



WINTON WETLANDS KANGAROO MONITORING PROGRAM RESULTS 2022

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1 Introduction and background

1.1. Ecological, social, and economic impacts of overabundant macropods

The active management of kangaroo populations is controversial and often polarising because kangaroos are viewed both as a national wildlife icon, valuable to tourism and the national identity, and yet also as a potential pest species for those involved in primary industries¹.

High-density populations of Eastern Grey Kangaroos (EGKs) have been associated with perceived (yet not often quantified) losses to primary industries through competition for food resources or reductions in crop yield². Kangaroos are known to graze selectively and, at times, heavily enough to have a negative impact on fauna and flora through depletion of habitat³. With increasing crossover between spaces used by humans and kangaroos, kangaroos are also known to create a heightened risk to human safety through increased risk of road traffic accidents⁴.

1.2. Current Victorian kangaroo control/pet meat legislation

Within Victoria, there are two means with which landholders can gain authority to control EGK populations by lethal means. Landholders can apply through Department of Environment, Land, Water & Planning (DELWP) for an Authority to Control Wildlife (ATCW). An ATCW permits the control of wildlife that is damaging property, farmland, or habitat, or posing a risk to the safety of people. An ATCW is required to scare, trap, move or destroy wildlife and comes with a range of conditions that must be adhered to under the *Wildlife Act 1975*. The number of ATCW's issued for EGKs has steadily increased from 1,250 permits in 2012 (maximum number of animals destroyed 44,469) to 2,849 permits in 2018, where over 150,000 kangaroos were permitted to be destroyed.⁵ In 2021 however, the ATCW permits issued dropped to 1514 (maximum number of animals destroyed 51,769)⁶.

Additionally, landholders can arrange for the commercial harvesting of their local kangaroo populations through the Kangaroo Pet Food Trial (KPFT) that has been implemented under the Victorian Kangaroo Harvest Management Plan. A key purpose of establishing Victoria's kangaroo harvesting program is to provide landholders with an alternative to undertaking their own legal kangaroo control. This program links landholders to registered 'harvesters' who are operating in their zone. The total sustainable kangaroo harvesting rate in Victoria is currently 10% of the estimated population. Estimated populations were calculated via state-wide aerial surveys conducted in 2017, 2018 and 2020.

The total sustainable harvesting rate in New South Wales is also calculated as a percentage of the total estimated population size⁷, whilst in the ACT, their culling program sets density targets of 1 kangaroo per hectare in grasslands, 0.9/ha for open woodlands and 0.5/ha for woodlands.⁸

1.3. Previous kangaroo surveys at Winton Wetlands

Formal EGK surveys have been conducted at Winton Wetlands by Steve Hamilton from Hamilton Environmental Services and by Winton Wetlands staff in September 2013 and in spring 2019, 2020 and 2021. These surveys utilised line transect (distance sampling) methodology to determine that Winton Wetlands had approximately 0.13 kangaroos per hectare in 2013 and 0.33 kangaroos per hectare in 2019, 0.45 kangaroos per hectare in 2020 and 1.38 kangaroos per hectare in 2021. No active kangaroo management was carried out after any of the previous surveys.

¹ Pople and Grigg 1999

² Coulson, 2007; Descovich et al., 2016

³ Neave and Tanton, 1989; Meers and Adams, 2003; Barton et al., 2011; Dorrough et al., 2012; Manning et al., 2013; Howland et al., 2014; McIntyre et al., 2014; Howland et al., 2016; Snape et al., 2018

⁴ Abu-Zidan et al, 2002; Coulson, 2007; Descovich et al., 2016; Brunton et al., 2018

⁵ DELWP, 2019

⁶ DELWP, 2021

⁷ Office of Environment and Heritage NSW, 2011

⁸ ACT Government, 2017

2 Kangaroo population estimation, September 2022

2.1 Ground Survey Methods

We employed line transect methodology for surveying macropod density. This is a well-established and precise⁹ methodology, successfully utilised by several ecologists to survey macropods throughout the 1980s and 1990s¹⁰. This was also the method employed by Hamilton (2013) in his initial macropod survey at the reserve, so for the benefit of direct comparison, we attempted to replicate Hamilton's study methods as closely as possible.

Line transect surveys were carried out between 7.00 am and 10.00 am by Winton Wetlands employees on three separate occasions during September 2022 (31st August, 7th and 14th September). All transects (See Table 2 and Figure 1 for details) were surveyed concurrently to reduce the incidence of double-counting kangaroos on the reserve. In the interests of comparison, we also utilized Hamilton's 'regional' approach to macropod population estimation, where the reserve was divided into four geographic regions- Northern, Southern, Eastern and South-Western (Figure 2). Transect number 9 and transect number 16 were not sampled due to lack of vehicular access (water) (Table 1).

