

South Australian Commercial Kangaroo Management Plan

2020-2024



**Government
of South Australia**

Department for
Environment and Water

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Definitions

Kangaroo – means an animal of the genus *Macropus* (kangaroos and wallabies). The kangaroo species that can be utilised under this management plan are: the red kangaroo (*Macropus rufus*), western grey kangaroo (*M. fuliginosus*), euro (*M. robustus*), eastern grey kangaroo (*M. giganteus*), tammar wallaby (*M. eugenii*) on Kangaroo Island and other islands, and other species as per relevant legislative amendment subsequent to the commencement of this plan.

Carcass – the entire body (including the skin) of the kangaroo, excluding the head and entrails.

National Code of Practice for the Humane Shooting of Kangaroos and Wallabies for Commercial Purposes (Commercial Code) and **National Code of Practice for the Humane Shooting of Kangaroos and Wallabies for Non-Commercial Purposes (Non-Commercial Code)** – the current nationally-endorsed codes, endorsed by the Natural Resource Management Ministerial Council in 2008. A reference to these codes will also apply to any subsequently nationally-endorsed codes.

Kangaroo Field Processor – a person, permitted under Section 60J of the *National Parks and Wildlife Act 1972* to harvest and sell or use kangaroos for commercial purposes.

Kangaroo Meat Processor – a person, permitted under Section 58 of the *National Parks and Wildlife Act 1972* to carry out the business of processing kangaroo carcasses for human or animal consumption and is permitted to keep and sell carcasses or skins.

Field Chiller – an appliance or structure, whether mounted on or forming part of a vehicle or otherwise, providing refrigeration facilities for the storage of the carcass of a kangaroo during the period between field processing of the carcass and the transportation of the carcass to the premises at which it is to be processed by a kangaroo meat processor.

Landholder – owner or occupier of specified lands.

Commercial Harvest Management Region (CHMR) – A designated area of the state at which commercial quota is determined. At the time of writing, regions are defined by the former Soil Conservation Board boundaries (or amalgamation thereof), and consist of five CHMRs (Eastern Agricultural, Western Agricultural, Eastern Pastoral, Western Pastoral and Southern Agricultural), which are split into 17 **Commercial Harvest Sub-Regions (CHSR)**. See Figure 1.

Note: All other terms are as defined in the *National Parks and Wildlife Act 1972*.

Established Commercial Harvest Sub-Regions – those established prior to this management plan and form part of the Eastern Agricultural, Western Agricultural, Eastern Pastoral and Western Pastoral Commercial Harvest Management Regions.

New Commercial Harvest Sub-Regions – those established in this management plan and form part of the Southern Agricultural Commercial Harvest Management Region.

Acronyms

NPW Act – the South Australian *National Parks and Wildlife Act 1972*

EPBC Act – the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

DEW – the South Australian Department for Environment and Water

CHMR – Commercial Harvest Management Region

CHSR – Commercial Harvest Sub-Region

1 Introduction

This plan has been developed to guide the sustainable management of commercially harvested kangaroos in South Australia. The plan satisfies the requirements of the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) as a Wildlife Trade Management Plan and meets the legislative requirements of the South Australian Government as a management plan under the *National Parks and Wildlife Act 1972* (NPW Act). The plan also aims to meet community expectations that kangaroo harvesting methods will not breach the *Animal Welfare Act 1985*. This plan is current for a maximum five-year period from 1 January 2020 to 31 December 2024 as per the requirements of the EPBC Act.

Since European settlement, widespread changes in land use have altered the abundance of many native species (Woinarski and Fisher 2003). Many species have declined in number, and some are now threatened. However, other species have been able to adapt to the changes and can exploit the opportunities provided by altered habitats. These species – including kangaroos – are now present in larger numbers, or have more widespread distributions, than before (Pople and Grigg 1999).

South of the dog-fence, kangaroos have increased above historic levels because of the changes in land use (Newsome 1975), increase in permanent watering points provided for stock and a reduction in predation pressure from dingos (Pople et al. 2000; Letnic et al. 2011). In these areas, high kangaroo numbers can be in conflict with various land uses and the objectives for which land is being managed. When this conflict occurs, kangaroos can cause detrimental impacts to environmental values, pasture, crops and infrastructure (e.g. Howland et al. 2014). Damage caused by kangaroos can be particularly high during dry periods following a number of high rainfall years. To help manage kangaroos, landholders may employ the services of the commercial kangaroo industry or apply for a Permit to Destroy Wildlife through the Department for Environment and Water (DEW). All kangaroo species included in this plan are common and causing significant impacts, as such, DEW regularly issues Permits to Destroy Wildlife for these species. The commercial industry provides an alternative tool for managing kangaroos and has the advantages of being undertaken by a professional shooter and makes use of the carcass for leather and meat production rather than leaving the carcass on the property, as is a requirement of the Permit to Destroy Wildlife.

Kangaroo impacts recently reached critical levels following a series of good seasons, which saw kangaroo numbers increase to a record high of 5 million during 2017 within South Australia's commercial harvest zone (DEW 2017). Recent drying conditions have resulted in a decline of kangaroo numbers in the north of South Australia, which has caused an animal welfare issue as kangaroos died primarily due to food scarcity related issues. In other parts of the state, populations have remained high, further damaging already stressed ecosystems.

The changes made in this management plan are the result of a detailed investigation into the kangaroo issue, including analysis of survey and harvest data and consultation with key stakeholders. This management plan has been altered to increase the flexibility of the commercial industry to assist landholders in managing kangaroos across the state by, expanding the commercial harvesting zone, increasing the number of species available for harvest and applying a risk-based approach to quota setting.

The commercial kangaroo harvesting zone now covers the entire State, excluding the Alinytjara Wilurara region for cultural reasons and metropolitan Adelaide. The expansion is managed through four new harvest sub-regions: Hills and Fleurieu (excluding metropolitan Adelaide), Kangaroo Island, Lower South East and Upper South East; and extensions to the existing Murray Mallee and Mid North sub-regions to include Murray Plains, and Yorke Peninsula and Lower North respectively. The new kangaroo species that are available for harvest are included below.

This plan relates to the following kangaroo species within South Australia:

- red kangaroo (*Macropus rufus*)
- western grey kangaroo (*Macropus fuliginosus*), including the Kangaroo Island subspecies (*Macropus fuliginosus fuliginosus*) and the mainland subspecies (*Macropus fuliginosus melanops*).
- euro (*Macropus robustus*)
- tammar wallaby (*Macropus eugenii*)
- eastern grey kangaroo (*Macropus giganteus*)
- other species as per relevant legislative amendment subsequent to the commencement of this plan

The primary goal of this plan is to ensure an ecologically sustainable harvest of kangaroos and to provide an alternative management option 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 that the viability of kangaroo populations is not compromised by any action undertaken under this plan. In addition, DEW requires that all kangaroos harvested or culled are done so humanely and in accordance with the National Code of Practice for the Humane Shooting of Kangaroos and Wallabies for Commercial Purposes (Commercial Code) and the National Code of Practice for the Humane Shooting of Kangaroos and Wallabies for Non-Commercial Purposes (Non-Commercial Code). This plan incorporates an adaptive approach to management, by collecting and applying reliable information to improve management over time.

2 Legislative Framework

2.1 Commonwealth

The EPBC Act requires the development and approval of Wildlife Trade Management Plans for permits to be issued for the commercial export of wildlife products. This plan has been developed to meet the requirements of an approved Wildlife Trade Management Plan under that Act.

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 only be given if the Minister is satisfied that:

- the plan is consistent with the objects of Part 13A of the EPBC Act
- an assessment of the environmental impacts of the activities in the plan has been undertaken
- the plan includes management controls directed towards ensuring the impacts of the activities covered by the plan are ecologically sustainable
- the activities in the plan are not detrimental to the species to which the plan relates or any relevant ecosystem
- the plan includes measures to mitigate, monitor and respond to the environmental impacts of the activity covered by the plan

In deciding whether to declare this plan as a Wildlife Trade Management Plan, the Minister must also have regard to whether:

- legislation relating to the protection, conservation, or management of the species to which the plan relates is in force in the State or Territory concerned
- the legislation applies throughout the State or Territory concerned
- in the opinion of the Minister, the legislation is effective

Finally, in deciding whether to declare this plan as a Wildlife Trade Management Plan, the Minister must also be satisfied that if an animal is killed, it is done in a way that is accepted to minimise pain and suffering. Animal welfare standards for the commercial harvesting and non-commercial culling of kangaroos are detailed in the Commercial Code and the Non-Commercial Code, respectively (www.environment.gov.au/biodiversity/trade-use/wild-harvest/kangaroo/practice.html). All kangaroos must be killed following these codes or any subsequent relevant nationally-endorsed code(s) that replace these documents.

In addition to the EPBC Act, this plan integrates with, and is informed by, the following pieces of legislation

- Commonwealth *Export Control Act 1982*
- Commonwealth *Native Title Act 1993*

2.2 South Australia

All kangaroo species are protected animals in South Australia under the NPW Act. The NPW Act, the National Parks and Wildlife (Kangaroo Harvesting) Regulations 2018 (Kangaroo Harvesting Regulations), and the National Parks and Wildlife (Wildlife) Regulations 2019 (Wildlife Regulations) make provisions for the permitting of a range of activities relating to the commercial harvesting of kangaroos in South Australia.

Harvesting of kangaroos in South Australia requires a Management Plan approved under section 60I of the NPW Act, which states that the plan must:

- assess the likely impact of harvesting animals of that species:
 - on the species concerned
 - on the ecosystems which animals of that species form part
 - on the diversity of the species of animals and plants comprising those ecosystems
 - on the ability of the species to maintain natural genetic diversity throughout its population
- identify factors that are likely to reduce or increase the number of animals of the species to be harvested
- identify any other factors that will affect the species as a renewable resource for harvesting in the future
- assess whether there is a need to reduce the number of animals of the species to protect the environment, crops, stock, or other property
- specify humane methods and procedures for the killing, capturing and killing, and treatment after capture of animals under a permit under this Division (of the NPW Act)
- address any other matters that should, in the opinion of the Minister, be addressed

This plan is designed to meet these requirements and is endorsed under the NPW Act. The Kangaroo Harvesting Regulations and the Wildlife Regulations manage the operations of the kangaroo industry through the issuing of permits, tags and record keeping. Permits are issued for harvesting kangaroos (Kangaroo Field Processor, section 60J NPW Act), processing and selling kangaroo meat (Kangaroo Meat Processor, section 58 NPW Act) or kangaroo skins (Kangaroo Skin Tanner, section 58 NPW Act). Tags are issued to kangaroo field processors under the Kangaroo Harvesting Regulations. Details on permitting structures are provided in Appendix 5.

Kangaroos may be harvested from land managed by DEW (e.g. national parks and conservation parks) in accordance with sections 38 and 60J of the NPW Act and specific park and species management plans. For example, section 38 states that the number of kangaroos harvested must not exceed the number that would be culled for land management purposes, and section 60J restricts harvesting on park to three kangaroo species; red kangaroo, mainland sub-species of western grey kangaroo and the euro.

In addition to the NPW Act, this plan integrates with, and is informed by, the following pieces of legislation:

- *Native Title (South Australia) Act 1994*
- *Natural Resources Management Act 2004*
- *Pastoral Land Management and Conservation Act 1989*
- *Animal Welfare Act 1985*
- *Primary Produce (Food Safety Schemes) Act 2004*

3 Goal and Aims

3.1 Goal

To provide for the sustainable use of kangaroo species referred to in this plan in accordance with the principles of ecologically sustainable development.

The principles of ecologically sustainable development are defined in section 3A of the EPBC Act:

- (a) decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations;
- (b) if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation;
- (c) the principle of inter-generational equity—that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations;
- (d) the conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making;
- (e) improved valuation, pricing and incentive mechanisms should be promoted.

To attain its overarching goal, this plan has seven aims, each of which encompasses a particular facet of kangaroo management. When combined, these aims provide a strategic direction for ensuring an ecologically sustainable harvest of kangaroos, and provide an alternative management option for reducing the damage to land condition caused by overabundant kangaroos.

Under each aim sits one or more actions detailing 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 plan can be measured.

Throughout the life of this plan, aims will be audited annually against performance indicators, with a major assessment and review to commence towards the end of 2023.

3.2 Aims

The aims of this management plan are to:

1. Ensure Humane Harvest of Kangaroos

Promote improved animal welfare outcomes and ensure that the commercial harvest of kangaroos under this plan is carried out in accordance with the Commercial Code.

2. Promote Community Awareness and Participation

Promote greater understanding of the program through communication with the public and encourage community participation in the commercial industry.

3. Manage Impacts of Kangaroos on Land Condition

Reduce conflicts between kangaroos and the environmental, economic, and social objectives of stakeholders.

4. Monitor Kangaroo Populations and set quotas

Monitor kangaroo populations to ensure harvesting is not negatively affecting kangaroo populations and to set commercial quotas based on population estimates.

5. Monitor Commercial Harvest

Manage the commercial utilisation of kangaroo species in accordance with the provisions of the NPW Act and Regulations, South Australian Government policies, the Commercial Code, and this plan to ensure the sustainable use of kangaroos.

6. Facilitate Adaptive Management and Research

Promote adaptive management of new quota setting procedures set out in this plan using historical data from kangaroo industry returns and population data. Facilitate research into other aspects of kangaroo ecology and harvest management as required to fill knowledge gaps.

7. Undertake Program Reporting and Review

Undertake regular reporting and a final program review in consultation with affected community members and stakeholders to ensure management is fully informed and to ensure outcomes remain consistent with the goal of this plan.

4 Management Actions and Performance Indicators

4.1 Aim 1: Ensure Humane Treatment of Kangaroos

Animal welfare is of prime concern to DEW. The Commercial Code is the current nationally-endorsed animal welfare standard for the commercial harvest of kangaroos. The Humaneness Model (Sharp and Saunders 2011) demonstrates that the 'head shot' required in the Commercial Code of Practice is considered to be relatively humane, based on the premise that there is virtually no welfare impact prior to death, and mode of death is instant if undertaken by a competent shooter. Accordingly, the commercial kangaroo industry in South Australia is required (by the Kangaroo Harvesting Regulations) to comply with the Commercial Code. Any approved subsequent code(s) will similarly be adopted as the animal welfare standard for the commercial harvest of kangaroos in South Australia.

Action 1: ***DEW staff will monitor compliance with the Commercial Code by commercial kangaroo industry operators.***

DEW staff will undertake both regular unannounced and opportunistic inspections of kangaroos taken and stored for sale by kangaroo field processors and all premises registered to kangaroo meat processors. DEW has a zero tolerance to breaches of the Commercial Code, and where kangaroos have been found to be taken other than by the Commercial Code, DEW will instigate compliance action.

