Management Plan for the Commercial Harvest of Kangaroos in Western Australia 2019-2023

January 2019

GOVERNMENT OF
WESTERN AUSTRALIA

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Contents

1 Introduction

The purpose of this plan is to provide a management framework for the sustainable commercial harvesting of kangaroos in Western Australia.

The export of wildlife products from Australia requires Commonwealth Government approval under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The *Management Plan for the Commercial Harvest of Kangaroos in Western Australia 2019-2024* (the Management Plan) has been developed to satisfy the requirements of the EPBC Act and to meet the legislative and other requirements of the Western Australian Government.

The Management Plan relates to the commercial harvest of red (*Macropus rufus*[1]) and western grey (*Macropus fuliginosus*) kangaroos within Western Australia (WA). Where the term kangaroo is used within this document it refers to the aforementioned macropod species only.

In Western Australia all native fauna is protected under the *Biodiversity Conservation Act 2016* (BC Act) and the Department of Biodiversity, Conservation and Attractions (the department) is responsible for administering the Act. The utilisation of kangaroos is regulated under the BC Act and the associated Regulations through the issue of licences and identifiers ("tags").

The primary goal of the Management Plan is to ensure that the commercial harvest of kangaroos is ecologically sustainable and to provide an alternative management approach for reducing the damage caused by overabundant kangaroos. This will be achieved through the application of the best available scientific knowledge, best practice management, and monitoring of outcomes to ensure the viability and welfare of kangaroo populations is not compromised by any action undertaken in accordance with the Management Plan. The Management Plan incorporates an adaptive approach to management to improve knowledge, facilitate appropriate adjustments to management and inform future programs.

The Management Plan does not provide the framework for the management of kangaroos on lands described under Part 2, Section 5 of the *Conservation and Land Management Act 1984* (e.g. national parks, nature reserves, conservation parks, State forest and timber reserves). Kangaroos cannot usually be taken for commercial purposes in these areas, which comprise a total area of about 26 million hectares or approximately 10 percent of the land area of Western Australia[2].

The Management Plan does not regulate the non-commercial culling of kangaroos for damage mitigation. Non-commercial culling of kangaroos is regulated through other provisions of the BC Act.

[1] Unless stated otherwise, scientific names used in this plan for macropods follow Van Dyck and Strahan (2008). The more recent genus name *Osphranter* is not being used in this document.

[2] In circumstances where an authority is granted to take kangaroos for commercial purposes in these areas, the principles of this management plan will apply.

The Management Plan sets the framework for the commercial harvest of kangaroos in accordance with the principles of ecologically sustainable development. Management in this context assists in balancing environmental, social and economic interests by ensuring the sustainable use of a renewable resource and provides for the sustainable harvest of kangaroos for products such as meat and leather to supply Australian and international markets.

The Management Plan will remain valid for a maximum period of five years ending 31 December 2023.

2 Legislative framework

2.1 Commonwealth

The EPBC Act requires the development and approval of wildlife trade management plans in order for permits to be issued for the commercial export of wildlife products.

The EPBC Act states that the Commonwealth Minister responsible for the environment may approve a wildlife trade management plan for a maximum of five years. The EPBC Act specifies that such approval must be given only if the Minister is satisfied that:

(a) the plan is consistent with the objects of Part 13A of the EPBC Act;

(b) an assessment of the environmental impacts of the activities of the plan has been undertaken;

(c) the plan includes management controls directed towards ensuring that the impacts of the activities covered by the plan are ecologically sustainable;

(d) the activities in the plan are not detrimental to the species to which the plan relates or any relevant ecosystem; and

(e) the plan includes measures to mitigate, monitor and respond to the environmental impacts of the activity covered by the plan.

In deciding whether to approve a plan, the Minister must also have regard to whether:

(a) legislation relating to the protection, conservation or management of the specimens to which the plan relates is in force in the State or Territory concerned; and

(b) the legislation applies throughout the State or Territory concerned; and

(c) in the opinion of the Minister, the legislation is effective.

In resolving whether to approve a plan, the Minister must also be satisfied that if an animal is killed, it is done in a way that is generally accepted to minimise pain and suffering. Animal welfare standards for the commercial harvesting of kangaroos are detailed in the National Code of Practice for the Humane Shooting of Kangaroos and Wallabies for Commercial Purposes (Commercial Code). All kangaroos taken for commercial purposes must be taken in accordance with this Code or any future, nationally-endorsed code that replaces or updates this document.

2.2 Western Australia

In Western Australia all native species, including kangaroo species and subspecies, are protected under the BC Act. The BC Act and the associated Regulations make provisions for the licensing of a range of activities relating to the commercial harvesting of kangaroos. Under the BC Act, lawful authority (a licence) is required to take, possess, process, deal, import or export fauna. Licences may include conditions, such as the manner in which fauna may be taken, or stored, including during transport, and the affixing of tags to the fauna.

Licences that relate to commercial kangaroo harvesting, processing and dealing are described in Appendix 1.

In addition to the BC Act, the following legislation (including subsidiary legislation) may also apply to activities undertaken in accordance with this plan:

- *Animal Welfare Act 2002*
- *Biosecurity and Agriculture Management Act 2007*
- *Conservation and Land Management Act 1984*
- *Food Act 2008*

Under the Management Plan the commercial harvesting of kangaroos in Western Australia is presently restricted to the Kangaroo Management Areas illustrated in Figure 1. Any changes to Kangaroo Management Area boundaries will be provided to the Commonwealth Government. Within the life of this plan, new areas may be opened to commercial harvesting where kangaroos are deemed to be overabundant. Surveys to estimate kangaroo abundance will be undertaken prior to any new areas being opened for commercial harvesting and the Commonwealth Government will be advised of any changes prior to implementation.

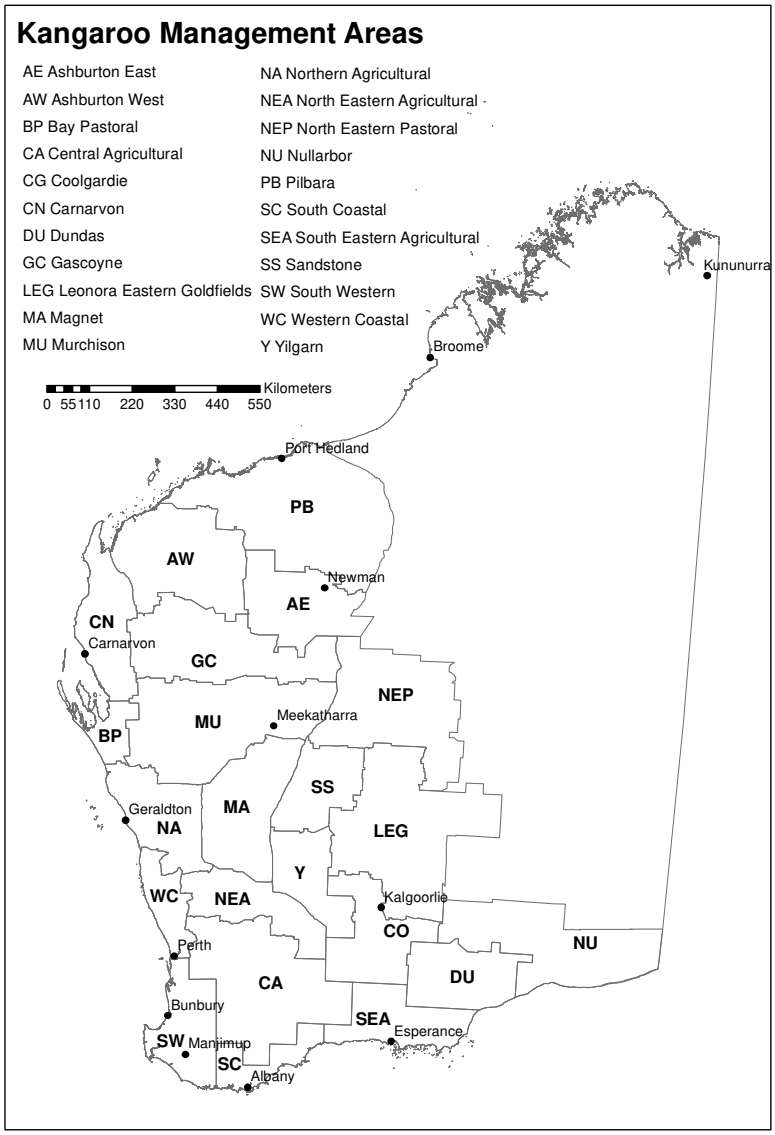

Figure 1. Kangaroo Management Areas in Western Australia.

3 Goal and aims

3.1 Goal

The overarching goal of the *Management Plan for the Commercial Harvest of Kangaroos in Western Australia 2019–2023* is:

> **To provide for the sustainable commercial harvest of red and western grey kangaroos in accordance with the principles of ecologically sustainable development.**

The principles of ecologically sustainable development are defined in Part 1, Section 3A of the EPBC Act.

In order to achieve the overarching goal, the Management Plan has seven aims. When the aims are combined, they set strategic directions for the management of the commercial kangaroo harvest in Western Australia.

