

2022 Quota Report

Commercial Kangaroo Harvest

South Australia

Version 2

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Contents

Tables and Figures	iii
Scope and Context	1
Legislation.....	1
Harvest regions used for quota setting	1
Kangaroo monitoring methods.....	3
Aerial surveys	3
Ground survey.....	3
Kangaroo population models	3
Quota setting procedures	4
Proportional harvest strategy.....	4
Low population thresholds.....	4
High Abundance Quota.....	4
Special Land Management Quota.....	4
Survey frequency	5
2021 surveys	5
Sub-regions surveyed 2021	5
Low harvest threshold	5
Population estimates	6
Red Kangaroo	6
Mainland Western Grey Kangaroo.....	7
Kangaroo Island Western Grey Kangaroo.....	8
Euro	8
Eastern Grey Kangaroo	9
Helicopter Survey Results	9
Tamar Wallaby.....	9
Adaptive management experiments	10
Harvest statistics	11
Harvest 2020.....	11
Harvest January to August 2021	13
2022 Quotas.....	15
Regional harvest quotas for 2022	16
References	20
Appendix 1	21

Tables and Figures

Table 1: Kangaroo Harvest Regions and Sub-regions in South Australia	1
Table 3: Sub-regions where kangaroo species have fallen below the low harvest threshold.....	5
Table 3: Survey methods, results and coefficient of variation for Western Grey Kangaroos on Kangaroo Island.	8
Table 4: Harvest summary calculated for 2020 from meat processor returns.	11
Table 5: Harvest statistics for 2020 from field processor returns. Excludes Special Land Management Quota.	12
Table 6: Harvest statistics for 2021 from field processor returns. Excludes Special Land Management Quota.	13
Table 7: Harvest region harvest summary calculated from field processor returns for 1 January to 31 August 2021.	14
Table 8: Commercial kangaroo harvesting quotas for 2022 and comparison with the 2021 quota	15
Table 9: Red Kangaroo population estimates in 2021 and harvest quotas for 2022	16
Table 10: Western Grey Kangaroo population estimates in 2021 and harvest quotas for 2022.....	17
Table 11: Euro population estimates in 2021 and harvest quotas for 2022.....	18
Table 12: Eastern Grey Kangaroo population estimates in 2021 and harvest quotas for 2022.....	19
Table 13: Tammar Wallaby population estimates in 2021 and harvest quotas for 2022..	19
Figure 1: Map of harvest regions and sub-regions of South Australia.....	2
Figure 2: Red Kangaroo 2021 population density estimates in each sub-region.....	6
Figure 3: Density estimates for Western Grey Kangaroos in the Southern Agricultural harvest region.	7
Figure 4: Western Grey Kangaroo 2021 population density estimates in each sub-region.....	7
Figure 5: Population density estimates for Euros	8

Scope and Context

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) allows for the sustainable harvest of the following species of kangaroo:

- Red Kangaroo (*Macropus rufus*)
- Western Grey Kangaroo (*M. fuliginosus*)
- Eastern Grey Kangaroo (*M. giganteus*)
- Euro (*M. robustus*)
- Tammar Wallaby (*M. eugenii*)

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.

As of 1 January 2020, the SA Commercial Kangaroo Management Plan 2020-2024 (Management Plan) was approved by the Minister for Environment and Water under the NPW Act, and approved by the Australian Government Minister for Environment under the EPBC Act on 13 March 2020.

In accordance with the Management Plan, harvest quotas are set annually for each species of harvested kangaroo. Quotas are detailed in the annual Quota Report endorsed by the Director of National Parks and Wildlife and forwarded to the Australian Government Department of Agriculture, Water and the Environment for information. Where quotas are set outside the standard quota parameters detailed in the Management Plan, they must be endorsed in writing by the Australian Government Department of Agriculture, Water and the Environment prior to implementation.

This quota report has been developed in accordance with the Management Plan. The quota report provides the necessary detail on quota-setting procedures and the Sustainable Use Quotas for five kangaroo species for 2022. It also sets out the Special Land Management Quota for 2022, that may be issued when all Sustainable Use quota has been allocated and land management issues remain. A summary of harvest statistics for 2020 and the incomplete year of 2021 (January-August) is also included in the Report.

Harvest regions used for quota setting

In accordance with the provisions of the Management Plan, annual harvest quotas are based on the results of direct surveys of kangaroo populations or model estimates.

Five harvest regions have been defined in the Management Plan: Western Pastoral, Eastern Pastoral, Western Agricultural, Eastern Agricultural and Southern Agricultural.

The harvest regions contain sub-regions (detailed in Table 1 and Figure 1) primarily based on the administrative boundaries of the former Soil Conservation Board districts (or an amalgamation thereof). Population estimates and commercial quotas for 2022 are derived and set at the harvest sub-region level. Sub-region quotas can be re-distributed within, but not between, each harvest region in response to spatial and temporal changes in kangaroo distribution as per Management Plan.

Table 1: Kangaroo Harvest Regions and Sub-regions in South Australia

Harvest Region	Harvest sub-region
Eastern Pastoral	North Flinders
	North East Pastoral
	Eastern Districts
	Mallee
Western Pastoral	Marla-Oodnadatta,
	Marree (inside dog fence)
	Marree (outside dog fence)
	Kingoonya
Eastern Agricultural	Gawler Ranges
	South Flinders
Western Agricultural	Yorke Mid North
	Eyre East
Southern Agricultural	Eyre West
	Hills and Fleurieu
	Kangaroo Island
	Upper South East
	Lower South East