Performance indicators:

1.1 DEW will instigate compliance action on all South Australian permit holders who are found to have breached permit conditions (i.e. the Commercial Code) relating to animal welfare

Action 2: ***DEW will promote research opportunities into improving animal welfare outcomes.***

DEW will work with other agencies to identify and investigate animal welfare concerns in the commercial harvest of kangaroos. Research to be encouraged may include aspects of the biology and ecology of kangaroos as they relate to the commercial harvest or harvest techniques. Contributions by DEW may include funding and/or in-kind support such as the provision of harvest data.

Performance indicators:

2.1 DEW will participate in a national review of the Commercial Code of Practice during the life of this plan.

2.2 DEW will promote research into improving animal welfare outcomes for commercial harvest of kangaroos.

4.2 Aim 2: Promote Community Awareness and Participation

Management strategies for kangaroos must meet detailed legislative requirements to ensure their sustainability, and stakeholders want to see their specific management objectives met. Community awareness of, and stakeholder participation in, kangaroo management is considered a key component in the success of the program.

Action 3: *Members of the Kangaroo Management Reference Group will be provided with information and afforded the opportunity to advise DEW on kangaroo management issues throughout the life of this plan.*

The Kangaroo Management Reference Group (KMRG), which is convened by DEW, is the primary forum through which stakeholder group representatives can raise issues for discussion, as well as communicate their group's positions and interests to Government and other stakeholders on a regular basis. KMRG members are selected based on their skills and experience relevant to their nominated position. The current membership of KMRG encompasses representatives of animal welfare, the kangaroo industry, landholder groups, Aboriginal communities, conservation organisations and government stakeholder groups (both Federal and State). Members hold their appointed positions for three-year terms. A key function of KMRG is to advise the Chief Executive of DEW on matters about the implementation and review of this plan.

Performance indicators:

3.1 DEW will provide KMRG members with information as required throughout the life of this plan.

3.2 DEW staff will organise KMRG meetings at least twice per year for members to provide advice to DEW on the management of kangaroos in South Australia and the implementation of this plan.

Action 4: *Public documents will be made available on the Kangaroo Conservation and Management web page.*

The provision of information to members of the public promotes understanding of the function of this plan and assists members of the community to develop informed opinions regarding kangaroo management issues.

Performance indicators:

4.1 DEW staff will update the Kangaroo Conservation and Management web page as required to ensure that the web page contains the following information:

- a statement of the reasons commercial harvest is undertaken in this State
- the current and previous South Australian Commercial Kangaroo Management Plans
- current and previous three annual Quota Reports
- current and previous three annual Harvest Reports
- historical and current population estimates and harvest data
- contact information for the Kangaroo Management Program
- current forms for commercial kangaroo permits and permit holders

4.2 DEW staff will ensure that documents outlined in 4.1 and any additional information, is published on the DEW web site within one month of becoming publicly available.

4.3 DEW staff will distribute publicly available kangaroo management information to interested parties within one month after such a request.

Action 5: *Where appropriate, DEW staff will participate in media interviews and prepare media releases.*

Participation in media interviews and preparation of media releases can be an efficient mechanism for communicating information regarding kangaroo management to a broad audience. Media releases also improve program transparency and accountability, and therefore public confidence.

Performance indicators:

- 5.1 DEW staff will participate in interviews on request from media agencies where appropriate.
- 5.2 DEW will prepare media releases when appropriate for issues of interest to the community, such as population surveys (June) and the release of the quota for the next calendar year, once approved by the State Minister (November).

Action 6: *Information about the Kangaroo Management Program and other information will be developed as required and distributed to stakeholders.*

A communication strategy will be prepared to ensure that internal and external stakeholders are kept up to date with changes to the Kangaroo Management Program, such as seasonal advice to internal staff or changes to permit conditions to external stakeholders.

Performance indicators:

- 6.1 DEW staff will develop a communication strategy for the Kangaroo Management Program, including both internal and external stakeholders. The communication strategy will include the newsletter that is currently provided to stakeholders.
- 6.2 DEW staff will issue an information package with every new Kangaroo Field Processor permit throughout the life of this plan to ensure permit holders are aware of permit requirements and responsibilities.

Action 7: *Involve Aboriginal stakeholders in the implementation of this plan.*

Feedback on kangaroo management strategies and implementation of this plan will be requested from Aboriginal people. This will enable Aboriginal people to participate in decision-making related to kangaroos and the development of management strategies for kangaroos. It will also facilitate an increased understanding of Aboriginal interests among DEW and other stakeholders of kangaroo management. Increased understanding and awareness of Aboriginal interests in kangaroo management among the broader community will be facilitated by the inclusion of information on the DEW Kangaroo Conservation and Management web page.

Performance indicators:

- 7.1 DEW staff will hold specific discussions with representatives of Aboriginal communities to develop more effective ways of sharing information.
- 7.2 DEW will encourage Aboriginal participation in kangaroo management.
- 7.3 DEW staff will involve Aboriginal people in the development of the communication strategy for the Kangaroo Management Program (Action 6).

4.3 Aim 3: Manage Impacts of Kangaroos on Land Condition

This plan adopts the ethic that the mitigation of environmental, economic, and social impacts of kangaroos should be allowed through culling, provided it takes place in a manner that is humane and does not pose a risk to the long-term conservation of kangaroos.

The NPW Act provides for the destruction of kangaroos for the purposes of mitigating or preventing damage to environmental values, pasture, crops and infrastructure. This process is managed outside of the commercial harvest through the Wildlife Permit System and DEW's Permit to Destroy Wildlife Policy, which guides staff in the issuing of non-commercial destruction permits (Permits to Destroy Wildlife). Where a property is within the commercial harvest area, DEW will encourage the landholder to consider the commercial industry before applying for a Permit to Destroy Wildlife. However, where the commercial industry is unable to meet the landholder's land management needs or the landholder does not wish to use the commercial industry, the landholder can apply for a permit to destroy a specified number of kangaroos when kangaroos are causing, or are likely to cause, detrimental impacts. Kangaroos culled under a Permit to Destroy Wildlife must be killed following the National Code of Practice for the Humane Shooting of Kangaroos and Wallabies for Non-Commercial Purposes (NRMMC 2008).

Action 8: *Educate DEW regional staff and land managers on best practice for combining the use of commercial and non-commercial options for kangaroo management.*

Performance indicators:

- 8.1 DEW staff will develop decision-making tools, including a pros and cons list of harvesting, to assist regional DEW staff in providing advice to land managers on commercial vs. non-commercial kangaroo management.
- 8.2 DEW staff will encourage landholders applying for a Permit to Destroy Wildlife (Kangaroos) within the commercial harvest area to use kangaroo field processors where possible.
- 8.3 DEW staff will investigate the introduction of training tools (like those undertaken by people applying to become kangaroo field processors) to improve awareness of the Non-Commercial Code of Practice for people requesting a non-commercial Permit to Destroy Wildlife (Kangaroos).
- 8.4 Investigate alternative ways to integrate commercial and non-commercial kangaroo management options to mitigate damage to land condition.

4.4 Aim 4: Monitor Kangaroo Populations and Set Quotas

Monitoring commercially harvested kangaroo populations, both directly (surveys) and indirectly (industry returns), ensures that potential negative consequences of harvesting (Appendix 2) are managed appropriately, and viable populations of kangaroos are maintained throughout their ranges.

The commercially used kangaroo and wallaby species are abundant within their current distributions in South Australia (Appendix 1- Conservation Status). A great deal is known about the biology of kangaroos including their habitats, distribution, diet, and reproduction (Appendix 1), and this knowledge is continually improving. In particular, the reproductive biology of kangaroos has been researched extensively. While there are variations between the kangaroo species (e.g. gestation period, lactation period and the interval between young), these are relatively well understood and accounted for in the various quotas set for each species.

A wide range of literature relating to kangaroos and their management is currently available (refer to the References and More Information sections of this plan). Results of aerial surveys since the late-1970s show that kangaroo populations fluctuate primarily in response to rainfall and other seasonal conditions. In South Australia the harvest has a negligible impact on kangaroo population dynamics. This is consistent across other Australian States that commercially harvest kangaroos (Hacker and McLeod 2003).

The results of the surveys are used to set sustainable harvest quotas each year and monitor the kangaroo populations in each harvest area. This plan introduces a new quota (high abundance quota) and a low harvest threshold, while retaining the proportional quota setting, special land management quota and low abundance thresholds. Appendix 4 provides an overview of the different quotas and thresholds used in this plan.

The commercial harvesting area has been expanded under this management plan and now covers the entire State, excluding the Alinytjara Wilurara region and metropolitan Adelaide. The new area contains four new harvest sub-regions: Hills and Fleurieu, Kangaroo Island, Upper South East and Lower South East; and extensions to the existing Murray Mallee sub-region to include the Murray Plains, and the Mid North sub-region to include the Yorke Peninsula and Lower North. The Commercial Harvest Sub-Regions are based on administrative boundaries for Soil Conservation Board districts established under historical soil conservation legislation (*Soil Conservation and Land Care Act 1989*). Some adjustments to the sub-region boundaries have been made for administrative efficiencies, such as amalgamations of Soil Conservation Board districts. The expansion has increased the number of Commercial Harvest Sub-Regions (CHSRs) from 13 to 17 and each of the CHSRs are grouped into five Commercial Harvest Management Region (CHMRs); Western Pastoral, Eastern Pastoral, Western Agricultural, Eastern Agricultural and the new Southern Agricultural Harvest Region (Figure 1).

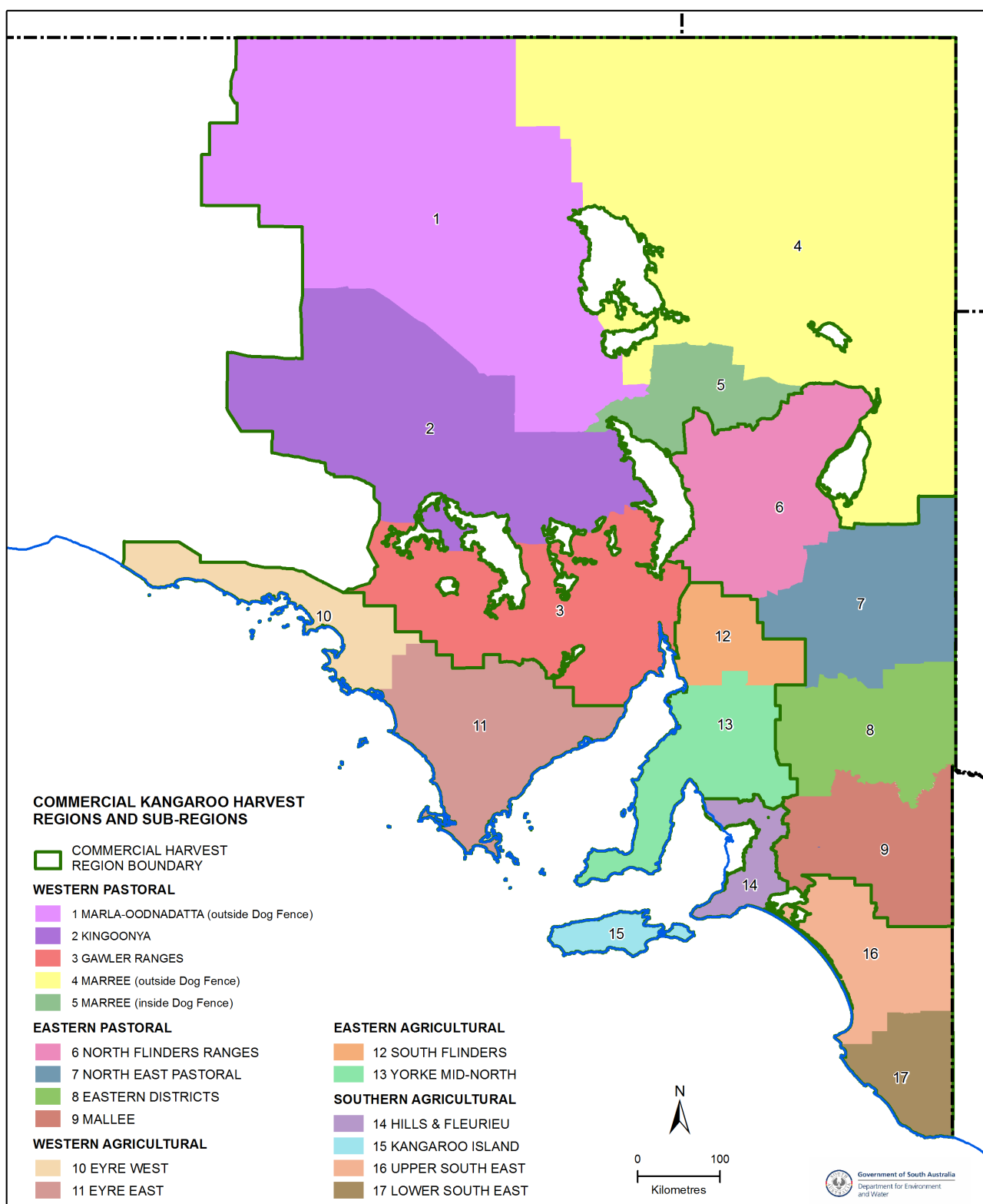


Figure 1: The five South Australian Kangaroo Commercial Harvest Regions, Western Pastoral, Eastern Pastoral, Western Agricultural, Eastern Agricultural and Southern Agricultural, which consist of 17 Harvest Sub-Regions. The map depicts the four new harvest sub-regions; Hills and Fleurieu, Upper South East, Lower South East and Kangaroo Island; and the extensions to the existing Yorke Mid-North and Mallee sub-regions.

Action 9: *Population estimates will be obtained using a combination of standard survey method and population model.*

Kangaroo population estimates may be obtained directly from surveys or a predictive population model developed from the long-term survey data. The data-driven population model will be used for the established harvest regions where data is available from at least 1996 or back to 1978. In the established CHSRs, surveys will be conducted in each CHSR every three years. During the years between surveys, the population model will be used to predict the population estimate based on previous surveys and rainfall. Three CHSRs will be surveyed annually to validate the model being applied to other regions. The population estimates will form the basis for setting the annual commercial quotas.

A combination of fixed-wing aircraft and ground surveys (walking and driving) will be used to survey kangaroo populations across South Australia. Aerial survey lines have been established at regular intervals across all sub-regions where possible, and the same lines are surveyed at the same time every survey year to allow comparison of results between years (for details of survey methods, refer to the Quota Report on the Kangaroo Conservation and Management web page). Ground surveys are employed in sub-regions where aerial survey is considered unsafe or dense vegetation prohibits observers from effectively counting kangaroos (Table 1).

