DEPARTMENT OF PLANNING, INDUSTRY & ENVIRONMENT

2021 Quota Report

New South Wales Commercial Kangaroo Harvest Management Plan 2017–2021

environment.nsw.gov.au

Cover photo: Western Ridge Walking Track, Mutawintji National Park. John Spencer/DPIE

Published by:

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ISBN 978-1-922493-43-9
EES 2020/0485
November 2020

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Introduction

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

This *2021 Quota Report: New South Wales Commercial Kangaroo Harvest Management Plan 2017–2021* gives details of the KMP quotas for the 2021 kangaroo harvest in accordance with NSW Commercial Kangaroo Harvest Management Plan 2017–2021 (the plan).

The report outlines 2020 population estimates for red kangaroos, eastern and western grey kangaroos, and wallaroos and commercial kangaroo harvesting quotas for 2021.

The report also provides details of trends in population variation over time, quotas and commercial take data.

All historical data for trends in kangaroo management can be found in the appendices.

Summary

Table 1 lists the quotas for 2020 and 2021.

Table 2 compares the 2021 quotas against the 2020 population estimates and gives the quotas as percentages of those estimates.

Table 3 lists the details of the 2020 commercial harvest up to 16 November 2020. ‘%q’ is the commercial harvest as a percentage of the 2020 approved quota. ‘%p’ is the commercial harvest as a percentage of the 2019 population estimate.

Table 1 Quotas for 2021 and 2020

	2021		2020	
	Quota	**Maximum special quota**	**Quota**	**Maximum special quota**
Red kangaroo	474,852	43,866	564,137	53,110
Eastern grey kangaroo	988,660	99,170	1,408,964	141,560
Western grey kangaroo*	90,765	9,304	129,030	13,258
Wallaroo	44,484	4,448	44,484**	4,448
Total	**1,598,761**	**156,788**	**2,146,615**	**212,376**

*There is a small population (7458) of western grey kangaroos in the Narrabri zone. This is included in the population estimate, but no quota is set for this species in this zone.
**This quota was 24,045 but has been updated to reflect a corrected population estimates (see Table 2).

Table 2 Population estimates for 2020 and quotas for 2021

	Population estimate 2020	Quota 2021	Quota as per cent of population
Red kangaroo	2,924,368	474,852	16.2 %
Eastern grey kangaroo (Western Plains)	2,490,702	370,568	14.9 %
Eastern grey kangaroo (Central and Northern Tablelands and South East NSW)	4,120,620	618,092	15.0 %
Western grey kangaroo	620,281*	90,765	14.6 %
Wallaroo (Northern Tablelands)	296,555**	44,484	15.0 %
Total	**10,452,526**	**1,598,761**	**15.3 %**

*There is a small population (7458) of western grey kangaroos in the Narrabri zone not included in quota and thus not included in the western grey population estimate shown.
**The Wallaroo population has been corrected by a factor of 1.85 as suggested by Cairns et al (2004).

Table 3 Commercial harvest for 2020 up to 16 November 2020

Management zone	No.	Eastern grey kangaroo				Red kangaroo				Western grey kangaroo				Wallaroo			
		2020 Quota	Harvest	%q	%p	2020 Quota	Harvest	%q	%p	2020 Quota	Harvest	%q	%p	2020 Quota	Harvest	%q	%p
Tibooburra	1	5,796	0		0%	0	0		0%	986	0		0%				
Broken Hill	2	20,435	1,218	5%	1%	191,100	34,574	16%	3%	28,562	5,264	17%	2%				
Lower Darling	4	17,780	10,573	54%	8%	117,490	18,738	14%	2%	39,027	5,239	11%	2%				
Cobar	6	0	0		0%	0	0		0%	0	0		0%				
Bourke	7	0	0		0%	84,504	8,931	9%	2%	0	0		0%				
Narrabri	8	114,009	22,637	18%	3%	58,897	5,970	9%	2%								
Armidale	9	63,285	27,001	36%	5%									17,594	1,480	8%	1%
Coonabarabran	10	213,288	34,252	15%	2%	85,023	7,236	7%	1%	17,156	62	0%	0%				
Glen Innes	13	81,780	16,199	17%	3%									20,230	1,096	5%	1%
Upper Hunter	14	24,975	17,068	62%	9%									6,660	2,282	34%	5%
South East NSW	16	258,210	46,960	16%	2%												
Griffith North	17	128,000	24,080	18%	3%	27,123	14,528	47%	8%	26,380	3,687	12%	2%				
Griffith South	18	82,091	22,419	23%	3%	0	0		0%	16,919	90	0%	0%				
Central Tablelands North	48	259,230	28,810	11%	2%												
Central Tablelands South	49	140,085	19,904	13%	2%												
Total		**1,408,964**	**271,121**	**17%**	**3%**	**564,137**	**89,977**	**14%**	**2%**	**129,030**	**14,342**	**10%**	**1%**	**44,484**	**4,858**	**11%**	**2%**

Survey methods and population estimates

How surveys are conducted

Survey methods vary slightly across the state owing to differences in terrain and species habitat preferences. However, the general underlying principles are essentially similar:

1. The aircraft flies at known specified speed and height, and the sighting distance on the ground is delineated by streamers or a boom.
2. Trained observers record kangaroos seen from the aircraft within delineated distances from a transect. The 'detection area' is calculated mathematically from the data. The result is an estimated density of kangaroos.
3. For each region of interest (e.g. a single commercial harvest zone), the total area of the region is known.
4. The estimated density (e.g. the number of animals per square kilometre) is multiplied by the area of the region to calculate the population estimate.

Surveys and Mark-Recapture Distance Sampling

The commercial harvest zones that occur in the Western Plains of New South Wales cover an area of about 530,000 km^2. Fixed-wing aerial surveys allow these areas to be surveyed quickly. The speed, however, and height the plane must travel limits the time available for observers to detect, identify and record observations.

In keeping with advances statistical analyses and survey methods, Mark-Recapture Distance Sampling (MRDS) is used to estimate the abundance of kangaroos in the Western Plains of New South Wales. This method accounts for kangaroos that are present during surveys but not counted. This approach allows for statistical consideration of the differences in detection between surveys, observers, species, group size, vegetation and other factors that may influence detection.

MRDS permits statistically reliable estimates of kangaroo abundance. MRDS combines two methods of surveying wildlife populations, line transect sampling and mark-recapture. On its own, conventional line transect sampling by aerial survey is likely to overestimate detection probability and therefore underestimate kangaroo density.

Mark-recapture estimates derived from the aerial survey, where two observers independently count animals along the same transect on both sides of the aircraft, is used to account for the bias in detection probability between observers.

The combination of mark-recapture and line transect sampling combines the strengths of both methods while reducing the influence of their potential biases.

Western Plains

Table 4 shows the current estimated population of kangaroos in each of the Western Plains management zones. Error margins are shown in brackets.

Table 4 Red and grey kangaroo population estimates and standard errors for 2020 for the Western Plains

Management zone	Red kangaroo population estimate	Red kangaroo density (km^2)	Grey kangaroo population estimate	Grey kangaroo density (km^2)
Tibooburra	200,465 (± 29,803)	3.65	6,859 (± 3,420)	0.12
Broken Hill	1,197,474 (± 150,143)	13.15	281,410 (± 70,990)	3.09
Lower Darling	583,802 (± 70,355)	10.31	314,639 (± 50,785)	5.56
Cobar	102,480 (± 24,791)	2.54	44,208 (± 16,644)	1.09
Bourke	117,975 (± 20,167)	2.14	41,501 (± 14,670)	0.75
Narrabri	190,468 (± 38,728)	2.90	745,775 (± 189,122)	11.34
Coonabarabran	152,052 (± 39,195)	2.46	891,090 (± 189,447)	14.44
Griffith North	126,160 (± 39,185)	1.92	421,161 (± 95,870)	6.4
Griffith South	253,492 (± 71,510)	3.95	371,796 (± 87,057)	5.8
Total	**2,924,368 (± 241,382)**	**5.27**	**3,118,439 (± 403,442)**	**5.62**

The estimated numbers and densities of red and grey kangaroos in each management zone from 1990 onwards are given in Tables 16 to 37. The population trends for each species are shown in Figures 1 and 2 and Tables 45 to49.

Combined red and grey kangaroo population estimates, authorised quotas and actual takes (from 1982 onwards) are shown in graphical form in Figure 3 and tabular form from 1975 onward in Table 45. Note that the combined grey kangaroo data in Figure 5 and Table 47 include eastern grey kangaroos in the Northern Tablelands, Central Tablelands and South East NSW.

Northern Tablelands

Before 2001, the commercial quota was set on the basis of ground (walked) surveys conducted in 1989–90, and the quotas were adjusted annually based on 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 in September 2019, according to a design developed using Distance© software.

Helicopter surveys are robust and scientifically rigorous, with each survey transect being randomised and stratified using information on kangaroo densities gained from the previous

survey in each zone, and advances in software capability. A full report outlining the design of the survey and analysis of the results is available on the Kangaroo Management Program web page.

Table 5 shows the current estimated densities and populations of kangaroos in each of the Northern Tablelands management zones based on aerial surveys conducted in 2019.

Table 5 Population estimates for 2020 for the Northern Tablelands

Management zone	Zone area (km^{-2}) *	Eastern grey kangaroo		Wallaroo	
		Density (km^{-2})	Population estimate	Density** (km^{-2})	Population estimate
Glen Innes	17,241	31.6	545,200	7.8	134,865
Armidale	15,023	28.1	421,900	7.8	117,290
Upper Hunter	7,983	20.9	166,500	5.6	44,400
Total	**40,247**		**1,133,600**		**296,555**

* '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 recommended by Cairns (2004).

Details of the population estimates and commercial take of wallaroos are given in Table 49 and Figure 7. Wallaroo population estimates and quotas for each zone are shown in Tables 37, 39 and 41.

Details of the population estimates and commercial takes of eastern grey kangaroos in all zones are given in Table 47 and Figure 5. Eastern grey kangaroo population estimates and quotas for each of the Northern Tablelands zones are shown in Tables 36, 38 and 40.

South East NSW

In 2018, the Government announced some changes to kangaroo management in New South Wales. For the commercial program, this meant an expansion of the South East Commercial Zone. The 2018 survey was extended to incorporate the Bombala Area to the south east of the zone.

South East NSW (kangaroo management zone 16) was surveyed in September 2018. About 25% of the total area of the zone is not available for commercial harvest as it is reserved for conservation or state forest, or the terrain is too difficult to access. These areas are excluded from the survey, which covers approximately 41,211 square kilometres including the Bombala Area (2720 km^2) addition. The population estimate from this survey will remain current until the next survey in 2021.

Table 6 shows the current estimated density and population of kangaroos in the South East NSW management zone.

Table 6 Population estimates for 2018 for eastern grey kangaroos comprising the South East NSW management zone

Management zone	Area (km^2)	Survey effort (km)	Density (km^{-2})	Population estimate
South East NSW (includes Bombala)	**41,211**	**1,980**	**(41.8)**	**1,721,400**

An interim population survey with reduced precision (40% compared with the normal 20% precision) was completed in 2020 to help assess effects of the 2019–020 bushfires on

kangaroo populations. The interim population survey will be used to monitor differences between the South East Tablelands survey in 2018 and the next South East Tablelands survey in 2021.

The interim survey results show the population has decreased from around 1,721,400 kangaroos in 2018 to 818,527 kangaroos in 2020 or 52.4% reduction.

Details of the population estimates and commercial takes of eastern grey kangaroos in all zones are given in Table 47 and Figure 5. Eastern grey kangaroo population estimates and quotas for the South East NSW zone are shown in Table 42.

Central Tablelands

The initial helicopter survey of the Central Tablelands management zone was completed 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, 2014, 2017 and 2020. 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 2020 helicopter survey are shown in Table 7.

Table 7 Population estimates for 2020 for eastern grey kangaroos the two Central Tablelands commercial harvest zones.

Zone	Area (km^2)	Density (km^{-2})	Population estimate
Central Tablelands North	23,185	33.5	777,350
Central Tablelands South	18,892	25.8	488,270
Total	**42,077**		**1,265,620**

Details of the population estimates and commercial takes of eastern grey kangaroos in all zones are given in Table 47 and Figure 5. Eastern grey kangaroo population estimates and quotas for the Central Tablelands zone are shown in Tables 43 and 44.

Determination of quotas

Commercial quotas

Population dynamics of red and grey kangaroos and wallaroos and the male bias of the commercial take have seen conservative quotas set and support viable kangaroo populations for conservation. More than 30 years of available data indicate kangaroo populations harvested at these rates continue to fluctuate primarily in response to seasonal conditions (Lunney *et al* 2018).