Under each aim are one or more actions that detail both how the aim will be delivered and operational directions for kangaroo management. A range of performance indicators for each action have also been developed so that progress towards achieving the goal and aims of the Management Plan can be measured.

3.2 Aims

The aims of the Management Plan are to:

1. Ensure humane harvest of kangaroos

Promote improved animal welfare outcomes by ensuring that the commercial harvest of kangaroos under the Management Plan is carried out in accordance with the Commercial Code.

2. Regulate the commercial harvest of kangaroos

The commercial utilisation of kangaroos will be regulated via the issue of licences and tags in accordance with the provisions of the BC Act and Regulations, Western Australian Government policies, the Commercial Code and the Management Plan.

3. Monitor industry compliance

The commercial kangaroo industry will be monitored to ensure compliance with the BC Act and Regulations, licence conditions, the requirements of the Commercial Code and the Management Plan.

4. Monitor kangaroo populations and set harvest quotas

Kangaroo populations will be monitored, and commercial harvest quotas set to ensure kangaroos are utilised in accordance with the goal of the Management Plan. Direct and indirect monitoring will be undertaken in all areas where kangaroos are commercially harvested.

5. Facilitate adaptive management and research

Adaptive management experiments and studies using data from kangaroo industry returns and population data will be supported to improve understanding of kangaroos and their interaction with environmental, social and economic systems. Research into other aspects of kangaroo biology and/or harvest management will be supported to fill knowledge gaps as needed.

6. Undertake program reporting and review

Annual reporting will be undertaken to ensure outcomes are consistent with the goal, aims and actions of the Management Plan.

7. Promote community awareness and engage stakeholders

Greater understanding about the commercial utilisation of kangaroos will be promoted by engaging with industry stakeholders and providing accessible information to members of the public.

3.3 Management actions and performance indicators

Aim 1: Ensure humane harvest of kangaroos

The department is committed to promoting and maintaining high standards in animal welfare. The *National Code of Practice for the Humane Shooting of Kangaroos and Wallabies for Commercial Purposes 2008* is the current, nationally-endorsed animal welfare standard for the commercial harvest of kangaroos in Australia. Any approved revisions to the Commercial Code will be adopted as the animal welfare standard for the commercial harvest of kangaroos in Western Australia. Applicants seeking to be licenced as prospective commercial kangaroo shooters are required to demonstrate they can achieve the standards of marksmanship required under the Commercial Code prior to obtaining a licence to take kangaroos.

ACTION 1: The department will ensure that the commercial kangaroo industry operates in accordance with the most up-to-date Commercial Code.

Compliance with the Commercial Code is a requirement for persons licensed to take kangaroos under the BC Act and Regulations and the Management Plan. Under licence conditions, licensed processors and dealers may not lawfully receive kangaroo carcasses unless kangaroos have been shot in accordance with the Commercial Code. Non-compliance with the licence conditions will result in penalties and/or other sanctions.

> **Performance Indicator 1**: Licence conditions for the commercial taking, processing and dealing of kangaroos will stipulate that kangaroos cannot be shot, sold or received unless they have been taken in accordance with the Commercial Code.
>
> **Performance Indicator 2:** Copies of the Commercial Code will be made available from the department's website.
>
> **Performance Indicator 3:** The department will participate in and support any revisions to the nationally-endorsed Commercial Code.

ACTION 2: The department will consult with the Sporting Shooters' Association of Australia-WA and any other shooter representative body to ensure that all licensed commercial kangaroo shooters are competent and able to achieve the standards of marksmanship required under the Commercial Code.

Prospective commercial kangaroo shooters must pass a skills test. The test is a practical assessment of marksmanship conducted under field conditions by independent examiners who are registered with the department. Additionally, prospective commercial kangaroo shooters must have completed accredited vocational training in Game Harvester Skill Set or equivalent prior to being issued with a licence.

> **Performance Indicator 4:** All prospective commercial kangaroo shooters must have completed an accredited test of marksmanship and completed accredited vocational training in Game Harvester Skill Set as a prerequisite before being issued with a licence to take fauna for commercial products.

Aim 2: Regulate the commercial harvest of kangaroos via licensing

In order to ensure that the commercial kangaroo harvest is adequately regulated, commercial activities will require the authority of licences, and operators must adhere to tagging procedures as provided for under the BC Act and the associated Regulations.

ACTION 3: All relevant industry activities are licensed in accordance with the BC Act and the associated Regulations and departmental policies.

All applications for licences relating to commercial kangaroo industry activities in Western Australia are to be assessed, processed and issued in accordance with the provisions of the BC Act and associated Regulations and relevant departmental policies.

> **Performance Indicator 5:** Audits of licences issued for commercial activities are conducted annually to ensure licences are being issued appropriately in accordance with relevant legislation and departmental policies.
>
> **Performance Indicator 6:** Databases are maintained to ensure licensee information is current and accurate.

ACTION 4: Licence conditions are applied as required.

Licence conditions must be effective and consistent with relevant Western Australian legislation, departmental policies and the goal and aims of the Management Plan. Accordingly, licence conditions for each licence type will be reviewed, and where necessary amended, in response to changes in relevant legislation and/or departmental policies. Licensees will be advised of any changes to their licence conditions in writing.

> **Performance Indicator 7:** Licence conditions are reviewed as required, and amended where necessary.
>
> **Performance Indicator 8:** Licensees are advised in writing of any changes to licence conditions within one month of such changes being approved by the CEO or delegate.

Aim 3: Monitor industry compliance

Monitoring industry compliance is essential to ensure the commercial harvest is managed sustainably and for maintaining public confidence in the management of the kangaroo industry.

ACTION 5: The department will undertake monitoring of commercial kangaroo licence holders for compliance with the BC Act and associated Regulations, the Management Plan and licence conditions.

In order to assess industry compliance, authorised officers will, on both a regular and opportunistic basis, inspect kangaroos taken by, and processed by commercial kangaroo licence holders and premises registered for processing kangaroos. The inspecting officers will check to ensure that the kangaroos have been taken in accordance with the Commercial Code.

> **Performance Indicator 9:** All active kangaroo processing establishments are inspected by authorised departmental officers annually to ensure compliance with legislative requirements.
>
> **Performance Indicator 10:** At least thirty percent of active chillers are inspected by authorised departmental officers annually to ensure compliance with legislative requirements.
>
> Note: An active chiller is one that is identified on the returns from licensed commercial kangaroo shooters where there is at least one shooting day of effort during the year assigned to it.

ACTION 6: Activities not in accordance with the BC Act, the associated Regulations and commercial kangaroo licences will be investigated and, where an offence has been committed and it is appropriate, prosecuted.

Investigation and prosecution of activities that are in breach of legislative requirements are essential for maintaining public, industry and stakeholder confidence in the effectiveness of the Management Plan as a mechanism for maintaining the sustainability and humaneness of the commercial kangaroo harvest.

> **Performance Indicator 11:** Reports of unlicensed activities and activities in breach of legislation and licence conditions are investigated to the fullest extent possible and, where sufficient evidence is available, offenders are issued with expiation notices or prosecuted as appropriate.

ACTION 7: The accuracy of industry returns will be monitored continually during the life of the Management Plan.

It is a licence condition that commercial kangaroo industry licensees submit monthly returns to the department. The data obtained from these returns are essential for monitoring whether the industry is harvesting kangaroos within approved quotas and for reporting. In addition, the data from industry returns are utilised for indirect monitoring of kangaroo populations.

> **Performance Indicator 12:** Incoming industry returns are reviewed, and discrepancies are investigated.

ACTION 8: A compliance database will be maintained and improved to support investigations and inspections.

A compliance database for use in investigations and inspections of the commercial industry will be maintained for use by staff involved with kangaroo management. The database facilitates compliance reporting to the Commonwealth Government and other stakeholders and also easy access to information for relevant authorised departmental officers.

> **Performance Indicator 13:** A compliance database will be maintained and improved to support investigations and inspections.

Aim 4: Monitor kangaroo populations and set commercial harvest quotas

Monitoring populations of commercially harvested species is essential to ensure that the commercial harvest is sustainable over the long term. The commercial harvest region in Western Australia is divided into four Population Monitoring Zones (PMZ) (Figure 2). These four PMZ encompass the Kangaroo Management Areas described in Section 2.2 (Table 1 shows the relationship between PMZ and the Management Areas).

The harvest quota for a species is the maximum number of individuals that can be commercially harvested in a calendar year. Kangaroo population estimates obtained from aerial surveys will be used as the basis for setting commercial harvest quotas for each of the PMZ.

Proportional threshold harvesting is one strategy for reducing the risk of over-harvesting (Engen *et al.* 1997). Proportional harvesting strategies have been well studied and are considered safe and efficient for fluctuating populations (Caughley 1987a; Engen *et al.* 1997). Kangaroo harvest quotas in Western Australia are consequently based on a proportion of the estimated population size. Moreover, Western Australia's program of regularly monitoring and estimating abundance allows for any other agents of mortality acting on kangaroo populations (e.g. drought, disease, road kill, non-commercial culling) to be detected and accounted for in the setting of annual commercial harvest quotas.

