2017 Quota Submissions for Commercially Harvested Macropods in Queensland

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September 2016

Executive summary

The commercial macropod harvest in Queensland is focused on three species (red kangaroo *Macropus rufus*, eastern grey kangaroo *Macropus giganteus*, common wallaroo *Macropus robustus*) located in four zones: no harvest zone, eastern harvest zone, central harvest zone and western harvest zone.

The harvest is administered through a quota and a quota submission which is released annually and outlines proposed quotas for each species in each zone for the following calendar year. Quotas are set between 10% and 20% of the estimated population for each species in each zone, depending on survey intensity and the standard error associated with population estimates.

Population estimates for 2016 and proposed sustainable use quotas for the 2017 commercial harvest

Species	Harvest zone	2016 estimated population (rounded to the nearest 50)	2017 sustainable use quota (rounded to the nearest 50)	Proportion of population (% rounded to the nearest whole number)
Red kangaroo	Central	5,137,600	1,027,500	20
	Eastern	145,200	14,500	10
	Western	485,850	48,600	10
	Combined	5,768,650	1,090,600	19
Eastern grey kangaroo	Central	8,111,850	1,216,800	15
	Eastern	5,873,850	587,400	10
	Western	7,250	0	0
	Combined	13,992,950	1,804,200	13
Common wallaroo	Central	2,205,600	330,850	15
	Eastern	552,500	55,250	10
	Western	47,050	4,700	10
	Combined	2,805,150	390,800	14

The formation of quotas is informed by criteria including:

- population trends (estimates obtained through aerial surveys)
- review of previous harvests
- the extent of non-commercial harvest mortality
- the extent of areas not subject to any harvest
- rainfall trends.

This quota submission outlines in detail the aspects of these criteria that pertain to the 2017 proposed quotas.

For 2016, aerial surveys were conducted at 12 monitor blocks across Queensland. Since regionalisation of the Queensland commercial macropod harvest was introduced in 2003, an estimate of macropod population size in the eastern and western zones has been made. The model used to estimate these populations is based on a small sample area and the reduced sampling effort is reflected in a conservative quota. This model was updated in 2012 to incorporate almost a decade of survey data and to generate trigger points for the commercial quota allocation.

Population estimates have decreased marginally for red kangaroos in all harvest zones in 2016. The eastern grey kangaroo population estimate for the central zone decreased but increased for the eastern and western zones. Common wallaroo population estimates decreased in the central and eastern zones but increased in the western zone. Overall combined totals for all three species declined marginally across the state.

Examination of long-term trends in population and block density estimates indicates that the 2016 estimates are within the realm of fluctuations in previous years. Estimates for all three commercially harvested species consistently number over 1,000,000 in Queensland.

In the 2015 harvest period, 25.9% of the commercial harvest quota was utilised, with the highest percentage of quota used being 32.8% for eastern grey kangaroos in the central zone. The overall harvest was male biased, with females comprising less than 4% of the overall harvest.

Figures available on 31 July 2016 show that 7% of the available quota for red kangaroos in the western zone had been harvested with 5% and 10% of the quota harvested in the eastern and central zones respectively. For eastern grey kangaroos, 17% and 4% of the quota was harvested in the central and eastern zones respectively. For common wallaroos, the highest percentage of quota harvested was 13% in the central zone, whilst only 3% of the quota was harvested in the eastern zone. Given these figures, it is unlikely that quotas will be met for each species in each zone in 2016.

Non-commercial take under damage mitigation permits (DMPs) were below quota for the 2015 harvest period. This trend is likely to be repeated in 2016 with a significant decrease in the uptake of DMPs by landholders.

The three commercially harvested macropod species continue to be protected from harvesting within the harvest zones in national parks and state forests. The protected area within the harvest zones is 79,981km^2. Macropods are further protected from harvest in Queensland within the non-harvest zones.

Annual rainfall across Queensland was drier than average during 2015 with many parts of the state drought declared throughout the year. Most of the eastern and western harvest zones are still drought declared whilst the entire central zone is drought declared at 31 July 2016.

Contents

Introduction

The commercial harvesting in Queensland of three macropod species—red kangaroo *Macropus rufus,* eastern grey kangaroo *Macropus giganteus* and common wallaroo *Macropus robustus*—is regulated through:

- *Environment Protection and Biodiversity Conservation Act 1999*
- Queensland Wildlife Trade Management Plan for Export—Commercially Harvested Macropods 2013–2017
- *Nature Conservation Act 1992*
  - Nature Conservation (Administration) Regulation 2006
  - Nature Conservation (Wildlife Management) Regulation 2006
  - Nature Conservation (Wildlife) Regulation 2006
  - Nature Conservation (Macropod) Conservation Plan 2005
  - Nature Conservation (Macropod Harvest Period) Notice
- *Animal Care and Protection Act 2001*
- *Food Production (Safety) Act 2000.*

The Department of Environment and Heritage Protection (EHP) administers the harvest of macropods in Queensland in accordance with the International Union for Conservation of Nature (IUCN) Recommendation 18.24, 'the ethical, wise and sustainable use of some wildlife can provide an alternative or supplementary means of productive land-use, and can be consistent with and encourage conservation, where such use is in accordance with appropriate safeguards' (IUCN 1990) and the Wildlife Trade Management Plan for Export—Commercially Harvested Macropods 2013–17, 'to provide for the sustainable use of macropod species covered by the plan, in accordance with the principles of ecologically sustainable development' (Anon 2012).

Management of the harvest is facilitated via a quota that sets the number of animals that can be taken. Quotas are established largely based on aerial surveys of the commercially harvested species and have been used in Queensland since 1975. The Director-General of EHP declares a harvest period open annually via the harvest period notice and sets quotas for this period having regard to the Queensland Wildlife Trade Management Plan for Export—Commercially Harvested Macropods 2013–17. Quotas are provided to the Commonwealth Minister for The Environment for endorsement.

Quotas in Queensland are set between 10% and 20% of the estimated population for each species in each zone. Harvesting at these levels will ensure a sustainable yield and long-term conservation of macropod populations.

Since 2003, quotas have been set for each species for four harvest zones to ensure that harvest pressure is distributed across the range of the species (Figure 1):

- no harvest zone (quota zero)
- eastern harvest zone
- central harvest zone
- western harvest zone.

This quota submission contains a summary of the recommended quotas for each of the species in each of the harvest zones for 2017. Additionally, the submission outlines the basis of how these quotas were determined.

The Nature Conservation (Macropod Harvest Period 2017) Notice 2016 is due for release in December 2016. The release of this notice will allow the harvest period to be declared open on 1 January 2017. The notice will outline specific conditions for the 2017 harvest period including, but not limited to, harvest zone boundaries, weights and more.

The proposed quotas were calculated using a fixed proportion of the estimated macropod populations within the Queensland harvest areas. Proportions were adjusted for each species across the harvest zones in relation to the margins of error present in population estimates derived from aerial surveys. The maximum proportions used for each species were 15% of the populations for eastern grey kangaroos and common wallaroos and 20% of the population for red kangaroos for the central zone. For the eastern and western zones, where survey effort is less extensive when compared to the central zone, the more conservative maximum proportion of 10% was applied for all three species.

These sustainable-use harvest proportions are based on research and modelling undertaken by Caughley et al. (1987) and Hacker et al. (2002) and are currently accepted by the scientific community, EHP and the Department of the Environment for determining state quota limits.

Proposed quotas

Table 1 – 2016 estimated populations and 2017 proposed quotas for each macropod species in each harvest zone

Species	Harvest zone	2016 estimated population	2017 sustainable use quota (rounded to the nearest 50)	Proportion of population (% rounded to the nearest whole number)
Red kangaroo	Central	5,137,600	1,027,500	20
	Eastern	145,200	14,500	10
	Western	485,850	48,600	10
	Combined	5,768,650	1,090,600	19
Eastern grey kangaroo	Central	8,111,850	1,216,800	15
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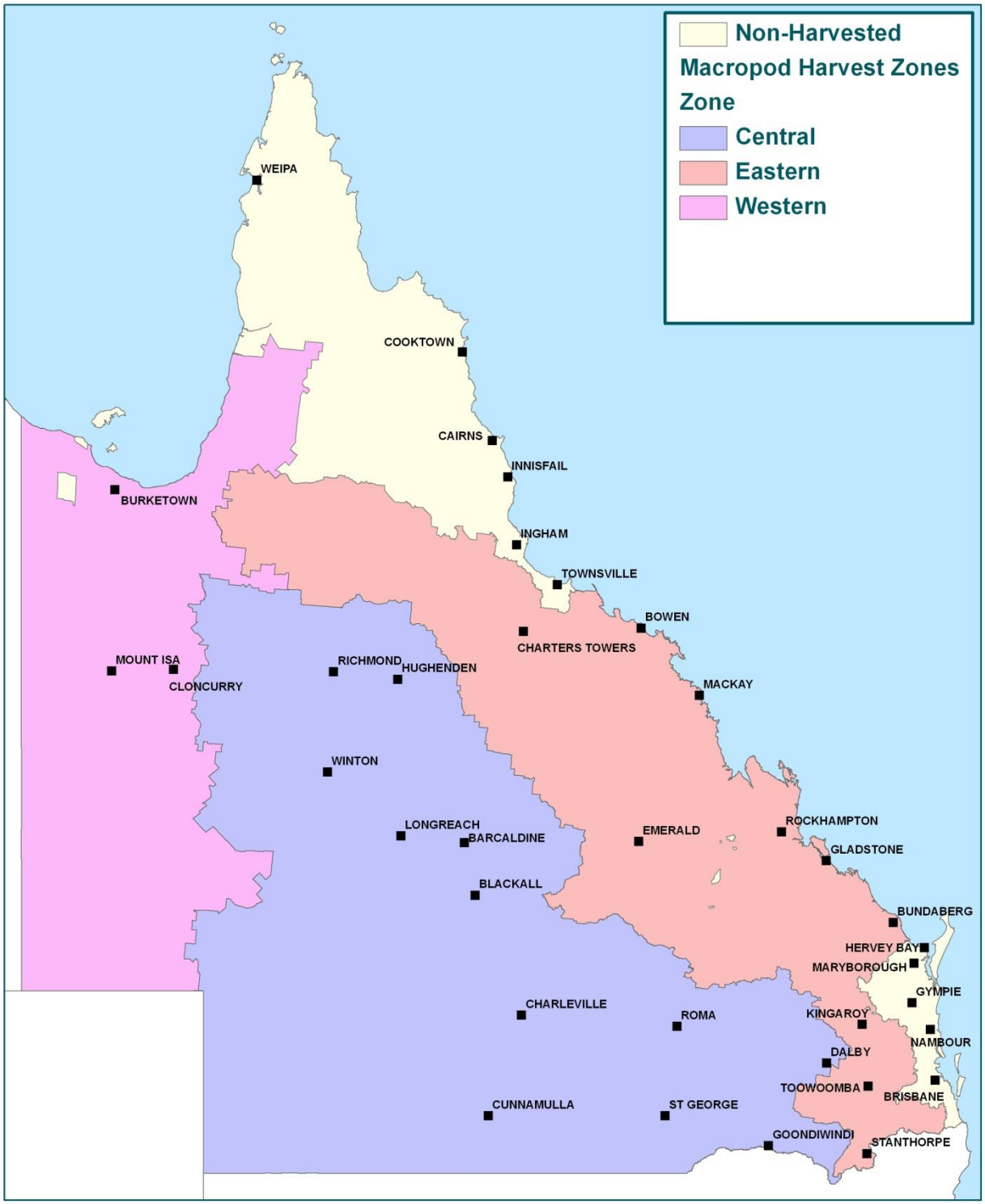
	Combined	2,805,150	390,800	14

Figure 1 – Queensland macropod harvest zones



Criteria considered in quota determination

The following criteria were considered in determining the quotas for each macropod species:

- population trends (estimates obtained through aerial surveys)
- review of previous harvests
- the extent of non-commercial harvest mortality
- the extent of areas not subject to any harvest
- rainfall trends.

Each of these criteria will be outlined in detail in this quota submission.

Long-term population trends

Population estimates

Since 1992, the Queensland Government has coordinated an annual program of aerial surveys to directly monitor populations of the three commercially harvested macropod species. These surveys occur over 22 representative monitor blocks across the state and are utilised to obtain population estimates that inform the quota. The methodology of the surveys is outlined in detail in Appendix 1. Since 2011 a correction factor of 1.85 has been applied to population estimates for common wallaroo in Queensland. Prior to this a correction factor of 1.2 was applied.

Current harvesting rates (quotas ranging from 10% to 20% of population estimates) are considered sustainable. None of the three commercially harvested species has shown a consistent decline in abundance since 1992 (figures 2, 3, 4 and 5), which would necessitate a reassessment of the harvest take and species conservation status. Whilst no consistent declines have been observed, the macropod populations in Queensland have fluctuated over time.

Density estimates

To contribute to ensuring commercially harvested macropod species are maintained across their distributions, density estimates are calculated for representative survey blocks as part of the aerial surveys (Appendix 2). For the purposes of interpreting this data in an easily understood manner, the density estimates for each species have been grouped into the eastern and western harvest zones, with the central harvest zone divided into three regions, central zone north (Mitchell Grass dominant), central zone south (Mulga Lands dominant) and central zone east (Brigalow Belt dominant) (Figure 6).

Figure 2 – Macropod population trends—1992–2016

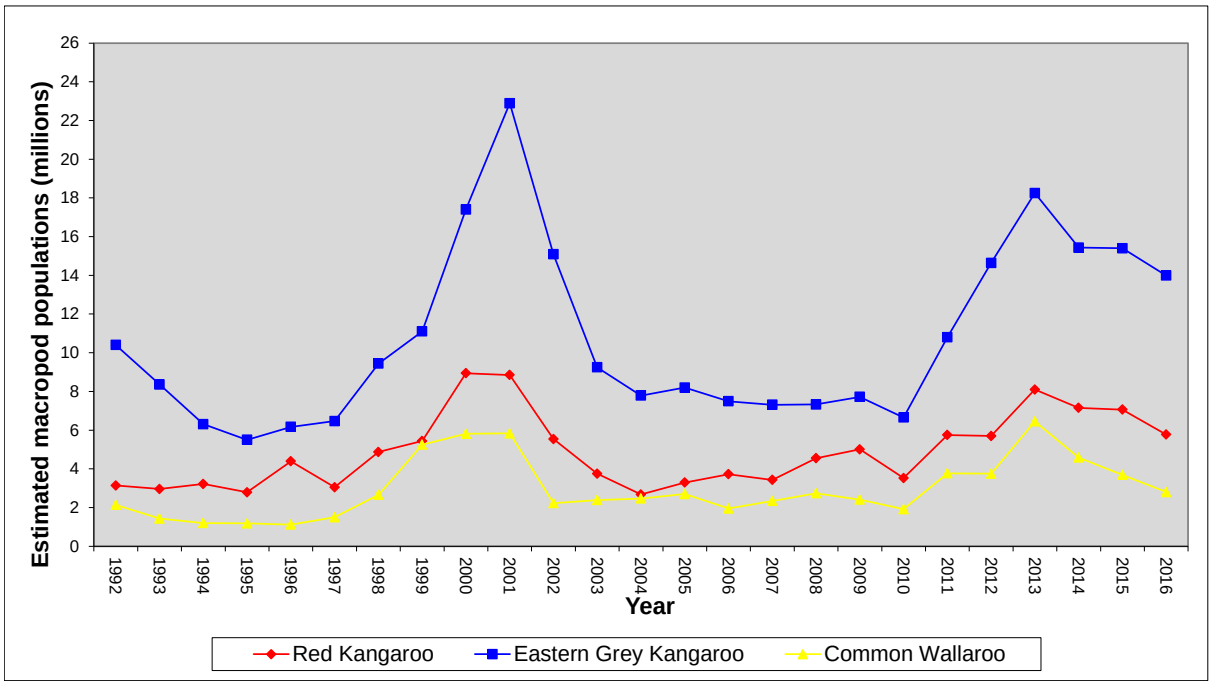


Figure 3 – Red kangaroo population estimates (with one standard error) since 1992

