KANGAROO MANAGEMENT RESEARCH WORKSHOP

SUMMARY REPORT

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Front cover: Photo of a group of Eastern Grey Kangaroos taken during a sweep count within Canberra Nature Park. Photo credit: Don Fletcher.

CONTENT

BACKGROUND

A kangaroo management research workshop was held in Canberra on the 21st of August 2018, to discuss and review recent research relating to the management of Eastern Grey Kangaroo (hereafter 'kangaroo') grazing in ACT's nature reserves. The workshop drew upon the knowledge of national and international researchers combined with expertise on kangaroos and grassy ecosystem management from within the ACT (see delegate list in Appendix 1). The insights and conclusions from the workshop are to help in guiding the management of kangaroos by the ACT Government as part of a broader approach to the management of the ACT's endangered grassy ecosystems. This workshop supported the Government's commitment to ensuring evidence based, best practise land management by reviewing new and existing research and applying new information and learning.

The specific aims of the workshop included:

- Review of relevant kangaroo grazing research completed over the last decade, including optimal grassy habitat condition for maintaining/improving biodiversity;
- Review kangaroo management policy to date (i.e. appropriateness, effectiveness and feasibility of the current "one kangaroo per hectare in grasslands" approach to calculating target densities;
- Present, for discussion, a new functional response model;
- Assist in setting grassy-layer targets to promote conservation in individual reserves going forward;
- Determine a framework for future research priorities to allow the efficacy of any updated approaches to be assessed in terms of improved ground layer vegetation structure and biodiversity outcomes.

Summaries of the presentations from the day are provided below, along with the overall recommendations from the workshop.

KANGAROOS AND THEIR MANAGEMENT IN THE ACT

Claire Wimpenny

Eastern Grey Kangaroos are abundant across much of the ACT. In some urban nature reserves, heavy grazing by kangaroos is causing negative environmental impacts, including threatening endangered species and communities. Kangaroos are also causing economic and social impacts, with an estimated 14,000 vehicles striking a kangaroo on ACT roads each year. Kangaroo management, for any purpose in the ACT, is undertaken in accordance with the Eastern Grey Kangaroo: Controlled Native Species Management Plan (ACT Government 2017). The goals of this plan are to maintain populations of kangaroos, whilst managing and minimising their impacts.

In 2009, culling of kangaroos for conservation purposes commenced in selected ACT lowland nature reserves. Since the program began, 16 of the 39 reserves in the ACT have been culled at least once. Kangaroo counting and management is undertaken within Kangaroo Management Units (KMUs), which are areas of more than one land tenure, occupied by one kangaroo population and bounded by features known to inhibit kangaroo movement (ACT Government 2017, Figure 1). In recent years, between 30 and 40 KMUs have been counted in winter to inform management and research. GPS tracking has shown that adult kangaroos, in Canberra reserves, are extremely faithful to small home ranges and excursions away from these areas are rare (Figure 2).

Results from a public opinion poll in 2015 show that opposition to culling under any circumstances is low (7%), whilst support for conservation culling is high (76%; Micromex 2015), and has increased compared to before the culling program commenced (2008 - 59%; Micromex 2008).

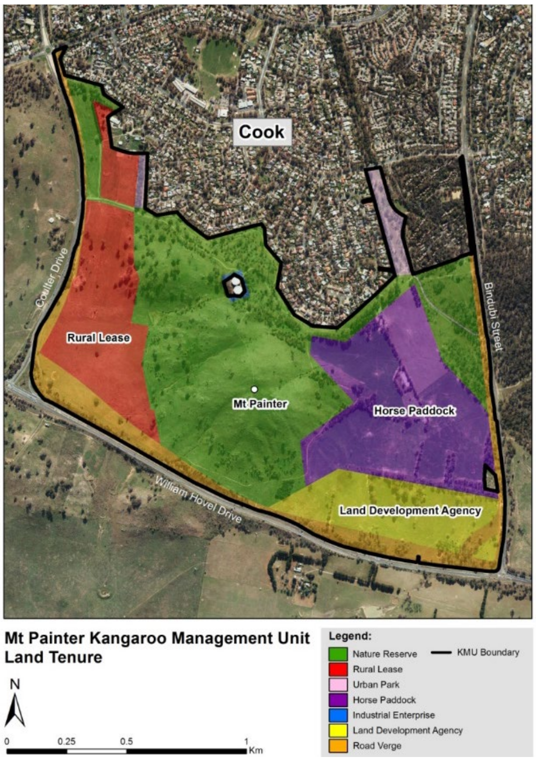

Figure 1. An example of a Kangaroo Management Unit (KMU).