Table 1: Relationship between Population Monitoring Zones and Kangaroos Management Areas

Northern Zone Management Areas	Central Zone Management Areas	Southeast Zone Management Areas	Southwest Zone Management Areas
Ashburton East Ashburton West Carnarvon Gascoyne Pilbara	Bay Pastoral Magnet Murchison North Eastern Pastoral Northern Agricultural North East. Agricultural Sandstone Yilgarn	Coolgardie Dundas Leonora East. Goldfields Nullarbor South East. Agricultural	Central Agricultural South Coastal South Western Western Coastal

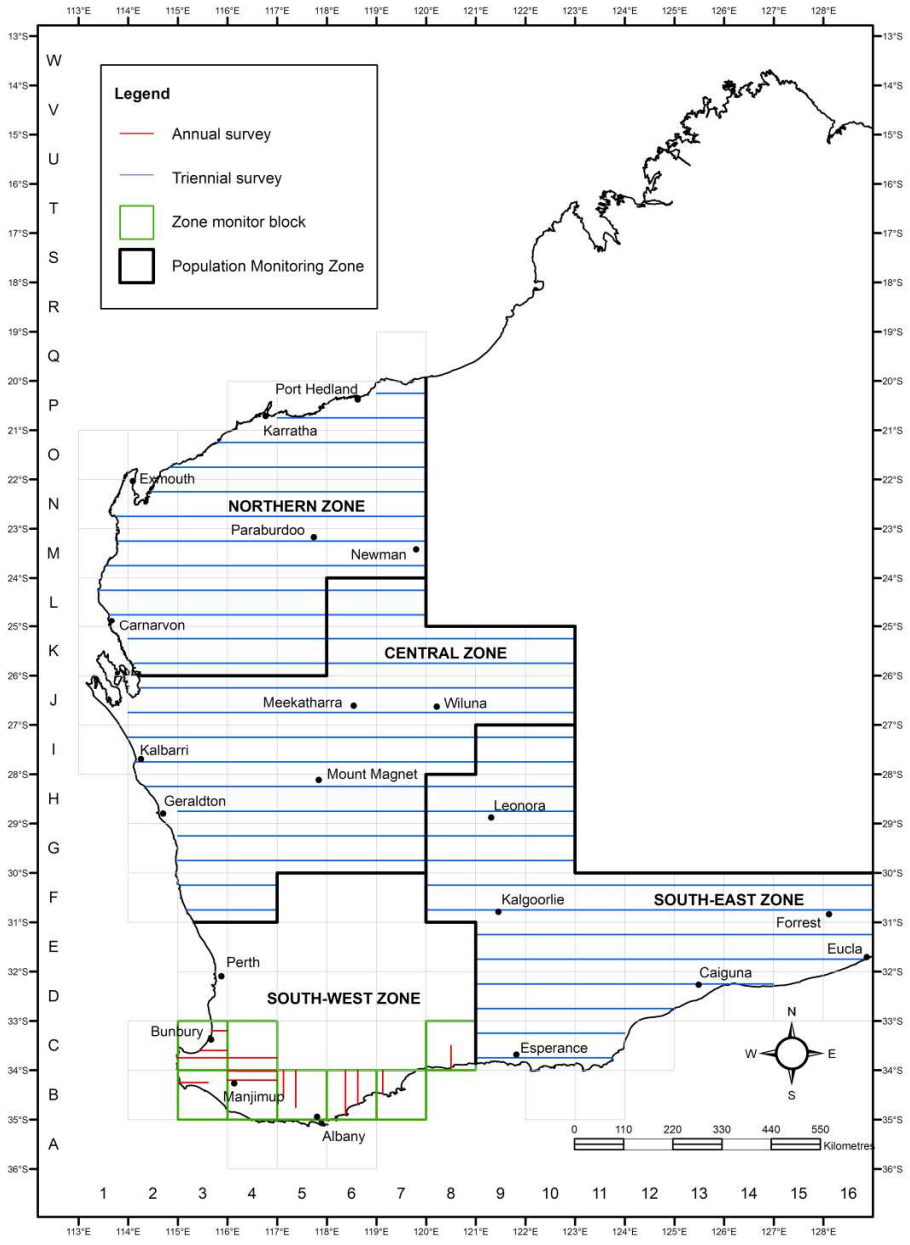

Figure 2. Aerial survey flight lines and Population Monitoring Zones.

ACTION 9: Aerial surveys will be conducted, with each PMZ being surveyed at least once every three years.

Aerial surveys from fixed-wing aircraft will be used to estimate the size of kangaroo populations within each PMZ. Survey lines have been established at regular intervals across the harvest region (Figure 2) and the same lines are surveyed during the same season each survey period to allow comparison of results between years.

All PMZs will be surveyed at least triennially. In the intervening years between aerial surveys, population estimates will be calculated using the most recent population estimate adjusted for regional rainfall and commercial harvest offtake, according to the equation:

$$\hat{N}_{t+1} = (\hat{N}_t - H) \times r,$$

where:

$\hat{N}_t$ = the most recent population estimate;

H = commercial harvest offtake between population estimates; and

r = population growth rate for a regional rainfall category.

Rainfall category for PMZ	r
Above average (decile rainfall >7)	1.20 to 1.30 (+20 to +30%)
Average (decile rainfall 4–7)	1.10 (+10%)
Below average (decile rainfall <4)	0.80 to 0.60 (–20 to –40%)

Performance Indicator 14: Aerial surveys are undertaken triennially for each monitoring zone and population estimates are calculated in accordance with the Management Plan.

ACTION 10: Commercial harvest quotas will be set and managed in accordance with the provisions of the Management Plan.

Quotas will be set for each commercially harvested kangaroo species and allocated to each PMZ. Quotas will be based on the most current population estimate for that zone and calculations will use habitat correction factors accepted at that time. The Commonwealth Government will be advised of the annual quotas prior to implementation.

The department retains the capacity to manage quotas at the Kangaroo Management Area level if required (through the allocation of tags and spatial and temporal closures in specific Management Areas), without the need to prescribe set quotas for each Kangaroo Management Area each year. The department may also decrease quotas to maintain the viability of kangaroo populations and to meet the other objectives of the Management Plan, where analysis of scientific information supports this action.

Quotas established under the Management Plan will be managed at the PMZ level. The harvest in each PMZ will be monitored and when the harvest for a particular PMZ is close to reaching the quota then the commercial harvest will cease in that zone. Furthermore, the Department will close the harvest in a management area or monitoring zone if it considers continued harvest pressure will pose a conservation risk to kangaroos in that area or zone, whether by potentially exceeding the quota or for some other reason.

Performance Indicator 15: Commercial harvest quotas are set in accordance with the Management Plan.

Performance Indicator 16: Population Monitoring Zone quotas and the state-wide quotas are never exceeded.

Performance Indicator 17: The Commonwealth Government is advised of commercial harvest quotas via a quota report for the following calendar year by 30 November.

The quota report will contain the following information:

- population estimates for each species in each PMZ
- details of the survey methods used and any changes to the survey method or analysis;
- quotas calculated as a proportion of the population estimate;
- any proposed changes to quotas;
- any changes to commercial harvest management areas or boundaries; and
- data showing trends in population, quota utilisation and harvest offtake over time.

Performance Indicator 18: The quota report will be made available to the public via the department's website.

ACTION 11: Harvest data will be analysed during the preparation of the quota submission.

Harvest returns are received monthly and are used to provide additional indirect data on kangaroo populations. Harvest returns detail the number of each species taken, average carcass weights, sex of animals taken, and location of take. Analysis of sex ratios and carcass weights will occur during the preparation of the quota submission, which potentially can alert managers to problems with the commercial harvest. Significant changes in harvest data may provide an indication of population status or changes in harvest practices.

Performance Indicator 19: Sudden, sustained or acute changes in the information provided through harvest returns will be investigated to identify possible causes of the change.

If necessary, management action will be taken to ensure the viability of the kangaroo population is maintained over the long term. Actions may include reducing or suspending the commercial harvest or increasing survey intensity at the next survey.

ACTION 12: The commercial quota for a particular species will be reduced or suspended within a Kangaroo Management Area or PMZ, if population densities fall below pre-determined trigger points.

Under the proportional threshold harvesting strategy, density thresholds are established that 'trigger' a management response. Typically, the harvest rate is reduced or the harvest is suspended at specific densities to reduce the risk of over-harvesting.

The Management Plan aims to accommodate natural fluctuations in kangaroo densities that change according to seasonal conditions. Calculating trigger points based on standard deviations from the long-term average density accounts for natural changes in kangaroo populations while also enabling the identification of changes that are unusual. In this context, standard deviation is a statistical measure of how much the population varies relative to its

average density. In erratic environments such as the arid inland area of Western Australia, population densities fluctuate much more widely as a proportion of their long-term average density than in more stable environments such as the South West. This means that the standard deviation will be different for each species.

It is important to note that the density estimates of kangaroos over much of Western Australia, particularly in rangelands areas, are significantly lower than in eastern Australia. Average densities in many areas of Western Australia are of the order of one kangaroo per square kilometre or lower, with average red kangaroo density estimates at the PMZ level ranging from less than 0.4 kangaroos per square kilometre to a high of around three kangaroos per square kilometre.