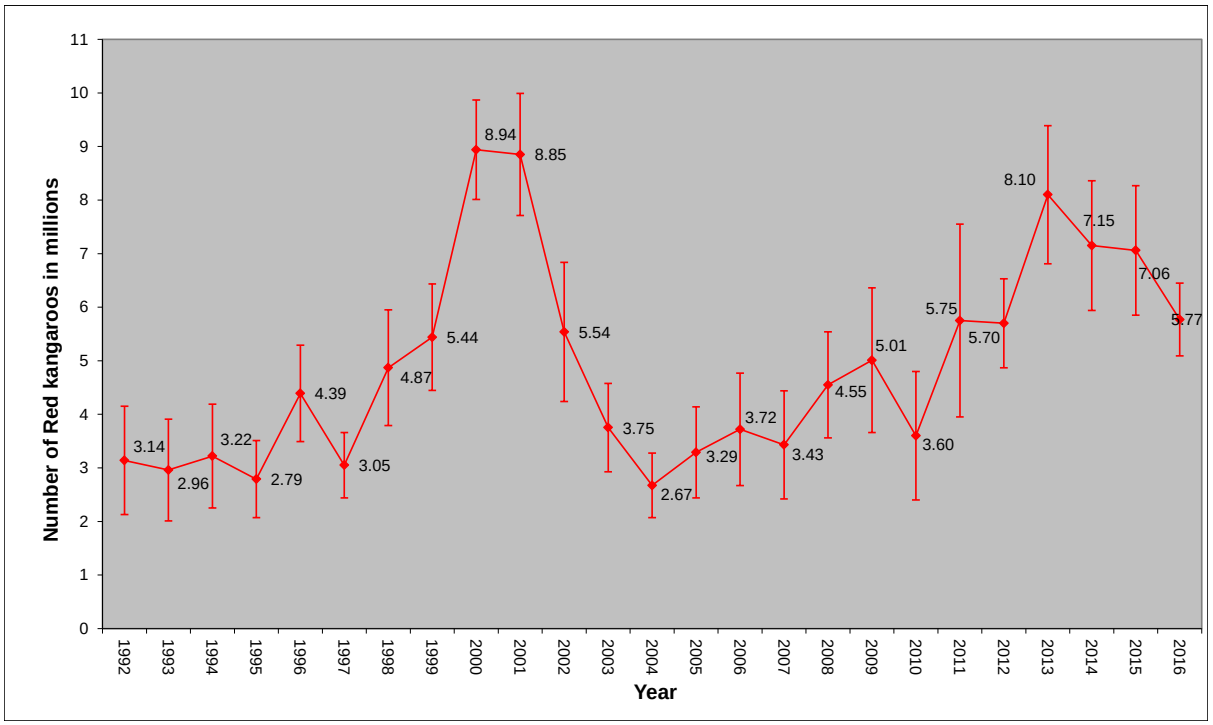


Figure 4 – Eastern grey kangaroo population estimates (with one standard error) since 1992

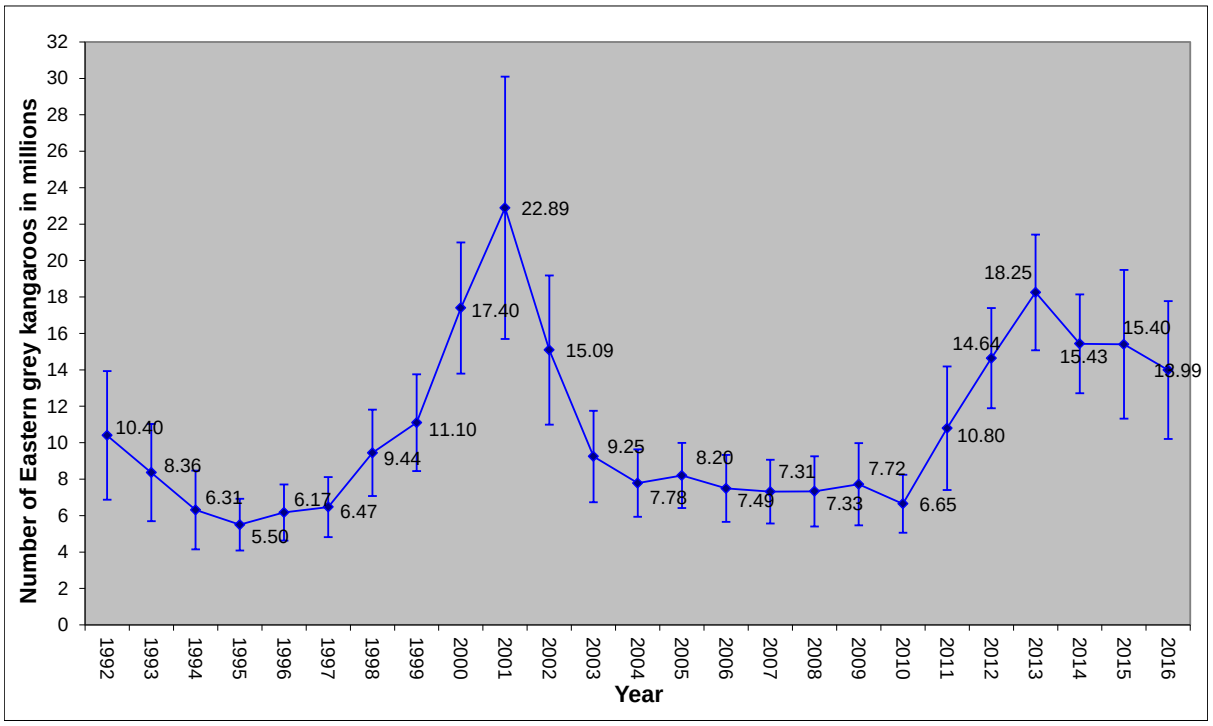
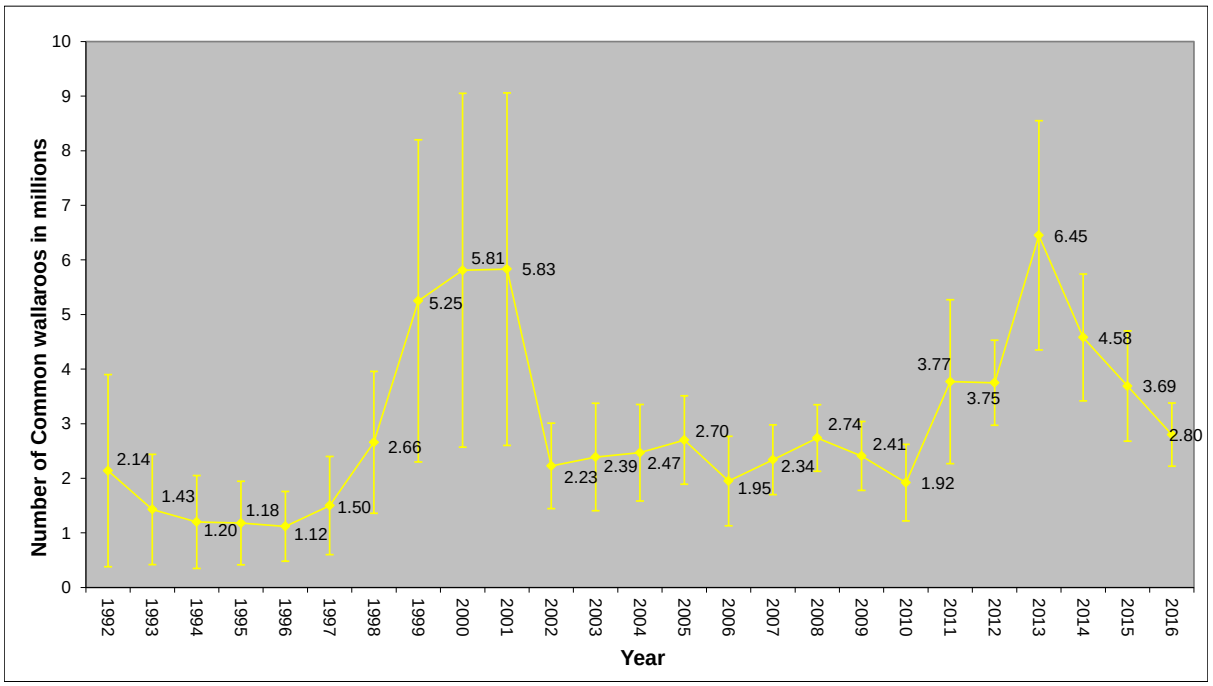


Figure 5 – Common wallaroo population estimates (with one standard error) since 1992. Estimates include a 1.85 correction factor for 2011 to 2016 and a 1.2 correction factor all other years



This data is monitored for any significant decreases in densities. This approach is possible for all data collected since 2005. Examination of trends in density for the three commercially harvested macropod species in the areas outlined above for the period 2005–2016 demonstrates densities do fluctuate over time (figures 7–11).

For red kangaroos densities are greatest in the central zone north and central zone south, with densities lowest in the eastern zone (Figure 10). Low densities in the eastern zone are expected as this area incorporates the edge of the distributional range for this species.

For eastern grey kangaroos highest densities are recorded in the central zone east (Figure 9). Eastern grey kangaroos occur in consistently low densities in the western zone at the edge of their distributional range. As such, there is no quota for eastern grey kangaroos in this zone (Table 1).

Common wallaroos occur in highest densities in the central zone north. This area is further divided into two regions for the purposes of estimating populations due to the considerably higher densities recorded around Blackall, Tambo and Longreach when compared to the rest of the zone (Figure 7 and Appendix 2). Lowest densities for this species occur in the western zone (Figure 1). Density fluctuations for this species do not follow the same patterns as those exhibited by red and eastern grey kangaroos (figures 7–11).

Figure 6 – Regions used to calculate population estimates of commercially harvested macropods

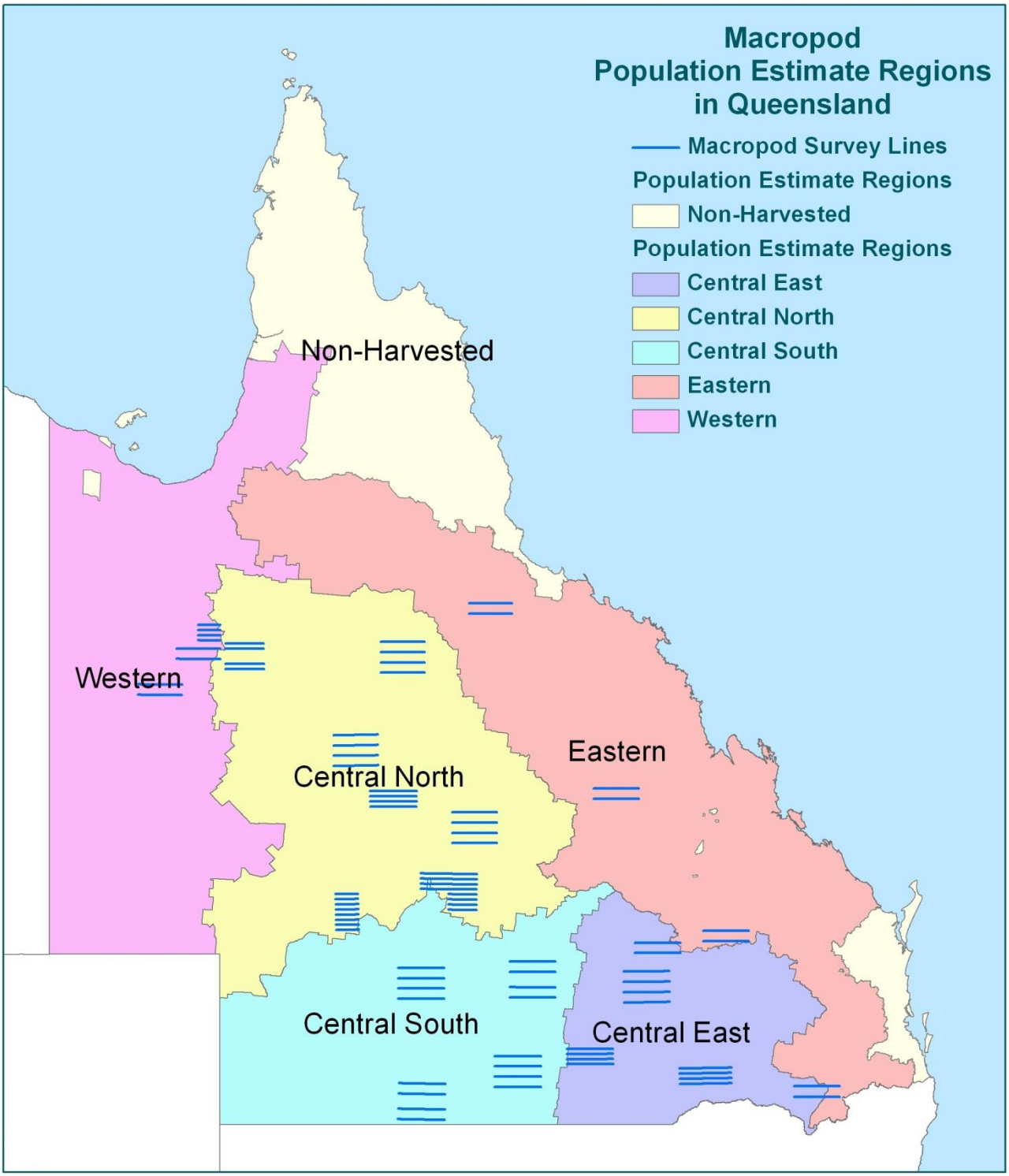
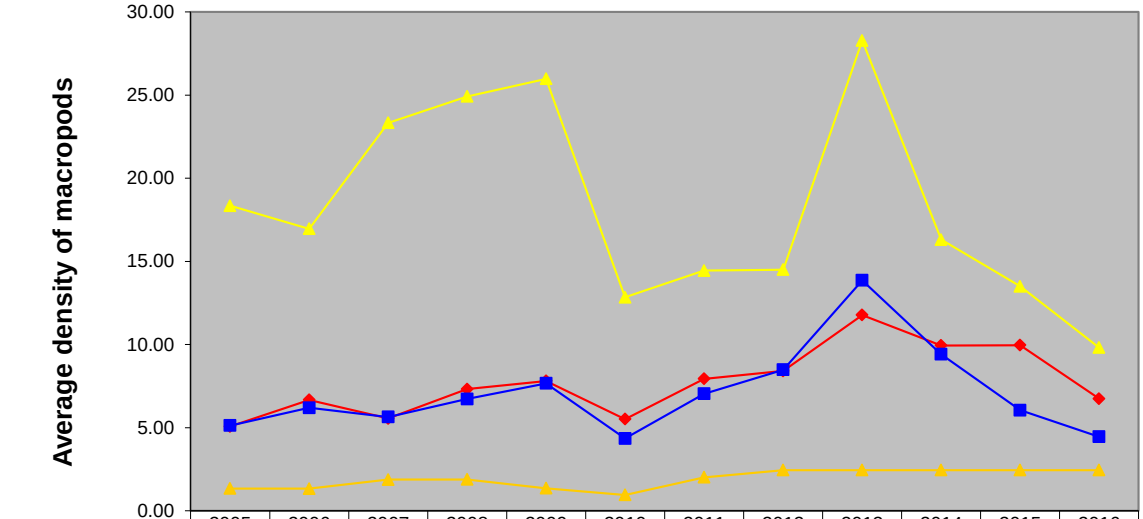
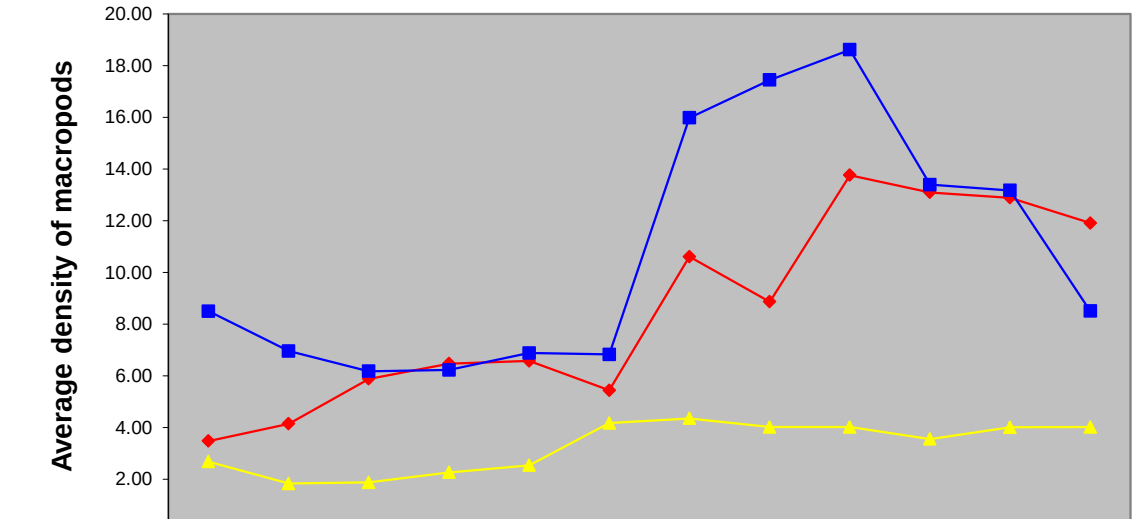


Figure 7 – Average density km^2 of commercially harvested macropods in the Central North population estimate region from 2005 to 2016 (Common wallaroos are represented by two areas in the Central North zone).



