

# 2019 Harvest Report

Commercial Kangaroo Harvest  
South Australia



**Government  
of South Australia**

Department for  
Environment and Water

Department for Environment and Water

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# Foreword

Kangaroos are an iconic part of South Australian landscapes. They are valued for their role in ecosystems, and as a resource that can be used sustainably. The Department for Environment and Water (DEW) is responsible for the conservation and management of kangaroos in South Australia in accordance with the *National Parks and Wildlife Act 1972* (NPW Act), ranging from policy leadership to on-ground operations in consultation with government, industry and communities.

Widespread changes to the environment since European settlement have changed the abundance of many native species. Some species have declined in number, while others have adapted to the changes and can exploit the opportunities provided by altered habitats. These species – including kangaroos – are now present in larger numbers, or are more widespread than before.

Large numbers of kangaroos may 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 that may be environmental, economic, or social in nature. The drying conditions associated with drought can magnify these conflicts especially where localised movement of kangaroos may occur as they seek feed and water resources.

The NPW Act provides for the destruction of kangaroos for the purposes of mitigating or preventing damage and allows for the commercial harvest of the three common kangaroo species (Red Kangaroo, Western Grey Kangaroo and Euro). High-quality science, effective monitoring and compliance provide the foundation for the management of our environment and natural resources, including our kangaroo species. This is achieved through appropriate management of legislation, research, investigations, assessments, monitoring and evaluation.

DEW's partnerships with industries, government agencies, Natural Resources Management Boards and the community ensures that there is continual capacity building with respect to kangaroo management, and that the best skills and expertise are used to inform decision making.



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**DEPARTMENT FOR ENVIRONMENT AND WATER**

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# Summary

## Legislation

All kangaroo species in South Australia are protected under the *National Parks and Wildlife Act 1972* (NPW Act), have value in ecosystem processes, and contribute to biodiversity. The NPW Act (section 60G) and associated regulations, allow for the sustainable harvest of the following common species of kangaroo:

- Red Kangaroo (*Macropus rufus*)
- Western Grey Kangaroo (*M. fuliginosus*)
- Euro (*M. robustus*)

The wildlife trade provisions of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) regulate the export of kangaroo products from Australia. The harvest and export of these protected species requires a management plan endorsed under the NPW Act and a Wildlife Trade Management Plan endorsed under the EPBC Act.

The Department for Environment and Water (DEW) manages the commercial harvest of the common kangaroo species in South Australia. Management of the commercial harvest of these kangaroo species has been implemented through a management plan approved under the NPW Act. Aerial survey of kangaroos, as a means to prepare population estimates, commenced in 1978 and continues on an annual basis. Commercial harvest quotas are adjusted according to ongoing research and population monitoring.

The South Australian Commercial Kangaroo Management Plan for 2018 - 2022 has been developed to meet the requirements of an approved Wildlife Trade Management Plan under the EPBC Act. This plan also meets the requirements of the NPW Act and provides the framework for the commercial harvesting of kangaroos in South Australia.

This report details the operation of the approved management plan for 2019 (South Australian Commercial Kangaroo Management Plan 2018 – 2022, the Management Plan) and includes the following information:

- Actual harvest, by harvest sub-region and species, for 2019;
- Harvest quota management;
- Special Land Management Quota issued;
- Non-commercial destruction statistics;
- Compliance statistics; and
- Current management programs on reserves and research.

## Harvest regions for 2019

In accordance with the provisions of the Management Plan, annual harvest quotas are based on the results of direct monitoring of kangaroo populations. Monitoring takes place in accordance with the standard survey techniques detailed in the Management Plan.

Four harvest regions are defined in the Management Plan: Western Pastoral, Eastern Pastoral, Western Agricultural and Eastern Agricultural.

The harvest regions consist of sub-regions (Table 1 and Figure 1) and are primarily based on the administrative boundaries of the former Soil Conservation Board districts (or an amalgamation thereof).