Surveys were carried out by an observer driving slowly (20-25km/h) in a vehicle along a marked out transect line and recording any kangaroos sighted along this transect. For each kangaroo sighting, the number of individuals in the 'mob' was recorded. The distance of this mob from the observer was then calculated using a laser rangefinder and the angle (from the transect line) recorded using a standard compass (Figure 3).

All raw data for the current (and previous) surveys is recorded and stored on the Winton Wetlands Sharepoint Drive.¹¹

Table 1. The details of the seventeen transects surveyed in September 2022. *Note: transect 7 from Hamilton's surveys was not sampled. Instead, we sampled a new transect number 20. * denotes transects unable to be sampled*

Region	Transect	Description	Length (km)	Direction (°)	Start		End	
					easting	northing	easting	northing
SW	1	Dam wall	7.068	300	412241	5965002	415307	5959493
SW	2	North Road	2.636	150	412281	5964103	413219	5961897
SW	3	Flynn's Track	1.248	60	413219	5961897	414356	5962466
SW	4	SW link track	1.373	150	414356	5962466	415107	5961303
SW	5	SW link track	1.706	160	415107	5961303	415531	5959559
SW	6	Flynn's Bike Path	2.89	340	415809	5963192	417103	5960629
S	8	Winton North Road	3.884	30	418411	5960100	421793	5965451
S	9*	Firebreak (Hernans Tk)	4.712	30	419045	5961065	422321	5963601
S	10	Lunette Track	2.676	360	419772	5962320	419152	5965108
S	11	Ashmeads Swamp Rd	1.602	120	421331	5964764	422414	5963667
E	12	Humphries Lane	4.879	30	421793	5965451	425294	5967081
E	13	Boggy Bridge Road	3.554	330	421873	5965609	420459	5968661
E	14	NE Track	2.464	70	421700	5969441	423893	5970590
E	15	Firebreak alignment	1.228	160	424079	5970630	424660	5969599
E	16*	Tom's track	5.037	290	424197	5966508	422691	5969956
E	17	Firebreak alignment	3.535	180	424660	5969599	424343	5966547
N	18	Pipeline track	10.204	45	412268	5964473	420485	5968529
SW	19	Flynn's Track	1.588	60	414356	5962466	415809	5963192

⁹ Glass *et al.*, 2015

¹⁰ (e.g. Coulson 1979; Morgan 1979; Coulson and Raines 1985; Clancy *et al.* 1997; Morgan 1979; Southwell 1994)

¹¹ L>Restoration Science>Terrestrial Ecology>Fauna>Native Species>Kangaroo Management>2022 Survey

SW	20	Boardwalk alignment	2.70	10	415758	5963223	415126	5965545
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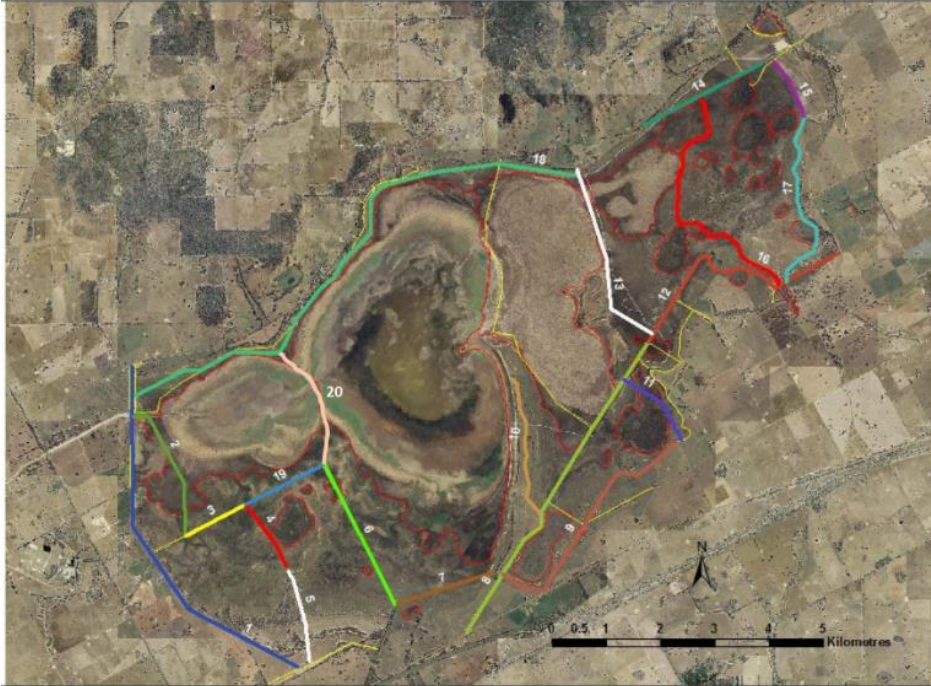