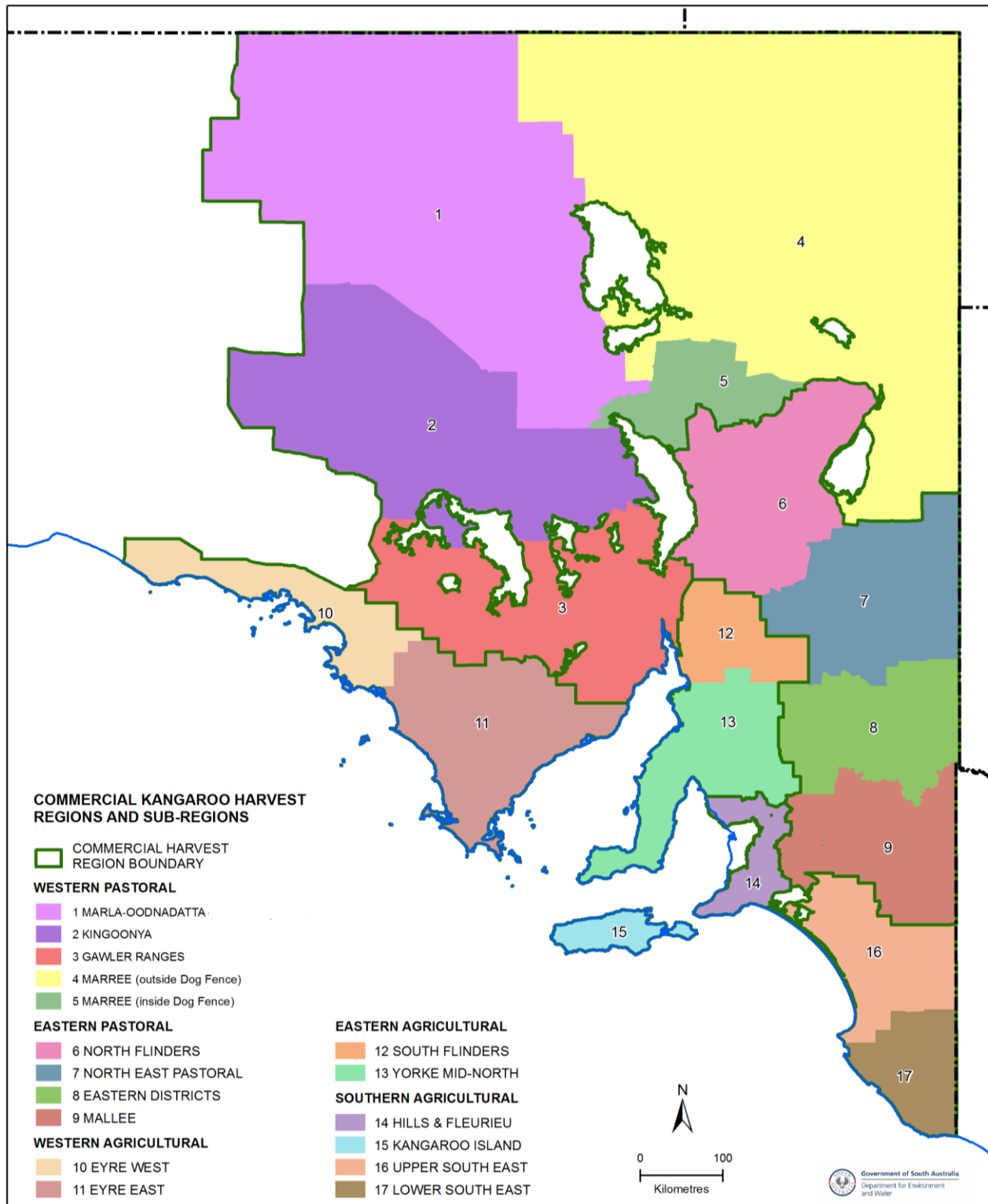


Figure 1: Map of harvest regions and sub-regions of South Australia

Kangaroo monitoring methods

A combination of fixed-wing aircraft and ground surveys (walking and driving) were used to survey kangaroo populations across South Australia between June and November 2021. 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. Ground surveys are employed in sub-regions where aerial surveys are considered unsafe, or dense vegetation prohibits observers from effectively counting kangaroos (Table 2).

Aerial surveys

Aerial surveys for Western Grey and Red Kangaroos have been conducted annually since 1978 using standard transect lines. Surveys are conducted using standard 200m fixed-strip width transect methodology with a fixed-wing aircraft (see Grigg et al. 1999 for further detail). Two observers (one on each side of the aircraft) count kangaroos as the aircraft maintains a speed of 185 km/hour (100 knots) and altitude of 76m (250 feet) above the ground. Raw counts are converted to density estimates for each harvest sub-region by applying species specific habitat correction factors.

On Kangaroo Island, the aerial survey was repeated at 100m and 200m strip width as a comparison to the survey conducted during 2020 (see Kangaroo Island Western Grey Kangaroo section below).

Ground survey

Two types of ground surveys were used where aerial surveys were not possible; these were driving and walking surveys. Both survey methods used the line transect 'Distance' sampling method (Buckland et al. 2001, Miller 2016). The ground surveys were designed to obtain sufficient data for line transect analyses to typically return results with a coefficient of variance less than 25%. The coefficient of variation represents the dispersion of data around the mean estimate and is explained in more detail under the proportional harvest strategy section in this report.

Walking surveys were used to count Euros. The technique aims to assess Euro densities in targeted areas of suitable habitat, areas of rocky hilly terrain, within the species' distribution. Typically, a small sample area is surveyed in each harvest sub-region. These localised densities are used to develop regional densities for

Euros, by multiplying obtained survey densities by the amount of suitable Euro habitat in each region.

Driving surveys were used in the Hills and Fleurieu, Lower South East and Kangaroo Island sub-regions. Approximately 480-550km of transect stratified for habitat type and based on public unsealed roads were surveyed once in each sub-region. Transects were slightly adjusted this year to improve the safety of the survey teams by removing some roads that were noted as unsafe last year. In the Hills and Fleurieu and Lower South East sub-regions the target species were Western Grey Kangaroos and Eastern Grey Kangaroos (Lower South East only); therefore, based on kangaroo activity patterns, transects were surveyed either in the early morning or the late afternoon. Spotlight driving surveys were used on Kangaroo Island to survey the Tammar Wallaby, as this species is mostly active at night.

Kangaroo population models

The 2021 Quota Report was the first DEW report to introduce the use of spatial population models for Red Kangaroos and Western Grey Kangaroos in established sub-regions (i.e. where long-term data exists) for South Australia. The population models have been developed in collaboration with Dr Tom Prowse of the University of Adelaide. Since the 2021 Quota Report was written, further improvements have been made to the models used for quota setting. The models used in this report use a coarser grid cell resolution of 50km², compared to the previous models which had a cell size of 5km². The coarser grid cell ensures that the spatial resolution of the inputs is smaller than the spatial resolution of the outputs, as rainfall and vegetation data are sparse in some areas of the state (i.e. have a coarser resolution than 5km² in some areas). Both rainfall and vegetation are important predictors of kangaroo numbers. As a result, there are some slight differences in the model outputs reported here, compared to those from the previous model. However, the dominant vegetation relationship picked up in a 5km² compared to a 50km² grid makes a minimal difference when being used to predict kangaroo densities at a harvest sub-region resolution (i.e. 12,000km² and greater). Overall, the coarser grid cell model provides a more appropriate scale to use for developing kangaroo population estimates at a sub-region level. For further details regarding the model used in this report, please refer to the technical report prepared by Dr Tom Prowse (Prowse, 2021).

Six sub-regions in the established harvest area (i.e. where long-term data exists) were surveyed during 2021. Direct survey-based population estimates were compared to the model population estimates for these sub-regions (Appendix 1). Where management actions, such as reduce or suspend quota, differed between the two estimates, or the model predictions were outside of the expected bounds (e.g. Yorke Mid North for Red Kangaroos), the most conservative (i.e. lower) population

estimate was used. Management actions, such as reducing or suspending quota when population estimates crossed a population threshold, were determined from this conservative estimate. This resulted in the model fitted estimates or predictions being used for all sub-regions in the established harvest area, except for Marree (outside dog fence), Yorke Mid North for Red Kangaroos, and Eastern Districts for Western Grey Kangaroos.

Quota setting procedures

Proportional harvest strategy

Sustainable Use and Special Land Management Quotas outlined in this report represent a constant proportional harvest strategy for kangaroos in South Australia.

