4.50			
Area in km^2		40,339			
Standard deviation		1.47			
Year	**Population**	**Density**	**% Change**	**Quota**	**% Population**
1990	264,300	6.6	26.3	38,300	18.3
1991	238,600	5.9	–9.7	48,500	18.4
1992	170,700	4.2	–28.5	45,300	19.0
1993	127,658	3.2	–25.2	27,312	16.0
1994	201,113	5	57.5	12,766	10.0
1995	151,314	3.8	–24.8	28,116	14.0
1996	170,917	4.2	13.0	31,441	20.8
1997	163,624	4.1	–4.3	19,780	11.6
1998	312,413	7.7	90.9	25,580	15.6
1999	228,367	5.7	–26.9	41,640	13.3
2000	231,400	5.7	1.3	29,375	12.9
2001	196,029	4.9	–15.3	29,700	12.8
2002	258,662	6.4	32.0	29,200	14.9
2003	121,756	3	–52.9	38,600	14.9
2004	146,292	3.6	20.2	20,699	17.0
2005	117,137	2.9	–19.9	24,870	17.0
2006	107,825	2.7	–7.9	19,913	17.0
2007	85,913	2.1	–20.3	18,330	17.0
2008	156,639	3.9	82.3	14,605	17.0
2009	97,823	2.4	–37.5	26,629	17.0
2010	148,177	3.7	51.5	16,630	17.0
2011	210,921	5.2	42.3	25,190	17.0
2012	252,750	6.3	19.8	35,857	17.0
2013	193,738	4.8	–23.3	42,968	17.0
2014				32,935	17.0

Table A4b. Grey kangaroo

Average density (kangaroos/km^2)		12.64			
Area in km^2		40,339			
Standard deviation		6.61			
Year	**Population**	**Density**	**% Change**	**Quota**	**% Population**
1990	275,100	6.8	10.0	38,800	15.5
1991	305,800	7.6	11.2	44,700	16.2
1992	313,000	7.8	2.4	73,400	24.0
1993	602,794	14.9	92.6	78,250	25.0
1994	558,152	13.8	–7.4	126,587	21.0
1995	894,671	22.2	60.3	47,542	8.5
1996	598,600	14.8	–33.1	73,738	8.2
1997	683,136	16.9	14.1	40,820	6.8
1998	775,992	19.2	13.6	40,900	6.0
1999	857,216	21.3	10.5	81,650	10.5
2000	755,493	18.7	–11.9	78,850	9.2
2001	1,052,432	26.1	39.3	67,700	9.0
2002	938,507	23.3	–10.8	131,500	12.5
2003	551,434	13.7	–41.2	114,900	12.2
2004	303,491	7.5	–45.0	82,715	15.0
2005	279,121	6.9	–8.0	45,524	15.0
2006	208,066	5.2	–25.5	41,868	15.0
2007	282,841	7.0	35.9	31,210	15.0
2008	350,925	8.7	24.1	42,426	15.0
2009	251,233	6.2	–28.4	52,639	15.0
2010	256,097	6.4	1.9	37,685	15.0
2011	176,060	4.4	–31.3	38,415	15.0
2012	311,522	7.7	76.9	21,384	12.1
2013	660,596	16.4	112.1	46,728	15.0
2014				99,089	15.0

Kangaroo management zone no. 7: Bourke

Table A5a. Red kangaroo

Average density (kangaroos/km^2)		5.63			
Area in km^2		55,005			
Standard deviation		2.78			
Year	**Population**	**Density**	**% Change**	**Quota**	**% Population**
1990	483,100	8.8	23.5	65,500	16.7
1991	356,600	6.5	–26.2	82,600	17.1
1992	245,300	4.5	–31.2	60,600	17.0
1993	380,260	6.9	55.0	39,248	16.0
1994	230,959	4.2	–39.3	68,447	18.0
1995	171,539	3.1	–25.7	14,920	6.5
1996	192,031	3.5	11.9	14,920	8.7
1997	208,276	3.8	8.5	19,080	9.9
1998	281,932	5.1	35.4	23,055	11.1
1999	380,435	6.9	34.9	45,950	16.3
2000	438,249	8	15.2	52,500	13.8
2001	487,321	8.9	11.2	59,200	13.5
2002	756,705	13.8	55.3	72,900	15.0
2003	191,581	3.5	–74.7	114,450	15.1
2004	203,764	3.7	6.4	32,569	17.0
2005	220,567	4	8.2	34,640	17.0
2006	258,668	2.7	17.3	37,496	17.0
2007	143,043	2.6	–44.7	43,973	17.0
2008	140,371	2.6	–1.9	24,317	17.0
2009	180,413	3.3	28.5	23,863	17.0
2010	251,196	4.6	39.2	30,670	17.0
2011	444,932	8.1	77.1	42,703	17.0
2012	429,000	7.80	–3.6	75,638	17.0
2013	460,225	8.37	7.3	72,930	17.0
2014				78,238	17.0

Table A5b. Grey kangaroo

Average density (kangaroos/km^2)		9.01			
Area in km^2		55,005			
Standard deviation		5.96			
Year	**Population**	**Density**	**% Change**	**Quota**	**% Population**
1990	454,300	8.3	65.6	42,000	15.3
1991	338,200	6.1	–25.6	75,600	16.6
1992	524,400	9.5	55.1	54,100	16.0
1993	1,147,159	20.9	118.8	144,734	27.6
1994	753,367	13.7	–34.3	240,903	21.0
1995	438,500	8	–41.8	50,473	6.7
1996	554,855	10.1	26.5	17,500	4.0
1997	645,291	11.7	16.3	34,005	6.1
1998	616,180	11.2	–4.5	47,090	7.3
1999	751,599	13.7	22.0	65,950	10.7
2000	828,888	15.1	10.3	79,250	10.5
2001	1,220,882	22.2	47.3	88,300	10.7
2002	1,013,389	18.4	–17.0	152,200	12.5
2003	298,422	5.4	–70.6	126,700	12.5
2004	268,883	4.9	–9.9	44,763	15.0
2005	181,025	3.3	–32.7	40,332	15.0
2006	110,115	2	–39.2	27,154	15.0
2007	183,442	3.3	66.6	16,517	15.0
2008	152,776	2.8	–16.7	27,516	15.0
2009	147,001	2.7	–3.8	22,916	15.0
2010	140,721	2.6	–4.3	14,194	9.7
2011	128,018	2.3	–9.0	16,508	11.7
2012	446,909	8.12	249.1	12,802	10.0
2013	541,622	9.85	21.2	67,036	15.0
2014				81,243	15.0

Kangaroo management zone no. 8: Narrabri

Table A6a. Red kangaroo

Average density (kangaroos/km^2)		5.52			
Area in km^2		65,787			
Standard deviation		3.73			
Year	**Population**	**Density**	**% Change**	**Quota**	**% Population**
1990	246,100	3.7	–9.6	44,500	16.3
1991	242,600	3.7	–1.4	41,700	16.9
1992	170,100	2.6	–29.9	41,200	17.0
1993	458,957	7	169.8	27,216	16.0
1994	222,974	3.4	–51.4	91,791	20.0
1995	297,913	4.5	33.6	17,220	7.7
1996	124,694	1.9	–58.1	26,809	9.0
1997	283,171	4.3	127.1	11,865	9.5
1998	1,046,075	15.9	269.4	23,200	8.2
1999	506,146	7.7	–51.6	109,450	10.5
2000	924,453	14.1	82.6	52,850	10.4
2001	532,460	8.1	–42.4	98,400	10.6
2002	692,966	10.5	30.1	79,800	15.0
2003	224,010	3.4	–67.7	103,950	15.0
2004	167,484	2.5	–25.2	38,082	17.0
2005	198,190	3	18.3	28,472	17.0
2006	233,780	3.6	18.0	33,692	17.0
2007	121,426	1.8	–48.1	39,743	17.0
2008	124,915	1.9	2.9	20,642	17.0
2009	189,118	2.9	51.4	21,236	17.0
2010	433,366	6.6	129.2	32,150	17.0
2011	530,367	8.1	22.4	73,672	17.0
2012	371,257	5.64	–30.0	90,162	17.0
2013	369,861	5.62	–0.4	63,114	17.0
2014				62,876	17.0