Figure 1. Aerial map of the twenty transects surveyed at Winton Wetlands Reserve in 2021 (map from Hamilton (2013), with additional transect 20 added)

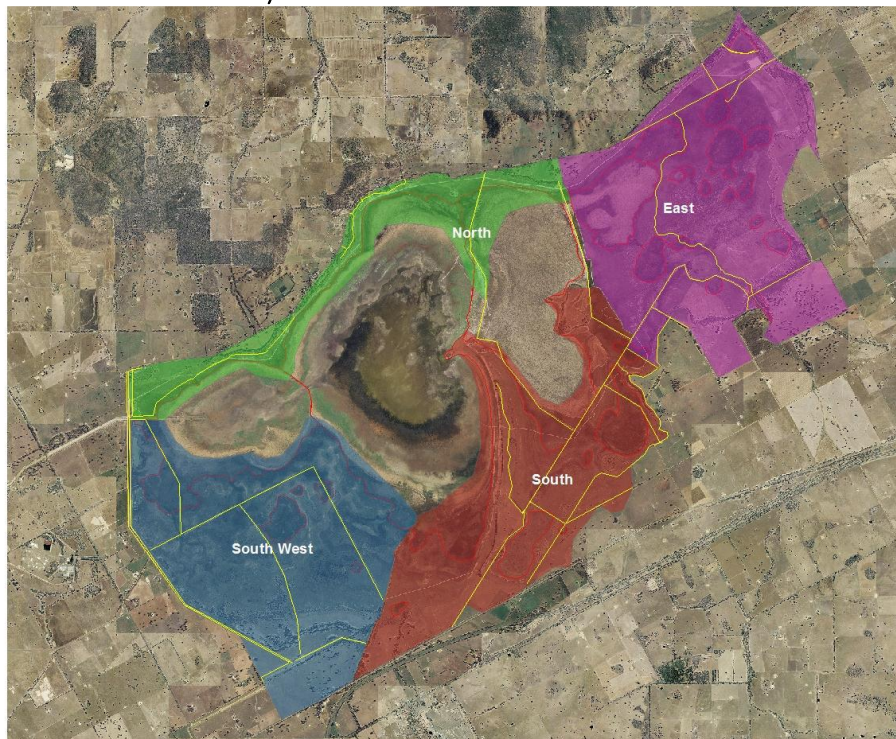


Figure 2. Map of defined 'regions' from Hamilton (2013), also used within our ongoing survey work (2019-2022)

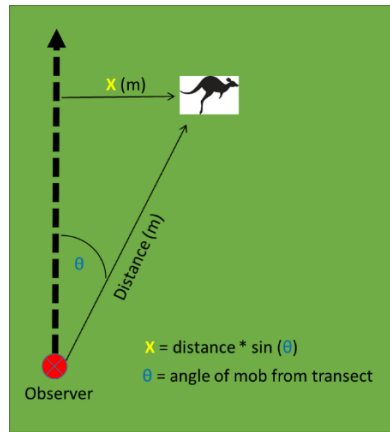


Figure 3. Illustration of survey method in the field. Observer travelling along transect in car measures distance from kangaroo mob using laser rangefinder and angle from mob using standard compass. A simple trigonometric formula allows calculation of X (m).

3 Survey Results

Raw data (distances, angles, and mob sizes) from the surveys were entered into a Microsoft excel spreadsheet. Distance 'x' (otherwise known as the perpendicular distance (m)) was calculated for each group of macropods observed using the formula $x = \text{distance (m)} * \sin(\theta)$.

These data were used in conjunction with the Distance (Buckland *et al.*, 2003) software package to model how detectability decreases with increasing distance from the transect. This allows estimation of total population density of macropods in the surveyed area (Table 3). These density estimates could then be extrapolated to the total area of available habitat on the reserve.

3.1 DISTANCE density and abundance estimate

Table 4. Eastern Grey Kangaroo density and abundance estimates calculated during each of three surveys (September 2022) using the conventional distance sampling software DISTANCE (Buckland *et al.* 2003). ^ indicates insufficient data collected and therefore no analyses

Survey date	Effort ^a (km)	N ^b	Model ^c	P ^d	Density ^e (no./ha)	Density ^f CI	CV ^g (%)	Abundance ^h	Abundance ⁱ CI	ESW ^j (m)
31/08/2022	55.3	148 (2507)	HR Cos	0.41	1.46	1.00-2.13	19	9383	6439-13674	158
07/09/2022	55.3	143 (1981)	HR Cos	0.44	0.79	0.51-1.21	22	5049	3271-7794	194
14/09/2022	55.3	143 (2639)	HR Cos	0.41	1.31	0.84-2.02	22	8389	5417-12993	178

^aThe distance of line transects surveyed within each of the regions, "All" is all data pooled together from that survey event

^bThe number of kangaroo 'mobs' or clusters, with the total number of Eastern Grey Kangaroos observed during each survey in parentheses