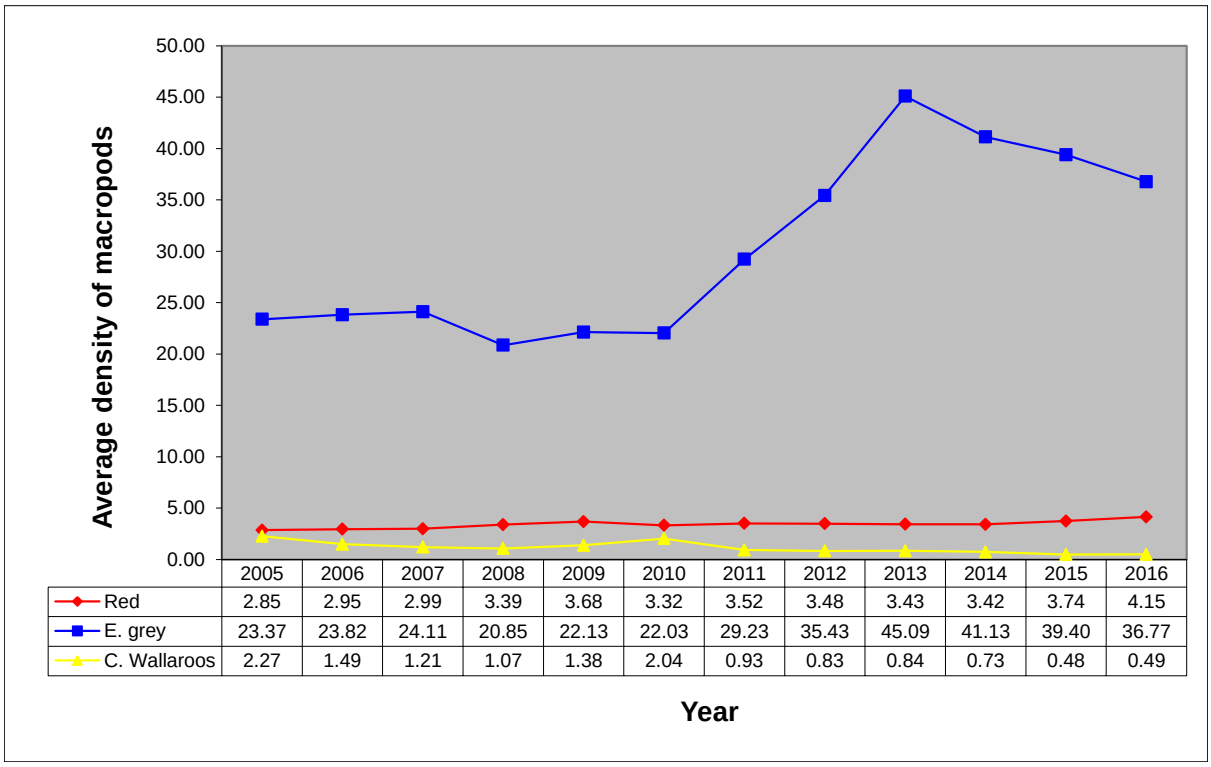
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Red	5.07	6.67	5.56	7.32	7.81	5.51	7.93	8.41	11.77	9.94	9.96	6.74
E. grey	5.12	6.19	5.64	6.72	7.66	4.35	7.04	8.48	13.86	9.41	6.05	4.45
C. Wallaroos A	18.35	16.95	23.33	24.92	25.98	12.84	14.44	14.50	28.28	16.31	13.50	9.81
C. Wallaroos B	1.34	1.33	1.87	1.88	1.35	0.95	2.01	2.45	2.45	2.45	2.45	2.45

Figure 8 – Average density km^2 of commercially harvested macropods in the Central South population estimate region from 2005 to 2016



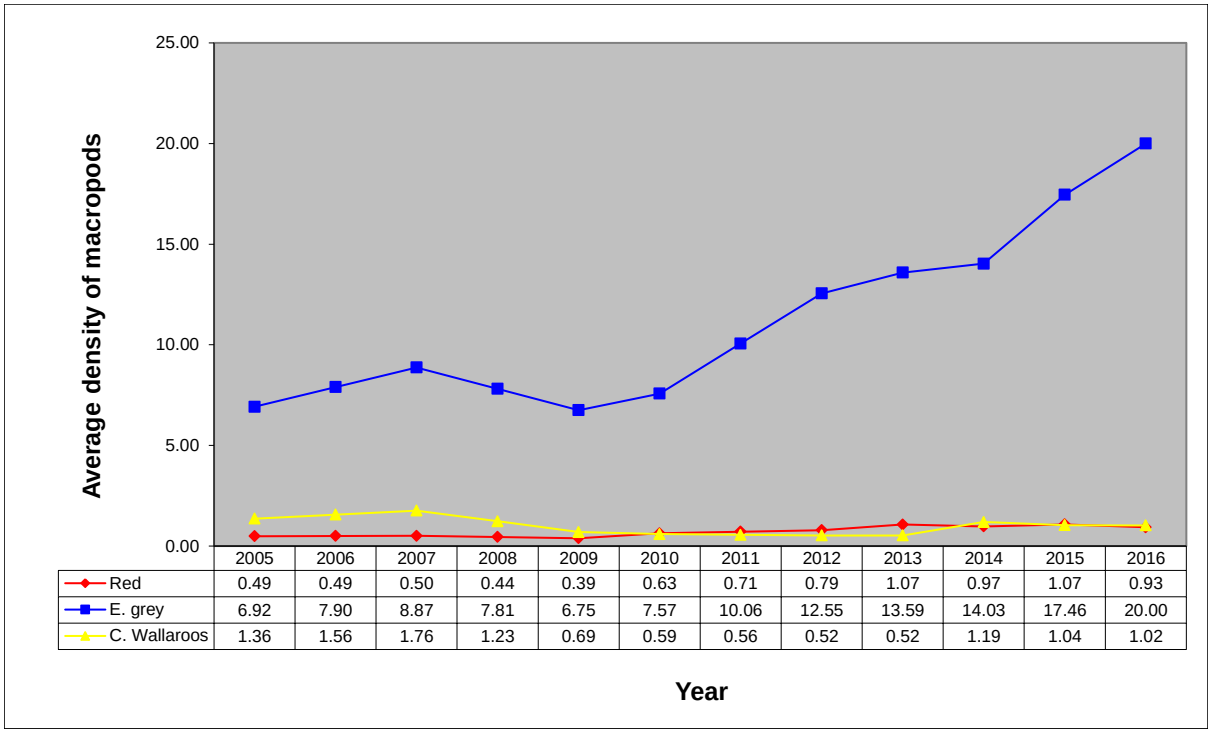
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Red	3.48	4.14	5.88	6.47	6.58	5.44	10.61	8.87	13.77	13.10	12.89	11.91
E. grey	8.50	6.96	6.18	6.23	6.88	6.83	15.98	17.45	18.62	13.40	13.18	8.51
C. Wallaroos	2.68	1.83	1.88	2.27	2.54	4.17	4.35	4.02	4.02	3.55	4.01	4.02

Figure 9 – Average density km^2 of commercially harvested macropods in the Central East population estimate region from 2005 to 2016



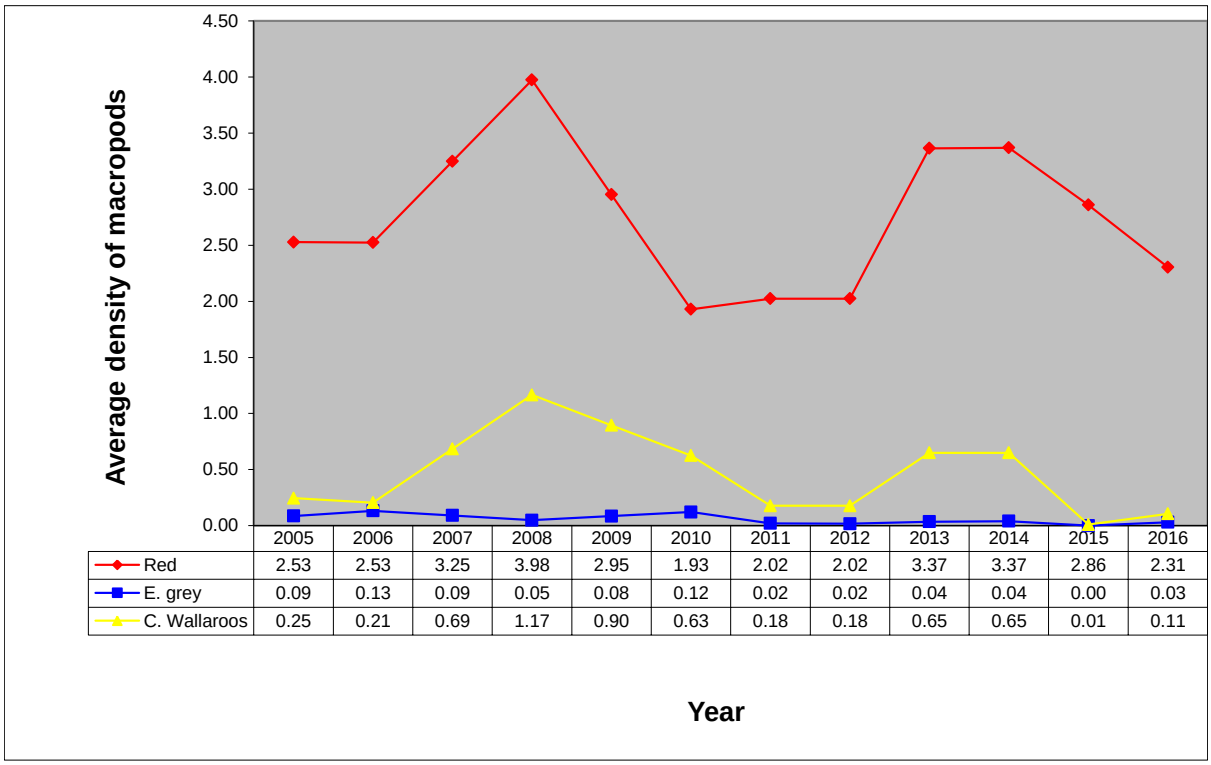
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Red	2.85	2.95	2.99	3.39	3.68	3.32	3.52	3.48	3.43	3.42	3.74	4.15
E. grey	23.37	23.82	24.11	20.85	22.13	22.03	29.23	35.43	45.09	41.13	39.40	36.77
C. Wallaroos	2.27	1.49	1.21	1.07	1.38	2.04	0.93	0.83	0.84	0.73	0.48	0.49

Figure 10 – Average density km^2 of commercially harvested macropods in the Eastern population estimate region from 2005 to 2016



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Red	0.49	0.49	0.50	0.44	0.39	0.63	0.71	0.79	1.07	0.97	1.07	0.93
E. grey	6.92	7.90	8.87	7.81	6.75	7.57	10.06	12.55	13.59	14.03	17.46	20.00
C. Wallaroos	1.36	1.56	1.76	1.23	0.69	0.59	0.56	0.52	0.52	1.19	1.04	1.02

Figure 11 – Average density km^2 of commercially harvested macropods in the Western population estimate region from 2005 to 2016



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Red	2.53	2.53	3.25	3.98	2.95	1.93	2.02	2.02	3.37	3.37	2.86	2.31
E. grey	0.09	0.13	0.09	0.05	0.08	0.12	0.02	0.02	0.04	0.04	0.00	0.03
C. Wallaroos	0.25	0.21	0.69	1.17	0.90	0.63	0.18	0.18	0.65	0.65	0.01	0.11

Trigger points

2013 marked the beginning of a new Queensland Wildlife Trade Management Plan for Export (Commercially Harvested Macropods 2013–17). Incorporated into this new plan are pre-determined trigger points for each of the commercial harvest quotas. Each trigger point represents a threshold level based on analysis of the long-term population estimate for each harvested species in each population estimate region.

Where an estimated population for a region falls below a trigger point of 1.5 standard deviations (SD) below the long-term average for that region then the harvest quota will be halved for that region in the next calendar year. If a population estimate falls below 2 SDs below the long-term average for that species in that region then there will be no quota for the following year.

Table 2 shows the calculated trigger points for 2017 for each species in each zone compared with the population estimates for those regions. The estimated population for each species and zone is above the calculated trigger points for 2017. As the western zone is on the very limit of the eastern grey kangaroo range no quota is set for this species in this zone. Consequently there are no trigger points calculated for this species in this zone.

Table 2 – Calculated trigger points for 2017 and estimated populations of commercially harvested macropod species in each region for 2016

Species	Population estimate region	2016 estimated population	2017 1.5 SD trigger point	2017 2 SD trigger point
Red kangaroo	Central North	2,367,350	1,801,850	1,587,900
	Central South	2,238,100	680,550	551,100
	Central East	532,150	94,900	71,800
	Eastern	145,200	73,150	63,800
	Western	485,850	173,150	136,100
Eastern grey kangaroo	Central North	1,287,650	1,283,000	1,061,950
	Central South	1,508,800	854,850	685,350
	Central East	5,315,400	2,426,500	2,048,200
	Eastern	5,873,850	1,109,750	854,700
	Western	7,250	NA	NA
Common wallaroo	Central North	1,715,500	460,350	351,350
	Central South	453,300	91,050	65,650
	Central East	36,800	15,250	11,550
	Eastern	552,500	242,500	206,700
	Western	47,050	20,650	12,350

Note: There is no quota set for eastern grey kangaroos in the western region.

Comparison between 2015 and 2016 population estimates

The total population estimates combined across all three harvest zones has decreased for all three species in 2016 compared with 2015 (Figure 12). However whilst some population estimates have decreased for specific zones others have increased (Table 3). Red kangaroo population estimates decreased in all harvest zones. The eastern grey population estimates increased in the eastern and western zones and decreased in the central zone. Common wallaroo population estimates decreased in the eastern and central zones and increased in the western zone.

Since regionalisation of the Queensland commercial macropod harvest was introduced in 2003 an estimate of macropod population size in the eastern and western zones has been made. The model used to estimate these populations is based on a small sample area and the reduced sampling effort is reflected in a conservative quota. This model was updated in 2012 to incorporate almost a decade of survey data and to generate trigger points for the commercial quota allocation.