Table A6b. Grey kangaroo

Average density (kangaroos/km^2)		15.04			
Area in km^2		65,787			
Standard deviation		7.54			
Year	**Population**	**Density**	**% Change**	**Quota**	**% Population**
1990	1,005,900	15.3	24.5	142,700	17.7
1991	987,000	15	–1.9	186,000	18.5
1992	898,500	13.7	–9.0	187,500	19.0
1993	1,964,801	29.9	118.7	188,685	21.0
1994	1,168,552	17.8	–40.5	412,608	21.0
1995	835,633	12.7	–28.5	103,530	8.9
1996	369,992	5.6	–55.7	61,964	7.4
1997	671,027	10.2	81.4	34,931	9.4
1998	1,214,523	18.5	81.0	63,543	9.5
1999	867,516	13.2	–28.6	175,310	14.4
2000	1,491,090	22.7	71.9	119,500	13.8
2001	1,523,954	23.2	2.2	182,500	12.2
2002	1,927,959	29.3	26.5	191,200	12.5
2003	874,080	13.3	–54.7	247,300	12.8
2004	367,179	5.6	–58.0	131,112	15.0
2005	399,672	6.1	8.8	55,077	15.0
2006	398,589	6.1	–0.3	59,853	15.0
2007	697,531	10.6	75.0	59,788	15.0
2008	513,617	7.8	–26.4	104,630	15.0
2009	447,330	6.8	–12.9	77,043	15.0
2010	752,771	11.4	68.3	67,002	15.0
2011	1,229,345	18.7	63.3	112,851	15.0
2012	1,246,675	19.0	1.4	184,304	15.0
2013	1,874,886	28.5	50.4	186,514	15.0
2014				280,485	15.0

Kangaroo management zone no. 10: Coonabarabran

Table A7a. Red kangaroo

Average density (kangaroos/km^2)		4.26			
Area in km^2		61,590			
Standard deviation		1.80			
Year	**Population**	**Density**	**% Change**	**Quota**	**% Population**
1990	186,000	3	–12.8	33,100	15.5
1991	311,600	5.1	67.5	29,900	16.1
1992	114,400	1.9	–63.3	71,700	23.0
1993	353,658	5.7	209.1	18,304	16.0
1994	95,586	1.6	–73.0	70,732	20.0
1995	254,715	4.1	166.5	9,675	10.1
1996	170,558	2.8	–33.0	23,494	9.2
1997	344,758	5.6	102.1	11,535	6.8
1998	567,057	9.2	64.5	24,015	7.0
1999	392,685	6.4	–30.8	64,100	11.3
2000	295,403	4.8	–24.8	44,000	11.2
2001	301,341	4.9	2.0	42,320	14.3
2002	345,431	5.6	14.6	45,100	15.0
2003	204,649	3.3	–40.8	51,300	14.9
2004	199,348	3.2	–2.6	34,790	17.0
2005	135,328	2.2	–32.1	33,889	17.0
2006	161,119	2.6	19.1	23,006	17.0
2007	168,001	2.7	4.3	27,390	17.0
2008	170,804	2.8	1.7	28,560	17.0
2009	202,199	3.3	18.4	29,037	17.0
2010	250,625	4.1	23.9	34,374	17.0
2011	343,239	5.6	37.0	42,606	17.0
2012	357,256	5.8	4.1	58,351	17.0
2013	373,924	6.07	4.7	60,734	17.0
2014				63,567	17.0

Table A7b. Grey kangaroo

Average density (kangaroos/km^2)		22.11			
Area in km^2		61,590			
Standard deviation		10.51			
Year	**Population**	**Density**	**% Change**	**Quota**	**% Population**
1990	755,700	12.3	7.0	124,600	17.6
1991	811,410	13.2	7.4	138,100	18.3
1992	521,100	8.5	–35.8	219,100	27.0
1993	2,151,730	34.9	312.9	88,587	17.0
1994	1,497,000	24.3	–30.4	537,933	25.0
1995	1,768,625	28.7	18.1	62,007	4.1
1996	1,422,035	23.1	–19.6	83,312	4.7
1997	1,683,707	27.3	18.4	54,810	3.9
1998	1,551,195	25.2	–7.9	91,245	5.4
1999	1,717,979	27.9	10.8	130,250	8.4
2000	1,430,884	23.2	–16.7	137,600	8.0
2001	2,078,208	33.7	45.2	112,700	7.9
2002	3,195,179	51.9	53.7	245,800	11.8
2003	1,824,168	29.6	–42.9	375,000	11.7
2004	1,259,605	20.5	–30.9	273,625	15.0
2005	702,576	11.4	–44.2	188,941	15.0
2006	905,594	14.7	28.9	105,386	15.0
2007	568,378	9.2	–37.2	135,839	15.0
2008	583,873	9.5	2.7	85,257	15.0
2009	695,066	11.3	19.0	87,581	15.0
2010	935,327	15.2	34.6	98,075	14.1
2011	1,089,829	17.7	16.5	135,214	14.5
2012	1,457,381	23.7	33.7	163,474	15.0
2013	2,071,115	33.6	42.1	218,607	15.0
2014				310,667	15.0

Kangaroo management zone no. 11: Griffith

Table A8a. Red kangaroo

Average density (kangaroos/km^2)		3.71			
Area in km^2		98,171			
Standard deviation		1.23			
Year	**Population**	**Density**	**% Change**	**Quota**	**% Population**
1990	311,800	3.2	24.8	38,300	15.3
1991	278,900	2.8	–10.6	51,800	16.6
1992	408,500	4.2	46.5	48,800	17.5
1993	370,933	3.8	–9.2	94,895	23.2
1994	490,469	5	32.2	35,040	9.4
1995	351,806	3.6	–28.3	72,952	14.9
1996	633,758	6.5	80.1	38,930	11.1
1997	333,569	3.4	–47.4	76,868	12.1
1998	272,267	2.8	–18.4	33,310	10.0
1999	548,493	5.6	101.5	32,650	12.0
2000	393,042	4	–28.3	58,950	10.7
2001	447,833	4.6	13.9	43,110	11.0
2002	401,414	4.1	–10.4	48,600	10.9
2003	290,084	3	–27.7	35,200	8.8
2004	212,159	2.2	–26.9	49,314	17.0
2005	277,153	2.8	30.6	36,067	17.0
2006	221,656	2.3	–20.0	47,116	17.0
2007	292,970	3.0	32.2	37,682	17.0
2008	228,433	2.3	–22.0	49,805	17.0
2009	231,422	2.4	1.3	38,834	17.0
2010	245,208	2.5	6.0	39,342	17.0
2011	556,415	5.7	126.9	41,685	17.0
2012	366,603	3.7	–34.1	94,591	17.0
2013	536,580	5.5	46.4	62,322	17.0
2014				91,219	17.0

Table A8b. Grey kangaroo

Average density (kangaroos/km^2)	9.44
Area in km^2	98,171
Standard deviation	3.73

Year	Population	Density	% Change	Quota	% Population
1990	566,000	5.8	41.1	62,800	15.7
1991	704,600	7.2	24.5	105,100	18.6
1992	669,100	6.8	–5.0	190,200	27.0
1993	1,395,898	14.2	108.6	160,584	24.0
1994	1,105,248	11.3	–20.8	108,744	7.8
1995	1,093,657	11.1	–1.0	128,016	11.6
1996	1,288,316	13.1	17.8	113,564	10.4
1997	1,121,800	11.4	–12.9	128,047	9.9
1998	1,349,050	13.7	20.3	74,650	6.7
1999	1,244,734	12.7	–7.7	154,860	11.5
2000	1,157,073	11.8	–7.0	131,050	10.5
2001	1,022,526	10.4	–11.6	147,600	12.8
2002	1,437,265	14.6	40.6	140,100	13.7
2003	874,589	8.9	–39.1	194,450	13.5
2004	722,872	7.4	–17.3	131,188	15.0
2005	701,493	7.1	–3.0	108,431	15.0
2006	677,124	6.9	–3.5	105,224	15.0
2007	571,999	5.8	–15.5	101,569	15.0
2008	638,262	6.5	11.6	85,800	15.0
2009	321,138	3.3	–49.7	95,739	15.0
2010	562,931	5.7	75.3	16,673	5.2
2011	541,306	5.5	–3.8	50,019	8.9
2012	700,388	7.1	29.4	78,012	14.4
2013	1,780,269	18.1	154.2	105,058	15.0
2014				267,040	15.0

