2019 Quota Report
New South Wales Commercial Kangaroo Harvest Management Plan 2017–2021
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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. During this time, adjustments have been made to the survey design, population estimation and method of determining the commercial quota.


The report includes current population estimates for 2018 for red kangaroos, eastern and western grey kangaroos, and wallaroos.

The report also sets the quotas for 2019 and provides details of trends in population estimates, quotas and commercial take data.

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

Summary

Table 1 lists the quotas for 2018 and 2019 Table 2 compares the 2019 quotas against the 2018 population estimates and gives the quotas as percentages of those estimates.

Table 1  Quotas for 2019 and 2018

<table>
<thead>
<tr>
<th></th>
<th>2019</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Quota</td>
<td>Maximum</td>
</tr>
<tr>
<td></td>
<td></td>
<td>special quota</td>
</tr>
<tr>
<td>Red kangaroo</td>
<td>432,198</td>
<td>43,975</td>
</tr>
<tr>
<td>Eastern grey</td>
<td>1,324,413</td>
<td>132,950</td>
</tr>
<tr>
<td>kangaroo</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Western grey</td>
<td>117,465</td>
<td>12,547</td>
</tr>
<tr>
<td>kangaroo*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wallaroo</td>
<td>30,135</td>
<td>3,013</td>
</tr>
<tr>
<td>Total</td>
<td>1,838,646</td>
<td>185,928</td>
</tr>
</tbody>
</table>

*There is a small population (5,895) 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.
<table>
<thead>
<tr>
<th>Wildlife Type</th>
<th>2018 Population Estimate</th>
<th>2019 Quota</th>
<th>Quota as % of Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red Kangaroo</td>
<td>2,931,693</td>
<td>432,198</td>
<td>15.0</td>
</tr>
<tr>
<td>Eastern Grey Kangaroo (Western Plains)</td>
<td>3,212,005</td>
<td>476,718</td>
<td>14.8</td>
</tr>
<tr>
<td>Eastern Grey Kangaroo (Central and Northern Tablelands and Southeast NSW)</td>
<td>5,651,300</td>
<td>847,695</td>
<td>15.0</td>
</tr>
<tr>
<td>Western Grey Kangaroo</td>
<td>836,496</td>
<td>117,465</td>
<td>14.0</td>
</tr>
<tr>
<td>Wallaroo (Northern Tablelands)</td>
<td>200,900</td>
<td>30,135</td>
<td>15.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>12,832,394</strong></td>
<td><strong>1,904,211</strong></td>
<td><strong>14.6</strong></td>
</tr>
</tbody>
</table>
Table 3 lists the details of the 2018 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 2018

<table>
<thead>
<tr>
<th>Management zone</th>
<th>No.</th>
<th>Eastern grey</th>
<th></th>
<th></th>
<th></th>
<th>Red</th>
<th></th>
<th></th>
<th></th>
<th>Western grey</th>
<th></th>
<th></th>
<th></th>
<th>Wallaroo</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Quota</td>
<td>Take</td>
<td>%q</td>
<td>%p</td>
<td>Quota</td>
<td>Take</td>
<td>%q</td>
<td>%p</td>
<td>Quota</td>
<td>Take</td>
<td>%q</td>
<td>%p</td>
<td>Quota</td>
<td>Take</td>
<td>%q</td>
<td>%p</td>
</tr>
<tr>
<td>Tibooburra</td>
<td>1</td>
<td>21,041</td>
<td>410</td>
<td>2%</td>
<td>0%</td>
<td>193,040</td>
<td>15,850</td>
<td>8%</td>
<td>1%</td>
<td>5,368</td>
<td>455</td>
<td>8%</td>
<td>1%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Broken Hill</td>
<td>2</td>
<td>27,410</td>
<td>4,623</td>
<td>17%</td>
<td>2%</td>
<td>139,946</td>
<td>65,419</td>
<td>47%</td>
<td>8%</td>
<td>38,310</td>
<td>11,526</td>
<td>31%</td>
<td>5%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower Darling</td>
<td>4</td>
<td>9,975</td>
<td>4,651</td>
<td>47%</td>
<td>7%</td>
<td>49,195</td>
<td>15,787</td>
<td>33%</td>
<td>5%</td>
<td>21,896</td>
<td>8,901</td>
<td>41%</td>
<td>6%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cobar</td>
<td>6</td>
<td>11,497</td>
<td>4,003</td>
<td>35%</td>
<td>5%</td>
<td>39,014</td>
<td>3,892</td>
<td>10%</td>
<td>2%</td>
<td>10,742</td>
<td>2,510</td>
<td>23%</td>
<td>2%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bourke</td>
<td>7</td>
<td>20,535</td>
<td>9,053</td>
<td>45%</td>
<td>7%</td>
<td>78,535</td>
<td>16,870</td>
<td>21%</td>
<td>4%</td>
<td>12,675</td>
<td>1,032</td>
<td>8%</td>
<td>1%</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Narrabri</td>
<td>8</td>
<td>66,378</td>
<td>38,582</td>
<td>58%</td>
<td>9%</td>
<td>133,486</td>
<td>10,874</td>
<td>8%</td>
<td>1%</td>
<td>0%</td>
<td>0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Armidale</td>
<td>9</td>
<td>63,120</td>
<td>13,221</td>
<td>21%</td>
<td>3%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10,890</td>
<td>2,222</td>
<td>20%</td>
<td>3%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coonabarabran</td>
<td>10</td>
<td>127,061</td>
<td>65,370</td>
<td>51%</td>
<td>8%</td>
<td>100,029</td>
<td>17,634</td>
<td>18%</td>
<td>3%</td>
<td>6,813</td>
<td>1,918</td>
<td>28%</td>
<td>3%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Griffith</td>
<td>11</td>
<td>157,032</td>
<td>32,561</td>
<td>21%</td>
<td>3%</td>
<td>139,307</td>
<td>21,446</td>
<td>15%</td>
<td>3%</td>
<td>32,363</td>
<td>6,414</td>
<td>20%</td>
<td>3%</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Glen Innes</td>
<td>13</td>
<td>88,110</td>
<td>15,225</td>
<td>17%</td>
<td>3%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8,235</td>
<td>3,221</td>
<td>39%</td>
<td>6%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper Hunter</td>
<td>14</td>
<td>38,940</td>
<td>12,524</td>
<td>32%</td>
<td>5%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11,010</td>
<td>3,584</td>
<td>33%</td>
<td>5%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Southeast NSW</td>
<td>16</td>
<td>192,645</td>
<td>6,669</td>
<td>3%</td>
<td>0.5%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central Tablelands North</td>
<td>48</td>
<td>259,230</td>
<td>17,702</td>
<td>7%</td>
<td>1%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central Tablelands South</td>
<td>49</td>
<td>140,085</td>
<td>18,273</td>
<td>13%</td>
<td>2%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>1,223,059</td>
<td>242,867</td>
<td>20%</td>
<td>3%</td>
<td>872,552</td>
<td>168,234</td>
<td>19%</td>
<td>3%</td>
<td>128,167</td>
<td>32,756</td>
<td>26%</td>
<td>4%</td>
<td>30,135</td>
<td>9,027</td>
<td>30%</td>
<td>4%</td>
</tr>
</tbody>
</table>
Population estimates and survey method used