Quotas are set at a maximum of 20% of the estimated population size of Red Kangaroos, 15% of Western Grey Kangaroos, Eastern Grey Kangaroos and Euros, and 10% of Tammar Wallabies.

Conservative quota percentages have been applied to sub-regions that are not surveyed on an annual basis and where a population model does not exist. Conservative quotas are also applied where the coefficient of variation associated with the density estimate is greater than 25%. For data with coefficient of variation greater than 25%, quotas are reduced by 3% of the standard proportion of the population estimate (e.g. for Euros, quotas are reduced from 15% to 12% of the population estimate) as per the Management Plan.

Some of the variation in the data can be explained by the patchy nature of kangaroos in the landscape, however high levels of variation suggest that there is more uncertainty in the mean estimate. For aerial survey data, the coefficient of variation is calculated as the standard error (~ standard deviation (SD) on a set of independent estimates) of the density estimates across all transects for each harvest sub-region using the ratio estimate (Sinclair et al. 2006). The standard error is then divided by the mean density of kangaroos for the harvest sub-region to give the coefficient of variation, which is expressed as a percentage. For ground survey data the coefficient of variation is calculated as the SD divided by the mean.

Quotas for 2022 are set at the harvest region level and then broken down into harvest sub-regions. The derivation of population estimates and quotas at the sub-region level provides added detail to allow for more accurate allocation of quota at the start of the harvest

year. Quotas for each sub-region are rounded down to the nearest hundred animals.

Low population thresholds

In accordance with the Management Plan, thresholds are set to restrict or close commercial harvest in each sub-region when the population estimate falls below a particular level. The thresholds are based on the long-term average of population size calculated for each harvest sub-region where sufficient data is available. If survey results or model estimates indicate a population has fallen below 1.5 standard deviations (SD) of the long-term mean, the harvest quota will be reduced to 10% of the population estimate. If survey results or model estimates indicate that the population has fallen below 2 SD of the long-term mean, the harvest quota will be suspended. These restrictions will remain in place until surveys indicate populations have increased.

High Abundance Quota

High Abundance Quota (HAQ) is intended for reducing kangaroo populations during times of high abundance. The HAQ is an additional quota to the Sustainable Use Quota and issued at the discretion of the Director of National Parks and Wildlife (refer to Aim 4 of Management Plan for more information).

Given that the population data has not indicated a high abundance of any kangaroo species, no HAQ was issued for 2022.

Special Land Management Quota

Special Land Management Quota (SLMQ) for 2022 has been set at 1.5% of the total estimated population for each species. SLMQ may be released in situations where the Sustainable Use Quota has been fully allocated and

land managers are experiencing ongoing kangaroo related land management impacts.

SLMQ allows the Department to respond to the needs of land managers in a timely manner, while encouraging the commercial take of kangaroos if possible. This quota component is only for the harvest of kangaroos that would otherwise be culled under non-commercial Permits to Destroy Wildlife, and is designed to minimise the number of kangaroos destroyed under these permits and not utilised. Permits to Destroy Wildlife are not considered as part of the quota, but numbers of kangaroos permitted for destruction on non-commercial permits are reported in the annual Harvest Report.

2021 surveys

Sub-regions surveyed 2021

Based on a risk assessment analysis that included harvest rate, previous population density, timing of last survey, natural disasters that had occurred since last survey (e.g. bush fires) and availability of model estimates, 12 sub-regions were surveyed during 2021.

Sub-regions surveyed included three 'core' sub-regions that are monitored annually to help inform the population models (North East Pastoral, South Flinders and Eastern Districts), as well as the following sub-regions: Marree (inside dog fence), Marree (outside dog fence), North Flinders, Eyre East, Eyre West, Hills and Fleurieu, Upper South East, Lower South East and Kangaroo Island.

In sub-regions that were not surveyed this year and where long-term data exists, the new kangaroo population model (either Red Kangaroo or Western Grey Kangaroo model) was used to predict the population density.

Euros have a consistently low harvest across all sub-regions where they are present. During 2021, Euros were surveyed in Eastern Districts and North Flinders sub-regions. Although harvest in North Flinders had fallen below the low harvest threshold, data were collected primarily for another management purpose, and have also been used in this report. In sub-regions that were not surveyed during 2021, population estimates derived from surveys undertaken in 2018, 2019 and 2020 have been used to set quota for 2022 and the quota percentage has been reduced to 10% of the population estimate.

Survey frequency

In accordance with the Management Plan, survey frequency has been reduced to every three years where the harvest is above the low harvest threshold (set at 1.5% of the average population estimate for each sub-region). Where the harvest is below this threshold, surveys will stop in the established harvest regions (Western Pastoral, Eastern Pastoral, Western Agricultural, Eastern Agricultural), or be reduced to every five years in the Southern Agricultural harvest region which was established in 2020 (refer the Management Plan for more information).

Low harvest threshold

Harvest rates have fallen below the low harvest threshold for the following species and sub-regions as per Table 3. No further surveys will be conducted in these sub-regions until harvest rates exceed the threshold for at least one species, or the maximum time between surveys lapses. Note that 'core' sub-regions (North East Pastoral, South Flinders and Eastern Districts) surveyed annually to inform population models are exempt from this rule.

Table 2: Sub-regions where kangaroo species have fallen below the low harvest threshold, calculated as 1.5% of the average population estimate for each species in each sub-region.

Species	Sub-region
Red Kangaroo	Marla - Oodnadatta
	Marree (outside dog fence)
	Marree (inside dog fence)
Western Grey	North East Pastoral
	Eastern Districts
	Gawler Ranges
	Kingoonya
	North East Pastoral
Euro	Marree (inside dog fence)
	North Flinders
	Eastern Districts
	North East Pastoral
	Gawler Ranges

Population estimates

Red Kangaroo

The estimated size of the Red Kangaroo population across the harvest area is 1,387,013. This is an increase of 18% from the previous year total of 1,178,888 and 23% lower than the 20 year rolling average of 1,806,873 (2001-2020 data from model estimates). The increase in Red Kangaroo numbers observed this year is likely in response to improved environmental conditions in the north of the State.

Density estimates for 2021 were below the long-term average for all sub-regions except Kingoonya, Gawler Ranges, Eastern Districts and Mallee.

Density estimates from the survey data were below the second low population threshold in Marree (outside dog fence), but were above both thresholds using the population model outputs. In this instance, a conservative approach has been taken and quota has been set based on the survey data population estimate. This means that quota has been suspended in this sub-region (Figure 2). Quota has also been suspended in the Marla-Oodnadatta sub-region based on the model population estimate. Harvest has now been suspended for two consecutive years in both of these sub-regions.

The previous year's population estimate (2021 Quota Report) has been used for Yorke Mid North, as the model predicted population estimate for 2021 was outside of expected bounds.

Red Kangaroos have increased in North East Pastoral since 2020, and the density estimate is now above the first low population threshold. After two consecutive years of a reduced quota in this sub-region, a full quota has been issued for 2022.