The quota is based on harvesting a proportion of the estimated population, and changes in populations are reflected in the quotas. Annual commercial quotas are set at a proportion of the estimated kangaroo populations. For red kangaroos, quotas are generally set at 17% of the estimated population and for eastern grey kangaroos, western grey kangaroos and wallaroos 15% of the estimated population. 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.

Low kangaroo populations are further protected by the incorporation of harvest thresholds in the plan. The above percentages are reduced, or the harvest suspended (zero quotas) if the population of a species falls below the relevant thresholds in that zone. Thresholds are set based on standard deviations relative to the long-term average population (*c.f.* Appendix B – Table 52).

Using a standardised measurement rather than estimated population size figures allows spatio-temporal variation between species and climatic zones to be considered when setting quota. Red kangaroo populations in the Far West, for example, change more rapidly and deviate more from the average than do eastern grey kangaroo populations in the Northern Tablelands. This variation is reflected in the standard deviation, and in the population change allowable before harvest reductions or suspensions are implemented.

Special quotas

A special quota for 2021 has been calculated in accordance with the provisions of the plan and will potentially be available to minimise the number of kangaroos culled 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 commercial quota; its sole purpose is to provide for commercial utilisation of kangaroos that would be culled 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 2020 survey).

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 harvested under special quota provisions in any commercial harvest zone is 5% of the population estimate for the species in the zone. Across the combined commercial zones, the special quota used must not exceed 1.5% of the population estimate for each 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 New South Wales and occurs even where commercial harvesting is available. Changes to non-commercial licence conditions were implemented in 2018 in response to the drought to maintain animal welfare standards and ecologically sustainable kangaroo populations.

The changes included:

- introducing ecologically sustainable limits on the number of kangaroos that may be culled, based on property size
- processing licence applications over the phone for previous and current licence holders
- increasing limits on shooters to operate under each licence
- reduced red tape on provision of shooter details to the National Parks and Wildlife Service (NPWS)
- and removal of the use of carcass tags (drop tags) and the 'shoot and let lie' licence condition to reduce biosecurity risks by allowing landholders and shooters to use carcasses for non-commercial purposes.

Trends in populations and quotas

Populations

In May 2018, just before the aerial surveys being conducted across the Western Plains, New South Wales was experiencing widespread agronomic drought conditions. As of 31 May 2018, 99% of the State was covered by one of the three drought categories, with 39% of the state in drought watch, 44% in drought onset and 16% in drought (DPI 2018). Drought declarations had not been lifted by the 2020 aerial surveys.

These conditions are likely to have caused decreased population size of eastern grey, western grey and red kangaroos across the Western Plains. For both eastern grey and western grey kangaroos, there is a 42.5% and 28.6% decline in the population estimate respectively and a decline of 17.4% in the red kangaroo population estimate.

Red kangaroo

The 2020 red kangaroo population estimate and trends in abundance since 1997 are shown in Table 8.

Table 8 Population estimates and trends in abundance for red kangaroo, 1997–2020

Year	Population estimate (millions)	Density (km–2)	Trends in abundance (% change from previous year)
2020	2.92	5.27	-17.4
2019	3.54	6.4	20.8
2018	2.93	5.16	-42.9
2017	5.13	9.76	-19.4
2016	6.36	12.64	8.1
2015	5.89	10.89	-8.3
2014	6.42	11.62	43.4
2013	4.50	8.47	8.0
2012	4.15	8.01	4.0
2011	3.97	7.39	32.0
2010	3.01	5.73	23.0
2009	2.46	4.58	-14.0
2008	2.87	5.26	14.0
2007	2.52	4.44	16.0
2006	2.18	4.05	-3.0
2005	2.24	4.32	-11.0
2004	2.51	4.66	12.0
2003	2.24	4.22	-53.0
2002	4.80	9.35	–6.0

Year	Population estimate (millions)	Density (km–2)	Trends in abundance (% change from previous year)
2001	5.12	9.74	*17.0
2000	4.39	8.49	-7.0
1999	4.71	8.82	-19.0
1998	5.81	11.36	10.0
1997	5.29	10.01	40.0

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. No shading for 2016 indicates new survey method MRDS.
* Invalid comparison due to a change in correction factors and survey strip width.

Refer to Figure 1 for trends in red kangaroo abundance on the Western Plains since 1984.

Eastern grey kangaroo

The 2020 grey kangaroo (eastern and western) estimate for the area surveyed by fixed-wing aircraft (Western Plains) is 3.12 million (density 5.62 greys.km^{-2}). The relative proportions of eastern and western grey kangaroos in the area surveyed were re-analysed in 2000. Application of these proportions to the 2020 survey gives an eastern grey kangaroo population estimate for Western Plains of 2.49 million (density 4.49 eastern greys.km^{-2}).

The 2020 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, 1997–2020

Year	Population estimate (millions)	Density (km^{-2})	Trend in abundance (% change from previous year)
2020	2.49	4.49	-36.5
2019	3.92	7.06	22.1
2018	3.21	5.78	9.3
2017	2.94	5.06	-38.0
2016	4.74	8.75	-0.5
2015	4.76	8.84	-13.2
2014	5.50	10.36	-13.0
2013	6.31	11.74	65.0
2012	3.83	7.36	28.0
2011	3.00	5.64	20.0
2010	2.50	4.70	38.0
2009	1.81	3.49	-16.0
2008	2.15	3.97	0.0
2007	2.15	3.99	0.0
2006	2.14	3.92	7.0

Year	Population estimate (millions)	Density (km^{-2})	Trend in abundance (% change from previous year)
2005	2.00	3.65	-25.0
2004	2.66	5.03	-31.0
2003	3.83	7.42	-51.0
2002	7.80	15.07	24.0
2001	6.29	12.48	*22.0
2000	5.17	9.86	6.0
1999	4.87	9.43	-6.0
1998	5.19	9.91	17.0
1997	4.43	8.53	12.0

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. No shading for 2016 indicates new survey method MRDS.
* Invalid comparison due to a change in correction factors and survey strip width.
Refer to Figure A2 for trends in grey kangaroo abundance on the Western Plains since 1984.

The Northern Tablelands management zones were surveyed in September 2019. The 2019 eastern grey kangaroo population estimate and trends in abundance on the Northern Tablelands since 2001 are shown in Table 10.

The Northern Tablelands region will be surveyed again in 2022.

Table 10 Population estimates and trends in abundance for eastern grey kangaroo in the Northern Tablelands zones, 2001–19

Zone	Armidale			Glen Innes			Upper Hunter			Total Population
	Population Estimate	Density	Trend	Population Estimate	Density	Trend	Population Estimate	Density	Trend	
2019	421,900	28.1	-7.2	545,200	31.6	0.3	166,500	20.9	-35.9	1,133,600
2016	420,800	28	60	587,400	34.1	57	259,600	32.5	105	1,267,800
2013	263,300	16.6	27	374,300	20.3	39	126,800	9.05	-24	764,400
2010	206,780	13.1	46	269,500	12.9	14	167,500	11.5	82	643,780
2007	141,610	8.7	-12	236,600	11.3	58	92,016	6.3	36	470,226
2004	161,726	10.2	4	149,621	8.1	-35	67,499	4.8	-28	378,846
2001	173,109	10.6	N/A	221,975	10.6	N/A	95,273	6.5	N/A	490,357

Tables 36, 38 and 40 show population estimates and quotas for eastern grey kangaroos in the Northern Tablelands management zones from 1993 to 2019.

Table 11 Population estimates and trends in abundance for eastern grey kangaroo in South East NSW, 2003–18

Year	Population estimate	Density (km^{-2})	Trend in abundance (% change from previous survey)
2018*	1,721,400	41.9	34
2015	1,284,300	33.4	49.5
2012	858,900	22.4	31.0
2009*	655,900	17.1	0.0
2006	415,271	14.07	42.0
2003	292,455	11.95	0.0

* The 2009 population estimate is for a larger area than in the previous two surveys, as it includes part of Riverina Local Land Services (LLS). It is therefore inappropriate to consider the difference between the 2006 and 2009 surveys as a trend.

* The 2018 population estimate is for a larger area than in the previous two surveys, as it includes the additional Bombala survey area. It is therefore inappropriate to consider the difference between the 2015 and 2018 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. The next survey was conducted in September 2011 and then 2014, 2017 and in 2020, providing some trend information (Table 12). 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 kangaroos on the Central Tablelands North and South, 2008–2020

Zone	Population estimate (millions)		Density (km^{-2})		Trend in abundance (% change from previous survey)		Total population
	CT North	CT South	CT North	CT South	CT North	CT South	
2020	**777,350**	**488,270**	**33.5**	**25.8**	**-55.0**	**-47.7**	**1,265,620**
2017	1,728,200	933,900	74.5	49.4	44.8	15	**2,662,100**
2014	1,193,600	811,800	47.1	35.9	94.9	133.4	**2,005,400**
2011	612,590	347,830	20.9	15.1	41.5	-35.1	**960,420**
2008	433,030	535,600	14.7	23.2	0	0	**968,630**

CT, Central Tablelands

Western grey kangaroo

As previously stated, the relative proportions of eastern and western grey kangaroos in the area surveyed were examined in 2000. Application of these proportions to the 2020 survey gives a western grey kangaroo population estimate for the Western Plains of 0.63 million (average density 1.13 western greys.km^{-2}).

The 2020 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, 1997–2020

Year	Population estimate (millions)	Density (km^{-2})	Trend in abundance (% change from previous year)
2020	**0.63**	**1.13**	**-29**
2019	0.88	1.50	5.7
2018	0.84	1.52	-8.7
2017	0.92	1.68	-42.5
2016	1.59	3.18	7.2
2015	1.49	3.02	-2.6
2014	1.53	3.16	-17.5
2013	1.82	3.83	116.0
2012	0.86	1.83	73.0
2011	0.50	1.02	-25.0
2010	0.66	1.39	-8.0
2009	0.72	1.49	-27.0
2008	0.99	2.07	36.0
2007	0.73	1.55	11.0
2006	0.65	1.35	9.0
2005	0.60	1.31	-33.0
2004	0.89	1.89	-29.0
2003	1.27	2.72	-47.0
2002	2.39	5.02	18.0
2001	2.03	4.53	*13.0
2000	1.79	3.86	-14.0
1999	2.09	4.50	11.0
1998	1.88	3.97	-11.0
1997	2.11	4.33	22.0

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. No shading for 2016 indicates new survey method MRDS.

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

Wallaroo

The trends in abundance for the Northern Tablelands management zones since 2001 are shown in Table 14. This area was last surveyed in 2019.

Tables 37, 39 and 41 show population estimates and quotas from 1993 to 2019.

Table 14 Population estimates and trends in abundance for wallaroo on the Northern Tablelands, 2001–19.

Zone	Armidale			Glen Innes			Upper Hunter			Total Population
	Population Estimate	Density	Trend	Population Estimate	Density	Trend	Population Estimate	Density	Trend	
2019	117,290	7.2	-12.7	134,865	6.5	32.8	44,400	3.0	-67.3	**296,555**
2016	134,310	8.2	198	101,565	4.9	258.8	135,790	9.2	395.9	**371,665**
2013	45,140	2.8	9.0	28,305	1.5	-12	27,380	1.9	83	**100,825**
2010	41,255	2.5	9.0.	32,190	1.5	-46	14,985	1.0	-81.3	**88,430**
2007	37,859	2.3	-58	59,570	2.8	5.1	80,105	5.5	29.9	**177,534**
2004	89,787	5.7	158	56,657	3.1	-56	61,660	4.4	7	**208,104**
2001	34,744	2.1	N/A	128,323	6.1	N/A	57,762	4.0	N/A	**220,829**

*Densities are based on the total zone areas as follows: Armidale – 16,326 km^2; Glen Innes – 20,920 km^2; and Upper Hunter – 14,697 km^2

Quotas

Quotas have been set at the same percentages of population estimates for several years. These proportions are specified in the plan. Based on the population dynamics of the species and the selectivity of kangaroo harvesters for male kangaroos, these quotas are considered conservative with low impact on kangaroo populations.

The plan includes low population thresholds used to determine if the commercial quota is to be reduced or suspended, depending on the magnitude of the decline relative to historical fluctuations. The thresholds are based on standard deviations, which are standardised measures that indicate how much a population varies from its average over time.

To set 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%. Quotas on populations that are two or more standard deviations below their averages are suspended.

Red kangaroo

The quota for 2021 of 474,852 represents 16.2% of the population estimated by aerial survey. The quota for Tibooburra and Bourke are reduced to 10% population estimate.