Under this Management Plan, the commercial harvest rate will be reduced or suspended if aerial surveys indicate that the population density within any particular PMZ has fallen to a predetermined density threshold for that zone. Any suspensions or reductions will remain in place until surveys, or populations estimates corrected for trends in rainfall, indicate that kangaroo densities have increased above no harvest density thresholds.

> **Performance Indicator 20:** Commercial kangaroo harvest rates will be reduced or the commercial kangaroo harvest suspended if density estimates reach the thresholds identified in Table 2. Any suspensions or reductions will remain in place until surveys or data indicates that kangaroo densities have increased above density thresholds.

Table 2: Density thresholds for Western Australia PMZ for red and western grey kangaroos

Zone[x]	**Density thresholds (kangaroos per km^2)**					
	Red kangaroos			Western grey kangaroos		
	17% HR (Threshold 1)	10% HR	No harvest (Threshold 2)	15% HR (Threshold 1)	10% HR	No harvest (Threshold 2)
Central	$D > 0.44^a$	$0.44^a \geq D > 0.28^b$	$D \leq 0.28^b$	$D > 0.12^b$	$0.12^b \geq D > 0.10^c$	$D \leq 0.10^c$
Northern	$D > 0.42^b$	$0.42^b \geq D > 0.31^c$	$D \leq 0.31^c$	Extralimital – no quota		
South East	$D > 0.35^c$	$0.35^c \geq D > 0.25^d$	$D \leq 0.25^d$	$D > 0.98^c$	$0.98^c \geq D > 0.80^d$	$D \leq 0.80^d$
South West	Vagrant – no quota			$D > 7.7^c$	$7.7^c \geq D > 5.8^d$	$D \leq 5.8^d$

x = The density thresholds for each Zone will also apply to any Management Area within that Zone.

HR = Harvest rate as a proportion of the population estimate

D = density estimate (kangaroos per km^2) from aerial surveys. Threshold densities were calculated as 1.0, 1.5, 2 or 3 standard deviations from the mean of density estimates for full surveys of a PMZ between 1995 and 2012. Note that zones are surveyed on a triennial basis.

a = 1.0 standard deviation (sd); b = 1.5 sd; c = 2.0 sd; d = 3.0 sd

Regular harvest (Threshold 1): Where aerial surveys indicate that the population density of a kangaroo species within a PMZ is greater than Threshold 1 (Table 2), the quota for the next calendar year will be calculated as a harvest rate of not greater than 17 percent of the population estimate for red kangaroos and 15 percent for western grey kangaroos.

Harvest reduction: Where aerial surveys indicate that the population density of a kangaroo species within a PMZ is less than or equal to Threshold 1 and greater than Threshold 2, the quota for the next calendar year will be calculated as a harvest rate of not greater than 10 percent of the population estimate. This harvest rate will remain in effect until aerial surveys or annual trends in rainfall indicate that population densities have increased above Threshold 1.

Harvest suspension (Threshold 2): Where aerial surveys indicate that the population density of a kangaroo species within a PMZ is less than Threshold 2, no commercial quota will be approved for the following calendar year. The harvest suspension will remain in force until population estimates indicate that kangaroo densities have increased above Threshold 2.

Note: the density thresholds tabled above will be kept under continual review during the life of the Management Plan and may be revised as new information is acquired. Any modification to the above figures will be identified in the annual quota document submitted to the Commonwealth Government.

Aim 5: Facilitate adaptive management and research

The ability to adapt the management program is essential for the delivery of the Management Plan and for maintaining public, industry and stakeholder confidence in the effectiveness of the plan and as a mechanism for maintaining the sustainability of kangaroo populations, as well as the commercial industry.

Research into particular aspects of kangaroo ecology, harvest management or land use practices can also assist in ensuring that the commercial harvest is sustainable over the long term. While there has been a large body of research on the ecology and management of kangaroos, there are information gaps which, when filled, may lead to improved management of the commercial harvest.

ACTION 13: The department will respond to changes as they arise. Changes made to the management program will be communicated to all relevant stakeholders.

> **Performance Indicator 21:** Changes to the kangaroo management program will be communicated to relevant stakeholders via the department's website and directly to stakeholders where appropriate.

ACTION 14: The department will support research into the ecology and harvest management of kangaroos.

Research relating to the commercial kangaroo harvest in Western Australia may be undertaken by a range of individuals or organisations including tertiary students, university professionals, consultants or departmental staff. The department will work with researchers and research organisations to identify and investigate issues relevant to the commercial harvest of kangaroos. Such research may include aspects of the biology and ecology of

kangaroos as they relate to the commercial harvest, harvest techniques or changes in land use practice that may significantly impact kangaroo populations.

Consideration of research findings and the results of analyses of harvest data are useful for the development of future management plans as well as for facilitating the adaptive management of kangaroo populations. The results of such analyses will be published in appropriate forums.

> **Performance Indicator 22:** During the life of the Management Plan, the department will support research on harvested species of kangaroos or commercial harvest management as appropriate.

ACTION 15: Where practicable, the department will support management experiments to test deliberate management interventions.

The department will consider proposals to undertake deliberate management experiments to improve aspects of kangaroo management, conservation and commercial utilisation of kangaroos. All proposals will be presented to the Kangaroo Management Advisory Committee (see Action 17) and reviewed through the department's scientific research approval process, including but not limited to assessment against the following criteria:

- the proponents' awareness of relevant background information;
- whether the proposal considers alternative models and hypotheses;
- whether the proposal is scientifically rigorous and statistically valid;
- whether the proposal incorporates a monitoring program;
- that there is substantial evidence that the risk of permanent damage to kangaroo populations is low;
- that the proposal is consistent with the goal of the Management Plan and relevant Western Australian legislation;
- that the proposal includes consideration of how management may be modified to accommodate the new knowledge gathered from the intervention; and
- that the proposal includes a commitment to publish results of the experiments in an appropriate forum.

All experiments that affect the commercial utilisation of kangaroos must also demonstrate how the experiment provides for reasonable business planning and investment.

> **Performance Indicator 23:** All proposals to undertake active adaptive management experiments are reviewed and assessed by the department in accordance with the criteria outlined in the Management Plan.

Aim 6: Undertake program reporting and review

Regular reporting and program review are essential for evaluating whether the goals and objectives of the Management Plan have been achieved; and for maintaining stakeholder confidence in the effectiveness of the Management Plan as a mechanism for ensuring that kangaroo populations are not over-harvested and that the commercial industry is managed sustainably over the long term.

Previous kangaroo management programs have generated a wide range of information relating to the commercial harvesting of kangaroos in Western Australia. This information will be analysed to provide data on trends in kangaroo populations, utilisation rates and demographic information to provide context to annual survey and harvest information. Other

specific information relating either to the commercial harvest or to kangaroo populations more generally may also be analysed.

> **Performance Indicator 24:** As a minimum, trends in population estimates, harvest tallies, carcass weights and sex ratios will be analysed annually and published on the department's website in annual and quota reports.

ACTION 16: A report will be prepared annually and submitted to the Commonwealth Government.

An annual report detailing the operation of the Management Plan over the previous year will be prepared and submitted to the Commonwealth Government. The report will provide information on harvest statistics, industry compliance and an assessment of actions against the Management Plan performance indicators.

> **Performance Indicator 25:** An annual report will be provided to the Commonwealth Government by 31 March of the following year.
>
> The annual report will include the following information:
>
> 1. Harvest statistics for each species taken in each PMZ including:
>
>   - Numbers of kangaroos taken;
>   - Sex ratio of the harvest; and,
>   - Average carcass weights of harvested animals for each sex taken.
>
> 2. Industry compliance statistics including:
>
>   - number of premises inspected;
>   - number of Caution Notices issued and reason for issue;
>   - number of alleged offences investigated and outcomes;
>   - number of prosecutions undertaken (offence and outcome); and
>   - any joint surveillance/enforcement activities completed with other agencies.
>
> 3. Any unusual situations that arose (e.g. disease outbreaks, drought conditions, market factors, etc).
>
> 4. Any research or adaptive management experiments that were undertaken or sponsored by the department.
>
> 5. An assessment of actions against the Management Plan performance indicators.

Aim 7: Promote community awareness and engage stakeholders

The harvesting of wildlife can be contentious and there are a large number of stakeholders in the commercial kangaroo industry. Consequently, community awareness of and stakeholder engagement in kangaroo management is considered a key component to the success of the program.

ACTION 17: A Kangaroo Management Advisory Committee (KMAC) will be convened to provide stakeholders in the industry with relevant information and to afford the opportunity to advise the department on key kangaroo management issues throughout the life of the Management Plan.

KMAC, which is convened by the department, is the main forum through which stakeholder group representatives can raise issues for discussion, as well as communicate their groups'

positions and interests to Government on a regular basis. Stakeholder groups presently represented on KMAC encompass the kangaroo industry, landholder groups, primary producers and government. Member organisations hold their appointed positions indefinitely. KMAC provides an opportunity for all stakeholder organisations to actively participate in directing the future development of the commercial kangaroo industry in Western Australia.

Performance Indicator 26: KMAC meets at least once per year to review the progress of the Management Plan in relation to the goal and aims of the plan.

Performance Indicator 27: KMAC is provided with annual updates on the commercial harvest and issue of tags issue throughout the life of the Management Plan.