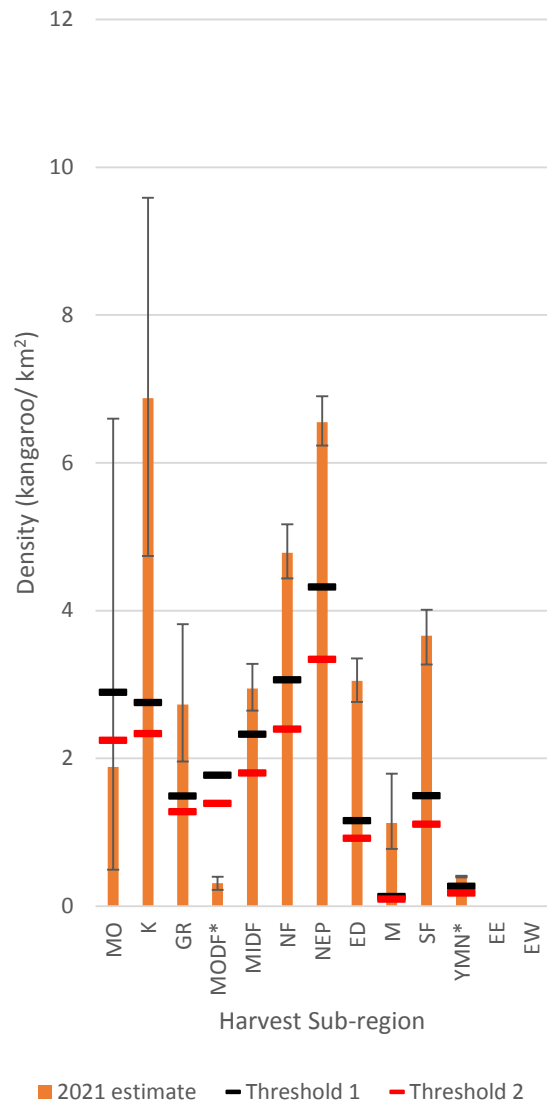


Figure 2: Red Kangaroo 2021 population density estimates in each sub-region compared to low population threshold 1 (black) and 2 (red). Estimates for NF, NEP, ED and SF are fitted model estimates based on 2021 survey data. All other estimates are model predictions. MO = Marla-Oodnadatta, K = Kingoonya, GR = Gawler Ranges, MODF = Marree (outside dog fence), MIDF = Marree (inside dog fence), NF = North Flinders, NEP = North East Pastoral, ED = Eastern Districts, M = Mallee, SF = South Flinders, YMN = Yorke Mid North, EE = Eyre East, EW = Eyre West. Error bars represent 95% confidence intervals.

*MODF population estimate and associated thresholds are calculated from survey data. YMN population estimate and associated thresholds are taken from the 2021 Quota Report model estimates.

Mainland Western Grey Kangaroo

The estimated size of the Western Grey Kangaroo population across the harvest area (excluding Southern Agricultural harvest region) is 752,185. This is an 11% decrease from the 2020 population estimate of 846,127 and 28% below the 20 year rolling average of 1,051,337 (2001-2020 data from model estimates). The decrease in population from 2020 is likely in response to ongoing dry conditions, particularly in the northern areas.

The population in the Southern Agricultural harvest region is estimated at 228,094, an increase of 8% from the 2020 population estimate of 208,811. However, only one of the four sub-regions, Upper South East, had density estimates higher than last year (Figure 3). See Helicopter Survey section below for update on Lower South East sub-region population estimate.

Density estimates in 2021 were below the long-term average in Kingoonya, Gawler Ranges, North East Pastoral, Eastern Districts and Eyre West.

Western Grey Kangaroos have increased in density above the low population thresholds in both North East Pastoral and in Eyre West, where they were below thresholds last year (Figure 4). Quota has been set at 15% of the population estimate in these sub-regions as per the Management Plan. Based on the survey data estimate, Western Grey Kangaroos have declined in the Eastern Districts sub-region to below the first low population threshold. A reduced quota has been set at 10% of the population estimate as per the Management Plan.

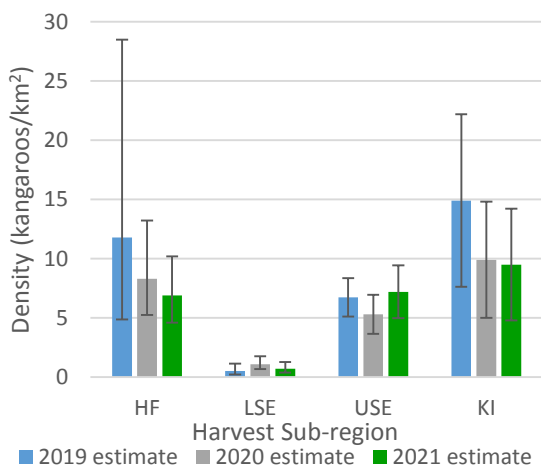


Figure 3: Density estimates 2019 (blue), 2020 (grey) and 2021 (green) for Western Grey Kangaroos in the Southern Agricultural harvest region. HF = Hills and Fleurieu, LSE = Lower South East, USE= Upper South East, KI = Kangaroo Island. Error bars represent 95% confidence intervals.