Eastern grey kangaroo

The quota for 2021 of 370,568 for the Western Plains represents 14.9% of the population estimated by aerial survey. Tibooburra has no assigned quota for 2021 and Bourke and Cobar both have reduced quotas set at 10% of the population estimate.

The quota for 2020 of 170,040 for the Northern Tablelands region represents 15% of the estimated population of 1,133,600 derived from aerial surveys in 2019.

The South East NSW quota is 258,210 which represents 15% of the population estimate of 1,721,400 derived from aerial surveys in 2018.

The quotas for Central Tablelands North and Central Tablelands South are 116,603 and 73,241 respectively, which represent 15% of the population estimates derived from aerial surveys in 2020.

The combined 2020 eastern grey quota is 988,660.

Western grey kangaroo

The quota for 2021 of 90,765 represents 14.5% of the total surveyed western grey population. There is no quota assigned for Tibooburra zone due to a low population estimate. Both Cobar and Bourke have been assigned reduced quota of 10% population estimate.

Wallaroo

In 2004, the quotas for wallaroos in the Northern Tablelands were changed from 5% to 15% of the population estimate because of the more rigorous scientific basis to survey and estimation methods. For the 2021 quota, this value will remain at 15% for the Armidale, Glen Innes and Upper Hunter zones, in accordance with the plan.

The 2021 quota is 44,484 for the Northern Tablelands.

New commercial harvest zones

No new zones have been added to the 2021 harvest area, two existing zones were recently expanded and changed.

In 2020, the Griffith commercial harvest zone (Zone 11 and 12) was expanded to include the non-commercial zone surrounding Wagga Wagga. As this created an extra-large Griffith Zone, Griffith was been split into Griffith North (Zone 17) and Griffith South (Zone 18) zones to manage quota and tag allocations. The expanded area was incorporated into the aerial survey in 2019 to establish population estimates, thresholds and to allocate quota. This is an addition of 24,480km^2 for commercial harvesting, supported by the NSW Government Drought Relief Package announced in 2018.

The South East Tablelands zone (Zone 16) was expanded in January 2019. The addition of the Bombala Area included an approximate 2720 km^2 available for commercial harvesting.

Increasing the area for commercial harvesting by licensed, professional, qualified commercial kangaroo harvesters is expected to reduce reliance by landholders on non-commercial damage mitigation licences. The total area added to the commercial harvest zones is 27,200km^2.

Proposed changes to quotas

For 2021, the Department does not propose to set quotas that are higher than those specified in the plan.

In accordance with the provisions of the plan, as shown in Table 15 below the Department has:

- reduced the harvest quota for eastern and western grey kangaroos in Cobar zone
- reduced the harvest quota for eastern and western grey kangaroos in the Bourke zone
- reduced the quota for red kangaroos in the Tibooburra zone

- suspended the harvest quota for eastern and western grey kangaroos in the Tibooburra zone.

Table 15 Zones with suspended or reduced quotas in 2021.

Zone	Species	Status
Cobar – Zone 06	Eastern grey	Reduced (10% quota)
	Western grey	Reduced (10% quota)
	Red kangaroo	Open
Bourke – Zone 07	Eastern grey	Reduced (10% quota)
	Western grey	Reduced (10% quota)
	Red kangaroo	Reduced (10% quota)
Tibooburra – Zone 01	Red kangaroo	Reduced (10% quota)
	Eastern grey	Closed
	Western grey	Closed
Griffith South – Zone 18	Red kangaroo	Open
	Eastern grey	Open
	Western grey	Open

[§]This table does not include all zones with quotas set as per summary table. It shows only zones with suspended or reduced quotas, or zones which have reopened from last year.

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Appendix A. Tables and Figures

Notes to the tables that follow:

- Dark shading indicates the use of 100 metre correction factors from September 2003; light shading indicates 200 metre correction factors for surveys of the Western Plains zones using fixed-wing aircraft, as described in the section on ‘Survey methods and population estimates’.
- From 2017 the rows will be clear (no shading) indicating MRDS method of surveying and only for the Western Plains.
- Note that a new survey and analysis method (MRDS) is used from 2016. Within each zone, variation between population size estimates in 2015 and 2016 are due to a combination of the new method, climatic conditions and movement of kangaroo between zones.
- ‘% Population’ refers to the commercial harvest 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.
- Management zones that are surveyed by helicopter are surveyed on a three-yearly cycle. Population estimates remain the same for the intervening period. Correctional factors do not apply to helicopter surveys.

Kangaroo management zone no. 1: Tibooburra

Table 16 Red kangaroo temporal variation - Tibooburra

Average density (kangaroos/km^2)		16.08	Standard deviation		7.75
Area in km^2		54,849			
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	17.1	51.0	105,591	17.0
2013	903,279	17.1	-3.7	159,399	17.0
2014	1,256,418	22.9	39.1	153,557	17.0
2015	1,061,784	19.4	-15.5	213,591	17.0
2016	1,567,598	30.2	47.6	180,503	17.0
2017	1,135,531	20.6	-27.6	266,492	17.0
2018	344,619	6.3	-69.7	193,040	17.0
2019	79,346	1.4	-77.0	0	0.0
2020	200,465	3.7	153	0	0.0
2021				**20,046**	**10.0**

Table 17 Grey kangaroo temporal variation - Tibooburra

Average density (kangaroos/km^2)		2.49	Standard deviation		1.67
Area in km^2		54,849			
Year	Population	Density	% Change	Quota	% Population
1990	83,400	1.5	48.7	7,400	13.2
1991	55,500	1.0	-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	3.0	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	5.0	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	1.0	-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	1.4	44.3	7,153	14.0
2013	163,392	3.0	121.2	11,082	15.0
2014	44,669	0.8	-72.7	24,509	15.0
2015	234,927	4.3	426.0	4,467	10.0
2016	451,594	6.8	92.2	35,239	15.0
2017	176,058	3.2	-61.0	67,739	15.0
2018	184,002	3.3	4.5	26,409	15.0
2019	48,502	0.9	-73.6	27,600	3.7
2020	6,859	0.1	-86	6,782	14.0
2021				**0.00**	**0.00**

Kangaroo management zone no. 2: Broken Hill

Table 18 Red kangaroo temporal variation – Broken Hill

Average density (kangaroos/km^2)		13.08	Standard deviation		4.27
Area in km^2		91,044			
Year	Population	Density	% Change	Quota	% Population
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	15.0	-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	8.0	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	2,192,347	24.1	79.8	207,307	17.0
2015	2,168,733	23.9	-1.1	372,699	17.0
2016	1,206,597	13.6	-44.4	368,685	17.0
2017	823,210	9.0	-31.8	205,121	17.0
2018	1,133,523	12.4	37.7	139,946	17.0
2019	1,124,115	12.3	-0.8	192,699	17.0
2020	1,197,474	13.2	7	191,100	17.0
2021				**203,571**	**17.0**

Table 19 Grey kangaroo temporal variation – Broken Hill

Average density (kangaroos/km²)		5.71	Standard deviation		3.04
Area in km²		91,044			
Year	Population	Density	% Change	Quota	% Population
1990	465,100	5.1	87.7	37,100	15.0
1991	449,700	5.0	-3.3	81,600	17.5
1992	457,500	5.0	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	8.0	13.2	71,650	11.1
2001	723,937	8.0	-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	444,547	4.9	-24.2	87,980	15.0
2015	564,083	6.2	26.9	66,682	15.0`
2016	672,187	7.4	19.2	84,612	15.0
2017	438,131	4.8	-34.8	100,828	15.0
2018	395,360	4.3	-9.8	65,720	15.0
2019	326,644	3.6	-17.4	59,304	15.0
2020	281,410	3.1	-14.0	48,977	15.0
2021				**42,212**	**15.0**

Kangaroo management zone no. 4: Lower Darling

Table 20 Red kangaroo temporal variation – Lower Darling

Average density (kangaroos/km^2)		6.0	Standard deviation		2.64
Area in km^2		56,599			
Year	Population	Density	% Change	Quota	% Population
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	2.0	-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	289,106	5.1	-31.7	71,998	17.0
2015	387,272	6.9	34.0	49,148	17.0
2016	619,113	11.0	59.9	65,836	17.0
2017	289,385	5.1	-53.3	105,249	17.0
2018	307,619	5.4	6.3	49,195	17.0
2019	691,119	12.2	124.7	52,295	17.0
2020	583,802	10.3	-16	117,490	17.0
2021				**99,246**	**17.0**

Table 21 Grey kangaroo temporal variation – Lower Darling

Average density (kangaroos/km²)		8.11	Standard deviation		4.28
Area in km²		56,599			
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	11.0	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	6.0	-34.4	78,300	15.3
2004	306,466	5.4	-8.9	50,458	15.0
2005	110,876	2.0	-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	3.8	-41.3	55,083	15.0
2010	231,585	4.1	7.5	32,313	15.0
2011	98,973	1.8	-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	397,584	7.0	-18.3	73,029	15.0
2015	360,959	6.4	-9.2	59,638	15.0
2016	566,970	10.7	57.1	54,144	15.0
2017	212,474	3.7	-62.5	85,046	15.0
2018	281,035	5.0	32.3	31,871	15.0
2019	378,718	6.7	34.8	42,155	15.0
2020	314,639	5.6	-17.0	56,808	15.0
2021				**47,196**	**15.0**

Kangaroo management zone no. 6: Cobar

Table 22 Red kangaroo temporal variation – Cobar

Average density (kangaroos/km^2)		4.67	Standard deviation		2.24
Area in km^2		40,419			
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	5.0	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	3.0	-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	298,459	7.4	54.1	32,935	17.0
2015	357,287	8.9	19.7	50,738	17.0
2016	437,129	10.8	22.3	60,739	17.0
2017	229,495	5.7	-47.5	74,312	17.0
2018	44,733	1.1	-80.5	39,014	17.0
2019	36,058	0.9	-19.4	0	0
2020	102,480	2.5	184.0	0	0
2021				**17,422**	**17.0**

Table 23 Grey kangaroo temporal variation – Cobar

Average density (kangaroos/km²)		11.42	Standard deviation		6.86
Area in km²		40,419			
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	546,338	13.5	-17.3	99,089	15.0
2015	492,207	12.2	–9.9	81,951	15.0
2016	405,079	10.0	-17.7	73,831	15.0
2017	184,069	4.5	-54.6	60,762	15.0
2018	81,391	2.0	-55.8	22,239	12.1
2019	7,317	0.2	-91.0	0	0.0
2020	44,208	1.1	504	0	0
2021				**4,421**	**10.0**

Kangaroo management zone no. 7: Bourke

Table 24 Red kangaroo temporal variation – Bourke

Average density (kangaroos/km^2)		5.97	Standard deviation		3.16
Area in km^2		55,019			
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	8.0	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	4.0	8.2	34,640	17.0
2006	258,668	4.7	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	7.8	-3.6	75,638	17.0
2013	460,225	8.4	7.3	72,930	17.0
2014	439,559	7.1	-4.5	78,238	17.0
2015	504,671	9.2	14.8	74,725	17.0
2016	730,140	13.3	44.7	85,794	17.0
2017	461,968	8.4	-36.7	124,124	17.0
2018	244,687	4.5	-47.0	78,535	17.0
2019	497,085	9.0	103.2	41,597	17.0
2020	117,975	2.1	-76.0	84,504	17.0
2021				**11,797**	**10.0**

Table 25 Grey kangaroo temporal variation – Bourke

Average density (kangaroos/km^2)		8.62	Standard deviation		6.02
Area in km^2		55,019			
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	8.0	-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	2.0	-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	8.1	249.1	12,802	10.0
2013	541,622	9.9	21.2	67,036	15.0
2014	471,812	8.6	-12.9	81,243	15.0
2015	474,326	8.6	0.5	70,772	15.0
2016	473,265	18.6	-0.2	71,149	15.0
2017	221,401	4.0	-53.2	70,990	15.0
2018	183,950	3.3	-16.9	33,210	15.0
2019	51,734	0.9	-71.9	27,592	15.0
2020	41,501	0.8	-20.0	0	0
2021				**4,150**	**10.0**

Kangaroo management zone no. 8: Narrabri

Table 26 Red kangaroo temporal variation – Narrabri

Average density (kangaroos/km^2)		5.76	Standard deviation		3.72
Area in km^2		65,755			
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	7.0	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	3.0	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	5.6	-30.0	90,162	17.0
2013	369,861	5.6	-0.4	63,114	17.0
2014	406,847	6.2	10.0	62,876	17.0
2015	315,429	4.8	-22.5	69,164	17.0
2016	780,834	11.9	147.5	53,623	17.0
2017	785,211	11.9	0.6	132,742	17.0
2018	353,348	5.4	-55.0	133,486	17.0
2019	346,451	5.3	-2.0	60,069	17.0
2020	190,458	2.9	-45.0	58,897	17.0
2021				**32,380**	**17.0**