Figure 12 – Comparison of overall macropod populations in the commercial harvest zones 2015 and 2016 (with one standard error)

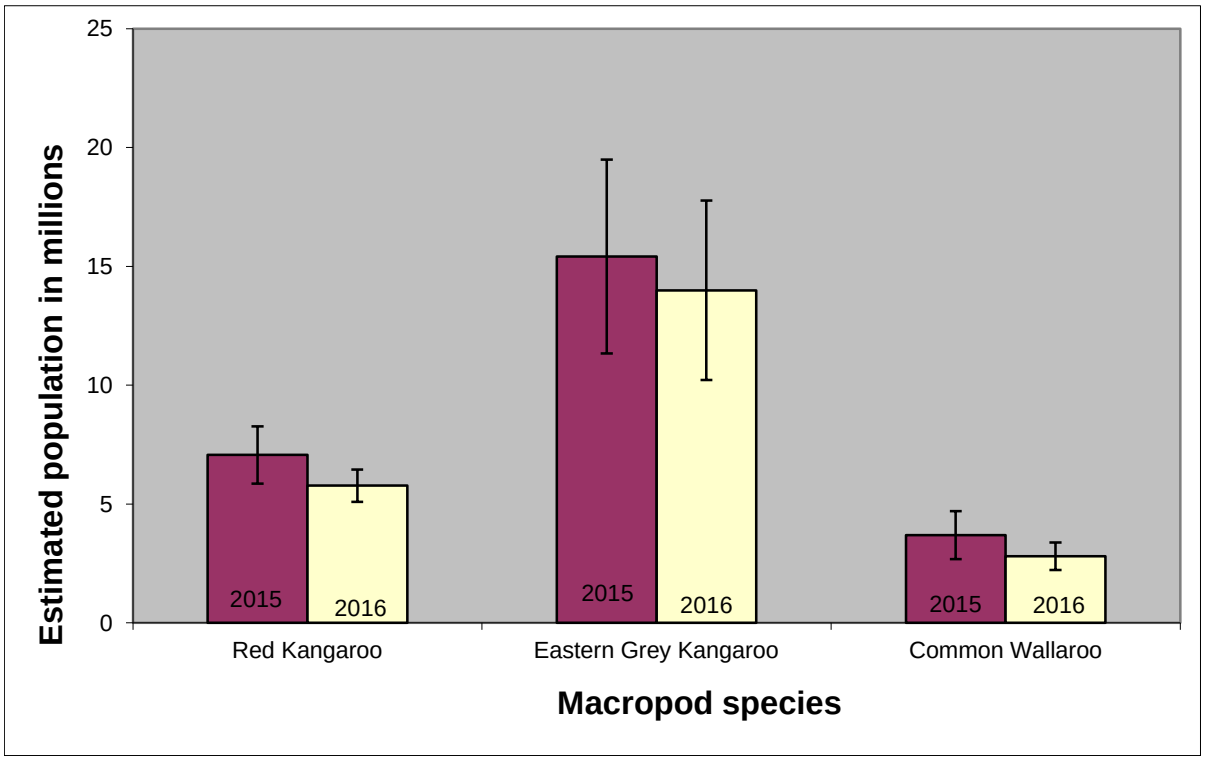


Table 3 – Comparison between 2015 and 2016 macropod population estimates

Species	Harvest zone	2015 population estimate	2016 population estimate
Red kangaroo	Central	6,298,150	5,137,600
	Eastern	171,500	145,200
	Western	591,550	485,850
	Combined	7,061,200	5,768,650
Eastern grey kangaroo	Central	10,291,590	8,111,850
	Eastern	5,115,080	5,873,850
	Western	0	7,250
	Combined	15,406,670	13,992,950
Common wallaroo	Central	3,130,208	2,205,600
	Eastern	559,385	552,500
	Western	4,520	47,050
	Combined	3,694,113	2,805,150

Figure 13 – Comparison of macropod populations from 2015 to 2016 by species and zone

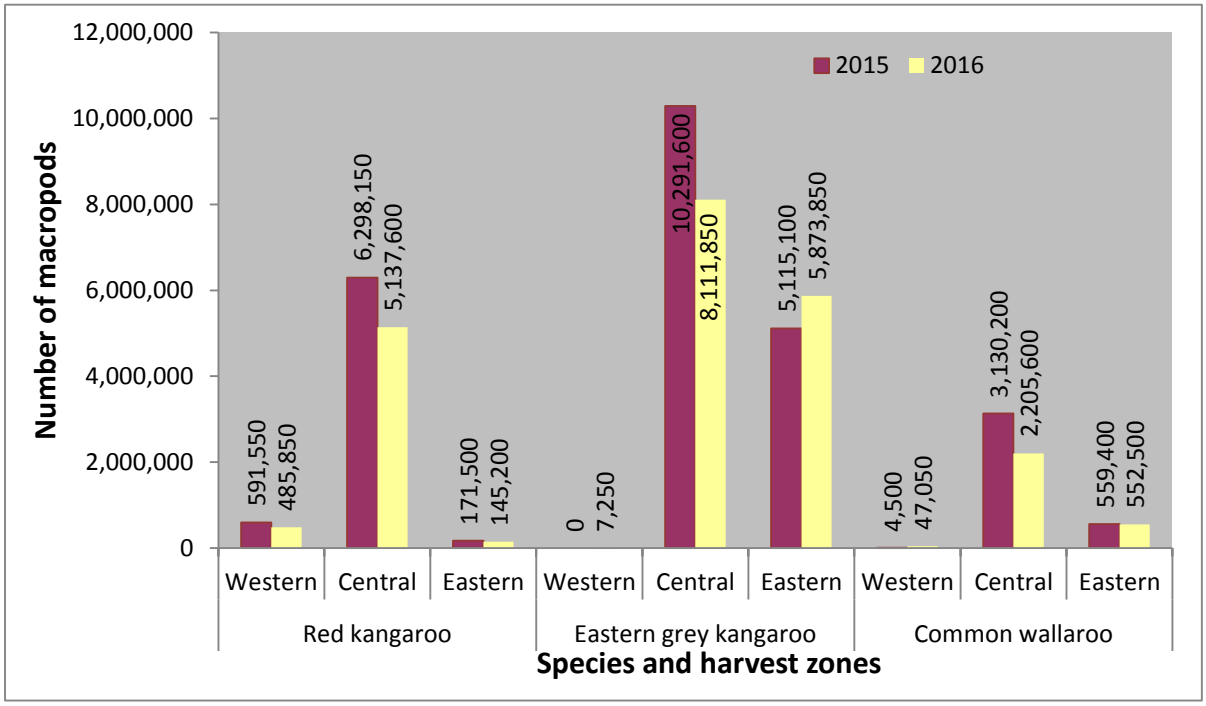
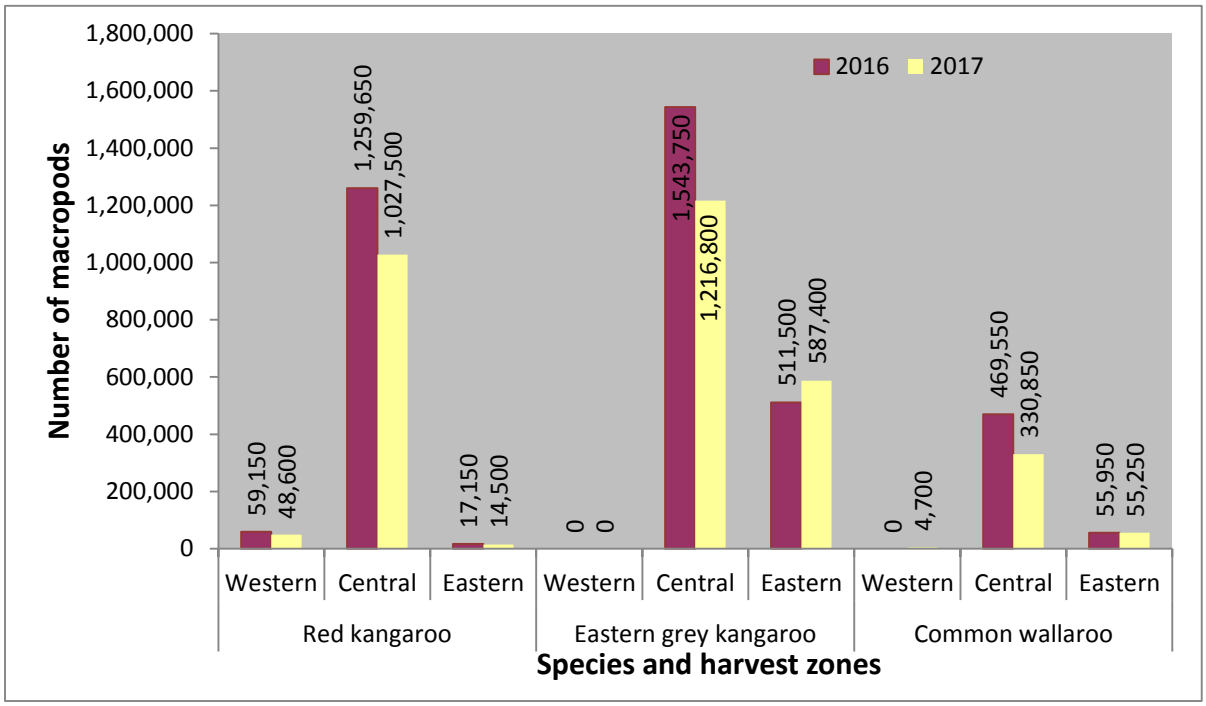


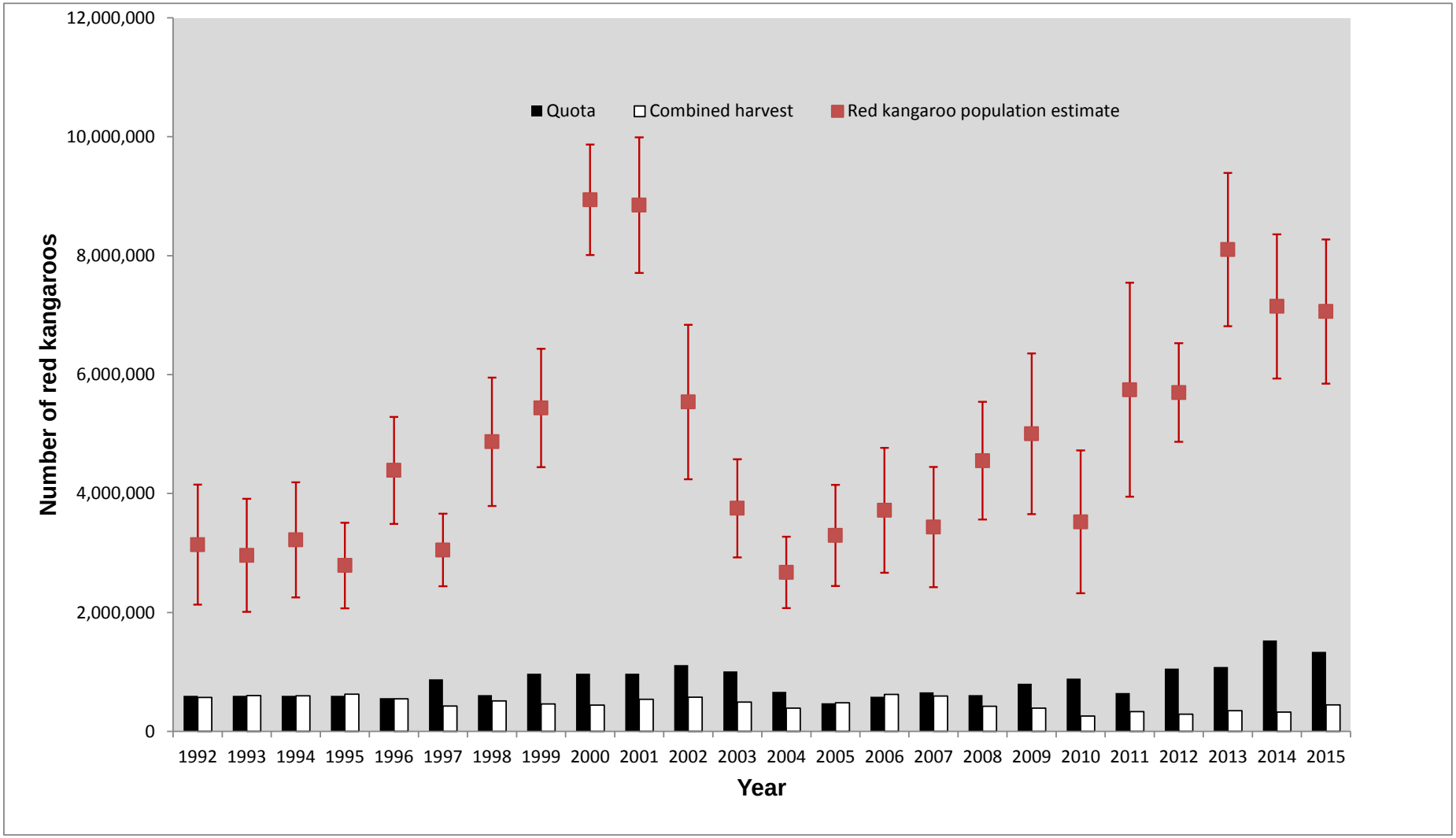
Figure 14 – Comparison of 2016 actual and 2017 proposed harvest quotas



Long-term quota and harvest trends

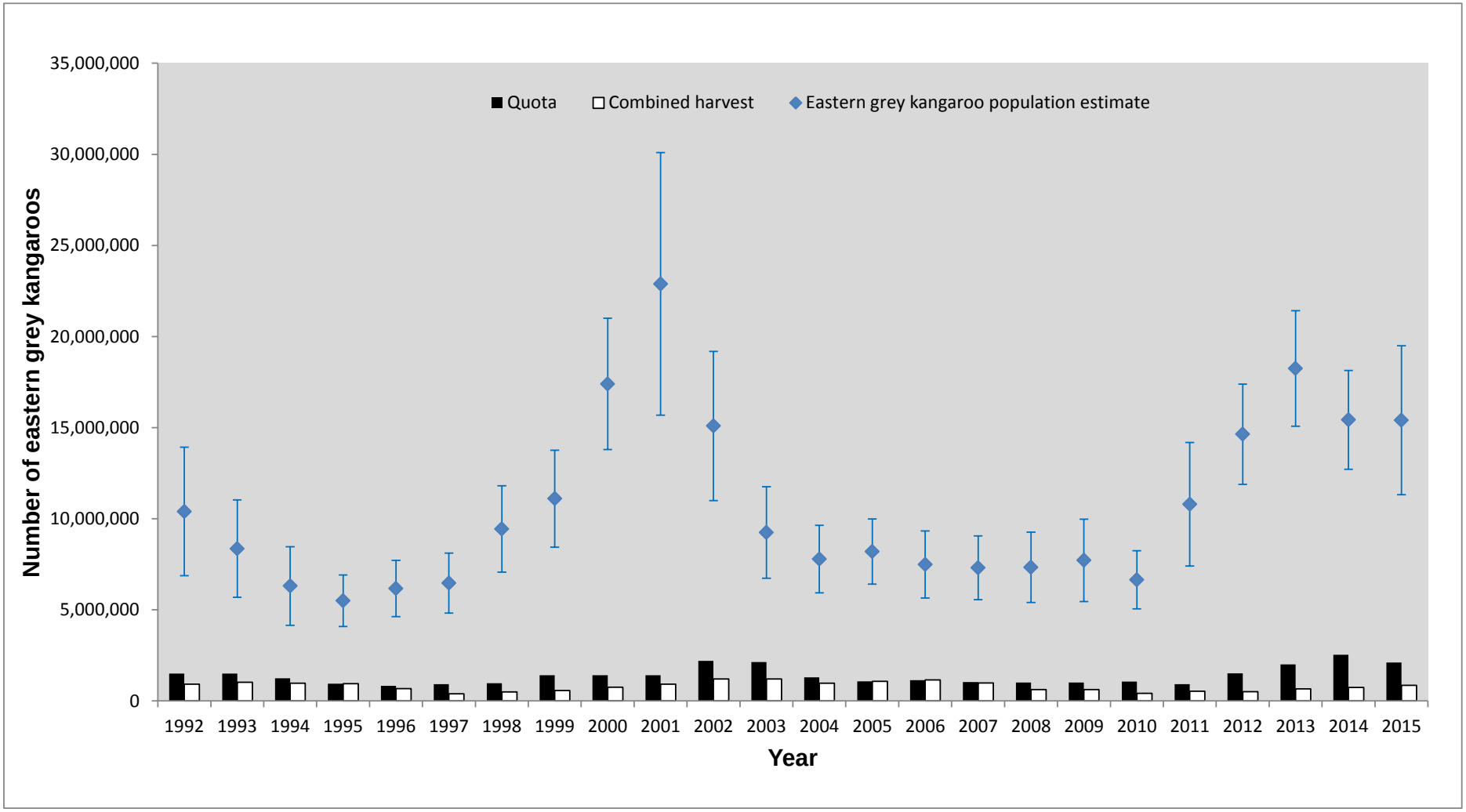
Figures 15 to 17 outline data on the three commercially harvested macropod species pertaining to estimated population, quota and harvest for the years 1992 to 2015. Please note that population estimates are based on aerial surveys conducted in the previous year to the quota and harvest. Combined population estimates, quota and harvest data have been used for the period post-regionalisation in 2003, to enable comparison with data collated prior to this period.

Figure 15 – Long-term population estimates (± one standard error), quota and harvest data (commercial harvest + damage mitigation permits) for the red kangaroo in Queensland.