Kangaroo management zone no. 9: Armidale

Table A9a. Wallaroo

Average density (kangaroos/km^2)	5.5
Area in km^2	16,331
Standard deviation	2.28

Year	Population	Density	% Change	Quota	% Population
1993	127,680	7.8	0	6,160	4.8
1994	121,296	7.4	–5	6,432	5.0
1995	126,148	7.7	4	6,118	5.0
1996	98,396	6.0	–22	6,308	5.0
1997	111,187	6.8	13	4,920	5.0
1998	120,860	7.4	9	5,559	5.0
1999	119,651	7.3	–1	6,043	5.0
2000	125,600	7.7	5	5,975	5.0
2001	125,600	7.7	0	6,250	5.0
2002	125,600	7.7	0	6,250	5.0
2003	34,744	2.1	–72	6,250	5.0
2004	89,787	5.7	158	5,212	15.0
2005	89,787	5.7	0	13,468	15.0
2006	89,787	5.7	0	13,468	15.0
2007	37,859	2.3	–58	13,468	15.0
2008	37,859	2.3	0	5,679	15.0
2009	37,859	2.3	0	5,679	15.0
2010	41,255	2.5	9	5,679	15.0
2011	41,255	2.5	0	6,188	15.0
2012	41,255	2.5	0	6,188	15.0
2013	45,140	2.8	9	6,188	15.0
2014				6,771	15.0

Table A9b. Grey kangaroo

Average density (kangaroos/km^2)		11.7			
Area in km^2		16,331			
Standard deviation		1.84			
Year	**Population**	**Density**	**% Change**	**Quota**	**% Population**
1993	234,655	14.4	5	46,931	21.0
1994	199,474	12.2	–15	46,931	20.0
1995	207,462	12.7	4	43,882	22.0
1996	161,821	9.9	–22	45,640	22.0
1997	182,857	11.2	13	32,364	20.0
1998	198,765	12.2	9	31,085	17.0
1999	196,777	12	–1	33,790	17.0
2000	206,600	12.7	5	33,450	17.0
2001	173,109	10.6	–16	35,100	17.0
2002	173,109	10.6	0	25,966	15.0
2003	180,456	11	4	25,966	15.0
2004	161,726	10.2	–10	27,068	15.0
2005	161,726	10.2	0	24,259	15.0
2006	161,726	10.2	0	24,259	15.0
2007	141,610	8.7	–12	24,259	15.0
2008	141,610	8.7	0	21,242	15.0
2009	141,610	8.7	0	21,242	15.0
2010	199,200	12.2	41	21,242	15.0
2011	206,780	13.1	4	29,880	15.0
2012	206,780	13.1	0	31,017	15.0
2013	263,300	16.1	27	31,017	15.0
2014				39,495	15.0

Kangaroo management zone no. 13: Glen Innes

Table A10a. Wallaroo

Average density (kangaroos/km^2)		4.6			
Area in km^2		20,941			
Standard deviation		2.55			
Year	**Population**	**Density**	**% Change**	**Quota**	**% Population**
1993	127,680	6.1	0	6,160	4.8
1994	121,296	5.8	–5	6,432	5.0
1995	126,148	6	4	6,118	5.0
1996	98,396	4.7	–22	6,308	5.0
1997	111,187	5.3	13	4,920	5.0
1998	120,860	5.8	9	5,559	5.0
1999	119,651	5.7	–1	6,043	5.0
2000	125,600	6	5	5,975	5.0
2001	215,500	10.3	72	6,250	5.0
2002	215,500	10.3	0	6,250	2.9
2003	128,232	6.1	–40	6,250	2.9
2004	56,657	3.1	–56	19,235	15.0
2005	56,657	3.1	0	8,499	15.0
2006	56,657	3.1	0	8,499	15.0
2007	32,184	1.5	–43	8,499	15.0
2008	32,184	1.5	0	4,828	15.0
2009	32,184	1.5	0	4,828	15.0
2010	32,190	1.5	0	4,828	15.0
2011	32,190	1.5	0	4,829	15.0
2012	32,190	1.5	0	4,829	15.0
2013	28,305	1.4	–12	4,829	15.0
2014				4,246	15.0

Table A10b. Grey kangaroo

Average density (kangaroos/km^2)		10.5			
Area in km^2		20,941			
Standard deviation		2.10			
Year	**Population**	**Density**	**% Change**	**Quota**	**% Population**
1993	234,655	11.2	5	46,931	21.0
1994	199,474	9.5	–15	46,931	20.0
1995	207,462	9.9	4	43,882	22.0
1996	161,821	7.7	–22	45,640	22.0
1997	182,857	8.7	13	32,364	20.0
1998	198,765	9.5	9	31,085	17.0
1999	196,777	9.4	–1	33,790	17.0
2000	206,600	9.9	5	33,450	17.0
2001	221,975	10.6	7	35,122	17.0
2002	221,975	10.6	0	33,296	15.0
2003	229,723	11	3	33,296	15.0
2004	149,621	8.1	–35	34,458	15.0
2005	149,621	8.1	0	22,443	15.0
2006	149,621	8.1	0	22,443	15.0
2007	236,600	11.3	58	22,443	15.0
2008	236,600	11.3	0	35,490	15.0
2009	236,600	11.3	0	35,490	15.0
2010	269,500	12.9	14	35,490	15.0
2011	269,500	12.9	0	40,425	15.0
2012	269,500	12.9	0	40,425	15.0
2013	374,300	17.9	39	40,425	15.0
2014				56,145	15.0

Kangaroo management zone no. 14: Upper Hunter

Table A11a. Wallaroo

Average density (kangaroos/km^2)		5.1			
Area in km^2		14,590			
Standard deviation		2.32			
Year	**Population**	**Density**	**% Change**	**Quota**	**% Population**
1993	109,440	7.5	0	5,280	4.8
1994	103,968	7.1	–5	5,512	5.0
1995	108,128	7.4	4	5,244	5.0
1996	84,340	5.8	–22	5,408	5.0
1997	95,304	6.5	13	4,217	5.0
1998	103,595	7.1	9	4,765	5.0
1999	102,559	7	–1	5,180	5.0
2000	107,650	7.4	5	5,125	5.0
2001	107,650	7.4	0	5,350	5.0
2002	107,650	7.4	0	5,350	5.0
2003	57,762	4	–46	5,350	5.0
2004	61,660	4.4	7	8,664	15.0
2005	61,660	4.4	0	9,249	15.0
2006	61,660	4.4	0	9,249	15.0
2007	44,923	3.1	–27	9,249	15.0
2008	44,923	3.1	0	6,738	15.0
2009	44,923	3.1	0	6,738	15.0
2010	14,985	1.0	–67	2,985	6.6
2011	14,985	1.0	0	0	0
2012	14,985	1.0	0	1,499	10.0
2013	27,380	1.9	83	1,499	10.0
2014				4,107	15.0

Table A11b. Grey kangaroo

Average density (kangaroos/km^2)	9.3
Area in km^2	14,590
Standard deviation	2.75

Year	**Population**	**Density**	**% Change**	**Quota**	**% Population**
1993	191,690	13.1	5	38,338	21.0
1994	162,952	11.2	–15	38,338	20.0
1995	169,476	11.6	4	35,848	22.0
1996	132,192	9.1	–22	37,283	22.0
1997	149,377	10.2	13	26,438	20.0
1998	162,372	11.1	9	25,394	17.0
1999	160,748	11	–1	27,600	17.0
2000	168,750	11.6	5	27,350	17.0
2001	95,273	6.5	–44	25,313	15.0
2002	95,273	6.5	0	14,291	15.0
2003	94,251	6.5	–1	14,291	15.0
2004	67,499	4.8	–28	14,138	15.0
2005	67,499	4.8	0	10,125	15.0
2006	67,499	4.8	0	10,125	15.0
2007	92,016	6.3	36	10,125	15.0
2008	92,016	6.3	0	13,802	15.0
2009	92,016	6.3	0	13,802	15.0
2010	167,500	11.5	82	13,802	15.0
2011	167,500	11.5	0	25,125	15.0
2012	167,500	11.5	0	25,125	15.0
2013	126,800	8.7	–24	25,125	15.0
2014				19,020	15.0

Kangaroo management zone: Southeast NSW

Table A12. Eastern grey kangaroo

Average density (kangaroos/km^2)		15.02			
Area in km^2		38,424			
Standard deviation		N/A			
Year	**Population**	**Density**	**% Change**	**Quota**	**% Population**
2003	292,455	11.95	–	–	–
2004	292,455	11.95	0	43,868	15.0
2005	292,455	11.95	0	43,868	15.0
2006	415,271	14.07	42	43,868	15.0
2007	415,271	14.07	0	62,291	15.0
2008	415,271	14.07	0	62,291	15.0
2009	655,900	15.69	47.6	62,291	15.0
2010	655,900	17.07	0	98,385	15.0
2011	655,900	17.07	0	98,385	15.0
2012	858,900	22.35	30.9	98,385	15.0
2013	858,900	22.35	0	128,835	15.0
2014				128,835	15.0

