ACT Government

EASTERN GREY KANGAROO

CONSERVATION CULLING ADVICE 2018

ENVIRONMENT, PLANNING AND SUSTAINABLE DEVELOPMENT DIRECTORATE

MARCH 2018

CONTENT

INTRODUCTION

The calculation used for determining the appropriate number of Eastern Grey Kangaroos to be culled on ACT nature reserves and adjacent land for conservation reasons is in accordance with the Nature Conservation (Eastern Grey Kangaroo) Conservation Culling Calculator, a notifiable instrument under section 2.3 of the Eastern Grey Kangaroo: Controlled Native Species Management Plan (2017; hereafter 'the Plan').

The purpose of conservation culling in protected areas of the ACT is to maintain densities of Eastern Grey Kangaroos at levels that retain grassland conservation values. In particular the aim is to moderate kangaroo grazing effects to achieve a grazing regime favourable for the conservation of plants and small animals that frequent the ground-layer vegetation.

The culling calculator takes into account that the heterogeneous pasture structure desired for biodiversity conservation does not develop at either extreme of high or low grazing and is designed to achieve 'grassland target densities' (see Section 5.3 of the Plan). The calculator uses the formula below and the outcome is then subject to expert ecological judgement to take into account annual variation in vegetation and climate and the requirements of any species of interest (e.g. threatened species) in each kangaroo management unit. Further details of kangaroo policy and supporting references can be found in the Plan.

NATURE CONSERVATION (EASTERN GREY KANGAROO) CONSERVATION CULLING CALCULATOR

CONSERVATION CULLING FORMULA

The (A) **target number of kangaroos to remain** after culling is subtracted from (B) the **current population**, making allowance for (C) **population growth** in the interim to the next cull. The three components of this formula are explained in the following points (A to C).

A: THE TARGET NUMBER OF KANGAROOS TO REMAIN AFTER CULLING

It is estimated that a density of approximately one kangaroo per hectare in grassland is likely to maintain the desired conservation environment under varying pasture growth conditions for small animals such as the Striped Legless Lizard. The corresponding figures for other vegetation types are inversely proportional to the percentage canopy cover: open woodland = 90% of grassland; woodland = 50% of grassland; and forest/open forest = 10% of grassland.

Thus it would be calculated that a reserve comprising 100 hectares of forest, 100 hectares of open woodland and 100 hectares of grassland could sustain 10+90+100=200 Eastern Grey Kangaroos without threatening the habitat of small ground dwelling animals.

Site specific target densities may be applied to support ecological research, when supported by a defined research project that has been approved by the Conservator of Flora and Fauna and which has gained ethics approval, if required. For example, this has been applied in the Goorooyarroo and Mulligans Flat Nature Reserves that are part of the Mulligans-Goorooyarroo Experiment (Visit the Mulligans-Goorooyarro Experiment Website)

B: THE CURRENT POPULATION

Population abundance is determined within a Kangaroo Management Unit (KMU), which is typically an area bounded by features known to inhibit kangaroo movement such as high speed roads and the suburban edge. A KMU typically consists of multiple land tenures occupied by one kangaroo

population, which is reflected in the kangaroo counts by conducting the counts across the land components rather than just the Nature Reserve. Refer to Appendix 1 of the Plan for methods of estimating kangaroo population abundance.

C: POPULATION GROWTH IN THE INTERIM TO THE NEXT CULL

The grassland target density is an average for the year, so the population starts the year below the target and ends the year above it. For example, if the target was 1/ha, and the annual population growth rate (PGR) was 20%, the cull should reduce the density to 0.91/ha and it will end the year at 1.10/ha.

The primary limit to kangaroo population size and PGR is the per capita availability of food. Other processes affecting PGR of local populations are motor vehicle collisions on high speed roads and the presence of foxes and dogs.

Post-cull growth rates are generally expected to be higher than those of unculled populations because more food is available per kangaroo. As a general guideline for kangaroo populations culled to well below the maximum possible density, 0-30% annual growth is currently taken as a reasonable expectation, depending on weather and site specific circumstances.

EXPERT ECOLOGICAL JUDGMENT

Ecologically based management requires professional judgment based on observations and current research, as well as answers from simple formulas. For example, a degraded grassland would recover faster if grazing pressure was kept lower for a few years, whereas a grassland which had grown tall for several years may benefit from higher grazing pressure for a short time.

Adjustments should also be made both between years and between reserves to allow for differences in environmental variables (for example, rainfall, pasture type, etc.) or to manage habitat for specific species. For example, monitoring indicates that the above formula can result in too much grass for Golden Sun Moths in wet years. If more kangaroos are desirable in reserves prioritised for Golden Sun Moths, refinements will be needed. Adjustment for pasture type and condition would also be appropriate, providing it is kangaroo specific, as Eastern Grey Kangaroos have different feeding preferences to livestock.

Biomass reduction within the KMU, such as fire (prescribed burns or wild fires), grazing by livestock or slashing may also require variations. For example, the temporary addition of livestock may complement kangaroo grazing where grass composition or structure makes areas unpalatable to kangaroos. Communications between the relevant parts of government are essential to effectively achieve this integrated approach.

A: THE TARGET NUMBER OF KANGAROOS TO REMAIN AFTER CULLING

The vegetation and tenure composition for KMUs considered as part of the 2018 conservation culling program are shown in Table 1, alongside the calculated number of kangaroos to remain (based on the vegetation based formula described in the previous section). Areas of a KMU not managed for conservation have nominal target densities (generally 0.1 kangaroos per hectare) based on assumptions regarding land management objectives (e.g. livestock production), however kangaroo management in these areas is at the discretion of the relevant land manager in accordance with the Nature Conservation (Eastern Grey Kangaroo) Rural Culling Calculator. Note that culling recommendations provided for ACT Government managed conservation land in this report will deviate from those calculated by the 'conservation calculator' at some sites based on site specific considerations described in the 'expert ecological judgement' section of this report.

Heavy kangaroo grazing can reduce the structural complexity of ground layer vegetation, resulting in a loss of habitat for species which rely on the grassy layer.

Table 1. Kangaroo management unit (KMU) land tenure and vegetation composition breakdown, with calculated number of kangaroos to remain at each site.

The target kangaroo population for each KMU considered as part of the 2018 kangaroo management program is shown. Note that a nominal 0.1 kangaroos per hectare has been used to calculate the target density for non-conservation areas however actual target densities for these areas are determined by the relevant land manager in accordance with the 'Nature Conservation (Eastern Grey Kangaroo) Rural Culling Calculator'. The target number of kangaroos to remain within areas managed for conservation by ACT Government is calculated according to the vegetation composition of such areas within each KMU. *Indicates that the target density has been set at 50% of that recommended by the formula as part of the Mulligans Flat Goorooyarroo Woodland Experiment. See section on 'Calculating the number of kangaroos to cull' for details.

SITE	Grassland (ha)	Open Woodland (ha)	Woodland (ha)	Open Forest (ha)	Forest (ha)	Pine Forest (ha)	Conservation Land Total (ha)	Rural Lease (ha)	Public Land - Rural (ha)	Livestock Agistment (ha)	Horse Paddock (ha)	Industrial Enterprise (ha)	Pine Forest (ha)	Future Urban (ha)	Urban Park (ha)	NSW Conservation Land (ha)	Commonwealth Managed As Reserve (ha)	Verge RLAHP (ha)	Grand Total (ha)	**Number of Kangaroos to Remain in KMU**
Ainslie Majura KMU	130.3	45.5	420.3	497.8	351.5	0.5	*1446*	335.4	0.0	0.0	104.9	5.5	86.5	0.0	17.7	0.0	70.9	45.4	2112	**581**
Aranda Bushland KMU	14.9	25.9	36.3	51.0	44.2	0.0	*172*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	172	**66**
Callum Brae KMU	0.0	112.8	30.5	0.0	0.0	0.0	*143*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	143	**117**
Crace KMU	121.2	0.0	10.7	10.0	0.0	0.0	*142*	0.0	31.1	0.0	0.0	6.5	0.0	0.0	0.0	0.0	0.0	0.0	180	**131**
Googong West KMU	673.0	590.5	389.9	88.6	13.2	0.0	*1755*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1755	**1410**
Goorooyarroo KMU	74.3	616.0	183.5	0.0	0.0	0.0	*874*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	874	**720**
Dunnarts Flat Exclosure*	18.4	88.1	5.5	0.0	0.0	0.0	*112*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	112	**50**
Forest Exclosure*	0.2	27.2	10.9	0.0	0.0	0.0	*38*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38	**15**
Gungaderra KMU	242.7	51.4	39.2	11.6	0.0	0.0	*345*	7.4	0.0	0.0	0.0	6.7	0.0	0.0	4.9	0.0	0.0	0.0	364	**310**
Jerrabomberra East Extended KMU (incl. Excl)	371.6	0.5	1.1	0.0	0.0	0.0	*373*	581.7	0.0	0.0	0.0	57.4	0.0	1.2	0.0	84.7	0.0	10.1	1108	**439**
Jerrabomberra West Extended KMU (incl. Excl)	182.7	58.6	25.9	0.0	0.0	0.0	*267*	639.6	0.0	0.0	0.0	216.5	0	7.2	0.0	0.0	0.0	6.9	1137	**313**
Kama Extended KMU	142.5	134.2	67.3	0.0	0.0	0.0	*344*	358.5	0.0	0.0	0.0	0.0	0.0	234.9	0.0	0.0	0.0	0.0	937	**356**
Mt Painter KMU	42.8	18.2	31.4	0.0	0.0	0.0	*93*	29.3	0.0	0.0	42.4	0.4	0.0	19.1	4.6	0.0	0.0	20.0	208	**84**
Mugga Isaacs KMU	3.3	219.8	269.3	26.6	6.9	59.9	*586*	46.6	0.0	0.0	0.0	32.5	77.6	0.0	1.0	0.0	0.0	1.9	746	**347**
Mulanggari KMU	100.0	57.2	0.0	0.0	0.0	0.0	*157*	0.0	0.0	0.0	0.0	4.3	0.0	0.0	0.0	0.0	0.0	0.0	181	**151**
Mulligans Flat KMU	7.1	91.5	191.8	61.9	0.0	0.0	*352*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	352	**192**
Dam Paddock Exclosure*	4.1	42.6	29.2	0.9	0.0	0.0	*77*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	77	**29**
East Exclosure*	0.0	3.5	5.3	0.0	0.0	0.0	*9*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9	**3**
West Exclosure*	0.0	8.5	0.0	0.0	0.0	0.0	*9*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9	**4**
Hatchet Exclosure*	0.0	5.0	19.0	0.4	0.0	0.0	*24*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24	**7**
North West Exclosure*	0.0	7.4	5.6	0.0	0.0	0.0	*13*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13	**5**
The Pinnacle KMU	0.5	59.8	89.9	6.8	0.0	0.0	*157*	83.2	0.0	105.5	0.0	3.5	0.0	0.0	0.0	0.0	0.0	16.0	365	**119**
Wanniassa Hills KMU	0.0	131.2	106.3	35.5	0.0	0.0	*273*	0.0	0.0	0.0	167.0	0.0	0.0	0.0	0.0	0.0	0.0	15.3	455	**191**

B: THE CURRENT POPULATION

The counting method used, the number of kangaroos counted, the population density, and the error associated with each of the counts undertaken to inform the 2018 conservation cull is shown in Table 2. Details of the count methods used are described in Appendix 1 of the Kangaroo Management Plan (ACT Government, 2010).

Table 2. KMU counts used to inform conservation culling advice for 2018.

Count methods include 'WLT', walked line transect count; 'Sweep', sweep count; 'Direct', direct count. The calculated 95% confidence interval and coefficient of variation are shown for WLT counts whist the range (minimum and maximum count) and number of repeat counts is shown in brackets for sweep and direct counts. Data in *italics* for Jerrabomberra East reflects the Jerrabomberra East and Queanbeyan Nature Reserve components only.

Site	Count Year	Count Type	Population Density	Number of Kangaroos	95% Confidence Interval (or Range)	CV (or Number of Counts)
Ainslie Majura KMU	2017	WLT	2.15	4527	3446 – 5948	13.7%
Canberry Fair	2017	WLT	1.72	168	120 – 235	17.2%
West Majura Grasslands	2017	WLT	4.56	1055	908 – 1226	7.6%
Aranda Bushland KMU	2017	Sweep	2.28	392	(378 – 406)	(2)
Callum Brae KMU	2017	WLT	2.01	288	226 – 366	12.2%
Crace KMU	2018	Direct	1.46	263	242 – 273	(3)
Googong West KMU	2017	WLT	2.56	4488	3452 – 5831	13.0%
Goorooyarroo KMU	2017	WLT	0.91	796	587 – 1080	15.2%
Dunnarts Flat Exclosure	2018	Sweep	2.54	284	-	(1)
Forest Exclosure	2018	Sweep	2.00	76	-	(1)
Gungaderra KMU	2018	Sweep	1.18	431	(407 – 455)	(2)
Jerra East Extended KMU	2017	WLT	1.43	1933	1310 – 2851	19.4%
JE NR and Qbn NR	*2018*	*Sweep*	*4.43*	*1098*	*(1030 – 1166)*	*(2)*
Jerra West Extended KMU	2017	WLT	3.78	4090	2936 – 5699	16.4%
Kama Extended KMU	2017	WLT	0.61	568	393 – 821	18.4%
Mt Painter KMU	2018	Sweep	1.53	319	(310 – 328)	(2)
Mugga Isaacs KMU	2017	WLT	0.63	468	343 – 642	16.0%
Mulanggari KMU	2018	Direct	1.31	237	(227 – 247)	(2)
Mulligans Flat KMU	2017	WLT	0.99	349	285 – 429	10.0%
Dam Paddock Exclosure	2018	Sweep	0.53	41	-	(1)
East Exclosure	2018	Sweep	1.89	17	-	(1)
West Exclosure	2018	Sweep	1.78	16	-	(1)
Hatchet Exclosure	2018	Sweep	0.16	4	-	(1)
North West Exclosure	2018	Sweep	1.15	15	-	(1)
The Pinnacle KMU	2017	Sweep	0.81	297	(279 – 318)	(2)
Wanniassa Hills KMU	2017	WLT	2.54	1145	884 – 1482	15%

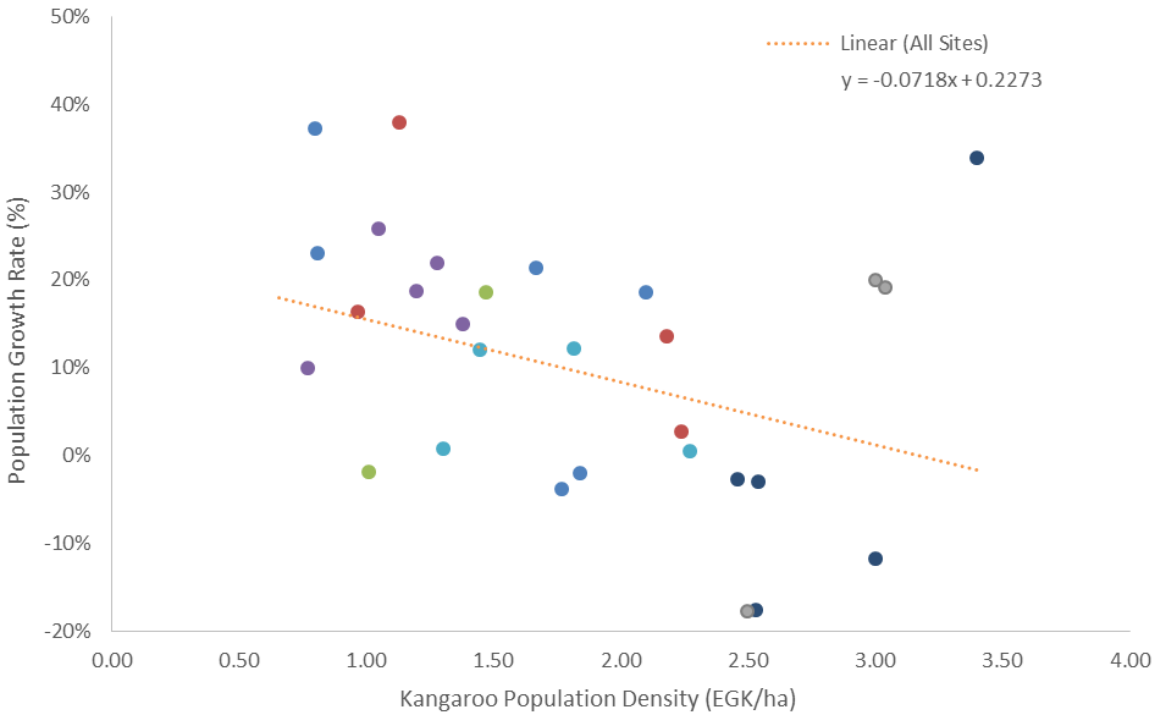
C: POPULATION GROWTH IN THE INTERIM TO THE NEXT CULL

A density dependent population growth model has been developed for use in the calculation of the 2018 conservation cull. Based on data available to date, the formula for predicting population growth rate within a KMU has been determined as:

Population Growth Rate (PGR) = -0.0718 x Population Density + 0.2273

This formula was developed based on linear regression between population density and annual population growth rates in a selection of isolated (i.e. low immigration) culled and un-culled reserves, in years where culling did not take place. This formula will be refined as more data becomes available.