^cThe most suitable detection function model and adjustments used to calculate Eastern Grey Kangaroo density and abundance (Buckland *et al.* 2003). -X = negative exponential, HR= Hazard-rate, HN= Half normal, Uni= Uniform, Cos= cosine adjustments, Poly= Polynomial adjustments, Herm= Hermite Polynomial adjustments

^dThe unconditional probability of detecting a kangaroo within the surveyed area (Buckland *et al.* 2003)

^eThe estimated density of Eastern Grey Kangaroo

^fThe 95% confidence interval for the density estimate

^gThe coefficient of variation (percentage) of the density estimate

^hThe estimated abundance of Eastern Grey Kangaroo within the surveyed area

ⁱThe 95% confidence interval for the abundance estimate

^jThe Effective Strip Width (ESW) in metres where there is an unconditional probability of detecting an Eastern Grey Kangaroo in the surveyed area (Buckland *et al.* 2003)

There were too few (n=8 total over 3 survey days) Black tailed Swamp Wallabies (BTWs) sighted to conduct any meaningful analyses.

During this survey 2507, 1981 and 2639 EGK were counted by observers across the approximately 55kms of transect surveyed. These EGK were in 148, 143 and 143 clusters, respectively. EGKs were observed in larger mobs up to over 100 individuals, however the average cluster size observed was 16 EGK.

EGK density estimates for the whole reserve ranged from 0.79-1.46 EGK/ha. These density estimates appear to be reasonable, given the modest values for the coefficient of variation (18-22%). Pooled data averaged across the three surveys was used to generate an overall mean EGK density for the reserve of 1.18 EGK/ha and there is a 95% chance that EGK density across the whole reserve was 0.97-1.38 EGK/ha. The abundance estimates were calculated using an available land area of 6428 ha. Given that the terrestrial area available for kangaroos to dwell has reduced substantially during inundation, this area is more accurately 5000 ha. Based on the density of 1.18 EGK/ha and the availability of approximately 5000 ha of land (most of the Red gum swamp areas are now underwater or too wet to inhabit) on the reserve, we believe that the reserve currently carries approximately 5900 EGK.

4 Discussion of results

4.1 Comparison with previous ground survey results

As we replicated the methods (and where possible the observers) for the on-ground survey we can directly compare the results of earlier surveys with 2022 density results. In 2020, we estimated a density of 0.45 EGK/ha (approximately 4000 EGK) on the reserve, slightly higher than the previous year (Figure 5). In 2021 we estimated a density that was approximately three times higher than that of 2020 (Figure 5), whilst in the most recent survey, density estimates have stabilised and were slightly lower than 2021 (Figure 5).

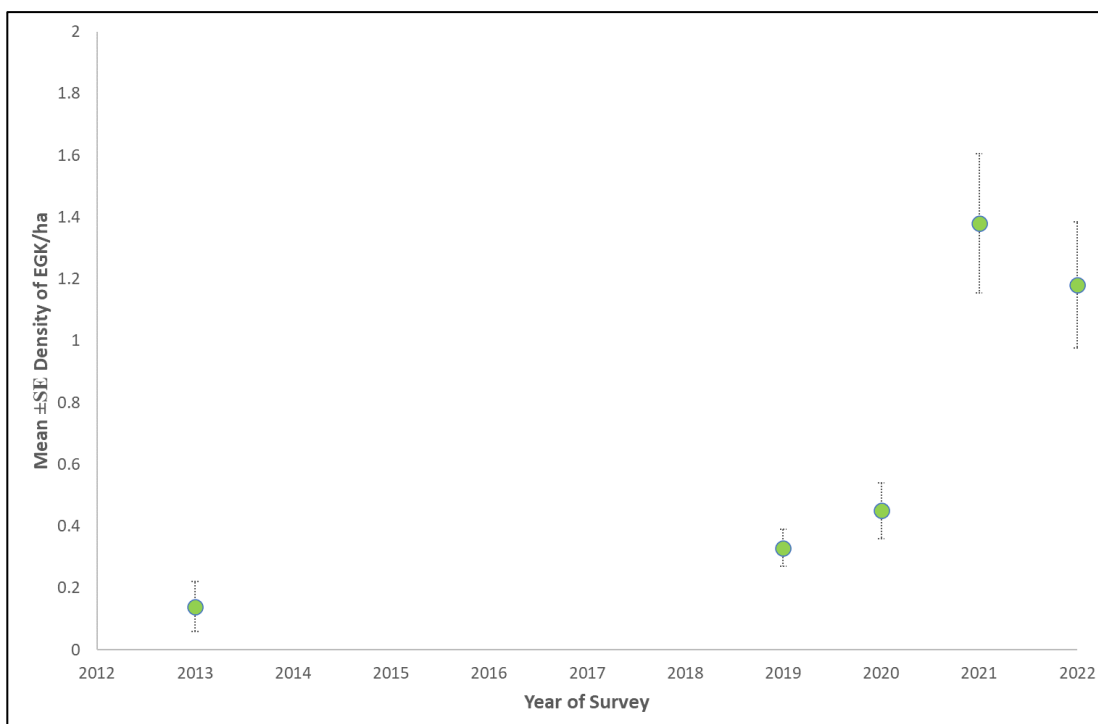


Figure 5. The average density (\pm S.E., EGK/ha) of Eastern Grey Kangaroos at Winton Wetlands Reserve, surveyed in Spring 2013, 2019, 2020, 2021 and 2022