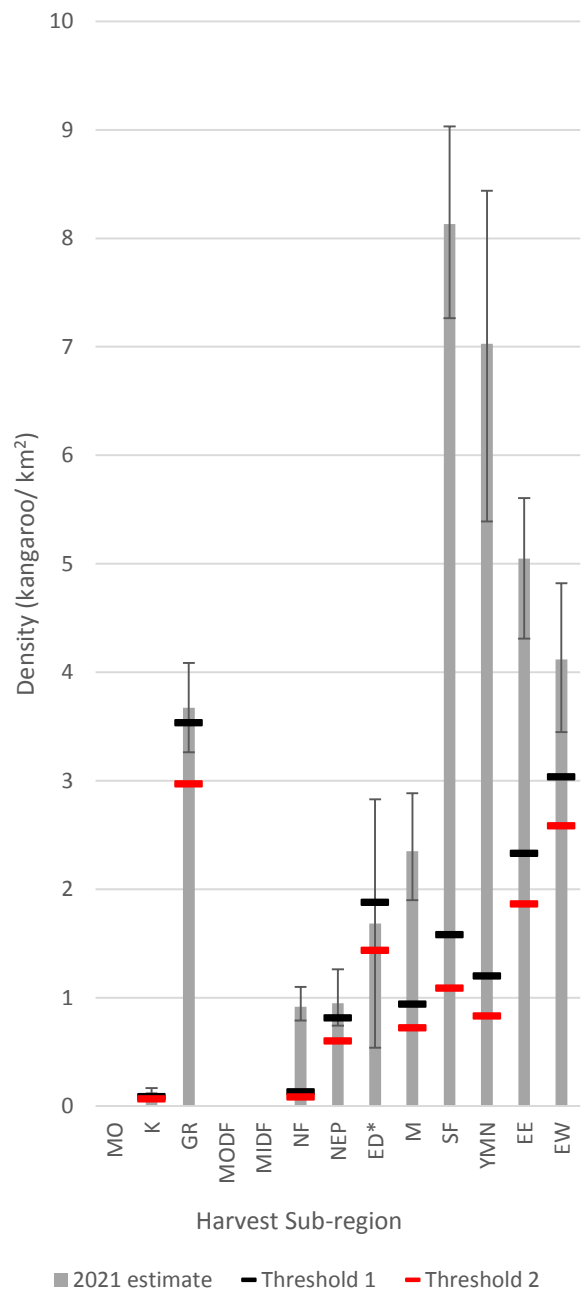


Figure 4: Western Grey Kangaroo 2021 population density estimates in each sub-region compared to low population threshold 1 (black) and 2 (red). Estimates for NF, NEP, SF, EE and EW are fitted model estimates based on 2021 survey data. MO = Marla-Oodnadatta, K = Kingoonya, GR = Gawler Ranges, MODF = Marree (outside dog fence), MIDF = Marree (inside dog fence), NF = North Flinders, NEP = North East Pastoral, ED = Eastern Districts, M = Mallee, SF = South Flinders, YMN = Yorke Mid North, EE = Eyre East, EW = Eyre West. Error bars represent 95% confidence intervals.

*Estimate for ED is calculated from 2021 survey data and corresponding trigger points. All other estimates are model predictions.

Kangaroo Island Western Grey Kangaroo

A fixed-wing aerial survey of Western Grey Kangaroos on Kangaroo Island was conducted at two strip widths (100m and 200m strip width) again this year to repeat the experiment conducted last year (Table 3). The results of these surveys support the findings of the 2020 surveys. Both the 100m and 200m strip width surveys produced a very similar density, however, the coefficient of variation was reduced by narrowing the strip width to 100m. The results of the 100m strip width survey have been used to set the quota for Western Grey Kangaroos on Kangaroo Island for 2022.

Table 3: Survey methods, results (density per km²) and coefficient of variation as a percentage (CV%) for Western Grey Kangaroos on Kangaroo Island.

Survey method	Density/km ²	CV%
Fixed-winged (200m strip)	9.1	38.3
Fixed-winged (100m strip)	9.5	25.3

The 2021 population density estimate for Western Grey Kangaroos on Kangaroo Island is 9.5/km² or 41,781 kangaroos (Figure 3). This population estimate is very similar to the 2020 population estimate of 9.9 km² or 43,540 kangaroos. A conservative quota of 10% of the population estimate has been set to allow the kangaroo population time to recover after the 2019/2020 bushfires.

Euro

During 2021, two sub-regions were surveyed for Euros – North Flinders and Eastern Districts (Figure 5). Other population estimates have come from data collected during 2018, 2019 and 2020.

The estimated size of the Euro population across the commercial harvest area is 302,821, a decrease of 41% from the 2020 estimate of 517,108 and 38% below the 20 year rolling average of 487,277 (2001 -2020). The decline in Euro population is due to ongoing dry conditions in the northern part of South Australia.

Densities from the 2021 surveys were above the long-term average for Eastern Districts, but below the long-term average for North Flinders. The density estimate for North Flinders is the lowest estimate for this sub-region since surveying began in the mid-1990s. Therefore, no quota has been set for Euros in North Flinders for 2022. Localised impacts may be managed using Special Land Management Quota.

No survey for Euros was conducted in North East Pastoral as population numbers have remained low due to dry conditions, therefore quota for Euros will be suspended in North East Pastoral for the second consecutive year. A survey of North East Pastoral Euros will be conducted next year.

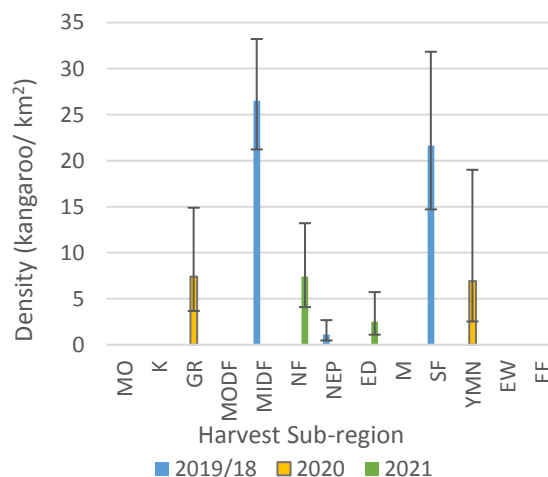


Figure 5: Population density estimates for Euros in the sub-regions surveyed 2018/19 in blue, 2020 in yellow and 2021 in green. MO = Marla-Oodnadatta, K = Kingoonya, GR = Gawler Ranges, MODF = Marree (outside dog fence), MIDF = Marree (inside dog fence), NF = North Flinders, NEP = North East Pastoral, ED = Eastern Districts, M = Mallee, SF = South Flinders, YMN = Yorke Mid North, EE = Eyre East, EW = Eyre West. Error bars represent 95% confidence intervals.

Eastern Grey Kangaroo

The 2021 population density estimate for Eastern Grey Kangaroos is 1.8/km², which equates to a population estimate of 20,933 across the Lower South East sub-region. The 2021 population estimate is a 40% decrease from the 2020 population estimate, or 13,950 kangaroos.

Quota are only set for Eastern Grey Kangaroos in the Lower South East sub-region. During 2021 the full quota for Eastern Grey Kangaroos in the Lower South East harvest sub-region is expected to be harvested and Special Land Management Quota was released during November 2021.

A conservative quota of 12% of the population estimate has been set for Eastern Grey Kangaroos for 2022 as the coefficient of variation was higher than 25%.

Data from the driving surveys does not appear to be adequately capturing the number of kangaroos in the landscape. The main cause of this appears to be the uneven distribution of kangaroos across the sub-region. Due to the fragmented nature of native vegetation and cover (e.g. pine plantations), kangaroos are in high numbers in relatively small areas and in low numbers across a larger proportion of the harvest sub-region.

DEW will re-survey the Lower South East sub- using a more robust survey method to provide a revised population estimate of kangaroos. Based on the results of this survey, DEW may re-set the sustainable use quota for the Lower South East sub-region as appropriate.

Helicopter Survey Results

A low level (250 ft above ground level) helicopter survey using mark-recapture line transect distance sampling was conducted in the Lower South East during May 2022. The helicopter flew east-west transects across 14 blocks that were stratified for land use type. Each block was approximately 100km² in area, with transects spaced 2km apart.

Larger numbers of kangaroos were sighted adjacent to forest areas (pine plantation, blue gum plantation and native vegetation), and less were sighted in the middle of paddocks or deeper into native vegetation areas. This finding confirmed that kangaroo distribution is non-uniform across the sub-region.

Eastern and Western Grey Kangaroo cannot be distinguished from each other during aerial surveys. Therefore, driving surveys that separated Eastern and Western Grey Kangaroos were conducted along roads and tracks within each of the helicopter blocks. Three repeats of each block were conducted to capture the

variability of day-to-day changes in kangaroo abundance. The total number of Eastern and Western Grey Kangaroos from the driving surveys was used to calculate a proportion of each species in the sub-region. The driving surveys showed a percentage of 70% Eastern Grey and 30% Western Grey Kangaroo in the sub-region. These percentages were then applied to the total population estimate of kangaroos from the helicopter survey.