Figure 1. Historic population growth rate data used to produce the density dependent population growth rate model used in estimating the population growth between counts being undertaken and culling (where counts were undertaken in 2017), and for the year subsequent to the cull such that the target density could be achieved 'on average' for the year ahead.

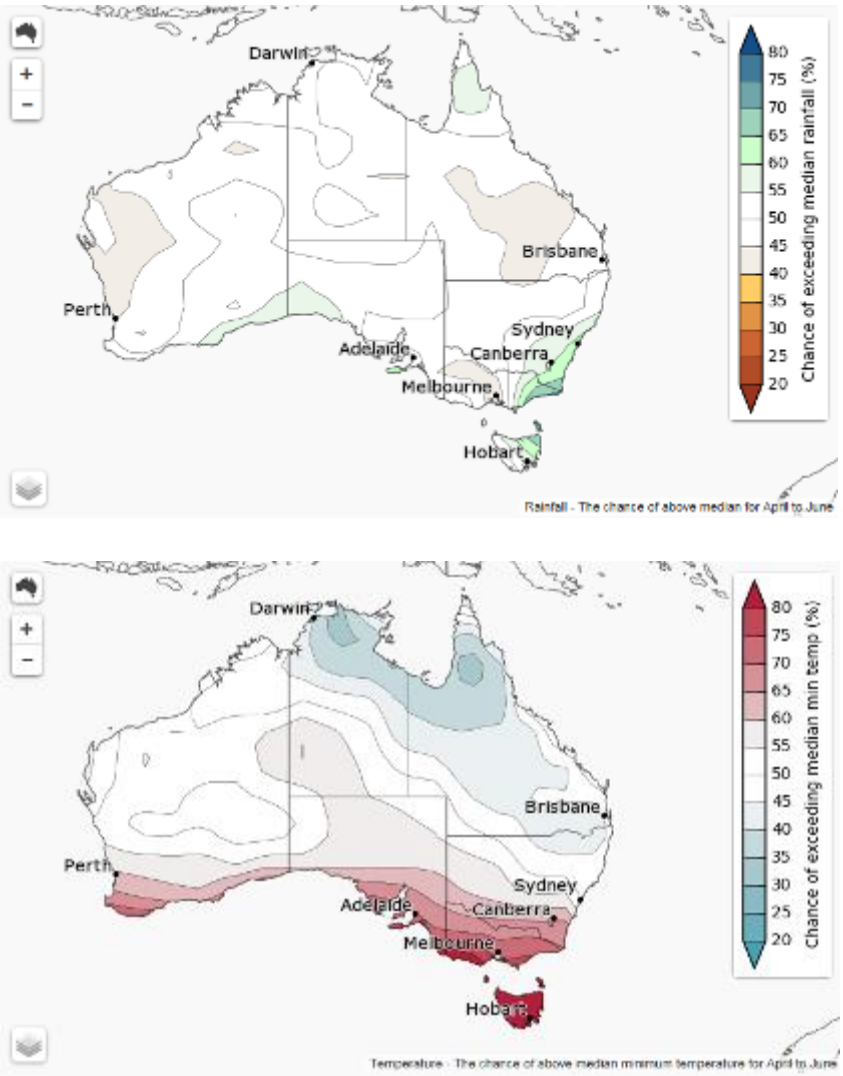


EXPERT ECOLOGICAL JUDGEMENT

CLIMATIC CONSIDERATIONS

Pasture growth is most heavily influenced by climatic conditions, with a combination of warm sunny days and frequent rainfall providing the optimum grass growth conditions. The Bureau of Meteorology provides monthly forecasts of rainfall and temperature for a three-month period ahead. The April to June forecasts for 2018 rainfall and temperature are shown in Figure 2. A 55-60% chance of exceeding the median rainfall for this period is predicted for the ACT (i.e. slightly higher than normal rainfall conditions) in association with a 60-70% chance of exceeding the median minimum temperature (i.e. somewhat less severe cold spells than normal). Predictions beyond this time are not available, however conditions for grass growth throughout autumn and into winter for 2018 are expected to be sufficient to maintain kangaroo densities 150-200% higher than that recommended by the conservation culling formula in some areas.

Figure 2. Rainfall (top) and temperature (bottom) forecasts for April to June 2018. Sourced from the Bureau of Meteorology Website.



SITE SPECIFIC CONSIDERATIONS

AINSLIE – MAJURA KMU

Background

The Ainslie-Majura KMU is situated in northern Canberra, surrounded by the suburbs of Ainslie and Hackett to the west, the Federal Hwy to the north, Majura Pkwy to the west, and Fairburn Ave to the south. It is comprised of the Mt Ainslie and Mt Majura Nature Reserves, government horse paddocks, a number of rural and private leases, and an area of commonwealth land. This KMU is expected to have little immigration/emigration, although kangaroos are known to move into the suburbs to graze during the night. The area is predominantly dry forest with open grassy areas at the base of the western slopes.

The Canberry Fair and West Majura Grasslands areas of the Ainslie-Majura KMU have been part of an adaptive management study assessing the effectiveness of sub-KMU scale culling on localised kangaroo densities since 2016. This project was initiated in response to the Ainslie-Majura KMU being considered too large and complex an area in which kangaroo density could be effectively reduced to the conservation target density within in a single culling season. 'Target' research areas have been counted quarterly to assess short-term changes in population density following culling being undertaken in the northern Canberry Fair area (blue 'target' area plus buffer; Figure 1). The West Majura Grasslands (red 'target' area) have been monitored as an un-culled comparison site in order to monitor natural fluctuations in kangaroo numbers across the site. Results in 2016-17 were inconclusive due to operational limitations in the culled area, however the study was repeated in 2017-18 and the outcomes of this study will be available later this year.

Site-specific considerations

The Ainslie Majura KMU contains significant areas of critically endangered Yellow Box - Red Gum Grassy Woodland, as well as a number of rare orchid species and populations of the Golden Sun Moth.

The West Majura grasslands to the south east of the site are currently managed as an Environmental Offset. As such, additional tracks and trails are likely to be put in place during 2018 subject to ongoing assessments of UXO risk. The installation of grazing management infrastructure (fences, watering points) has also been discussed, however it is recognised that there is no requirement for strategic stock grazing at West Majura at this time.

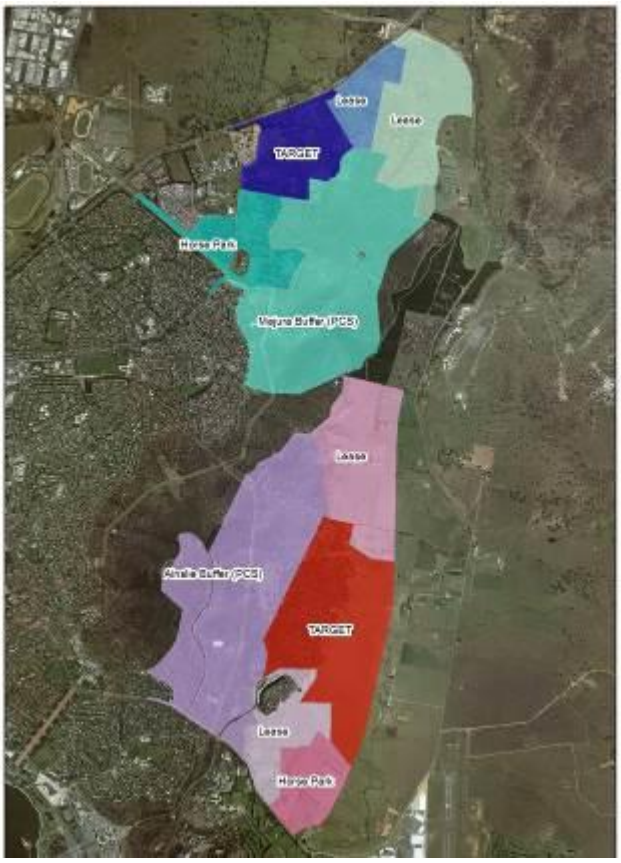


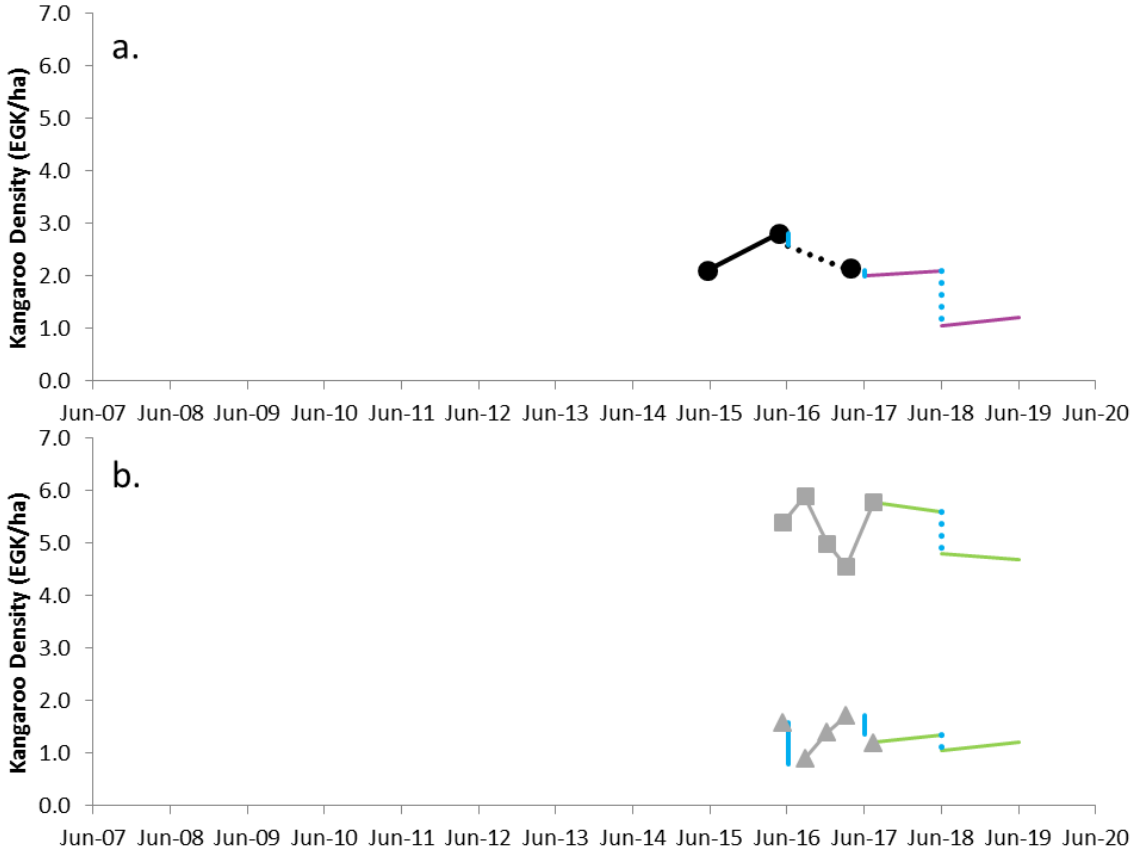
Figure 3 (right). Map showing the Canberry Fair (dark blue) and West Majura Grasslands (red) target areas for the limited area cull trial; and the associated buffer areas.

Rabbit numbers have also been monitored in the Ainslie Majura KMU over recent years and active management has been undertaken by the Parks and Conservation Service in collaboration with the local ParkCare groups to reduce the impacts of this species on ground layer vegetation and the regeneration of shrubs and trees. Rabbit management is expected to be maintained in 2018.

Culling advice

The results of the 2017 counts for the Ainslie Majura KMU, as well as the Canberry Fair and Campbell Park research 'target' areas, are shown in Table 2. Changes in kangaroo density at this site over recent years are shown in Figure 4. In 2018, culling in the Ainslie-Majura KMU is recommended for both the Canberry Fair and Campbell Park areas (see Table 3) to reduce total grazing pressure across the KMU and permit the recovery of ground layer vegetation. It is recognised that dense vegetation, steep terrain and high visitor use across the Ainslie Majura KMU provide operational constraints to culling across the KMU as a whole.

Figure 4. Changes in kangaroo density over time within the Ainslie Majura KMU as a whole ● (a), and in the component areas of Canberry Fair △ and West Majura Grasslands □ (b); predicted density dependent growth to mid-2019 —/—; and conservation culls I (planned culls are dotted).



ARANDA KMU

Background

The Aranda KMU is separated by Bindubi Street from the Mount Painter Nature Reserve and from Black Mountain Nature Reserve by Gungahlin Drive. The KMU is comprised partly of dense, hilly forest in the higher elevation areas and of an open grassland with scattered snow gums in the lower area toward William Hovel Drive. Low levels of immigration may occur between Mt Painter and Aranda Bushland based on a high incidence of kangaroo road kill on Bindubi Street, but very little is expected across other surrounding roads or through the suburb of Aranda.

Site specific considerations

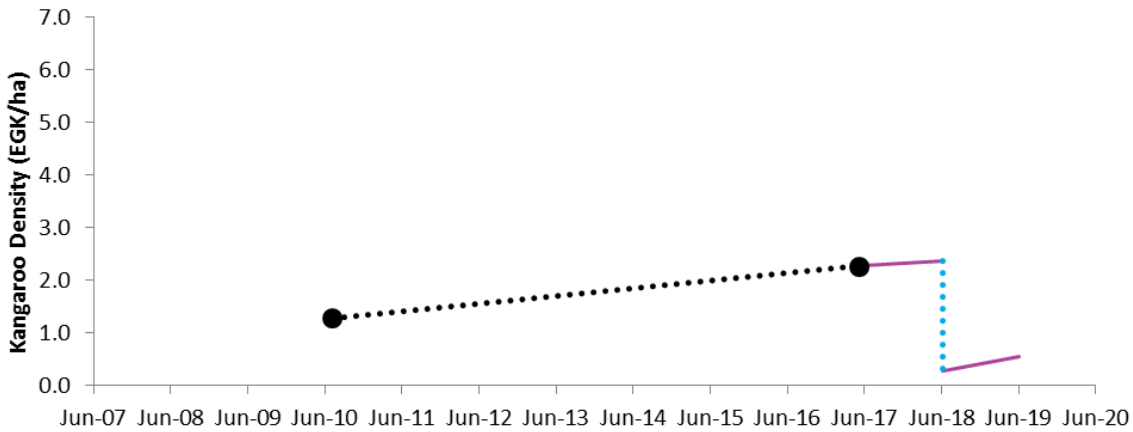
The Aranda KMU contains areas of critically endangered Yellow Box - Red Gum Grassy Woodland as well as an area containing heritage listed Snow Gums. Aranda KMU is also important for the protection of a number of rare plant species.

The majority of the kangaroos in the Aranda KMU spend their time in the open grassy areas which are kept short as 'marsupial lawns' as a result of a large, presumably food limited, kangaroo population. The Friends of Aranda Snowgums have installed exclosure cages in response to concerns that excessive grazing pressure was inhibiting the ability of the *Themeda* dominated grassy layer to set seed, and also undertake vegetation surveys on a regular basis. The small size of the heavily used grassy area creates operational difficulties for counting kangaroos, in regards to avoiding spooking animals onto busy roads, and similar constraints may occur during management operations.

Culling advice

The result of the 2017 count at Aranda KMU is shown in Table 2. The change in kangaroo density since the previous count in 2010 is shown in Figure 5 (note that the 2010 count was not replicated). Based on application of the conservation target density formula, a cull is recommended for Aranda KMU in 2018 (see Table 3) – subject to operational capacity. As a new site, it will be considered as a lower priority compared to maintaining appropriate densities at previously managed sites.

Figure 5. Changes in kangaroo density over time within the Aranda KMU ●; predicted density dependent growth to mid-2019 —/—; and conservation culls | (planned cull is dotted).



CALLUM BRAE KMU

Background

The Callum Brae KMU is in Canberra's south and includes only Callum Brae Nature Reserve. The south and east of Callum Brae KMU are continuous with rural leases and Jerrabomberra West Nature Reserve (and to a lesser extent, the Mugga-Isaacs KMU) and hence there is expected to be reasonably high levels of immigration and emigration from this management unit. The area is predominantly woodland.

Site specific considerations

The vegetation within Callum Brae KMU includes critically endangered Yellow Box – Red Gum Grassy Woodlands, as well as populations of the listed Perunga Grasshopper and a number of rare plants.