Table 1: Survey method used in each harvest sub-region and sub-regions where population model will be used between survey years.

Harvest Region	Survey Method	Population Model
Western Pastoral		
Marla - Oodnadatta	Aerial	✓
Kingoonya	Aerial	✓
Gawler Ranges	Aerial	✓
Marree (inside dog fence)	Aerial/ walking	✓
Marree (outside dog fence)	Aerial	✓
Eastern Pastoral		
North Flinders	Aerial/ walking	✓
North-east Pastoral	Aerial/ walking	✓
Eastern Districts	Aerial/ walking	✓
Mallee	Aerial	✓
Eastern Agricultural		
South Flinders	Aerial/ walking	✓
Yorke Mid North	Aerial/ walking	✓
Western Agricultural		
Eyre West	Aerial	✓
Eyre East	Aerial	✓
Southern Agricultural		
Hills and Fleurieu	Driving	
Upper South East	Aerial	
Lower South East	Aerial/ driving	
Kangaroo Island	Aerial/ driving	

Performance indicators:

9.1 Population models developed by The University of Adelaide and run by DEW staff will be used to predict annual population estimates for species in CHSRs with long-term datasets. Established CHSRs are surveyed by DEW once every three years, except for three sub-regions that will be surveyed annually.

9.2 Surveys are conducted by DEW in new CHSRs to establish a population estimate for each species before they are opened for commercial harvesting.

Action 10: *A risk-based approach is used for determining which Commercial Harvest Sub-Regions are surveyed each year.*

Kangaroo populations fluctuate in response to rainfall and feed availability. During dry periods, populations can decline dramatically. Therefore, a risk assessment will be conducted by the DEW Kangaroo Management Program prior to each survey period to determine CHSRs that will be surveyed that year. Information taken into consideration will include:

- Climatic variables (e.g. rainfall, maximum day time temperatures)
- Future predictions of dry periods/ drought within the next 12 months that may cause animal welfare concerns due to starvation
- Harvest rate
- Length of time since last survey
- Reports from kangaroo industry, land managers, regional DEW staff or researchers

If the kangaroo management program is concerned that kangaroo populations are approaching management thresholds (e.g. Low Harvest Threshold or thresholds to reduce or suspend harvest), additional surveys may be conducted to ensure accurate information on the population size is obtained prior to setting quotas.

10.1 DEW staff will survey additional CHSRs if the DEW Kangaroo Management Program are concerned that kangaroo populations are approaching management thresholds.

Action 11: *Sustainable commercial kangaroo harvest quotas will be set annually per Commercial Harvest Sub-Region for each species.*

South Australia uses a proportional harvesting strategy to account for the fluctuations in species abundance over time (Caughley 1987; Engen *et al.* 1997; McLeod and Pople 1998). Based on kangaroo population dynamics, quotas set at 15 to 20% are considered sustainable in the long-term (Caughley 1987, Hacker *et al.* 2004). Commercial quotas are set at a maximum of 20% of the estimated population size for red kangaroos, 15% for grey kangaroos (eastern and western) and euros, and 10% for tammar wallabies within each CHSR where each species occurs. A conservative quota is set for the tammar wallaby as this species is restricted in its distribution compared to the large kangaroo species. A more conservative quota may be set for any species when coefficients of variation for population estimates exceed 25%.

Population estimates and commercial quotas are derived and set at the level of each CHSR. However, for the purposes of providing flexibility to manage quotas in response to spatial and temporal changes in kangaroo distribution, CHSR quotas may be moved between other CHSRs within the same Commercial Harvest Management Region (CHMR). Quotas cannot be moved between any of the five CHMRs. Quotas may be shifted between CHSRs for approved damage mitigation reasons, and only where available quota in a CHSR has been fully allocated. For species that do not have a quota in a particular CHSR, but do within the larger CHMR, quota may be moved into a CHSR for approved damage mitigation purposes. Once all available quota for a species has been reached in a CHMR, no additional quota will be issued for that species in that CHMR until the following year (except for Special Land Management Quota, Action 12).

This management plan introduces a new quota called the High Abundance Quota (HAQ) that will be applied to established CHSRs (Figure 2). The intent of the High Abundance Quota (HAQ) is to reduce the population peaks following periods of abundant resources, and therefore reduce the environmental damage caused by over-grazing and the number of kangaroos subject to death by deprivation that inevitably follows. Reduction in the population peaks may reduce the population average, unless the reduced impact on resources is reflected in reductions in population troughs. The operation of the HAQ will be reviewed prior to each new management plan to assess the potential for long-term impact on population trends. Knowing what an ecologically sustainable population, and therefore what an ecologically target density, would be for each CHSR would provide a more stable benchmark from which to set both low harvest (described in Action 10) and high abundance thresholds for determining quotas. It is proposed that this research will be undertaken during the life of this management plan (refer to Facilitate Adaptive Management Research section).

The HAQ allows for all animals above the threshold (the average of the population estimate for each CHSR) to be removed by harvest. The total quota is derived by adding the HAQ to the species specific proportional quota (

Figure 2). The trigger for activation of the HAQ is when a species' population estimate exceeds the average population estimate by the proportional quota for that year within a CHSR. When a species' population estimate reaches the HAQ threshold, the Director of National Parks and Wildlife has the authority to release the HAQ if deemed necessary.

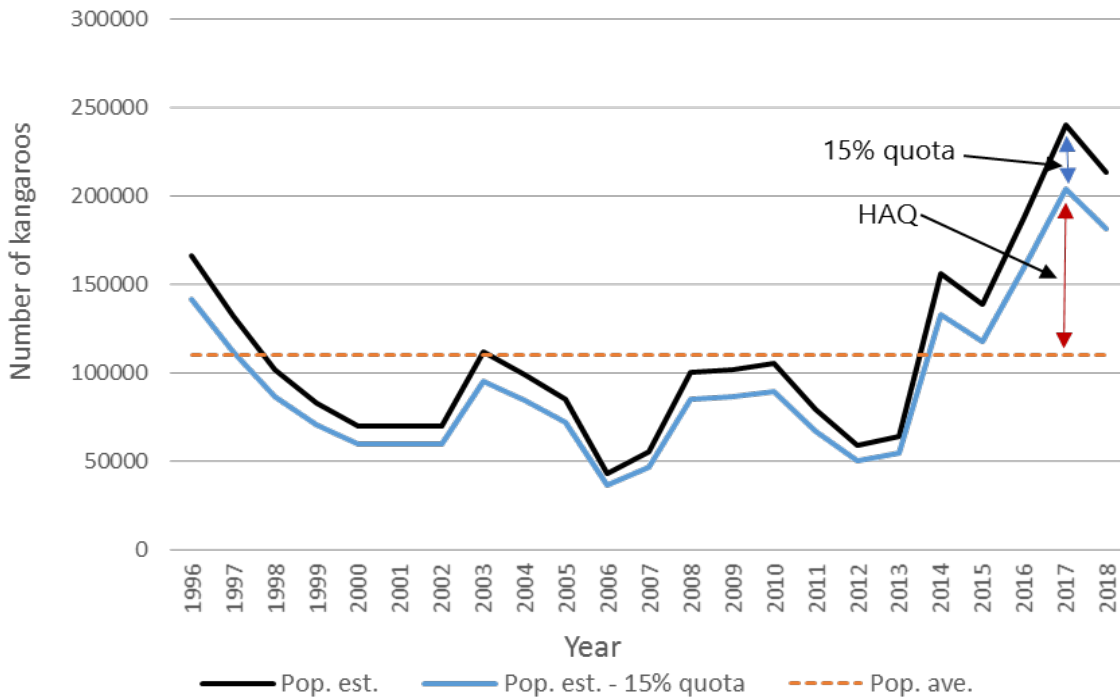


Figure 2: Illustration on how the high abundance quota (HAQ) will be applied to kangaroo populations when the population estimate is above the population average, using the western grey kangaroo data from Eastern Districts harvest sub-region as an example.

Performance indicators:

11.1 DEW sets species specific proportional quota for each species within each CHSR based on the most recent population estimate.

11.2 Director of National Parks and Wildlife may issue High Abundance Quota (HAQ) for species when the current population estimate for that species in a CHSR is above the threshold (average population estimate).

11.3 DEW will reduce quotas in between survey years if the kangaroo management program are concerned that kangaroo populations are approaching management thresholds if trajectory continues based on risk assessment detailed in Action 10.

11.4 DEW will review the HAQ method at the end of the life of this management plan.

Action 12: Surveys will be reduced or stopped in CHSRs with a consistently low harvest and will start again once the harvest has reached the low harvest threshold.

This management plan introduces a risk-based approach to surveying and quota setting, which will result in CHSRs only being surveyed when the harvest is above a certain number of animals, referred to as the low harvest threshold. A number of CHSRs consistently have very low harvest rates for all species. The risk posed to populations by very low harvest has been modelled using South Australian data and it is insignificant to regional kangaroo populations (Pople 2008), therefore reducing the survey frequency would not increase the risk of overharvest.

The low harvest threshold is calculated as 1.5% of the average population estimate for each species in each CHSR. The threshold of 1.5% of the average population estimate was chosen because in CHSRs where surveys have occurred since at least 1996 (some since 1978), 1.5% of the population average falls below the sustainable quota that would be set when the population is at its lowest recorded estimate. In addition, 1.5% of the average population estimate across the established CHSRs represents a very low number of animals (low harvest threshold = range 46 to 4845 kangaroos as influenced by the size of each CHSR and the proportion occupied by a species).

Low harvest thresholds will only be triggered within CHSRs that experience harvests below the threshold for three consecutive years. Where the harvest falls below the threshold, the last proportional quota will either be reissued annually until the next survey, or where a population model exists, annual proportional quotas will be calculated from predicted population estimates. For the established CHSRs, no survey will occur until the harvest exceeds the harvest threshold, at which point a survey will be triggered for the following survey period (June-August each year) to re-estimate the population, reset the now static proportional quota and recalibrate the population model. For new CHSRs with insufficient data for calculating averages or estimating population using models, populations will be resurveyed at five-yearly intervals until the harvest reaches the threshold to trigger three-yearly surveys.

For a CHSR where multiple species are harvested, only one species is required to be harvested above the low harvest threshold for surveys to resume. However, where multiple methods are used, surveys will not be continued for all species if a separate method is used for the species below the threshold. For example, euros are surveyed using walking surveys and usually have a low harvest, including in areas where the larger kangaroo species are harvested above the low harvest threshold. In these instances, walking surveys for euros will stop in CHSRs where euro harvesting is below the threshold, but aerial surveys for the larger kangaroo species will continue.

Performance indicators:

12.1 DEW staff will monitor harvest data through permit returns in all CHSRs and survey frequency will be varied as required.

12.2 In established CHSRs, if the harvest declines below the low harvest threshold (1.5% of the population average) DEW will stop surveys until the harvest reaches the threshold.

12.3 After DEW conducts the initial survey to allow harvesting in new CHSRs, additional surveys will be conducted at five-yearly intervals until harvest exceeds 1.5% of the most recent population estimate, at which point surveys will be conducted at three-yearly intervals. If the harvest then declines below the low harvest threshold, a five-yearly survey interval will be resumed.

Action 13: *When kangaroo populations decline to specific thresholds (low abundance thresholds), the commercial harvest of these particular species in the particular Commercial Harvest Sub-Regions will be reduced or suspended.*

This management plan aims to accommodate fluctuations in kangaroo populations to change according to seasonal conditions. Calculating thresholds based on the long-term average population estimates or densities, and standard deviations (SDs) recognise these environmental differences (Appendix 3). Thresholds are calculated for each species in each CHSR using the entire data set (1978 to present). The population density data are normalised using a log-transformation, and the thresholds are calculated as the long-term average minus either 1.5 times (Threshold 1) or 2 times (Threshold 2) the standard deviation of the transformed data. The lognormal thresholds are then back-transformed to allow comparison to the untransformed population densities reported in the Quota Report. If survey results indicate a population has fallen below either threshold for that species in that CHSR, the commercial quota will be reduced or suspended in that CHSR for the following calendar year (Table 1). The reduction or suspension will remain in place until surveys indicate the population has increased above Threshold 1.

In established CHSRs calculations already exist that represent the first and second thresholds. In new harvest areas, thresholds will be created as survey data is gathered over time.

Table 2: Process for reducing or suspending quota based on most recent population density estimates for each species in each Commercial Harvest Sub-Region (CHSR). Threshold quotas will remain in place until survey results indicate that the population has increased above Threshold 1.

Population density estimate	Status	Quota Setting (Maximum)
Population density greater than 1.5 SD below average	Business as normal	Normal quota
Population density less than 1.5 SD but greater than 2 SD below average	Threshold 1 reached	Quota reduced to 10% for that species in that CHSR
Population density less than 2 SD below average	Threshold 2 reached	Quota suspended for that species in that CHSR

If commercial quotas are reduced or suspended due to low population estimates, the issuing of a non-commercial Permit to Destroy Wildlife for kangaroos may also be reduced or suspended.

Performance indicators:

13.1 DEW will reduce commercial harvest quotas if population density estimates fall below 1.5 standard deviations of the average density (Threshold 1), or suspended harvest if population estimates fall below 2 standard deviations of the average density (Threshold 2).

Action 14: Special Land Management Quota will be set annually.

A Special Land Management Quota (SLMQ) for CHMRs will be set annually at a maximum of 1.5% of the population of each species across all CHMRs.

SLMQ is a reserve pool of tags allocated within a CHMR for use when all commercial quota has been exhausted (allocated) in the CHMR to mitigate ongoing land condition damage. SLMQ will only be issued if warranted by climatic trends, destocking orders, kangaroo population trends, or other extenuating circumstances. SLMQ will provide for commercial utilisation of kangaroos that would be shot and left in the field under the non-commercial permitting system.

Performance indicator:

14.1 DEW will issue Special Land Management Quota as needed. Any issue of Special Land Management Quota and the reasons for its issue are recorded and reported through annual Harvest Report.

Action 15: Population estimates and quotas will be reported annually in Quota Report

Performance indicator:

15.1 DEW will set all commercial kangaroo harvest quotas in accordance with the *South Australian Commercial Kangaroo Management Plan 2020-2024* throughout the life of the plan.

15.2 DEW will develop a Quota Report each year to report population estimates and harvest quotas for the following calendar year.