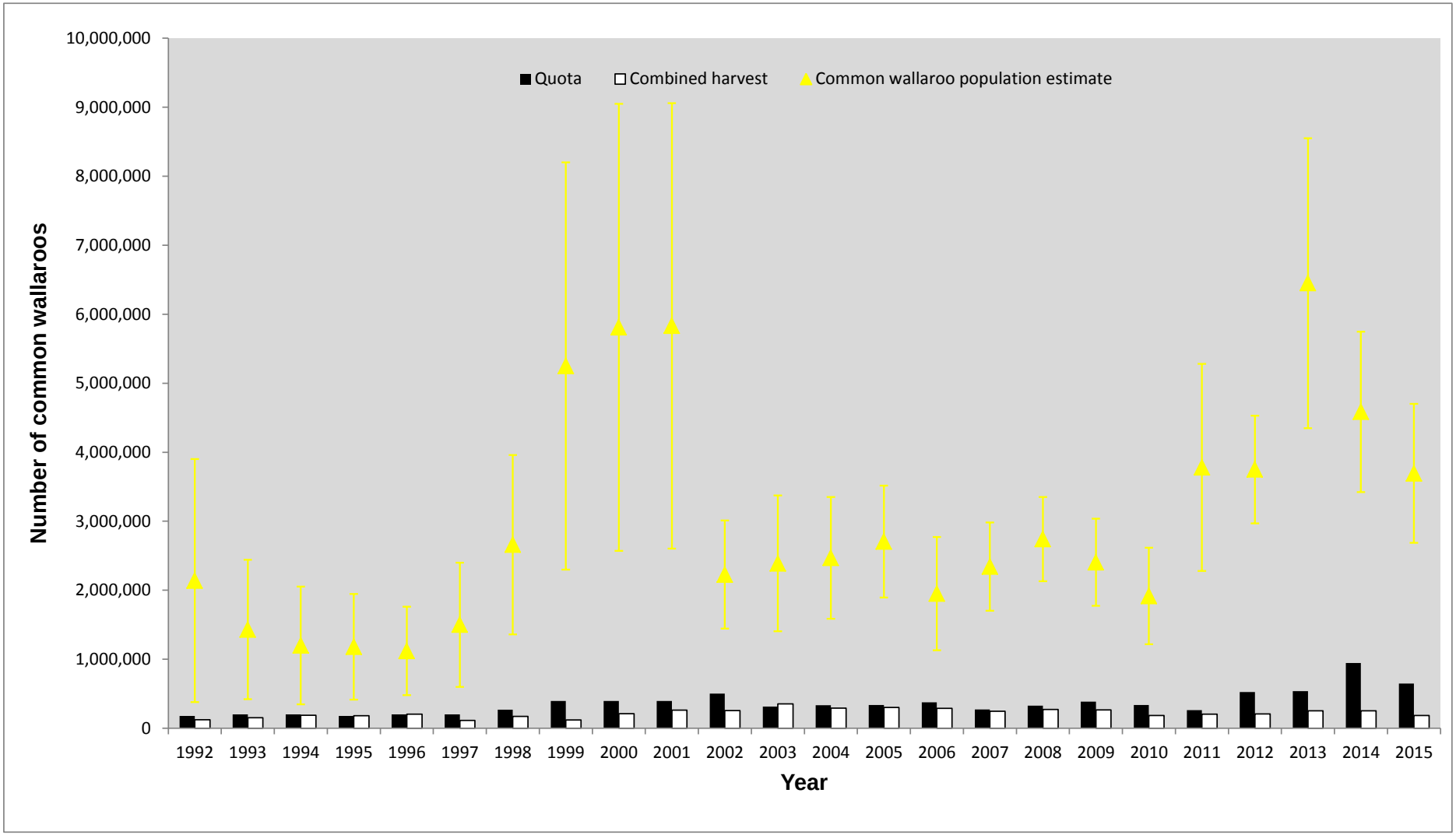
Note: population estimates are based on aerial surveys conducted the year before the harvest was taken.

Figure 16 – Long-term population estimates (± one standard error), quota and harvest data (commercial harvest + damage mitigation permits) for the eastern grey kangaroo in Queensland.



Note: population estimates are based on aerial surveys conducted the year before the harvest was taken.

Figure 17 – Long-term population estimates (± one standard error), quota and harvest data (commercial harvest + damage mitigation permits) for the common wallaroo in Queensland.



Note: population estimates are based on aerial surveys conducted the year before the harvest was taken.

As previously outlined, there has been no consistent decline in the populations of the three commercially harvested species since 1992 (figures 15 to 17). Of these species, the eastern grey kangaroo is consistently most abundant across the harvest zones, followed by the red kangaroo. Common wallaroos are the least numerous. Population estimates for all three species are in excess of one million across the harvest zones.

As quotas are set as a constant proportion of the populations, they fluctuate as population estimates fluctuate (figures 15 to 17). However, numerous factors influence harvest rates for commercial macropods. These include population levels, market forces, environmental conditions and access by harvesters. As a consequence, there is no clear pattern or trend in the proportion of the quota harvested since 1992.

Review of the 2015 harvest

Dealer returns for the year 2015 indicate that there were 1,061,009 macropods taken in Queensland, which represents 25.9% of the overall combined quota. Of the 1,061,009 animals harvested, there were 340,821 red kangaroos, 602,400 eastern grey kangaroos and 117,788 common wallaroos harvested (table 4). Quotas for individual species in each harvest zone were not exceeded in 2015, the maximum commercial take as a percentage of the approved quota of 32.8% being for eastern greys in the central zone (tables 4 to 7).

Table 4 – Total harvest in 2015

Species	Population estimate 2014	Quota 2015	Harvest take 2015	% quota used 2015	% population harvested 2015
Red kangaroo	7,147,850	1,336,950	340,821	25.5%	4.8%
Eastern grey kangaroo	15,427,250	2,105,850	602,400	28.6%	3.9%
Common wallaroo	4,584,750	647,300	117,788	18.2%	2.6%
Total	27,159,850	4,090,100	1,061,009	25.9%	3.9%

Note: population estimates are based on aerial surveys conducted in 2014, which were used to set the 2015 quota.

Table 5 – Harvest of red kangaroos in 2015

Zone	Population estimate 2014	Quota 2015	Harvest take 2015	% quota utilised 2015	% population harvested 2015
Central	6,221,550	1,244,300	330,654	26.6%	5.3%
Eastern	166,350	16,650	2,248	13.5%	1.4%
Western	759,950	76,000	7,919	10.4%	1.0%
Total	7,147,850	1,336,950	340,821	25.5%	4.8%

Note: population estimates are based on aerial surveys conducted in 2014, which were used to set the 2015 quota.

Table 6 – Harvest of eastern grey kangaroos in 2015

Zone	Population estimate 2014	Quota 2015	Harvest take 2015	% quota utilised 2015	% population harvested 2015
Central	11,280,150	1,692,000	555,301	32.8%	4.9%
Eastern	4,138,650	413,850	47,099	11.4%	1.1%
Western	8,450	0	0	NA	NA
Total	15,427,250	2,105,850	602,400	28.6%	3.9%

Note: population estimates are based on aerial surveys conducted in 2014, which were used to set the 2015 quota.

Table 7 – Harvest of common wallaroos in 2015

Zone	Population estimate 2014	Quota 2015	Harvest take 2015	% quota utilised 2015	% population harvested 2015
Central	3,776,550	566,500	111,930	19.8%	3.0%
Eastern	649,650	64,950	5,114	7.9%	0.8%
Western	158,550	15,850	744	4.7%	0.5%
Total	4,584,750	647,300	117,788	18.2%	2.6%

Note: population estimates are based on aerial surveys conducted in 2014, which were used to set the 2015 quota.

Sex ratio by species and zone

Commercial harvest is typically biased towards males (figure 19) as they are usually larger and heavier than females. In 2015, the total harvest for each species comprised between 95.9% and 99.9% males. Data gathered throughout 2015 indicates 3.5% of the overall harvest was female (figure 18).

Figure 18 Proportion of 2015 harvest, male and female by species

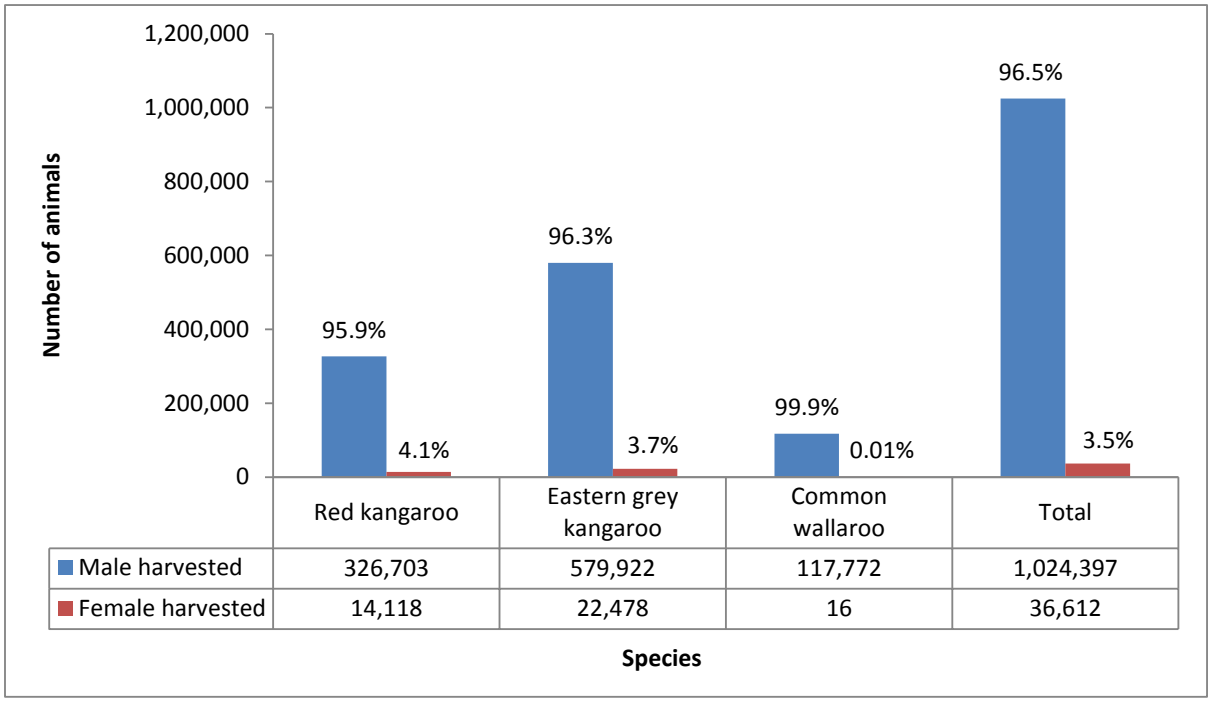
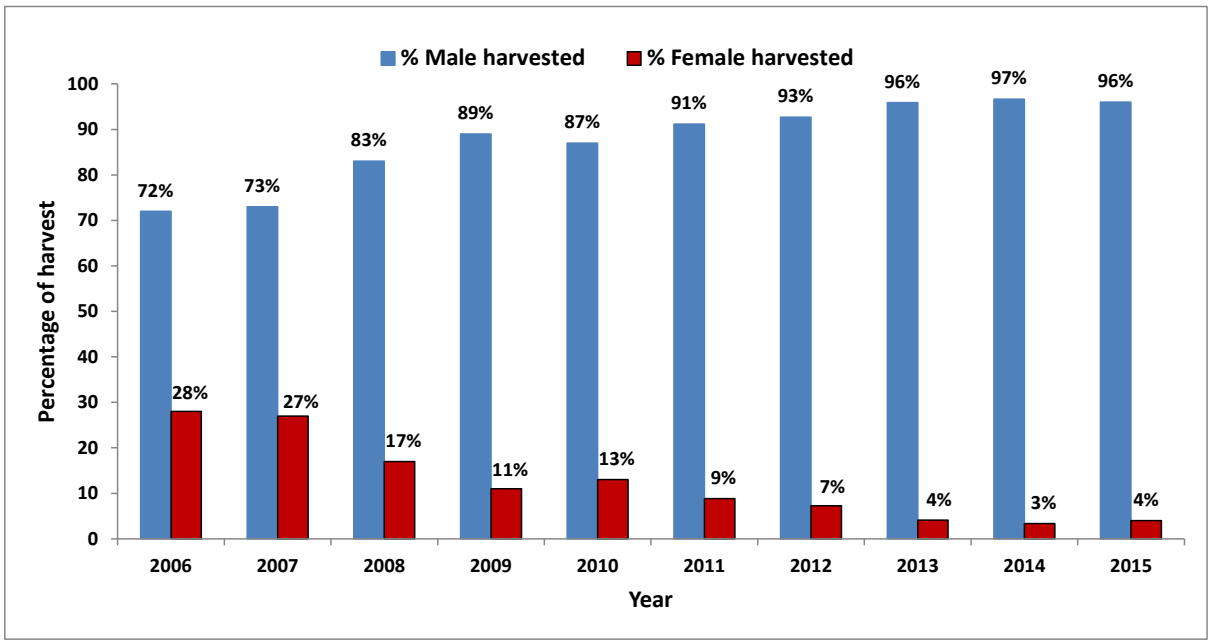


Figure 19 – Overall sex ratio from 2006 to 2015 (percentages rounded to the nearest whole number).



Harvest update for 2016

The total number of tags issued up to 31 July 2016 was 700,100. A comparison of tag sales and harvest returns in relation to quotas in each zone is given in table 8. The number of tags produced does not exceed the maximum quota for each species in each zone therefore it is not possible for the commercial harvest quotas to be over allocated. Given the low percentage of the quota that has currently been issued in tags, it is unlikely quotas will be met for any species in any zone. The 2016 harvest will be comprehensively reported on in the 2016 annual report, due for release in March 2017.

Table 8 – Tags issued and reported harvest for 2016 at 31 July

Species	Harvest zone	2016 sustainable use quota (rounded to the nearest 50)	Tags issued to 31 July 2016	Reported harvest to 31 July 2016
Red kangaroo	Central	1,259,650	194,750	127,132
	Eastern	17,150	4,000	865
	Western	59,150	6,450	4,216
Eastern grey kangaroo	Central	1,543,750	354,500	254,908
	Eastern	511,500	41,450	20,927
	Western	NA	NA	NA
Common wallaroo	Central	469,550	92,000	59,840
	Eastern	55,950	6,950	1,867
	Western	NA	NA	NA

The extent of non-commercial harvest mortality

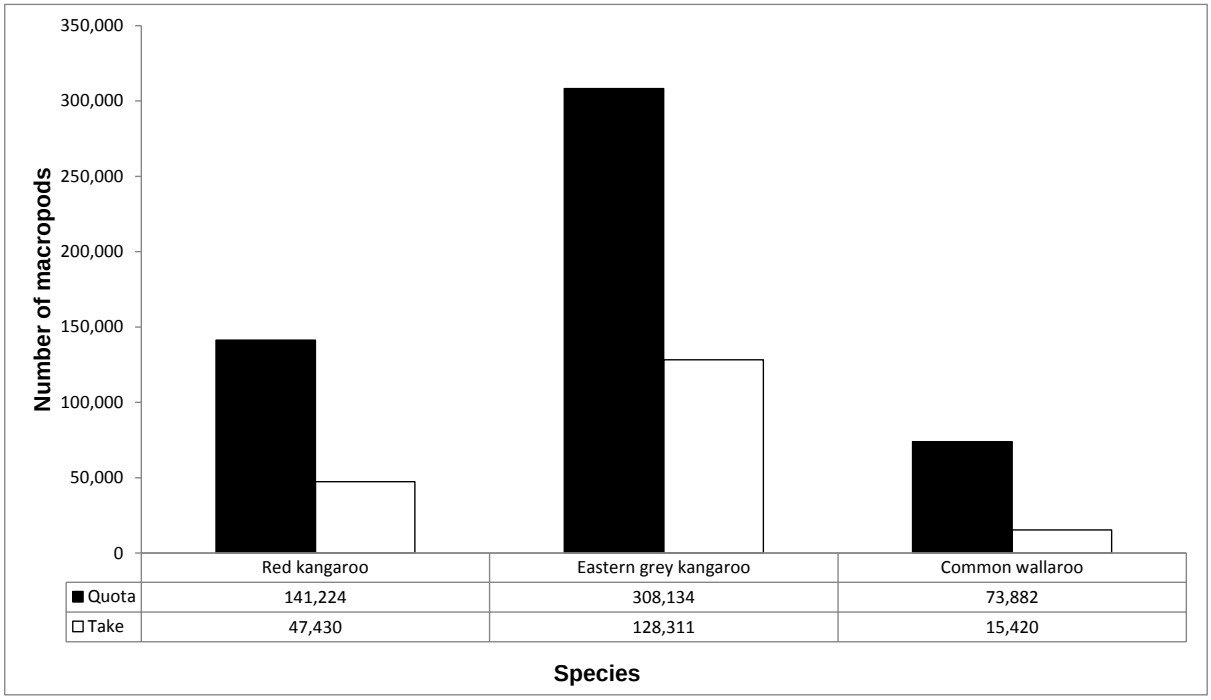
There are many forms of macropod mortality outside of the commercial harvest. It is possible for EHP to collect and report data on three forms of non-commercial harvest mortality which can be considered when determining commercial quotas. These include Damage Mitigation Permits (DMPs), licensed recreational harvest and disease outbreak mortality.