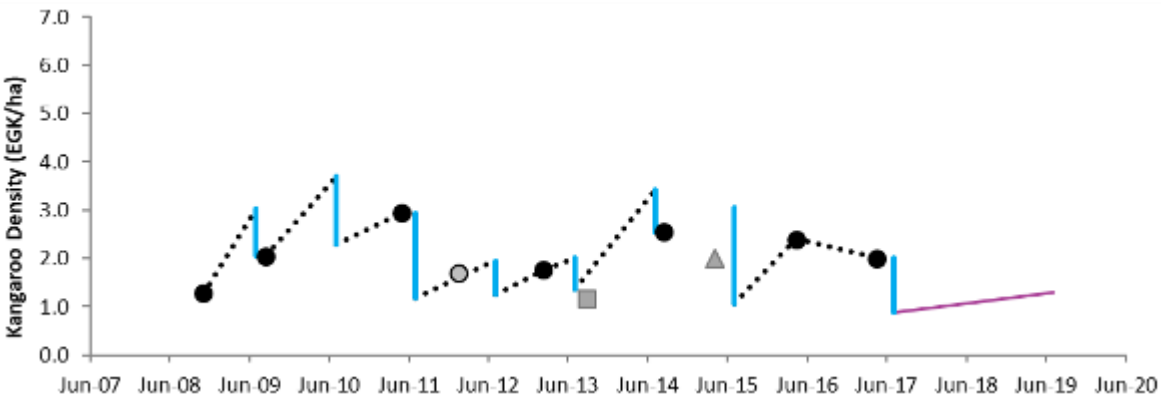
Culling at Callum Brae should be considered in the context of the greater landscape as a continuous kangaroo population is likely to be shared between Callum Brae and the Jerrabomberra West and Leases KMU (and, to a lesser extent, the Mugga Isaacs KMU). The continuous nature of this kangaroo habitat, and resultant opportunity for high levels of post-cull immigration, likely explains the high rates of annual population growth rate at this site. Previous attempts to count the Callum Brae – Jerrabomberra West – Mugga Isaacs area as a single KMU provided a density estimate at too coarse a scale to inform management.

Recent significant (but anecdotal) reductions in rabbit numbers at Callum Brae reserve are considered likely to alleviate some of the grazing pressure at this reserve. An ecological burn to tackle blackberry bushes is planned for 2018 at this site and may increase ground layer productivity at this small scale.

Culling advice

The results of the 2017 count at Callum Brae KMU is shown in Table 2. Changes in kangaroo density at this site over recent years are shown in Figure 6. In light of the efforts to increase grazing pressure in the adjacent area of Jerrabomberra West grasslands, and due to high levels of post-cull immigration observed in previous years, culling is not recommended for Callum Brae in 2018 (see Table 3).

Figure 6. Changes in kangaroo density over time within the Callum Brae KMU ●, including a driven line transect count ○ (subsequently deemed to be an unreliable estimation technique), the density estimated for the combined Jerrabomberra West/Callum Brae/Mugga Isaacs KMU in 2013 ■, and a count considered to be unreliable based on survey error and comparison with both prior and subsequent counts ▲. Predicted density dependent growth to mid-2019 — and conservation culls | are also shown.



CRACE KMU

Background

Crace KMU is located in the south of the Gungahlin Valley and is bounded by Gungahlin Drive in the west, the Barton Highway in the south, Randwick and Flemington roads to the east and the suburb of Mitchell to the north. The KMU includes Crace Grasslands Nature Reserve as well as areas of rural lease and land used for commercial purposes. The area is predominantly grassland with some woodland patches. Immigration and emigration are considered likely to be low.

Site specific considerations

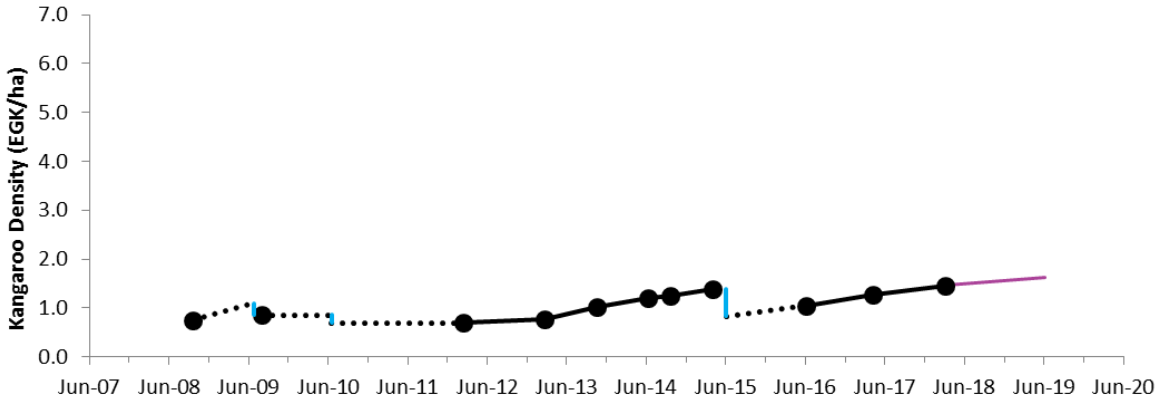
Crace KMU contains large areas of critically endangered Natural Temperate Grassland and is key habitat for threatened species such as the Striped Legless Lizard, Golden Sun Moth, Button Wrinklewort, Hoary Sunray and Perunga Grasshopper.

Crace KMU is currently a research site for the Grasslands Restoration Project, which is assessing the suitability of fire and livestock grazing as tools for grassland restoration. The site also includes areas identified as asset protection zones, in which herbage mass is kept low (often through livestock grazing) in order to manage the risk of wildfire to nearby infrastructure (including private property).

Culling advice

The Crace KMU has been counted recently in 2018 and this result is shown, along with the 2017 count, in Table 2. Changes in kangaroo density at this site over recent years are shown in Figure 7. The reductions in herbage mass brought about by the habitat restoration treatments and asset protection zones is likely to result in a highly productive grassy layer across much of the site. As such, the target density for this site in 2018 has been set at 200% of that set by the base conservation target density formula in order to maintain habitat variability for ground-frequenting species. With this adjustment, no cull is recommended for Crace KMU in 2018 (see Table 3).

Figure 7. Changes in kangaroo density over time within the Crace KMU ●, predicted density dependent growth to July 2019 —, and conservation culls |.



GOOGONG WEST KMU

Background

Googong West KMU comprises the western part of the Googong Nature Reserve, an ACT managed area of Commonwealth land situated in New South Wales. The management of kangaroos at Googong is undertaken in accordance with the ACT Kangaroo Management Plan (2010) as it is outside of the ACT. The Googong foreshore is primarily managed as a water catchment, although it also supports a diversity of flora and fauna, including ground-layer dependent threatened species such as the Pink-tailed Worm-lizard. Maintaining a healthy and intact ground vegetation layer is also important to avoid erosion and maintain water quality.

Site specific considerations

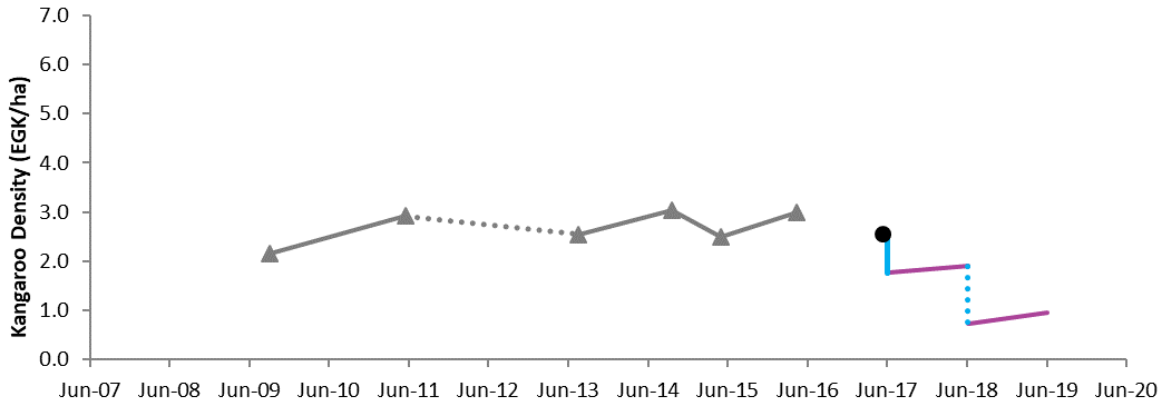
Googong KMU contains significant areas of Yellow Box - Red Gum Grassy Woodland as well as a number of rare or threatened plant and animal species, including the Pink-tailed Worm-lizard.

Googong West KMU is one of the largest areas undertaken as part of the kangaroo management program. Kangaroos are only managed on the western foreshore as this area provides more suitable, open habitat. The area of management has been expanded since 2017 to also include the south-western part of the reserve. Kangaroo off-take data continues to be collected from the north-western part of the reserve as part of the kangaroo grazing impacts research being undertaken by the Conservation Research unit, and further vegetation surveys are routinely conducted by the Parks and Conservation staff on site.

Culling advice

The results of the 2017 count at Googong West KMU are shown in Table 2. Changes in kangaroo density at this site over recent years are shown in Figure 8, although note that the area counted increased in 2017. To further alleviate grazing pressure in this water catchment area, and to facilitate an increase in ground layer vegetative cover, culling is recommended for Googong in 2018 (see Table 3).

Figure 8. Changes in kangaroo density over time within the Googong West KMU ●, and previous Googong Foreshore KMU ▲. Predicted density dependent growth to mid-2019 —, and conservation culls I are also shown (planned cull is dotted).



GOOROOYARROO KMU & EXCLOSURES

Background

Goorooyarroo KMU is situated in the north-eastern area of the ACT and is comprised predominantly of Yellow Box – Red Gum Grassy Woodland. It is bordered by Mulligans Flat Woodland Sanctuary (which is surrounded by a kangaroo proof fence) to the north, Horsepark Drive and the Federal Highway to the west and south, and rural properties across the border into NSW to the east. Adjoining areas of the KMU previously managed under rural lease are now managed for conservation alongside the gazetted reserve through the Environmental Offsets program (Kenny and Throsby).

Site specific considerations

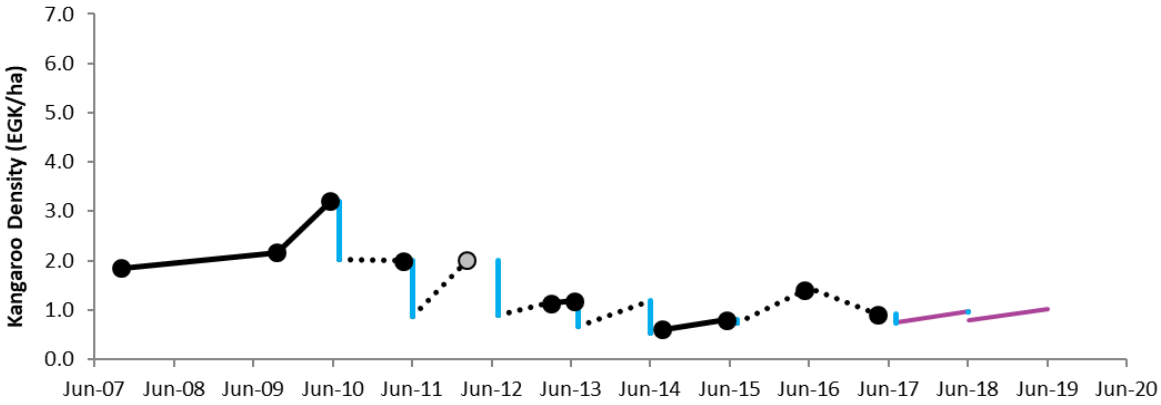
The Goorooyarroo KMU is one of the two sites heavily involved in the Mulligans Flat – Goorooyaroo Woodland Experiment being undertaken by the Australian National University in collaboration with the Woodlands and Wetlands Trust, CSIRO and the ACT Government. This study aims to assess methods of restoring the ecological function of degraded woodland environments. The construction of kangaroo exclosures in Goorooyarroo aimed to assess the effects of grazing intensity on woodland restoration efforts, and a reduced kangaroo density is an ongoing goal for these areas. In 2018, a large proportion of the Goorooyarroo Nature Reserve will be enclosed within a predator (and kangaroo) proof fence. Whilst this will affect the area counted in 2018 (i.e. only that which will be inside the extended sanctuary will be counted) the target kangaroo density for 2018 will not be affected by this construction.

Note that density estimates for kangaroo exclosures are based on a single indicative count, as animals tend to move through the 'leaky' fences during the survey such that a second count is deemed non-representative. Goorooyarroo KMU contains critically endangered Yellow Box - Red Gum Grassy Woodland as well as the Golden Sun Moth, Hoary Sunray, Superb Parrot and Striped Legless Lizard. Rabbit management will continue to be undertaken in the gazetted reserve as well as the area managed as an Environmental Offset in 2018. Livestock grazing is ongoing in the offset areas to manage habitat for threatened species in accordance with EPBC obligations for these offset areas.

Culling advice

The results of the 2017 count at Goorooyarroo KMU are shown in Table 2. Changes in kangaroo density at this site over recent years are shown in Figure 9. The special 'research target density' of 1 kangaroo per hectare applied previously at this site has been replaced in 2018 such that the target density is in keeping with that estimated by the conservation culling calculator used elsewhere (see Table 3). The target density in the kangaroo exclosures will be reduced to 10-50% of that of the remainder of the KMU to maintain the experimental treatment. Culling is recommended for Goorooyarroo KMU in 2018.

Figure 9. Changes in kangaroo density over time within the Goorooyarroo KMU ●, including a driven line transect count ○ (subsequently deemed to be an unreliable estimation technique), predicted density dependent growth to mid-2019 —, and conservation culls I (planned cull is dotted).



GUNGADERRA KMU

Background

Gungaderra KMU is located in the Gungahlin Valley and is bounded by Gungahlin Drive in the east, the Barton Highway in the south, the suburb of Crace in the west and Nirta Place (edge of the suburb of Palmerston) to the north. The KMU includes Gungaderra Grasslands Nature Reserve, as well as an area of rural lease, land used for commercial purposes (radio station), and the woodland of Gungahlin Hill. Immigration and emigration are considered likely to be low.

Site specific considerations

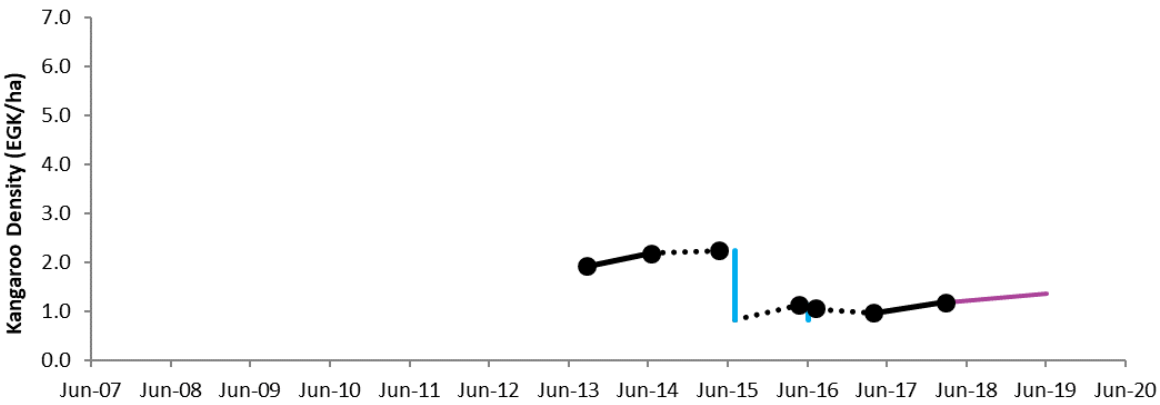
Gungaderra KMU contains large areas of Natural Temperate Grassland as well as Yellow Box - Red Gum Grassy Woodland. It is key habitat for threatened species such as the Striped Legless Lizard, Golden Sun Moth and Perunga Grasshopper.

Gungaderra KMU is currently a research site for the Grasslands Restoration Project, which is assessing the suitability of fire and livestock grazing as tools for grassland restoration. It is also a site involved in the kangaroo impacts research being undertaken by the Conservation Research unit. Gungaderra KMU also includes areas identified as asset protection zones, in which herbage mass is kept low in order to manage the risk of wildfire to nearby infrastructure (including private property).

Culling advice

The Gungaderra KMU has been counted recently in 2018 and this result is shown, along with the 2017 count, in Table 2. Changes in kangaroo density at this site over recent years are shown in Figure 10. The reductions in herbage mass brought about by the habitat restoration treatments and asset protection zones is likely to result in a highly productive grassy layer across much of the site. As such, the target density for this site in 2018 has been set at 200% of that set by the base conservation target density formula in order to maintain habitat variability for ground-frequenting species. With this adjustment, no cull is recommended for Gungaderra KMU in 2018 (see Table 3).

Figure 10. Changes in kangaroo density over time within the Gungaderra KMU ●, predicted density dependent growth to mid-2019 ▬, and conservation culls |.



JERRABOMBERRA EAST KMU & EXCLOSURE

Background

The Jerrabomberra East KMU is in the east of the ACT, straddling the border of NSW due to contiguous areas of Queanbeyan Nature Reserve across which a large kangaroo population is shared. It is bordered by the Monaro Highway to the south-west, Lanyon Drive to the south-east, and Canberra Avenue and Hindmarsh Drive to the north. Jerrabomberra East KMU has been expanded in recent years from considering just the conservation area in the east and Queanbeyan Nature Reserve across the border, to include the adjoining leased land to the west and an area of former lease now managed for conservation as an Environmental Offset (Bonshaw). The Jerrabomberra East Nature Reserve has historically held some of the highest densities of kangaroos recorded in Australia, and continues to be counted separately (along with kangaroos within the Queanbeyan Nature Reserve) to inform management of the kangaroo population and known threatened species populations which are concentrated in this area.