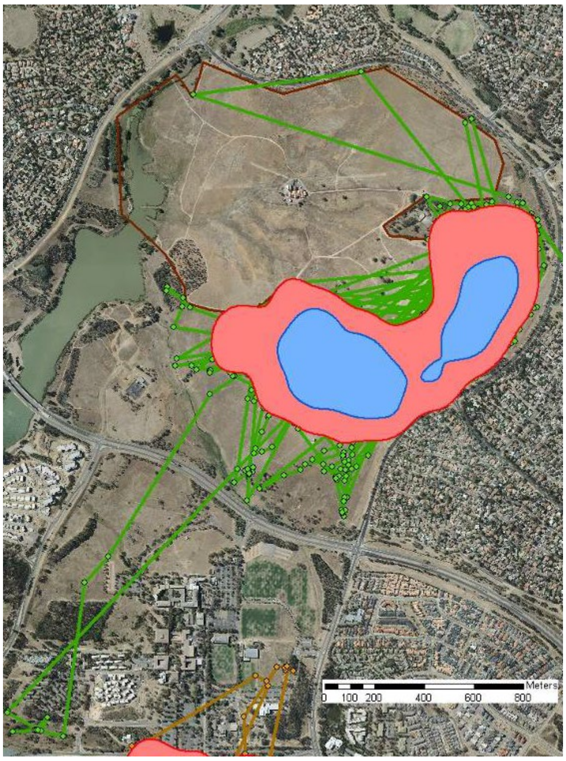

Figure 2. Annual home range and excursions of a female eastern grey kangaroo at Lawson, ACT, January 2019 to January 2010. The 90% kernel (red) and 50% kernel (blue) are overlayed on GPS locations (green points) recorded by a tracking collar.

POPULATION DYNAMICS IN EASTERN GREY KANGAROOS

Marco Festa-Bianchet

Individual survival, growth and reproduction of Eastern Grey Kangaroos has been monitored in a high-density, predator-free population at the Wilsons Promontory, Victoria, since 2008. Grass production in and out of exclosures, that prevent grazing by rabbits and larger mammals, has been monitored since 2009. Population dynamics appear mostly driven by changes in recruitment, which in turn are affected by grass availability (Figure 4). Grass availability also strongly influences daily offtake by the population (Figure 5). Adult mortality varies among years and may be related to changes in age structure, because survival of females aged 2-7 years has remained very high at about 92%. Kangaroos respond to decreases in grass availability by reducing both allocation to reproduction and their own body mass. Our research suggests that when forage is scarce, recruitment can fall to near zero, even though pouch young are still produced: in 3 of 9 years, fewer than 5% of adult females weaned a young. When sufficient forage is available, however, survival of pouch young to adulthood is high and populations can still increase despite densities of over 5 kangaroos/ha. Despite 10 years of monitoring, it remains unclear what role animal density plays in population dynamics, which appear driven mostly by forage availability, which in turns depends partly on rainfall.

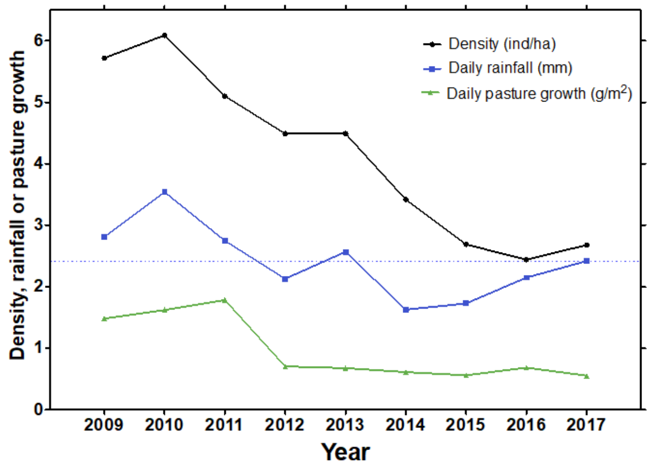

Figure 4. Trends in kangaroo density over time in relation to daily rainfall and pasture growth rates.