Performance Indicator 28: KMAC is provided with other relevant information as required or as necessary throughout the life of the Management Plan.

ACTION 18: Relevant documents will be made available from the department's website and other publicly available information will be made available on request.

The timely provision of information promotes improved understanding of kangaroo management, the objectives of the Management Plan, and allows members of the community to make better-informed judgements regarding kangaroo management issues.

Performance Indicator 29: Throughout the life of the Management Plan, the department's website will contain the following information as a minimum standard:

- the current management plan;
- the current quota report;
- the current annual report submitted to the Commonwealth Government;
- information sheets on kangaroo biology and management;
- the Commercial Code; and
- relevant contact information.

Additional relevant information will be posted on the department's website as available and appropriate.

Performance Indicator 30: Publicly available information on kangaroo management is provided to interested parties as soon as practicable on request.

ACTION 19: Where appropriate, relevant departmental staff will participate in media interviews and prepare media releases.

Participation in media interviews and the preparation of media releases can be an effective mechanism for communicating information regarding kangaroo management to a broad audience. Moreover, it improves program transparency and accountability, and therefore public confidence.

Performance Indicator 31: Relevant departmental staff will participate in interviews with the media where appropriate.

Performance Indicator 32: Media releases are prepared for issues of interest to the community when appropriate.

ACTION 20: Information about the kangaroo management program and other relevant information will be developed as required and distributed to relevant stakeholders.

Relevant information regarding licensing arrangements will be developed and distributed to all licensees as required. Licensees and operators will be provided with written information relevant to their licensing arrangements to assist in achieving a high level of compliance with the licensing framework.

> **Performance Indicator 33:** As a minimum, all first time commercial kangaroo licence holders, or those who have not held a valid licence during the term of the current Management Plan, will be provided with an up to date information pack to make licence holders aware of relevant requirements and responsibilities.

Appendix 1 Licences for the commercial take, processing and dealing in kangaroos.

This section contains detail on the various licences related to kangaroo management.

Licences are issued under the *Biodiversity Conservation Act 2016* and associated Regulations. Licence conditions are reviewed regularly and may change during the life of this plan. Any changes to the conditions will need to be in accordance with this plan, and relevant parties will be notified.

Fauna taking (commercial products) licence

Commercial Kangaroo SHOOTER

Licence	**Licence issued under regulation 23 of the Biodiversity Conservation Regulations 2018.** **This licence authorises the licence holder to take fauna by means of a firearm on land for which there is commercial quota, field dress the carcasses into a form suitable for sale (undertake initial processing) and transport and sell the carcasses to a licenced Kangaroo Processer or Dealer.**
Accreditation	The applicant must hold a current Western Australian Firearms Licence that includes an appropriate calibre firearm that complies with the Commercial Code. The applicant must have successfully completed an accredited firearms competency test in marksmanship. Successful completion of the Game Harvester Skill Set or an equivalent accredited course.
Relevant detail	The licence holder may only shoot kangaroos on land on which they have written authorisation of the landholder. All kangaroos must be shot following the Commercial Code. Only kangaroos that have been killed by a single shot to the brain shall be delivered to a kangaroo processor. The licence holder may process in the field to the extent of evisceration and removal of head, tail and limbs. The licence holder must affix to each kangaroo carcass a commercial use identifier (tag) issued in accordance with Regulations. The licence holder must attach the appropriate tag for each species of kangaroo that is harvested. The licence holder must keep records of kangaroos that are harvested, and supply harvest returns to the department in the approved format.

Further detail	For further detail see the department's Kangaroo Management website.

Fauna processing licence

Commercial Kangaroo PROCESSOR

Licence	**Licence issued under regulation 37 of the Biodiversity Conservation Regulations 2018.** **This licence permits the licence holder to undertake the processing of kangaroo carcasses at a specified establishment.**
Accreditation	The applicant must have thorough knowledge of relevant sections of the *Biodiversity Conservation Act 2016* and associated Regulations. The applicant must have all authorities and licences required under local authority by-laws.
Relevant detail	The licence holder shall only accept kangaroo carcasses from a person licenced to take fauna for commercial products. The licence holder shall only accept kangaroo carcasses that have been killed with a single shot to the brain. The licence holder shall only accept kangaroo carcasses with an affixed identifier (tag). The licence holder must keep records of kangaroo carcasses received and processed and supply returns to the department in the approved format.
Further detail	For further detail see the department's Kangaroo Management website.

Fauna dealing (general dealer's) licence

Commercial Kangaroo DEALER/SKIN DEALER

Licence	**Licence issued under regulation 38 of the Biodiversity Conservation Regulations 2018.** **This licence permits the licence holder to deal (purchase or supply) kangaroo carcasses or products, including skins.**
Accreditation	The applicant must have thorough knowledge of the relevant sections of the *Biodiversity Conservation Act 2016* and associated Regulations. The applicant must have all authorities and licences required under local authority by-laws.
Relevant detail	The licence holder shall only accept kangaroo carcasses or skins from a person licenced to take or deal in fauna for commercial products.

	The licence holder shall only accept kangaroo carcasses or skins from kangaroos that have been killed with a single shot to the brain. The licence holder shall only deal in kangaroo carcasses or skins with an affixed identifier (tag). The identifier (tag) is to remain attached to the skin until the tanning process has started. The licence holder must obtain the relevant licences for import and export of kangaroo carcasses or skins, issued under the *Biodiversity Conservation Act 2016*, for consignments of kangaroo products that enter or leave Western Australia. The licence holder must keep records of kangaroo carcasses and skins received and processed and supply returns to the department in the approved format.
Further detail	For further detail see the department's Kangaroo Management website.

Fauna importing and exporting licences

Import Licence	**Licence issued under regulation 40 of the Biodiversity Conservation Regulations 2018.** This licence permits the licence holder to import fauna of a specified species into Western Australia. The fauna to be imported under the licence has been, or will be, lawfully taken under a law of another State or Territory.
Export Licence	**Licence issued under regulation 41 of the Biodiversity Conservation Regulations 2018.** This licence permits the licence holder to export fauna of a specified species from the state of Western Australia to other Australian States or Territories. The relevant authority in the State of Territory to which the consignment is destined, approves the importation of the fauna to that State or Territory. N.B export of kangaroo products from Australia requires a separate export permit issued by the Commonwealth Government.
Further detail	For further detail see the department's Kangaroo Management website.

Appendix 2 Biology, Ecology and Conservation of Kangaroos

A2.1 Introduction

Kangaroos are among the most widely studied species of fauna in Australia. Information on the biology, ecology, conservation and harvesting of kangaroos has been comprehensively documented in a large number of widely available publications. It is beyond the scope of the Management Plan to reproduce this information. Accordingly, the following sections provide only a concise summary of different aspects of kangaroo biology, ecology, conservation, management and harvesting. The information provided is largely adapted from Pople and Grigg (1999) who provided a comprehensive overview of the commercial harvesting of kangaroos in Australia. More detailed information can be found in the publications listed in the reference section of the Management Plan.

A2.2 Impacts of European settlement on kangaroo populations

The two kangaroo species that are the subject of the Management Plan are common and abundant over a broad area of Western Australia as well as the Australian continent (Figs 3 and 4). Within the sheep and cattle grazing pastures of Western Australia's rangelands, the provision of permanent watering points has meant that kangaroos are now more likely to be limited by food than water (Oliver 1986). This has had a profound effect on their distribution as well as their abundance (Newsome 1965a). It has been suggested that sheep and cattle also improved the habitat of kangaroos through facilitative grazing; creating a sub-climax pasture (Newsome 1975). These changes to the environment would have been most pronounced in the late 1800s when average sheep numbers in the rangelands of New South Wales and other parts of Australia were nearly twice what they are today (Caughley 1976). Other changes to Australia's rangelands following European settlement included the introduction and establishment in the wild of numerous species of eutherian herbivores and predators; and at the same time numerous small native mammal species disappeared and many are now extinct. As Caughley (1987b) explained, not only was the habitat modified, but the ecological system was 'changed beyond recognition'. The current distribution and abundance of kangaroos may therefore bear only a vague resemblance to what it was prior to European settlement.

Vegetation clearing, provision of artificial watering points and control of dingo (*Canis familiarus*) and wild dog populations to facilitate the grazing of domestic stock in the pastoral zone have "improved" the habitat for red and western grey kangaroos and thus resulted in a general population increase from pre-European times (Russell 1974; Newsome 1975; Caughley *et al.* 1980; Squires 1982; Grigg 1983). Conversely, intensive agriculture is not regarded as beneficial to either red or western grey kangaroos (Grigg 1983; Short & Grigg 1982). However, little red kangaroo habitat has been altered by intensive agriculture.

A2.3 Biology and ecology of the red kangaroo (*Macropus rufus*)

The red kangaroo is the most abundant species of kangaroo. It is distributed over much of dry, inland Australia and is the only species exclusively restricted to the arid zone (Tyndale-

Biscoe 2005; Figure 3). This distribution reflects the interaction between mean annual precipitation and mean annual temperature (Caughley *et al.* 1987). In Western Australia, red kangaroos occur at varying densities over a range that occupies about 75 percent of the State (Fig. 3) – an area of approximately 1.9 million km^2 (McNamara & Prince 1986). Rainfall has been shown to be a driving factor in the increase and decrease of red kangaroo populations (Caughley et al 1984).