Site specific considerations

The Jerrabomberra East KMU contains areas of Natural Temperate Grasslands, as well as populations of Golden Sun Moth, Perunga Grasshopper, Button Wrinklewort, Striped Legless Lizard and the critically endangered Grassland Earless Dragon. A population of Ginninderra Peppercress was also recently discovered, making this only the third known population of this plant in the world. This range of listed species have varied habitat requirements, highlighting the need for a variable ground layer vegetation structure across the site.

During the millennium drought the Jerrabomberra grasslands were heavily impacted by kangaroo grazing and a kangaroo exclosure was constructed to protect habitat for the Grassland Earless Dragon which suffered a massive decline in abundance. In recent years, this exclosure has been open to kangaroo grazing and a number of small strategic burns have taken place within the area to open up the grassy layer which had become tall and rank. Populations of threatened species remain both inside and outside of the exclosure, which was considered as part of the KMU for the purposes of kangaroo management in 2018. A new kangaroo exclosure was also constructed in 2017 in Queanbeyan Nature Reserve however this has remained open to date.

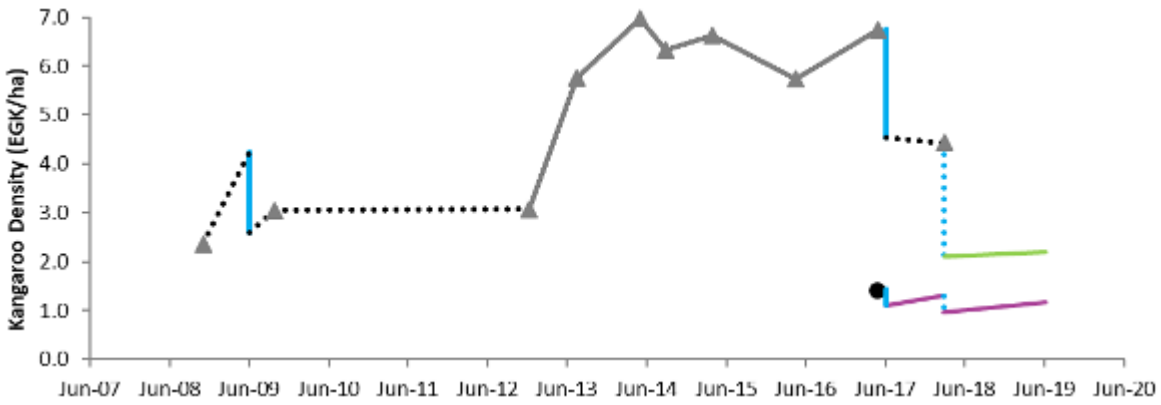
The Jerrabomberra East KMU, especially the conservation areas, are studied to assess habitat preferences for Grassland Earless Dragons (NRM team), as part of the Grasslands Restoration Project, and as part of the kangaroo impacts research undertaken by the Conservation Research unit. Rabbit management is ongoing on site as is the management of significant weed species.

Culling advice

The Jerrabomberra East Nature Reserve (and adjoining Queanbeyan Nature Reserve) were counted in 2018 and this result is shown, along with the 2017 count for the KMU as a whole, in Table 2. Changes in kangaroo density at this site and at the KMU as a whole over recent years are shown in Figure 11. The extremely high kangaroo density in the area of this KMU managed for conservation will continue to be cautiously managed in 2018 to reduce the impacts of overgrazing in this area whilst maintaining habitat appropriate for the ground layer dependent species known to inhabit this area. Because of the sensitivity of the Grassland Earless Dragon (and likely Ginninderra Peppercress) to a lack of open tussock structure, the kangaroo density will be reduced incrementally over a number of years and in consultation with neighbouring land managers towards a target density of 200% of that recommended by the conservation culling calculator (see Table 3). The distribution of kangaroos across the KMU as a whole, and their localised grazing impacts, will also be carefully monitored as land management techniques and the use of the landscape by kangaroos shift to reflect changes in land tenure (i.e. rural lease to Environmental Offset). Efforts to manage areas of

this KMU currently dominated by weeds should continue, to improve habitat condition for threatened species and provide additional foraging opportunities for the kangaroo population.

Figure 11. Changes in kangaroo density over time within the Jerrabomberra East KMU ●, including the component area currently managed for conservation (Jerrabomberra East Nature Reserve and Queanbeyan Nature Reserve; ▲). The predicted density dependent growth to mid-2019 —/—, and conservation culls I are also shown (planned culls are dotted).



JERRABOMBERRA WEST KMU & EXCLOSURE

Background

The Jerrabomberra West KMU is in the east of the ACT, and includes the Jerrabomberra West Nature Reserve in addition to adjoining rural lease properties. It is bounded by Narrabundah Lane to the north, the Monaro Highway to the east and south, and Mugga Lane to the west. The Callum Brae KMU and, to a lesser extent the Mugga-Isaacs KMU across Mugga Lane, are contiguous with the Jerrabomberra West KMU and hence immigration into this site is likely to be high as a result of the home ranges of individual kangaroos spanning multiple KMUs. Evidence for this type of habitat use by resident kangaroos is indicated by high rates of kangaroo-vehicle collisions on Mugga Lane. The three KMUs listed here are counted separately however to inform more detailed kangaroo management advice across this larger area.

Site specific considerations

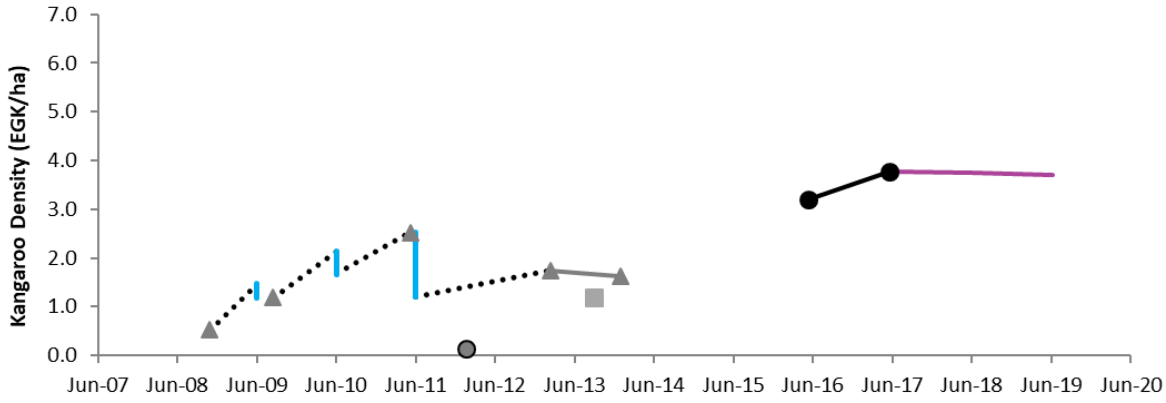
The Jerrabomberra West KMU contains areas of Natural Temperate Grasslands, as well as Golden Sun Moth and a remnant population of the critically endangered Grassland Earless Dragon. A kangaroo exclosure was constructed at Jerrabomberra West during the millennium drought to protect remaining grassy habitat for the Grassland Earless Dragon from grazing by kangaroos. Sheep grazing was also removed from this area around a similar time. Since the breaking of the drought, reduced grazing pressure has resulted in an increase in herbage mass both inside and outside of the exclosure and a reduction in Grassland Earless Dragon habitat and population size. Strategic burns have been conducted in recent years to open up the grassy layer and to encourage kangaroo grazing, and grazing by sheep has also been introduced in key areas to assist in restoration of the grassy layer.

The Jerrabomberra West KMU is studied to assess habitat preferences for Grassland Earless Dragons (NRM team) and is also subject to strategic burning and grazing as part of the Grasslands Restoration Project.

Culling advice

The 2017 count for the Jerrabomberra West KMU is shown in Table 2. The advice provided includes the kangaroo exclosure as it was open during this time period. Changes in kangaroo density at this site over recent years are shown in Figure 12. In keeping with the encouragement of grazing to open up the grassy layer in the Jerrabomberra West Grassland reserve, no conservation cull is recommended for the Jerrabomberra West KMU in 2018 (see Table 3). Strategic burning and livestock grazing will continue to supplement kangaroo grazing in the area to improve habitat for the critically endangered Grassland Earless Dragon, and management in the contiguous areas of Callum Brae and Mugga Isaacs KMUs will also consider these broader scale conservation objectives.

Figure 12. Changes in kangaroo density over time within the Jerrabomberra West KMU ●. Earlier counts considered only the Jerrabomberra West Grassland reserve △, and included a driven line transect count ○ (subsequently deemed to be an unreliable estimation technique). The density estimated for the combined Jerrabomberra West/Callum Brae/Mugga Isaacs KMU is shown for 2013 ■. Predicted density dependent growth to mid-2019 ▬ and conservation culls ▌ are also shown.



KAMA EXTENDED KMU

Background

The Kama Extended KMU is found in the west of the ACT between William Hovell Drive to the north and the Molonglo River to the south. It is bounded to the east by Coppins Crossing Road and joins to contiguous grazing land to the west. The Kama Nature Reserve is a predominantly wooded reserve within the KMU, although it opens into grassland in the lower areas towards the river. The remaining areas are grazed under management by rural lease holders or the Land Development Agency. Kangaroo density across this area is generally low, which will likely limit immigration rates despite the KMU having no effective boundary to kangaroo movement to the west.

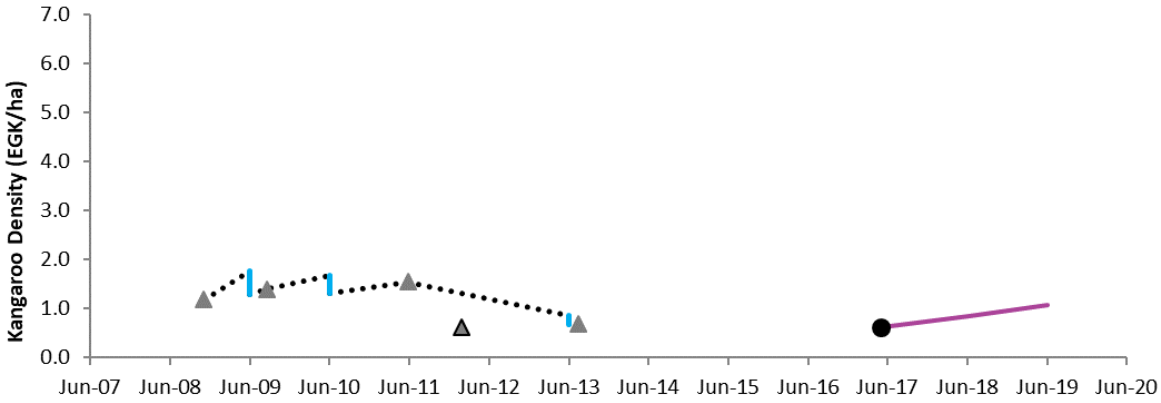
Site specific considerations

The Kama Nature Reserve contains critically endangered Yellow Box - Red Gum Grassy Woodland and is an important woodland for the protection of declining woodland birds. Habitat restoration involving the addition of surface rocks, reintroduction of threatened reptile species, and strategic burns are being undertaken as part of the Grasslands Restoration Project in the reserve and a seed production garden is being considered for the site. Grazing by livestock, especially in the northern paddocks, is undertaken as part of the management of weeds and fire fuel loads.

Culling advice

The 2017 count for the Kama KMU is shown in Table 2. Changes in kangaroo density at this site over recent years are shown in Figure 13. Due to the low density of kangaroos in this area, no conservation cull is recommended for the Kama Extended KMU in 2018 (see Table 3).

Figure 13. Changes in kangaroo density over time within the Kama Extended KMU ●. Earlier counts considered only the Kama Nature Reserve ▲, and included a driven line transect count △ (subsequently deemed to be an unreliable estimation technique). Predicted density dependent growth to mid-2019 — and conservation culls I are also shown.



MT PAINTER KMU

Background

Mt Painter KMU is situated in the Belconnen area, bordered by William Hovell Drive to the south, Bindubi Street to the east, Coulter Drive to the west, and the suburb of Cook to the north. The KMU is comprised of Mt Painter Nature Reserve (including the 'Wild Flower Triangle'), rural lease and horse paddocks. The area is predominantly open woodland. Immigration to the area is expected to be low due to significant anthropomorphic barriers to kangaroo movement, although high rates of vehicle strike on Bindubi Street may indicate some movement occurs between Mt Painter and Aranda KMUs.

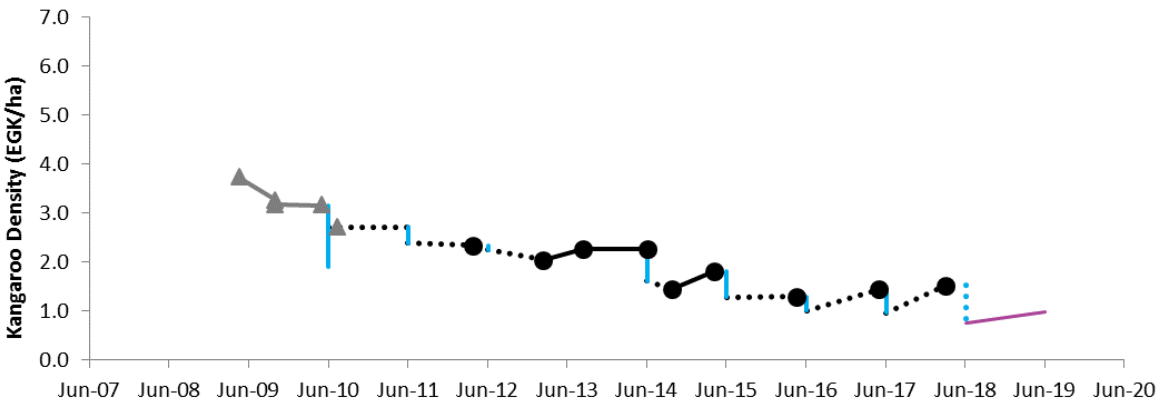
Site specific considerations

Mt Painter KMU contains areas of Yellow Box – Red Gum Grassy Woodland as well as a diversity of orchids and declining woodland birds. The Wildflower Triangle is burned strategically to achieve both fuel management and ecological objectives, and erosion control and revegetation efforts are undertaken by the Friends of Mt Painter.

Culling advice

The 2017 count for the Mt Painter KMU is shown in Table 2. Changes in kangaroo density at this site over recent years are shown in Figure 14. In keeping with recommendations of the conservation culling formula for this site, a modest cull is recommended for Mt Painter KMU in 2018 (see Table 3), subject to operational capacity.

Figure 14. Changes in kangaroo density over time within the Mt Painter KMU ●. Earlier 'sector' counts (▲) were undertaken by the Parkcare group. Predicted density dependent growth to mid-2019 ▬ and conservation culls ▌ are also shown.



MUGGA ISAACS KMU

Background

The Mugga Isaacs KMU is situated in the south east of the ACT and is comprised predominantly of the Mount Mugga Mugga and Isaacs Ridge Nature Reserves. Other major land tenures include an area of commercial pine forest and rural lease. The area is dominated by woodland and is surrounded by Mugga Lane to the east, Hindmarsh Drive to the north, Long Gully Lane to the south and the suburbs of O'Malley and Isaacs to the west. The weak barrier to kangaroo movement provided by Mugga Lane, coupled with high rates of kangaroo-vehicle collisions along this road, indicate that immigration and emigration between Mugga Isaacs KMU, Callum Brae KMU and Jerrabomberra West KMU may be high; however the components are counted independently to enable more detailed management across this larger area.

Site specific considerations

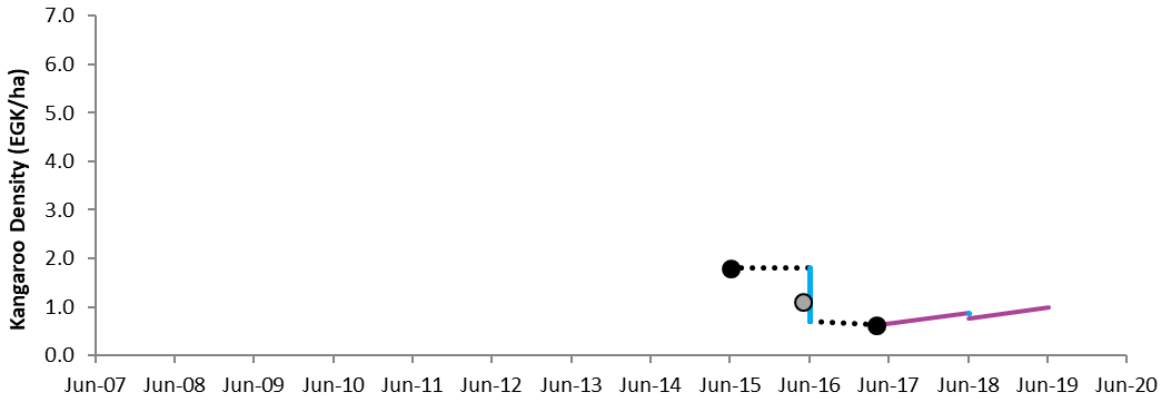
The Mugga Isaacs KMU contains significant areas of critically endangered Yellow Box – Red Gum Grassy Woodland which provide habitat for declining woodland bird species, including the Glossy Black Cockatoo. The site also provides habitat for populations of Pink-tailed Worm-lizard and a variety of rare plants.