The Quota Report will contain the following information:

- population estimates for each species in each Commercial Harvest Sub-Region and details of how estimates were developed (e.g. from model predictions, surveys or static estimates from previous surveys).
- details of the survey methods used and any changes to the survey method or analysis
- quotas calculated as per the approved Commercial Kangaroo Management Plan (including Special Land Management Quota or High Abundance Quota)
- any proposed changes to quotas
- data showing trends in population/quota/harvest over time

15.3 DEW will advise the Commonwealth Government of commercial harvest quotas through the Quota Report for the following calendar year by 30 November.

15.4 If Commonwealth approval is required for quotas set above the rates specified in the plan as part of an adaptive management experiment, DEW will obtain such approval before the additional quota is implemented.

Action 16: *Kangaroo populations will be monitored indirectly throughout the life of this plan.*

Indirect data on kangaroo populations will be obtained continuously throughout the life of this plan from commercial kangaroo industry returns. Permit holder returns detail the number of each species taken, average carcass weights, sex, and location of take, depending on the type of permit.

Monitoring of permit returns by DEW could identify significant changes in harvest for effort, which may provide an indication of population trends and accessibility.

Performance indicators:

16.1 DEW will monitor permit holder returns at the point of data entry for sudden, sustained, or acute changes in the information provided and will investigate changes to determine, where practicable, the cause of the change.

16.2 DEW staff will collate data from Permit to Destroy Wildlife for kangaroos, to support data gathered from industry returns.

4.5 Aim 5: Monitor Industry Compliance

To ensure that viable populations of kangaroos are maintained throughout their ranges, the commercial kangaroo industry in South Australia is closely regulated by a range of permitting and tag procedures provided for under the NPW Act, Kangaroo Harvesting Regulations, Wildlife Regulations, DEW policy and this plan. Permitting procedures are described in detail in Appendix 5. The compliance of the kangaroo industry with the above legislation and policy is essential for maintaining viable populations of kangaroos and ensuring public confidence in the management of kangaroos in South Australia.

Action 17: *All activities are permitted in accordance with South Australian legislation and DEW policy.*

All applications for permits relating to the South Australian commercial kangaroo industry operations are to be assessed, processed, and issued by the provisions of the NPW Act and Regulations and DEW policy.

Performance indicator:

17.1 DEW will assess a sample of commercial kangaroo permits across South Australia twice per year to determine that they are processed and issued by South Australian legislation and DEW policy.

Action 18: *DEW will ensure that permit conditions are adequate and reflect current South Australian legislation, DEW policy and this plan.*

To manage commercial kangaroo operations in South Australia effectively and efficiently, permit conditions must be sufficient and consistent with Commonwealth and South Australian legislation, DEW policy and this plan. Accordingly, the standard permit conditions for each permit type will be reviewed, and where necessary amended, in response to changes in Commonwealth and South Australian legislation and/or DEW policy. However, permit conditions cannot be modified during the life of the permit. All proposed amendments to permit conditions will be assessed by DEW's legal representatives before implementation and permit holders will be advised of changes to their permit conditions in writing. Any changes to the conditions will need to follow this plan, and the Commonwealth will be notified of any significant changes.

Performance indicators:

18.1 DEW will review permit conditions annually before permits are renewed and, where necessary, amended before a new/ renewed permit is issued.

18.2 DEW will notify permit holders in writing of changes to permit conditions that will be implemented, should they choose to renew their permit, within one month of such changes being approved.

Action 19: *DEW will consider improvements to the sealed tag system as appropriate.*

DEW will monitor technological developments in how kangaroos are tagged and how industry returns are provided to DEW. Improvements in these areas will allow DEW to monitor the quota taken more efficiently and effectively.

Performance indicator:

19.1 DEW will monitor technological developments in tagging systems, and consider trials of electronic tags (or other technologies), along with technological advances in other aspects of kangaroo management.

Action 20: *DEW staff will undertake both regular and opportunistic monitoring of compliance by commercial kangaroo industry operators.*

To assess industry compliance, DEW officers will, on a regular and opportunistic basis, inspect kangaroo harvesting sites, kangaroos taken and stored by kangaroo field processors and all premises registered to kangaroo meat processors and skin tanners. The assessment may also include carcasses that are imported into SA from other states if imported carcasses are present at kangaroo meat processing works at the time of inspection. The inspecting officers will check that SA kangaroos have been taken following the NPW Act and Kangaroo Harvesting Regulations, this plan, and permit conditions. Assessments of both SA and interstate carcasses (when present) to ensure compliance with the current Commercial Code will be a priority. Biosecurity SA (Food Safety) also undertakes regular checks of field chillers and processing plants, but for compliance with food and health policies. Biosecurity SA (Food Safety) will report any observed breaches of permit conditions to DEW for further investigation. Likewise, DEW officers will inform Biosecurity SA (Food Safety) staff of suspected breaches of their legislation. DEW will develop a Memorandum of Understanding with Biosecurity SA (Food Safety) to formalise these relationships.

DEW will also develop a Memorandum of Understanding with the Commonwealth Department of Agriculture and Water Resources in relation to inspection of carcasses at processing plants registered for the export of meat products for human consumption that reflects the Meat Notice 2019/01 (or any subsequent notice that replaces it) and guidelines developed by DEW. Under this agreement, information about possible breaches of DEW permit conditions are reported by the Department of Agriculture and Water Resources and, where appropriate, further investigated by DEW (or interstate agencies as appropriate).

Performance indicators:

20.1 DEW staff and/or Biosecurity SA (Food Safety) staff will inspect field chiller premises at least annually during the life of this plan to ensure compliance with South Australian legislation and permit conditions. Chiller premises that are registered but known to be non-operational may not require regular inspection.

20.2 DEW staff and/or Biosecurity SA (Food Safety) staff inspect all kangaroo processing works in South Australia at least twice a year during the life of this plan to ensure compliance with South Australian legislation and permit conditions.

20.3 DEW will develop Memoranda of Understanding with Biosecurity SA (Food Safety) and the Department of Agriculture and Water Resources during the life of this plan.

Action 21: *DEW will ensure that all Kangaroo Field Processors are competent to achieve the standards set out in the Commercial Code, and other necessary requirements.*

To ensure that the kangaroo harvest is humane, kangaroo field processors are required to demonstrate their competency with the Commercial Code before obtaining their permits. Kangaroo field processors must also hold a current firearms licence, complete the Firearms Proficiency Course for Field Processors in South Australia (or another approved state's equivalent course), and complete the Wild Game Harvester Field Processing (Kangaroo) course endorsed by Primary Industries and Regions South Australia (Biosecurity SA) (or another approved course interstate). DEW may require that kangaroo field processors undertake further training as a corrective action if non-head shot carcasses are discovered during inspections. All successful applicants for a Kangaroo Field Processor Permit have completed the approved accreditation.

Performance indicators:

21.1 On receipt of Kangaroo Field Processor Permit applications, DEW staff will ensure that applicants have valid Firearms Proficiency accreditation, Wild Game Harvester Field Processing (Kangaroo) accreditation, a valid firearms licence (Class B7 or as directed by South Australian Police), and other licences and accreditation/s as required (e.g. Food Safety accreditations).

21.2 DEW will liaise with training providers (e.g. TAFE SA) to ensure that the kangaroo field processor training syllabus is up to date with current legislation, the Commercial Code or any other standards approved nationally.

Action 22: *Activities not following South Australian legislation will be investigated and where an offence has been committed, appropriate compliance action will be taken.*

Investigation and prosecution of activities in breach of South Australian legislation are essential for delivery of this plan. Good compliance also maintains public, industry and stakeholder confidence in the effectiveness of the plan as a mechanism for maintaining the viability of kangaroo populations, and thus the commercial kangaroo industry.

Performance indicator:

22.1 Reports of unauthorised activities and activities in breach of permit conditions are investigated, and where sufficient evidence is available, offenders are prosecuted and/or issued with Expiation Notices as appropriate.

Action 23: *The accuracy of industry returns will be continually monitored during the life of this plan.*

It is a permit condition, as set out in regulation, that commercial kangaroo industry operators submit regular returns to DEW. The data obtained from these returns are essential for monitoring whether the industry is harvesting kangaroos within approved quotas and for reporting to the Commonwealth Government, industry, and the public. Also, the data from industry returns are used to monitor the kangaroo populations indirectly. Audits of industry returns encompass the manual assessment of returns, application of the customised database utilised by DEW and extensive verbal and written communication between DEW staff and industry operators.

Performance indicator:

23.1 During the life of this plan, incoming industry returns are scrutinised, and discrepancies are investigated.

Action 24: *A compliance database will be maintained to support investigations, inspections, and audits.*

A compliance database for use in kangaroo management investigations and inspections will be maintained for use by staff involved with kangaroo management. The database facilitates compliance reporting to the Commonwealth Government and other stakeholders, and easy access to information for authorised DEW officers. Compliance information is recorded and maintained, including reports of alleged breaches of the NPW Act, Regulations and/or permit conditions, investigation activities undertaken and outcomes of investigations. Data input is accurate and timely.

Performance indicator:

24.1 DEW will maintain compliance records relating to the commercial kangaroo industry.

4.6 Aim 6: Facilitate Adaptive Management and Research

Adaptive management experiments and studies using historical data from kangaroo industry returns and population data are essential to improving our understanding of kangaroos and their interaction with environmental, social, and economic systems, and thereby effectively maintaining viable populations of kangaroos throughout their ranges. Research into aspects of kangaroo ecology or harvest management can also assist in ensuring that kangaroo populations are maintained at sustainable levels across their ranges in 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 more efficient management of the commercial harvest.

Action 25: *During the life of this plan, further research using the population model (referred to in Aim 4) will be conducted to define ecologically sustainable kangaroo densities for CHSRs, which will replace the average population estimate as the trigger for releasing HAQ.*

The Kangaroo Management Program has obtained a wide range of data relating to the commercial harvesting of kangaroos in South Australia. The data-driven population model developed for the established CHSRs uses data collected since 1978. The new thresholds (low harvest threshold and HAQ) detailed in this management plan (Aim 4) should be considered the first step in a process to improve kangaroo management in South Australia. The program now uses a combination of proportional harvest and thresholds to manage industry take and administration costs. Both of the new thresholds are considered conservative with respect to the risk they may have on the viability of the kangaroo population. However, further modelling work is required to improve the sensitivity of these thresholds. In particular, the threshold for releasing the HAQ should align with ecologically sustainable kangaroo densities for each CHSR, which should be the management goal for kangaroo management south of the dog-fence. During the life of this management plan (2020-2024), research into determining ecologically sustainable densities will be progressed, with the aim to better inform future thresholds for releasing the HAQ and reducing survey intensity.

Performance indicators:

25.1 DEW will investigate ecologically sustainable kangaroo densities for species and harvest regions where a population model has been developed using the long term data. These densities may then be used as the thresholds for releasing the HAQ and reducing survey intensity in the next management plan.

25.2 DEW will ensure that the results of research using historical kangaroo harvest and management data are published in an appropriate form.

Action 26: *Where practicable, adaptive management experiments will be performed to test deliberate management interventions during the life of this plan.*

Under active adaptive management, management activities are conducted as a deliberate experiment. Alternative strategies are viewed as treatments and are implemented through statistically valid experimental design; monitoring is the data-collection step of the experiment. Active adaptive management can establish cause-and-effect relationships between activities and changes in ecological conditions. The appropriate form for dissemination will vary according to the type of research and the target audience. However, it is expected that any research conducted as an active adaptive management experiment following the provisions of this plan will be made available for the information of the Kangaroo Management Reference Group and DEW for inclusion on the Kangaroo Conservation and Management web page. Commonwealth approval is required if the adaptive management experiment will result in a harvest rate that is more than the harvest rate set out in this plan.

As per the criteria outlined below, all active adaptive management experiment proposals must have monitoring programs incorporated. Monitoring programs must be maintained during the life of the experiment. All monitoring must be conducted following any conditions imposed with the approval.

All proposals for adaptive management must be approved following the provisions of this plan before implementation. Proposals to undertake adaptive management trials will be assessed by whether a proposal:

- is following the goal of this plan
- is consistent with legislation for kangaroo management (or whether legislation requires amendment for the trial to occur)
- is scientifically rigorous and statistically valid
- incorporates an adequate monitoring and review program
- addresses adaptive management or research areas for kangaroos
- would involve stakeholder input or feedback.

Performance indicators:

26.1 All proposals to undertake active adaptive management experiments are reviewed and assessed by DEW in accordance with the criteria outlined in this plan.

26.2 DEW will ensure that all necessary approvals – including animal care and ethics – are obtained before commencement of experiments testing deliberate management interventions.

26.3 DEW will ensure that all adaptive management experiments are continuously monitored and conducted according to approved conditions.

26.4 DEW will ensure that results of all experiments testing deliberate management interventions are published in an appropriate forum.

Action 27: *Where knowledge gaps exist, DEW will facilitate research into the biology and ecology of commercially harvested kangaroo species.*

DEW will work with external research organisations to identify and investigate issues of importance to the commercial harvest of kangaroos. Research may include aspects of the biology, ecology, disease, and genetics of kangaroos as they relate to the commercial harvest, survey techniques, or the impact of commercial harvesting processes on numbers of non-native predators and scavengers. Contributions by DEW may include funding and/or in-kind support such as the provision of harvest data.

Performance indicator:

27.1 Issues associated with the ecology of harvested species and the management of the commercial harvest are identified by DEW, and research proposals are sought from universities and other research institutions during the life of this plan.

4.7 Aim 7: Undertake Program Reporting and Review

Regular program review and associated reporting are essential to maintain viable populations of kangaroos throughout their ranges; they ensure management outcomes remain consistent with the aims of the plan, and that management is fully informed.

Action 28: *An annual report on the South Australian Commercial Kangaroo Management Plan 2020 – 2024 will be prepared and submitted to the Commonwealth.*

An annual report detailing the operation of this plan for the previous calendar year will be prepared and submitted to the Commonwealth. This report will provide information on the previous year's quotas and harvest rates, any use of special quotas and details of research involvement. This report will also identify whether any adaptive management experiments were undertaken and provide details about compliance actions undertaken within the guidelines of this plan. Finally, this report will audit the aims of the plan against the performance indicators so that progress towards achieving the goal of the plan can be measured.

Performance indicators

28.1 An annual report on the operation of the *South Australian Commercial Kangaroo Management Plan 2020 - 2024* for the previous calendar year is submitted to the Commonwealth by 31 March of the following year. At the time of writing, this report is titled the Commercial Kangaroo Harvest Report for South Australia.