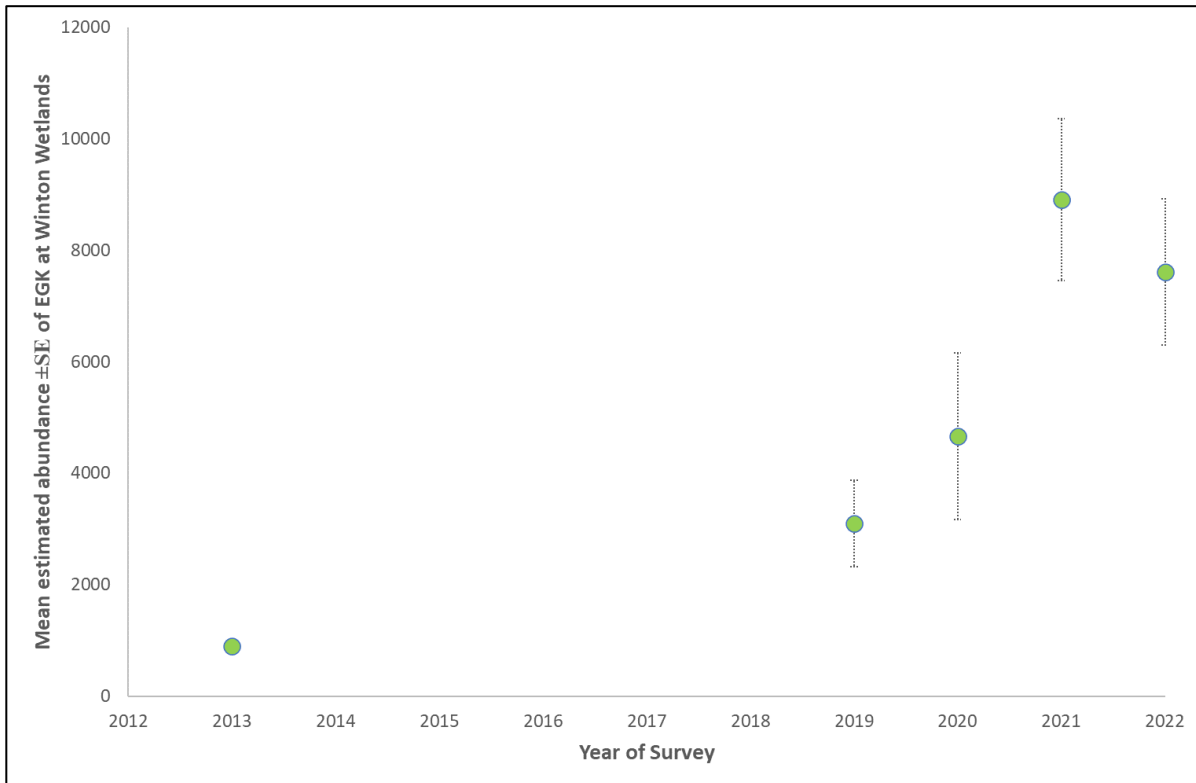


Figure 6. The average estimated abundance (\pm S.E.) of Eastern Grey Kangaroos at Winton Wetlands Reserve, surveyed in Spring 2013, 2019, 2020, 2021 and 2022 (calculated based on an available land area of 6428ha).