Red kangaroos occupy a wide range of habitats including mulga and mallee scrub, shrubland, woodland, grassland and even desert (Caughley 1964; Russell 1974; Johnson & Bayliss 1981; Low *et al.* 1981; Short *et al.* 1983; Croft & Clancy 2008), however studies suggest a preference for open plains habitat (Croft and Clancy 2008, Russell 1974).

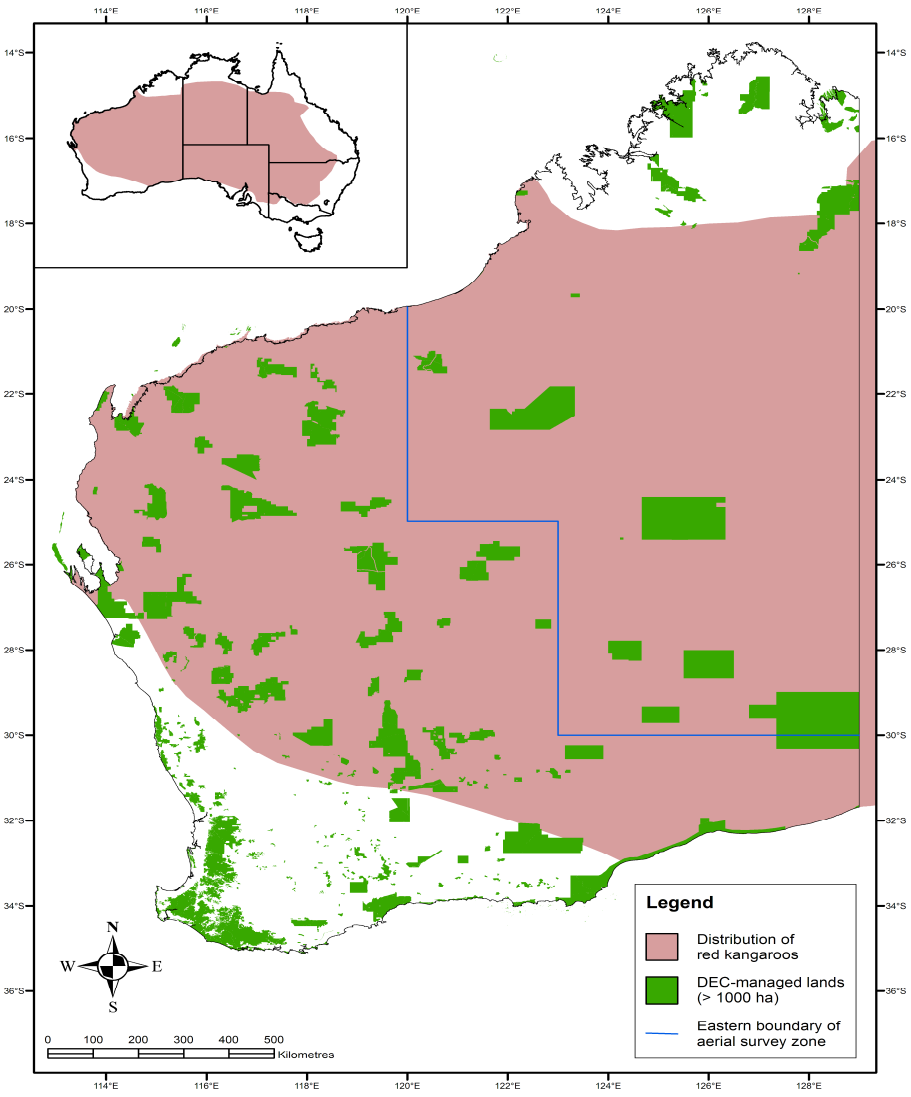

Figure 3. Distribution of the red kangaroo (*Macropus rufus*). Note, kangaroos would not normally be culled on DBCA-managed lands. Spatial data modified from the IUCN Red List of Threatened Species (Version 2010.4) using departmental records.

The red kangaroo is a herbivore and several detailed dietary studies indicate a preference for green herbage including grasses and dicotyledonous plants (Griffiths & Barker 1966;

Chippendale 1968; Storr 1968; Bailey *et al.* 1971; Ellis 1976), although they will browse chenopods and shrubs when necessary (Tyndale-Biscoe 2005).

Red kangaroos are opportunistic breeders and females are potentially fertile throughout the year, except in periods of extreme drought which can lead to the suppression of the oestrus cycle (Frith & Sharman 1964; Newsome 1964a, b, 1965b; Sharman 1964; Sharman & Pilton 1964; Moss & Croft 1999). Females can come into breeding condition almost immediately after drought-breaking rains. The female may give birth 33 days after mating and may mate again a day or two later. The mating system of the red kangaroo appears to be based on polygamy (Croft 1980).

The red kangaroo is a gregarious species (Kirkpatrick 1967) and although relatively large groups may sometimes form, these groups are unstable in their composition (Croft 1980). Several studies have examined the movement patterns of red kangaroo (Frith 1964; Bailey 1971; Denny 1980; Croft 1980; Oliver 1986; Priddel 1987; Norbury & Norbury 1993; Norbury *et al.* 1994). These studies indicate that the majority of the population is relatively sedentary, moving distances of no more than 10 km, although a small proportion of animals may move tens or hundreds of kilometres. Dispersal of younger individuals is male-biased (Edwards *et al.* 1994) and dispersal distances tend to increase during drought (Johnson 1989).

Individual home ranges have been found to overlap. In Western Australia, Norbury *et al.* (1994) found that red kangaroos had very large home ranges and attributed this to the inherently poor vegetation production and the occurrence of drought during their study. These findings were quite different from those of Croft (1991) who studied red kangaroos during a non-drought period in better quality habitat and found weekly home ranges varied from 259 to 560 hectares.

A2.4 Biology and ecology of the western grey kangaroo (*Macropus fuliginosus*)

Eastern and western grey kangaroos have probably diverged from a common ancestor quite recently with the biological and ecological differences between the two species being subtle. The western grey kangaroo was only confirmed as a separate species from the eastern grey kangaroo in 1972 (Kirsch & Poole 1967, 1972). Consequently, western grey kangaroos are very similar to eastern grey kangaroos in most aspects of their biology (Coulson 2008).

The western grey kangaroo occurs across the south of the continent, with a distribution extending northwards through western New South Wales and into a small area of southern central Queensland (Figure 4). This distribution corresponds to areas of uniform or winter rainfall (Caughley *et al.* 1987). Where the western grey kangaroo overlaps in its range with the eastern grey kangaroo, the latter is more abundant.

Coulson and Norbury (1988) found that the western grey kangaroo feeds mainly on grasses. In north-western Victoria, Norbury (1987) found that western grey kangaroos ate more than 75 percent grass in a mixed pasture but, as pasture biomass declined, shifted to forbs and shrubs. Barker (1987) described a similar shift from forbs and grasses to shrubs for western greys feeding on pastures in western New South Wales and southern Queensland.

Like red kangaroos, western grey kangaroos are potentially fertile throughout the year, except in periods of extreme drought. The reproductive biology of the western grey kangaroo

shows some minor differences with the eastern grey kangaroo: the mean lengths of the oestrus cycle (35 days), gestation period (31 days) and pouch life (42 weeks) are shorter in the western grey kangaroo (Coulson 2008). Furthermore, western grey kangaroos do not exhibit embryonic diapause.

Both eastern and western greys are less mobile than red kangaroos. Studies of eastern grey kangaroos by Jarman and Taylor (1983) and Jarman and Southwell (1986) indicate that the species occupies well-defined, highly overlapping home ranges. Few individuals have been shown to disperse, those that do being young males. Western grey kangaroos were studied by Priddel (1987), Priddel *et al.* (1988a, b) and Arnold *et al.* (1989) and show the same general patterns, with individuals occupying relatively small home ranges that overlap extensively.