Damage to primary production

DMPs are issued by EHP where macropods are causing demonstrable damage to primary production. The issuing of these permits is limited to a maximum of 2% of the population estimate for each species in each zone. It is a condition of the permit that macropods are taken in accordance with the requirements of the National Code of Practice for the Humane Shooting of Kangaroos and Wallabies for Non-commercial Purposes. Consistent with the Queensland government's policy of reducing red tape EHP made a number of significant improvements to the DMP process in 2014 that greatly enhanced landholders' ability to manage macropods:

Uptake of DMPs has increased since these changes were instigated (figure 21). In August 2015 changes were made to the Nature Conservation (Macropod) Conservation Plan 2005 to further assist landholders comply with legislative requirements when managing macropods for damage mitigation purposes. The quota for DMPs of commercially harvested macropods was increased from 1% to 2% of the estimated population.

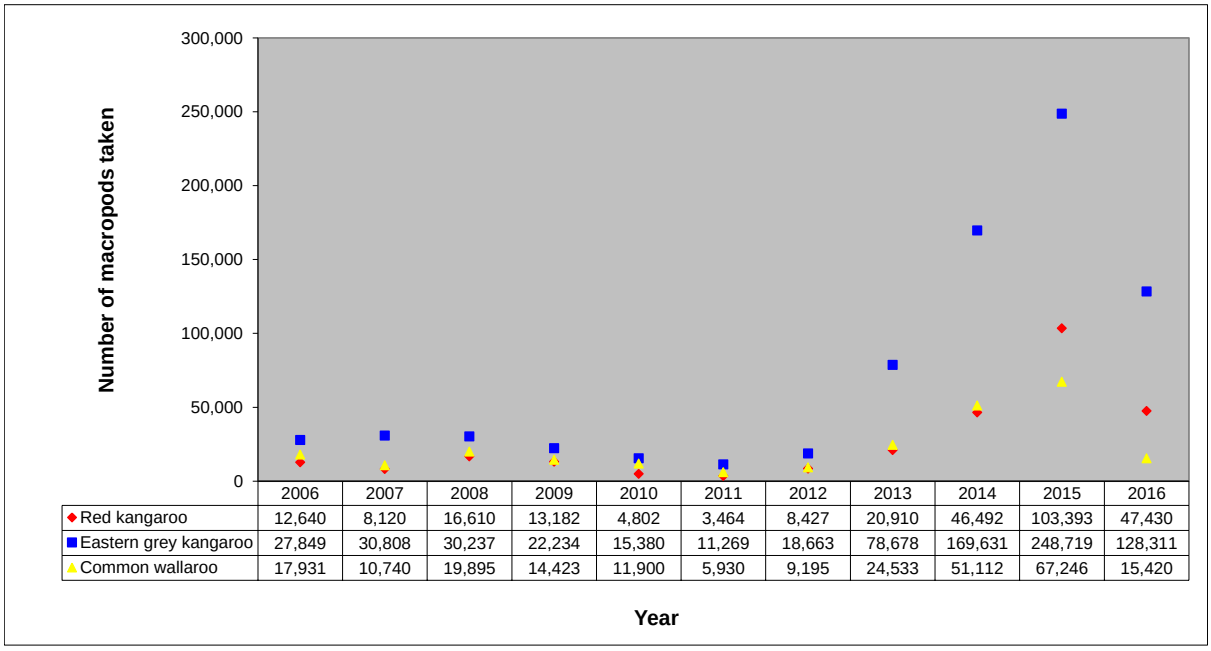
Figure 20 – Macropod quota and take for DMP in 2016



	Red kangaroo	Eastern grey kangaroo	Common wallaroo
Quota	141,224	308,134	73,882
Take	47,430	128,311	15,420

Note: Figures are as recorded on 25 August 2016

Figure 21 – Macropods taken under a DMP 2006–2016



	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Red kangaroo	12,640	8,120	16,610	13,182	4,802	3,464	8,427	20,910	46,492	103,393	47,430
Eastern grey kangaroo	27,849	30,808	30,237	22,234	15,380	11,269	18,663	78,678	169,631	248,719	128,311
Common wallaroo	17,931	10,740	19,895	14,423	11,900	5,930	9,195	24,533	51,112	67,246	15,420

Note: 2016 figures are as recorded on 25 August 2016

Disease outbreak mortality and its significance

No incidence of significant disease mortalities have been recorded for macropod populations in Queensland during the past year. Above average temperatures, and extremely dry conditions, have continued across majority of the commercial harvest zones in the past 12 months. Most of the local government areas within the harvest zones have been drought declared for over three years. These conditions reduce the available feed for all grazing species including macropods. The main areas to experience a significant reduction in macropod numbers is in the west of the state.

The last disease related non-harvest mortality event recorded in Queensland macropod populations was in March 2010. Localised disease related mortalities for some commercially harvested species were recorded in the south-west of the state from the New South Wales border to just north of Quilpie in the Paroo and Bulloo river systems. Investigation and surveillance over the weeks following the reports established that the deaths were very limited and restricted to small areas only. This was documented in the 2011 Quota Submission for Queensland. The aerial surveys conducted in 2011 showed that in the year following the reported mortalities, macropod populations had increased indicating that the reported mortalities in 2010 did not have a significant effect on macropod populations in the area.

Licensed recreational wildlife harvesting licence (macropods)

The recreational macropod harvest in Queensland is centred on the same three species as the commercial harvest and runs for the same harvest period. The recreational harvesting of these macropods is regulated through:

- *Environment Protection and Biodiversity Conservation Act 1999*
- *Nature Conservation Act 1992*
    - Nature Conservation (Administration) Regulation 2006
    - Nature Conservation (Wildlife Management) Regulation 2006
    - Nature Conservation (Wildlife) Regulation 2006
    - Nature Conservation (Macropod) Conservation Plan 2005
    - Nature Conservation (Macropod Harvest Period) Notice
- *Animal Care and Protection Act 2001.*

A person holding a Commercial Wildlife Harvesting Licence (macropods) cannot hold a Recreational Wildlife Harvesting Licence (macropods). The harvest is restricted to a maximum of 50 tags per licence holder during a harvest period. The recreational harvest of macropods in Queensland is small with a total of 1170 tags issued in 2016 to 24 Licence holders (Recreational Wildlife Harvesting Licence) (figures current at 31 August 2016).

Proportion of the population not subject to harvesting

Commercial harvesting of macropods can only occur in three harvest zones in Queensland. Cape York Peninsula and the south east corner of Queensland are designated Non-harvest zones (figure 22). Within the three commercial harvest zones macropods cannot be harvested within National Parks, States Forests, Regional Parks, Timber Reserves and Forest Reserves. Table 9 outlines the size of these land tenures within the commercial harvest zones (current in 2016).

Figures 22 to 24 show the general distribution of each of the commercially harvested macropods in relation to the population estimate regions. Eastern grey kangaroos are only harvested in the eastern and western harvest zones (figure 23). Red kangaroos are harvested in the western and central harvest zones and in the north of the eastern harvest zone (figure 22). Common wallaroos have the broadest distribution throughout Queensland and can be harvested in the central, eastern and western zones.

Table 9 – Area of land tenures within the Queensland commercial harvest zones where harvesting of macropods is not permitted.

	Western harvest zone km^2	Central harvest zone km^2	Eastern harvest zone km^2	Total km^2
National Park	21,450	11,778	16,255	49,483
State Forest	NA	10,788	16,254	27,042
Regional Park	1,048	167	1,365	2,580
Forest Reserve	NA	NA	225	225
Timber Reserve	79	451	121	651
Total km^2	22,577	23,184	34,220	79,981

Figure 22 – Red kangaroo *Macropus rufus* distribution

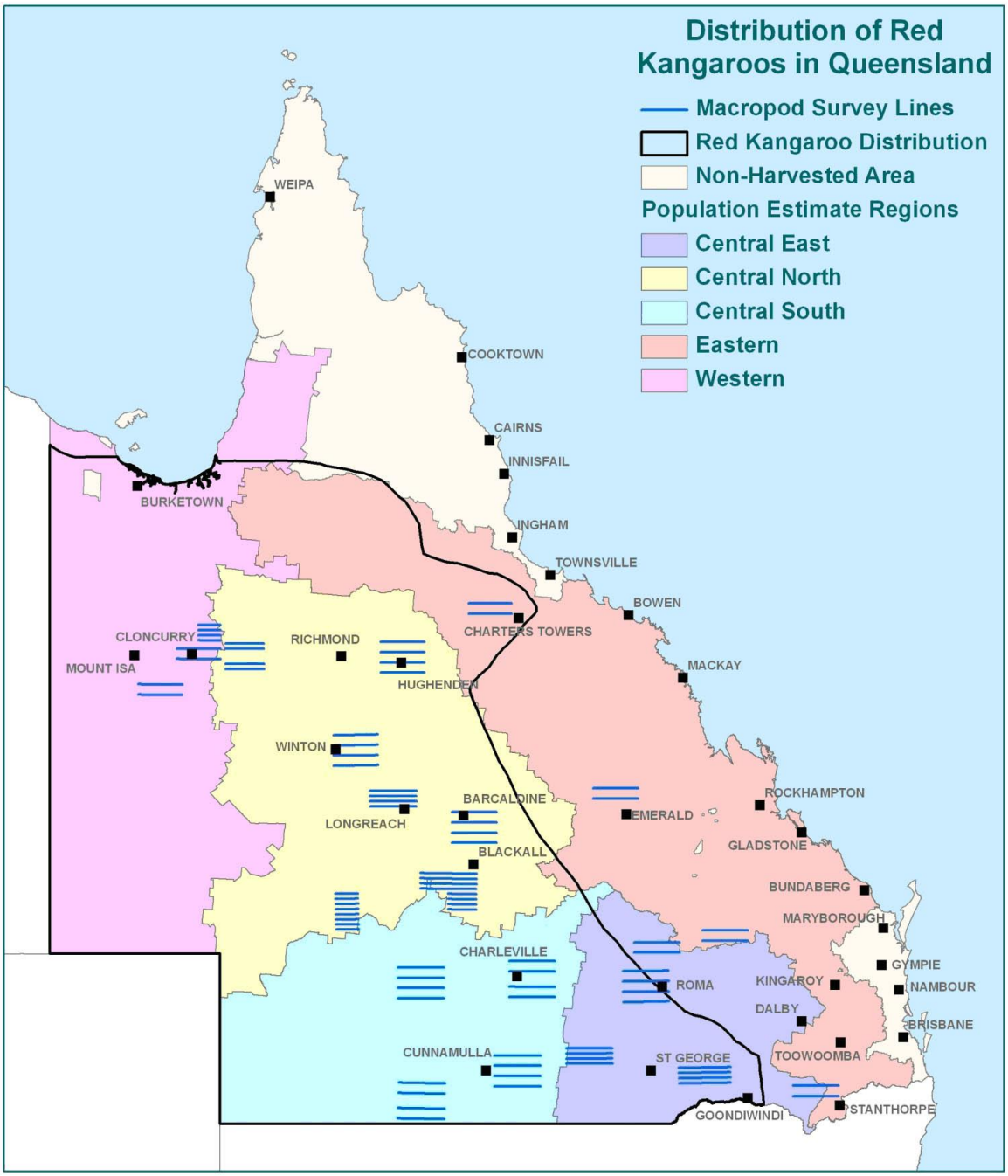


Figure 23 – Eastern grey kangaroo *Macropus giganteus* distribution

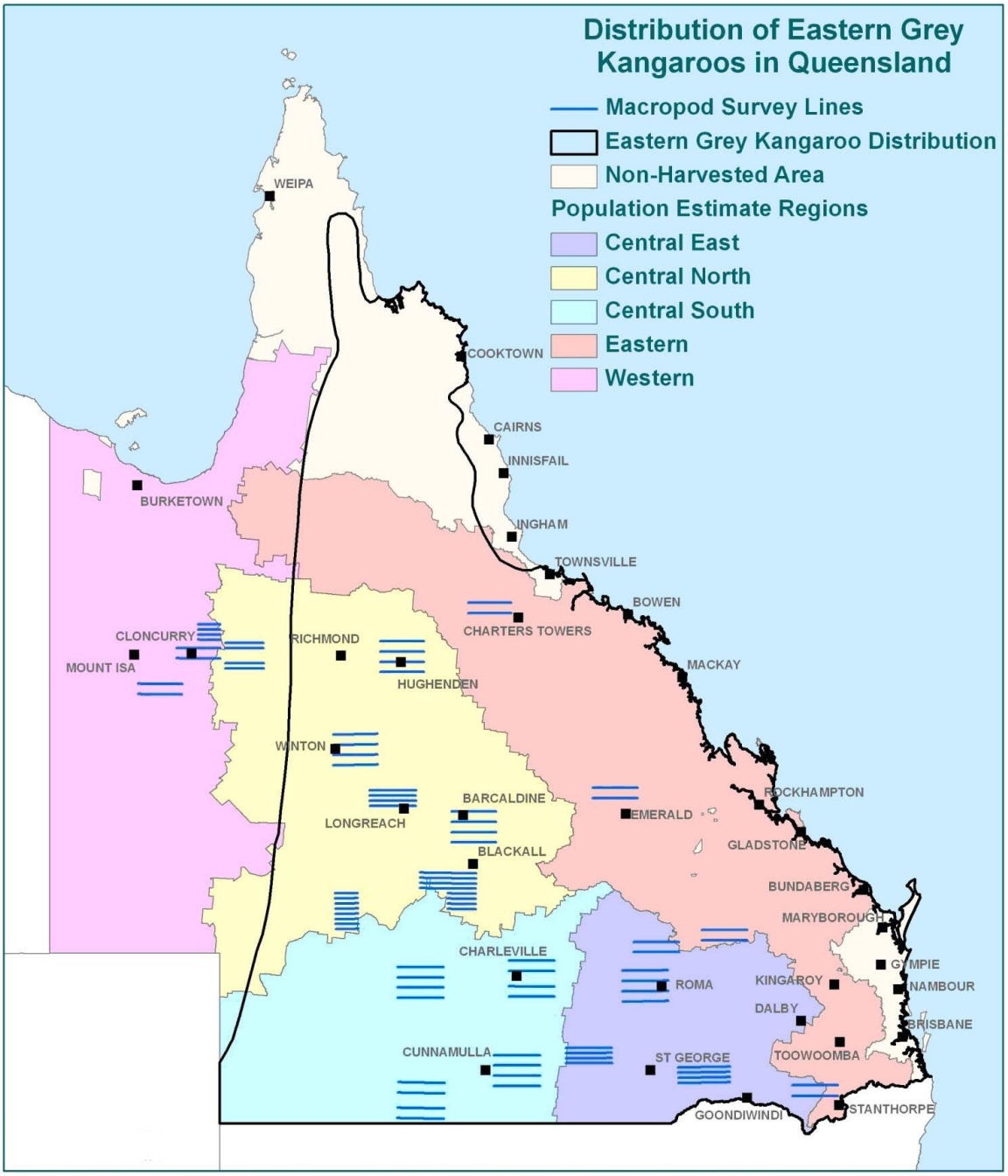
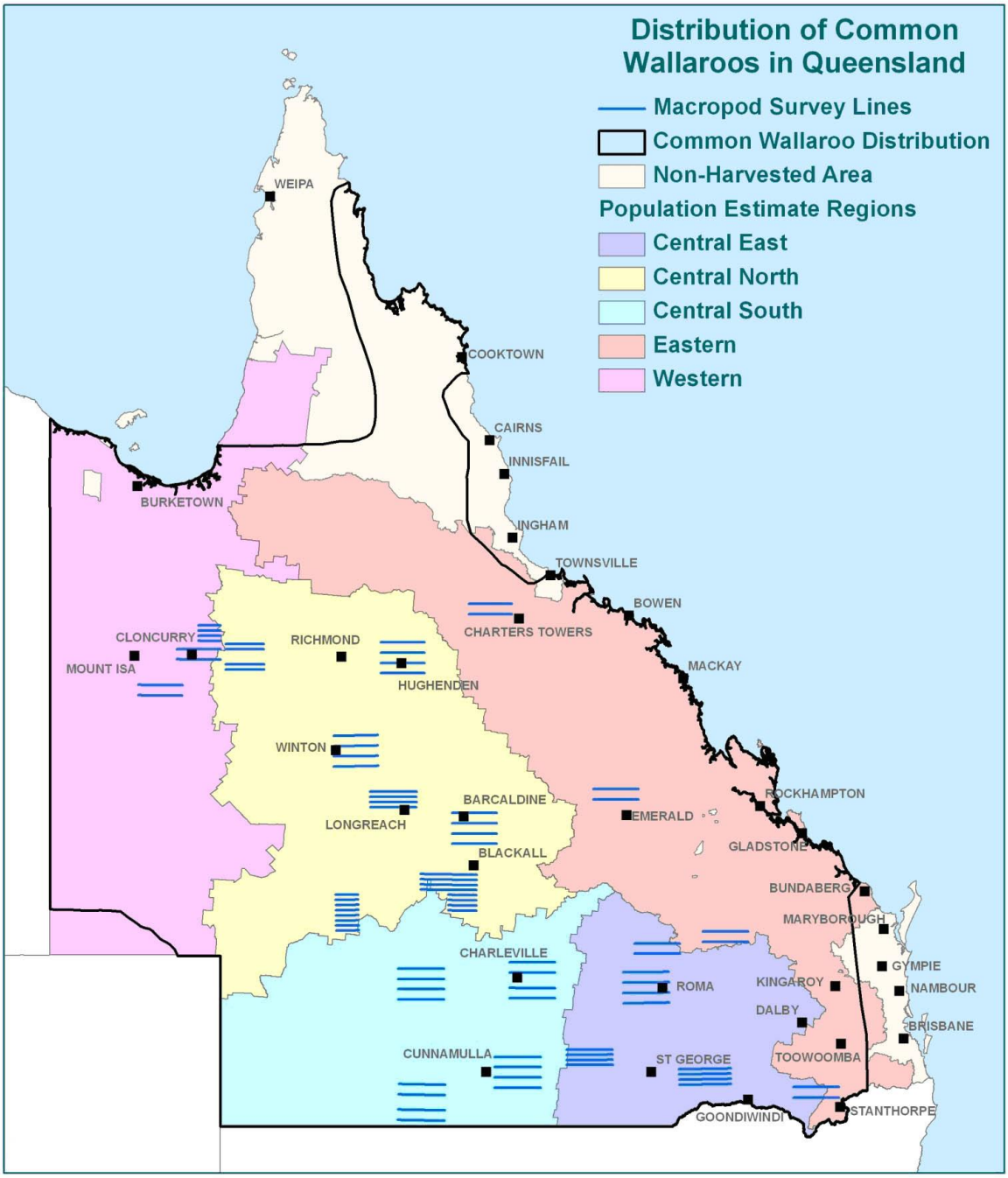