An area adjacent to Isaacs Ridge is now managed for conservation as an Environmental Offset. A tree thinning project is underway to assess the factors related to dieback in Blakley's Red Gum and shrubs are also being planted to restore the mid-story vegetation layer. Neither project will impact on target densities set for kangaroos.

Culling advice

The 2017 count for the Mugga Isaacs KMU is shown in Table 2. Changes in kangaroo density at this site over recent years are shown in Figure 15. In keeping with recommendations of the conservation culling formula for this site, a modest cull is recommended for Mugga Isaacs KMU in 2018 (see Table 3), subject to operational capacity.

Figure 15. Changes in kangaroo density over time within the Mugga Isaacs KMU ●. Changes in population density have been inferred from 2015 and 2017 data for 2016 due to the density estimate having high sampling error in that year ○ and being inconsistent with counts in 2017. Predicted density dependent growth to mid-2019 ▬ and conservation culls ▌ are also shown (planned cull is dotted).



MULANGGARI KMU

Background

Mulanggari KMU is located in the north of the Gungahlin Valley and is bounded by Gungahlin Drive to the south-west, Gungahlin town centre to the north and the suburb of Franklin to the south east. The development of an area previously classified as 'future urban' to the north of the KMU has resulted in a reduction in the total area for 2018, and the KMU is now almost completely comprised of Yellow Box - Red Gum dominated nature reserve. Immigration is expected to be low at this site due to the area being bounded by significant anthropomorphic barriers.

Site specific Considerations

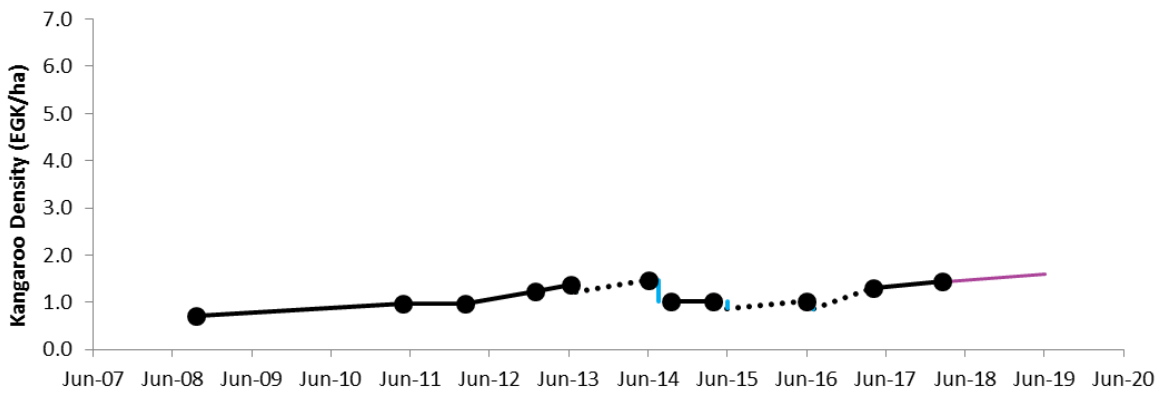
Mulanggari KMU contains large areas of Natural Temperate Grassland as well a Yellow Box – Red Gum Grassy Woodland. It is key habitat for threatened species such as the Striped Legless Lizard, Golden Sun Moth and Hoary Sunray.

Mulanggari KMU is currently a research site for the Grasslands Restoration Project, which is assessing the suitability of fire and livestock grazing as tools for grassland restoration. The site also includes areas identified as asset protection zones, in which herbage mass is kept low in order to manage the risk of wildfire to nearby infrastructure (including private property).

Culling advice

The Mulanggari KMU has been counted recently in 2018 and this result is shown, along with the 2017 count, in Table 2. Changes in kangaroo density at this site over recent years are shown in Figure 16. The reductions in herbage mass brought about by the habitat restoration treatments and asset protection zones is likely to result in a highly productive grassy layer across much of the site. As such, the target density for this site in 2018 has been set at 200% of that set by the conservation culling calculator in order to maintain habitat variability for ground-frequenting species. With this adjustment, no cull is recommended for Mulanggari KMU in 2018 (see Table 3).

Figure 16. Changes in kangaroo density over time within the Mulanggari KMU ●, predicted density dependent growth to mid-2019 ▬, and conservation culls |.



MULLIGANS FLAT KMU & EXCLOSURES

Background

Mulligans Flat KMU is situated in north-east ACT and is comprised predominantly of Yellow-box Red-gum grassy woodland. The KMU is synonymous with the Mulligans Flat Woodland Sanctuary, in that it is surrounded on all sides by a predator (and kangaroo) proof fence.

Site specific considerations

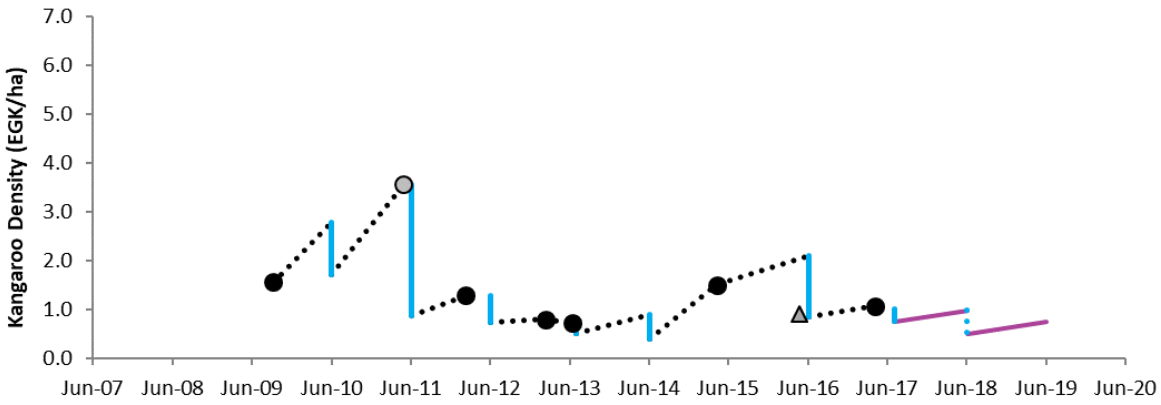
Mulligans Flat KMU is one of the two sites heavily involved in the Mulligans Flat – Goorooyaroo Woodland Experiment being undertaken by the Australian National University in collaboration with the Woodlands and Wetlands Trust, CSIRO and the ACT Government, and with assistance from the Friends of Mulligans Flat. This study aims to assess methods of restoring the ecological function of degraded woodland environments. The construction of kangaroo exclosures in Mulligans Flat aimed to assess the effects of grazing intensity on woodland restoration efforts, and a reduced kangaroo density is an ongoing goal for these areas. The absence of predators in the sanctuary has enabled an increase in the abundance of Swamp and Red Necked Wallabies within the sanctuary, however populations of these remain low compared to Eastern Grey Kangaroos based on line transect estimates and their numbers are not currently managed. A population of Eastern Bettongs has also been established in the sanctuary and may contribute in a small way to total grazing pressure.

Note that density estimates for kangaroo exclosures are based on a single indicative count, as animals tend to move through the 'leaky' fences during the survey such that a second count is deemed non-representative. Mulligans Flat KMU contains critically endangered Yellow Box – Red Gum Grassy Woodland as well as populations of Hoary Sunray and Austral Toadflax.

Culling advice

The results of the 2017 count at Mulligans Flat KMU are shown in Table 2. Changes in kangaroo density at this site over recent years are shown in Figure 17. The special 'research target density' of 1 kangaroo per hectare applied previously at this site has been replaced in 2018 such that the target density is in keeping with that estimated by the conservation culling calculator (see Table 3). Individual counts made of the kangaroo exclosures in 2018 are also shown in Table 2. The target density in the kangaroo exclosures will be reduced to 10-50% of that of the remainder of the KMU to maintain the experimental grazing treatment. Culling is recommended for Mulligans Flat KMU in 2018.

Figure 17. Changes in kangaroo density over time within the Mulligans Flat KMU ●, including a driven line transect count ○ (subsequently deemed to be an unreliable estimation technique), and the 2016 count which was also deemed unreliable based on large sampling error and the number of animals counted in 2017 subsequent to the 2016 cull △. Predicted density dependent growth to mid-2019 —, and conservation culls | are also shown (planned cull is dotted).



THE PINNACLE KMU

Background

The Pinnacle KMU is situated in the Belconnen area, bordered by William Hovell Drive to the south and west, Coulter Drive to the east, and Springvale Drive and the suburb of Hawker to the north. The KMU is comprised of The Pinnacle Nature Reserve (recently expanded through gazetting of an area protected via the Environmental Offsets program), rural lease and horse paddocks. The area is predominantly open woodland. Immigration to the area is expected to be low due to significant anthropomorphic barriers to kangaroo movement.

Site specific considerations

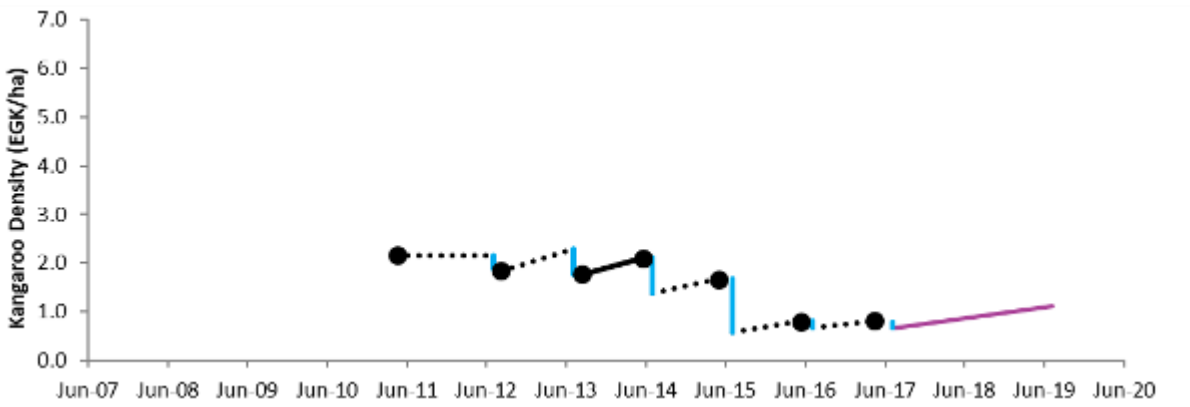
The Pinnacle KMU contains areas of Yellow Box – Red Gum Grassy Woodland as well as populations of the Pink-tailed Worm-lizard and a number of rare plants. The Friends of the Pinnacle contribute significant time and expertise to the conservation of this woodland ecosystem.

Fire fuel management is undertaken occasionally in The Pinnacle KMU, usually through grazing by livestock. A number of shrubs have been planted recently in the reserve and are protected from browsing. Rabbits continue to be managed across the conservation area, although rabbit numbers are very low. An underground water pipe will be installed in the reserve in 2018 which will involve a temporary construction fence being installed on site for the duration of the works.

Culling advice

The 2017 count for The Pinnacle KMU is shown in Table 2. Changes in kangaroo density at this site over recent years are shown in Figure 4. As the current kangaroo density at the site is deemed appropriate given the forecasted climatic conditions, no conservation cull is recommended for The Pinnacle KMU in 2018 (see Table 3).

Figure 18. Changes in kangaroo density over time for The Pinnacle KMU ●. Predicted density dependent growth to mid-2019 ▬ and conservation culls ▌ are also shown.



WANNIASSA HILLS KMU

Background

Wanniassa Hills KMU is situated in the south of Canberra and is comprised predominantly of Wanniassa Hills Nature Reserve and horse paddocks with a Special Purpose Reserve overlay. It is bordered by Erindale Drive and Long Gully Road to the north, Mugga Lane, the Monaro Highway and Isabella Drive to the east, and the suburbs of Fadden and MacArthur to the south. The vegetation is largely open woodland and woodland, including areas of Yellow Box – Red Gum Grassy Woodland. Kangaroo grazing is focused on the more open areas, including those of the horse paddocks.

Site specific considerations

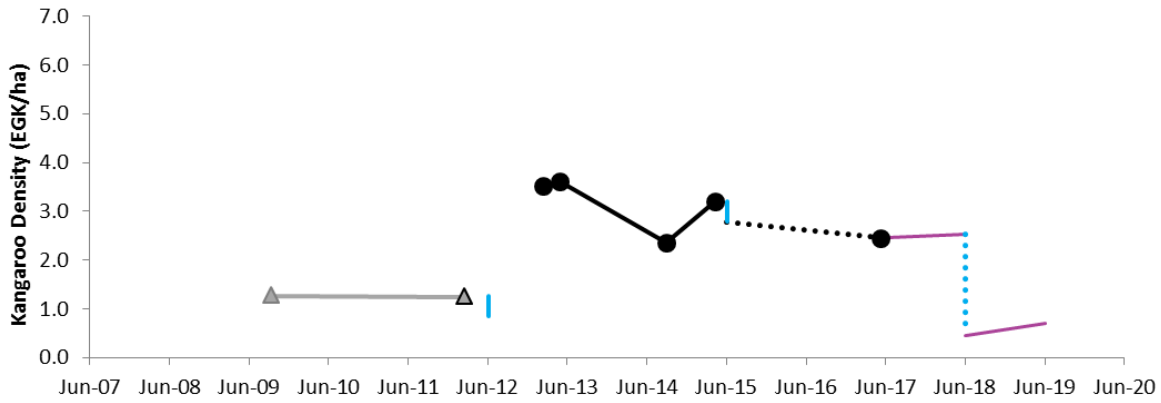
The Wanniassa Hills KMU contains areas of critically endangered Yellow Box – Red Gum Grassy Woodland, as well as populations of Horay Sunray, Pink-tailed Worm-lizard, and a number of listed woodland bird species. Ground cover is generally scarce at Wanniassa Hills Nature Reserve, and erosion control methods are in place to minimise the loss of soil, nutrients and native seed banks from this area.

Management of this KMU requires close cooperation with neighbouring land managers. Whilst the need for a reduction in kangaroo density in this KMU is recognised, consideration of the operational constraints (the large number of animals which would need to be removed to allow ground layer recovery) often preclude management in this reserve when considered in light of other priority areas.

Culling advice

The 2017 count for Wanniassa KMU is shown in Table 2. Changes in kangaroo density at this site over recent years are shown in Figure 19. A conservation cull is recommended for Wanniassa Hills KMU in 2018 (see Table 3), subject to operational capacity and coordination with neighbouring land managers.

Figure 19. Changes in kangaroo density over time within the Wanniassa KMU ●, and earlier within Wanniassa Hills Nature Reserve △ (including a driven line transect count △ subsequently deemed to be an unreliable estimation technique). Predicted density dependent growth to mid-2019 —, and conservation culls I are also shown.



SUMMARY OF 2018 CONSERVATION CULLING ADVICE

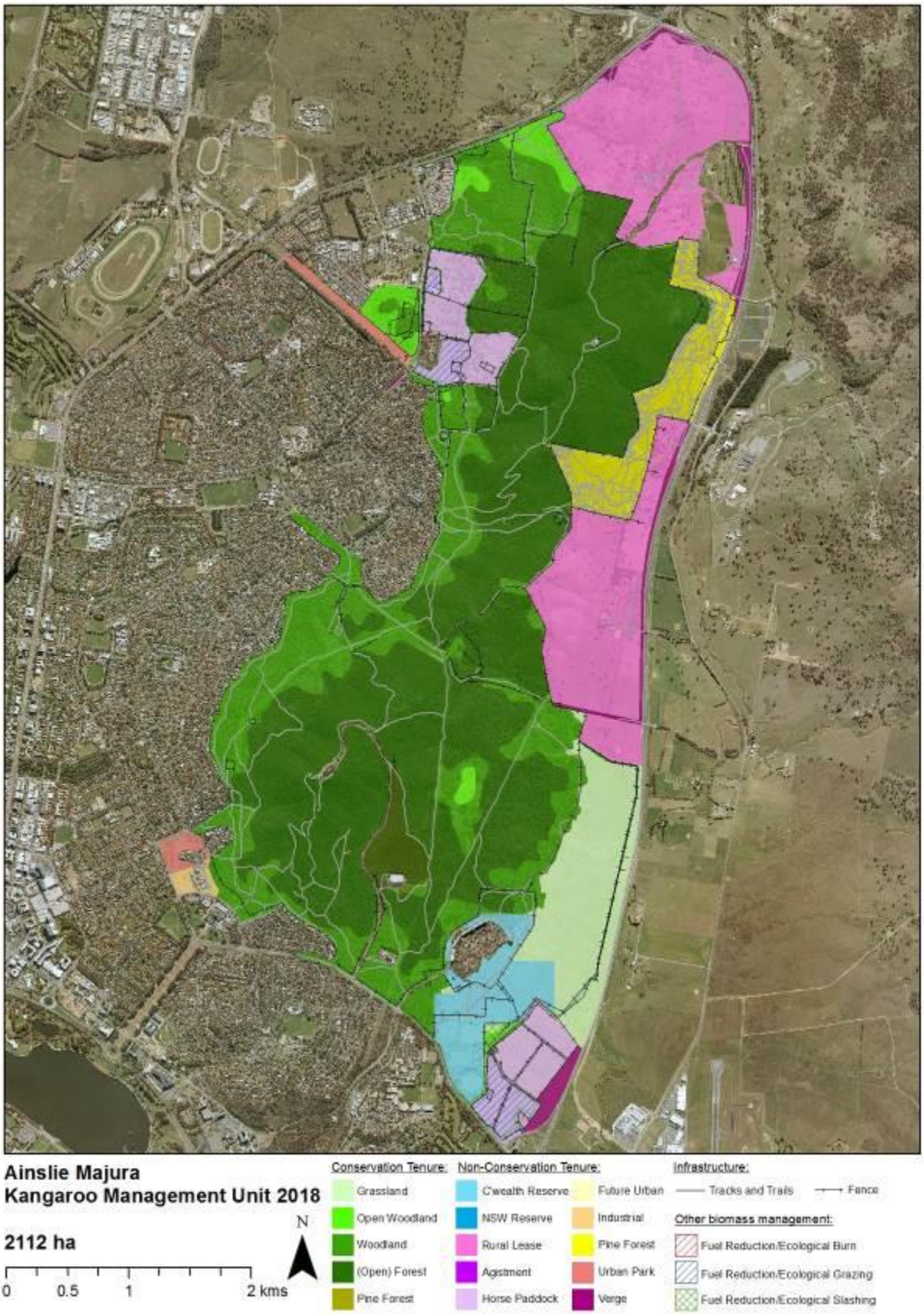
Table 3. Management areas, target kangaroo densities, recent kangaroo counts and predicted population growth information used to determine the number of kangaroos to cull within the conservation areas managed by ACT Government for each kangaroo management unit (KMU).