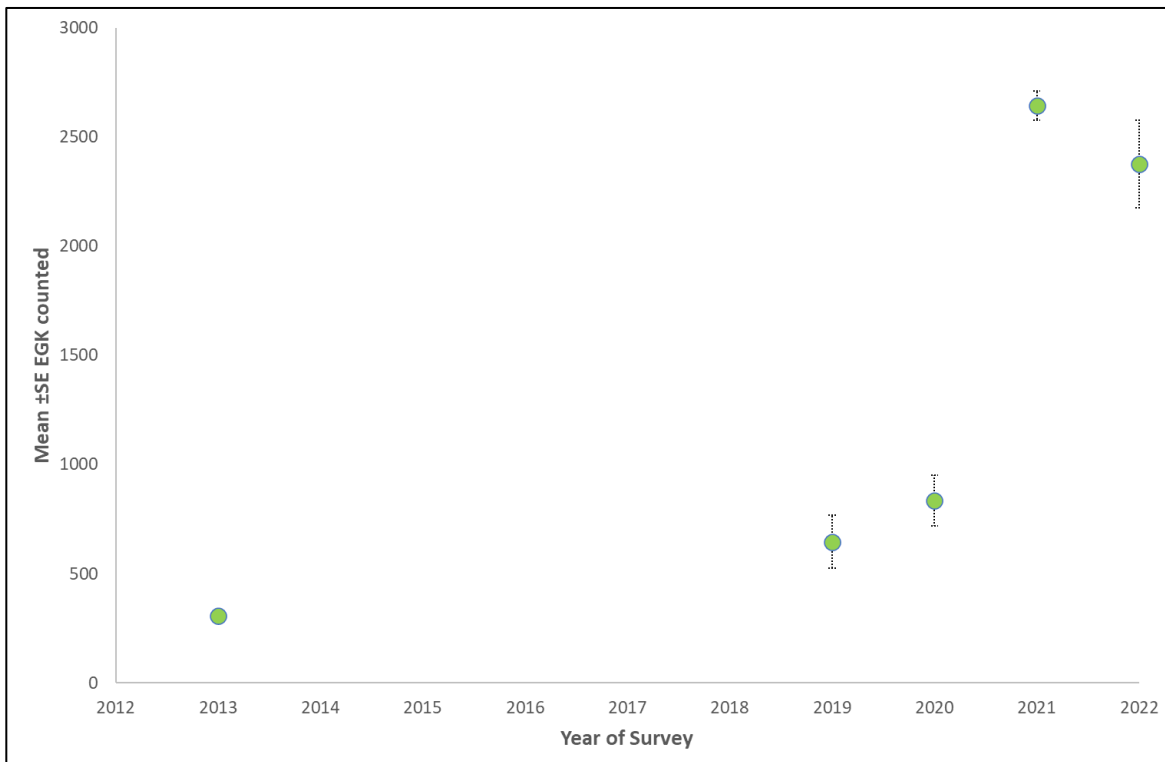


Figure 7. The average number (\pm S.E.) of Eastern Grey Kangaroos counted during spring surveys at Winton Wetlands Reserve (surveyed in Spring 2013, 2019, 2020, 2021 and 2022).

4.2 Factors affecting Eastern Grey Kangaroo population/density

Kangaroo populations are known to expand and contract owing to a complex relationship between rainfall, resource availability, fecundity, and mortality (Caughley et al., 1984; Caughley et al., 1987; Davis et al., 2003; Fletcher, 2006; McLeod et al., 2021). It is highly likely that the increase in food resource availability (possibly as a result of greater rainfall; Figure 8) at Winton Wetlands could be one factor driving the increase in EGK densities measured in the 2021 surveys (compared with the 2020 surveys) and why the density has remained at around the same level in 2022.