How surveys are conducted

The 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 (MRDS)

The commercial harvest zones that occur in the rangelands of New South Wales cover an area of about 530,000 km². Aerial surveys allow these areas to be surveyed quickly. However, the speed and height that the plane must travel limits the time available for observers to detect, identify and record observations.

In keeping with statistical and methodological advances in survey techniques, mark-recapture distance sampling (MRDS) is used to estimate the abundance of kangaroos in the rangelands 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.

Mark-recapture distance sampling (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, is used to account for the bias in detection probability.

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 density and population of kangaroos in each of the Western Plains management zones.
Table 4  Red and grey kangaroo population estimates for 2018 for the Western Plains

<table>
<thead>
<tr>
<th>Management zone</th>
<th>Red kangaroo population estimate</th>
<th>Grey kangaroo population estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tibooburra</td>
<td>344,619 ± 55,972</td>
<td>184,002 ± 107,949</td>
</tr>
<tr>
<td>Broken Hill</td>
<td>1,133,523 ± 144,264</td>
<td>395,360 ± 58,378</td>
</tr>
<tr>
<td>Lower Darling</td>
<td>307,619 ± 35,210</td>
<td>281,035 ± 33,825</td>
</tr>
<tr>
<td>Cobar</td>
<td>44,733 ± 10,071</td>
<td>81,391 ± 14,612</td>
</tr>
<tr>
<td>Bourke</td>
<td>244,867 ± 62,957</td>
<td>183,950 ± 42,593</td>
</tr>
<tr>
<td>Narrabri</td>
<td>353,348 ± 76,662</td>
<td>728,648 ± 160,517</td>
</tr>
<tr>
<td>Coonabarabran</td>
<td>218,312 ± 50,751</td>
<td>1,274,243 ± 184,129</td>
</tr>
<tr>
<td>Griffith</td>
<td>284,853 ± 85,509</td>
<td>912,282 ± 146,307</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,931,693 ± 212,166</strong></td>
<td><strong>4,047,911 ± 315,131</strong></td>
</tr>
</tbody>
</table>

The estimated numbers and densities of red and grey kangaroos in each management zone from 1990 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 South East NSW.

**Northern Tablelands**

The Northern Tablelands commercial harvest area covers some 40,000 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, 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 conducted between 12 September and 24 September 2016, 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 web page.

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 kangaroo 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; this data is based on aerial surveys conducted in 2016.
<table>
<thead>
<tr>
<th>Management zone</th>
<th>Zone area (km²)*</th>
<th>Density (km⁻²)</th>
<th>Population estimate</th>
<th>Quota</th>
<th>Density** (km⁻²)</th>
<th>Population estimate</th>
<th>Quota</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glen Innes</td>
<td>17,241</td>
<td>34.1</td>
<td>587,400</td>
<td>88,110</td>
<td>3.2</td>
<td>54,900</td>
<td>8,235</td>
</tr>
<tr>
<td>Armidale</td>
<td>15,023</td>
<td>28.0</td>
<td>420,800</td>
<td>63,120</td>
<td>4.8</td>
<td>72,600</td>
<td>10,890</td>
</tr>
<tr>
<td>Upper Hunter</td>
<td>7,983</td>
<td>32.5</td>
<td>259,600</td>
<td>38,940</td>
<td>9.2</td>
<td>73,400</td>
<td>11,010</td>
</tr>
<tr>
<td>Total</td>
<td>40,247</td>
<td></td>
<td>1,267,800</td>
<td>190,170</td>
<td></td>
<td>200,900</td>
<td>30,135</td>
</tr>
</tbody>
</table>

* ‘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).

South East NSW

In 2018 the Government announced changes to kangaroo management in New South Wales and part of these changes was to expand the Southeast Commercial Zone. Therefore, the survey this year 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, 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 41,211 square kilometres and this also includes the addition of the Bombala Area being approximately 2,720 sq kilometres. The population estimate gained from this survey will remain current until the next survey in 2021.