The helicopter survey produced a total Grey Kangaroo density of 11.46/km², which equated to 131,882 kangaroos. Using the species percentages from the driving surveys, this equated to 92, 317 Eastern Grey and 39,565 Western Grey Kangaroos in the Lower South East sub-region. These results confirm that the previous driving survey design was not adequate in capturing the number of kangaroos in the landscape, and true densities for both grey kangaroo species are higher in the Lower South East than the 2021 driving surveys showed.

Based on these findings, an additional sustainable use quota for Eastern and Western Grey kangaroos in the Lower South East has been released (see Regional Harvest Quota Section below). Quotas have been set at a conservative 7.5% of the population estimate for each species and minus the previous sustainable use quotas already issued this calendar year.

Tammar Wallaby

The Kangaroo Island spotlight survey from 2019 produced a density estimate of 16.1 wallabies/km², which, compared to the 2020 spotlight survey estimate of 9.6/km², suggested a population reduction of approximately 40% following the 2019-20 fires.

Wallabies were surveyed during 2021, however data collected did not meet the requirements of the line transect distance sampling method and were not used in this report. The raw number of wallabies observed was similar to the number observed during 2020, therefore the previous estimate has been used again this year for quota setting. As in 2020, a reduced quota for wallabies has been set at 7% of the population estimate to allow the population to continue to recover post fire. The Department is continuing to explore other survey options for wallabies on Kangaroo Island, including night-time thermal imaging with unmanned aerial vehicles (UAVs) which is showing promise.

Adaptive management experiments

Aim 6 of the Management Plan allows for adaptive management experiments to improve the management of kangaroos.

No adaptive management experiments were carried out during 2021.

Harvest statistics

Harvest 2020

In 2020, the commercial kangaroo harvest in South Australia was 98,962 including Special Land Management Quota (data from 2020 Commercial Kangaroo Harvest Report for South Australia). This figure represents 19% of the approved quota of 532,400 (including Special Land Management Quota, Table 4). Special Land Management Quotas of 800 Red Kangaroos for Western Agricultural Harvest Region and 900 Eastern Grey Kangaroos for the Lower South East Harvest Sub-region were issued during 2020. Of this, 245 Red Kangaroos and 900 Eastern Grey Kangaroos were harvested. The total commercial harvest based on kangaroo field processor returns was 99,223, a discrepancy of 0.05% between field processor and meat processor returns was noted.

Table 4: Harvest summary calculated for 2020 from meat processor returns. Note that Special Land Management Quotas of 800 Red Kangaroos for Western Agricultural Harvest Region and 900 Eastern Grey Kangaroos for the Lower South East Harvest Sub-region were released during 2020.

Species	Quota	Harvest	% Quota Harvested
Red Kangaroo	277,500	49,784	18
Western Grey Kangaroo	177,200	36,603	21
Euro	60,300	4,303	7
Eastern Grey Kangaroo	8,300	8,272	100
Tammar Wallaby	9,100	0	0
TOTAL	532,400	98,962	19

The Eastern Agricultural harvest region had the greatest percentage of quota harvested for Red Kangaroos (35%), Western Grey Kangaroos (35%), and Euros (24%) compared to the other harvest regions. The Southern Agricultural harvest region was the only harvest region with quota available for Eastern Grey Kangaroos and Tammar Wallabies and the percentage of quota harvested was 99% Eastern Grey Kangaroos. Harvest on Kangaroo Island (where Tammar Wallabies occur) was suspended for the 2020 quota year after extensive bush fires in early January, therefore no commercial harvest of either Tammar Wallabies or Kangaroo Island sub-species of Western Grey Kangaroos took place during 2020. The extent of harvest for each harvest region and species is shown in Table 5 based on kangaroo field processor returns.

Table 5: Harvest statistics for 2020 from field processor returns. Excludes Special Land Management Quota.

Harvest Region	Red Kangaroo			Western Grey Kangaroo			Euro			Eastern Grey Kangaroo			Tammar Wallaby		
	Quota	Harvest	Harvest %	Quota	Harvest	Harvest %	Quota	Harvest	Harvest %	Quota	Harvest	Harvest %	Quota	Harvest	Harvest %
Western Pastoral	159,900	21,194	13	30,800	3,137	10	19,300	661	3	0	0	-	0	0	-
Eastern Pastoral	77,700	17,270	22	33,600	4,661	14	29,000	1,441	5	0	0	-	0	0	-
Western Agricultural	0	0	-	24,200	3,531	15	0	0	-	0	0	-	0	0	-
Eastern Agricultural	32,200	11,353	35	43,000	15,103	35	9,200	2,241	24	0	0	-	0	0	-
Southern Agricultural	0	0	-	38,800	10,124	26	0	0	-	7,400	7,362	99	8,700	0	-
Total	269,800	49,817	18	170,400	36,556	21	57,500	4,343	8	7,400	7,362	99	8,700	0	-

Harvest January to August 2021

A total of 67,971 kangaroos were harvested by field processors during the first eight months of 2021 (1 January 2021 – 31 August 2021; Table 6). This represents 17% of the combined sustainable use kangaroo harvest quota for the year. Based on current harvest rates, the projected harvest for 2021 for all species is 99,745, recognising the sustainable use quota for Eastern Grey Kangaroos is anticipated to be fully harvested. This will represent a 25% harvest of the combined quotas.

The harvest projection for 2021 (Table 6) represents a small increase from the 2020 harvest of 98,078 (calculated from field processor returns, excluding Special Land Management Quota).

A harvest summary for each species in each harvest region for the 2021 year-to-date (1 January – 31 August) is shown in Table 7. No harvest has occurred on Kangaroo Island since the extensive bush fires in early 2020, even though quota is available in 2021.

Table 6: Harvest statistics for 2021 from field processor returns. Excludes Special Land Management Quota.

Species	Quota	Actual (1 Jan - 31 Aug)		Projected (1 Jan – 31 Dec)	
		Harvest	Harvest as % of Quota	Harvest	Harvest as % of Quota
Red Kangaroo	196,500	29,339	15	44,008	22
Western Grey Kangaroo	149,300	28,091	19	42,136	28
Euro	53,100	5,601	11	8,401	16
Eastern Grey Kangaroo	5,200	4,940	95	5,200	100
Tammar Wallaby	2,900	0	-	0	-
Total	407,000	67,971	17	99,745	25

Table 7: Harvest region harvest summary calculated from field processor returns for 1 January to 31 August 2021. Excludes Special Land Management Quota.