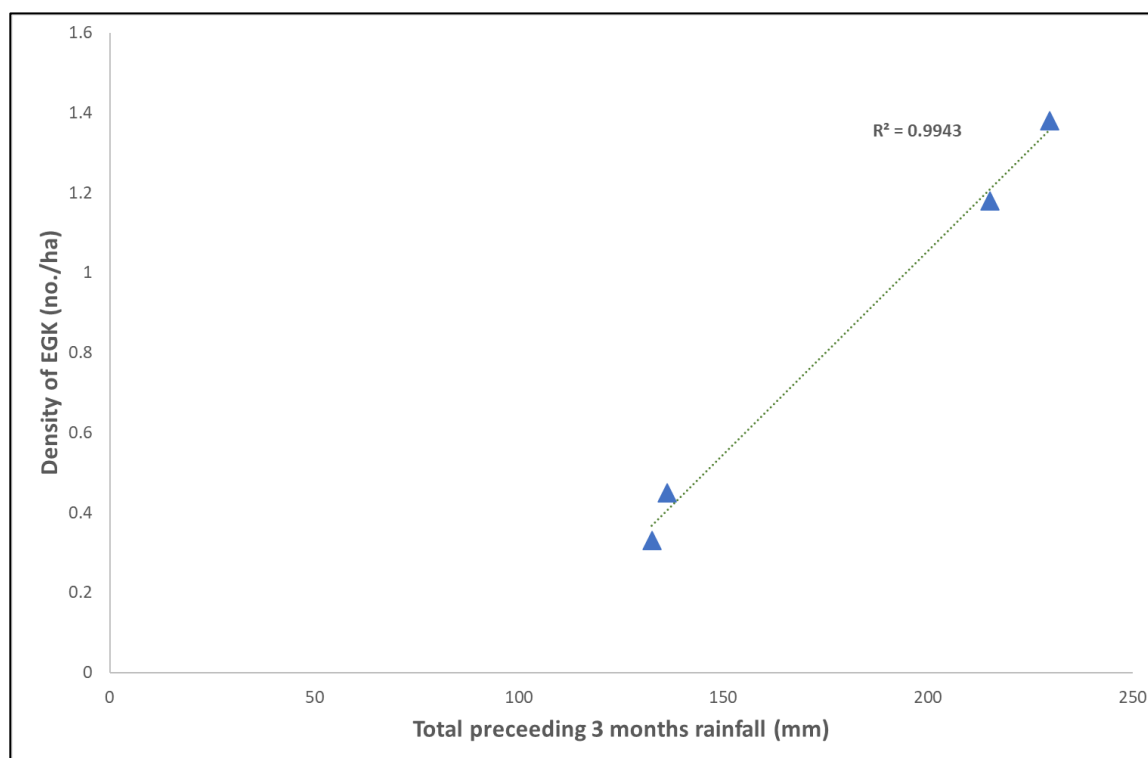


Figure 8. The average density of Eastern Grey Kangaroos counted during spring surveys at Winton Wetlands Reserve in relation to preceding winter rainfall (rainfall total recorded at Benalla Airport June, July, August).

4.3 Comparison with previous surveys and kangaroo densities elsewhere in Victoria/Australia

It is difficult to compare what we have found at Winton Wetlands in 2021 with anywhere else in Victoria as the next state-wide aerial surveys are not scheduled until 2022. Estimated EGK densities from aerial surveys of non-forested areas of the north east region (the region in which the reserve lies) have decreased from 0.12 EGK/ha in 2018 (Moloney et al., 2018) to 0.10 EGK/ha in 2020 (Ramsay and Scroggie, 2020; Moloney et al., 2021). EGK abundance estimates have reduced from 288,000 for the north-east region in 2018 to 239,850 in 2020 and 221,100 in 2021 (Ramsay and Scroggie, 2020; Moloney et al., 2021; Ramsay and Scroggie, 2021). The 2021 abundance estimates are predicted only as no state-wide aerial survey data was collected at that time. Further aerial survey data is needed to validate the predictive kangaroo abundance modelling at the state level.

Whilst the EGK densities reported in this survey (1.18 EGK/ha) are far higher than those in the north-east region (in 2020), they are relatively low compared to areas where active kangaroo management activities are the norm. In the ACT, EGKs have been recorded at densities as high as 7 EGK/ha (Jerrabomberra Nature Reserve) and are largely >1 EGK/ha across all of the kangaroo management areas in the territory (ACT Government, 2017).

5 Macropod management actions at Winton Wetlands

5.1 Managing for kangaroos or managing for conservation/restoration outcomes?

Our data collected during 2022 have confirmed that estimated kangaroo densities at Winton Wetlands (1.18 EGK/ha) have stabilised.

It is very easy to simply label kangaroos as the ‘problem’, where in reality the true definition of the problem (from all stakeholder’s perspectives) is not ‘overabundant kangaroos’ (Coulson, 2007). Instead, the problems are more accurately defined as things like decreased neighbouring crop yield, failure of regeneration or revegetation efforts or increased road accidents etc. It is important to clearly define these potential problems, explore whether kangaroos are indeed the *cause* of these through research and if so, plan to manage the kangaroo population to reduce the ‘problem’ (not to just reduce the kangaroo population). Recent publications advocate for a commitment to management focussed on achieving pasture outcomes rather than reduction in kangaroo population density per se (Snape et al., 2021).

5.2 Quantifying kangaroo related problems

5.2.1 Impacts on revegetation and regeneration of flora

Whilst acknowledging the presence of a variety of herbivores on Winton Wetlands reserve, we have little *quantified* understanding of the impact of herbivory on our restoration efforts. In a discussion with Andie Guerin from the Regent Honeyeater Project, he highlighted that as kangaroo densities have increased:

- There has been an increase in damage to newly planted tubestock by kangaroos (and hares) and there is now an increased necessity for using taller (900mm) guards during tree planting work. This is increasing the on-ground cost of revegetation work on the reserve.
- There has been increasing physical damage to tree guards and stakes (kangaroo strikes)
- The ‘tastier’ shrub species are struggling to establish due to selective kangaroo browsing and are struggling to reach a height beyond 900mm high.

WWCoM has seen the successful development of canopy vegetation through the 2014/15 large scale revegetation works and has also observed highly successful tubestock and direct seeding works conducted by GBCMA in 2017 along the Lunette.

Andie has also suggested that strategically planting canopy vegetation close to existing old trees or fence posts is decreasing the amount of kangaroos striking and damaging tree guards and stakes. This method is of no use in the establishment of mid storey species as there are not enough natural objects in the landscape in which to plant next to. He has also suggested that they may trial the use of temporary fencing in some instances in order to take the pressure of the youngest plants.