*Table 1: Kangaroo Harvest Regions and Sub-regions for South Australia during 2019.*

Harvest Region	Harvest Sub-region
Eastern Pastoral	North Flinders North East Pastoral Eastern Districts Murray Mallee
Western Pastoral	Marla-Oodnadatta, Marree (inside dog fence) Marree (outside dog fence) Kingoonya Gawler Ranges
Eastern Agricultural	South Flinders Mid North
Western Agricultural	Eyre East Eyre West

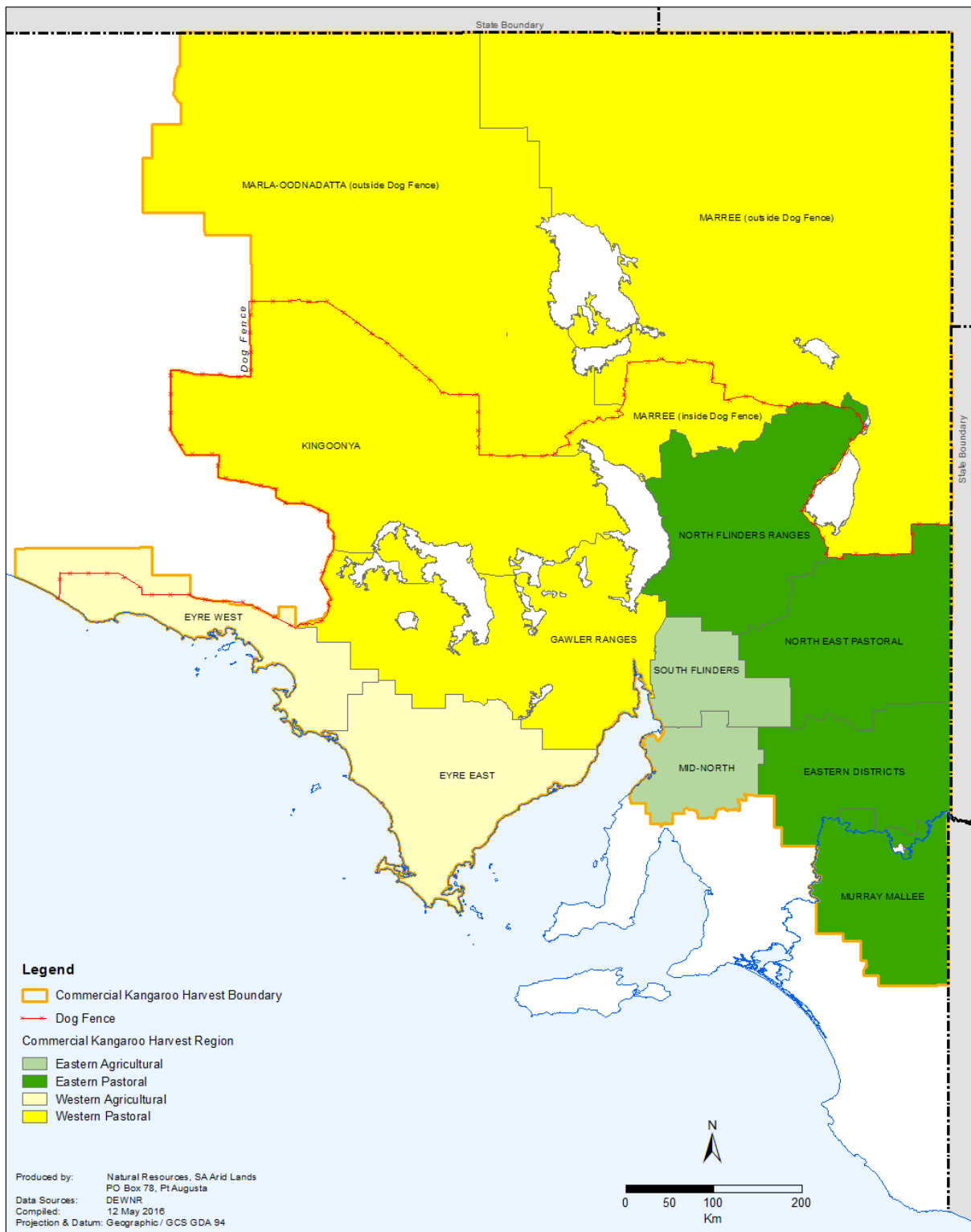


Figure 1: Map of harvest regions and sub-regions of South Australia

# 2019 Harvest Details

Harvest returns are received each month by the Department for Environment and Water from kangaroo field processors (shooters) and kangaroo meat processors. Harvest data for 2019 are provided in the tables below. Table 2 is sourced from kangaroo field processor returns and may be subject to amendment. Table 3 is sourced from kangaroo meat processor returns and is regarded as the more accurate in terms of numbers, as these data are related to payments made to kangaroo field processors. Table 3 also shows a comparison with the 2018 commercial harvest statistics.