Figure 24 – Common wallaroo *(Macropus robustus)* distribution



Rainfall trends

A decreasing rainfall trend across Queensland has occurred since 2011 and 2012 when flooding events occurred in parts of the state (figure 25). Recorded rainfall totals for Queensland are outlined in figure 26 for 1 September 2015 to 31 August 2016. It shows 2015 was a hot year overall for Queensland being the third hottest on record. Heatwaves across much of the harvest zones were experienced in October through to December. Most of the harvest districts were dry and drought declared throughout 2015. The hot and dry conditions continued over much of the state during 2016 and can be described as severe in many areas. As at 1 September 2016 most of the eastern and western macropod harvest zones were still drought declared with the entire central zone being declared (figure 27). Much of the commercial harvest zones have now been drought declared for four consecutive years.

Despite the ongoing drought conditions sufficient rainfall has occurred in some parts of the harvest zones over the last 12 months to produce feed for macropods. Whilst overall population estimates in 2016 are less than 2015 a dramatic decline across the entire state has not occurred. The central harvest zone has experienced the greatest decline in macropod numbers for all three commercial species. Estimated populations of red kangaroos increased in the eastern zone with eastern grey kangaroos and common wallaroos observed declining slightly. There is the potential for macropod densities to decrease dramatically like they did in 2002 (figure 25) if drought conditions continue across the harvest zones.

Figure 25 Estimated macropod populations plotted with annual rainfall totals from Queensland from 1992 to 2016

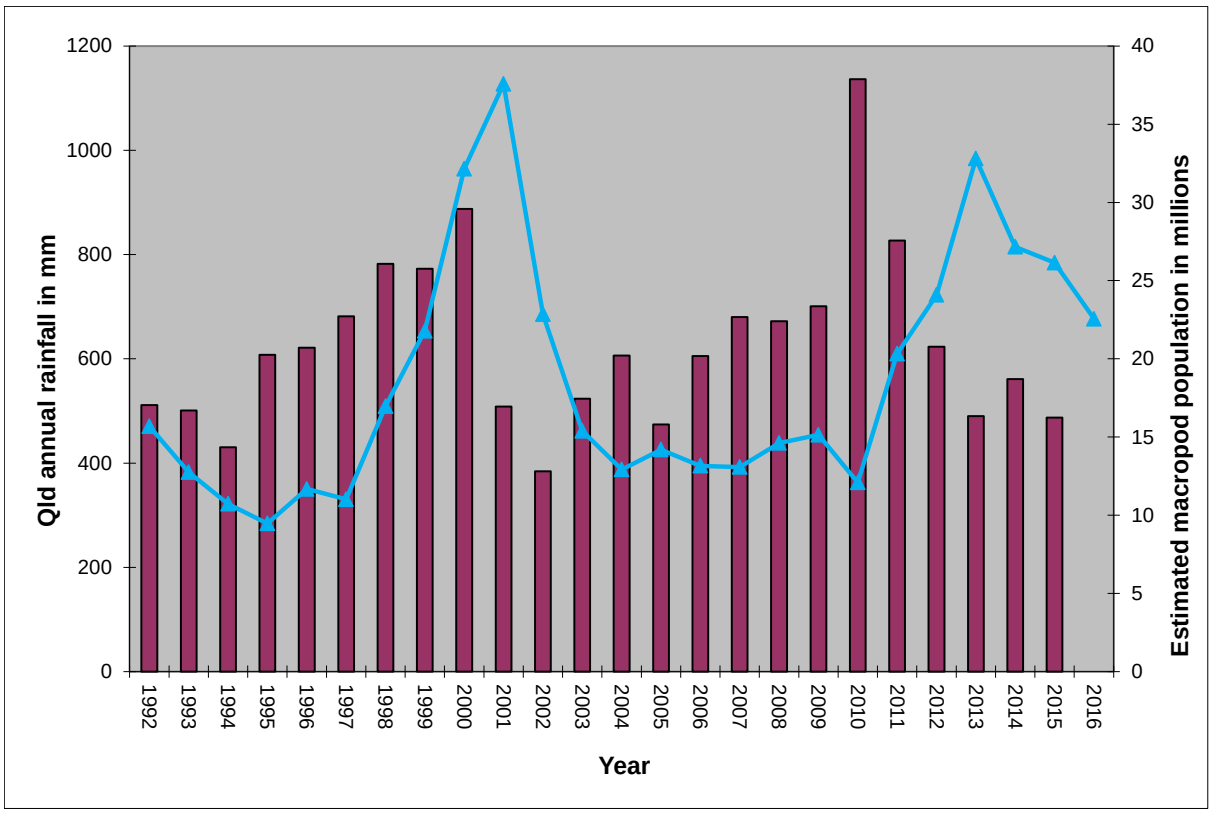


Figure 26 – Queensland rainfall totals from 1 September 2015 to 31 August 2016.

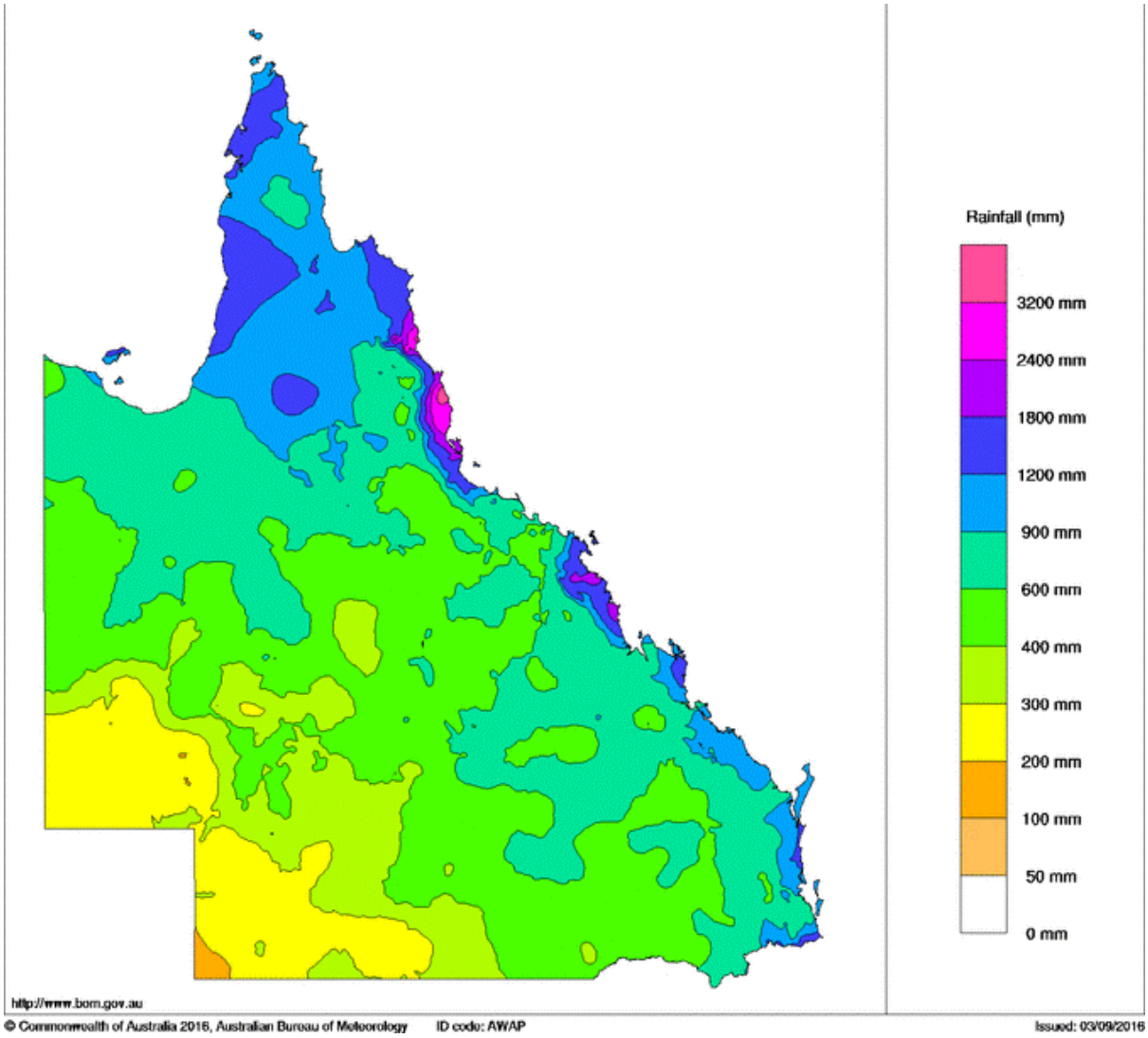
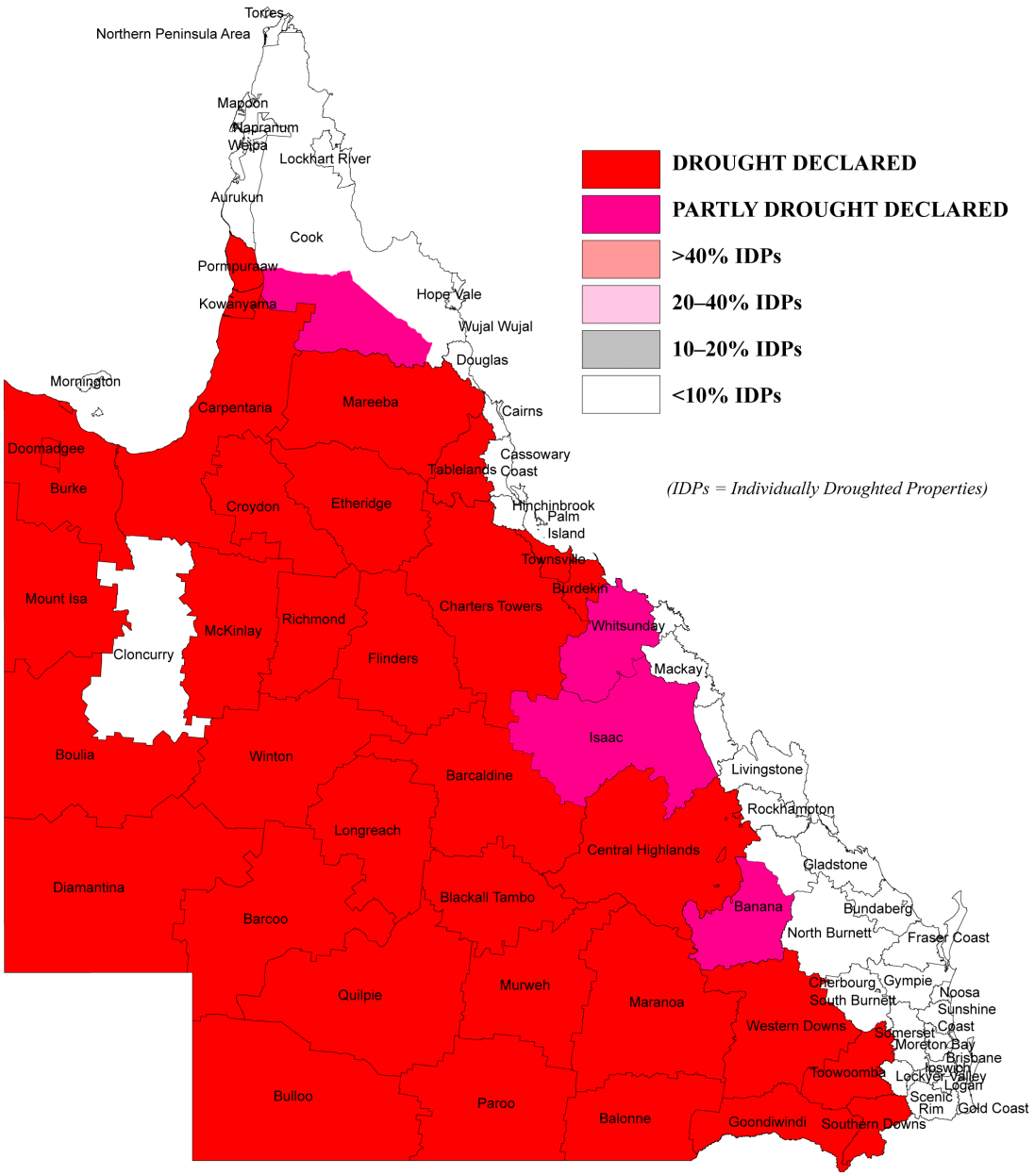


Figure 27 – Queensland drought declarations at 1 August 2016.



Summary and conclusion

The proposed quotas for the 2017 commercial macropod harvest in Queensland have been formulated by following an established methodology, which is largely based on constant proportions of population estimates and monitoring of long-term population trends. Population estimates are derived from representative aerial surveys across the harvest zones that are informed by the best available science. Other factors considered in the setting of the 2017 commercial harvest quotas include a review of previous harvests, extent of non-commercial harvest, proportion of the population not subject to harvesting, non-commercial harvest mortality and its significance, and rainfall trends.

Long-term trend data relating to population size since 1992, when Queensland began an annual program of helicopter surveys, demonstrates there has been no consistent increase or decline in the populations of red kangaroos, eastern grey kangaroos or common wallaroos in Queensland. However, populations do fluctuate over time. Population estimates for all species indicate that numbers over 1,000,000 occur in the harvest area. Thus, current harvest rates can be viewed as not having a long-term detrimental impact on populations.

Since regionalisation of the Queensland commercial macropod harvest was introduced in 2003, an estimate of macropod population size in the eastern and western zones has been made. The model used to estimate these populations is based on a small sample area and the reduced sampling effort is reflected in a conservative quota. This model was updated in 2012 to incorporate almost a decade of survey data and to generate trigger points for the commercial quota allocation. The population estimates in the eastern and western zones are a function of both the new model and the survey data for 2016.