Kangaroo management zone: Central Tablelands North

Table A13. Grey kangaroo

Average density (kangaroos/km^2)		16.27			
Area in km^2		29,379			
Standard deviation		N/A			
Year	**Population**	**Density**	**% Change**	**Quota**	**% Population**
2008	433,030	14.74	N/A		
2009	433,030	14.74	N/A	64,995	15
2010	433,030	14.74	N/A	64,995	15
2011	612,590	20.85	41.47	64,955	15
2012	612,590	20.85	N/A	91,889	15
2013	612,590	20.85	N/A	91,889	15
2014				91,889	15

Kangaroo management zone: Central Tablelands South

Table A14. Grey kangaroo

Average density (kangaroos/km^2)		21.15			
Area in km^2		23,105			
Standard deviation		N/A			
Year	**Population**	**Density**	**% Change**	**Quota**	**% Population**
2008	535,600	23.18	N/A		
2009	535,600	23.18	N/A	80,340	15
2010	535,600	23.18	N/A	80,340	15
2011	347,830	15.05	–35.06	80,340	15
2012	347,830	15.05	N/A	52,175	15
2013	347,830	15.05	N/A	52,175	15
2014				52,175	15

Table A15. Red and grey kangaroo annual population estimates: annual quotas, annual take figures and relative percentages

Note	Year	Population	Quota	% Population	Take	% Population	% Quota
1	1975	3,365,300	212,000	0	123,000	0	58.0
1	1976	no estim.	319,400	9.49	96,000	2.85	30.1
1	1977	4,699,000	321,000	0	167,200	0	52.1
1	1978	4,383,000	345,000	7.3	220,000	4.7	63.8
1	1979	4,288,000	645,000	14.7	520,000	11.9	80.6
1	1980	6,174,000	645,000	15.0	619,023	14.4	96.0
1	1981	7,046,000	694,500	11.2	488,647	7.9	70.4
1	1982	9,400,000	843,000	12.0	664,342	9.4	78.8
1	1983	5,500,000	843,000	9.0	400,477	4.3	47.5
2	1984	2,738,000	500,000	9.1	229,484	4.2	45.9
2	1985	4,155,000	300,000	11.0	326,028	11.9	108.7
2	1986	4,662,100	577,000	13.9	444,509	10.7	77.0
2	1987	5,425,000	577,000	12.4	473,454	10.2	82.1
2	1988	5,498,000	730,000	13.5	421,200	7.8	57.7
3	1989	7,593,500	804,000	14.6	500,355	9.1	62.2
3	1990	9,150,000	1,172,000	15.4	633,000	8.3	54.0
3	1991	9,734,000	1,520,000	16.6	856,406	9.4	56.3
3	1992	7,981,900	2,074,000	21.3	796,007	8.2	38.4
3	1993	14,618,672	1,663,600	20.8	775,220	9.7	46.6
3	1994	11,476,951	1,409,100	9.6	971,694	6.6	69.0
3	1995	12,123,100	1,146,626	10.0	977,459	8.5	85.2
3	1996	9,942,520	1,206,000	9.9	1,149,917	9.5	95.3
3	1997	12,341,062	976,000	9.8	897,937	9.0	92.0
3	1998	13,443,170	1,175,140	9.5	940,789	7.6	80.1
3	1999	12,220,865	1,532,916	11.4	937,642	7.0	61.2
3	2000	11,939,107	1,416,285	11.6	883,478	7.2	62.4
3	2001	13,982,496	1,418,212	11.9	1,169,500	9.8	82.5
3	2002	15,479,854	1,920,100	13.7	1,441,276	10.3	75.1
4	2003	8,127,976	2,083,590	13.5	996,507	6.4	47.8
4	2004	6,732,789	1,263,900	15.5	827,291	10.2	65.5
4	2005	5,514,526	1,060,083	15.7	731,772	10.9	69.0
4	2006	5,772,567	871,912	15.8	810,104	14.7	92.9
4	2007	6,286,831	909,540	15.8	780,999	13.5	85.9
4	2008	6,894,305	1,001,757	15.9	584,803	9.3	58.4
4	2009	7,088,320	1,091,539	15.8	435,751	6.3	39.9
5	2010	8,433,682	1,053,753	14.9	380,403	5.4	36.1

Table A15 *continued*. Red and grey kangaroo annual population estimates: annual quotas, annual take figures and relative percentages

Note	Year	Population	Quota	% Population	Take	% Population	% Quota
5	2011	9,726,685	1,275,493	15.1	377,997	4.5	29.6
5	2012	11,302,163	1,506,113	15.5	335,967	3.5	22.3
5	2013	15,229,573	1,771,235	15.7			
5	2014		2,374,048	15.6			

1 Based on survey of seven 1:250 000 monitor blocks

2 Based on survey of the Western Plains of NSW

3 Western Plains of NSW plus Northern Tablelands

4 Western Plains plus Northern Tablelands and Southeast NSW

5 Western Plains plus Central and Northern Tablelands and Southeast NSW

Table A16. Summary statistics of commercial take: red kangaroo

Year	Population estimate	Quota	% of previous year's population	Take	% of previous year's population	% of quota
1976	no survey	110,000	5			
1977	2,669,000	150,000				
1978	2,069,000	150,000	6			
1979	2,355,000	300,000	15			
1980	3,377,000	300,000	13			
1981	4,626,000	333,000	10			
1982	5,700,000	550,000	12	398,200	8.6	72.4
1983	3,400,000	550,000	10	264,900	4.6	48.2
1984	1,650,000	270,000	8	158,000	4.6	58.5
1985	2,363,000	190,000	12	213,300	12.9	112.3
1986	2,574,000	313,000	13	263,000	11.1	84.0
1987	2,777,000	313,000	12	270,500	10.5	86.4
1988	3,440,000	354,000	13	218,100	7.9	61.6
1989	4,101,000	487,000	14	297,000	8.6	61.0
1990	4,499,000	626,000	15	377,200	9.2	60.3
1991	4,755,000	706,000	16	496,000	11.0	70.3
1992	3,348,900	956,000	20	412,200	8.7	43.1
1993	4,395,426	598,800	18	359,820	10.7	60.1
1994	3,960,106	483,850	11	397,791	9.1	82.2
1995	4,185,494	483,680	12	431,663	10.9	89.2
1996	3,787,113	507,000	12	531,370	12.7	104.8
1997	5,285,995	450,780	12	415,395	11.0	92.2
1998	5,809,757	648,560	12	495,100	9.4	76.3
1999	4,705,664	642,070	11	450,020	7.7	70.1
2000	4,391,385	590,450	13	389,204	8.3	65.9
2001	5,121,413	558,750	13	527,521	12.0	94.4
2002	4,798,558	765,900	15	538,856	10.5	70.4
2003	2,235,114	704,350	15	274,900	5.7	39.0
2004	2,508,236	379,970	17	244,379	10.9	64.3
2005	2,241,497	426,400	17	241,503	9.6	56.6
2006	2,182,788	381,054	17	338,631	15.1	88.9
2007	2,524,448	371,074	17	304,732	14.0	82.1
2008	2,869,709	429,156	17	210,654	8.3	49.1
2009	2,456,795	487,850	17	182,858	6.4	37.5
2010	3,013,908	417,655	17	117,811	4.8	28.2

Table A16 *continued.* Summary statistics of commercial take: red kangaroo

Year	Population estimate	Quota	% of previous year's population	Take	% of previous year's population	% of quota
2011	3,972,522	512,364	17	125,843	4.2	24.6
2012	4,148,316	675,329	17	134,893	3.4	20
2013	4,480,580	705,214	17			
2014		761,699	17			

Notes:

1975–1983 population estimates based on survey of seven 1:250 000 monitor blocks

1984–2000 population estimates based on survey of virtually all the Western Plains

2001–2009 population estimates based on survey of virtually all the Western Plains, and incorporates revised correction factors