*Table 2: Harvest statistics from kangaroo field processor returns for the 2019 calendar year.*

Species	Quota*	Harvest*	% Quota Harvested
Red Kangaroo	501,200	68,864	14
Western Grey Kangaroo	170,900	24,573	14
Euro	80,000	6,015	8
<b>Total</b>	<b>752,100</b>	<b>99,452</b>	<b>13</b>

\* Including Special Land Management Quota.

There is a discrepancy between meat processor and field processor returns of 163 kangaroo carcasses. This represents 0.02% of the quota and is not considered significant in light of the varied sources from which these data are compiled. The higher number of kangaroos recorded using the field processor returns may relate to kangaroos which have been harvested but not yet purchased by meat processors. Also, DEW has outstanding issues awaiting resolution with field processors and meat processors, where errors have been identified on their returns. The discrepancy may change once these matters have been resolved.

*Table 3: Harvest statistics from kangaroo meat processor returns for the 2019 and 2018 calendar years.*

Species	Quota*	Harvest*	% Quota Harvested
Red Kangaroo			
2019	501,200	68,711	14
2018	498,800	74,597	15
Western Grey Kangaroo			
2019	170,900	24,565	14
2018	205,400	26,697	13
Euro			
2019	80,000	6,013	8
2018	81,600	7,247	9
<b>2019 Total</b>	<b>752,100</b>	<b>99,289</b>	<b>13</b>
<b>2018 Total</b>	<b>785,800</b>	<b>108,541</b>	<b>14</b>

\* Including Special Land Management Quota.

The 2019 kangaroo harvest by harvest region and species is provided in Tables 4, 5 and 6. Data for these tables are sourced from field processor returns. These tables do not include the Special Land Management Quota (SLMQ) which is covered in the Harvest Quota Management section below.

The harvest of kangaroos in South Australia during recent years has been relatively static at around 100,000 kangaroos per year, even though numbers across the landscape have been high. The 2019 harvest shows a decrease of around 9,000 kangaroos when compared to 2018. Economic factors of the commercial harvest, such as the low price of carcasses in the current market conditions and increasing input costs, continue to impact the viability of the industry.



Table 4: Harvest of Red Kangaroos during 2019 calendar year.

Harvest Region	Quota	Harvest*	% q	% p	Avg Female Weight	Avg Male Weight	# Females	# Males
Western Pastoral	262,000	27,552	11	10-20	16.9Kg	26.7 Kg	7,809	19,736
Eastern Pastoral	203,800	18,827	9	10-20	16.8 Kg	23.8 Kg	6,624	12,203
Western Agricultural	0	0	-	-	-	-	0	0
Eastern Agricultural	22,700	21,594	95	17-20	17.3 Kg	22.8 Kg	5,755	15,839
<b>Total</b>	<b>488,500</b>	<b>67,973</b>	<b>14</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>20,188</b>	<b>47,778</b>

Note: Quota and Harvest do not include Special Land Management Quota; % q = commercial take as percentage of approved quota; % p = allowed commercial take as percentage of population estimate (range relates to individual harvest sub-region quotas). \* Harvest includes 7 carcasses left in field (did not meet industry standards). These carcasses are not included in the # Females and # Males.

Table 5: Harvest of Western Grey Kangaroos during 2019 calendar year.