Population estimates have decreased marginally for red kangaroos in all harvest zones in 2016. The eastern grey kangaroo population estimate for the central zone decreased but increased for the eastern and western zones. Common wallaroo population estimates decreased in the central and eastern zones but increased in the western zone. Overall combined totals for all three species declined marginally across the state.

For the 2015 commercial harvest no quotas were exceeded, with the maximum percentage of quota utilised, being 32.8% for eastern kangaroos in the central zone. Sex ratios from harvest data continue to be biased towards males with the overall percentage of females harvested below 4%. Thus, the last completed harvest period provides no indication of adverse pressure on populations that would influence proposed quotas.

For the 2016 harvest period up to 31 July, 7% of the available quota for red kangaroos in the western zone had been harvested with 5% of the quota harvested in the eastern, and 10% in the central zones respectively. For eastern grey kangaroos, 17% of the quota was harvested in the central and and 4% in the eastern zones respectively. For common wallaroos, the highest percentage of quota harvested was 13% in the central zone, with 3% harvested in the eastern zone. Given these figures, it is unlikely that quotas will be met for each species in each zone in 2016.

Usage of DMPs in 2015 were below the 2% of the population estimate quota for all species for all zones. The current percentages for usage of DMP quotas for 2016 are below the new quota limit of 2%.

The three commercially harvested macropod species are protected from harvesting within the harvest area through national parks and state forests. These ‘refuges’ occur in patches throughout the distributional ranges of all three species. Macropods are further protected from harvest in Queensland within the non-harvest zones.

Whilst macropod numbers observed in the eastern harvest zone increased in 2016, for eastern grey kangaroos, they decreased for common wallaroos and red kangaroos. The majority of the harvest zones are drought declared and macropod numbers overall have decreased slightly. Should the widespread dry conditions continue throughout the state it is possible that observed macropod numbers will decrease again in 2016.

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Appendixes

Appendix 1 Summary of the methodology for population monitoring and quota derivation for Queensland

Aerial surveys

Since 1992, the Queensland Government has conducted an annual program of aerial surveys by helicopter to directly monitor populations of the three large macropod species covered by the Wildlife Trade Management Plan for Export—Commercially Harvested Macropods 2013–2017. This method employs line transect methodology (Buckland et al.1993), which is significantly more robust to variations in sightability than standard fixed-wing methods and provides more accurate and precise population estimates (Clancy et al. 1997). A detailed description of the methodology employed in these surveys is provided in Clancy et al. (1997).

Surveys are conducted over 22 fixed monitor blocks, covering an area of 136,000km^2 (Figure 1) or 25% of the original fixed-wing survey area sampled by the Australian National Parks and Wildlife Service (ANPWS) between 1984 and 1995. In each helicopter survey block, between two to eight east-west running 50–90km transect lines have been placed systematically 10km apart. Sampling intensity within each block is approximately 2.5%.

The placement of the original 10 of the 22 survey blocks used in this monitoring program was designed to provide appropriate coverage of representative densities of macropods over the core harvest area of 630,000km^2 (Pople et al. 1998). In response to the introduction of regional management to Queensland in 2003, a further 12 survey blocks were added to provide broader coverage of the entire harvest area and to ensure all bioregions were sampled. Placement of these new survey blocks was optimised using fixed-wing survey data collected across the harvest zone during 2001. These surveys provided data to reassess the representativeness of the existing helicopter monitor blocks and to investigate alternative scenarios for future survey design. Analysis of these data in combination with harvest data has led to improved stratification of the survey area and hence increased the power to extrapolate data from survey monitor blocks to other regions in the harvest zone. These investigations were conducted in collaboration with the University of Queensland as part of the Australian Research Council (ARC) funded ROOSPIRT Linkage project (Pople et al. 2006).

No correction factors are applied to surveys of eastern grey and red kangaroos as comparisons of ground and aerial surveys conducted by Clancy et al. (1997) concluded that the helicopter line transect technique is both accurate and precise in determining population densities for both these species over a range of habitats, seasons and densities. Whilst the method is less accurate for common wallaroos there are still close correspondences between the results of helicopter surveys and those of ground counts. Estimates derived from ground surveys for common wallaroo density are approximately 1.9–2.0 times that recorded for helicopter surveys. Accordingly, since 1998, the Queensland Government has applied a conservative correction factor of 1.2 to the wallaroo density estimates derived from helicopter surveys. In 2011, this conservative correction factor has been increased to 1.85 in line with that used in New South Wales.

Frequency and coverage of aerial surveys

Due to the costs and logistics associated with conducting helicopter aerial surveys over 22 monitor blocks, not all monitor blocks are surveyed on an annual basis. To ensure adequate coverage of the harvest area in Queensland and to enable accurate tracking of population trends, all blocks are surveyed at least once every two years. Decisions on the frequency and coverage of the aerial survey program were based on analyses completed by the University of Queensland as part of the ARC funded ROOSPIRT Linkage project. This redesign of the monitoring program also sought to introduce a level of bioregional stratification to provide for improved potential to monitor populations at that scale as a possible prelude to the introduction of further harvest zones in Queensland.

The main feature of the current monitoring program is the establishment of pairs of closely correlated monitor blocks within each of the bioregions. The process of pairing monitor blocks was based on linear modelling that examined the relationships between macropod population densities, rainfall and harvest off-take for all monitoring blocks within each bioregion. The process of pairing blocks and the development and refinement of these linear models enables the frequency of monitoring of blocks to

be reduced without compromising the efficacy of the monitoring program. Using this approach monitoring blocks with bioregional pairs will be monitored on a rotating basis with each block being subject to surveys every two years.

Linear models utilising data on rainfall, harvest off-take and population rates of increase for the monitored block within a pair are then used to predict population changes in the unmonitored block of the pair. The models are refined annually as further data is collated and enhancements are made to the modelling process. In the situation where there is only a single monitor block within a bioregion or where a monitor block samples a unique macropod community, such as the Blackall block which contains moderate densities of all three species and particularly high densities of common wallaroo, these blocks are sampled annually. In order to calibrate the models and to provide a benchmark of the states' macropod populations, a survey of the complete set of 22 monitor blocks will be completed every five years. The table below summarises the current stratification, pairing and sampling frequency for all 22 of the fixed aerial survey monitor blocks used in the Queensland monitoring program.

Due to the significantly lower macropod densities and associated lower harvest densities recorded historically from the eastern and western harvest zones, these two zones are not surveyed with the same intensity as the central harvest zone. Within both the eastern and western harvest zones, population density estimates are based on helicopter aerial surveys of three monitor blocks established in 2004 and monitored on a two yearly rotation. The results are used in association with data derived from fixed-wing aerial surveys conducted over parts of these zones during 2001 to adjust approximations of the population rates of increase calculated by comparing fixed-wing survey data from 1981–82, 1984 and 2001 with the most recent helicopter aerial survey data and past ground surveys completed in equivalent habitats.

Population estimation

Population estimates are calculated by extrapolating the mean monitor block densities to a larger harvest area of 1,097,410km^2 for eastern grey kangaroos, 1,105,587km^2 for red kangaroos and 1,104,222km^2 for common wallaroos. To improve precision and remove bias in density estimates used in the calculation of population sizes and their standard errors, the data collected since 2003 have been stratified (Buckland et al. 1993) by observer and bioregion. Helicopter surveys are conducted with two observers, which results in twice the sampling intensity as one observer. To account for differences between observers, the data was post-sampling stratified by applying 'goodness of fit' models to the data from each observer using the computer program 'Distance' (Buckland et al. 1993). 'Distance' was then used to obtain an overall macropod density estimate for the survey block. The survey blocks were stratified by bioregion, and their weighted (by sampling intensity) density estimates used to calculate population sizes for the harvest area according to the methods and calculations outlined in Clancy et al. 1994 and 1997. For all species, stratification of the data by observer and bioregion has not significantly changed the population size estimate but has reduced the standard error associated with that estimate. However, with common wallaroos the standard errors associated with the population estimate remain high due to the high variability in densities across the state.

Quota derivation

Sustainable harvest quotas are calculated using a fixed proportion of the estimated macropod populations within the Queensland harvest area. The proportions used vary between species and are adjusted across the harvest zones in relation to the margins of error present in population estimates. The maximum proportions used for each species are 15% of populations for eastern grey kangaroos and common wallaroos and 20% of the population for red kangaroos. These maximum proportions are only applied to populations within the central harvest zone where survey effort is greatest and hence confidence limits for population estimates are within acceptable limits. In both the eastern and western harvest zones more conservative harvest proportions of 10% for all three species are applied. These sustainable-use harvest proportions are based on research and modelling undertaken by Caughley et al. (1987) and Hacker et al. (2002) and are currently accepted by the scientific community, the Queensland Department of Environment and Heritage Protection and the Commonwealth Department of Sustainability, Environment, Water, Population and Communities for determining state quota limits.

Stratification, pairing and sampling frequency for fixed aerial survey monitor blocks in Queensland

Harvest zone	Bioregion	Monitor block	Years 1 and 3	Years 2 and 4	Year 5
Central	Brigalow Belt South	Injune	✓		✓
		Taroom		✓	✓
		Westmar	✓		✓
		Roma		✓	✓
	Mulga Lands	Charleville	✓	✓	✓
		Cunnamulla	✓		✓
		Bollon		✓	✓
		Quilpie	✓		✓
		Hungerford		✓	✓
	Mitchell Grass Down	Blackall	✓	✓	✓
		Winton	✓		✓
		Longreach		✓	✓
		Julia Creek	✓		✓
		Hughenden		✓	✓
	Desert Uplands	Barcaldine	✓	✓	✓
	Channel Country	Windorah	✓	✓	✓
Eastern	Not stratified	Inglewood		✓	✓
		Emerald		✓	✓
		Charters Towers		✓	✓
Western	Not stratified	Duchess	✓		✓
		Cloncurry	✓		✓
		Cloncurry	✓		✓

Appendix 2 Densities per km^2 of the commercially harvested macropod species 2004–2016

	Eastern grey kangaroo												
Block	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Barcaldine	20.61	13.17	22.77	17.65	23.15	29.50	12.871	23.92	24.09	44.10	24.96	19.31	14.71
Blackall	7.57	7.10	6.22	7.51	8.28	11.19	7.082	6.08	9.87	19.41	10.59	8.75	5.29
Bollon	25.66	25.31		30.53		31.74	30.143		47.2		32.01	24.95	
Charleville	17.51	19.91	15.96	12.05	11.20	12.95	12.229	28.11	25.12	26.77	11.77	8.4	10.47
Charters		1.63		5.02		5.33	5.568		3.37		3.14	2.01	
Cloncurry	0.01		0.16		0.02		0.214	0.012		0.07		0.00	0.06
Cunnamulla	13.20		9.97		11.44		11.642	32.82		41.04		35.87	18.73
Duchess	0.00		0.00		0.00		0.00	0.00		0.00		0.00	0.00
Emerald		3.95		3.41		4.05	5.035		2.75		7.01	5.29	
Hughenden	0.77	0.58		1.16		0.97	0.795		0.53		1.17	1.41	
Hungerford	1.16	1.10		0.77		0.94	0.651		2.20		4.00	3.79	
Inglewood		8.72		18.62		9.75	12.326		29.10		32.73	49.88	
Injune	13.53	18.85		18.62	6.82		16.599	17.75		31.32		22.52	40.62
Julia Creek	1.08	0.87	1.05		0.76		0.276	0.28		0.84		0.84	0.2
Longreach	9.05	8.48		6.63		6.61	6.129		18.07		20.17	5.25	
Quilpie	1.86		0.97		1.42		2.795	1.57		3.61		4.65	2.66
Roma	25.05	24.98	25.46	25.12		23.43	19.298		27.16		40.56	32.23	
Taroom	8.12	13.37		8.44		7.87	7.362		14.98		13.24	12.65	
Westmar	25.53		23.17		21.18		22.083	37.25		62.54		77.9	66.07
Windorah	1.58	2.69	1.14	1.39	2.39	1.26	0.858	2.68	1.24	1.80	0.79	1.02	2.13
Winton	4.86	2.98	3.74		4.78		2.432	3.57		6.61		5.79	4.46

	Red kangaroo												
Block	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Barcaldine	6.07	4.07	11.07	6.72	9.03	9.83	7.58	10.05	7.83	12.30	9.2	16.24	8.54
Blackall	3.99	3.29	4.55	3.78	6.45	7.24	4.70	12.37	14.17	17.47	10.35	11.58	9.69
Bollon	4.13	8.87		8.35		11.16	9.90		7.78		7.27	9.83	
Charleville	4.55	5.48	7.36	9.57	7.58	8.47	6.46	14.69	5.53	7.03	4.97	5.06	6.32
Charters		0.02		0.05		0.00	0.70		0.24		0.21	0.62	
Cloncurry	2.14		4.18		6.17		3.01	3.34		5.91		4.06	3.45
Cunnamulla	3.54		4.59		9.02		10.65	18.27		28.76		27.29	16.54
Duchess	2.92		0.87		1.78		0.85	0.71		0.82		1.66	1.61
Emerald		0.00		0.00		0.00	0.02		0.05		0.00	0.00	
Hughenden	1.97	1.59		1.59		1.29	0.92		2.22		2.67	1.52	
Hungerford	1.04	2.57		3.90		4.41	2.60		7.01		8.75	9.7	
Inglewood		0.00		0.00		0.00	0.50		0.00		0.00	0.00	
Injune	1.02	0.14	0.05		0.72		0.00	0.86		0.04		0.00	0.11
Julia Creek	4.08	5.13	4.91		5.39		3.16	3.30		8.10		5.6	4.58
Longreach	9.53	11.86		11.33		14.71	12.24		14.43		19.26	4.79	
Quilpie	2.19		1.39		5.13		2.06	4.70		9.80		9.51	12.27
Roma	2.19	1.62	2.54	2.66		2.37	2.26		3.47		5.02	2.83	
Taroom	0.02	0.37		0.00		0.00	0.00		0.00		0.00	0.00	
Westmar	0.97		0.59		0.55		1.14	1.49		1.14		2.28	4.69
Windorah	4.42	4.52	7.32	4.48	9.85	12.62	6.67	10.47	10.77	11.84	8.11	12.29	12.16
Winton	3.69	5.02	5.62		6.05		3.32	4.44		9.73		16.98	8.57

	Common wallaroo												
Block	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Barcaldine	6.59	12.30	8.63	16.42	19.98	16.20	5.521	8.306	5.53	9.02	4.69	6.79	4.89
Blackall	18.02	21.17	22.15	34.98	39.14	49.05	23.819	21.549	20.2	54.43	28.58	24.86	11.29
Bollon	4.72	2.64		1.55		1.67	0.363		2.44		0.7	0.31	
Charleville	7.21	6.20	5.79	4.66	4.70	5.36	11.803	13.439	10.65	5.09	4.47	4.07	3.81
Charters Towers		0.30		2.84		0.61	1.069		0.51		1.03	0.22	
Cloncurry	0.00		0.30		0.64		0.507	0.260		0.14		0.02	0.21
Cunnamulla	1.68		0.45		0.64		1.951	0.611		0.70		2.53	2.60
Duchess	0.57		0.11		1.69		0.743	0.093		1.16		0.00	0.00
Emerald		0.02		0.00		0.78	0.024		0.33		0.19	0.32	
Hughenden	1.65	1.28		2.28		0.24	0.411		0.94		0.93	0.22	
Hungerford	1.19	0.36		0.24		0.48	0.254		0.47		1.27	1.93	
Inglewood		3.08		4.03		0.34	1.013		1.22		3.18	3.42	
Injune	0.01	2.30	1.34		0.91		4.053	0.00		0.63		0.84	0.60
Julia Creek	2.74	0.00	0.04		0.11		0.013	0.00		0.00		0.00	0.03
Longreach	17.96	21.57		18.59		12.69	9.185		17.77		15.67	8.84	
Quilpie	5.41		0.78		3.36		2.686	3.007		5.58		7.51	3.42
Roma	1.35	3.74	2.49	2.08		1.16	3.447		0.87		1.01	0.75	
Taroom	0.22	2.04		0.17		1.05	0.253		0.02		0.38	0.18	
Westmar	0.74		0.02		0.13		0.299	0.00		0.01		0.00	0.28
Windorah	2.14	2.30	1.81	2.72	3.03	3.07	2.422	3.185	3.32	5.29	2.82	1.46	4.86
Winton	1.73	1.78	1.70		3.14		0.955	4.191		6.35		0.76	1.14