Table A17. Summary statistics of commercial take: eastern grey kangaroo

Year	Population estimate	Quota	% of population	Take	% of population	% of quota
1989	2,535,000	444,000	–	257,300	–	58.0
1990	3,354,800	394,000	15.5	170,800	6.7	43.4
1991	3,587,300	548,000	16.3	254,800	7.6	46.5
1992	3,313,000	790,300	22.0	264,400	7.4	33.5
1993	7,738,749	757,000	22.8	284,300	8.6	37.6
1994	5,426,382	657,200	8.5	363,659	4.7	55.3
1995	5,384,828	474,177	8.7	370,757	6.8	78.2
1996	4,427,575	480,000	8.9	402,356	7.5	83.8
1997	4,947,349	391,290	8.8	333,426	7.5	85.2
1998	5,754,812	382,500	7.7	314,328	6.4	82.2
1999	5,426,433	657,641	11.4	355,845	6.2	54.1
2000	5,755,494	582,697	10.7	376,851	6.9	64.7
2001	6,829,471	628,416	10.9	527,521	9.2	83.9
2002	8,293,707	882,625	12.9	704,010	10.3	79.8
2003	4,627,831	1,065,789	12.9	616,718	7.4	57.9
2004	3,328,133	694,175	15.0	490,868	10.6	70.7
2005	2,670,822	499,220	15.0	419,220	12.6	84.0
2006	2,936,255	400,623	15.0	388,396	14.5	96.9
2007	3,036,020	440,438	15.0	394,906	13.4	89.7
2008	3,035,904	455,403	15.0	320,026	10.5	70.3
2009	3,909,270	455,386	15.0	214,218	7.1	47.0
2010	4,756,792	552,904	14.1	237,038	6.1	42.9
2011	5,258,104	684,278	14.4	235,579	5.0	34.4
2012	6,297,955	782,349	14.9	177,234	3.4	22.7
2013	8,775,664	944,693	15.0			
2014		1,334,443	15.0			

Notes:

Quota based on a grey kangaroo ratio of 72% to 28% eastern to western grey kangaroos

1987–01 populations and quotas based on aerial surveys and counts of grey kangaroos, applying species proportions determined from ground surveys for Western Plains

1975–1983 population estimates based on survey of seven 1:250 000 monitor blocks

1984–2000 population estimates based on survey of the Western Plains (not monitor blocks)

2001–2007 population estimates based on survey of the Western Plains and incorporate revised correction factors

Helicopter surveys of the Northern Tablelands were undertaken for the first time in 2001. Before this, estimates were based on ground surveys conducted in the 1980s.

Southeast NSW management zone added from 2003 population estimate

Central Tablelands zones added from 2009 population estimate

Table A18. Summary of commercial take: western grey kangaroos

Year	Population estimate*	Quota	% of previous year's population	Take	% of previous year's population	% of quota
1987	806,500	75,000		62,900		83.9
1988	626,500	105,000	13.0	72,800	9.0	69.3
1989	957,500	95,000	15.2	67,300	10.7	70.8
1990	1,296,400	152,000	15.9	83,700	8.7	55.1
1991	1,391,700	220,000	17.0	106,600	8.2	48.5
1992	1,320,000	327,700	23.5	173,600	12.5	53.0
1993	2,484,496	307,800	23.3	191,000	14.5	62.1
1994	2,090,463	268,050	10.8	210,244	8.5	78.4
1995	2,552,778	188,800	9.0	175,039	8.4	92.7
1996	1,727,832	219,000	8.6	216,191	8.5	98.7
1997	2,107,718	148,000	8.6	141,167	8.2	95.4
1998	1,878,601	151,700	7.2	123,826	5.9	81.6
1999	2,088,768	220,119	11.7	122,481	6.5	55.6
2000	1,792,228	216,553	10.4	107,902	5.2	49.8
2001	2,031,612	203,556	11.4	145,787	8.1	71.6
2002	2,387,589	271,575	13.4	183,513	9.0	67.6
2003	1,265,031	313,378	13.1	104,889	4.4	33.5
2004	896,420	189,755	15.0	92,044	7.3	48.5
2005	602,208	134,463	15.0	71,049	7.9	52.8
2006	653,524	90,331	15.0	83,077	13.8	92.0
2007	726,363	98,029	15.0	81,361	12.4	83.0
2008	989,559	108,954	15.0	54,123	7.5	49.7
2009	722,255	148,434	15.0	38,675	3.9	26.1
2010	662,982	83,194	11.5	25,554	3.5	30.7
2011	496,059	78,851	11.9	16,575	2.5	21.0
2012	855,892	48,435	9.8	18,366	3.7	37.9
2013	1,852,710	121,328	14.2			
2014		277,906	15.0			

Notes:

1987–04 populations and quotas based on aerial survey counts of grey kangaroos, applying species proportions determined from ground surveys

1975–1983 population estimates based on survey of seven 1:250 000 monitor blocks

1984–2000 population estimates based on survey of the Western Plains

2001–2009 population estimates based on survey of the Western Plains and incorporates revised correction factors

* There is a small population (3249 in 2012) of western grey kangaroos in the Narrabri management zone. This is included in the population estimate, but no quota is set for this species in this zone.

Table A19. Summary commercial take: wallaroos (Northern Tablelands)

Year	Population estimate	Quota	% of previous year's population	Take	% of previous year's population	% of quota
1979		5,000				
1980		5,000				
1981		5,000				
1982		5,000		2,066		41.3
1983		5,000		714		14.3
1984		1,000		632		63.2
1985		1,000		763		76.3
1986		0		0		
1987		0		0		
1988		0		0		
1989	300,000	1,000		97		9.7
1990	413,700	10,000	3.3	1,967	0.7	19.7
1991	434,000	10,000	2.4	1,378	0.3	13.8
1992	456,000	22,000	5.1	1,377	0.3	6.3
1993	456,000	22,000	4.8	1,678	0.4	7.6
1994	433,200	17,600	3.9	3,431	0.8	19.5
1995	450,528	17,700	4.1	7,949	1.8	44.9
1996	351,414	22,300	4.9	6,530	1.4	29.3
1997	397,096	17,780	5.1	6,323	1.8	35.6
1998	431,879	19,900	5.0	5,035	1.3	25.3
1999	427,559	21,586	5.0	5,490	1.3	25.4
2000	448,750	21,355	5.0	6,562	1.5	30.7
2001	448,750	22,330	5.0	9,053	2.0	40.5
2002	448,750	22,330	5.0	6,615	1.5	29.6
2003	220,738	22,330	5.0	13,388	3.0	60.0
2004	208,104	33,111	15.0	15,304	6.9	46.2
2005	208,104	31,216	15.0	21,299	10.2	68.2
2006	208,104	31,216	15.0	24,540	11.8	78.6
2007	114,966	31,216	15.0	22,532	10.8	72.2
2008	114,966	17,245	15.0	12,069	10.5	70.0
2009	114,966	17,245	15.0	10,073	8.8	58.4
2010	88,430	17,245	15.0	9,178	8.0	53.2
2011	88,430	11,017	12.5	4,940	5.6	44.8
2012	88,430	12,515	14.2	5,474	6.2	43.7
2013	100,825	12,515	14.2			
2014		15,124	15.0			

Notes:

1979–85, whole of commercial zone

1989–2000, Tablelands only

2001, helicopter survey of Tablelands

2004, helicopter survey of Tablelands

2007, helicopter survey of Tablelands

2004 quota changed from 5% to 15% in line with KMP 2002–2006

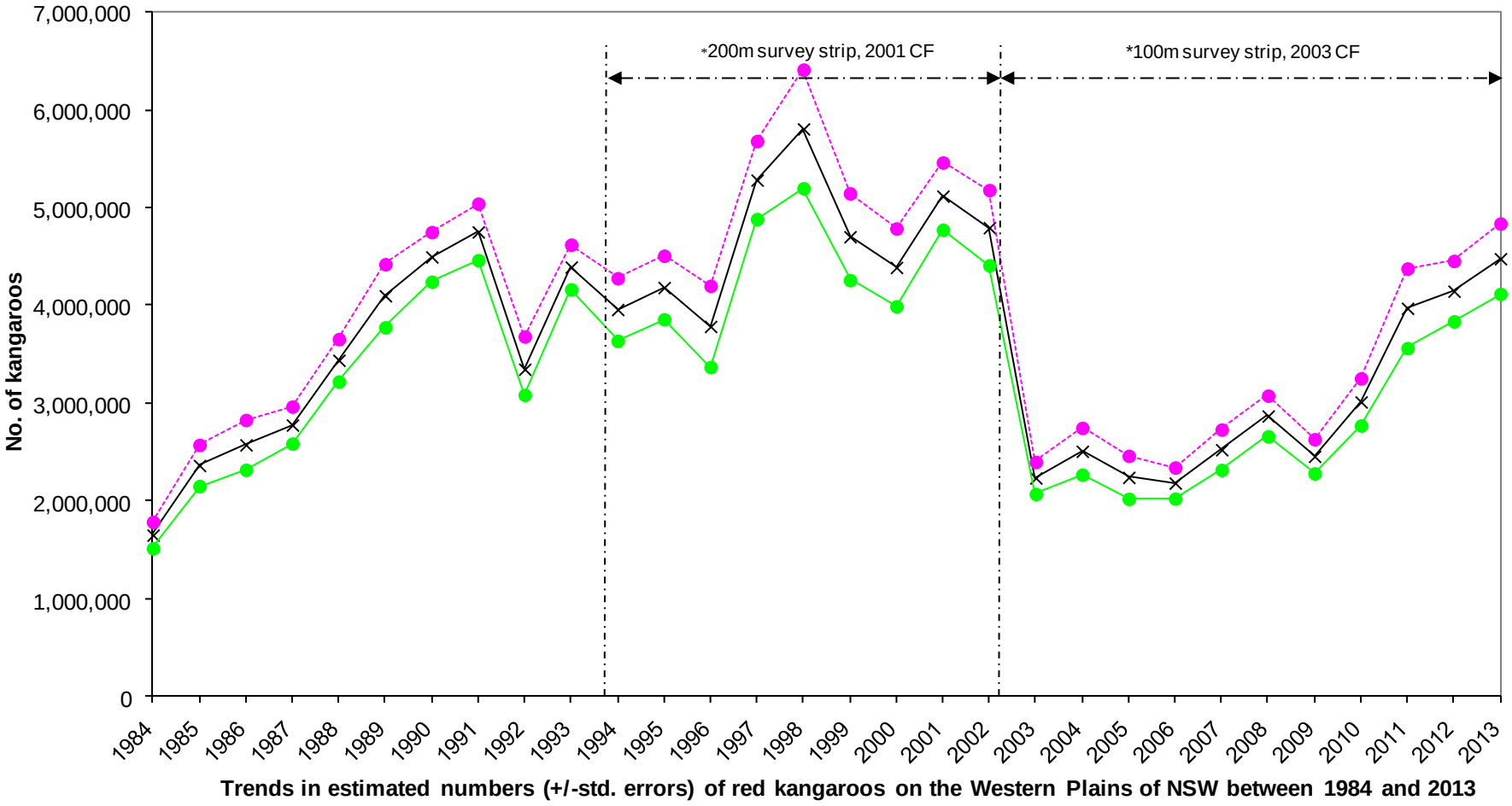

Figure A1. Population trends in red kangaroos on the Western Plains of NSW. The pink and green lines indicate the standard error for the population estimate. That is, the actual population may be higher (the pink line) or lower (the green line) than the estimate indicated by the black line.

Figure A2. Population trends in grey kangaroos on the Western Plains of NSW. The pink and blue lines indicate the standard error of the population estimate. That is, the actual population may be more (pink line) or less (blue line) than the estimate (red line).

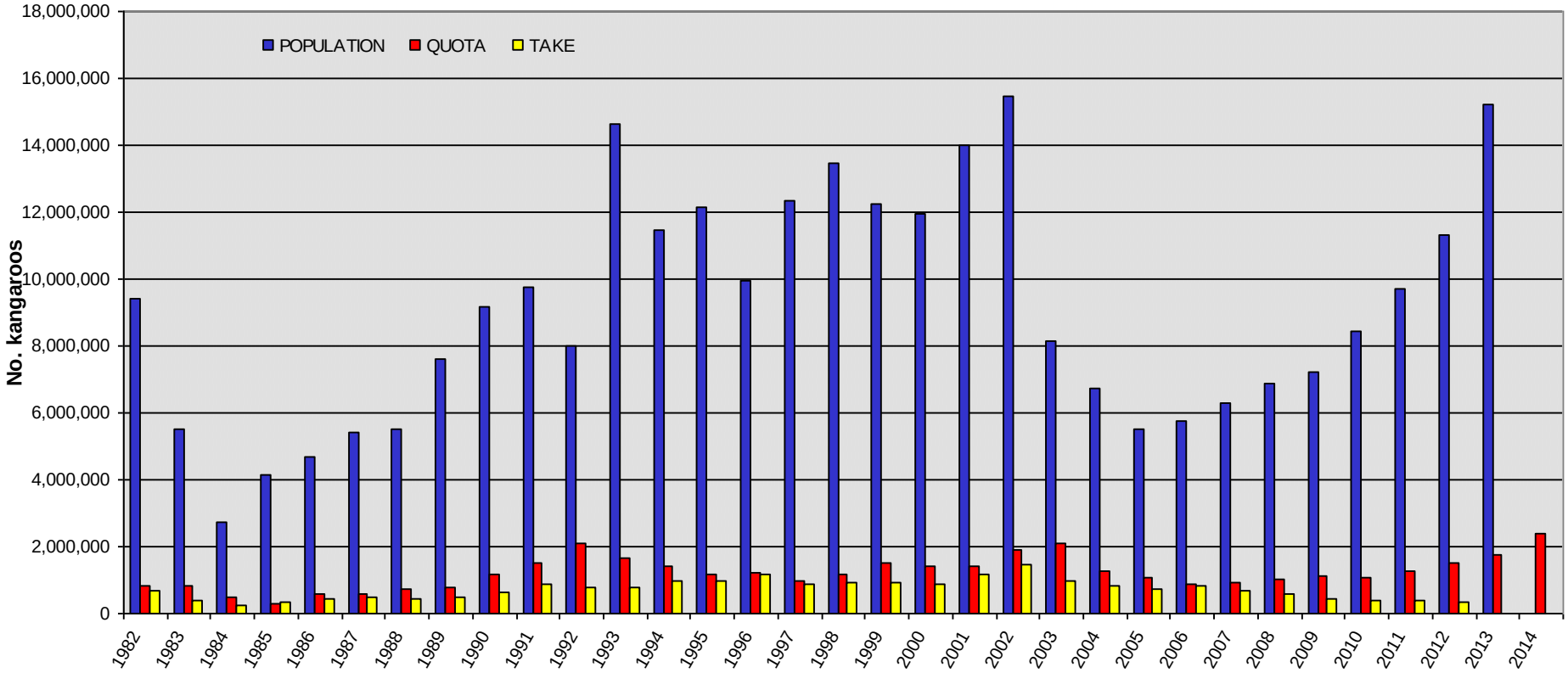

Figure A3. NSW combined red and grey kangaroo population estimates, authorised quotas and actual takes, 1982–2014