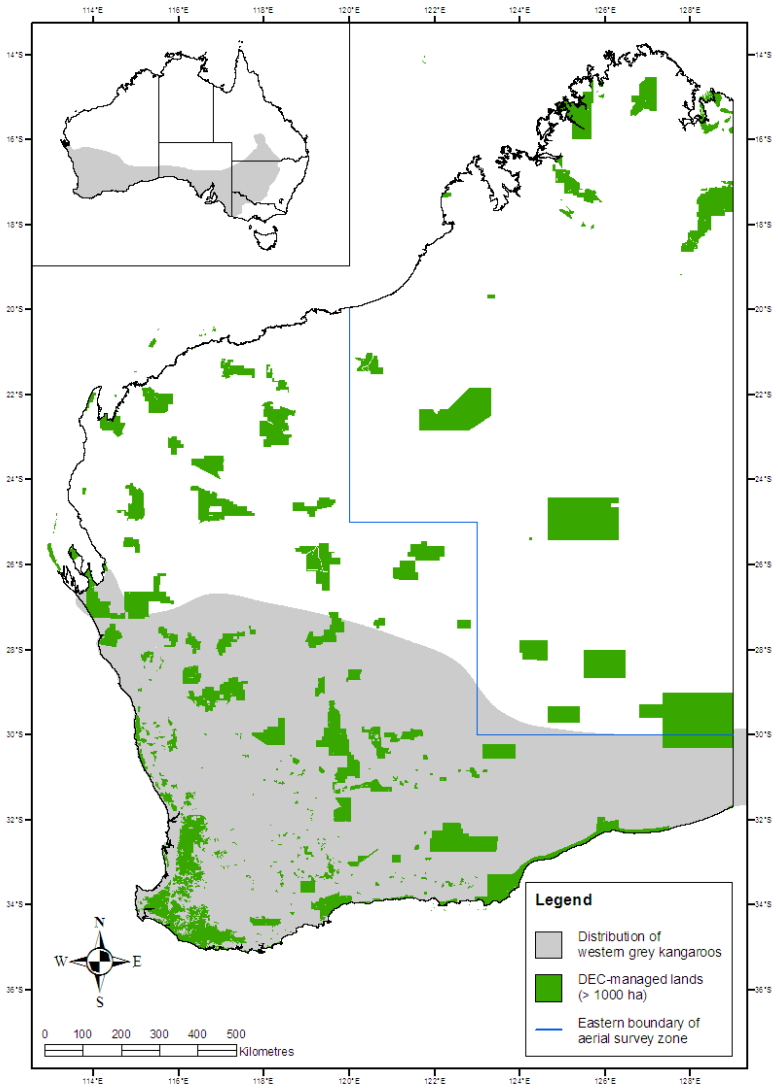

Figure 4. Distribution of the western grey kangaroo (*Macropus fuliginosus*). Note, kangaroos would not normally be culled on DBCA-managed lands. Spatial data modified from the IUCN Red List of Threatened Species (Version 2010.4) using departmental records.

A2.5 Conservation status

The conservation status of the commercially harvested kangaroo species in Western Australia reflects their abundance and therefore their utilisation. The listing status under State and Commonwealth legislation and international lists and agreements for red and western grey kangaroos is as follows:

- Not listed as threatened or endangered in Western Australia (Biodiversity Conservation Act 2016)
- Not listed as threatened in Australia (EPBC Act)
- Listed as Least concern on the IUCN Red List 2018
- Not listed under Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES 2017)

Appendix 3 Threats and Assessment of Impacts

In the context of commercial kangaroo harvesting in Western Australia:

- threats to the conservation status of harvested kangaroo species are limited;
- issues relating to the conservation and harvesting of kangaroos are well understood; and,
- assessments of the impacts of harvesting on kangaroos, as well as other species, habitats and ecosystems, are comprehensive.

A3.1 Threats to kangaroos

Kangaroo populations in Western Australia have the potential to be impacted by a range of environmental and anthropogenic factors. The extent of the impact can vary. Environmental factors include: changing climate, drought, disease and predation. Potential anthropogenic threats to the conservation status of kangaroos principally arise from the commercial harvest and other human-mediated practices such as habitat loss and modification.

Table 3 identifies the threats that may impact kangaroo populations and the likely risk of those threats to the long-term conservation status of kangaroos.

Table 3: Threats and issues pertinent to the long-term conservation of kangaroos.

Threats	Comments	Selected References
Drought	Rainfall and its impact on plant productivity is the single most important factor affecting kangaroo population dynamics. Droughts can drastically reduce kangaroo numbers. However, kangaroos are well adapted to a dynamic environment and populations recover quickly after drought-driven population crashes, even with continued harvesting. Therefore, drought is not considered a threat to the long-term conservation of kangaroos.	Bayliss (1987); Cairns & Grigg (1993); Cairns *et al.* (2000); Caughley *et al.* (1985); McCarthy (1996); Pople (2003); Pople, Grigg *et al.* (2010); Robertson (1986).
Flood	Flooding has been found to affect the short-term distribution and abundance of kangaroos and has been associated with occasional localised epizootic disease. Flooding is not considered a threat to the long-term conservation of kangaroos.	Choquenot (1991); Clancy *et al.* (1990).
Climate change	Shifts in climate regimes have the potential to significantly impact on all biodiversity including the commercially harvested species of kangaroos. Modelling indicates that northern Western Australia is likely to become warmer and wetter while south-western Western Australia warmer and drier. Rainfall patterns and therefore vegetation associations and pasture biomass may also be significantly different from current and historical patterns. This will likely lead to variable responses across the landscape and may benefit some populations and adversely impact on others. While the potential effects of climate change on kangaroos are not well understood, the methods used for setting harvest quotas are responsive to fluctuating densities of kangaroos and will alert managers to potential problems.	Jonzén *et al.* (2010).

Threats	Comments	Selected References
Habitat loss and modification	Red and western grey kangaroos have benefited significantly from habitat modification: their numbers have increased, and ranges extended, due principally to the expansion of grasslands and the provision of permanent sources of fresh water for livestock. Conversely, kangaroo numbers have generally declined where there is intensive agriculture, urbanisation or extensive clearing. Despite more than 200 years of heavy exploitation and clearing of the land, the larger kangaroos have maintained their populations or increased in abundance and range. Accordingly, habitat loss and modification are not considered a threat to the long-term conservation of kangaroos.	Calaby & Grigg (1989); Dawson *et al.* (2004); Pople, Grigg *et al.* (2010); Short & Grigg (1983).
Disease	A range of parasites and pathogens infect kangaroos. Epidemics have caused significant short-term reductions in kangaroo numbers in particular areas, but these populations have recovered rapidly. Diseases do not appear to be important agents of mortality in kangaroos over the long-term and, therefore, are not considered to pose a threat to their conservation.	Caughley (1987a); Gilroy et al. (1999); Kirkpatrick (1985); Pople & Grigg (1999); Speare et al. (1989); Hooper et al. (1999); Reddacliff et al. (1999).
Harvesting – general	In over forty years of managed harvest in Western Australia, viable populations of the harvested kangaroo species have been maintained across their natural range. Furthermore, the distributional ranges of red and western grey kangaroos have expanded. Therefore, harvesting is not considered a threat to the long-term conservation of kangaroos.	Cairns & Coombs (1992); Calaby & Grigg (1989); Dawson *et al.* (2004); Grigg & Pople (2001).
Harvesting – genetic	Harvesting, especially non-random or selective harvesting, has the potential to alter the genetic structure and genetic diversity of a population. The safeguards in place to protect the genetic diversity of harvested kangaroos include conservative harvest quotas and protected areas where harvesting is prohibited. Several studies have examined genetic diversity of harvested macropod populations and there is no evidence to suggest that current harvesting practices are a threat to the long-term genetic integrity of kangaroo populations.	Clegg *et al.* (1998); Hacker *et al.* (2004); Hacker & McLeod (2003); Hale (2001, 2004); Neaves *et al.* (2009, 2012); Tenhumberg *et al.* (2002, 2004).
Predation	In some circumstances, dingoes (*Canis familiaris*) and wild dogs have been shown to limit kangaroo populations and there is increasing evidence for this species having a regulatory effect. Other predators such as European fox (*Vulpes vulpes*) and wedge-tailed eagle (*Aquila audax*) do not appear to exert much influence on the harvested species of kangaroo. Therefore, predation is not considered a threat to the long-term conservation of kangaroos.	Banks *et al.* (2000); Caughley *et al.* (1980); Corbert & Newsome (1987); Jarman & Denny (1976); Letnic & Koch (2010); Pople & Page (2001); Thompson (1992).

A3.2 Management and regulatory controls

Commercial harvesting is not considered a threat to the genetic integrity or conservation status of kangaroos in Western Australia. In over 40 years of commercial harvesting in Western Australia, viable populations of the harvested kangaroo species have been maintained across their natural range. However, to ensure that the commercial kangaroo harvest in Western Australia remains sustainable and does not jeopardise the viability of

kangaroo populations across their range in the future, the department enacts a range of management and regulatory controls including:

Undertaking regular and ongoing monitoring of kangaroo populations.

The strictly standardised survey techniques employed in Western Australia for the broad-scale monitoring and estimation of kangaroo populations are widely regarded as best practice, both in Australia and overseas (Caughley *et al.* 1976; Caughley & Grigg 1981; Anderson & Southwell 1995; Southwell *et al.* 1995; Pople 2004, 2008; Pople *et al.* 2006).

Indirect monitoring is also undertaken using harvest statistics, but is currently used only to supplement direct monitoring from aerial surveys. Predictive models using harvest statistics, rainfall and other data are not yet considered sufficiently advanced to replace direct monitoring (Pople, Evans *et al.* 2010; Pople, Grigg *et al.* 2010).

Managing the commercial harvest using a proportional harvesting strategy based on regular estimates of abundance.

Proportional harvesting strategies have been well studied and are considered safe and efficient for fluctuating populations (Caughley 1987a; Engen *et al.* 1997). Moreover, Western Australia's program of regularly monitoring and estimating abundance allows for any other agents of mortality acting on kangaroo populations (e.g. drought, disease, road kill, non-commercial culling) to be detected and accounted for in the setting of annual commercial harvest quotas.