The study area was originally surveyed in 2003 in accordance with a design developed by consultants based on the latest methodologies (Pople, Cairns & Menke 2003). 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 advances in survey design software.

Because 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).

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 Southeast NSW management zone

<table>
<thead>
<tr>
<th>Management Zone</th>
<th>Area (km²)</th>
<th>Survey effort (km)</th>
<th>Density (km⁻²)</th>
<th>Population estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>South East NSW (includes Bombala)</td>
<td>41,211</td>
<td>1,980</td>
<td>(41.9)</td>
<td>1,721,400</td>
</tr>
</tbody>
</table>

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 kangaroo population estimates and quotas for the South East NSW zone are shown in Table A12.
Central Tablelands

The initial helicopter survey of the 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, 2014 and 2017. 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 2017 helicopter survey are shown in Table 7.

Table 7  Population estimates for 2017 for eastern grey kangaroos in each of the new Central Tablelands commercial harvest zones.

<table>
<thead>
<tr>
<th>Zone</th>
<th>Area (km²)</th>
<th>Density (km⁻²)</th>
<th>Population estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hunter–Mudgee (Central Tablelands North)</td>
<td>23,185</td>
<td>74.5</td>
<td>1,728,200</td>
</tr>
<tr>
<td>Central Tablelands South</td>
<td>18,892</td>
<td>49.4</td>
<td>933,900</td>
</tr>
<tr>
<td><strong>Total or (Average)</strong></td>
<td><strong>42,077</strong></td>
<td><strong>62.0</strong></td>
<td><strong>2,662,100</strong></td>
</tr>
</tbody>
</table>

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 kangaroo 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% of the estimated red kangaroo population and 15% of the estimated population of eastern grey and western grey kangaroos.

For the Northern Tablelands, quotas have been set at 15% for both eastern grey kangaroos and wallaroos.

Eastern grey kangaroo quotas for the South East NSW and Central Tablelands zones have also been set at 15%.

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.

Considering 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 30 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 2019 are still considered to be sustainable in the long-term.
Low kangaroo populations are further protected by the incorporation of harvest thresholds in 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, e.g. red kangaroo populations in the Far West 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 that is allowable before harvest reductions or suspensions are implemented.

**Special quotas**

A special quota for 2019 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 2018 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 taken under special quota provisions in any commercial harvest zone is 5% 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% 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 New South Wales 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

In May 2018 just prior to 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).

These seasonal conditions have resulted in a slight increase in populations of eastern grey and slight decrease in western grey and a large decrease in red kangaroos across the Western Plains. For both eastern grey and western grey kangaroos, there is 9.3% and -8.7% change (about 272,480 and 80,087 respectively). Decrease in red kangaroo populations -42.9% (about 2,200,961).

Observed population decreases are consistent with the drier than normal conditions and widespread reduction in pasture growth and water resources in most areas during 2017 up to May 2018 prior to surveys.

Red kangaroo

The 2018 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, 1997–2018

<table>
<thead>
<tr>
<th>Year</th>
<th>Population estimate (millions)</th>
<th>Density (km–²)</th>
<th>Trends in abundance (% change from previous year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>2.93 ± 0.21</td>
<td>5.16</td>
<td>-42.9</td>
</tr>
<tr>
<td>2017</td>
<td>5.13 ± 0.57</td>
<td>9.76</td>
<td>-19.4</td>
</tr>
<tr>
<td>2016</td>
<td>6.36 ± 0.49</td>
<td>12.64</td>
<td>8.1</td>
</tr>
<tr>
<td>2015</td>
<td>5.89 ± 0.41</td>
<td>10.89</td>
<td>-8.3</td>
</tr>
<tr>
<td>2014</td>
<td>6.42 ±0.50</td>
<td>11.62</td>
<td>43.4</td>
</tr>
<tr>
<td>2013</td>
<td>4.50 ±0.36</td>
<td>8.47</td>
<td>8.0</td>
</tr>
<tr>
<td>2012</td>
<td>4.15 ±0.31</td>
<td>8.01</td>
<td>4.0</td>
</tr>
<tr>
<td>2011</td>
<td>3.97 ± 0.41</td>
<td>7.39</td>
<td>32.0</td>
</tr>
<tr>
<td>2010</td>
<td>3.01 ± 0.24</td>
<td>5.73</td>
<td>23.0</td>
</tr>
<tr>
<td>2009</td>
<td>2.46 ± 0.17</td>
<td>4.58</td>
<td>-14.0</td>
</tr>
<tr>
<td>2008</td>
<td>2.87 ± 0.21</td>
<td>5.26</td>
<td>14.0</td>
</tr>
<tr>
<td>2007</td>
<td>2.52 ± 0.21</td>
<td>4.44</td>
<td>16.0</td>
</tr>
<tr>
<td>2006</td>
<td>2.18 ± 0.16</td>
<td>4.05</td>
<td>-3.0</td>
</tr>
<tr>
<td>2005</td>
<td>2.24 ± 0.22</td>
<td>4.32</td>
<td>-11.0</td>
</tr>
<tr>
<td>2004</td>
<td>2.51 ± 0.24</td>
<td>4.66</td>
<td>12.0</td>
</tr>
<tr>
<td>2003</td>
<td>2.24 ± 0.16</td>
<td>4.22</td>
<td>-53.0</td>
</tr>
<tr>
<td>2002</td>
<td>4.80 ± 0.39</td>
<td>9.35</td>
<td>-6.0</td>
</tr>
<tr>
<td>2001</td>
<td>5.12 ± 0.34</td>
<td>9.74</td>
<td>*17.0</td>
</tr>
<tr>
<td>2000</td>
<td>4.39 ± 0.40</td>
<td>8.49</td>
<td>-7.0</td>
</tr>
<tr>
<td>1999</td>
<td>4.71 ± 0.44</td>
<td>8.82</td>
<td>-19.0</td>
</tr>
<tr>
<td>1998</td>
<td>5.81 ± 0.61</td>
<td>11.36</td>
<td>10.0</td>
</tr>
<tr>
<td>1997</td>
<td>5.29 ± 0.40</td>
<td>10.01</td>
<td>40.0</td>
</tr>
</tbody>
</table>

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.