Columns marked (a) – (c) refer to the components of the culling calculation formula referred to in the 'Calculating the number of kangaroos to cull' section of this document. Kangaroo densities are number of kangaroos per hectare. Areas managed by ACT Government for conservation include nature reserve, areas managed as nature reserve (including environmental offset sites), and road verges adjacent to nature reserves. Where these areas comprise the whole KMU, KMU data is not shown separately. Conservation target densities have been increased at some sites (*), or culls recommended by the formula forgone ($^{\Delta}$), where high pasture productivity is expected and/or where additional grazing pressure is desired to restore or maintain a variable grassy layer habitat structure.

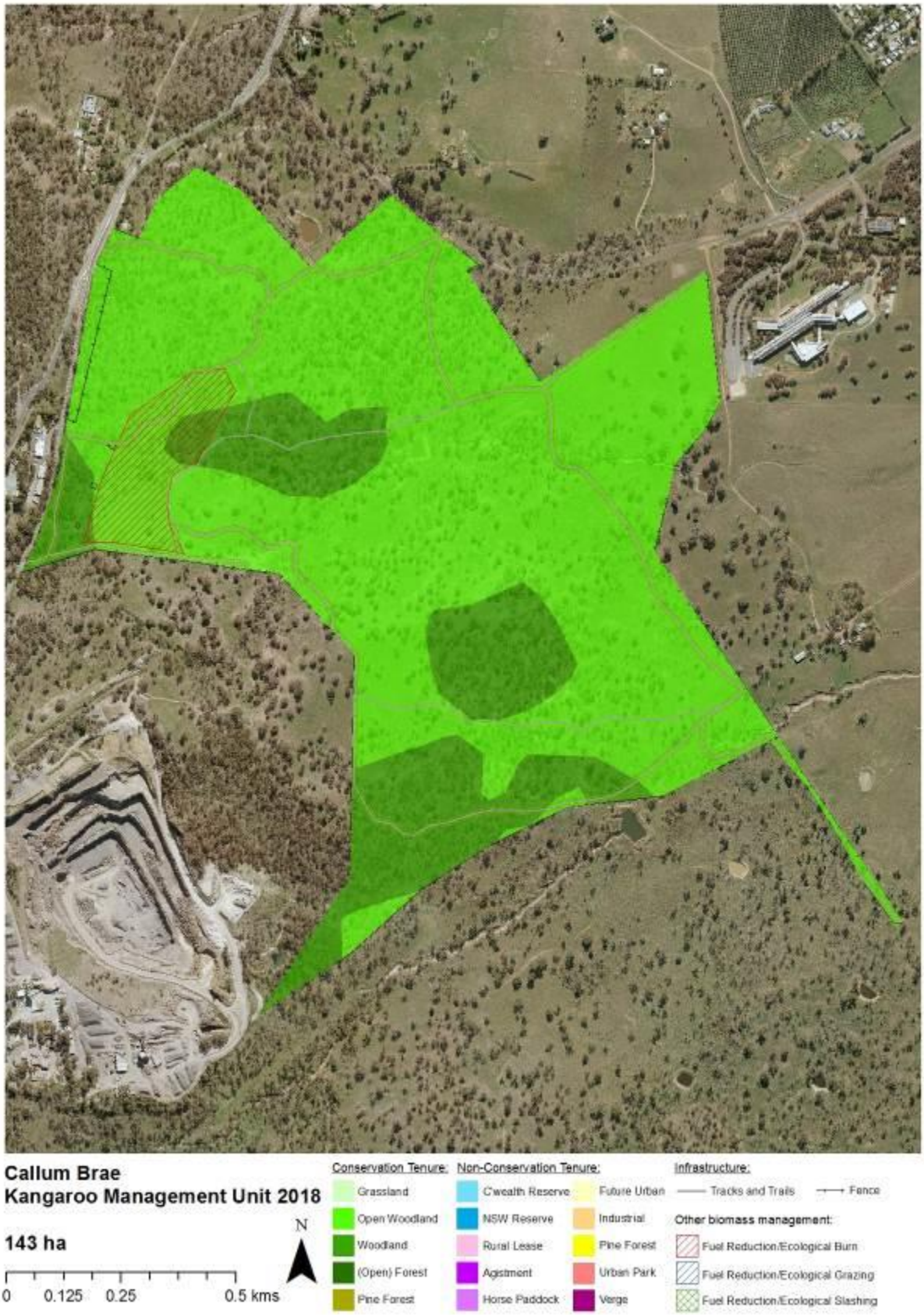
					Values Below Relate Only to Areas Managed for Conservation by ACT Government							
SITE	Total Area of KMU (ha)	Area Managed by ACT Government for Conservation (ha)	(a) Conservation Area TARGET Number (and Density) for 2018-19	KMU Population (and Density) at 2017 Count	Population (and Density) at 2017 Count	Number (and Density) Culled in 2017	Population (and Density) Post-Cull 2017	Expected PGR 2017-18	(b) Population (and Density) Expected/ Measured (bold) 2018	(c) Expected PGR 2018-19 based on TARGET Density	2018 Post-Cull TARGET Population (and Density) to Achieve (a)	Recommended Number to Cull in 2018
Ainslie Majura KMU	2112	1446	466 (0.32)	4527 (2.15)	3109 (2.15)	207 (0.14)	2902 (2.01)	0.08	3143 (2.17)	0.20	423 (0.29)	-
Canberry Fair	712	439	112 (0.26)	1532 (2.15)	468 (1.07)	207 (0.47)	261 (0.60)	0.18	309 (0.70)	0.21	101 (0.23)	**208**
West Majura Grasslands	1112	827	896 (1.08)*	2392 (2.15)	1587 (1.92)	0 (0.00)	1587 (1.92)	0.09	1729 (2.09)	0.15	834 (1.01)	**895**
Aranda Bushland KMU	-	172	66 (0.38)	-	392 (2.28)	0 (0.00)	392 (2.28)	0.06	418 (2.42)	0.20	60 (0.35)	**358**
Callum Brae KMU	-	143	117 (0.82)	-	288 (2.01)	162 (1.13)	126 (0.88)	0.16	146 (1.02)	0.17	108 (0.75)	0^{Δ}
Crace KMU	180	142	256 (1.80)*	190 (1.05)	149 (1.05)	0 (0.00)	149 (1.05)	0.15	**207 (1.46)**	0.10	244 (1.72)	0
Googong West KMU	-	1755	1410 (0.80)	-	4488 (2.56)	1406 (0.80)	3082 (1.76)	0.10	3399 (1.94)	0.17	1300 (0.74)	**2099**
Goorooyarroo KMU	-	874	720 (0.82)	-	795 (0.91)	147 (0.17)	648 (0.74)	0.17	761 (0.87)	0.17	664 (0.76)	**97**
Dunnarts Flat Exclosure	-	112	50 (0.45)	-	-	-	-	-	**244 (2.54)**	0.20	46 (0.41)	**198**
Forest Exclosure	-	38	15 (0.39)	-	-	-	-	-	**76 (2.00)**	0.20	14 (0.36)	**62**
Gungaderra KMU	364	345	620 (1.80)*	354 (0.97)	335 (0.97)	0 (0.00)	335 (0.97)	0.16	**407 (1.18)**	0.10	591 (1.71)	0
Jerrabomberra East Extended KMU	1108	112	224 (2.00)*	1933 (1.43)	756 (6.75)‡	360 (3.21)	396 (3.54)	-0.03	**496 (4.43)**	0.08	215 (1.92)	**281**
Jerrabomberra West Extended KMU	1137	267	992 (3.72)*	4090 (3.78)	1009 (3.78)	0 (0.00)	1009 (3.78)	-0.04	965 (3.61)	-0.04	1012 (3.79)	0
Kama Extended KMU	937	344	297 (0.86)	568 (0.61)	210 (0.61)	0 (0.00)	210 (0.61)	0.18	248 (0.72)	0.17	27 (0.80)	0
Mt Painter KMU	208	92	75 (0.82)	301 (1.45)	133 (1.45)	99 (1.08)	34 (0.37)	0.20	**141 (1.53)**	0.17	69 (0.75)	**72**
Mugga Isaacs KMU	746	586	342 (0.58)	468 (0.63)	369 (0.63)	51 (0.09)	318 (0.54)	0.19	378 (0.65)	0.19	313 (0.53)	**65**
Mulanggari KMU	162	157	302 (1.92)	237 (1.31)	206 (1.31)	0 (0.00)	206 (1.31)	0.13	**254 (1.62)**	0.09	289 (1.84)	0
Mulligans Flat KMU	-	352	192 (0.55)	-	349 (0.99)	50 (0.14)	299 (0.85)	0.17	348 (0.99)	0.19	175 (0.50)	**173**
Dam Paddock Exclosure	-	77	29 (0.38)	-	-	-	-	-	**41 (0.53)**	0.20	26 (0.34)	**15**
Hatchet Exclosure	-	24	7 (0.29)	-	-	-	-	-	**4 (0.16)**	0.21	6 (0.26)	0
North West Exclosure	-	13	5 (0.38)	-	-	-	-	-	**15 (1.15)**	0.20	5 (0.35)	**10**
East Exclosure	-	9	3 (0.33)	-	-	-	-	-	**17 (1.89)**	0.20	3 (0.30)	**14**
West Exclosure	-	9	4 (0.44)	-	-	-	-	-	**16 (1.78)**	0.20	4 (0.40)	**12**
The Pinnacle KMU	365	157	100 (0.64)	297 (0.81)	127 (0.81)	48 (0.31)	79 (0.50)	0.19	94 (0.60)	0.18	92 (0.58)	0^{Δ}
Wanniassa Hills KMU	455	273	175 (0.64)	1145 (2.54)	693 (2.54)	0 (0.00)	693 (2.54)	0.04	725 (2.65)	0.18	160 (0.59)	**564**
TOTAL												**5123**

APPENDIX: KANGAROO MANAGEMENT UNIT TENURE MAPS

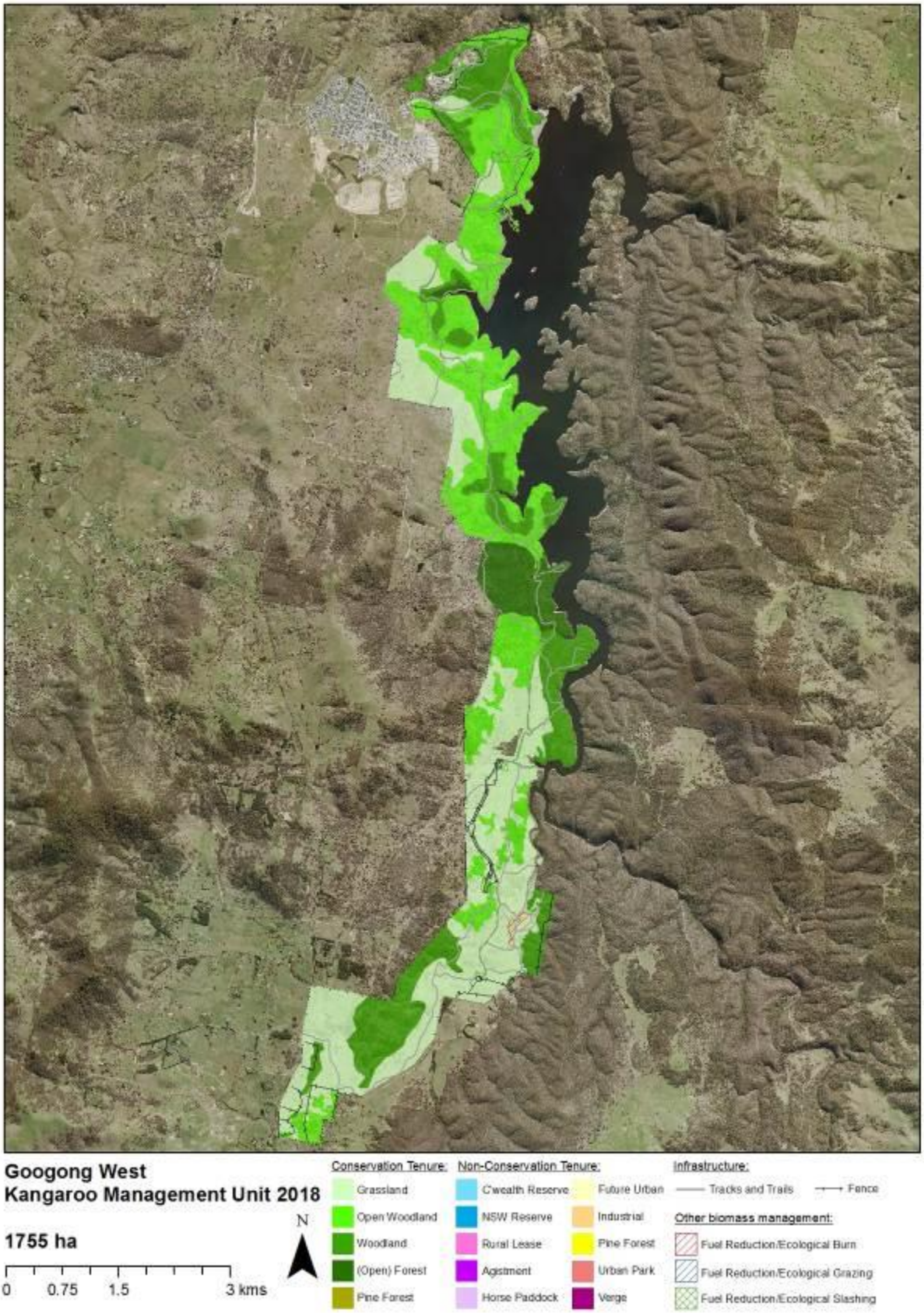
Maps showing land tenure and vegetation composition of areas managed by ACT Government for conservation are shown for each Kangaroo Management Unit considered in this report. Plans for alternative ground layer vegetation management operations (e.g. livestock grazing, slashing and strategic burning) are also shown.