Harvest Region	Quota	Harvest*	% q	% p	Avg Female Weight	Avg Male Weight	# Females	# Males
Western Pastoral	60,400	3,634	6	0-15	17.1 Kg	25.3 Kg	803	2,831
Eastern Pastoral	47,600	4,536	10	9-15	16.3 Kg	22.9 Kg	1,572	2,963
Western Agricultural	24,200	1,054	4	12-15	17.2 Kg	27.5 Kg	335	717
Eastern Agricultural	32,500	15,349	47	10	17.4 Kg	24.9 Kg	4,265	11,082
<b>Total</b>	<b>164,700</b>	<b>24,573</b>	<b>15</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>6,975</b>	<b>17,593</b>

Note: Quota and Harvest do not include Special Land Management Quota; % q = commercial take as percentage of approved quota; % p = allowed commercial take as percentage of population estimate (range relates to individual harvest sub-region quotas). \* Harvest includes 5 carcasses left in field (did not meet industry standards). These carcasses are not included in the # Females and # Males.

Table 6: Harvest of Euros during 2019 calendar year.

Harvest Region	Quota	Harvest	% q	% p	Avg Female Weight	Avg Male Weight	# Females	# Males
Western Pastoral	22,200	1,400	6	0-15	11.9 Kg	22.8 Kg	72	1,328
Eastern Pastoral	46,900	1,727	4	0-15	15.0 Kg	20.9 Kg	35	1,692
Western Agricultural	0	0	-	-	-	-	0	0
Eastern Agricultural	7,900	2,888	37	9	15.6 Kg	25.7 Kg	57	2,831
<b>Total</b>	<b>77,000</b>	<b>6,015</b>	<b>8</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>164</b>	<b>5,851</b>

Note: Quota and Harvest do not include Special Land Management Quota; % q = commercial take as percentage of approved quota; % p = allowed commercial take as percentage of population estimate (range relates to individual harvest sub-region quotas).

# Sex bias and average weights

Commercial harvests typically have a bias towards larger and heavier animals. Data detailing the average weight and sex bias for 2019, and compared to 2018, is provided in Table 7, Table 8 and Table 9.

*Table 7: Average weights and sex bias of harvested Red Kangaroos during 2019 (2018 data in parentheses).*

<b>Red kangaroo</b>	<b>Ave. male weight (kg)</b>	<b>Ave. female weight (kg)</b>	<b>Male bias (%)</b>
Western Pastoral	26.7 (28.9)	16.9 (18.2)	72 (89)
Eastern Pastoral	23.8 (26.7)	16.8 (17.4)	65 (95)
Western Agricultural	-	-	-
Eastern Agricultural	22.8 (24.5)	17.3 (17.5)	73 (93)
<b>Total</b>	<b>24.6</b>	<b>17.0</b>	<b>72</b>

*Table 8: Average weights and sex bias of harvested Western Grey Kangaroos during 2019 (2018 data in parentheses).*

<b>Western Grey Kangaroo</b>	<b>Ave. male weight (kg)</b>	<b>Ave. female weight (kg)</b>	<b>Male bias (%)</b>
Western Pastoral	25.3 (27.3)	17.1 (17.6)	78 (92)
Eastern Pastoral	22.9 (25.8)	16.3 (17.6)	65 (92)
Western Agricultural	27.5 (24.0)	17.2 (16.8)	68 (70)
Eastern Agricultural	24.9 (27.1)	17.4 (18.0)	72 (90)
<b>Total</b>	<b>24.7</b>	<b>17.1</b>	<b>72</b>

*Table 9: Average weights and sex bias of harvested Euros during 2019 (2018 data in parentheses).*

<b>Euro</b>	<b>Ave. male weight (kg)</b>	<b>Ave. female weight (kg)</b>	<b>Male bias (%)</b>
Western Pastoral	22.8 (26.8)	11.9 (12.0)	95 (99)
Eastern Pastoral	20.9 (22.8)	15.0 (15.5)	98 (99)
Western Agricultural	-	-	-
Eastern Agricultural	25.7 (27.3)	15.6 (15.0)	98 (99)
<b>Total</b>	<b>23.6</b>	<b>13.8</b>	<b>97</b>

# Harvest Quota Management

Sealed tags were sold throughout the year in accordance with the allocated harvest region quotas for 2019. Harvest reports were viewed regularly, allowing the progress of the kangaroo harvest for each region to be monitored.