**Eastern grey kangaroo**

The 2018 grey kangaroo (eastern and western) estimate for the area surveyed by fixed-wing aircraft is 4.04 million (density 7.31 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 2018 survey gives an eastern grey kangaroo population estimate for the area surveyed by air of 3.2 million (density 5.78 km–²).

The 2018 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, 1997–2018**

<table>
<thead>
<tr>
<th>Year</th>
<th>Population estimate (millions)</th>
<th>Density (km(^{-2}))</th>
<th>Trend in abundance (% change from previous year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>3.21 ± 0.28</td>
<td>5.78</td>
<td>9.3</td>
</tr>
<tr>
<td>2017</td>
<td>2.94 ± 0.28</td>
<td>5.06</td>
<td>-38.0</td>
</tr>
<tr>
<td>2016</td>
<td>4.74 ± 0.56</td>
<td>8.75</td>
<td>-0.5</td>
</tr>
<tr>
<td>2015</td>
<td>4.76 ± 0.64</td>
<td>8.84</td>
<td>-13.2</td>
</tr>
<tr>
<td>2014</td>
<td>5.50 ± 0.71</td>
<td>10.36</td>
<td>-13.0</td>
</tr>
<tr>
<td>2013</td>
<td>6.31 ± 0.64</td>
<td>11.74</td>
<td>65.0</td>
</tr>
<tr>
<td>2012</td>
<td>3.83 ± 0.48</td>
<td>7.36</td>
<td>28.0</td>
</tr>
<tr>
<td>2011</td>
<td>3.00 ± 0.44</td>
<td>5.64</td>
<td>20.0</td>
</tr>
<tr>
<td>2010</td>
<td>2.50 ± 0.31</td>
<td>4.70</td>
<td>38.0</td>
</tr>
<tr>
<td>2009</td>
<td>1.81 ± 0.19</td>
<td>3.49</td>
<td>-16.0</td>
</tr>
<tr>
<td>2008</td>
<td>2.15 ± 0.21</td>
<td>3.97</td>
<td>0.0</td>
</tr>
<tr>
<td>2007</td>
<td>2.15 ± 0.27</td>
<td>3.99</td>
<td>0.0</td>
</tr>
<tr>
<td>2006</td>
<td>2.14 ± 0.32</td>
<td>3.92</td>
<td>7.0</td>
</tr>
<tr>
<td>2005</td>
<td>2.00 ± 0.33</td>
<td>3.65</td>
<td>-25.0</td>
</tr>
<tr>
<td>2004</td>
<td>2.66 ± 0.32</td>
<td>5.03</td>
<td>-31.0</td>
</tr>
<tr>
<td>2003</td>
<td>3.83 ± 0.58</td>
<td>7.42</td>
<td>-51.0</td>
</tr>
<tr>
<td>2002</td>
<td>7.80 ± 1.02</td>
<td>15.07</td>
<td>24.0</td>
</tr>
<tr>
<td>2001</td>
<td>6.29 ± 0.72</td>
<td>12.48</td>
<td>*22.0</td>
</tr>
<tr>
<td>2000</td>
<td>5.17 ± 0.57</td>
<td>9.86</td>
<td>6.0</td>
</tr>
<tr>
<td>1999</td>
<td>4.87 ± 0.42</td>
<td>9.43</td>
<td>-6.0</td>
</tr>
<tr>
<td>1998</td>
<td>5.19 ± 0.54</td>
<td>9.91</td>
<td>17.0</td>
</tr>
<tr>
<td>1997</td>
<td>4.43 ± 0.63</td>
<td>8.53</td>
<td>12.0</td>
</tr>
</tbody>
</table>

**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.

The Northern Tablelands management zones were surveyed in September 2016. Based on this survey, the number of eastern grey kangaroos estimated to be in the Northern Tablelands region is 1,267,800 (Table 10). The Northern Tablelands region will be surveyed again in 2019.
## Population estimates and trends in abundance for eastern grey kangaroo in the Northern Tablelands zones, 2001–16