Table 27 Grey kangaroo temporal variation – Narrabri

Average density (kangaroos/km²)		14.58	Standard deviation		7.13
Area in km²		65,755			
Year	Population	Density	% Change	Quota	% Population
1990	1,005,900	15.3	24.5	142,700	17.7
1991	987,000	15.0	-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	1,321,410	20.1	–29.5	280,485	15.0
2015	813,425	12.4	-38.4	197,692	15.0
2016	1,434,755	21.8	76.4	121,072	15.0
2017	445,768	6.8	-68.9	215,213	15.0
2018	728,648	11.1	63.5	66,378	14.9
2019	765,632	11.5	5.1	108,413	14.9
2020	745,775	11.3	-3.0	114,009	14.9
2021				**110,748**	**14.9**

Kangaroo management zone no. 10: Coonabarabran

Table 28 Red kangaroo temporal variation – Coonabarabran

Average density (kangaroos/km^2)		4.83	Standard deviation		2.34
Area in km^2		61,711			
Year	Population	Density	% Change	Quota	% Population
1990	186,000	3.0	-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	6.1	4.7	60,734	17.0
2014	590,194	9.6	57.8	63,567	17.0
2015	505,429	8.2	-14.4	100,333	17.0
2016	421,498	6.8	-16.6	85,923	17.0
2017	588,404	9.5	39.6	71,655	17.0
2018	218,312	3.5	-62.9	100,029	17.0
2019	500,137	8.1	129.1	37,113	17.0
2020	152,052	2.5	-70.0	85,023	17.0
2021				**25,849**	**17.0**

Table 29 Grey kangaroo temporal variation – Coonabarabran

Average density (kangaroos/km^2)		22.48	Standard deviation		10.19
Area in km^2		61,711			
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	2,417,012	39.2	16.7	310,667	15.0
2015	1,836,656	29.8	-24.0	362,552	15.0
2016	1,089,374	17.7	-40.7	275,498	15.0
2017	915,211	14.8	-16.0	163,406	15.0
2018	1,274,243	20.7	39.2	133,875	14.6
2019	1,536,291	24.9	20.6	191,136	15.0
2020	891,090	14.4	-42	230,444	15.0
2021				**133,663**	**15.0**

Kangaroo management zone no. 11: Griffith*

Table 30 Red kangaroo temporal variation – Griffith*

Average density (kangaroos/km^2)		4.18	Standard deviation		1.82
Area in km^2		98,171			
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	5.0	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	4.0	-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	3.0	-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	950,341	9.7	77.1	91,219	17.0
2015	589,282	6.0	-38.0	161,558	17.0
2016	601,325	6.1	2.0	100,178	17.0
2017	819,450	7.8	36.3	102,225	17.0
2018	284,853	2.7	-65.2	139,307	17.0

*Zone expanded prior to 2019 and population now estimated for Zone 17 and Zone 18. See Tables 32, 33 and tables 34 and 35.

Table 31 Grey kangaroo temporal variation – Griffith

Average density (kangaroos/km^2)		10.07	Standard deviation		3.68
Area in km^2		98,171			
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	18.3	154.2	105,058	15.0
2014	1,376,362	14.0	-22.7	267,040	15.0
2015	1,476,232	15.0	7.3	206,454	15.0
2016	1,241,399	12.6	-15.9	221,435	15.0
2017	1,262,635	12.0	1.7	186,210	15.0
2018	919,282	8.7	-27.2	189,395	15.0

*Zone expanded prior to 2019 and population now estimated for Zone 17 and Zone 18. See Tables 32, 33 and tables 34 and 35.

Kangaroo management zone no. 17: Griffith North

Table 32 Red kangaroo temporal variation – Griffith North

Average density (kangaroos/km^2)		2.16	Standard deviation		0.34
Area in km^2		65,758			
Year	Population	Density	% Change	Quota	% Population
2019	159,645	2.4	0.0	0	0
2020	126,160	1.9	-21.0	27,123	17.0
2021				21,447	17.0

Table 33 Grey kangaroo temporal variation – Griffith North

Average density (kangaroos/km^2)		11.05	Standard deviation		6.58
Area in km^2		65,758			
Year	Population	Density	% Change	Quota	% Population
2019	1,029,202	15.7	0.0	0	0
2020	421,161	6.4	-59.0	154,380	15.0
2021				63,174	15.0

Kangaroo management zone no. 18: Griffith South

Table 34 Red kangaroo temporal variation – Griffith South

Average density (kangaroos/km^2)		2.83	Standard deviation		1.59
Area in km^2		64,126			
Year	Population	Density	% Change	Quota	% Population
2019	106,788	1.7	0.0	0	0
2020	253,492	4.0	137.0	0	0
2021				43,094	17.0

Table 35 Grey kangaroo temporal variation – Griffith South

Average density (kangaroos/km^2)		8.05	Standard deviation		3.18
Area in km^2		64,126			
Year	Population	Density	% Change	Quota	% Population
2019	660,066	10.3	0.0	0	0
2020	371,796	5.8	-44	99,000	15.0
2021				55,769	15.0

Kangaroo management zone no. 9: Armidale

Table 36 Eastern grey kangaroo temporal variation – Armidale

Average density (kangaroos/km^2)		14.7	Standard deviation		6.63
Area in km^2		16,326			
Year	Population	Density	% Change	Quota	% Population
1993	234,655	14.4	5.0	46,931	21.0
1994	199,474	12.2	-15	46,931	20.0
1995	207,462	12.7	4.0	43,882	22.0
1996	161,821	9.9	-22.0	45,640	22.0
1997	182,857	11.2	13.0	32,364	20.0
1998	198,765	12.2	9.0	31,085	17.0
1999	196,777	12.0	-1.0	33,790	17.0
2000	206,600	12.7	5.0	33,450	17.0
2001	173,109	10.6	-16.0	35,100	17.0
2002	173,109	10.6	0.0	25,966	15.0
2003	180,456	11	4.0	25,966	15.0
2004	161,726	10.2	-10.0	27,068	15.0
2005	161,726	10.2	0.0	24,259	15.0
2006	161,726	10.2	0.0	24,259	15.0
2007	141,610	8.7	-12.0	24,259	15.0
2008	141,610	8.7	0.0	21,242	15.0
2009	141,610	8.7	0.0	21,242	15.0
2010	199,200	12.2	41.0	21,242	15.0
2011	206,780	13.1	4.0	29,880	15.0
2012	206,780	13.1	0.0	31,017	15.0
2013	263,300	16.1	27.0	31,017	15.0
2014	263,300	16.1	0.0	39,495	15.0
2015	263,300	16.1	0.0	39,495	15.0
2016	420,800	28.0	60.0	39,495	15.0
2017	420,800	28.0	60.0	63,120	15.0
2018	420,800	28.0	60.0	63,120	15.0
2019	421,900	28.1	0.0	63,120	15.0
2020	421,900	28.1	0.0	63,285	15.0
2021				**63,285**	**15.0**

Table 37 Common wallaroo temporal variation – Armidale

Average density (kangaroos/km^2)		4.94	Standard deviation		2.15
Area in km^2		16,326			
Year	Population	Density	% Change	Quota	% Population
1993	127,680	7.8	0.0	6,160	4.8
1994	121,296	7.4	-5.0	6,432	5.0
1995	126,148	7.7	4.0	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	9.0	5,559	5.0
1999	119,651	7.3	-1.0	6,043	5.0
2000	125,600	7.7	5.0	5,975	5.0
2001	125,600	7.7	0.0	6,250	5.0
2002	125,600	7.7	0.0	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	0.0	13,468	15.0
2006	89,787	5.7	0.0	13,468	15.0
2007	37,859	2.3	-58	13,468	15.0
2008	37,859	2.3	0.0	5,679	15.0
2009	37,859	2.3	0.0	5,679	15.0
2010	41,255	2.5	9.0	5,679	15.0
2011	41,255	2.5	0.0	6,188	15.0
2012	41,255	2.5	0.0	6,188	15.0
2013	45,140	2.8	9.0	6,188	15.0
2014	45,140	2.8	0.0	6,771	15.0
2015	45,140	2.8	0.0	6,771	15.0
2016^	134,310	8.2	197.5	6,771	15.0
2017^	134,310	8.2	0.0	20,147	15.0
2018^	134,310	8.2	0.0	20,147	15.0
2019*	117,290	7.2	-12.7	20,147	15.0
2020*	117,290	7.2	0.0	17,594**	15.0
2021				**17,594**	**15.0**

*In the 2020 quota report this population estimate was published as 63,400. This was an uncorrected population estimate and should be 117,290.
^In the 2017-2019 quota report this population estimate was published as 72,600. This was an uncorrected population estimate and should be 134,310.
**This quota was managed as 9,510, due to the calculation error only being discovered in late 2020.

Kangaroo management zone no. 13: Glen Innes

Table 38 Eastern grey kangaroo temporal variation – Glen Innes

Average density (kangaroos/km^2)		13.33	Standard deviation		7.97
Area in km^2		20,920			
Year	Population	Density	% Change	Quota	% Population
1993	234,655	11.2	5.0	46,931	21.0
1994	199,474	9.5	-15.0	46,931	20.0
1995	207,462	9.9	4.0	43,882	22.0
1996	161,821	7.7	-22.0	45,640	22.0
1997	182,857	8.7	13.0	32,364	20.0
1998	198,765	9.5	9.0	31,085	17.0
1999	196,777	9.4	-1.0	33,790	17.0
2000	206,600	9.9	5.0	33,450	17.0
2001	221,975	10.6	7.0	35,122	17.0
2002	221,975	10.6	0.0	33,296	15.0
2003	229,723	11.0	3.0	33,296	15.0
2004	149,621	8.1	-35.0	34,458	15.0
2005	149,621	8.1	0.0	22,443	15.0
2006	149,621	8.1	0.0	22,443	15.0
2007	236,600	11.3	58.0	22,443	15.0
2008	236,600	11.3	0.0	35,490	15.0
2009	236,600	11.3	0.0	35,490	15.0
2010	269,500	12.9	14.0	35,490	15.0
2011	269,500	12.9	0.0	40,425	15.0
2012	269,500	12.9	0.0	40,425	15.0
2013	374,300	17.9	39.0	40,425	15.0
2014	374,300	17.9	0.0	56,145	15.0
2015	374,300	17.9	0.0	56,145	15.0
2016	587,400	34.0	57.0	56,145	15.0
2017	587,400	34.0	57.0	88,110	15.0
2018	587,400	34.0	57.0	88,110	15.0
2019	545,200	31.6	-7.0	88,110	15.0
2020	545,200	31.6	-7.0	81,780	15.0
2021				**81,780**	**15.0**

Table 39 Common wallaroo temporal variation – Glen Innes

Average density (kangaroos/km^2)		4.79	Standard deviation		2.29
Area in km^2		20,920			
Year	Population	Density	% Change	Quota	% Population
1993	127,680	6.1	0.0	6,160	4.8
1994	121,296	5.8	-5.0	6,432	5.0
1995	126,148	6.0	4.0	6,118	5.0
1996	98,396	4.7	-22.0	6,308	5.0
1997	111,187	5.3	13.0	4,920	5.0
1998	120,860	5.8	9.0	5,559	5.0
1999	119,651	5.7	-1.0	6,043	5.0
2000	125,600	6.0	5.0	5,975	5.0
2001	215,500	10.3	72.0	6,250	5.0
2002	215,500	10.3	0.0	6,250	2.9
2003	128,232	6.1	-40.0	6,250	2.9
2004	56,657	3.1	-56.0	19,235	15.0
2005	56,657	3.1	0.0	8,499	15.0
2006	56,657	3.1	0.0	8,499	15.0
2007^^	59,570	2.8	5.1	8,499	15.0
2008^^	59,570	2.8	0.0	8,936	15.0
2009^^	59,570	2.8	0.0	8,936	15.0
2010	32,190	1.5	0.0	8,936	15.0
2011	32,190	1.5	0.0	4,829	15.0
2012	32,190	1.5	0.0	4,829	15.0
2013	28,305	1.4	-12.0	4,829	15.0
2014	28,305	1.4	0.0	4,246	15.0
2015	28,305	1.4	0.0	4,246	15.0
2016^	101,565	4.9	258.8	4,246	15.0
2017^	101,565	4.9	0.0	15,235	15.0
2018^	101,565	4.9	0.0	15,235	15.0
2019*	134,865	6.4	-32.8	15,235	15.0
2020*	134,865	6.4	0.0	20,230**	15.0
2021				**20,230**	**15.0**

*In the 2020 quota report this population estimate was published as 72,900. This was an uncorrected population estimate and should be 134,865.
^In the 2017-2019 quota report this population estimate was published as 54,900. This was an uncorrected population estimate and should be 101,565.
^^In the 2008-2010 quota report this population estimate was published as 32,184. This was an uncorrected population estimate and should be 59,570.
**This quota was managed as 10,935 due to the calculation error only being discovered in late 2020.