The Harvest Report will include the following information:

- actual harvest, by Commercial Harvest Sub-Region and species, compared to quotas
- any Special Land Management Quota or High Abundance Quota utilised
- sex bias and average weights for each species in each Commercial Harvest Sub-Region
- non-commercial cull statistics within the Commercial Harvest Sub-Regions
- compliance statistics:
 - number of premises inspected
 - number of penalty notices issued and the reason for the issue
 - number of alleged offences investigated and outcomes
 - number of prosecutions undertaken (offence and outcome)
 - any joint surveillance/enforcement activities completed
- any unusual situations that arose (e.g. flood/disease outbreak, market factors)
- any experiments or research undertaken or sponsored by DEW
- any improvements to animal welfare adopted

28.2 DEW will publish all annual reports prepared during the life of this plan on the DEW Kangaroo Conservation and Management web page.

Action 29: *The review of the South Australian Commercial Kangaroo Management Plan 2020-2024 will commence no later than twelve months before the expiry of this plan.*

The review of this plan will commence no later than twelve months before the plan expires and will assess the success of the plan in achieving its goal and aims. The aim of the review will be to improve on the current plan in the development of subsequent plans.

Performance indicators:

29.1 The success of the current plan in achieving its goal is self-assessed by DEW, measuring the department's performance against the performance indicators in the plan.

29.2 DEW will commence a review of the plan by November 2023.

29.3 DEW submits a report on the results of the review to the Commonwealth for their information and is published on the Kangaroo Conservation and Management web page. The report should summarise the results of the final review including an explanation of any proposed changes to the plan. It should also include an assessment of DEW performance against the performance indicators. The report should be submitted to the Commonwealth by 31 October 2024.

Appendix 1: Biology, Ecology, and Conservation of Kangaroos

Biology and ecology

Impacts of European settlement on kangaroo populations

The kangaroos that are the subject of this management plan have been influenced by European settlement. These kangaroo populations are considered secure within their current distributions in South Australia. Many changes have been brought about in the last 200-plus years of European settlement. These include widespread changes to the landscape, through replacement of native vegetation in many areas with agricultural and urban land uses. In places where native vegetation has not been widely cleared (e.g. pastoral rangelands), the landscape has still been modified by settlement, through measures such as the provision of watering points for stock, and construction of a dingo-proof fence across Australia to protect sheep in the southern rangelands from dingo predation.

These changes have altered the natural distribution and abundance of kangaroos. The species to which this plan relates have all been advantaged by these changes and in many places are present in higher abundances than they were prior to European settlement. Increased pasture, greater availability of water and reduced predator pressure have all contributed to an increased abundance of red kangaroo, eastern grey kangaroo, western grey kangaroo and euro (Pople and Grigg 1999). However, the introduction of foxes by Europeans led to the extinction of the tammar wallaby on mainland South Australia. Fortunately, no foxes were released on Kangaroo Island and the island population of tammar wallabies has benefited from an absence of foxes and abundance of preferred habitat, including improved pastures where it is known to feed (TSSC 2019).

There are large populations of each of the harvested species in Australia. During 2017 the national population of the three large kangaroo species (red kangaroo, western and eastern grey) within commercial harvest areas was estimated at 41.8 million and euros or wallaroos were estimated to be 4.3 million (Department for Environment and Energy 2018, <http://www.environment.gov.au/biodiversity/wildlife-trade/natives#a.3>). In the commercially harvested parts of South Australia, populations range up to numbers exceeding three million red kangaroos and one-and-a-half million western grey kangaroos (Pople et al. 2010a). Localised surveys of euro suggest that there are

currently (2018) around 600,000 euros in the commercially harvested area of South Australia (DEW 2018).

Eastern grey kangaroos are widespread in eastern Australia and exhibit high levels of population connectivity (gene flow) across their range (Zenger et al. 2003). In recent years, eastern greys have expanded their distribution in south-eastern South Australia. The population estimate in South Australia is suggested to be at least 20,000 individuals, however, this is considered an underestimate (TSSC 2019).

The tammar wallaby is common on Kangaroo Island and previous studies have reported high levels of genetic diversity, which suggests a large connected population (Taylor and Cooper 1999; MacDonald et al. 2013; Eldridge et al. 2017). The likelihood of impact to agriculture due to the large number of wallabies on the island sees the issuing of destruction permits for between 7,000 and 8,000 wallabies annually to mitigate the risk (DEW, quota reports, various 2014-2018). Anecdotal reports suggest that at least 100,000 wallabies are present on Kangaroo Island (pers comm A. Maguire 2018), and this is likely to be an underestimate.

Systematics

A kangaroo is a marsupial from the Family Macropodidae. This family contains kangaroos, wallabies and tree kangaroos. At the time of writing, only six species of the genus *Macropus* are the subject of this plan:

- *Macropus rufus* (Desmarest, 1822), the red kangaroo – the largest of all kangaroos and the largest present era marsupial.
- *Macropus fuliginosus* (Desmarest, 1817), the western grey kangaroo – two subspecies: *Macropus fuliginosus fuliginosus* on Kangaroo Island and *Macropus fuliginosus melanops* on the mainland. Both subspecies are subject to this plan. The western grey kangaroo was identified as a separate species from the eastern grey kangaroo in 1972 (Kirsch and Poole 1972).
- *Macropus robustus* (Gould, 1841), the euro – a smaller kangaroo with four subspecies. The subspecies that is subject to this plan is *Macropus robustus erubescens*. In other parts of Australia, *M. robustus* is referred to as common wallaroo or hill kangaroo, however, in this plan, the name euro is used.

- *Macropus eugenii eugenii* (Desmarest, 1817), the tammar wallaby (South Australia) – the smallest species of wallaby. In 2015, the genus of the tammar wallaby was reverted to *Notamacropus* from *Macropus*, however in keeping with South Australian naming, *Macropus* has been retained in this management plan. Recent genetic research determined that the Kangaroo Island and South Australian mainland subpopulations of tammar wallaby are the same subspecies, and *Notamacropus eugenii eugenii* has now been synonymised with *Notamacropus eugenii decres* (Eldridge *et al.* 2017). The other subspecies, *Notamacropus eugenii derbianus* (Western Australia) is not subject to this plan.
- *Macropus giganteus* (Shaw, 1790), the eastern grey kangaroo.

Conservation status

The commercially harvested kangaroo species that are the subject of this plan are widespread and secure.

This secure nature is reflected in the fact that they are:

- Not listed as threatened in South Australia (under Schedules 7, 8 and 9 of the NPW Act)
- Not listed as threatened in Australia (under the EPBC Act)
- Lower Risk – least concern with a stable population on an international scale (IUCN Red List 2017)
- Not listed under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES 2017)

Species Distribution

The red kangaroo is particularly well-adapted to the arid environment of central Australia and has a distribution covering most of the continent west of the Great Dividing Range, but excluding Cape York, Arnhem Land, the Kimberley region, the southwest corner and Tasmania (Pople and Grigg 1999) (Figure 3). Red kangaroos prefer more open habitats with scattered trees (Pople 1989), such as grassland, open scrub, mulga, low shrub lands and open woodlands.

Within South Australia, the highest densities of red kangaroo coincide with the more open areas of the sheep grazing rangelands (Cairns *et al.* 1991) inside the dingo exclusion fence. Over the time that aerial surveys have been flown in South Australia, the area of highest red kangaroo density has been just south of Lake Frome in the north-eastern section of the pastoral zone (Pople *et al.* 2006). The long-term monitoring data also suggest a westward shift in the range of the red kangaroo (Pople

et al. 2010a) over the period that kangaroo surveys have been conducted.

The western grey kangaroo is found along the southern part of Australia, excluding Tasmania, and extending into New South Wales and Queensland at the eastern end of its distribution (Pople and Grigg 1999) (Figure 4). The western grey kangaroo is associated with less arid environments than the red kangaroo and is affiliated with semi-arid mallee scrub, shrub woodland, and forests (Pople and Grigg 1999). Western grey kangaroos mainly exploit mosaic environments with areas of shrub interspersed with open habitats and cleared areas.

Within South Australia, the western grey kangaroo is found in the southern half of the State and on Kangaroo Island. Aerial survey data have revealed that western grey kangaroo densities are consistently highest in the Gawler Ranges and the south-eastern section of the South Australian pastoral zone (Pople *et al.* 2006). This distribution is complementary to that of red kangaroos, with high western grey kangaroo densities occurring in woodland areas where red kangaroo numbers are lower. Over the last 20 years, the western grey kangaroo has had a northwards expansion in its distribution and has become more common in the northern parts of the South Australian pastoral zone (Pople *et al.* 2010a).

The euro has a widespread distribution covering most of mainland Australia (Pople and Grigg 1999) (Figure 5). However, within this wide distribution, the presence of euros is patchy and localised, reflecting their preferences for rocky and hilly habitat. Euros can be found in a wide range of habitats but prefer areas where steep escarpments, rocky hills or stony rises are available to them. The euro can build up to localised high densities when conditions are favourable.

The eastern grey kangaroo has been increasing its range in South Australia over recent decades and now inhabits the lower and upper South East, parts of the Murray-Darling Basin, the eastern and northern Mount Lofty Ranges and the north and south Olary Plains (north and south of the Barrier Highway) (Figure 6). Pastoral development has resulted in a marked increase in populations of the eastern grey (Pople and Grigg 1999).

The species is associated with forest and woodland habitats with clearings and adjacent pastures.

In South Australia, the tammar wallaby is found on Kangaroo Island where it is considered widespread and secure, and within Innes National Park at the tip of the Yorke Peninsula, where it was reintroduced and is now considered stable. It is also known to inhabit a number of offshore islands – Wardang, Boston and Greenly Islands (Figure 7).

Biology of the Red Kangaroo (*Macropus rufus*)

Red kangaroos are opportunistic breeders and will breed throughout the year except in periods of extreme drought. This species exhibits a reproductive technique called embryonic diapause, where a viable embryo can be carried in the uterus for many months with its development arrested at the stage of a blastocyst (e.g. 70-100 cells). A blastocyst will remain in diapause while there is another young in the pouch, or when environmental conditions are poor. This reproductive strategy reduces the time between breeding events. Largely a gregarious species, the red kangaroo has a polygamous mating system (i.e. one male, many females). The species exhibits sexual dimorphism, with males larger than females.

The red kangaroo grazes grasses and dicotyledonous plants and browses chenopods and shrubs when necessary (Tyndale-Biscoe 2005). The red kangaroo is dependent upon the presence of green herbage for breeding. As the supply of green pick dwindles, breeding is reduced.

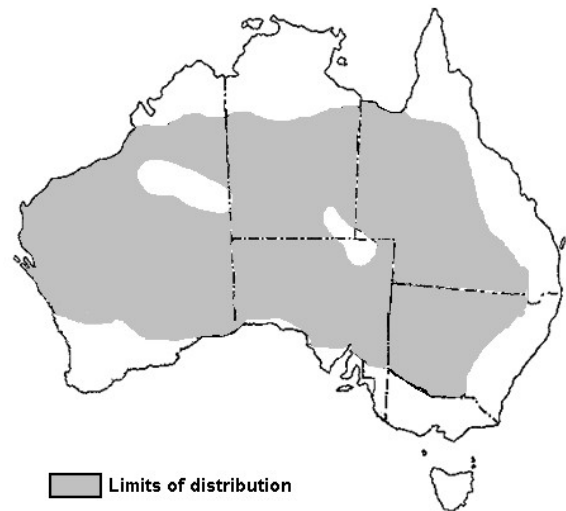
Red kangaroos have sedentary populations that move within home ranges of variable size (typical weekly home range size may be up to 560 hectares or 5.6km² (Croft 1991). Red kangaroos range more widely in response to drought and can move a long way to access the better feed. Movements of up to 30km to obtain fresh pasture growth in response to rainfall have been recorded (Croft 1991). Occasional long-distance movements (i.e. >100km) of mature individuals of both sexes have been recorded (Bailey and Best 1992). Long-distance movements of red kangaroos to access better feed have also been found in the long-term aerial monitoring dataset for South Australia (Pople et al. 2006).

Figure 3: Distribution of red kangaroo (*Macropus rufus*) determined from aerial survey (Pople and Grigg 1999).

Biology of the Western Grey Kangaroo (*Macropus fuliginosus*)

Like the red kangaroo, the western grey kangaroo will breed year round except in very poor seasons. Breeding peaks in spring and summer have been recorded

(Hacker et al. 2004). However, unlike in red kangaroos, embryonic diapause is not found in this species, so the species is not as able to rapidly increase in response to favourable conditions. Western grey kangaroos are sexually dimorphic in body size, with males larger than



females.

Western grey kangaroos feed mainly on grasses and also browse on some selected shrubs (Coulson and Norbury 1988). While red kangaroos will move a long way to access the better feed, western grey kangaroos do not do this and are more sedentary with small individual home ranges (Priddel 1987). Dispersing individuals tend to be young males.

The western grey kangaroo has higher water requirements than the red kangaroo (Dawson 1995), and so an expansion of available water in pastoral areas has enabled an expansion of this species into more arid areas.

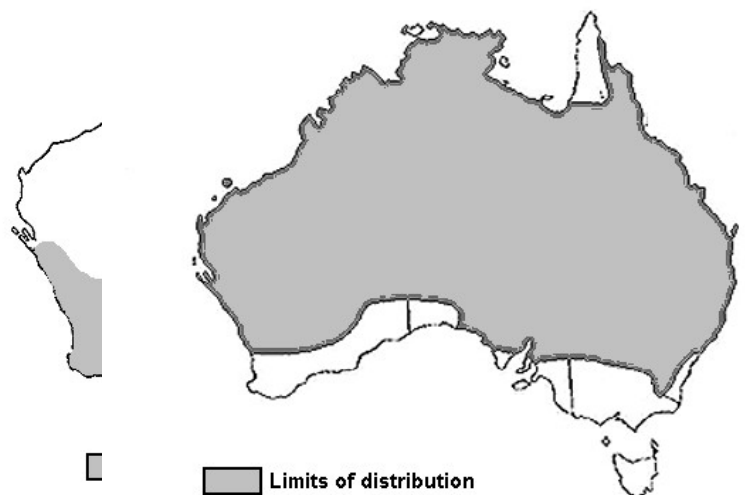


Figure 4: Distribution of western grey kangaroo (*Macropus fuliginosus*) determined from aerial survey (Pople and Grigg 1999).

Biology of the Euro (*Macropus robustus*)

Euros are opportunistic breeders, with continuous breeding possible throughout the year. Breeding is reduced during dry conditions and may cease during prolonged drought. Like red kangaroos, embryonic diapause occurs in this species. The euro exhibits marked sexual dimorphism, with mature males attaining twice the weight of mature females.

The euro feeds mainly on grasses and shrubs. The species is relatively sedentary, and individuals occupy small stable home ranges. The euro exhibits a less gregarious social structure than red and western grey kangaroos.