<table>
<thead>
<tr>
<th>Year</th>
<th>Zone</th>
<th>Population estimate</th>
<th>Density (km²)</th>
<th>Trend in abundance (% change from previous survey)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Armidale</td>
<td>420,800</td>
<td>28.0</td>
<td>60.0</td>
</tr>
<tr>
<td>2016</td>
<td>Glen Innes</td>
<td>587,400</td>
<td>34.1</td>
<td>57.0</td>
</tr>
<tr>
<td></td>
<td>Upper Hunter</td>
<td>259,600</td>
<td>32.5</td>
<td>105.0</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>1,267,800</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>Armidale</td>
<td>263,300</td>
<td>16.6</td>
<td>27.0</td>
</tr>
<tr>
<td></td>
<td>Glen Innes</td>
<td>374,300</td>
<td>20.3</td>
<td>39.0</td>
</tr>
<tr>
<td></td>
<td>Upper Hunter</td>
<td>126,800</td>
<td>9.05</td>
<td>-24.0</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>764,400</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>Armidale</td>
<td>206,780</td>
<td>13.1</td>
<td>46.0</td>
</tr>
<tr>
<td></td>
<td>Glen Innes</td>
<td>269,500</td>
<td>12.9</td>
<td>14.0</td>
</tr>
<tr>
<td></td>
<td>Upper Hunter</td>
<td>167,500</td>
<td>11.5</td>
<td>82.0</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>643,780</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>Armidale</td>
<td>141,610</td>
<td>8.7</td>
<td>-12.0</td>
</tr>
<tr>
<td></td>
<td>Glen Innes</td>
<td>236,600</td>
<td>11.3</td>
<td>58.0</td>
</tr>
<tr>
<td></td>
<td>Upper Hunter</td>
<td>92,016</td>
<td>6.3</td>
<td>36.0</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>470,226</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td>Armidale</td>
<td>161,726</td>
<td>10.2</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td>Glen Innes</td>
<td>149,621</td>
<td>8.1</td>
<td>-35.0</td>
</tr>
<tr>
<td></td>
<td>Upper Hunter</td>
<td>67,499</td>
<td>4.8</td>
<td>-28.0</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>378,846</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2001–2002</td>
<td>Armidale</td>
<td>173,109</td>
<td>10.6</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Glen Innes</td>
<td>221,975</td>
<td>10.6</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Upper Hunter</td>
<td>95,273</td>
<td>6.5</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>490,357</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In Appendix A, tables A9b, A10b and A11b show population estimates and quotas for eastern grey kangaroos in the Northern Tablelands management zones from 1993 to 2016.

Before the approval of the commercial harvest zone in South East 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% in the population since the 2003 survey. The area was surveyed again in 2009 and included a large portion of the Riverina Local Land Service Area (Table 11). The trend in abundance is not shown in Table 11, as the areas surveyed in 2006 and 2009 were different.

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, 2003–18

<table>
<thead>
<tr>
<th>Year</th>
<th>Population estimate</th>
<th>Density (km⁻²)</th>
<th>Trend in abundance (% change from previous survey)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>1,721,400</td>
<td>41.9</td>
<td>34%</td>
</tr>
<tr>
<td>2015</td>
<td>1,284,300</td>
<td>33.4</td>
<td>49.5</td>
</tr>
<tr>
<td>2012</td>
<td>858,900</td>
<td>22.4</td>
<td>31.0</td>
</tr>
<tr>
<td>2009*</td>
<td>655,900</td>
<td>17.1</td>
<td>0.0</td>
</tr>
<tr>
<td>2006</td>
<td>415,271</td>
<td>14.07</td>
<td>42.0</td>
</tr>
<tr>
<td>2003</td>
<td>292,455</td>
<td>11.95</td>
<td>0.0</td>
</tr>
</tbody>
</table>

* The 2009 population estimate is for a larger area than in the previous two surveys, as it includes part of Riverina LLS (Local Land Services). 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. The next survey was conducted in September 2011 and then 2014 and in 2017, 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, 2008–17

<table>
<thead>
<tr>
<th>Year</th>
<th>Zone</th>
<th>Population estimate</th>
<th>Density (km⁻²)</th>
<th>Trend in abundance (% change from previous survey)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>CT North</td>
<td>1,728,200</td>
<td>74.5</td>
<td>44.8</td>
</tr>
<tr>
<td></td>
<td>CT South</td>
<td>933,900</td>
<td>49.4</td>
<td>15.0</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>2,662,100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>CT North</td>
<td>1,193,600</td>
<td>47.1</td>
<td>94.9</td>
</tr>
<tr>
<td></td>
<td>CT South</td>
<td>811,800</td>
<td>35.9</td>
<td>133.4</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>2,005,400</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>CT North</td>
<td>612,590</td>
<td>20.9</td>
<td>41.5</td>
</tr>
<tr>
<td></td>
<td>CT South</td>
<td>347,830</td>
<td>15.1</td>
<td>-35.1</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>960,420</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>CT North</td>
<td>433,030</td>
<td>14.7</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>CT South</td>
<td>535,600</td>
<td>23.2</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>968,630</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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 2018 survey
NSW Kangaroo Management Program 2019 Quota Report

gives a western grey kangaroo population estimate for the area surveyed by air of 0.84 million (average density 1.52 km\(^{-2}\)).