The harvest of kangaroos in most harvest regions was generally low when compared to the available quota. However, the sustainable use quota for Red Kangaroos in the Eastern Agricultural Harvest Region was fully allocated during November 2019 and Special Land Management Quota (SLMQ) was released. The aerial kangaroo survey in 2019 recorded an increase in kangaroos for this harvest region, consistent with a movement of kangaroos from the pastoral areas into the agricultural areas in search of feed and water as the drought conditions continued.

The reason for the overall low harvest across the state is likely to be due to the economic situation facing the industry as a result of increasing input costs and the low price paid per kilogram of product supplied.

## Special Land Management Quota

Special Land Management Quota (SLMQ) may be set at up to 1.5% of the estimated population size of each species, and is used when land management issues arise that may be due to localised or widespread seasonal conditions. This quota component is only for the harvest of kangaroos that would otherwise be culled under Permits to Destroy Wildlife, and is designed to minimise the number of kangaroos destroyed under these permits and not utilised by the commercial industry.

SLMQ is only considered for issue once the sustainable use quota for a harvest region has been fully issued, is expected to be harvested, and land management issues remain.

SLMQ was released in 2019 for Red Kangaroos in the Eastern Agricultural Harvest Region. Of a quota of 1,600 released, a total of 891 kangaroos were harvested, comprising 564 males, 325 females and two carcasses left in the field, which did not meet industry standards.

# Non-commercial destruction permits

Details of permits issued for non-commercial destruction of kangaroos (Permit to Destroy Wildlife) in each commercial harvest region for 2019 are provided in Table 10.

Table 10: Non-commercial destruction of kangaroos per commercial harvest region and outside of the commercial harvest area during 2019.

Harvest region	Species available for commercial harvest						Species not available for commercial harvest				total permits issued <sup>c</sup>	total animals on permit
	Red Kangaroo		Western Grey Kangaroo <sup>a</sup>		Euro		Eastern Grey Kangaroo		Tamar Wallaby			
	permits issued <sup>b</sup>	animals on permit	permits issued <sup>b</sup>	animals on permit	permits issued <sup>b</sup>	animals on permit	permits issued <sup>b</sup>	animals on permit	permits issued <sup>b</sup>	animals on permit		
Western Pastoral	6	1130	10	1,550	4	490	-	-	-	-	<b>20</b>	<b>3,170</b>
Eastern Pastoral	59	7232	126	8,330	23	4685	-	-	-	-	<b>208</b>	<b>20,247</b>
Western Agricultural	12	795	142	10,703	5	200	-	-	-	-	<b>159</b>	<b>11,698</b>
Eastern Agricultural	113	10,810	181	16,770	116	7623	-	-	-	-	<b>410</b>	<b>35,203</b>
Outside commercial harvest	46	1,695	887	43,782	21	240	44	1,810	63	10,342	<b>1,061</b>	<b>57,869</b>
<b>Total</b>	<b>236</b>	<b>21,662</b>	<b>1,346</b>	<b>81,135</b>	<b>169</b>	<b>13,238</b>	<b>44</b>	<b>1,810</b>	<b>63</b>	<b>10,342</b>	<b>1,858</b>	<b>128,187</b>

<sup>a</sup> includes both the mainland and the Kangaroo Island sub-species.

<sup>b</sup> number of permits that include this species.

<sup>c</sup> as a single permit may list multiple species, the reported 'total permits issued' are greater than the actual number of permits issued.

# Compliance

During 2019, DEW staff prepared for the expansion of the commercial harvest area that was implemented in January 2020. This included training 9 local DEW staff who will assist with compliance in the expanded commercial harvest area. This training will continue in 2020 to include all aspects of the commercial harvest industry.

The National Parks and Wildlife (Kangaroo Harvesting) Regulations 2003 were reviewed and new regulations were proclaimed in September 2018. DEW allowed for a 12 month period of education, prior to fully enforcing the new requirements. The compliance results for 2019 reflect this approach.

During 2019, staff of the Kangaroo Management Program routinely checked field processor returns for incorrect information which was then investigated and corrected. The lodgement of monthly returns was monitored, with compliance action taken against permit holders who submitted late returns. Likewise, field processors with outstanding expired sealed tags were followed-up to ensure tags were returned.