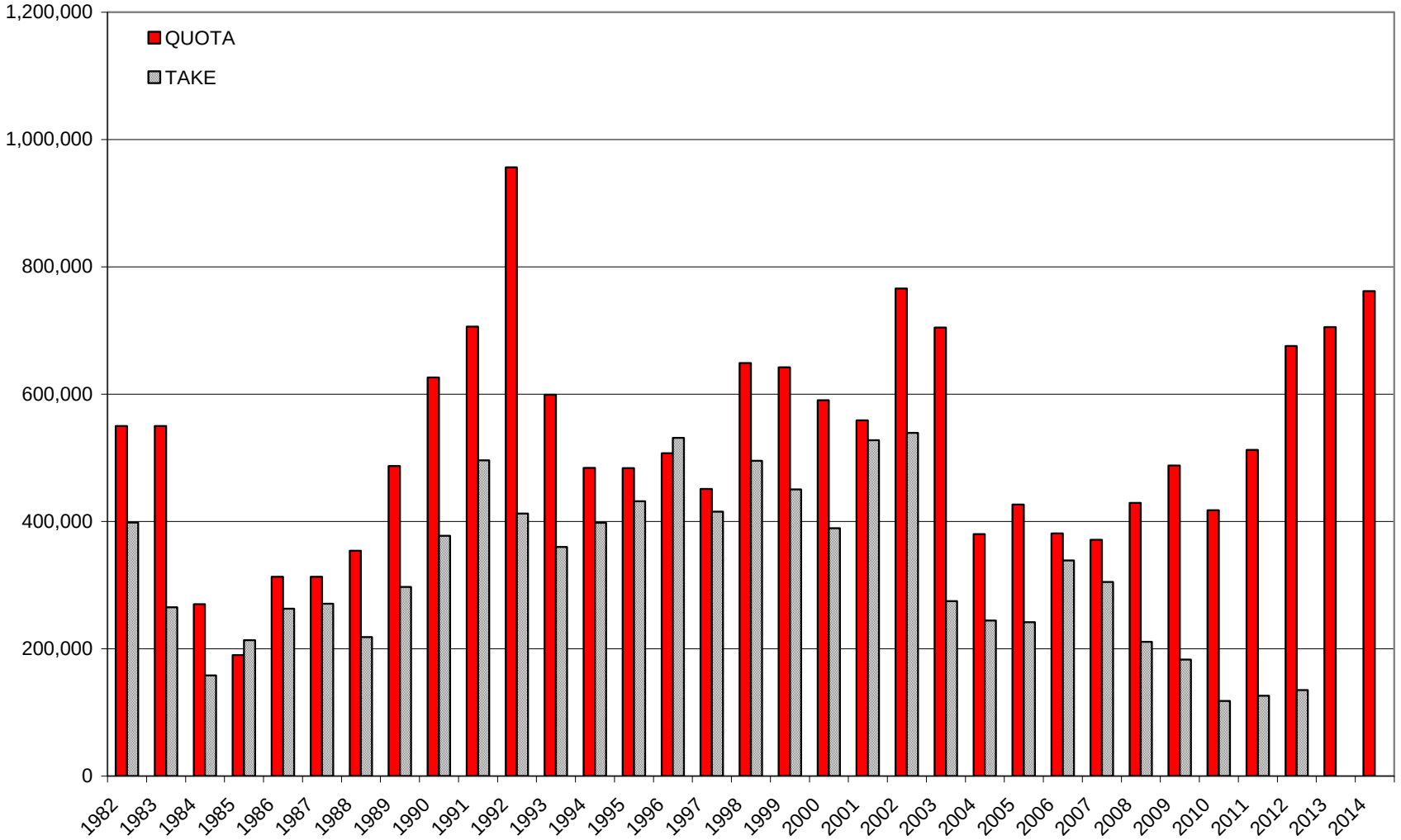

Figure A4. NSW red kangaroo quotas and takes, 1982–2014

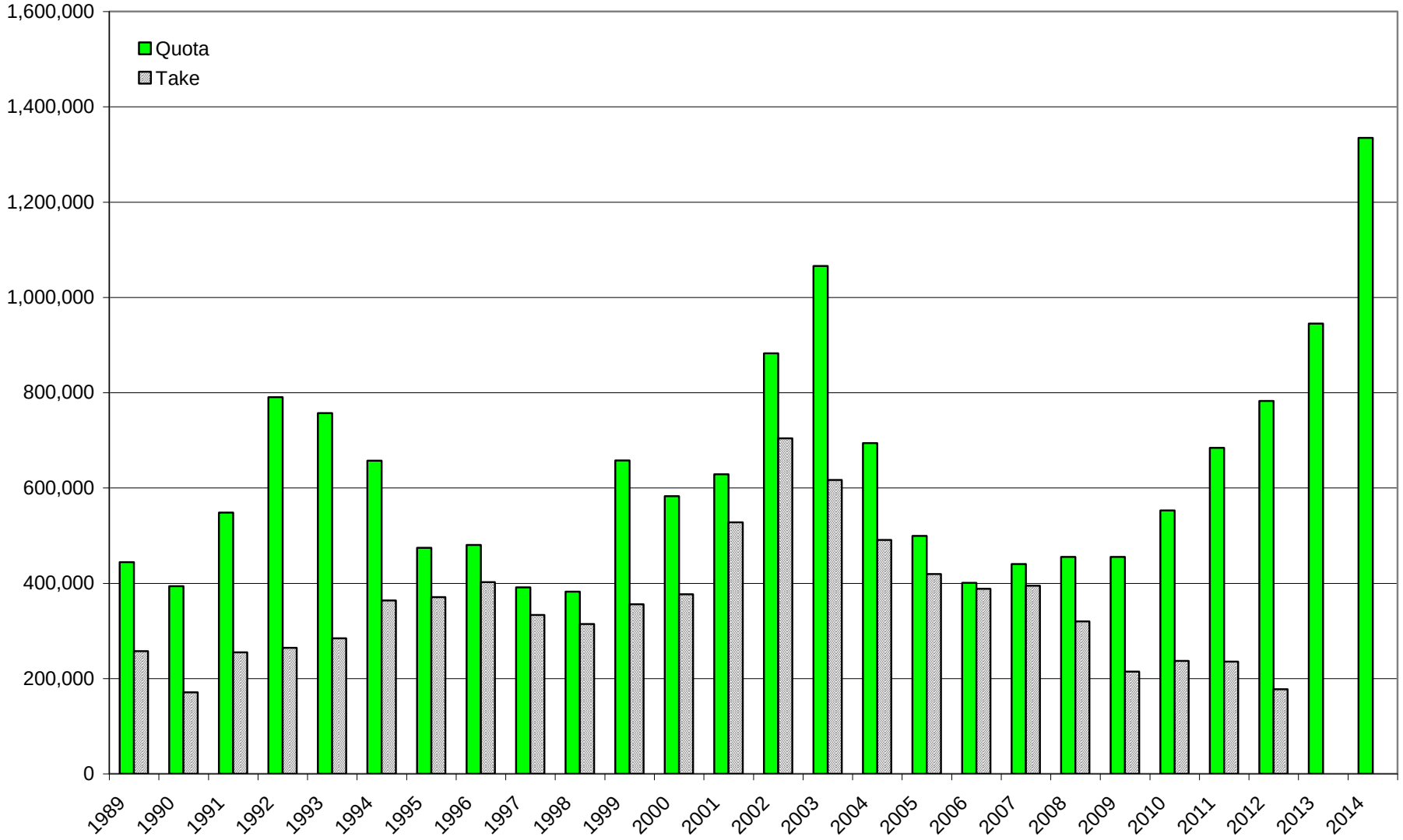

Figure A5. NSW eastern grey kangaroo quotas and takes, 1989–2014

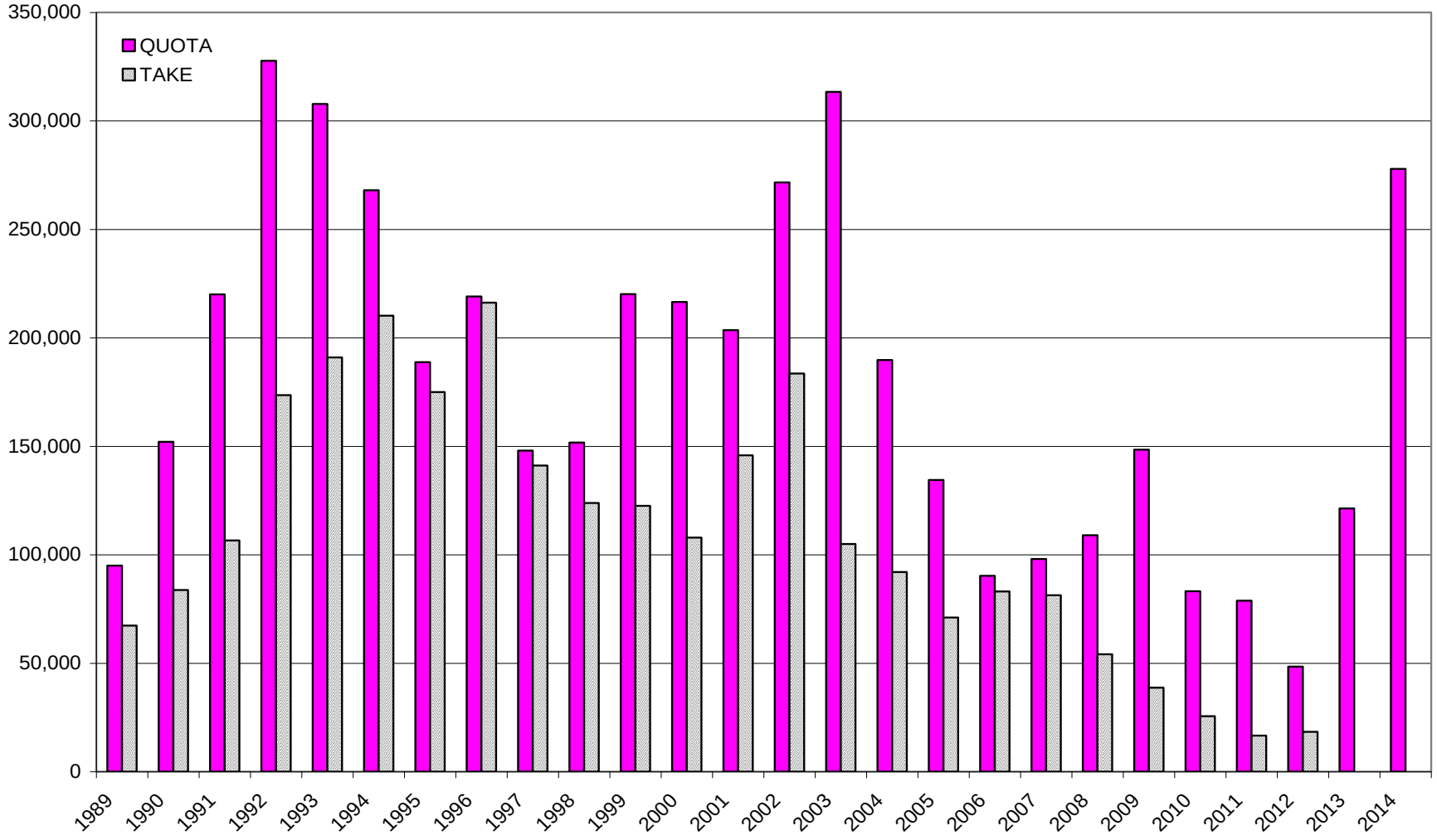

Figure A6. NSW western grey kangaroo quotas and takes, 1989–2014

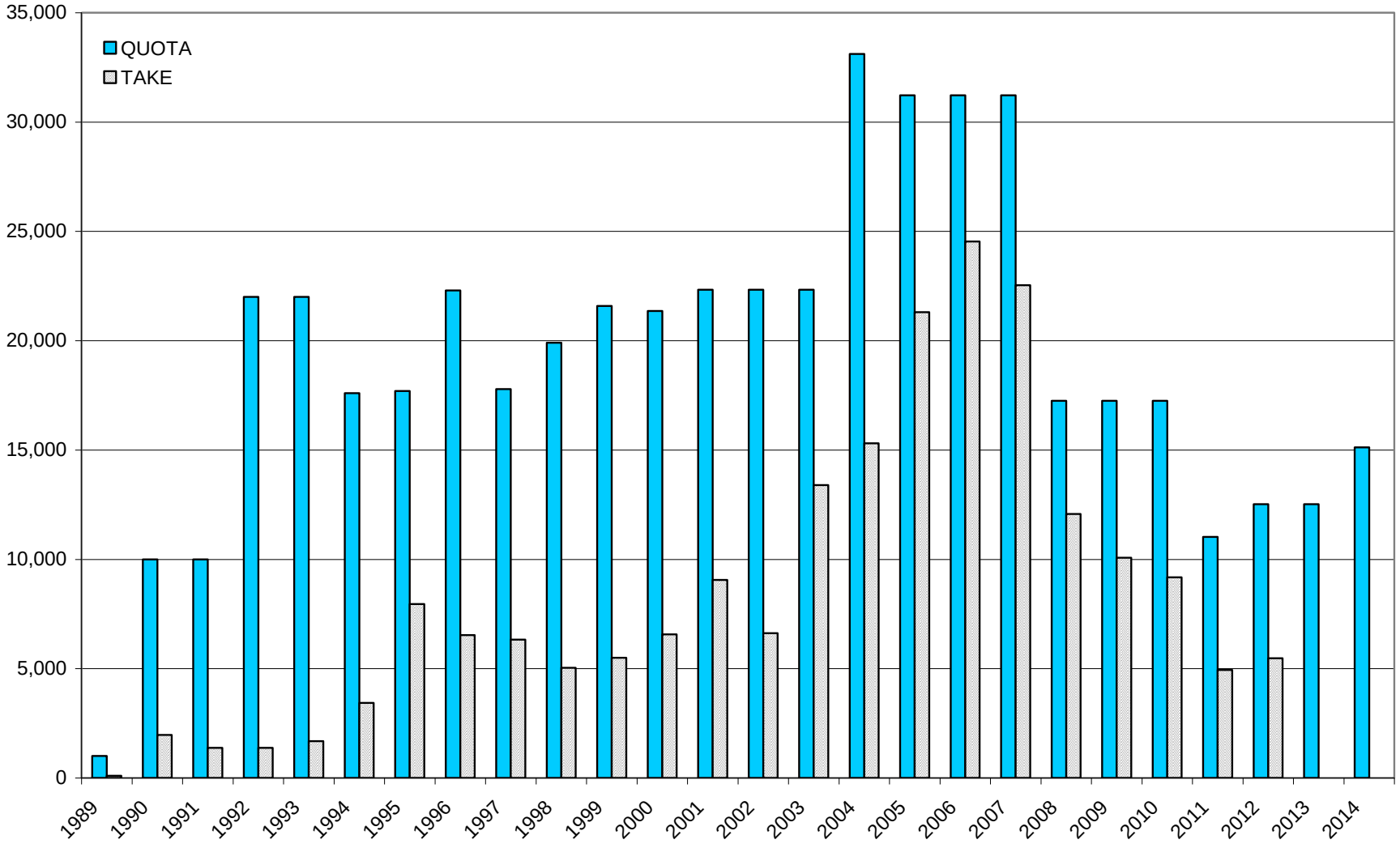

Figure A7. NSW wallaroo quotas and takes, 1989–2014

Appendix B Low population thresholds applicable for 2014

The Plan protects low populations by requiring the commercial harvest quota to be either reduced or suspended, depending on the current population estimate relative to the mean (average) population over the time for which records are available. Thresholds have been set on the basis of standard deviations, which are statistical measures that indicate how much a population varies from the average population. A small standard deviation indicates that the population doesn't vary by much from the average, whereas a large standard deviation indicates that the population varies more. Each species in each zone has its own thresholds.

For the purposes of managing commercial quotas, the thresholds are based on densities of kangaroos, calculated as the number of kangaroos per square kilometre at the time of the aerial survey. There are two thresholds, representing increasingly significant population declines. Threshold 1 is set at 1.5 standard deviations below the average density. Threshold 2 is set at 2.0 standard deviations below the average density.

If a population falls to below Threshold 1, but not as low as Threshold 2, the commercial quota for the following year is calculated at 10 per cent of the population rather than the usual 15 or 17 per cent. Reducing the quota will help the kangaroo population to recover when the decline is not sufficient to warrant complete suspension of the harvest. If a population falls below Threshold 2, no commercial quota is set for the following year.

The current population densities and thresholds are shown in Table B1.