The 2018 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, 1997–2018

<table>
<thead>
<tr>
<th>Year</th>
<th>Population estimate (millions)</th>
<th>Density (km(^{-2}))</th>
<th>Trend in abundance (% change from previous year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>0.84 ± 0.58</td>
<td>1.52</td>
<td>-8.7</td>
</tr>
<tr>
<td>2017</td>
<td>0.92 ± 0.15</td>
<td>1.68</td>
<td>-42.5</td>
</tr>
<tr>
<td>2016</td>
<td>1.59 ± 0.25</td>
<td>3.18</td>
<td>7.2</td>
</tr>
<tr>
<td>2015</td>
<td>1.49 ± 0.18</td>
<td>3.02</td>
<td>-2.6</td>
</tr>
<tr>
<td>2014</td>
<td>1.53 ± 0.24</td>
<td>3.16</td>
<td>-17.5</td>
</tr>
<tr>
<td>2013</td>
<td>1.82 ± 0.20</td>
<td>3.83</td>
<td>116.0</td>
</tr>
<tr>
<td>2012</td>
<td>0.86 ± 0.11</td>
<td>1.83</td>
<td>73.0</td>
</tr>
<tr>
<td>2011</td>
<td>0.50 ± 0.07</td>
<td>1.02</td>
<td>-25.0</td>
</tr>
<tr>
<td>2010</td>
<td>0.66 ± 0.08</td>
<td>1.39</td>
<td>-8.0</td>
</tr>
<tr>
<td>2009</td>
<td>0.72 ± 0.08</td>
<td>1.49</td>
<td>-27.0</td>
</tr>
<tr>
<td>2008</td>
<td>0.99 ± 0.10</td>
<td>2.07</td>
<td>36.0</td>
</tr>
<tr>
<td>2007</td>
<td>0.73 ± 0.09</td>
<td>1.55</td>
<td>11.0</td>
</tr>
<tr>
<td>2006</td>
<td>0.65 ± 0.11</td>
<td>1.35</td>
<td>9.0</td>
</tr>
<tr>
<td>2005</td>
<td>0.60 ± 0.09</td>
<td>1.31</td>
<td>-33.0</td>
</tr>
<tr>
<td>2004</td>
<td>0.89 ± 0.11</td>
<td>1.89</td>
<td>-29.0</td>
</tr>
<tr>
<td>2003</td>
<td>1.27 ± 0.26</td>
<td>2.72</td>
<td>-47.0</td>
</tr>
<tr>
<td>2002</td>
<td>2.39 ± 0.30</td>
<td>5.02</td>
<td>18.0</td>
</tr>
<tr>
<td>2001</td>
<td>2.03 ± 0.22</td>
<td>4.53</td>
<td>*13.0</td>
</tr>
<tr>
<td>2000</td>
<td>1.79 ± 0.24</td>
<td>3.86</td>
<td>-14.0</td>
</tr>
<tr>
<td>1999</td>
<td>2.09 ± 0.19</td>
<td>4.50</td>
<td>11.0</td>
</tr>
<tr>
<td>1998</td>
<td>1.88 ± 0.18</td>
<td>3.97</td>
<td>-11.0</td>
</tr>
<tr>
<td>1997</td>
<td>2.11 ± 0.27</td>
<td>4.33</td>
<td>22.0</td>
</tr>
</tbody>
</table>

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 2016 wallaroo population estimate and trends in abundance for the Northern Tablelands management zones since 2001–02 are shown in Table 14.

In Appendix A, tables A9a, A10a and A11a show population estimates and quotas from 1993 to 2016.
## Table 14  Population estimates and trends in abundance for wallaroo on the Northern Tablelands, 2001–16.

<table>
<thead>
<tr>
<th>Year</th>
<th>Zone</th>
<th>Population estimate</th>
<th>Density (km⁻²)</th>
<th>Trend in abundance (% change from previous survey)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Armidale</td>
<td>72,600</td>
<td>4.8</td>
<td>61.0</td>
</tr>
<tr>
<td>2016</td>
<td>Glen Innes</td>
<td>54,900</td>
<td>3.2</td>
<td>94.0</td>
</tr>
<tr>
<td></td>
<td>Upper Hunter</td>
<td>73,400</td>
<td>9.2</td>
<td>168.0</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>200,900</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Armidale</td>
<td>45,140</td>
<td>2.8</td>
<td>9.0</td>
</tr>
<tr>
<td>2013</td>
<td>Glen Innes</td>
<td>28,305</td>
<td>1.5</td>
<td>-12.0</td>
</tr>
<tr>
<td></td>
<td>Upper Hunter</td>
<td>27,380</td>
<td>1.9</td>
<td>83.0</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>100,825</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Armidale</td>
<td>41,255</td>
<td>2.5</td>
<td>9.0</td>
</tr>
<tr>
<td>2010</td>
<td>Glen Innes</td>
<td>32,190</td>
<td>1.5</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Upper Hunter</td>
<td>14,985</td>
<td>1.0</td>
<td>-67.0</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>88,430</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Armidale</td>
<td>37,859</td>
<td>2.3</td>
<td>-58.0</td>
</tr>
<tr>
<td>2007</td>
<td>Glen Innes</td>
<td>32,184</td>
<td>1.5</td>
<td>-43.0</td>
</tr>
<tr>
<td></td>
<td>Upper Hunter</td>
<td>44,923</td>
<td>3.1</td>
<td>-27.0</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>114,966</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Armidale</td>
<td>89,787</td>
<td>5.7</td>
<td>158.0</td>
</tr>
<tr>
<td>2004</td>
<td>Glen Innes</td>
<td>56,657</td>
<td>3.1</td>
<td>-56.0</td>
</tr>
<tr>
<td></td>
<td>Upper Hunter</td>
<td>61,660</td>
<td>4.4</td>
<td>7.0</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>208,104</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Armidale</td>
<td>34,744</td>
<td>2.1</td>
<td>N/A</td>
</tr>
<tr>
<td>2001–2002</td>
<td>Glen Innes</td>
<td>128,323</td>
<td>6.1</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Upper Hunter</td>
<td>57,762</td>
<td>4.0</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>220,829</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 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 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%, 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 2019 of 432,198 represents 14.74% of the population estimated by aerial survey, as specified in the Plan (Quota for Cobar and Tibooburra are removed). Cobar and Tibooburra zone populations of red kangaroos is below the threshold at which the quota will be suspended.

Eastern grey kangaroo

The quota for 2019 of 476,718 for the Western Plains represents 14.8% of the population estimated by aerial survey — the maximum commercial quota specified in the Plan (Note that quota for Cobar is removed). The quota for 2019 of 190,170 for the Northern Tablelands region represents 15% of the estimated population of 1,267,800 derived from aerial surveys in 2016. 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 259,230 and 140,085 respectively, which represent 15% of the population estimates derived from aerial surveys in 2017. The combined 2018 eastern grey quota is 1,324,413.