Checks of field chillers were carried out at various times of the year to ensure compliance with legislation. Forty field chillers (including mobile chillers and drive-through sites) were in operation throughout the pastoral and some agricultural areas of the State during 2019. A total of 27 field chillers were inspected by DEW wardens. The aim of these checks is to ensure that field operations are compliant with the *National Parks and Wildlife Act 1972* (the Act) and associated regulations.

When inspected, field chillers are checked to ensure:

- Kangaroos are taken according to the National Code of Practice for the Humane Shooting of Kangaroos and Wallabies for Commercial Purposes
- Sealed tags are correctly affixed to carcass
- Sealed tags are valid for use
- Sealed tags affixed to each species are of the correct colour for that species
- Kangaroos are presented in the correct form
- Any meat hygiene issues are documented and reported to the Biosecurity SA Food Safety Program (PIRSA)

Field trips are also an important means of maintaining relationships with landholders, gaining an understanding of landscape condition and sharing information with field processors (53 permit holders in 2019). Not all chillers were checked during the year, as many were not operational for extended periods due to the economic hardships facing the industry in South Australia.

Four kangaroo meat processors and two tanneries operated in South Australia during 2019. Compliance inspections at the meat processors' facilities provide a good picture of the level of field processors adherence with carcass tagging requirements and the National Code of Practice for the Humane Shooting of Kangaroos and Wallabies for Commercial Purposes. Seven inspections were made of four processing facilities. No inspections were conducted of the two tanneries that operated during 2019.

Staff of the DEW Kangaroo Management Program, located at Port Augusta, undertook the majority of the compliance activities associated with the South Australian Kangaroo Management Program.

In addition to these activities, DEW staff across the State may investigate reports of:

- Illegal shooting
- Illegal transport of carcasses
- Breaches of permit conditions

## Compliance action

Wardens are able to issue verbal warnings, warning letters, written cautions or expiation notices. Expiation notices attract a penalty. If a 'caution' is issued to an individual and that person continues to commit the same offence, an expiation notice that incurs a penalty is generally issued. Serious or habitual offenders may have court action taken against them, which may result in the cancellation of permits. Probationary periods may be used for less serious, habitual offenders where they are formally advised their permit may be revoked/not renewed if offending continues.

During 2019, one expiation notice, 19 caution notices and five warning letters were issued for offences in relation to kangaroos harvested in SA, as detailed in Table 11. Expiation notices where a fee was incurred are recorded as a penalty.

Table 11: Kangaroo management compliance activities for kangaroos harvested in South Australia during 2019.

Description of Offence	Result
Permit holder to supply returns within 14 days	13 Cautions 1 Warning letter 1 Penalty (\$270)
Import animal without an Import Permit	1 Caution
Tag must not be out of date	4 Cautions
Tag must be completed and locked into place	1 Caution
Tag not nominated for Harvest Sub-region	1 Warning letter
Field records incorrect	1 Warning letter
Harvesting without a permit	1 Warning letter
Field records incorrect and tags to be returned before 30 days out of date.	1 Warning letter
One kangaroo carcass with projectile damage	No Further Action (NFA), as damage resulted from shrapnel.

## Interstate Liaison

Two South Australian meat processors imported carcasses from New South Wales or Queensland for processing during 2019. During routine inspections, and

as a result of information received, 64 imported kangaroo carcasses were identified as having possible projectile damage. Evidence collected was forwarded to interstate authorities for follow-up investigation. A summary of the results of these investigations are provided in Table 12.

## Compliance priorities 2019

The following points summarise the outcomes against the 2019 compliance priorities:

- A total of nine audits (17%) were conducted of the licensed field processors (target was 20%).

## Compliance priorities 2020

The priorities for 2020 are:

- Complete training of nine DEW staff within the expanded commercial harvest area to assist in kangaroo management program compliance inspections.
- To visit all field chiller locations within the expanded commercial harvest area.
- To audit all new field processors who have commenced harvesting within the 2019 and 2020 calendar years, to check their compliance with field record books and landowner consent forms.

Table 12: Compliance issues detected in kangaroo carcasses imported by South Australian meat processors during 2019.