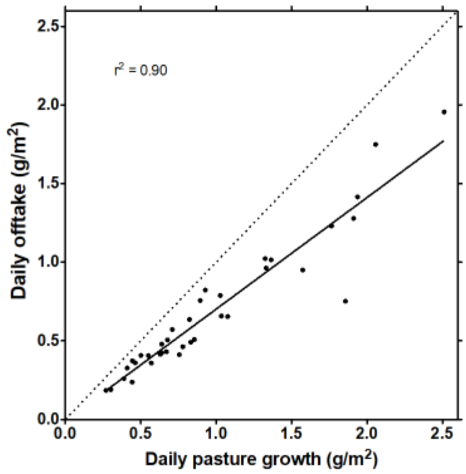

Figure 5. Relationship between pasture growth rates and daily offtake by kangaroos.

KANGAROOS, GRASS AND BIODIVERSITY

Brett Howland

Kangaroos can impact on ground layer biodiversity through altering grass structure. Changes in grass structure can influence thermoregulation, predation risk and food availability for ground foraging fauna species, as well as habitat suitability for flora. As grazing pressure increases, grass biomass (herbage mass) declines, grass structure is simplified and a very open, short structure remains. A lack of appropriate disturbance from grazing can also lead to a loss of structural variability under high herbage mass conditions. Research into the habitat requirements of reptiles and birds, in grassy ecosystems across south-eastern Australia, has found that different species (or functional groups) preferred different grass structures (Howland et al. 2014; Howland et al. 2016; Howland et al. 2016). More recent work has also identified a strong relationship between native plant richness and grass structure, with highest plant diversity found at intermediate grass heights in structurally diverse native grasslands (McIntyre et al. 2010).

To conserve a full complement of species, heterogeneity of grass structure needs to be promoted within and between the reserves in the ACT. Research undertaken by ACT Government has identified a ‘safe operating environment’ or “Limits of Acceptable Change” for grass structure represented by average grass heights of between approximately 6 and 10 cm (Figure 6). Average grass heights below 5 cm or above 12 cm may be detrimental to native biodiversity in grassy habitats in the ACT, depending on the specific resident taxa.

Appropriate grassy layer structure may be achieved through limiting the occurrence of excessively high and low grazing pressure, and through promoting selective, non-uniform grazing by animals across the landscape. Importantly, fire and natural variation in grass growth form and productivity due to grass composition, soil and topography can also promote heterogeneity.

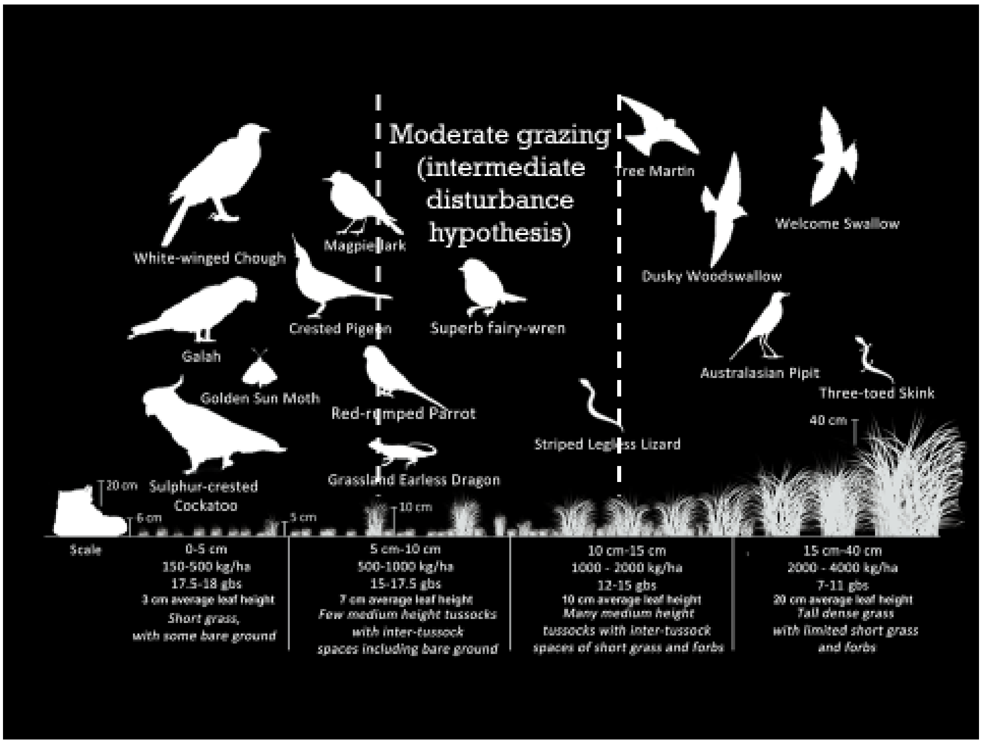

Figure 8. Grass structure preferences vary between different bird and reptile species. A ‘safe operating environment’ target of 6 – 12 cm has been identified as a management target, to promote a variable grassy layer structure which supports a breadth of biodiversity.