Euros are found in mountains and rocky hill habitat. Because this habitat type is not continuous across the landscape, the distribution of euro is likewise patchy (Dawson 1995). The steep escarpments, rocky hills and stony rises favoured by euro (Olsen and Braysher 2000) are less frequently cleared for agriculture, and thus this species is less affected by land-use changes.

and upper South East, parts of the Murray-Darling Basin, the eastern and northern Mount Lofty Ranges and the north and south Olary Plains (north and south of the Barrier Highway).

Eastern greys are a gregarious species that often form large groups in the tens to over 100 individuals where food is abundant. These groups favour forest and woodland habitats with clearings and adjacent pastures. Breeding occurs throughout the year, however is known to peak in the summer months (Pople and Grigg 1999). Unlike western grey kangaroos, occasional observations of embryonic diapause have been recorded for this species (Pople and Grigg 1999).

Eastern greys have been known to have similar habitat preferences to the western grey kangaroo (Pople and Grigg 1999). Recent studies in the Grampians of western Victoria by Garnick, et al. (2016a) found that eastern grey kangaroos occupied habitats with open grassy areas, but also occupied reasonably dense shrubby woodland. They less often occupied heathy habitats (heathy woodland, seasonally damp heath and sand



Figure 5: Distribution of euro (*Macropus robustus*) (Pople and Grigg 1999). Note that distribution is patchy within the range, based on the availability of suitable habitat.

Biology of the Eastern Grey Kangaroo (*Macropus giganteus*)

The eastern grey kangaroo is considered abundant on the Australian mainland and occurs extensively from north-eastern Queensland (Cape York Peninsula) to south-eastern South Australia. The eastern grey kangaroo is often confused with the western grey kangaroo and as a consequence it is considered that the species has been unreported or under-reported for many years and across much of its range. Since European settlement, the range of eastern grey kangaroos has been extending west, including into South Australia, due to an increase in semi-permanent stock watering points (Pople and Grigg 1999). Over recent decades the species has expanded into the lower

heathland).



Figure 6: Distribution of the eastern grey kangaroo (*Macropus giganteus*) (Van Dyck et al. 2013).

Biology of the Tammar Wallaby (*Macropus eugenii*)

Tammar wallabies inhabit coastal scrub, heath, dry sclerophyll forest habitats and thickets in mallee and woodland (Hinds 2008). The subspecies prefers dense low vegetation for daytime shelter and more open grassy areas for feeding, preferentially eating grass, but will also eat other herbs, shrubs and small trees (DEH 2004). They also consume seedlings of a variety of perennial plant species and, are able to prevent the recruitment of many species when in high densities (DEH 2004).

The Kangaroo Island tammar wallaby population is considered abundant. The subspecies has benefited from both an absence of foxes and an abundance of their preferred habitat - dense bushland adjacent to pasture or cropland. On Kangaroo Island, impacts to newly emergent crops and pastures and native revegetation, due grazing pressure by tammar wallabies occurring at high densities, has been recorded.

Breeding cycles of the Kangaroo Island population of tammar wallaby have been well studied. The subspecies is a seasonal breeder, with a high rate of reproduction, generally birthing one joey between late January and early February (Hinds, 2008). Like euros and red kangaroos, tammar wallabies undergo embryonic diapause. It has been found that the Kangaroo Island population has the longest period of embryonic diapause recorded in mammals, with the blastocyst remaining dormant for nearly one year (Renfree and Shaw 2000, cited in Renfree et al. 2011). They exhibit sexual dimorphism, with males being larger than females and have defined home ranges that overlap the home ranges of several other individuals.

Figure 7: Distribution of the tammar wallaby (*Macropus eugenii*), light blue indicates former range and dark blue indicates current range (Van Dyck et al. 2013).

Appendix 2: Threats to Kangaroos

Threats to kangaroos

Detailed legislative requirements in the NPW Act and the EPBC Act require that threats which may impact negatively on kangaroo populations or the sustainability of harvest must be detailed and considered in this plan. This section provides a summary and assessment of such threats.

Threats to kangaroos are either biological or anthropogenic. Possible current and future threats to kangaroos and their ability to be used as a sustainable resource are detailed below.

Biological threats

Biological threats are factors that have the potential to regulate kangaroo populations (Table 3).

Table 3: Biological threats that may regulate kangaroo populations.

Threat	Description	References
Environmental Conditions – Drought	Rainfall distribution can determine kangaroo densities, as populations move in response to localised rainfall and subsequent new plant growth. Droughts limit the amount of food available and therefore the carrying capacity of the habitat. Kangaroo populations naturally decline in times of poor environmental conditions (or drought) due to starvation (biased towards mature males and juveniles) and suppressed reproductive activity. The reproductive strategies of kangaroos allow for rapid recovery of populations following the end of drought conditions.	Caughley <i>et al.</i> 1985; Robertson 1986; Bayliss 1985; Bayliss 1987; Cairns and Grigg 1993; McCarthy 1996; Cairns <i>et al.</i> 2000; Pople 2003; Dawson <i>et al.</i> 2007; Pople <i>et al.</i> 2010b
Environmental Conditions – Flood	Flooding events will limit the short-term movement of kangaroos. Where access to forage is cut off through flooding, starvation is a threat. When access to forage is still available, other biological needs may be somewhat limited (e.g. dispersal events such as those undertaken by young males moving or establishing territories, may be temporally limited during flooding events). Some kangaroo diseases are linked with flooding events	Hale 2004
Disease	Disease by itself is not considered a significant mortality factor, and tends to have a compensatory mortality effect in combination with conditions such as overcrowding, malnutrition, and flooding. Diseases can be linked to flooding events (e.g. when the resultant outbreak of biting insects can transmit arbovirus among kangaroo populations), although such infections are not necessarily terminal. The impact of kangaroo diseases tends to be localised.	Kirkpatrick 1985; Caughley 1987; Speare <i>et al.</i> 1989; Hopper <i>et al.</i> 1999; Pople and Grigg 1999; Roberts <i>et al.</i> 2010; Barnes <i>et al.</i> 2007; Parameswaran <i>et al.</i> 2009
Predation	Dingoes (<i>Canis lupus dingo</i>), wedge-tailed eagles (<i>Aquila audax</i>), and foxes (<i>Vulpes vulpes</i>) can predate on kangaroos, although only dingoes will predate upon large adult kangaroos. In South Australia, densities of red kangaroos differ on either side of the dingo-proof fence, in part due to the presence of dingoes. North of the dingo-proof fence kangaroo numbers are significantly lower than in the fenced sheep rangelands, suggesting that Dingo predation may play a role in regulating kangaroo populations. South of the dingo-proof fence predation is not a significant source of kangaroo mortality and is limited to fox and eagle predation on juvenile kangaroos.	Pople <i>et al.</i> 2000; Caughley <i>et al.</i> 1980; Corbett and Newsome 1987; Thompson 1992; Banks <i>et al.</i> 2000; Pople and Page 2001; Letnic and Crowther 2012; Fillios <i>et al.</i> 2010; Purcell 2010
Climate change	The potential effects of climate change on kangaroos are not well documented, however potential effects may include changes in forage availability (due to potential changes in rainfall and wild fire frequency), fecundity, species distribution, movement patterns and an increase die-off of individuals due to extreme heat events, which may increase due to climate change. While climate change may be considered anthropogenic, the effects are biological, and so it is included here under biological threats to kangaroos, rather than in anthropogenic threats to kangaroos.	Goldie and van Wensveen 2003; Ritchie and Bolitho 2008; Dunlop and Brown 2008; Jonzen <i>et al.</i> 2010

Anthropogenic threats to kangaroos

Anthropogenic threats to kangaroos are those that result from human activities (Table 4).

Table 4: Anthropogenic threats that may regulate kangaroo populations.

Threat	Description	References
Habitat loss	Since European settlement, clearance of native habitat has occurred. Increased areas of land used for agriculture and pastoralism, combined with increased availability of water and control of predators, has benefited kangaroos. More intensive land use, such as intensive agriculture and urban development, can lead to contractions in the range of kangaroos. Intensive development is not a common land use within the commercial harvest zone and across the distributions of kangaroos in South Australia and is therefore considered to be a low threat to the harvested kangaroo species in South Australia. Furthermore, the common kangaroo and wallaby species described here have increased in number due to anthropogenic changes in land use to date.	Short and Grigg 1982; Calaby and Grigg 1989; Pople <i>et al.</i> 2010a
Human predation	Commercial harvest, non-commercial destruction for damage mitigation and traditional hunting by Aboriginal people are the three methods of human predation. Harvest and hunting take place at levels that are considered sustainable for kangaroos (see Impacts of commercial harvest below).	
Socio-economic changes	Changes in the relative value of meat products, or the extent to which kangaroos are considered as a valuable resource, may influence the extent to which the quota is taken. However, the maximum harvest defined by sustainable harvest quotas will ensure that harvest remains at sustainable levels.	

Impacts of commercial harvest

Under South Australian and Commonwealth environment legislation, commercial harvest of kangaroos can take place only where it is ecologically sustainable for kangaroos. At a broad level, this translates to ensuring that commercial harvest will not be detrimental to kangaroos. At a finer scale, this means knowing the potential impacts of harvest on kangaroos and developing and implementing management controls that prevent, mitigate and/or minimise these effects. In accordance with the requirements of the NPW Act and the EPBC Act, this section details the potential impacts of harvest on kangaroos, and on habitats and ecosystems of which kangaroos form part, and details the management controls that are in place to prevent and minimise these impacts and ensure the sustainability of commercial harvest.

Harvesting

Commercial harvesting has occurred for over 35 years, and it is clear from the extensive monitoring and research that has been conducted over that time that harvest is demonstrably sustainable (e.g. see Pople and Grigg 1999; Olsen and Low 2006). Kangaroo populations naturally increase and decrease as rainfall varies. During drought conditions, population numbers will stay low until conditions improve and the availability of food increases.

Potential negative effect mitigated by:

- **Action 9 and 10:** Regular monitoring and setting of quotas to allow for fluctuations in populations.
- **Action 11:** A proportional harvest strategy is used that allows for fluctuating populations (Caughley 1977) and is robust to bias or uncertainty in population estimates (Milner-Gulland et al. 2001).
- **Action 11 and 12:** New thresholds described in this plan (high abundance quota and low harvest threshold) are set at conservative levels with a commitment to further research to refine these thresholds within the life of this plan.
- **Action 11:** Commercial harvest quotas are set at levels that are ecologically sustainable for kangaroo populations (Caughley 1987; Pople et al. 2010a), even when combined with other mortality factors (including predation).
- Commercial harvest is patchy within management regions and properties, leaving areas of unharvested refuge habitat.
- **Action 10:** A risk-based approach is taken that enables the kangaroo management team to conduct additional surveys or reduce quota if anecdotal reports from field processors or land managers and environmental conditions indicate the kangaroo populations may be in decline.
- **Action 13:** If kangaroo populations fall below thresholds calculated from the long-term population data, such as during a drought, harvesting will be reduced or suspended as necessary.
- Economic threshold density below which it is not financially viable to harvest (see Hacker et al. 2004).
- The knowledge that harvesting mortality during drought is compensatory, not additive – harvesting removes animals that would die of natural causes during steep population declines, i.e. larger, older males (Pople and McLeod 2000).
- A process for developing management responses to evaluate and minimise risk to kangaroo populations in an adaptive approach to management.

Population demographics

Commercial harvesting may affect the demography (e.g. size, growth, distribution and birth and death rates) of harvested kangaroo populations by selecting the larger kangaroos, which tend to be the older males (Allendorf et al. 2008).

Commercially harvested populations may have a lower average age compared to that of unharvested populations. The average size of kangaroos in harvested populations may be lower, and populations contain a higher proportion of young animals than unharvested populations, but these differences are lessened during drought when older animals are lost from unharvested populations (Pople 1996).

The sex bias (i.e. the percentage of harvested kangaroos that are male) has increased from 60-70% male (DEWNR 2013) to 92-97% male for red and western grey kangaroos (DEWNR 2017). The increase in sex-bias is due, in part, to some meat processors only accepting male carcasses for a number of years, although currently all meat processors in South Australia accept both male and female carcasses. The sex bias of the euro harvest has historically been higher due to the small size of female euros, but the sex-bias has also increased from 75-95% male (DEWNR 2013) to 99% male (DEWNR 2017). However, a recent analysis of the size of skulls of the commercially harvested kangaroo species since the early 1800s has not produced any evidence to indicate that harvesting has reduced the average size of kangaroos at a species distribution scale (Prowse et al. 2015). Overall, the demographic impacts of harvest appear to be of little conservation concern (Pople and Grigg 1999), but further research may be required in the future.

Potential negative effect mitigated by:

- Environmental conditions tend to determine the structure of populations, suggesting that natural influences on population structure are stronger than the influences of harvesting. Both harvested and unharvested populations show unstable age distributions and a female sex bias (Newsome 1977; Pople 1996).
- Kangaroos have high fecundity and the ability to reproduce quickly following losses due to drought or harvesting (Appendix 1).
- Populations of kangaroos are not isolated in the landscape, and dispersing individuals can contribute to restocking a harvested population.
- The extent of harvesting is patchy, and refugia (e.g. areas that are not harvested) or areas that are lightly harvested occur across the harvested area.
- **Action 16:** Harvest sex bias and the size of harvested kangaroos are monitored through the regular collection of harvest returns from permit holders.
- **Action 27:** Where knowledge gaps exist, DEW will promote research into effects of harvesting on the population demographics of harvested kangaroo species.

Populations genetics

The genetic diversity and fitness of animal populations may be influenced by the selective removal of individuals that display a particular physical characteristic before they can contribute to the next generation (Allendorf et al. 2008; Coltman 2008). Consequently, there is the potential that the selective harvest of kangaroos (i.e. harvest efforts biased towards older, larger males) may lead to changes in the population genetic structure.

Potential negative effect mitigated by:

- **Action 11:** Harvesting at current rates has been assessed using genetic theory, empirical data and modelling, with the conclusion that it has negligible impacts on kangaroo genetics under present conditions (Hale 2001, 2004 Tenhumberg et al. 2004).
- Dispersal of individuals between populations (Clegg et al. 1998; Neaves et al. 2009) and patchiness of harvest allow for gene flow between populations, which helps to prevent genetic changes in a population.
- Species exhibit high levels of genetic diversity and limited genetic structure across their distributions (e.g. Neaves et al. 2009).
- **Action 27:** Where knowledge gaps exist, DEW will promote research into effects of harvesting on the genetic structure and diversity of harvested kangaroo species.

Humane killing

Commercial harvest involves the shooting of individual kangaroos and when required, the destruction of pouch young. As such, harvest carries a risk of animals not being killed humanely.