Western grey kangaroo

The quota for 2019 of 117,465 represents 14% for six zones. Cobar zone quota is removed from the population estimated by aerial survey.

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 2019 quota, this value will remain at 15% for the Armidale, Glen Innes and Upper Hunter zones, in accordance with the Plan.

The 2019 quota is 30,135 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 carcass weight requirement increased from 12 to 14 kilograms for carcasses dressed for pet food processing, and from 13 to 15 kilograms for carcasses dressed for human consumption processing. Because of the size difference between male
and female wallaroos this requirement almost eliminates females from the harvest, as they are generally too small to meet the carcass weight requirement.

The impact on the other harvested species is less pronounced. In all cases, the average carcass weights for the period 1 January 2018 to 30 September 2018 (average 27.6 kilograms) and for 2017 (average 29.0 kilograms) and well above the long-term average (average 22.5 kilograms) (1999–2017).

**Red kangaroo**

Harvester returns for 2017 indicated that 96.9% of red kangaroos taken were males. For the year to 30 September 2018, harvester returns reported a male bias of 93.5%, which is well above the long-term average (1999–2017) of 75.1%.

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 2017 was 44.9%.

**Eastern grey kangaroo**

Harvester returns for 2017 indicate that 93.7% of eastern grey kangaroos taken were males. For the year to 30 September 2018, harvester returns reported a male bias of 89.5%, higher than the long-term average (1999–2017) of 73.9%.

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 2017 was 51.1%.

**Western grey kangaroo**

Harvester returns for 2017 indicate that 94.0% of western grey kangaroos taken were males. For the year to 30 September 2018, harvester returns recorded a male bias of 88.4%, well above the long-term average (1999–2017) of 70.6%.

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 2017 was 40.1%.

**Wallaroo**

Harvester returns for 2017 indicate that 99.2% of wallaroos taken were males. For the year to 30 September 2018, harvester returns recorded a male bias of 99.7%, well above the long-term average (1999–2017) of 90.9%.

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 2017 was 48.3%. 

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Proposed changes to quotas

For 2019, OEH does not propose to set quotas that are higher than those specified in the Plan.

However, in accordance with the provisions of the Plan, OEH proposes to suspend the harvest quota for reds, eastern and western greys in Cobar zone and suspend the quota for reds in the Tibooburra zone.

New commercial harvest zones

No new commercial harvest zones are proposed for commencement in 2019. However, the Southeast zone has been expanded to include the Bombala Area an approximate addition of 2720 square kilometres and will be available for harvesting in 2019.

References


Pople AR, Cairns SC and Menke N 2003, Monitoring Kangaroo Populations in South Eastern New South Wales. Consultancy report to NSW NPWS, Dubbo, NSW.
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 ‘Population estimates and survey method used’.

- 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 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 2018, these are not reflected in the following tables. Full details of adjustments will be given in the Annual Report for 2018.

- 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 A1a  Red kangaroo

<table>
<thead>
<tr>
<th>Average density (kangaroos/km²)</th>
<th>17.01</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area in km²</td>
<td>54,848</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>7.09</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Population</th>
<th>Density</th>
<th>% Change</th>
<th>Quota</th>
<th>% Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>1,004,500</td>
<td>18.3</td>
<td>-10.6</td>
<td>161,900</td>
<td>14.4</td>
</tr>
<tr>
<td>1991</td>
<td>1,468,600</td>
<td>26.8</td>
<td>46.2</td>
<td>149,200</td>
<td>14.9</td>
</tr>
<tr>
<td>1992</td>
<td>845,000</td>
<td>15.4</td>
<td>-42.5</td>
<td>337,800</td>
<td>23.0</td>
</tr>
<tr>
<td>1993</td>
<td>1,230,319</td>
<td>22.4</td>
<td>45.6</td>
<td>135,200</td>
<td>16.0</td>
</tr>
<tr>
<td>1994</td>
<td>1,103,648</td>
<td>20.1</td>
<td>-10.3</td>
<td>221,457</td>
<td>18.0</td>
</tr>
<tr>
<td>1995</td>
<td>1,078,399</td>
<td>19.7</td>
<td>-2.3</td>
<td>139,300</td>
<td>12.6</td>
</tr>
<tr>
<td>1996</td>
<td>1,009,295</td>
<td>18.4</td>
<td>-6.4</td>
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<td>1997</td>
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<td>65.8</td>
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<td>28.7</td>
<td>-5.8</td>
<td>190,900</td>
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</tr>
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<td>1999</td>
<td>925,897</td>
<td>16.9</td>
<td>-41.3</td>
<td>104,570</td>
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<tr>
<td>2000</td>
<td>927,889</td>
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<td>0.2</td>
<td>107,300</td>
<td>11.6</td>
</tr>
<tr>
<td>2001</td>
<td>1,389,398</td>
<td>25.3</td>
<td>49.7</td>
<td>106,200</td>
<td>11.4</td>
</tr>
<tr>
<td>2002</td>
<td>754,013</td>
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<td>-45.7</td>
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<tr>
<td>2003</td>
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<td>-44.2</td>
<td>124,700</td>
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<td>107,015</td>
<td>17.0</td>
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<td>7.9</td>
<td>19.5</td>
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<td>73,456</td>
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<td>10.2</td>
<td>-7.6</td>
<td>103,108</td>
<td>17.0</td>
</tr>
<tr>
<td>2010</td>
<td>636,038</td>
<td>11.6</td>
<td>13.4</td>
<td>95,320</td>
<td>17.0</td>
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<tr>
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<td>621,124</td>
<td>11.3</td>
<td>-2.3</td>
<td>108,126</td>
<td>17.0</td>
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<tr>
<td>2012</td>
<td>937,643</td>
<td>17.1</td>
<td>51.0</td>
<td>105,591</td>
<td>17.0</td>
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<td>2013</td>
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<td>17.1</td>
<td>-3.7</td>
<td>159,399</td>
<td>17.0</td>
</tr>
<tr>
<td>2014</td>
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<td>39.1</td>
<td>153,557</td>
<td>17.0</td>
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<td>19.4</td>
<td>-15.5</td>
<td>213,591</td>
<td>17.0</td>
</tr>
<tr>
<td>2016</td>
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<td>30.2</td>
<td>47.6</td>
<td>180,503</td>
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</tr>
<tr>
<td>2017</td>
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<tr>
<td>2018</td>
<td>344,619</td>
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<td>-69.7</td>
<td>193,040</td>
<td>17.0</td>
</tr>
<tr>
<td>2019</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table A1b  Grey kangaroo