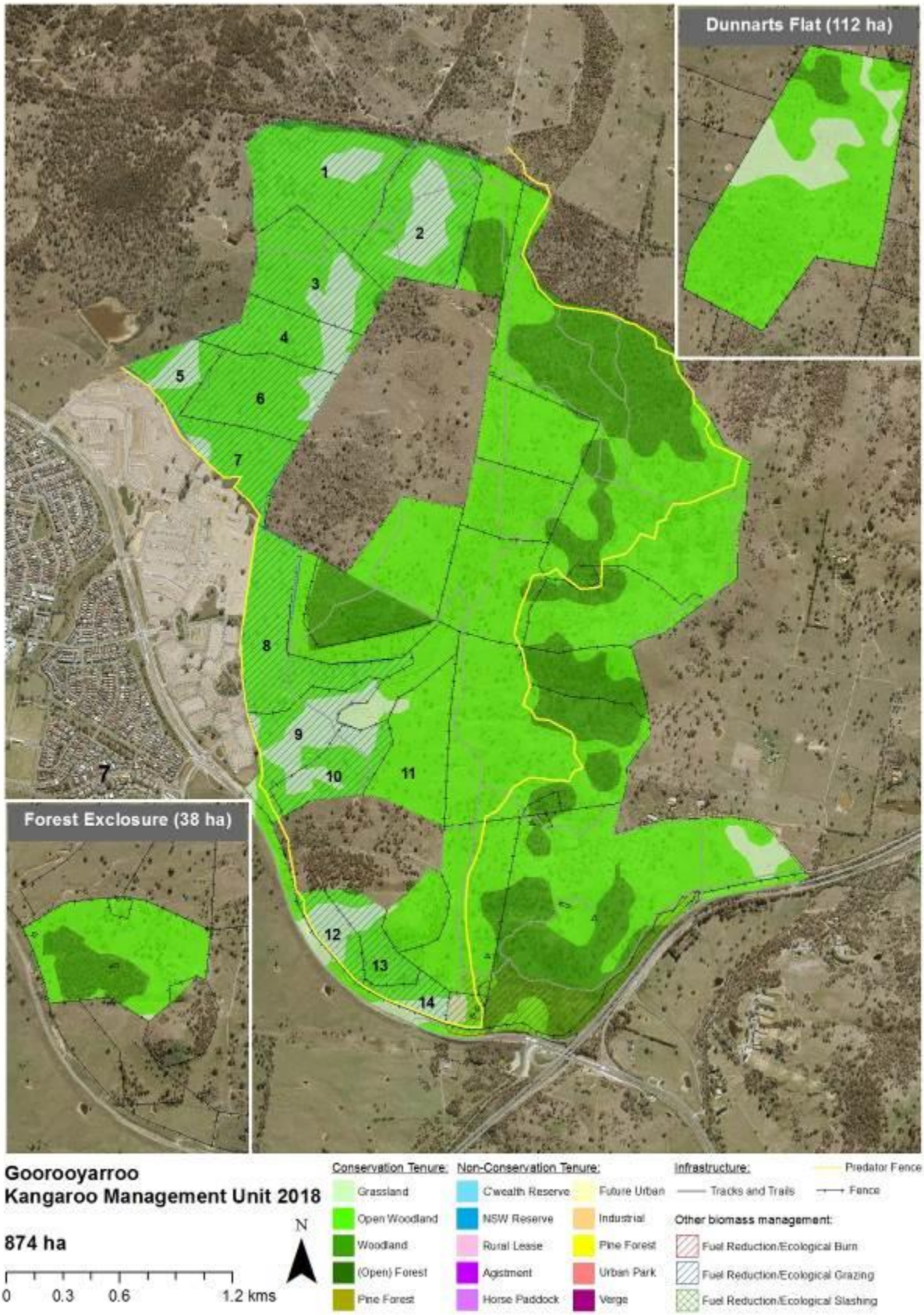

Ainslie Majura
Kangaroo Management Unit 2018
2112 ha
0
0.5
1
2 kms
N
Conservation Tenure:
Grassland
Open Woodland
Woodland
(Open) Forest
Pine Forest
Non-Conservation Tenure:
C'wealth Reserve
NSW Reserve
Rural Lease
Agistment
Horse Paddock
Future Urban
Industrial
Pine Forest
Urban Park
Verge
Infrastructure:
Tracks and Trails
Fence
Other biomass management:
Fuel Reduction/Ecological Burn
Fuel Reduction/Ecological Grazing
Fuel Reduction/Ecological Slashing


Aranda
Kangaroo Management Unit 2018
172 ha
0 0.125 0.25 0.5 kms
N
Conservation Tenure:
Grassland
Open Woodland
Woodland
(Open) Forest
Pine Forest
Non-Conservation Tenure:
C'wealth Reserve
NSW Reserve
Rural Lease
Agistment
Horse Paddock
Future Urban
Industrial
Pine Forest
Urban Park
Verge
Infrastructure:
Tracks and Trails
Fence
Other biomass management:
Fuel Reduction/Ecological Burn
Fuel Reduction/Ecological Grazing
Fuel Reduction/Ecological Slashing

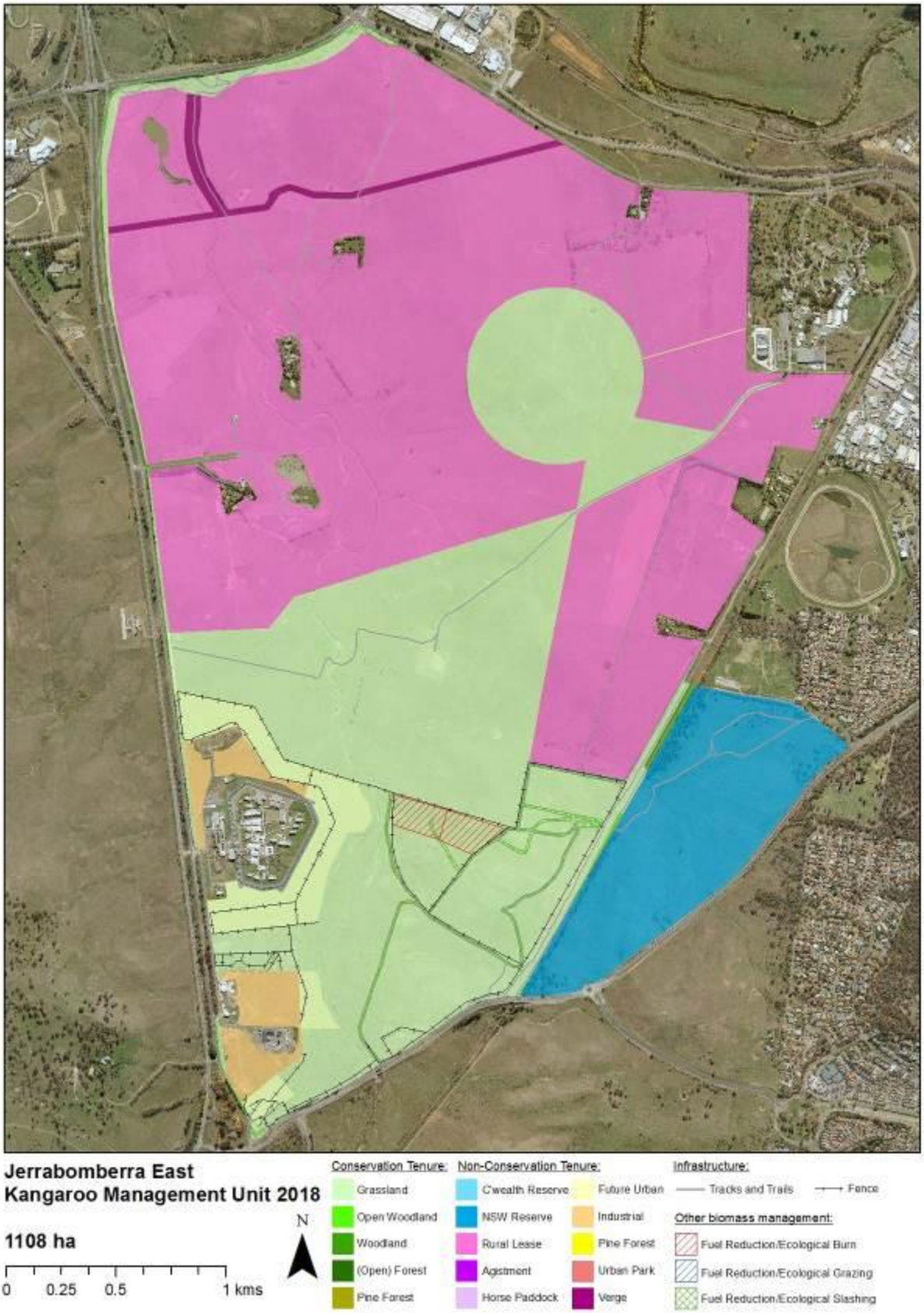

Callum Brae
Kangaroo Management Unit 2018
143 ha
0 0.125 0.25 0.5 kms
N
Conservation Tenure:
Grassland
Open Woodland
Woodland
(Open) Forest
Pine Forest
Non-Conservation Tenure:
C'wealth Reserve
NSW Reserve
Rural Lease
Agistment
Horse Paddock
Future Urban
Industrial
Pine Forest
Urban Park
Verge
Infrastructure:
Tracks and Trails
Fence
Other biomass management:
Fuel Reduction/Ecological Burn
Fuel Reduction/Ecological Grazing
Fuel Reduction/Ecological Slashing

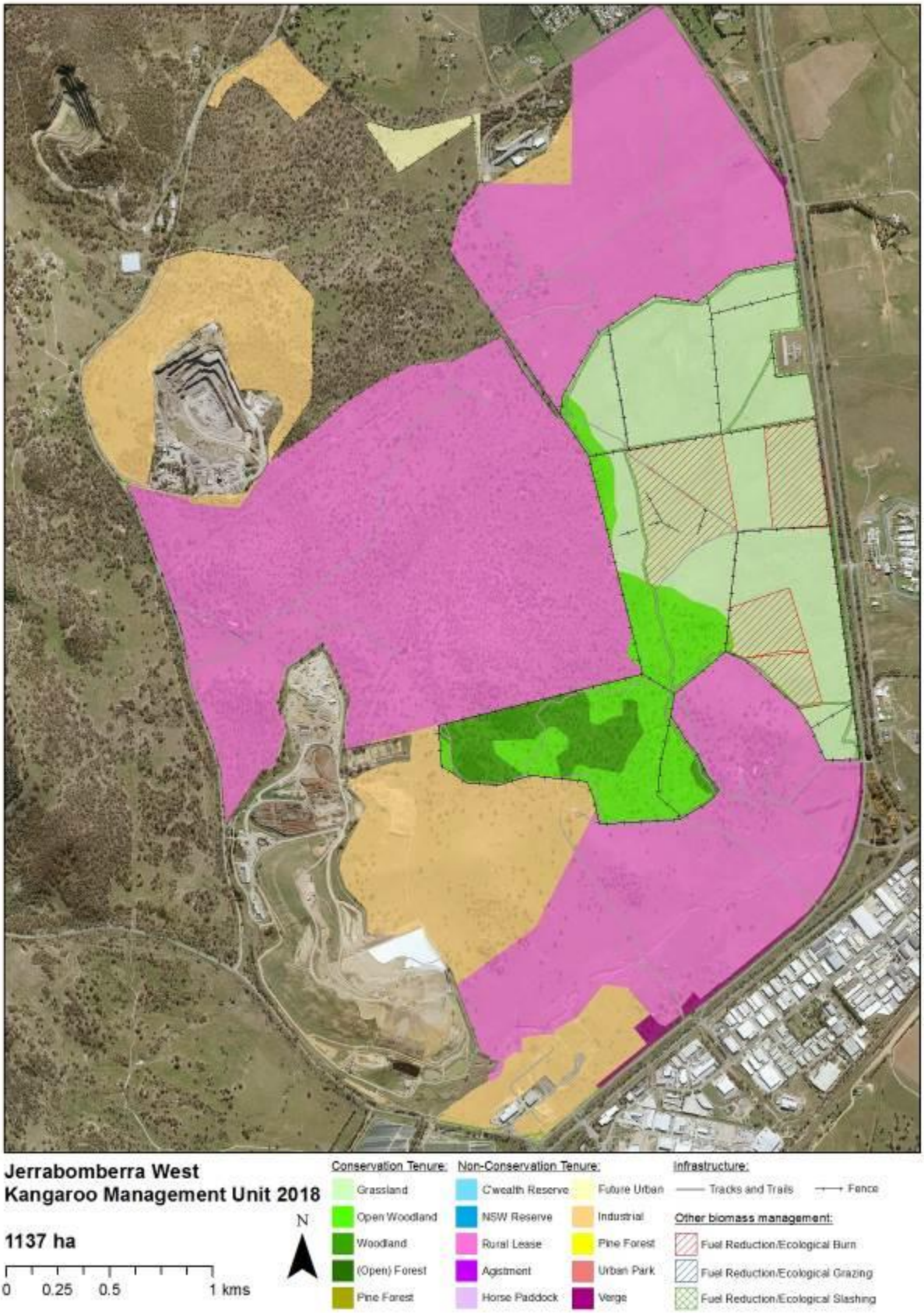

Crace
Kangaroo Management Unit 2018
180 ha
0
0.15
0.3
0.6 kms
N
Conservation Tenure:
Grassland
Open Woodland
Woodland
(Open) Forest
Pine Forest
Non-Conservation Tenure:
C'wealth Reserve
NSW Reserve
Rural Lease
Agistment
Horse Paddock
Future Urban
Industrial
Pine Forest
Urban Park
Verge
Infrastructure:
Tracks and Trails
Fence
Other biomass management:
Fuel Reduction/Ecological Burn
Fuel Reduction/Ecological Grazing
Fuel Reduction/Ecological Slashing

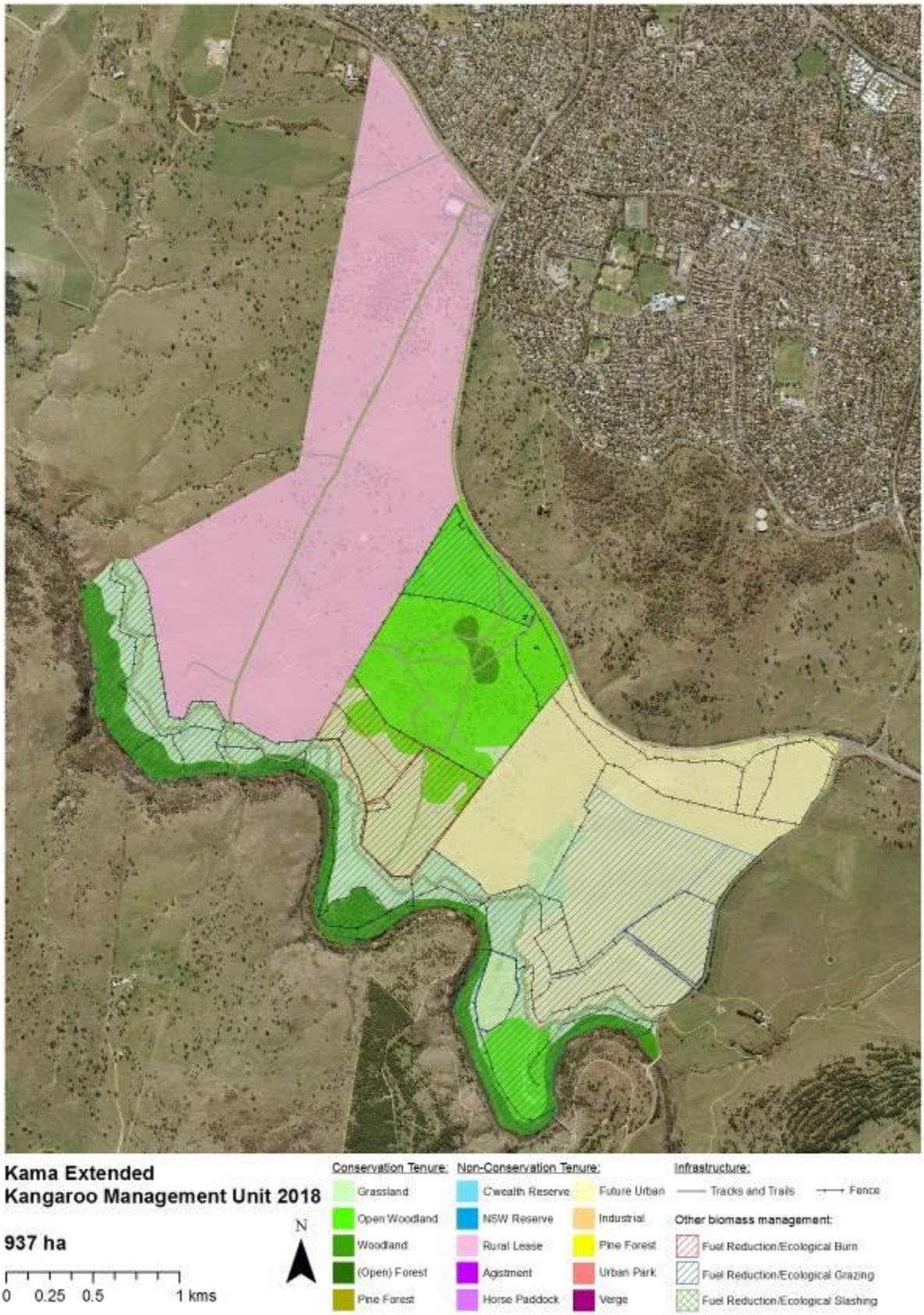

Googong West
Kangaroo Management Unit 2018
1755 ha
0 0.75 1.5 3 kms
N
Conservation Tenure:
Grassland
Open Woodland
Woodland
(Open) Forest
Pine Forest
Non-Conservation Tenure:
C'wealth Reserve
NSW Reserve
Rural Lease
Agistment
Horse Paddock
Future Urban
Industrial
Pine Forest
Urban Park
Verge
Infrastructure:
Tracks and Trails
Fence
Other biomass management:
Fuel Reduction/Ecological Burn
Fuel Reduction/Ecological Grazing
Fuel Reduction/Ecological Slashing


Dunnarts Flat (112 ha)
Forest Exclosure (38 ha)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Goorooyarroo
Kangaroo Management Unit 2018
874 ha
0 0.3 0.6 1.2 kms
N
Conservation Tenure:
Grassland
Open Woodland
Woodland
(Open) Forest
Pine Forest
Non-Conservation Tenure:
C'wealth Reserve
NSW Reserve
Rural Lease
Agistment
Horse Paddock
Future Urban
Industrial
Pine Forest
Urban Park
Verge
Infrastructure:
Tracks and Trails
Predator Fence
Fence
Other biomass management:
Fuel Reduction/Ecological Burn
Fuel Reduction/Ecological Grazing
Fuel Reduction/Ecological Slashing