With all of this information in mind, **our new research and development** plan (to be provided to Universities this Spring) will include research topics that specifically examine the impacts of herbivores (including kangaroos, rabbits, hares and wallabies) on native and introduced plants at Winton Wetlands and test the efficacy of innovative on-ground solutions (such as the fencing) to some of these negative impacts. These research opportunities will be circulated to local universities in an effort to engage post graduate student participation.

Our **updated revegetation plan** will include goals for pasture and revegetation outcomes and suggest how, through measuring pasture and revegetation outcomes, we can make a better informed decision with regards to the necessity of local kangaroo culls.

5.2.2 Increased road collisions

There has been ongoing concerns from local residents with regards to the increase in the incidence of cars colliding with kangaroos along Lake Mokoan Road. Whether or not this is due to increases in kangaroo

densities, or simply an increase in road traffic using the thoroughfare has yet to be determined. One simple way to potentially reduce the incidence of kangaroo collisions would be to reduce the speed limit along Lake Mokoan Road. Winton Wetlands would support the local neighbours in a bid to reduce the speed limit along the length of the road to 80km/h. In studies of kangaroo collisions in the ACT, most kangaroo collisions occurred in areas with speed limits above 60 km/h (Dunne and Doran, 2021). It follows that a reduction in the speed limit will actively reduce the likelihood of kangaroo collisions and increase the response time of the drivers to on road hazards.

5.3 Ongoing macropod population monitoring and management at Winton Wetlands

Due to the fact that kangaroos are highly mobile grazing species, any active management (such as culls) should be applied at a large scale. Whilst Winton Wetlands provides kangaroos with highly suitable habitat in which to shelter and feed, the reserve is not fenced, hence the local macropods represent an ‘open population’ that allows for both emigration and immigration of animals. This movement of animals into and out of the reserve represents an issue when considering any culling activity. Our ongoing broadscale efforts at fox control are largely being negated by the constant emigration of new foxes into the landscape from neighbouring untreated land. A similar situation would exist should we consider localised culling of kangaroos in the reserve.

A statement released in 2021 on “Improving Kangaroo Management” recognises the need to apply kangaroo management methods at larger scales (Read et al., 2021). It states the need for the establishment of both Regional Kangaroo Management Groups (that have input from land managers, ecologists, Indigenous, welfare, industry, government and conservation stakeholders) and also advocate for the creation of a National Kangaroo Strategy. Winton Wetlands would be an active participant in any regional kangaroo management group that was to form as a result of these recommendations.

This year’s kangaroo density results suggest that our kangaroo population has stabilised (when compared to 2021 results), but is still considerably higher than during drier times (2019, 2020). This increase in population density may represent a true increase in population size; however, we would encourage the readers of this report to consider the *true drivers* of this density increase. The increase in rainfall and hence food resource availability (and resulting increase in successful breeding), combined with the marked decrease in available habitat (at least 3750 ha of area was inundated at the time of surveys) may well be driving the density increase in EGK at Winton Wetlands. As the wetlands have inundated and the terrestrial habitat decreased, the kangaroo population has clustered and moved to the higher ground. This has highly likely resulted in us 1) counting more kangaroos in total during the surveys and 2) counting larger mobs of kangaroos. The consistency of the density results in 2021 and 2022 lend further support to this argument as both surveys have been conducted during inundation events.

The benefit of long-term monitoring of our kangaroo population is that we can begin to track changes in density with changes in resource availability and understand the ‘booms’ and ‘busts’ in both kangaroo populations and their associated available food and habitat resources. To gain a more complete understanding of the nuances in local kangaroo population fluctuations, we need to gather further years of information – four years of data is a great start but is by no means a long-term trend. As such we will not be pursuing any active kangaroo management at this stage. We believe that the consistent collection of this local kangaroo population information will be vital to establishing any potential culling targets within the region, should the need exist to conduct those activities in the future.

Macropod population monitoring will continue at the wetlands on an annual basis, in early spring, following the same ground-based methods as outlined for previous surveys. This will allow us to track long term annual changes in the population density and examine any correlation between resource and habitat availability and local kangaroo density/population estimates. These data will assist us in adjusting our management activities when/where necessary. Methods used in this, and Hamilton (2013) study are easily

replicated, and staff requirements and costs are minimal. WWCOW owns 3 laser rangefinders and 3 compasses that can be used for future surveys. It took 27 staff hours total to complete the field component of the survey work (three staff for three hours per morning for 3 mornings). The three vehicles used would only use a maximum of a tank of fuel each, meaning overall ongoing annual costs of the survey are likely to be approximately \$1500-\$2000 including staff pay.

Appendix I: Raw data collection sheet pro forma (from Hamilton 2013)

Transect Number	Section	Start Time	Finish Time	Species	Number	Distance (m)	Angle (°)
				K or W			
				K or W			
				K or W			
				K or W			

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