Potential negative effect mitigated by:

- **Action 1:** All kangaroos killed under permit in South Australia must be killed humanely following the Commercial Code.
- **Action 1:** Compliance with the Commercial Code is monitored routinely, and breaches are penalised.
- **Action 21:** Kangaroo field processors must pass mandatory firearms accuracy accreditation specific to kangaroo shooting before receiving a permit.
- **Action 21:** All kangaroo field processors are provided with a copy of the Commercial Code to ensure their awareness of the Commercial Code.
- **Action 20:** Compliance with Commonwealth and State policy and legislation for animal welfare.
- **Action 8:** Landholders applying for non-commercial destruction permits (Permits to Destroy Wildlife) are required to show knowledge of the firearm specifications and shooting requirements for kangaroos in the Non-Commercial Code by completing the method of destruction information on Permit to Destroy Wildlife application form.
- **Action 8:** Introduction of a training tool for non-commercial destruction permit applicants, in order to raise awareness of the Non-Commercial Code.
- All persons engaged to cull kangaroos on DEW parks and reserves must have successfully passed a firearms accuracy accreditation course specific to kangaroo shooting and are aware of the correct method of shooting a kangaroo under the Non-Commercial Code.

Impact of harvesting on habitats and ecosystems

Impacts of the commercial harvest on habitats and ecosystems may be positive or negative in nature. Impacts on habitats from the commercial harvest are more likely to be positive than negative, due to biodiversity benefits resulting from total grazing pressure management. These include an increase in the regeneration of native vegetation, increased recruitment (although for some arid-zone plant species, recruitment may be most closely linked to episodic rainfall events) and a reduction in the extent of non-palatable weed species.

Kangaroo harvest allows for kangaroo grazing pressure to be managed as a component of total grazing pressure (Grigg 1995). When managed in combination with sustainable stocking practices and management of feral herbivores, this would likely reduce the effects of overgrazing in some areas.

Potential negative impacts of harvesting on habitats and ecosystems include potential damage to vegetation and soil structure through kangaroo field processors driving off-track and the food source and potential disease risk provided by offcuts of the commercial harvest.

Offcuts of commercial harvest are produced when kangaroo field processors dress a carcass at the site of the shooting. Several carcasses may be dressed at the one site, leaving small piles of offcuts called dumps (Wilson and Read 2003). These dumps can provide a food resource for predators such as foxes or birds of prey (Read and Wilson 2004). However, they can also provide positive impacts such as improved soil nutrition, and a food resource for native scavengers.

Potential negative impacts of harvesting on habitats and ecosystems are minimised through:

- The presence of offcuts in ecosystems is minimised through full carcass only shooting in South Australia.
- The impacts of offcuts tend to be localised in nature.

Appendix 3: Setting and applying harvest thresholds

South Australia has adopted the harvest thresholds method used in New South Wales and described in the *New South Wales Commercial Kangaroo Harvest Management Plan 2017-2021*. The following explanation on harvest threshold setting by SR McLeod and AR Pople (2011), is taken from the NSW Commercial Kangaroo Harvest Management Plan.

Setting thresholds for proportional threshold harvest strategies

When populations fluctuate widely, harvest strategies that track changes in population size have been found to reduce the likelihood of overharvest (Lande et al. 1995). A proportional harvest strategy is currently used to set quotas for the commercial harvest of kangaroos in Australia (Pople and Grigg 1999). This harvest strategy tracks fluctuations in population abundance and adjusts quotas accordingly, and has been found to have a low risk of overharvesting (Engen et al. 1997). Proportional threshold harvesting is a modification of proportional harvesting and sets a threshold in population abundance, below which the proportion of the population that can be harvested is reduced eventually to zero. Harvest thresholds thus lower the risk of over-harvesting by reducing harvest mortality at times of low population size.

Harvest strategies that use thresholds will not necessarily result in substantially lower yields. Research on proportional threshold harvesting (Lande et al. 1997) indicated that average yield may even be increased if thresholds are set optimally. However, a drawback of threshold harvesting is that it may increase variance in annual yield since there may be some years when no harvesting is allowed if the population remains below the lowest threshold. Nevertheless, proportional threshold harvesting has been shown to be superior, in terms of reducing depletion and extinction while maintaining yield, to other harvesting strategies including proportional harvesting.

Threshold abundance levels can be set in a number of ways. Using a time series of abundance data, the threshold can be set at the minimum observed abundance (Deroba and Bence 2008). A potential disadvantage of this method is that the time series needs to be sufficiently long to be representative of the conditions (environmental and anthropogenic) that influence a population's abundance, and so establish a reliable threshold. For example, if a rare event caused abundance to fall to a historically low level that is unlikely to occur again, the threshold might be set too low. Furthermore, if abundance falls below the threshold, which can happen even in the absence of harvesting, should the threshold be adjusted to the new low abundance or not? The somewhat arbitrary nature of the threshold can make management actions unclear when abundance falls below the threshold.

Alternatively, the threshold can be based on statistical properties of a time series of the population's abundance. For example, a time series of abundance estimates can be plotted as a histogram (Figure 8). In this example, the distribution of abundance follows an approximately lognormal distribution with a mean of 15.2 kangaroos per square kilometre and a standard deviation of 5.8 kangaroos per square kilometre. In the long term, kangaroo density is expected to follow a lognormal distribution. This distribution can also be represented using z-scores. The z-score transformation quantifies the variables in terms of standard deviations from the mean. The z-score transformation also standardises the variables so that the mean of the distribution is zero and the standard deviation is one. The area under the curve between two z-scores represents the probability that an element of the distribution is the specified number of standard deviations from the mean (Figure 9). In terms of setting harvesting thresholds, a threshold set at a z-score of -1.5 would represent the lowest 6.7 percent of the distribution, while a z-score of two represents the lowest 2.3 percent of the distribution.

The advantage of this method of setting the threshold over a more arbitrary 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.

Applying this method of setting thresholds to red kangaroos in NSW's harvest zone 2 (Figure 10) indicates an initial threshold of 7.8 red kangaroos per square kilometre and a lower threshold of 6.4 red kangaroos per square kilometre. If the annual aerial survey indicates that the population of red kangaroos is below 7.8 kangaroos per square kilometre, the annual quota is reduced from 17 to 10 percent of the estimated population size. If the survey indicates that the population abundance of red kangaroos is below 6.4 kangaroos per square kilometre, then all harvesting in the zone will cease until at least the next survey when the annual harvest quota is reappraised. Thus, thresholds allow the population to fluctuate within its normal range in abundance, but prevent harvest mortality from depleting the population when it is at low abundance.

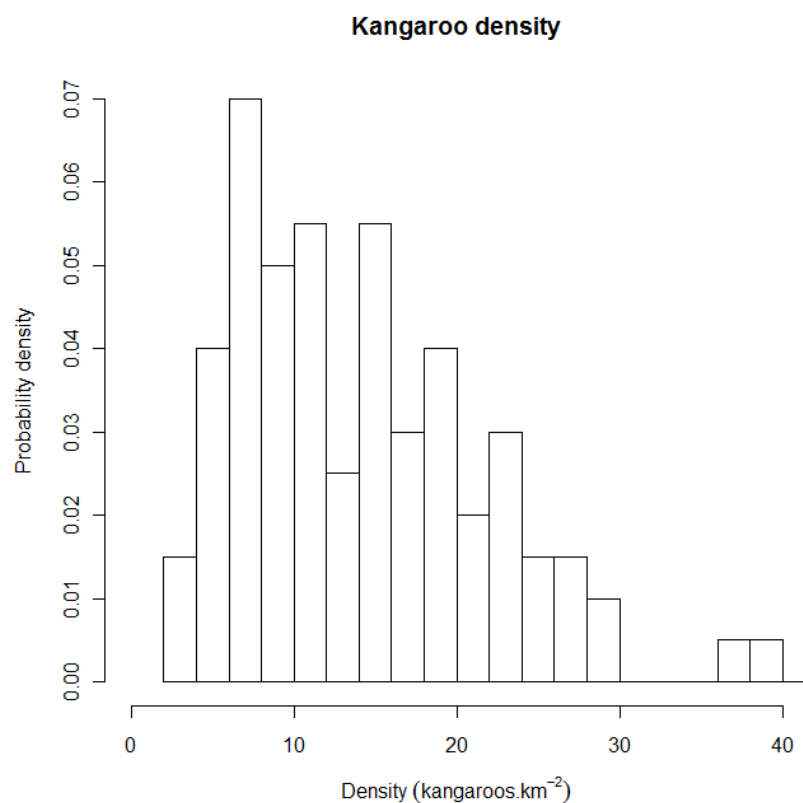


Figure 8: Histogram of a theoretical population of kangaroos. Density is estimated by aerial survey and the frequency of estimated densities is converted to probability densities. The distribution of kangaroo densities is approximately lognormal.

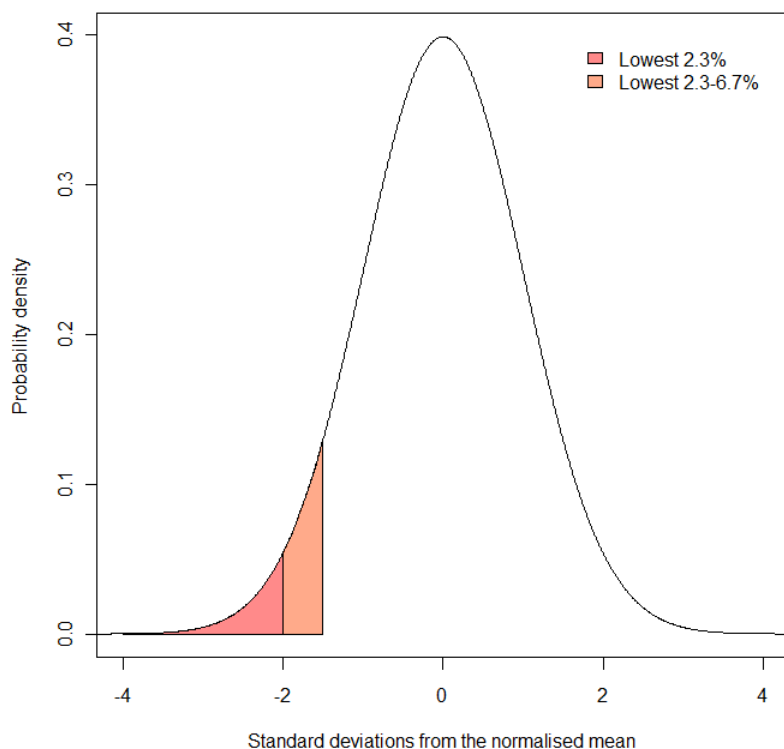


Figure 9: A theoretical distribution after z-score transformation. The mean of the distribution is zero and the standard deviation is one. Areas under the distribution represent probabilities. The orange shaded region represents the probability that a sample is between 1.5 and two standard deviations below the mean (and represents 4.4 percent of the area). The red-shaded region represents the probability that a sample is more than two standard deviations below the mean (and represents 2.3 percent of the area).

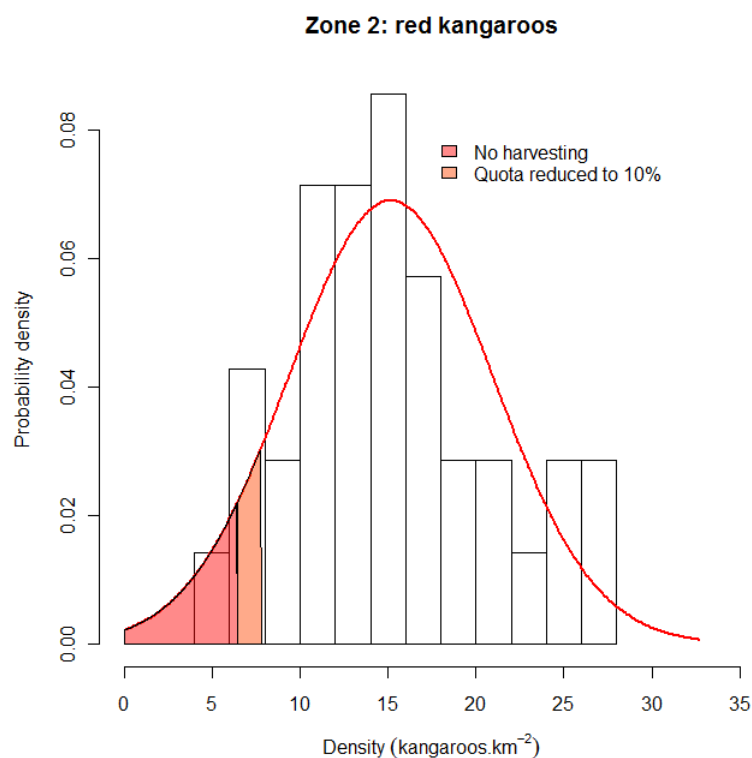


Figure 10: Example of setting harvest thresholds for red kangaroos in NSW's Zone 2.

The red line represents a normal probability distribution of the observed data with a mean of 15.2 kangaroos per square kilometre and a standard deviation of 5.8 kangaroos per square kilometre. The upper range of the orange region (7.8 kangaroos per square kilometre) represents the threshold within which harvest rate is reduced from 17 percent to 10 percent. This lower rate is maintained unless density falls below 6.4 kangaroos per square kilometre, at which point harvesting ceases (red region). The thresholds were calculated after log-transforming the data.

The following section shows how model simulations can be used to examine the relative effects of different thresholds applied to harvesting a theoretical population of red kangaroos.

Reducing the risk of overharvesting: an example using red kangaroos

The recommended strategy to minimise the risk of overharvesting is to reduce harvest rate as density declines, with changes in harvest rate triggered at predetermined density thresholds. Appropriate thresholds can be considered by harvesting a simulated population of kangaroos (e.g. Milner-Gulland et al. 2001). An appropriate population model for red kangaroos was developed by Caughley (1987) and various forms of the model have continued to be used for assessing strategies for managing the kangaroo harvest (e.g. Hacker et al. 2004; Pople 2003, 2008).

Briefly, changes in kangaroo numbers are modelled as a function of pasture biomass which, in turn, is determined by recent rainfall, past pasture biomass and the density of kangaroos (and livestock) consuming the pasture. Harvesting obviously reduces kangaroo numbers, but the reduced density results in higher pasture biomass and therefore higher rates of increase of kangaroos. This improvement in environmental conditions for a population, which without harvesting has no long-term trend, is a basic requirement for the sustainability of a harvest. The population can be simulated 10,000 times over a 20 year period. Each run is different as, every three months, rainfall is drawn from a probability distribution using the average and standard deviation for rainfall in western NSW and thus reflects the uncertain food supply in this arid environment. Population size is also estimated with uncertainty by aerial surveys, and so this too was drawn from a probability distribution using the average and standard deviation associated with aerial surveys (Pople 2008). The population was harvested at an annual rate of 15 percent or less if it was below a particular threshold.