Kangaroo management zone no. 14: Upper Hunter

Table 40 Eastern grey kangaroo temporal variation – Upper Hunter

Average density (kangaroos/km^2)		12.01	Standard deviation		6.77
Area in km^2		14,697			
Year	Population	Density	% Change	Quota	% Population
1993	191,690	13.1	5.0	38,338	21.0
1994	162,952	11.2	-15.0	38,338	20.0
1995	169,476	11.6	4.0	35,848	22.0
1996	132,192	9.1	-22.0	37,283	22.0
1997	149,377	10.2	13.0	26,438	20.0
1998	162,372	11.1	9.0	25,394	17.0
1999	160,748	11.0	-1.0	27,600	17.0
2000	168,750	11.6	5.0	27,350	17.0
2001	95,273	6.5	-44.0	25,313	15.0
2002	95,273	6.5	0.0	14,291	15.0
2003	94,251	6.5	-1.0	14,291	15.0
2004	67,499	4.8	-28.0	14,138	15.0
2005	67,499	4.8	0.0	10,125	15.0
2006	67,499	4.8	0.0	10,125	15.0
2007	92,016	6.3	36.0	10,125	15.0
2008	92,016	6.3	0.0	13,802	15.0
2009	92,016	6.3	0.0	13,802	15.0
2010	167,500	11.5	82.0	13,802	15.0
2011	167,500	11.5	0.0	25,125	15.0
2012	167,500	11.5	0.0	25,125	15.0
2013	126,800	8.7	-24.0	25,125	15.0
2014	126,800	8.7	0.0	19,020	15.0
2015	126,800	8.7	0.0	19,020	15.0
2016	259,600	32.5	105.0	19,020	15.0
2017	259,600	32.5	105.0	38,940	15.0
2018	259,600	32.5	105.0	38,940	15.0
2019	166,500	20.9	-36.0	38,940	15.0
2020	166,500	20.9	-36.0	24,975	15.0
2021				**24,975**	**15.0**

Table 41 Common wallaroo temporal variation – Upper Hunter

Average density (kangaroos/km^2)		5.49	Standard deviation		2.42
Area in km^2		14,697			
Year	Population	Density	% Change	Quota	% Population
1993	109,440	7.5	0.0	5,280	4.8
1994	103,968	7.1	-5.0	5,512	5.0
1995	108,128	7.4	4.0	5,244	5.0
1996	84,340	5.8	-22.0	5,408	5.0
1997	95,304	6.5	13.0	4,217	5.0
1998	103,595	7.1	9.0	4,765	5.0
1999	102,559	7.0	-1.0	5,180	5.0
2000	107,650	7.4	5.0	5,125	5.0
2001	107,650	7.4	0.0	5,350	5.0
2002	107,650	7.4	0.0	5,350	5.0
2003	57,762	4.0	-46.0	5,350	5.0
2004	61,660	4.4	7.0	8,664	15.0
2005	61,660	4.4	0.0	9,249	15.0
2006	61,660	4.4	0.0	9,249	15.0
2007^	80,105	5.5	29.9	9,249	15.0
2008^	80,105	5.5	0.0	12,016	15.0
2009^	80,105	5.5	0.0	12,016	15.0
2010	14,985	1.0	-67.0	5,287	6.6
2011	14,985	1.0	0.0	0	0.0
2012	14,985	1.0	0.0	1,499	10.0
2013	27,380	1.9	83.0	1,499	10.0
2014	27,380	1.9	0.0	4,107	15.0
2015	27,380	1.9	0.0	4,107	15.0
2016^	135,790	9.2	395.9	4,107	15.0
2017^	135,790	9.2	0.0	20,369	15.0
2018^	135,790	9.2	0.0	20,369	15.0
2019*	44,400	3	-39.5	20,369	15.0
2020*	44,400	3	0.0	6,660**	15.0
2021				**6,660**	**15.0**

*In the 2020 quota report this population estimate was published as 24,000. This was an uncorrected population estimate and should be 44,400.
^In the 2017-2019 quota report this population estimate was published as 73,400. This was an uncorrected population estimate and should be 135,790.
^^In the 2008-2010 quota report this population estimate was published as 44,923. This was an uncorrected population estimate and should be 80,105.
**This quota was managed as 3,600 due to the calculation error only being discovered in late 2020.

Kangaroo management zone no. 16: South East NSW

Table 42 Eastern grey kangaroo temporal variation – South East NSW

Average density (kangaroos/km^2)		24.67	Standard deviation		12.71
Area in km^2		58,043			
Year	Population	Density	% Change	Quota	% Population
2003	292,455	11.95	–	–	–
2004	292,455	11.95	0.0	43,868	15.0
2005	292,455	11.95	0.0	43,868	15.0
2006	415,271	14.07	42.0	43,868	15.0
2007	415,271	14.07	42.0	62,291	15.0
2008	415,271	14.07	42.0	62,291	15.0
2009	655,900	17.07	58.0	62,291	15.0
2010	655,900	17.07	58.0	98,385	15.0
2011	655,900	17.07	58.0	98,385	15.0
2012	858,900	22.35	30.9	98,385	15.0
2013	858,900	22.35	30.9	128,835	15.0
2014	858,900	22.35	30.9	128,835	15.0
2015	1,284,300	33.04	49.5	128,835	15.0
2016	1,284,300	33.04	49.5	192,645	15.0
2017	1,284,300	33.04	49.5	192,645	15.0
2018	1,721,400	41.9	34.0	192,645	15.0
2019	1,721,400	41.9	34.0	258,210	15.0
2020	1,721,400	41.9	34.0	258,210	15.0
2021				**258,210**	**15.0**

Kangaroo management zone no. 48: Central Tablelands North

Table 43 Eastern grey kangaroo temporal variation – Central Tablelands North

Average density (kangaroos/km^2)		38.15	Standard deviation		23.8
Area in km^2		30,190			
Year	Population	Density	% Change	Quota	% Population
2008	433,030	14.74	0.0		
2009	433,030	14.74	0.0	64,995	15.0
2010	433,030	14.74	0.0	64,995	15.0
2011	612,590	20.85	41.5	64,955	15.0
2012	612,590	20.85	41.5	91,889	15.0
2013	612,590	20.85	41.5	91,889	15.0
2014	1,193,600	47.13	95.0	91,889	15.0
2015	1,193,600	47.13	95.0	179,040	15.0
2016	1,193,600	47.13	95.0	179,040	15.0
2017	1,728,200	74.54	45.0	179,040	15.0
2018	1,728,200	74.54	45.0	259,230	15.0
2019	1,728,200	74.54	45.0	259,230	15.0
2020	777,350	33.53	-55.0	259,230	15.0
2021				**116,603**	**15.0**

Kangaroo management zone no. 49: Central Tablelands South

Table 44 Eastern grey kangaroo temporal variation – Central Tablelands South

Average density (kangaroos/km^2)		29.86	Standard deviation		13.09
Area in km^2		23,345			
Year	Population	Density	% Change	Quota	% Population
2008	535,600	23.18	0.0		
2009	535,600	23.18	0.0	80,340	15.0
2010	535,600	23.18	0.0	80,340	15.0
2011	347,830	15.05	-35.06	80,340	15.0
2012	347,830	15.05	-35.06	52,175	15.0
2013	347,830	15.05	-35.06	52,175	15.0
2014	811,800	35.87	133.0	52,175	15.0
2015	811,800	35.87	133.0	121,770	15.0
2016	811,800	35.87	133.0	121,770	15.0
2017	933,900	49.40	15.0	121,770	15.0
2018	933,900	49.40	15.0	140,085	15.0
2019	933,900	49.40	15.0	140,085	15.0
2020	488,270	25.85	-48.0	140,085	15.0
2021				**73,241**	**15.0**

Table 45 Red and grey kangaroo annual population estimates: annual quotas, annual take figures and relative percentages

Note	Year	Population	Quota	% population	Take	% of previous year's Population	% quota
1	1975	3,365,300	212,000	N/A	123,000	N/A	58.0
1	1976	no estim.	319,400	9.49	96,000	2.85	30.1
1	1977	4,699,000	321,000	N/A	167,200	N/A	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

Note	Year	Population	Quota	% population	Take	% of previous year's Population	% quota
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
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	344,453	3.0	19.4
5	2014	17,071,705	2,374,048	15.6	355,976	2.3	15.0
5	2015	16,196,802	2,686,988	15.7	357,189	2.1	13.3
5	2016	17,256,357	2,547,318	15.7	352,464	2.2	13.8
5	2017	14,202,962	2,715,912	15.7	453,021	2.6	16.7
5	2018	12,631,495	2,223,779	15.7	467,456	3.3	21.0
5	2019	13,861,850	1,874,076	14.8	547,318	3.9	29.2
5	2020	10,155,971	2,102,131	15.2			
5	2021		1,554,277	15.3			

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 South East NSW
5 Western Plains plus Central and Northern Tablelands and South East NSW

Table 46 Summary statistics of commercial take: red kangaroo

Year	Population estimate	Quota	% of previous year's population	Harvest	% of previous year's population	% of quota
1976	no survey	110,000	5.0			
1977	2,669,000	150,000				
1978	2,069,000	150,000	6.0			
1979	2,355,000	300,000	15.0			
1980	3,377,000	300,000	13.0			
1981	4,626,000	333,000	10.0			
1982	5,700,000	550,000	12.0	398,200	8.6	72.4
1983	3,400,000	550,000	10.0	264,900	4.6	48.2
1984	1,650,000	270,000	8.0	158,000	4.6	58.5
1985	2,363,000	190,000	12.0	213,300	12.9	112.3
1986	2,574,000	313,000	13.0	263,000	11.1	84.0
1987	2,777,000	313,000	12.0	270,500	10.5	86.4
1988	3,440,000	354,000	13.0	218,100	7.9	61.6
1989	4,101,000	487,000	14.0	297,000	8.6	61.0
1990	4,499,000	626,000	15.0	377,200	9.2	60.3
1991	4,755,000	706,000	16.0	496,000	11.0	70.3
1992	3,348,900	956,000	20.0	412,200	8.7	43.1
1993	4,395,426	598,800	18.0	359,820	10.7	60.1
1994	3,960,106	483,850	11.0	397,791	9.1	82.2
1995	4,185,494	483,680	12.0	431,663	10.9	89.2
1996	3,787,113	507,000	12.0	531,370	12.7	104.8
1997	5,285,995	450,780	12.0	415,395	11.0	92.2
1998	5,809,757	648,560	12.0	495,100	9.4	76.3
1999	4,705,664	642,070	11.0	450,020	7.7	70.1
2000	4,391,385	590,450	13.0	389,204	8.3	65.9
2001	5,121,413	558,750	13.0	527,521	12.0	94.4
2002	4,798,558	765,900	15.0	538,856	10.5	70.4
2003	2,235,114	704,350	15.0	274,900	5.7	39.0
2004	2,508,236	379,970	17.0	244,379	10.9	64.3
2005	2,241,497	426,400	17.0	241,503	9.6	56.6
2006	2,182,788	381,054	17.0	338,631	15.1	88.9
2007	2,524,448	371,074	17.0	304,732	14.0	82.1
2008	2,869,709	429,156	17.0	210,654	8.3	49.1
2009	2,456,795	487,850	17.0	182,858	6.4	37.5
2010	3,013,908	417,655	17.0	117,811	4.8	28.2

Year	Population estimate	Quota	% of previous year's population	Harvest	% of previous year's population	% of quota
2011	3,972,522	512,364	17.0	125,843	4.2	24.6
2012	4,148,316	675,329	17.0	134,893	3.4	20.0
2013	4,480,580	705,214	17.0	152,851	3.7	21.7
2014	6,423,271	761,699	17.0	149,789	3.3	19.7
2015	5,889,886	1,091,956	17.0	144,680	2.3	13.2
2016	6,364,234	1,001,281	17.0	151,059	2.6	15.1
2017	5,132,654	1,081,920	17.0	199,059	3.1	18.4
2018	2,931,693	872,551	17.0	177,359	3.5	20.3
2019	3,540,644	432,198	15.0	148,522	5.1	34.4
2020	2,924,368	564,137	16.0			
2021		**474,852**	**16.2**			

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 47 Summary statistics of commercial take: eastern grey kangaroo

Year	Population estimate	Quota	% of population	Take	% of previous year's 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	169,263	2.7	17.9
2014	9,119,616	1,334,443	15.0	178,011	2.0	13.3
2015	8,818,588	1,366,344	15.0	185,517	2.0	13.6
2016	9,298,261	1,322,788	15.0	179,957	2.0	13.6
2017	8,153,725	1,394,739	15.0	225,679	2.4	16.2
2018	8,863,205	1,223,059	15.0	243,689	3.0	19.9
2019	9,437,361	1,324,413	14.9	382,459	4.3	28.9
2020	6,611,322	1,408,964	14.9			
2021		**988,660**	**15.0**			

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 incorporate revised correction factors
Helicopter surveys of the Northern Tablelands were undertaken for the first time in 2001.
South East zone added from 2003, Central Tablelands zones added from 2014.