Table B1. Average and current density estimates, and thresholds for quota reduction and suspension

Western Plains								
Western grey								
Zone	Tibooburra	Broken Hill	Lower Darling	Cobar	Bourke	Narrabri	Coonabarabran	Griffith
Average density	0.62	4.88	8	7.99	2.97		2.23	1.84
Threshold 1: 10% quota	0.24	1.61	2.09	3.18	0.85		1.19	0.68
Threshold 2: suspension of quota	0.18	1.18	1.45	2.44	0.6		0.99	0.51
2013 density estimate (kangaroos/km^2)	**0.72**	**3.96**	**5.87**	**9.57**	**3.41**		**4.04**	**3.0**
Eastern grey								
Zone	Tibooburra	Broken Hill	Lower Darling	Cobar	Bourke	Narrabri	Coonabarabran	Griffith
Average density	1.98	1.55	2.31	5.05	7.72	15.87	27.07	7.61
Threshold 1: 10% quota	0.69	0.22	0.72	1.79	1.86	6.46	11.75	3.04
Threshold 2: suspension of quota	0.52	0.13	0.52	1.33	1.26	4.98	9.21	2.33
2013 density estimate (kangaroos/km^2)	**2.26**	**2.5**	**2.76**	**6.82**	**6.43**	**28.42**	**29.5**	**15.13**
Red								
Zone	Tibooburra	Broken Hill	Lower Darling	Cobar	Bourke	Narrabri	Coonabarabran	Griffith
Average density	18.57	15.07	5.47	4.81	5.93	5.06	4.52	3.89
Threshold 1: 10% quota	7.87	7.83	2.48	2.47	2.6	1.83	2.34	2.07
Threshold 2: suspension of quota	6.14	6.44	1.97	2.03	2.05	1.38	1.92	1.71
2013 density estimate (kangaroos/km^2)	**16.5**	**13.42**	**7.5**	**4.8**	**8.37**	**5.6**	**6.7**	**5.47**

Table B1 *continued*. Average and current density estimates, and thresholds for quota reduction and suspension

Tablelands						
Eastern grey						
Zone	Armidale	Glen Innes	Upper Hunter	Southeast NSW	Central Tablelands North	Central Tablelands South
Average density	10.37	10.77	7.53	15.02	14.70	23.20
Threshold 1: 10% quota	4.71	4.85	3.32	7.19	7.07	10.79
Threshold 2: suspension of quota	3.63	3.74	2.59	5.52	5.53	8.36
2013 density estimate (kangaroos/km^2)	16.6	20.3	9.05	22.35	20.90	15.10

Wallaroo			
Zone	Armidale	Glen Innes	Upper Hunter
Average density	3.50	2.03	2.83
Threshold 1: 10% quota	1.47	0.88	1.13
Threshold 2: suspension of quota	1.13	0.68	0.88
2013 density estimate (wallaroos/km^2)	2.8	1.50	1.9