Extinction is highly unlikely for this simulated population unless there is some combination of low numbers, catastrophic weather and unsustainable harvesting (i.e. much greater than 15 percent). A more useful measure of threshold performance is the probability of the population dropping to a relatively low density. This can be calculated as the proportion of the 10,000 simulation runs where the population falls below particular densities. Thresholds can be expressed in terms of standard deviations (SDs) below long-term average density for a kangaroo management zone. That way, the aim of the threshold harvest strategy is to keep the harvested population above historically low density.

The effect of reducing harvest rate at varying SDs below the long-term average density for the simulated kangaroo population is shown in Figure 11. Reducing the threshold not surprisingly reduces the probability of very low density, but the decline in probability from no threshold (15 percent harvest) to no harvest is smooth. There is, therefore, no obvious optimum with the choice being somewhat arbitrary. Notably, even an unharvested population has some chance of declining to very low density.

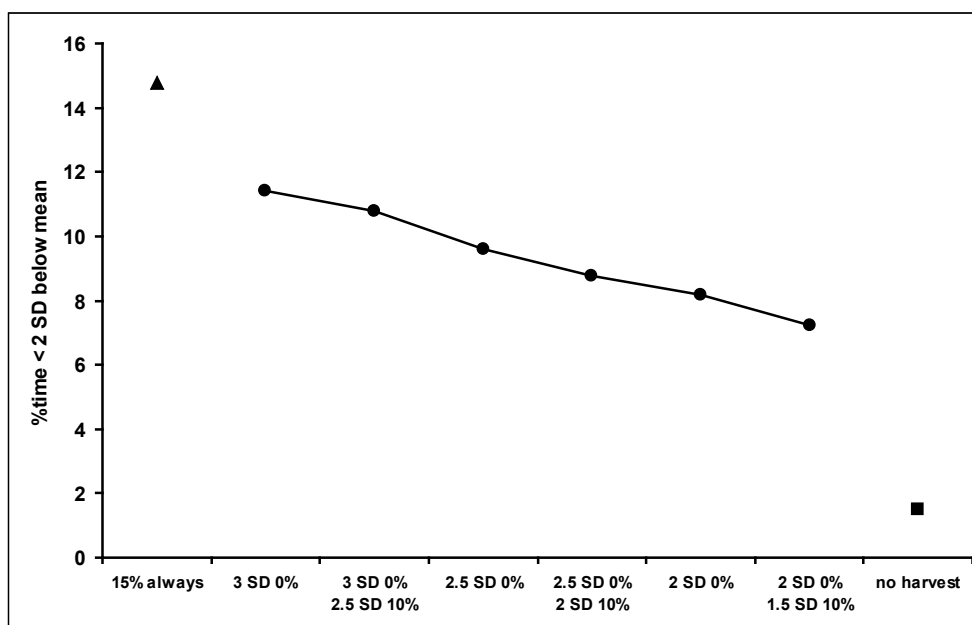


Figure 11: 10,000 simulations for a population fluctuating over 20 years.

Standard deviation (over time) was calculated from a lognormal distribution. Mean population size was about eight kangaroos per square kilometre. Density was about four kangaroos per square kilometre at two standard deviations below the mean.

Other factors that could be considered in setting thresholds is the time spent below some relatively low density (e.g. Figure 12), and the long-term average and variability in harvest offtake (including years with zero offtake) (Pople 2003). For these simulations, average harvest offtake was similar among the thresholds shown in Figures 11 and 12, but variability in the annual harvest increased slightly as the threshold was reduced.

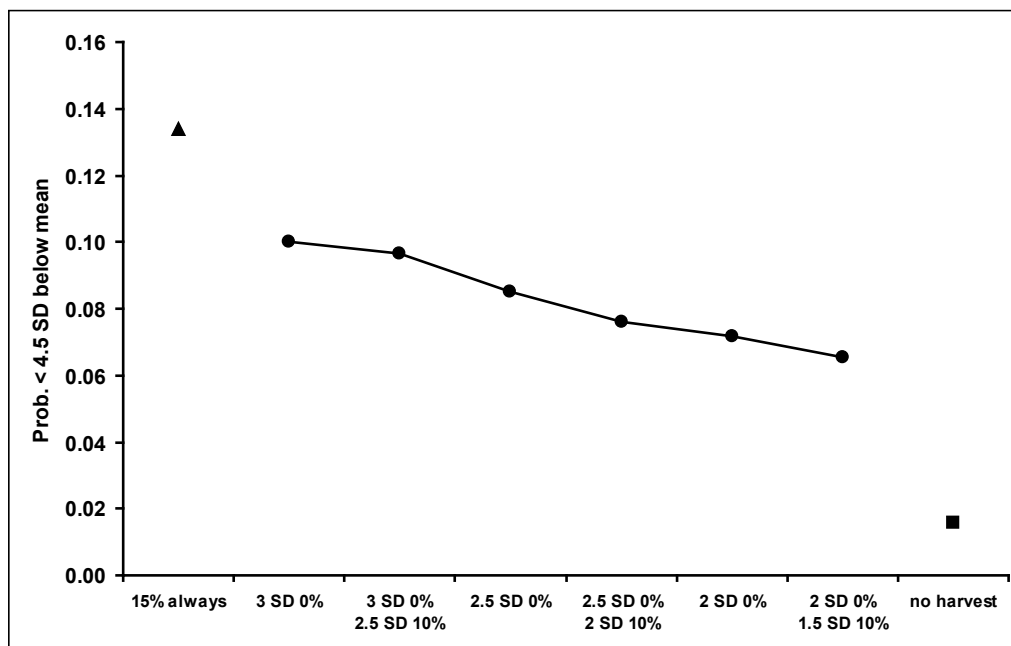


Figure 12: Simulated population as described for Figure 8.

Density was about two kangaroos per square kilometre at 4.5 standard deviations below the mean.

Appendix 4. Summary of quotas and thresholds

Quotas	Description	Management actions	
Proportional quota (Action 11)	Proportional quota is set for each species in each CHSR based on latest population estimate (either survey or model prediction).	Red kangaroo	20% of population est.
		Western grey kangaroo	15% of population est.
		Eastern grey kangaroo	15% of population est.
		Euro	15% of population est.
		Tammar wallaby	10% of population est.
High Abundance Quota (HAQ) (Action 11)	HAQ is additional quota that can be issued in combination with the proportional quota when a population estimate in a CHSR is above the long-term average. Quota is issued at the discretion of the Director of National Parks and Wildlife.	HAQ issued when population in a CHSR is above the long-term average.	
Special land management quota (SLMQ) (Action 14)	Additional quota that can be released when all proportional quota has been allocated within a CHMR to mitigate ongoing land condition damage. Quota is set at a maximum of 1.5% of the population estimate of each species in each CHSR.	SLMQ is released when all proportional quota has been allocated and kangaroo populations are still causing damage to land or infrastructure.	
Thresholds			
Low harvest threshold (Action 12)	Threshold based on harvest within each CHSR. Threshold is set at 1.5% of the average population estimate. If harvest falls below threshold for three consecutive years, management actions are triggered.	Established CHSR	If harvest is lower than threshold, stop surveys until harvest exceeds threshold.
		New CHSR	If harvest is lower than threshold, reduce survey effort to every 5 years until harvest exceeds threshold.
Low abundance thresholds (Action 13)	Thresholds are based on population estimates to ensure that populations are not overharvested when at low densities. When population estimates fall below thresholds, management actions are triggered.	Threshold 1	Quota is reduced to 10% of population estimate.
		Threshold 2	Harvest is suspended until population estimate increases above threshold.

Appendix 5. Permit types and detail

This section contains detail on the various permit types related to kangaroo management, including Field Processor, Meat Processor and Skin Tanner Permits, and Permit to Destroy Wildlife.

Permits are issued under the *National Parks and Wildlife Act 1972* and subordinate regulations. Permit 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 the Commonwealth will be notified of any significant changes.

Kangaroo Field Processor

Permit	<p>Holds a permit issued under section 60J of the <i>National Parks and Wildlife Act 1972</i> and the Kangaroo Harvesting Regulations.</p> <p>The permit allows for the permit holder to take kangaroos by means of a firearm on land for which there is a commercial quota, field-dress the carcasses into a form suitable for sale, and sell the carcasses to a Kangaroo Meat Processor.</p>
Permit prerequisite	<p>The applicant must hold a current Firearms Licence (Class B7 or as otherwise recommended by SAPOL).</p> <p>The applicant must have completed an approved Kangaroo Field Processors Firearms Proficiency course in South Australia or another state.</p> <p>The applicant must have completed the Wild Game Harvester Field Processing (Kangaroo) course endorsed by Primary Industries and Regions South Australia or an accredited interstate course.</p> <p>The permit holder must be accredited by Primary Industries and Regions South Australia.</p>
Detail/ Permit conditions	<p>The permit holder may shoot kangaroos only on land on which they have the landowner's written permission to shoot.</p> <p>The permit holder may shoot kangaroos only following allocated quotas and using sealed tags.</p> <p>All kangaroos must be shot following the Commercial Code.</p> <p>The permit holder must affix to each kangaroo carcass a commercial use sealed tag issued in accordance with regulations. Royalty for each tag must be paid to DEW. Each uniquely-numbered tag used is subtracted from the quota and allows for an individual carcass to be tracked through the processing chain. The permit holder must attach the appropriate tag for each species of kangaroo that is harvested, and the tag must be valid for the harvest sub-region in which the kangaroo is taken. The tags are self-locking and can only be removed from the carcass or skin when it is processed by a licenced meat processor or skin tanner, respectively.</p> <p>The permit holder may sell kangaroos only in the form approved under regulation 42 of the Kangaroo Harvesting Regulations for sale to persons holding a Kangaroo Meat Processor permit.</p> <p>The permit holder must keep records of kangaroos that are harvested, and supply harvest returns to DEW in the approved format.</p>
Further detail	<p>For further detail, see the National Parks and Wildlife (Kangaroo Harvesting) Regulations 2018 and National Parks and Wildlife (Wildlife) Regulations 2019, or any amended versions of these regulations.</p>

Kangaroo Meat Processor

Permit	<p>Holds a permit issued under section 58 of the <i>National Parks and Wildlife Act 1972</i>.</p> <p>The permit allows for the permit holder to keep and sell kangaroo meat products and skins.</p>
Permit prerequisite	<p>The applicant must have a thorough knowledge of the <i>National Parks and Wildlife Act 1972</i> and regulations under this Act.</p> <p>The permit holder must be accredited by Primary Industries and Regions South Australia.</p>
Detail/ Permit conditions	<p>The permit holder may purchase kangaroo carcasses only from a Kangaroo Field Processor in South Australia, from another licenced Kangaroo Meat Processor in South Australia, or from an accredited dealer that has obtained carcasses through an accredited interstate kangaroo harvest program.</p> <p>The permit holder must purchase or accept only those kangaroo carcasses that have a sealed tag affixed (both for carcasses taken within South Australia, or imported from another state).</p> <p>The permit holder must obtain import or export permits, issued under the <i>National Parks and Wildlife Act 1972</i> for consignments of kangaroo products that enter or leave South Australia respectively. (N.B.: export of kangaroo products from Australia requires a separate export permit issued by the Commonwealth).</p> <p>The permit holder must keep records of carcasses and skins that are purchased and sold, and supply returns to DEW in the approved format.</p>
Further detail	<p>For further detail, see the National Parks and Wildlife (Kangaroo Harvesting) Regulations 2018, the Wildlife Variation Regulations 2003, and National Parks and Wildlife (Wildlife) Regulations 2019, or any amended versions of these regulations.</p>

Kangaroo Skin Tanner

Permit	<p>Holds a permit issued under section 58 of the <i>National Parks and Wildlife Act 1972</i>.</p> <p>The permit allows for the permit holder to keep and sell kangaroo skins.</p>
Permit prerequisite	<p>The applicant must have a thorough knowledge of the <i>National Parks and Wildlife Act 1972</i> and regulations under this Act.</p>
Detail/ Permit conditions	<p>The permit holder may purchase kangaroo skins only from a Kangaroo Meat Processor in South Australia, another licenced Skin Tanner in South Australia or from an accredited dealer that has obtained carcasses or skins through an accredited interstate kangaroo harvest program.</p> <p>The permit holder must purchase or accept only those kangaroo skins that have a sealed tag affixed (both for carcasses taken within South Australia, or imported from another state).</p> <p>The permit holder must obtain import or export permits, issued under the <i>National Parks and Wildlife Act 1972</i>, for consignments of kangaroo skins that enter or leave South Australia. (N.B.: export of kangaroo products from Australia requires a separate export permit issued by the Commonwealth).</p> <p>The permit holder must keep records of skins that are purchased and sold.</p>
Further detail	<p>For further detail, see the National Parks and Wildlife (Kangaroo Harvesting) Regulations 2018, the Wildlife Variation Regulations 2003, and National Parks and Wildlife (Wildlife) Regulations 2019, or any amended versions of these regulations.</p>

Permit to Destroy Wildlife (Non-Commercial/Damage mitigation)

Permit	<p>A permit issued under section 53(1)(c), or 53(1)(d) of the <i>National Parks and Wildlife Act 1972</i>.</p> <p>The permit allows for the permit holder to destroy a specified number of kangaroos that are causing, or are likely to cause, damage to the environment, or to stock, crops or other property, or that constitute a safety risk or hazard.</p>
Permit prerequisite	<p>The permit holder, or the person listed on the permit to shoot kangaroos, must hold a current firearms licence.</p> <p>The permit holder, or the person listed on the permit to shoot kangaroos, must comply with the Non-Commercial Code.</p>
Detail/ Permit conditions	<p>Kangaroos must be shot in accordance with the Non-Commercial Code.</p> <p>Where a permit holder does not have the marksmanship skills to comply with the Non-Commercial Code, they can list another person(s) with the required marksmanship skills to conduct the shooting in accordance with the Non-Commercial Code.</p> <p>Carcasses must be left in the field or disposed of in accordance with carcass management options approved by DEW unless approved by DEW for personal use by the permit holder or authorised shooters listed on the permit.</p> <p>Where carcasses are to be used, a valid personal use sealed tag must be attached to each carcass after shooting and must remain on the carcass or skin until product is used. A royalty must be paid to DEW for each personal use tag.</p> <p>The Permit to Destroy Wildlife permit holder must provide a return of the number of animals destroyed (and, if personal use sealed tags were issued, the range of tag numbers used) to DEW in the approved format.</p>

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