Table 48 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	22,339	2.6	18.4
2014	1,528,818	277,906	14.9	22,757	1.2	8.2
2015	1,488,329	228,168	14.9	21,017	1.4	9.2
2016	1,595,023	222,307	15.0	21,448	1.4	9.6

Year	Population estimate*	Quota	% of previous year's population	Take	% of previous year's population	% of quota
2017	916,583	239,253	15.0	28,283	1.8	11.8
2018	836,496	128,169	14.0	38,166	4.2	29.8
2019	883,845	117,465	14.0	16,337	2.0	13.9
2020	627,738*	129,030	14.6			
2021		**90,765***	**14.5**			

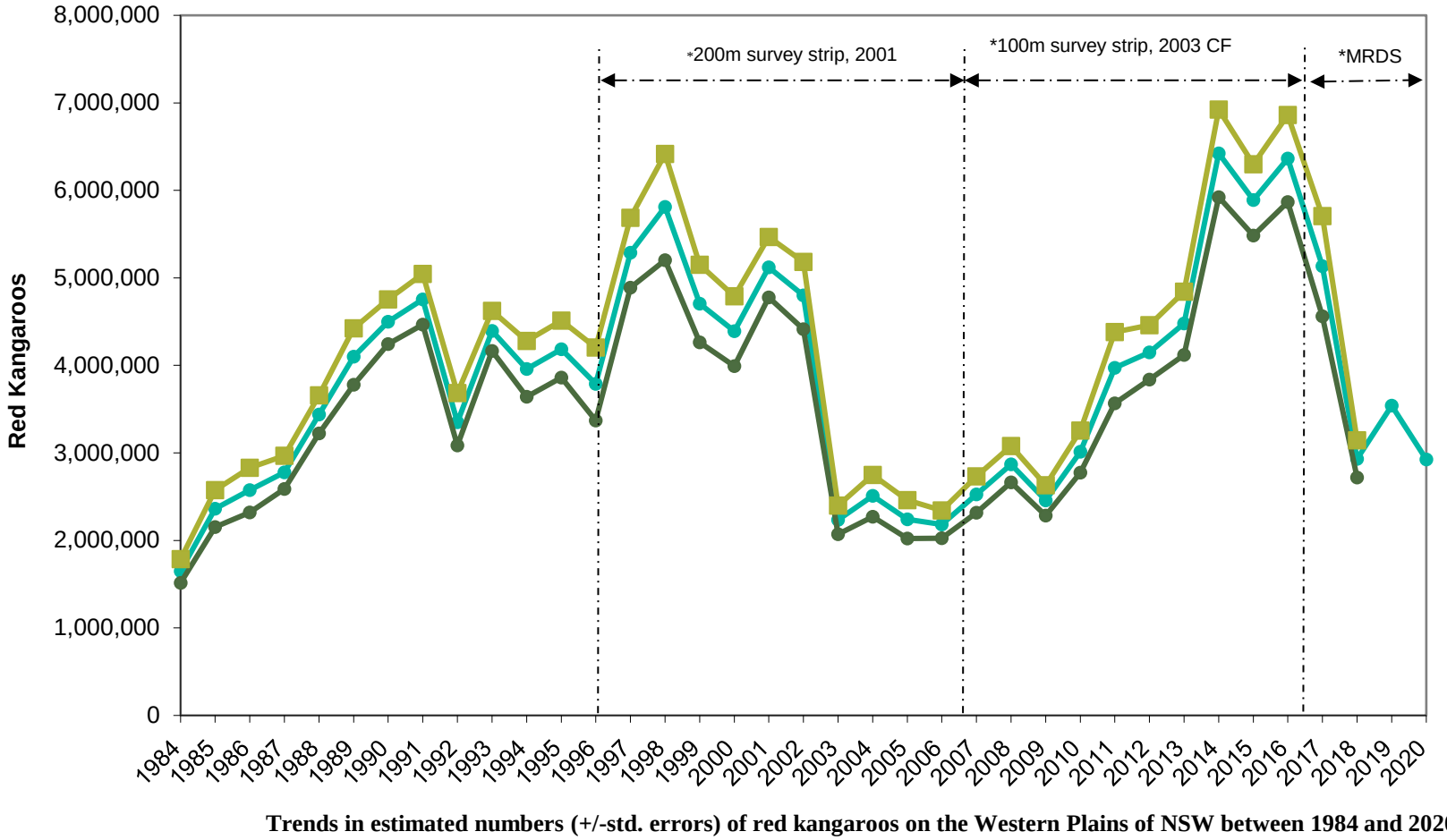
1987–04 populations and quotas based on aerial survey counts of grey kangaroos, applying species proportions determined from ground surveys
1975–1983 population estimates based on survey of seven 1:250 000 monitor blocks
1984–2000 population estimates based on survey of the Western Plains
2001–2009 population estimates based on survey of the Western Plains and incorporates revised correction factors
* There is a small population (7458 in 2020) of western grey kangaroos in the Narrabri management zone. This is included in the population estimate shown, but no quota is set for this species in this zone.

Table 49 Summary commercial take: wallaroos (Northern Tablelands)

Year	Population estimate	Quota	% of previous year's population	Take	% of previous year's population	% of quota
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

Year	Population estimate	Quota	% of previous year's population	Take	% of previous year's population	% of quota
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	177,534	31,216	15.0	22,532	10.8	72.2
2008	177,534	26,630	15.0	12,069	6.8	45.3
2009	177,534	26,630	15.0	10,073	5.7	37.8
2010	88,430	19,901	11.2	9,178	5.2	34.5
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	4,402	5.0	35.2
2014	100,825	15,124	15.0	5,419	5.4	35.8
2015	100,825	15,124	15.0	5,962	5.9	39.4
2016	371,665	15,124	15.0	7,060	7.0	46.7
2017	371,665	55,750	15.0	4,967	1.1	7.7
2018	371,665	55,750	15.0	8,242	2.2	14.8
2019	296,555	55,750	15.0	13,994	3.8	25.1
2020	296,555	44,484	15.0			
2021		**44,484**	**15.0**			

Notes:
1979–85, whole of commercial zone
1989–2000, Tablelands only
2001, helicopter survey of Tablelands
2004, helicopter survey of Tablelands
2004 quota changed from 5% to 15% in line with KMP 2002–2006.
2007, helicopter survey of Tablelands. Survey figures have had 1.85 correction factor retrospectively applied.
2016 survey figures have had 1.85 correction factor retrospectively applied.
2019 survey figures have had 1.85 correction factor retrospectively applied..



Trends in estimated numbers (+/-std. errors) of red kangaroos on the Western Plains of NSW between 1984 and 2020

Figure 1 **Population trends for red kangaroos on the Western Plains of NSW. The dark green and light green lines indicate the standard error for the population estimate.**

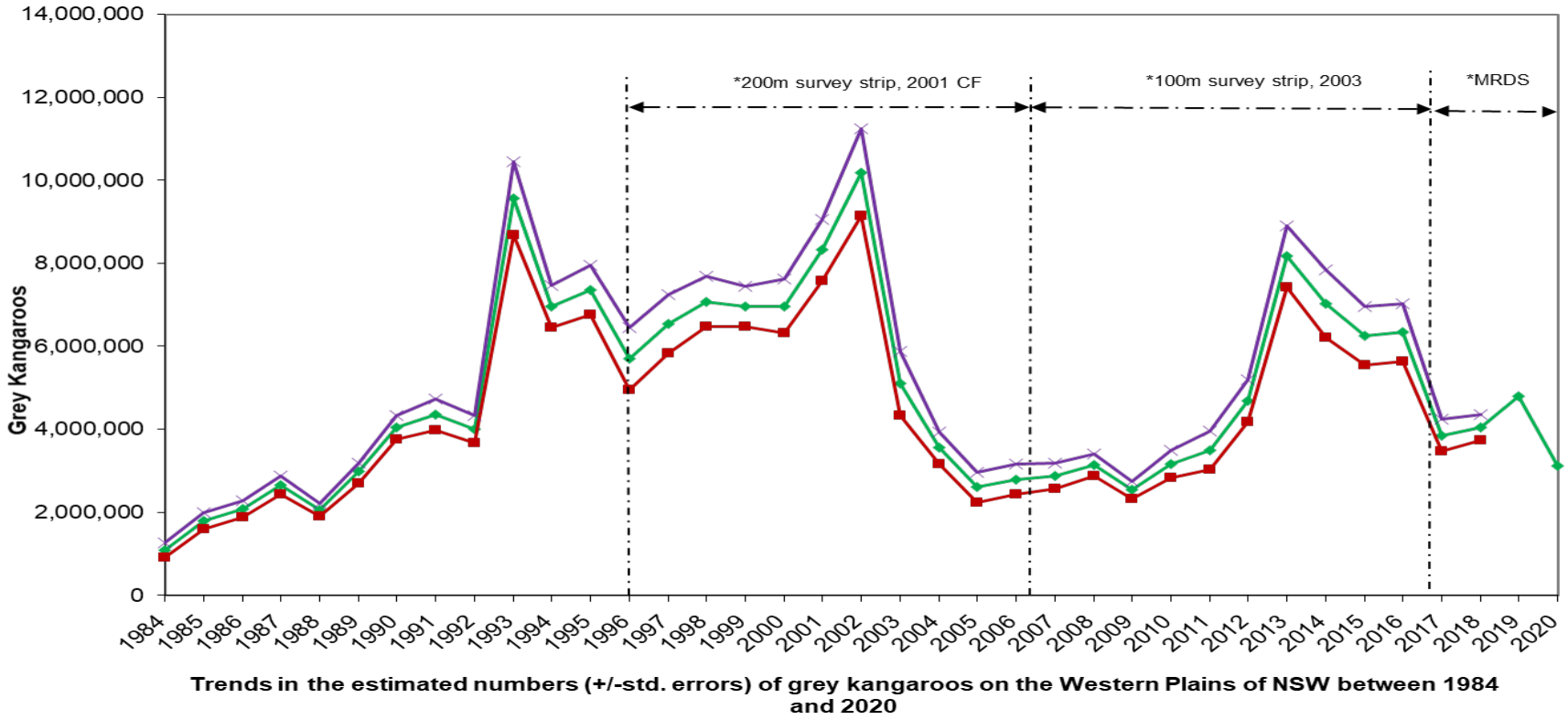


Figure 2 **Population trends in grey kangaroos on the Western Plains of NSW. The purple and brown lines indicate the standard error of the population estimate.**