Description of Offence	Result
Sixteen kangaroo carcasses imported from QLD with possible projectile damage. Evidence was collected and forwarded to QLD authorities for follow-up investigation	<ul style="list-style-type: none"> <li>• Shrapnel wound. Education provided to harvesters in relation to nine carcasses, no further action.</li> <li>• NFA (No Further Action) – As no tag was not retained with the skin for one carcass.</li> <li>• NFA -There was insufficient evidence for two carcasses, as the skin with the tag attached had not been retained.</li> <li>• Two Penalty Infringement Notices issued relating to four carcasses.</li> </ul>
Forty eight kangaroo carcasses imported from NSW with possible projectile damage. Evidence was collected and forwarded to NSW authorities for follow-up investigation	<ul style="list-style-type: none"> <li>• Currently awaiting feedback for 9 carcasses.</li> <li>• NFA - as no tag was retained with the skin for 3 carcasses.</li> <li>• Warning letters were issued in relation to 4 carcasses.</li> <li>• Official Cautions were issued in relation to 17 carcasses</li> <li>• Penalty Notices were issued for 15 carcasses.</li> </ul>

# Kangaroo Management on Reserves

On DEW reserves, kangaroos are managed where they impact reserve conservation values. The management of kangaroos on DEW-managed land is guided by a policy framework that is based on scientific principles and informed by the objectives of the *National Parks and Wildlife Act 1972* and the South Australian Commercial Kangaroo Management Plan 2018-2022. A proposal to control kangaroo populations on reserves must demonstrate the impact of an overpopulation of kangaroos on the conservation values of the reserve, detail monitoring programs to evaluate the success of the control program, and demonstrate adequate control measures for introduced herbivores. All kangaroos are culled in accordance with the National Code of Practice for the Humane Shooting of Kangaroos and Wallabies for Non-Commercial Purposes.

During 2019, kangaroo control programs (shoot and let lie) were undertaken on nine DEW reserves. A total of 1,891 Western Grey Kangaroos and 1,533 Euros were culled (Table 13). The objectives of these programs were to improve conservation values by aiding ecological restoration and/or threatened species recovery.

*Table 13: Numbers of macropods culled (shoot and let lie) on reserves declared under the National Parks and Wildlife Act 1972 in South Australia during 2019.*

Harvest region	Reserve	Western Grey Kangaroo	Euro
Western Agricultural	Venus Bay Conservation Park	30	
	Coffin Bay National Park	383	
	Lincoln National Park	318	
Western Pastoral	Gawler Ranges National Park	825	192
Eastern Pastoral	Ikara-Flinders Ranges National Park	41	1,341
Outside Commercial Harvest Regions	Para Wirra Conservation Park	126	
	Sandy Creek Conservation Park	59	
	Kaiserstuhl Conservation Park	8	
	Deep Creek Conservation Park	101	
<b>Total kangaroos</b>		<b>1,891</b>	<b>1,533</b>

# Research

DEW has committed to the following research project:

## **Spatial population models to inform kangaroo management in South Australia**

Population (or 'demographic') models can be used to simulate the population dynamics of a given wildlife species over time, and to evaluate different management alternatives. This project has used c. 30 years of aerial kangaroo monitoring to fit spatial populations models for the two most common species: the red (*Macropus rufus*) and western grey kangaroo (*Macropus fuliginosus*). These data-driven models are being used to understand the population ecology of these species through the South Australian rangelands, including the maximum population growth rates obtained during periods of abundant resources (i.e., high rainfall and pasture availability), the survival rates of kangaroos during drought, and the long-range dispersal of animals across the landscape.

The spatial modelling will be used:

- (1) To generate short-term forecasts of spatial kangaroo densities (e.g., 1 year ahead), for the regions covered by the aerial surveys, to assist with management planning.
- (2) To evaluate the efficacy of historical harvest/culling regimes to limit the potential for environmentally damaging grazing by kangaroos.
- (3) To test different management strategies, by projecting kangaroo densities under different harvest/culling scenarios. These scenarios could include male- or female-biased management strategies, fixed or variable annual offtake targets, proportional culling, spatial rotation of management effort over time, and/or adaptive sterilisation strategies (e.g., in which regions with high kangaroo densities are preferentially targeted). Simulated offtake regimes could be evaluated according to their ability to control kangaroos below certain population sizes within different management units, or below threshold densities above which the negative effects on vegetation are felt.



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