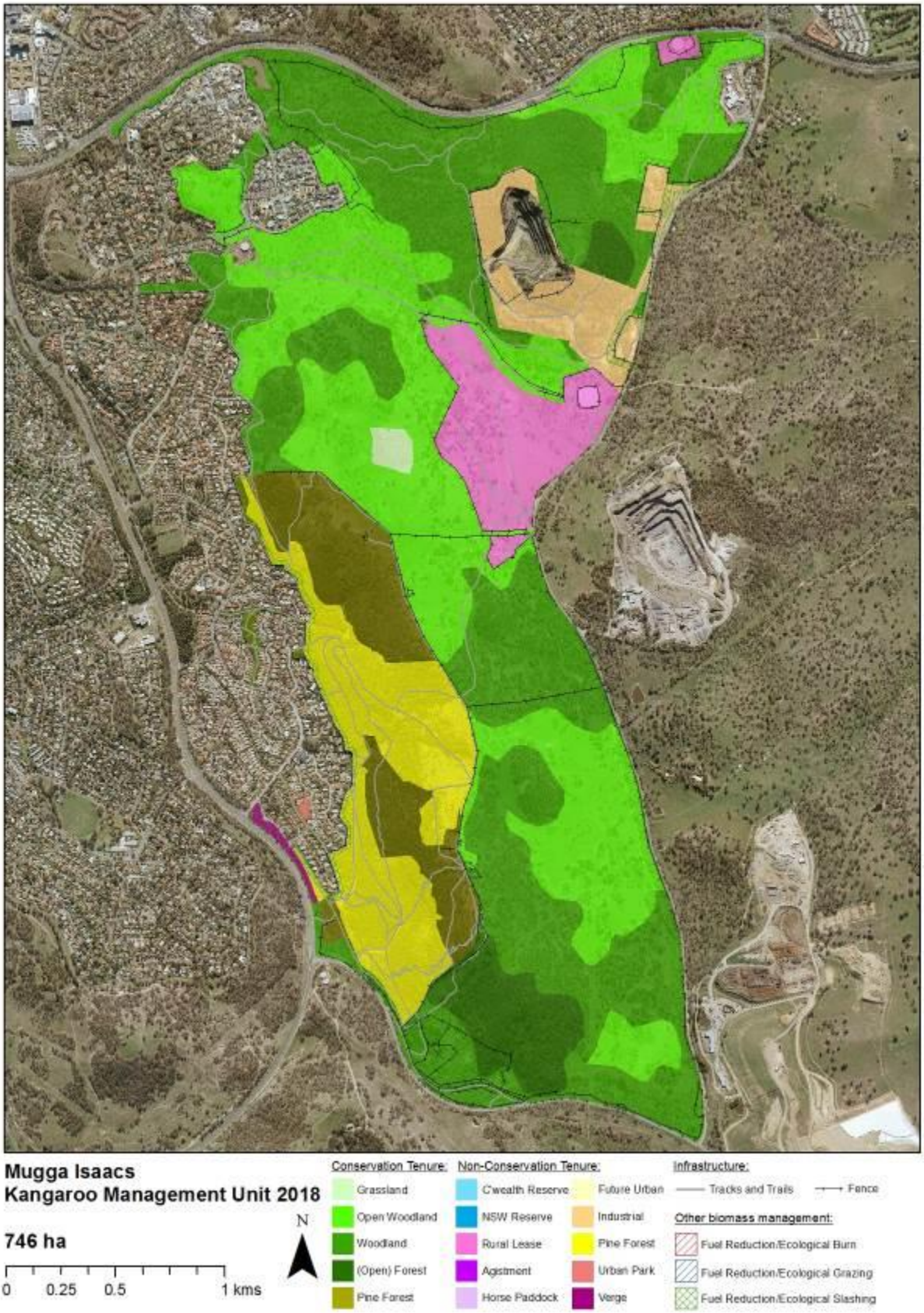

Gungaderra
Kangaroo Management Unit 2018
364 ha
0 0.25 0.5 1 kms
N
Conservation Tenure:
Grassland
Open Woodland
Woodland
(Open) Forest
Pine Forest
Non-Conservation Tenure:
C'wealth Reserve
NSW Reserve
Rural Lease
Agistment
Horse Paddock
Future Urban
Industrial
Pine Forest
Urban Park
Verge
Infrastructure:
Tracks and Trails
Fence
Other biomass management:
Fuel Reduction/Ecological Burn
Fuel Reduction/Ecological Grazing
Fuel Reduction/Ecological Slashing


Jerrabomberra East
Kangaroo Management Unit 2018
1108 ha
0 0.25 0.5 1 kms
N
Conservation Tenure:
Grassland
Open Woodland
Woodland
(Open) Forest
Pine Forest
Non-Conservation Tenure:
C'wealth Reserve
NSW Reserve
Rural Lease
Agistment
Horse Paddock
Future Urban
Industrial
Pine Forest
Urban Park
Verge
Infrastructure:
Tracks and Trails
Fence
Other biomass management:
Fuel Reduction/Ecological Burn
Fuel Reduction/Ecological Grazing
Fuel Reduction/Ecological Slashing


Jerrabomberra West
Kangaroo Management Unit 2018
1137 ha
0 0.25 0.5 1 kms
N
Conservation Tenure:
Grassland
Open Woodland
Woodland
(Open) Forest
Pine Forest
Non-Conservation Tenure:
C'wealth Reserve
NSW Reserve
Rural Lease
Agistment
Horse Paddock
Future Urban
Industrial
Pine Forest
Urban Park
Verge
Infrastructure:
Tracks and Trails
Fence
Other biomass management:
Fuel Reduction/Ecological Burn
Fuel Reduction/Ecological Grazing
Fuel Reduction/Ecological Slashing

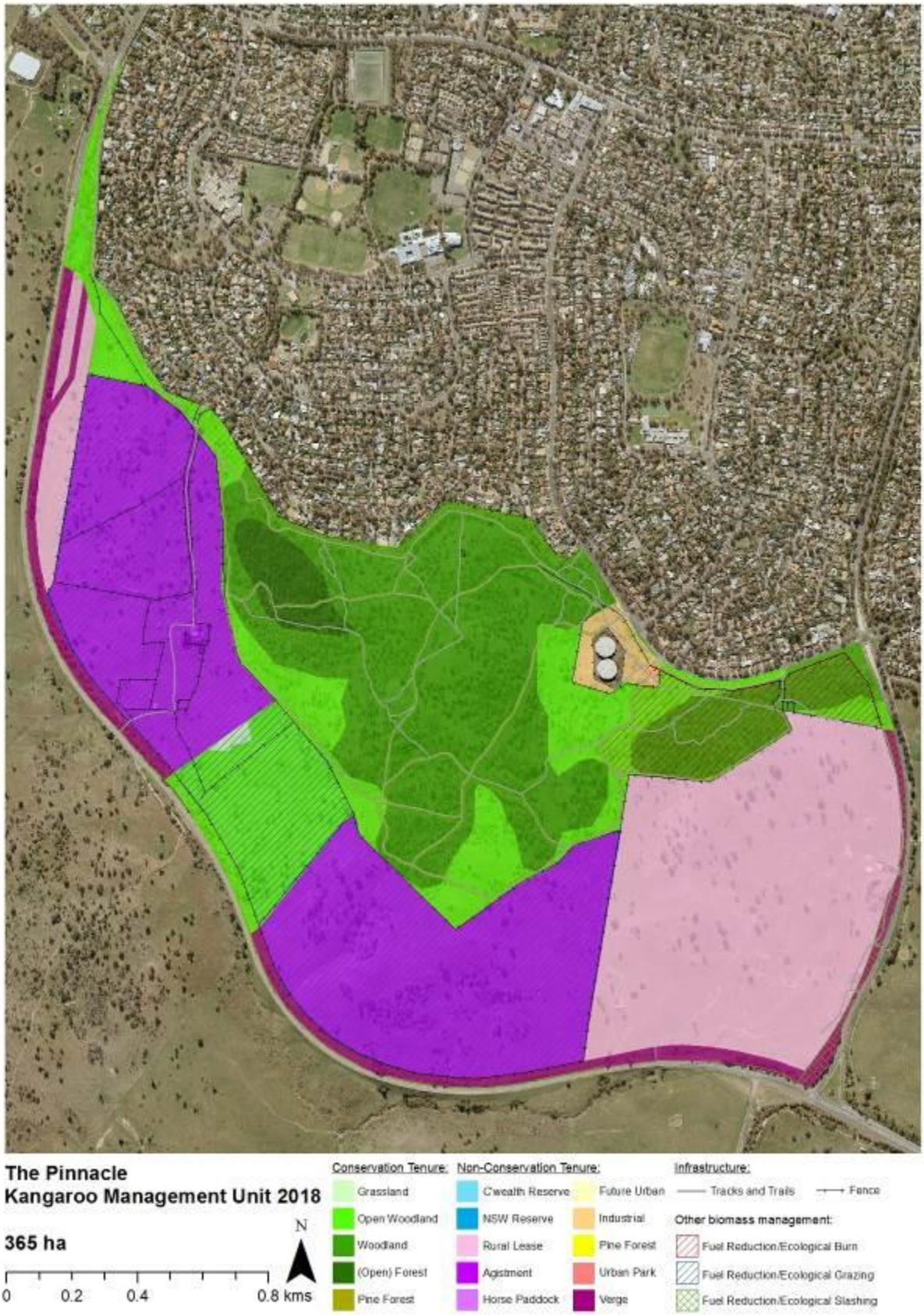

Kama Extended
Kangaroo Management Unit 2018
937 ha
0 0.25 0.5 1 kms
N
Conservation Tenure:
Grassland
Open Woodland
Woodland
(Open) Forest
Pine Forest
Non-Conservation Tenure:
C'wealth Reserve
NSW Reserve
Rural Lease
Agistment
Horse Paddock
Future Urban
Industrial
Pine Forest
Urban Park
Verge
Infrastructure:
Tracks and Trails
Fence
Other biomass management:
Fuel Reduction/Ecological Burn
Fuel Reduction/Ecological Grazing
Fuel Reduction/Ecological Slashing

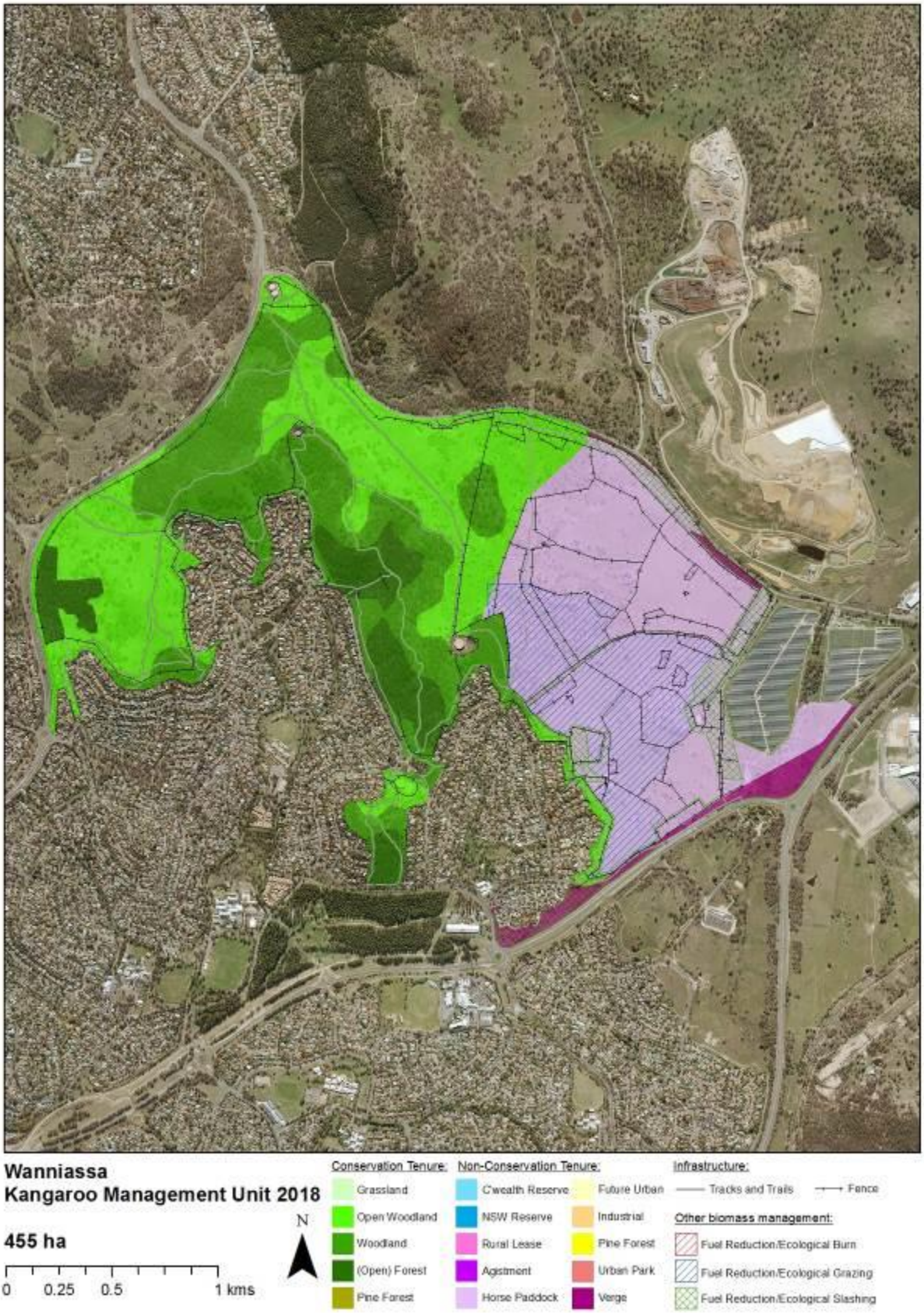

Mount Painter
Kangaroo Management Unit 2018
208 ha
N
0
0.15
0.3
0.6 kms
Conservation Tenure:
Grassland
Open Woodland
Woodland
(Open) Forest
Pine Forest
Non-Conservation Tenure:
C'wealth Reserve
NSW Reserve
Rural Lease
Agistment
Horse Paddock
Future Urban
Industrial
Pine Forest
Urban Park
Verge
Infrastructure:
Tracks and Trails
Fence
Other biomass management:
Fuel Reduction/Ecological Burn
Fuel Reduction/Ecological Grazing
Fuel Reduction/Ecological Slashing


Mugga Isaacs
Kangaroo Management Unit 2018
746 ha
0 0.25 0.5 1 kms
N
Conservation Tenure:
Grassland
Open Woodland
Woodland
(Open) Forest
Pine Forest
Non-Conservation Tenure:
C'wealth Reserve
NSW Reserve
Rural Lease
Agistment
Horse Paddock
Future Urban
Industrial
Pine Forest
Urban Park
Verge
Infrastructure:
Tracks and Trails
Fence
Other biomass management:
Fuel Reduction/Ecological Burn
Fuel Reduction/Ecological Grazing
Fuel Reduction/Ecological Slashing


Mulanggari
Kangaroo Management Unit 2018
162 ha
0
0.15
0.3
0.6 kms
N
Conservation Tenure:
Grassland
Open Woodland
Woodland
(Open) Forest
Pine Forest
Non-Conservation Tenure:
C'wealth Reserve
NSW Reserve
Rural Lease
Agistment
Horse Paddock
Future Urban
Industrial
Pine Forest
Urban Park
Verge
Infrastructure:
Tracks and Trails
Fence
Other biomass management:
Fuel Reduction/Ecological Burn
Fuel Reduction/Ecological Grazing
Fuel Reduction/Ecological Slashing


Hatchets (24 ha) and NW (13 ha) Exclosures
East (9 ha) and West (9 ha) Exclosures
Dam Paddock (77 ha)
Mulligans Flat
Kangaroo Management Unit 2018
352 ha
0
0.25
0.5
1 kms
N
Conservation Tenure:
Grassland
Open Woodland
Woodland
(Open) Forest
Pine Forest
Non-Conservation Tenure:
C'wealth Reserve
NSW Reserve
Rural Lease
Agistment
Horse Paddock
Future Urban
Industrial
Pine Forest
Urban Park
Verge
Infrastructure:
Tracks and Trails
Fence
Predator Fence
Other biomass management:
Fuel Reduction/Ecological Burn
Fuel Reduction/Ecological Grazing
Fuel Reduction/Ecological Slashing


The Pinnacle
Kangaroo Management Unit 2018
365 ha
N
0
0.2
0.4
0.8 kms
Conservation Tenure:
Grassland
Open Woodland
Woodland
(Open) Forest
Pine Forest
Non-Conservation Tenure:
C'wealth Reserve
NSW Reserve
Rural Lease
Agistment
Horse Paddock
Future Urban
Industrial
Pine Forest
Urban Park
Verge
Infrastructure:
Tracks and Trails
Fence
Other biomass management:
Fuel Reduction/Ecological Burn
Fuel Reduction/Ecological Grazing
Fuel Reduction/Ecological Slashing


Wanniassa
Kangaroo Management Unit 2018
455 ha
0 0.25 0.5 1 kms
N
Conservation Tenure:
Grassland
Open Woodland
Woodland
(Open) Forest
Pine Forest
Non-Conservation Tenure:
C'wealth Reserve
NSW Reserve
Rural Lease
Agistment
Horse Paddock
Future Urban
Industrial
Pine Forest
Urban Park
Verge
Infrastructure:
Tracks and Trails
Fence
Other biomass management:
Fuel Reduction/Ecological Burn
Fuel Reduction/Ecological Grazing
Fuel Reduction/Ecological Slashing

ACT Government

Environment, Planning and Sustainable Development Directorate

March 2018