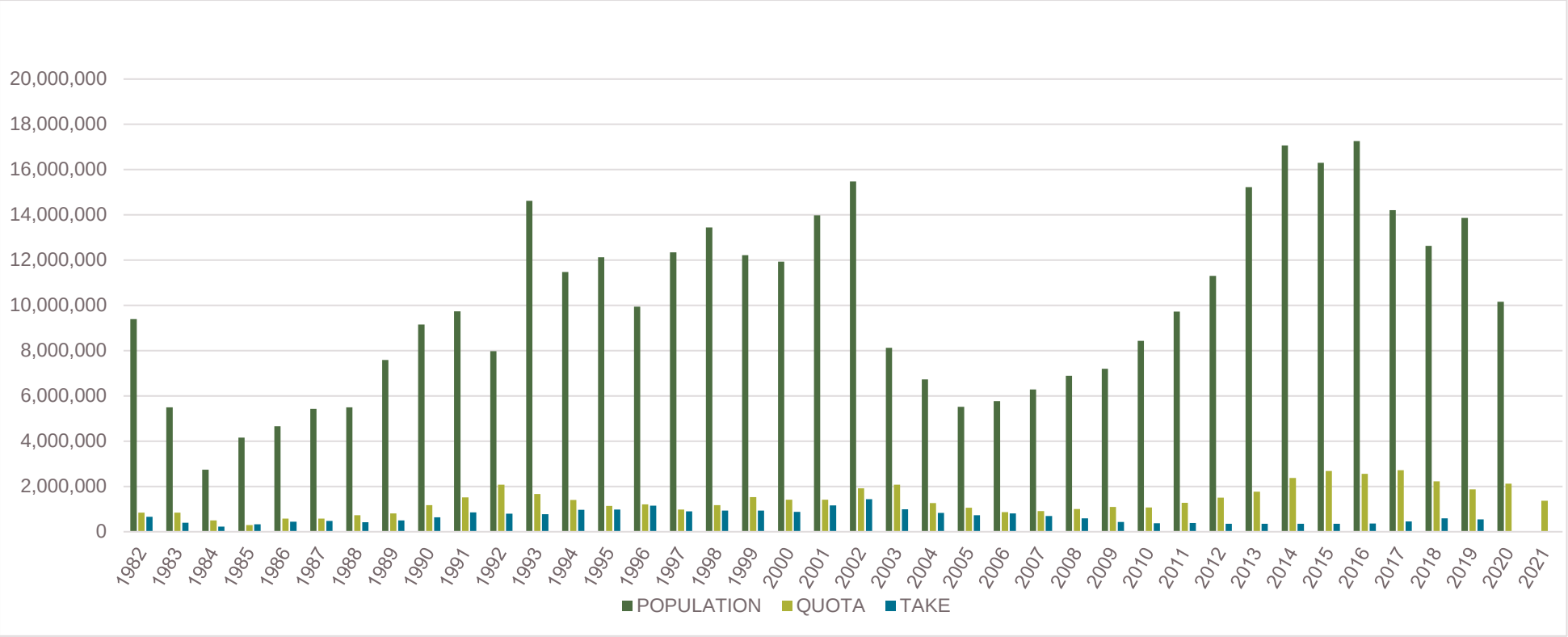


Figure 3 **NSW combined red and grey kangaroo population estimates, authorised quotas and actual takes, 1982–2021.**