<table>
<thead>
<tr>
<th>Year</th>
<th>Population</th>
<th>Density</th>
<th>% Change</th>
<th>Quota</th>
<th>% Population</th>
</tr>
</thead>
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Kangaroo management zone no. 6: Cobar

Table A4a  Red kangaroo

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## Kangaroo management zone no. 7: Bourke

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Kangaroo management zone no. 10: Coonabarabran

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# Kangaroo management zone no. 11: Griffith

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### Kangaroo management zone: Southeast NSW

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# Kangaroo management zone: Central Tablelands North

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## Kangaroo management zone: Central Tablelands South

Table A14  Grey kangaroo

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

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<th>Take</th>
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Table A15 continued Red and grey kangaroo annual population estimates: annual quotas, annual take figures and relative percentages

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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
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## Table A16 continued  Summary statistics of commercial take: red kangaroo

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<th>Take</th>
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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

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<th>% of population</th>
<th>% of quota</th>
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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 A18  Summary of commercial take: western grey kangaroos

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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 (3606 in 2017) 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)

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<tr>
<th>Year</th>
<th>Population estimate</th>
<th>Quota</th>
<th>% of previous year's population</th>
<th>Take</th>
<th>% of previous year's population</th>
<th>% of quota</th>
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<td>Quota</td>
<td>% of previous year’s population</td>
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<td>% of previous year’s population</td>
<td>% of quota</td>
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<td>30,135</td>
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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 brown lines indicate the standard error for the population estimate. That is, the actual population may be higher (the brown line) or lower (the pink line) than the estimate indicated by the green line.
Figure A2  Population trends in grey kangaroos on the Western Plains of New South Wales. The purple and brown lines indicate the standard error of the population estimate. That is, the actual population may be more (purple line) or less (brown line) than the estimate (green line).
Figure A3  NSW combined red and grey kangaroo population estimates, authorised quotas and actual takes, 1982–2019
Figure A4  NSW red kangaroo quotas and takes, 1982–2019
Figure A5  NSW eastern grey kangaroo quotas and takes, 1989–2019
Figure A6  NSW western grey kangaroo quotas and takes, 1989–2019
Figure A7  NSW wallaroo quotas and takes, 1989–2019
Appendix B Low population thresholds applicable for 2019

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 based on 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% of the population rather than the usual 15 or 17%. 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.

Reds, Eastern and Western greys Cobar Zone

The average density of red kangaroos in Cobar zone is 5.07, eastern grey 4.78 and western grey 7.47 per square kilometre. Following the 2018 aerial surveys of the Cobar zone, the estimated population of red kangaroos had a density of 1.11, eastern greys 0.84 and western greys 1.18 per square kilometre. The density for each species fell below Threshold 2 (refer to Table B1). Therefore, the commercial quota for all species in Cobar zone will be suspended for 2019.

Reds Tibooburra Zone

The average density of red kangaroos in Tibooburra zone is 18.61 per square kilometre. Following the 2018 aerial surveys of the Tibooburra zone, the estimated population of red kangaroos had a density of 6.26 per square kilometre. The current density of 6.26 is lower than Threshold 2 (refer to Table B1). Therefore the commercial quota for red kangaroos in Tibooburra zone will be suspended for 2019.

The current population densities and thresholds are shown for all zones in Table B1.
## Table B1  Average and current density estimates, and thresholds for quota reduction and suspension

### Western Plains

#### Western grey

<table>
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<tr>
<th>Zone</th>
<th>Tibooburra</th>
<th>Broken Hill</th>
<th>Lower Darling</th>
<th>Cobar</th>
<th>Bourke</th>
<th>Narrabri</th>
<th>Coonabarabran</th>
<th>Griffith</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average density</td>
<td>0.63</td>
<td>4.50</td>
<td>7.07</td>
<td>7.47</td>
<td>2.81</td>
<td>0.04</td>
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<td><strong>1.28</strong></td>
<td><strong>0.05</strong></td>
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### Eastern grey

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<th>Cobar</th>
<th>Bourke</th>
<th>Narrabri</th>
<th>Coonabarabran</th>
<th>Griffith</th>
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<tbody>
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### Red

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<th>Bourke</th>
<th>Narrabri</th>
<th>Coonabarabran</th>
<th>Griffith</th>
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Table B1 continued. Average and current density estimates, and thresholds for quota reduction and suspension

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<th>Glen Innes</th>
<th>Upper Hunter</th>
<th>Southeast NSW</th>
<th>Central Tablelands North</th>
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