Harvest Region	Red Kangaroos			Western Grey Kangaroos			Euro			Eastern Grey Kangaroos		
	Quota	Harvest	Harvest %	Quota	Harvest	Harvest %	Quota	Harvest	Harvest %	Quota	Harvest	Harvest %
Western Pastoral	108,200	11,281	10	33,200	2,519	8	15,900	872	5	0	0	-
Eastern Pastoral	73,600	13,299	18	39,600	2,861	7	28,500	1,909	7	0	0	-
Western Agricultural	0	0	-	10,800	1,487	14	0	0	-	0	0	-
Eastern Agricultural	14,700	4,759	32	36,700	9,763	27	8,700	2,820	32	0	0	-
Southern Agricultural	0	0	-	29,000	11,461	40	0	0	-	5,200	4,940	95
Total	196,500	29,339	15	149,300	28,091	19	53,100	5,601	11	5,200	4,940	95

2022 Quotas

Commercial kangaroo harvesting quotas for the 2022 quota year for South Australia are shown in Table 8. The 2022 harvest region quotas for each species are shown in Tables 9-10. Quota for Western Grey and Eastern Grey Kangaroos have been edited to reflect the total quota issued during 2022 and includes additional quota released for both species in the Lower South East. The highest recorded annual quotas were 555,000 for Red Kangaroos (1997), 280,000 for Western Grey Kangaroos (1997), and 103,000 for Euros (1997).

Table 8: Commercial kangaroo harvesting quotas for 2022 and comparison with the 2021 quota. Quotas do not include Special Land Management Quota. Quotas have been amended to reflect additional quotas released for Western and Eastern Grey Kangaroos in the Lower South East sub-region.

Species	2021	2022	% Change 2021-2022
Red Kangaroo	196,500	236,200	20%
Western Grey Kangaroo	149,300	143,900	-4%
Euro	53,100	23,300	-56%
Eastern Grey Kangaroo	5,200	6,900	33%
Tammar Wallaby	2,900	2,900	0%
Total Quota	407,000	413,200	2%

Regional harvest quotas for 2022

Table 9: Red Kangaroo population estimates in 2021 and harvest quotas for 2022. Population densities and estimates are produced from the Red Kangaroo population model except where stated otherwise. Not Applicable (NA) denotes sub-regions where the species is not present, based on its distribution, therefore no surveys are conducted and no quota has been set in these sub-regions.

Harvest region	Area (km ²)	Pop density/ km ²	Pop estimate	Harvest %	Quota
Western Pastoral					133,500
Marla – Oodnadatta ¹	128,908	2.9**	169,383	0	0
Kingoonya	73,392	6.9	500,120	20	100,000
Gawler Ranges	45,811	2.7	124,992	20	24,900
Marree (inside dog fence) ²	14,680	2.9	43,250	20	8,600
Marree (outside dog fence) ^{1,2}	177,517	0.3**	26,628	0	0
Eastern Pastoral					93,300
North Flinders ²	34,622	4.8	165,493	20	33,000
North East Pastoral ²	31,448	6.6	206,003	20	41,200
Eastern Districts ²	22,920	3.1	73,277	20	14,600
Mallee	23,994	1.1	26,848	17	4,500
Eastern Agricultural					9,400
South Flinders ²	11,883	3.7	43,520	20	8,700
Yorke Mid North ⁴	22,217	0.4	7,499	10	700
Western Agricultural					NA
Eyre West ²	22,459	NA	NA	NA	NA
Eyre East ²	31,164	NA	NA	NA	NA
Total	641,015		1,387,013		236,200
Special Land Management Quota⁵					20,800
Total quota available for 2022					257,000

¹ Model population prediction scaled to 45% area suitability for Marla-Oodnadatta and 50% area suitability for Marree (outside dog fence).

² Sub-region surveyed during 2021, survey data was incorporated into the population model to produce a model fitted estimate

³ Quota has been reduced to 17% of the population estimate as the coefficient of variation was greater than 25%.

⁴ Model estimate from last year (2020) and quota reduced to 10% of population estimate.

⁵ Special Land Management Quota has been set at 1.5% of the total population estimate for the commercial harvest area.

** Red kangaroo populations in Marla-Oodnadatta and Marree (outside dog fence) sub-regions have reached the second low population threshold and quotas have been suspended.

Table 10: Western Grey Kangaroo population estimates in 2021 and harvest quotas for 2022. Population densities and estimates are produced from the Western Grey Kangaroo population model. Not Applicable (NA) denotes sub-regions where the species is not present, based on its distribution, therefore no surveys are conducted and no quota has been set in these sub-regions. Western Grey Kangaroo population estimate and quota for Lower South East, total quota for Southern Agricultural Harvest Region, Special Land Management Quota and Total Quota have been amended to reflect results of surveys conducted in the Lower South East during May 2022.

Harvest region	Area (km ²)	Pop. density/ km ²	Pop. estimate	Harvest %	Quota
Western Pastoral					26,600
Marla – Oodnadatta	128,908	NA	NA	NA	NA
Kingoonya	73,392	0.1	9,526	15	1,400
Gawler Ranges	45,811	3.7	168,250	15	25,200
Marree (inside dog fence) ¹	14,680	NA	NA	NA	NA
Marree (outside dog fence) ¹	177,517	NA	NA	NA	NA
Eastern Pastoral					21,300
North Flinders ¹	34,622	0.9	31,711	15	4,700
North East Pastoral ¹	31,448	0.9	29,806	15	4,400
Eastern Districts ¹	22,920	1.7*	38,964	10	3,800
Mallee	23,994	2.4	56,094	15	8,400
Eastern Agricultural					29,700
South Flinders ¹	11,883	8.1	96,625	15	14,400
Yorke Mid North	22,217	7.0	102,028	15	15,300
Western Agricultural					32,700
Eyre West ¹	22,459	4.1	67,968	15	10,100
Eyre East ¹	31,164	5.0	151,213	15	22,600
Southern Agricultural					32,700
Hills and Fleurieu ³	7,137	6.9	47,065	15	7,000
Lower South East ⁴	11,508	3.4	39,565	7.5	2,000
Upper South East ²	18,238	7.2	131,314	15	19,600
Kangaroo Island ^{2,5}	4,398	9.5	41,781	10	4,100
Total	682,296		980,279		143,000
Special Land Management Quota⁶					15,100
Total quota available for 2022					158,100

¹ Sub-region surveyed during 2021, survey data was incorporated into the population model to produce a fitted estimate.

² 2021 aerial survey data population estimate was used for Eastern Districts, Upper South East and Kangaroo Island.

³ Driving surveys were used to determine population estimates in the Hills and Fleurieu. Driving transects were stratified based on habitat type and densities applied across habitat blocks, excluding large towns.

⁴ Helicopter survey was completed during May 2022 using a block design stratified for land use type, population estimate and quota have been updated. Quota has been set at 7.5% of the population estimate, minus the 900 quota initially issued for the calendar year of 2022.

⁵ Quota has been reduced to 10% of the population estimate to allow the population to recover post-fire.

⁶ Special Land Management Quota has been set at 1.5% of the total population estimate for the commercial harvest area.

* Western Grey Kangaroo population in the Eastern Districts sub-region has reached the first low population threshold and quota has been reduced to 10%.

Table 11: Euro population estimates in 2021 and harvest quotas for 2022. Not Applicable (NA) denotes sub-regions where the species is not present, based on its distribution, therefore no surveys are conducted and no quota has been set in these sub-regions.