Proportional threshold harvesting is considered the optimal strategy for maintaining a viable yield and minimising any adverse risks to the sustainability of the harvested species (Engen et al 2007, Pople 2004). Using this strategy thresholds are set under which the proportion of the population to be harvested, (i.e. the quota) is reduced and finally ceased to avoid any risk of over harvesting. Western Australia adopts a proportional threshold harvesting strategy for the commercial harvest of macropods.

Using conservative species correction factors.

The department uses correction factors for calculating population estimates from aerial survey data that are generally regarded as conservative because they tend to underestimate kangaroo abundance.

Setting commercial harvest quotas at levels that are considered ecologically sustainable for kangaroo populations.

Western Australia will set harvest quotas for red kangaroos at ≤17 percent and for western grey kangaroos at ≤15 percent of the populations estimate. These levels are regarded as ecologically sustainable (e.g. Caughley 1987a; Hacker *et al.* 2004) and have been demonstrably sustainable in practice.

Providing refuge habitat.

In Western Australia, conservation reserves and State forest, a total area in excess of 26 million hectares or approximately 10 percent of the land area of the State (see Figures 3 and 4) is exempt from commercial harvesting. Additionally, kangaroos would not normally be culled these areas unless such actions are deemed a necessary operation under the *Conservation and Land Management Act 1984*, or where an area management plan specifies that the management of overabundant populations is warranted.

The department also has limited management responsibilities for unallocated Crown Land (UCL) and unmanaged reserves (UMR) outside the metropolitan area and townsites. The area of UCL and UMR for which the department has limited management responsibilities totals about 90 million hectares. The commercial harvesting of kangaroos would not normally occur on UCL and UMR. Additionally, the commercial kangaroo harvest is patchy within Kangaroo Management Areas and individual properties, leaving many other areas unharvested or providing refuge habitat (see Tenhumberg *et al.* 2004).

A3.3 Assessment of the impacts of commercial kangaroo harvest on other species, habitats and ecosystems

Impacts on species, habitats and ecosystems resulting from actions detailed within the Management Plan are unlikely to be significant, and in some instances are expected to be positive (Table 4).

Table 4: Impacts of the commercial kangaroo harvest on other species, habitats and ecosystems.

Potential Impacts	Comments	Selected References*
Land degradation caused by the erosion of soil	The commercial kangaroo harvest is unlikely to cause land degradation due to the erosion of soil. Licensed commercial kangaroo shooters generally operate on pre-existing tracks and are reluctant to risk damage to their vehicles, especially punctured tyres, by traversing rough terrain. Moreover, kangaroo harvest off-cuts have been shown to contribute to soil nutrient retention and cycling, thereby improving soil quality.	Wilson & Read (2003).
Detrimental effects on water bodies, watercourses, wetlands and natural drainage systems	There is no evidence that suggests the commercial kangaroo harvest will have detrimental effects on water bodies, watercourses, wetlands and natural drainage systems.	
Vegetation clearing or modification	No vegetation is likely to be cleared or modified as a consequence of the commercial kangaroo harvest. However, the commercial harvest may provide indirect benefits to vegetation by potentially contributing to an integrated approach to reducing total grazing pressure or facilitating the retention of vegetation that provides habitat for kangaroos by private landholders.	Fisher *et al.* (2004); Grigg (1988, 1995).
Detrimental effects on threatened flora	There is no evidence that the commercial kangaroo harvest has a detrimental effect on threatened flora species,	

Potential Impacts	**Comments**	**Selected References***
species, populations or their habitats	populations or their habitats.	
Endangering, displacing or disturbing native fauna, or creating a barrier to their movement	Native fauna is unlikely to be endangered, displaced or disturbed as a consequence of the commercial kangaroo harvest. Furthermore, the commercial harvest is unlikely to create a barrier to the movement of native fauna. Kangaroo harvest off-cuts are utilised by species that scavenge, such as some raptors and corvids, thereby benefiting these species.	Read & Wilson (2004).
Detrimental effects on threatened fauna species, populations or their habitats	There is no evidence that the commercial kangaroo harvest has a direct detrimental effect on threatened fauna species, populations, or their habitats, but there may be indirect effects on threatened fauna species and/or populations (see section on introduced predators below).	
Detrimental impacts on ecological communities of conservation significance	Ecological communities of conservation significance are unlikely to be impacted by the commercial kangaroo harvest.	
Positive effects on introduced predators	Kangaroo harvest off-cuts are utilised by introduced predators, particularly foxes (*Vulpes vulpes*) and may sustain populations of these predators during periods of low prey availability. Maintenance of artificially high predator populations may in turn threaten prey populations, including endangered taxa. However, Western Australia undertakes extensive aerial baiting programs to protect endangered fauna from fox predation and to protect livestock from wild dog predation, which would mitigate this effect.	Kay *et al.* (2000); Read & Wilson (2004); Saunders *et al.* (1995).
Positive effects on introduced herbivores	The commercial kangaroo harvest, by reducing kangaroo populations and thus competition, may allow populations of introduced herbivores such as goat (*Capra hircus*) and rabbit (*Oryctolagus cuniculus*) to increase. However, the limited magnitude of the reduction in kangaroo numbers coupled with ongoing pest animal control programs undertaken across Western Australia mitigates the potential positive effect on populations of introduced herbivores.	
Introduction and/or dispersal of invasive weeds	There is no evidence that commercial kangaroo harvesters contributes to the introduction and/or dispersal of invasive weeds more than other land users.	

**Where applicable and/or available*

Appendix 4 Setting and applying harvest thresholds

In 2008, the Administrative Appeals Tribunal of Australia, in reviewing a wildlife trade management plan for kangaroos in New South Wales (AATA 2008a,b,c) expressed their concern that the plan did not encompass a specific response to an unusual decline in kangaroo numbers and determined that the plan should incorporate concrete measures to suspend the harvest in response to this scenario. In their decision, they concluded that the plan should be amended to include such a provision and identified a trigger point of a 30 percent population decline (approximately twice the harvest rate), which was acknowledged as being somewhat arbitrary. However, kangaroo populations are known to decline by as much as 30–60 percent over three months during drought (Robertson 1986) and have recovered from such fluctuations in the face of continued harvest pressure in the past. A trigger point set at a 30 percent population decline underestimates natural fluctuations in kangaroo populations and the ability of kangaroos to recover from such declines.

Proportional threshold harvesting is one strategy for reducing the risk of over-harvesting (Engen *et al.* 1997). Using this strategy, density thresholds are established that 'trigger' a management response. Typically, the harvest rate is reduced or the harvest is suspended at specific densities to reduce the risk of over-harvesting. However, care must be taken when quantifying trigger points as threshold policies can induce cyclic behaviour in an otherwise stable exploited population as a consequence of the combination of harvest pressure and excessively protective threshold densities. This behaviour may be of significant concern in terms of both the conservation and management of exploited populations (Da Silveira Costa & Faria 2011).

The Management Plan aims to accommodate natural fluctuations in kangaroo densities that change according to seasonal conditions. Calculating trigger points based on standard deviations from the long-term average density accounts for natural changes in kangaroo populations while also enabling the identification of changes that are unusual. In this context, standard deviation is a statistical measure of how much the population varies relative to its average density. In erratic environments such as the arid inland area of Western Australia, population densities fluctuate much more widely as a proportion of their long-term average density than in more stable environments such as the South West. This means that the standard deviation will be different for each species of kangaroo in each PMZ.

It is important to note that the density estimates of kangaroos over much of Western Australia, particularly in rangelands areas, are significantly lower than in eastern Australia. Average densities in many areas are of the order of one kangaroo per square kilometre or lower, with average red kangaroo density estimates at the population monitoring zone level ranging from less than 0.4 kangaroos per square kilometre to a high of around three kangaroos per square kilometre.

Land use practices can also influence the densities of kangaroos across both the broader landscape and at local scales. It is considered that the kangaroo densities experienced over the last 40 years of commercial harvesting are significantly higher than they would have been prior to the commencement of widespread sheep grazing in the rangelands. The

department recognises that as part of the cessation of sheep grazing in many rangeland areas, the dismantling of artificial water points and less intensive wild dog control, kangaroo densities are moving back to levels approaching pre-European settlement densities. It has been established that kangaroo densities are routinely much lower in areas subject to dingo predation compared with adjacent areas where wild dogs and dingoes are controlled (Pople *et al.* 2000). Provision of artificial water sources and dismantling of these water sources can also affect local kangaroo densities. It is difficult to estimate with any certainty how much lower historic population levels would have been in the presence of dingoes and in the absence of artificial water sources and livestock grazing.

Harvest thresholds for kangaroo management in Western Australia were set using the statistical properties of a time series of the population's estimated abundance (see McLeod and Pople, 2011). Standard deviations (1.0, 1.5, 2.0 and 3.0) from the long term mean of kangaroo abundance (calculated from survey data from 1995 to 2012) have been used to set the harvest thresholds shown in Section 3.3, Table 2. The advantage of this method is that the threshold is unlikely to be biased by a single low abundance. Additionally, as more survey data are added to the time series of abundance for a population, the estimates of the population's mean and standard deviation become more robust. The thresholds allow the population to fluctuation within the average observed range of abundance (normal range) but prevent harvest mortality from depleting the population when it's at low abundance through the provision of management triggers.

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