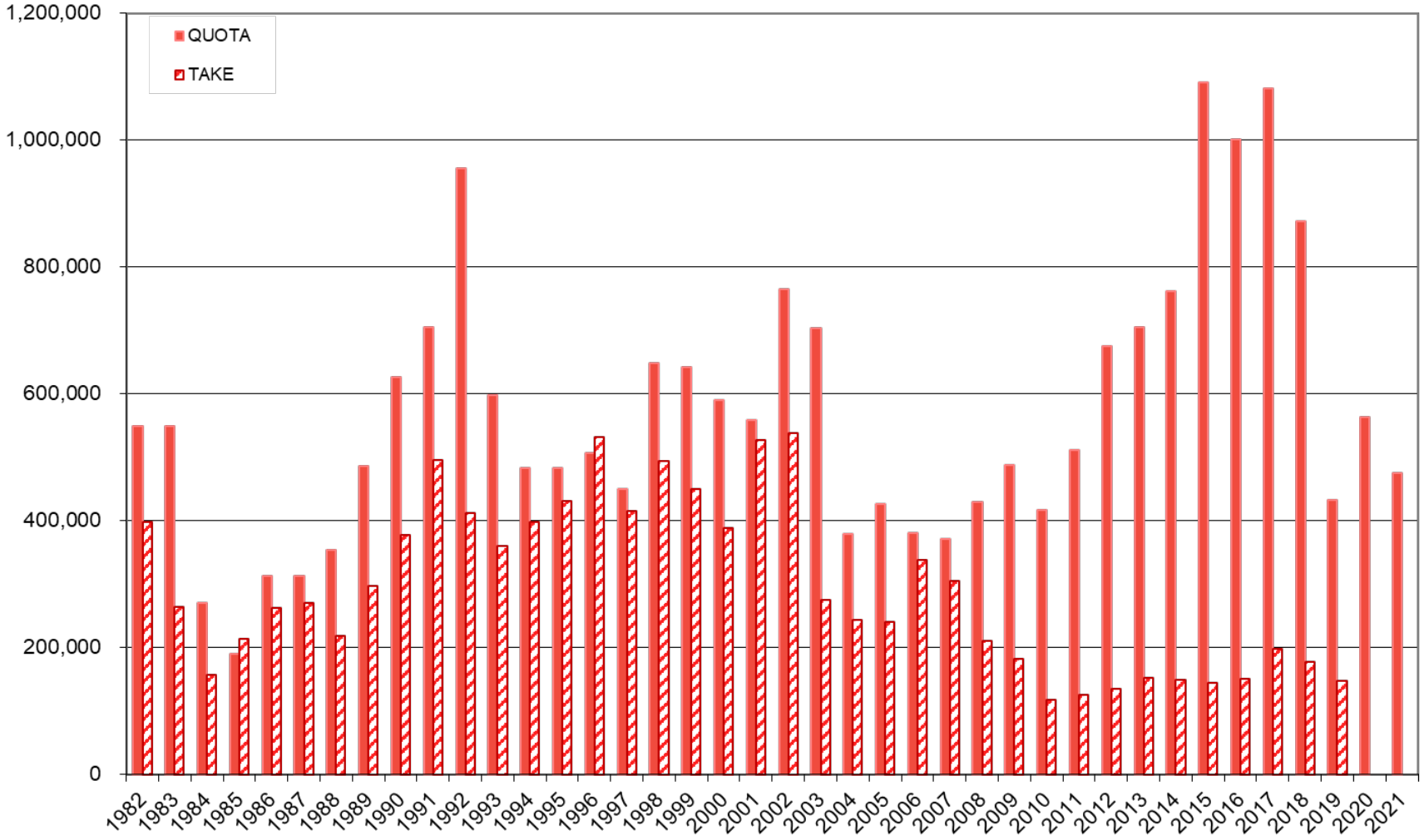


Figure 4 **NSW red kangaroo quotas and takes, 1982–2021**

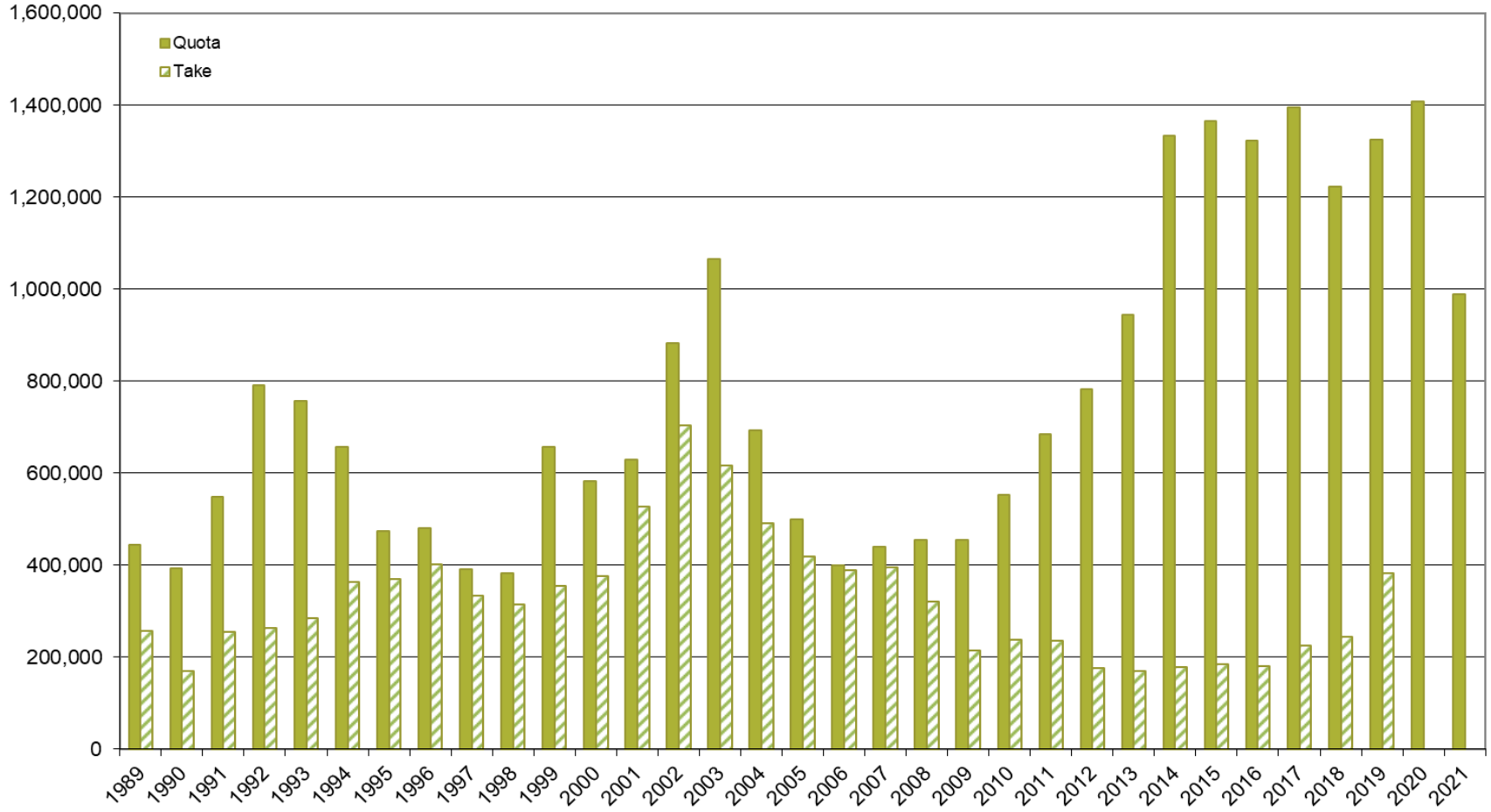


Figure 5 NSW eastern grey kangaroo quotas and takes, 1989–2021

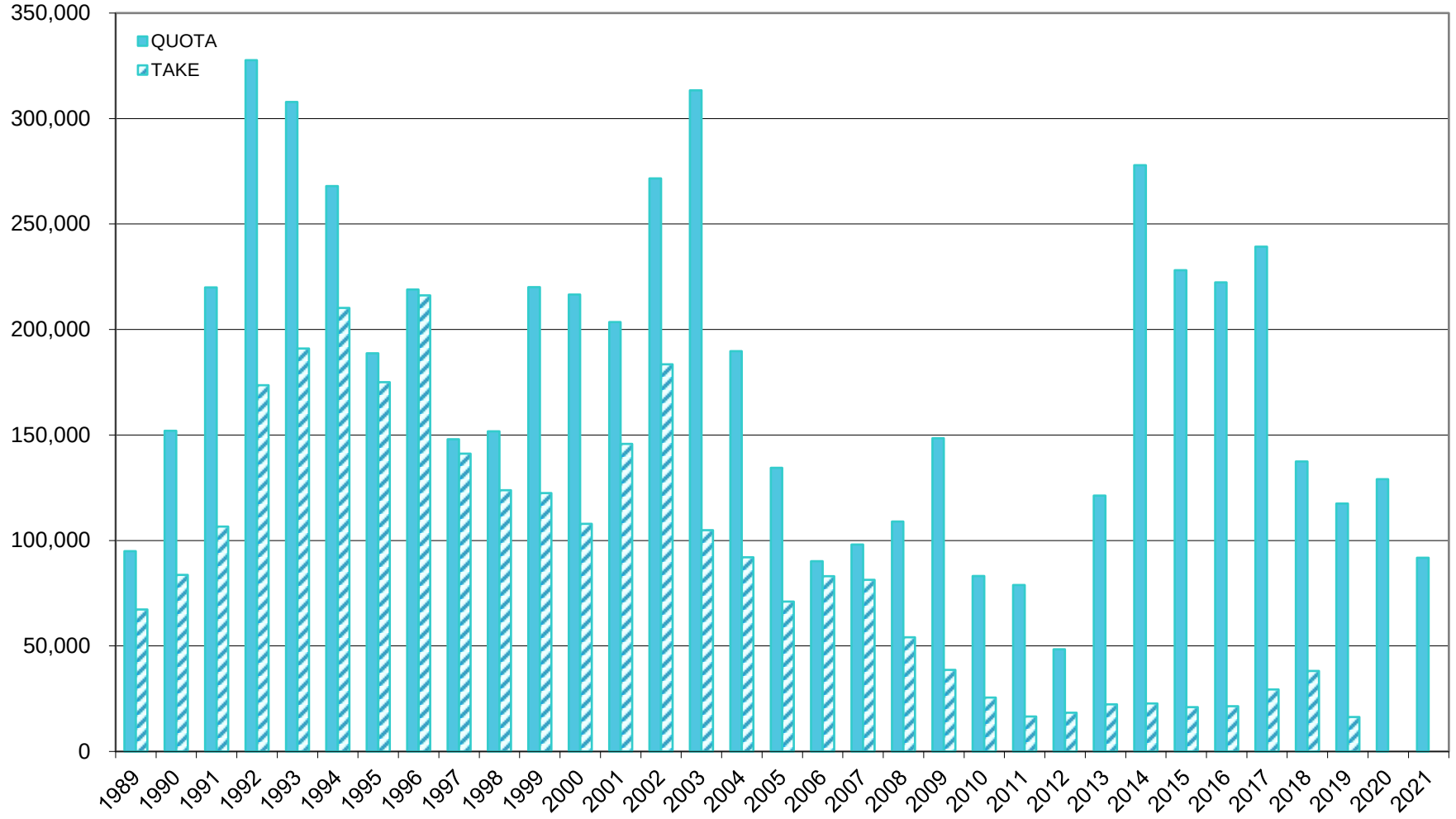


Figure 6 **NSW western grey kangaroo quotas and takes, 1989–2021**

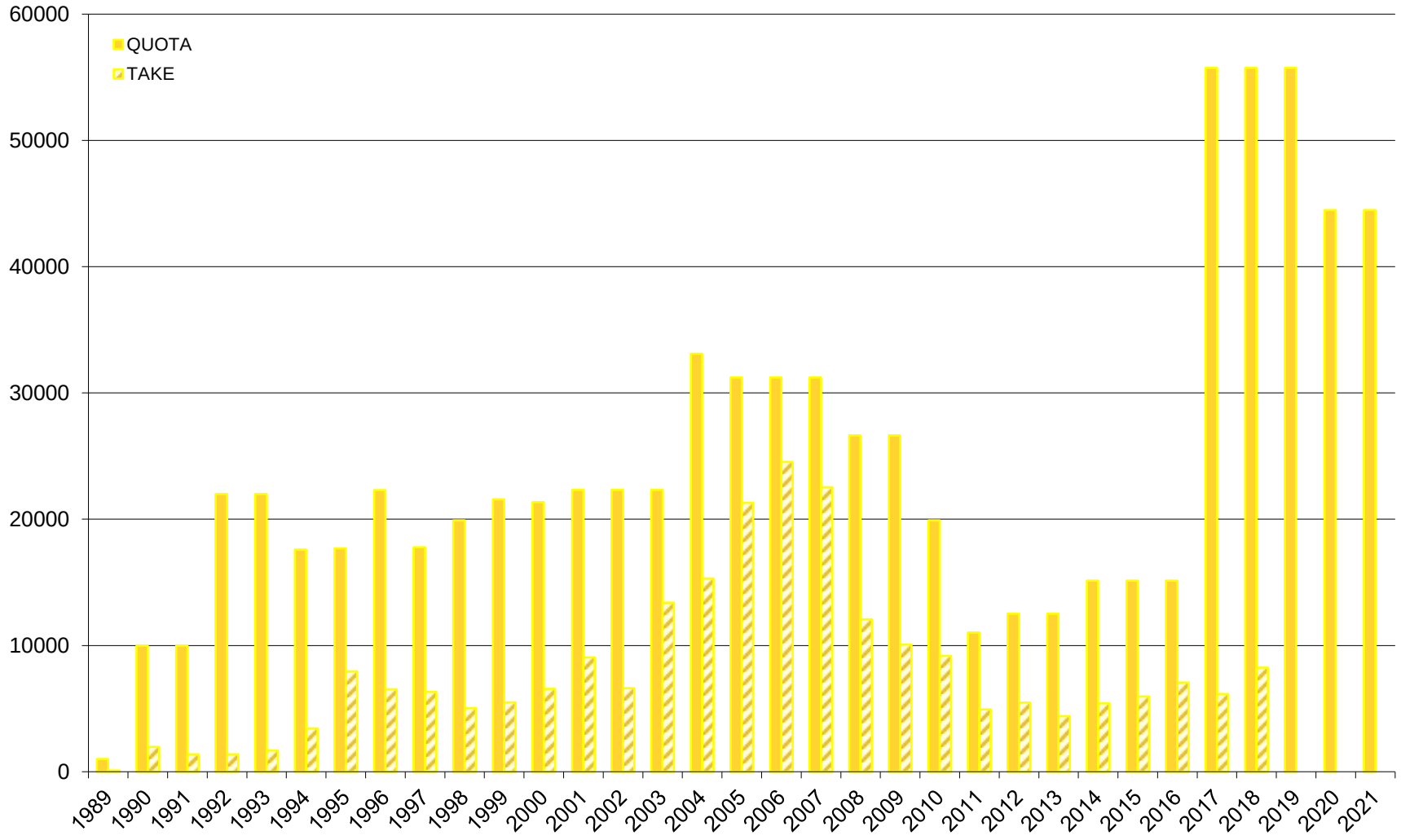


Figure 7 NSW wallaroo quotas and takes, 1989–2021*

* This table has been updated using corrected figures from 2007, 2016 and 2019 surveys.

Appendix B Low population thresholds applicable for 2021

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 long term mean. Thresholds have been set based on standard deviations, which are standardised 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.

To manage 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% of the population rather than the usual 15% (greys) or 17% (reds). 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 2020 surveys mark 20 years since the survey method moved from 200 m to 100 m strip counts (Pople et al., 1998). It is also 20 years since helicopter surveys began in the tablelands. The last 20 years of survey data have been used to calculate thresholds that inform quotas for 2021. This is because data collected over this time period is sufficiently long enough to determine population variance without relying on data that was collected under multiple different methods. The motive to do so was to ensure scientific rigour in reducing the amount of bias as far as possible in the data.

Zones impacted by reduced or suspended quota in 2021

Density for reds in Tibooburra this year was 3.65 km^{-2} and greys were even lower at 0.12 km^{-2}. Consequently, Tibooburra will have a 10% quota for reds and no quota for eastern or western greys in 2021 (Table B3).

The density of greys in Cobar and Bourke respectively were estimated to be 1.09 and 0.75. This places eastern and western greys in Cobar and Bourke between the upper and lower thresholds for those commercial management zones (CMZ). Consequently, Cobar and Bourke will have 10% quota for eastern and western greys (Table B3).

We are confident that restricted quotas in the above-mentioned zones will ensure ongoing population viability in those zones. Quota by species and zone breakdown is shown in table 50 below.

Expansion of South East Tablelands and Griffith Zones

In 2018 the NSW Government released the Drought Relief Package. This included increasing the area available for commercial kangaroo harvesting, being the preferred method to manage kangaroo populations and the contribution of kangaroo grazing to total grazing pressure. Two regions previously part of the non-commercial zone (no harvesting areas) in the south surrounding Wagga Wagga (Hume) and south east extending from South

East Tablelands Zone (Bombala), had historically been surveyed to expand the commercial harvesting area. At those times, the new areas were not incorporated as part of the commercial program.

Improvements to aerial survey methods used since 2017, changing from strip sampling along east-west transects to line transect Distance sampling and specifically Mark-Recapture Distance Sampling in survey blocks using the fixed-wing aircraft, has enabled rapid adaptation of annual aerial surveys and instant expansion of zones. For instance, Bombala was surveyed using line transect distance sampling during the 2018 helicopter surveys and was opened for commercial harvesting in 2019. In the 2019 fixed-wing surveys, survey blocks were included in the Hume non-commercial area to expand the Griffith Zone for commercial harvesting in 2020.

Thresholds for new zones – Griffith North and Griffith South

Expanding Griffith Zone meant it increased from 98,171km^2 to 129,884.10km^2. Compared with other zones, this would have been a very large zone and challenging to manage commercial harvesting activity due to fluctuations in kangaroo densities responding to dry and wet conditions. To counteract this the expanded Griffith Zone was divided into Griffith North (65758.40km^2) and Griffith South (64125.70km^2) zones.

Calculation of thresholds for older zones is straightforward because each kangaroo management zone has a long time-series of estimated abundances. No long time-series exists for the new zones, Griffith North and Griffith South, so an alternative method of estimating the thresholds in the zones must be used.

Since Griffith North and South have only two years of population data, thresholding for these zones is determined against the long term data for Griffith. A population estimate is determined for the combined Griffith North and South zones. This is then converted to density by dividing by the area. Threshold evaluation is performed against a density for Griffith before converting back to Griffith North and South zones. Quota determinations are then applied to population estimates for Griffith North and Griffith South.

Assuming the estimated densities in the old Griffith kangaroo management zones are representative of the densities of kangaroos in the new zones then the thresholds calculated for the new zones will be identical for the old Griffith Zone (Table 50).

Table 50 Density and threshold determination for Griffith

Zone	Species	Upper threshold (kangaroos/km^2)	Lower threshold (kangaroos/km^2)	Density 2020
Griffith	Red kangaroo	1.47	1.17	2.92
	Grey kangaroo	3.44	2.75	6.11

There will be no reduction in harvest rates for any species in Griffith North or Griffith South kangaroo management zones in 2021.

The current population densities and thresholds are shown for all zones in Table 52.

Table 51 NSW 2021 zone closures and available quota summary

Zone name	Red kangaroo quota	Western grey kangaroo quota	Eastern grey kangaroo quota	Common wallaroo quota
Tibooburra	**20,046**	0	0	
Broken Hill	203,571	24,483	17,729	
Lower Darling	99,246	32,565	14,631	
Cobar	17,422	**2564**	**1857**	
Bourke	11,797	**1577**	**2573**	
Narrabri	32,380		110,748	
Coonabarabran	25,849	9,356	124,307	
Griffith North	21,447	10,739	52,435	
Griffith South	43,094	9,481	46,288	
Northern Tablelands - Glen Innes			81,780	20,230
Northern Tablelands - Armidale			63,285	17,594
Northern Tablelands - Upper Hunter			24,975	6,660
Central Tablelands - North			116,602	
Central Tablelands - South			73,240	
South East Tablelands			258,210	
Total	**474,852**	**90,765**	**988,660**	**44,484**

Red shading indicates the species in that zone is closed.
Orange shading indicates a reduced quota % has been applied (10% of population estimate)
*Wallaroo quota based on corrected population estimate as per Cairns (2004).

Table 52 Average and current density estimates, and thresholds for quota reduction and suspension

Western Plains								
Grey kangaroos (eastern and western greys)								
Zone	Tibooburra	Broken Hill	Lower Darling	Cobar	Bourke	Narrabri	Coonabarabran	Griffith
Average density	0.82	3.13	4.14	2.66	2.39	9.45	15.68	5.51
Threshold 1: 10% quota	0.4	1.9	2.55	1.16	1.16	5.55	9.53	3.44
Threshold 2: suspension of quota	0.26	1.49	2.02	0.66	0.75	4.25	7.48	2.75
2020 density estimate (kangaroos/km^2)	**0.12**	**3.09**	**5.56**	**1.09**	**0.75**	**11.34**	**14.44**	**6.1**
Red kangaroos								
Zone	**Tibooburra**	**Broken Hill**	**Lower Darling**	**Cobar**	**Bourke**	**Narrabri**	**Coonabarabran**	**Griffith**
Average density	7.37	10.31	3.86	2.69	4.37	3.67	3.67	2.37
Threshold 1: 10% quota	3.86	6.98	2.27	1.46	2.48	2.08	2.26	1.47
Threshold 2: suspension of quota	2.69	5.87	1.74	1.05	1.85	1.55	1.79	1.17
2020 density estimate (kangaroos/km^2)	**3.65**	**13.15**	**10.31**	**2.54**	**2.14**	**2.90**	**2.46**	**2.92**

Table 53 Average and current density estimates, and thresholds for quota reduction and suspension

Tablelands						
Eastern grey						
Zone	**Armidale**	**Glen Innes**	**Upper Hunter**	**South East NSW**	**Central Tablelands North**	**Central Tablelands South**
Average density	11.7	11.48	7.04	9.57	21.14	21.29
Threshold 1: 10% quota	7.32	6.92	4.37	5.16	12.32	13.79
Threshold 2: suspension of quota	5.86	5.4	3.48	3.69	9.38	11.29
2018 density estimate (kangaroos/km^2)	25.84	26.06	11.33	33.25	25.74	20.91

Table 54 Average and current density estimates, and thresholds for quota reduction and suspension*

Wallaroo			
Zone	**Armidale**	**Glen Innes**	**Upper Hunter**
Average density	2.80	2.13	2.03
Threshold 1: 10% quota	1.60	1.20	1.10
Threshold 2: suspension of quota	1.20	0.89	0.79
2019 density estimate (wallaroos/km^2)	7.18	6.45	3.02

*Densities shown in this table are based on population estimates with 1.85 correction factor retrospectively applied, as per Cairns (2004).