Harvest region	Area (km ²)	% Area suitable	Pop density /km ²	Pop estimate	Harvest %	Quota
Western Pastoral						14,200
Marla – Oodnadatta	128,908	0	NA	NA	NA	NA
Kingoonya	73,392	0	NA	NA	NA	NA
Gawler Ranges ³	45,811	25	7.4	84,521	10	8,400
Marree (inside dog fence) ¹	14,680	15	26.5	58,353	10	5,800
Marree (outside dog fence)	177,517	0	NA	NA	NA	NA
Eastern Pastoral						1,000
North Flinders ⁴	34,622	25	7.4**	64,051	0	0
North East Pastoral ²	31,448	15	1.1**	5,236	0	0
Eastern Districts ^{4,5}	22,920	15	2.5	8,595	12	1,000
Mallee	23,994	0	NA	NA	NA	NA
Eastern Agricultural						8,100
South Flinders ²	11,883	20	21.6	51,406	10	5,100
Yorke Mid North ³	22,217	20	6.9	30,659	10	3,000
Western Agricultural						0
Eyre West	22,459	0	NA	NA	NA	NA
Eyre East	31,164	0	NA	NA	NA	NA
Total	636,736			302,821		23,300
Special Land Management Quota⁶						4,500
Total quota available for 2022						27,800

¹ Sub-region surveyed during 2018, quota reduced to 10% of population estimate.

² Sub-regions surveyed during 2019, quota reduced to 10% of population estimate.

³ Sub-region surveyed during 2020, quota reduced to 10% of population estimate.

⁴ Sub-regions surveyed during 2021.

⁵ Quota has been reduced to 12% of the population estimate as the coefficient of variation was greater than 25%.

⁶ Special Land Management Quota has been set at 1.5% of the total population estimate for the commercial harvest area.

**Harvest is suspended in North Flinders and North East Pastoral.

Table 12: Eastern Grey Kangaroo population estimates in May 2022 and harvest quotas for 1 July – 31 December 2022 (inclusive). Not Applicable (NA) denotes sub-regions where the species is not present, based on its distribution, therefore no surveys are conducted and no quota is set in these areas.

Harvest region	Area (km ²)	Pop density/ km ²	Pop estimate	Harvest %	Quota
Southern Agricultural					
Hills and Fleurieu	7,137	NA	NA	NA	NA
Upper South East	18,238	NA	NA	NA	NA
Lower South East ¹	11,508	8.0	92,317	7.5	4,400
Kangaroo Island	4,398	NA	NA	NA	NA
Total	41,281		92,317		4,400
Special Land Management Quota²					1,300
Total quota available for 2022					5,700

¹ Helicopter survey was completed during May 2022 using a block design stratified for land use type. Quotas have been updated in the Lower South East to reflect the results of the May 2022 survey. Quota has been set at a conservative 7.5% of the population estimate, minus the 2,500 quota already issued for the calendar year of 2022.

² Special Land Management Quota has been set at 1.5% of the total population estimate for the commercial harvest area.

Table 13: Tammar Wallaby population estimates in 2021 and harvest quotas for 2022. Not Applicable (NA) denotes sub-regions where the species is not present based on its distribution and therefore no surveys are conducted and no quota is set in these areas.

Harvest region	Area (km ²)	Pop density/ km ²	Pop estimate	Harvest %	Quota
Southern Agricultural					
Hills and Fleurieu	7,137	NA	NA	NA	NA
Upper South East	18,238	NA	NA	NA	NA
Lower South East	11,508	NA	NA	NA	NA
Kangaroo Island ^{1,2}	4,398	9.6	42,221	7	2,900
Total	41,281		42,221		2,900
Special Land Management Quota³					600
Total quota available for 2022					3,500

¹ Spotlight driving surveys were used to determine population estimate. Driving transects were stratified, based on habitat type and densities applied across habitat blocks, excluding large towns. Population estimate used is from data collected in 2020.

² Quota reduced to 7% of the population estimate to allow population to recover post-fire.

³ Special Land Management Quota has been set at 1.5% of the total population estimate for the commercial harvest area.

References

Buckland, S.T., Anderson, D.R., Burnham, K.P, Laake, J.L, Borchers, D.L., and Thomas, L. 2001. Introduction to Distance Sampling: Estimating abundance of biological populations. Oxford University Press, Melbourne. 432pp.

Grigg, G.C., Beard, L.A., Alexander, P., Pople, A.R., and Cairns, S.C. 1999. Aerial survey of kangaroos in South Australia 1978 – 1998: A brief report focusing on methodology. Australian Zoologist 31: 292 – 300.

Lethbridge, M.R. 2020 Kangaroo Island Macropod Surveys: A comparison of aerial and ground survey methods. Report to the Department for Environment and Water.

Miller, D.L. 2016. Distance: Distance Sampling Detection Function and Abundance Estimation. R package version 0.9.6. <https://CRAN.R-project.org/package=Distance>

Prowse, T. A. A (2021) Spatial population models for red and western grey kangaroos in the South Australian rangelands, report to the Department for Environment and Water, The University of Adelaide, Adelaide.

Sinclair, A.R.E., Fryxell, J.M. and Caughley G. 2006. Wildlife Ecology, Conservation, and Management 2nd Edition. Blackwell Publishing, Oxford.

2021 Quota Report (2020) Department for Environment and Water.

Appendix 1

Table A1: Results of model and survey density estimates for Red Kangaroos and Western Grey Kangaroos as they relate to management actions, full quota issued, reduced quota issued (population below first low population threshold) or harvest suspended (population below second low population threshold). In sub-regions where the model and survey estimate produced different management actions, the more conservative management action was used. Results used in this quota report are highlighted in bold.

Harvest Region	Last Survey Year	Red Kangaroo		Western Grey Kangaroo	
		Survey Result	Model Result	Survey Result	Model Result
Western Pastoral					
Marla – Oodnadatta	2019	NA	Suspended quota	-	-
Kingoonya	2019	NA	Full quota	NA	Full quota
Gawler Ranges	2019	NA	Full quota	NA	Full quota
Marree (inside dog fence)	2021	Full quota	Full quota	-	-
Marree (outside dog fence)	2021	Suspended quota	Full quota	-	-
Eastern Pastoral					
North Flinders	2021	Full quota	Full quota	Full quota	Full quota
North East Pastoral	2021	Full quota	Full quota	Full quota	Full quota
Eastern Districts	2021	Full quota	Full quota	Reduced quota	Full quota
Mallee	2019	NA	Full quota	NA	Full quota
Eastern Agricultural					
South Flinders	2021	Full quota	Full quota	Full quota	Full quota
Yorke Mid North	2020	NA	Full quota	NA	Full quota*
Western Agricultural					
Eyre West	2021	-	-	Full quota	Full quota
Eyre East	2021	-	-	Full quota	Full quota

* 2020 model population estimate (as published in 2021 Quota Report) has been used for Yorke Mid North for Western Grey Kangaroos.

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