CALCULATION OF THE NUMBER OF KANGAROOS TO CULL IN CANBERRA RESERVES, 2010-2017

Don Fletcher

Based on an empirical model of weather, growth of ground-layer vegetation, measured functional response of female Eastern Grey Kangaroos (EGK) and kangaroo population numerical response, it was decided that, on average across sites and years, reducing kangaroo populations from 2 to 7 EGK/ha down to 1.0 EGK/ha in temperate grassland would be associated with increased herbage mass sufficient for tussocky grass structures to develop. Decision rules were developed to calculate numbers of kangaroos licenced to be culled.

1. Kangaroo counting and management would be based on the Kangaroo Management Unit rather than the reserve.
2. Target density for the conservation land, averaged across sites and years, would be 1.0 EGK/ha in areas of grassland, 0.9 EGK/ha in areas of open woodland, 0.5 EGK/ha in woodland, and 0.1 EGK/ha in forest and open forest. Because vegetation composition is different for each reserve, the average target density (kangaroos/ha) is particular to each reserve.
3. An experienced ecologist would increase or decrease the calculated target density, for each area, each year, based on relevant factors. These include vegetation condition, expected seasonal conditions, cull history, alternative herbage mass management activities (e.g. use of fire or strategic livestock grazing), and management of adjoining areas. This process is comparable to agronomists using a combination of mathematical modelling tools and on-farm experience to manage pastures for livestock.
4. The number of kangaroos to cull would then be calculated as the current population, based on counting, minus the target population, allowing for annual population growth.

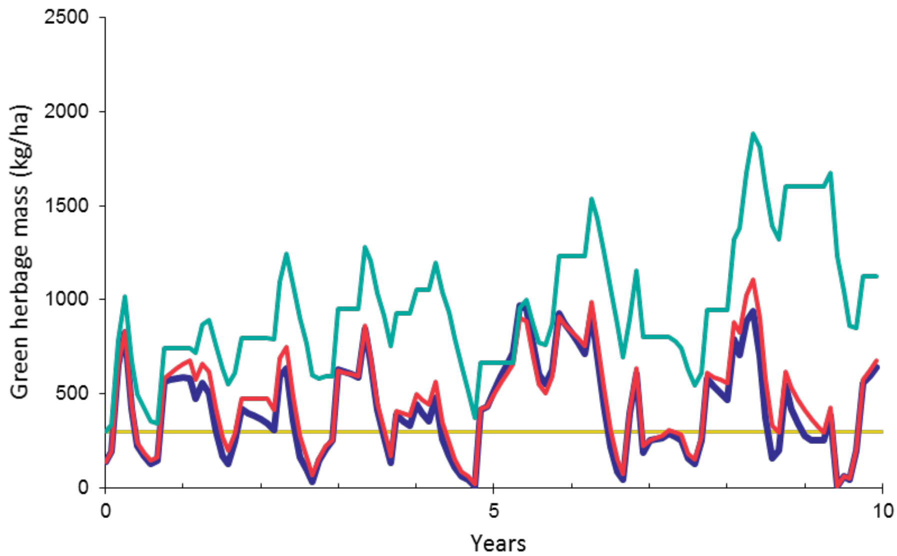

Figure 9. Modelled green herbage mass responses (kg/ha) to different kangaroo management regimes including no management (dark blue), commercial harvest/sustainable yield (red) and conservation culling to one kangaroo per hectare (green). Modelled based on typical climate and grass growth conditions for the area. The yellow line denotes the threshold for suitable grassy habitat identified at the time (minimum of 300 kg/ha), below which a loss of biodiversity and/or ecosystem function was expected.

TYPE IV FUNCTIONAL RESPONSE

Melissa Snape and Peter Caley

The interactions between ground layer vegetation composition and rates of off-take by Eastern Grey Kangaroos were examined, over four years, using paired quadrats with and without grazing exclusion cages (*n* = 150-180 pairs measured at six-monthly intervals across sites with densities of 0-7 EGK/ha). Where the grassy layer was dominated by native species (commonly *Themeda triandra, Austrostipa spp., Rytidosperma spp., Poa spp., Bothrichloa macra,* or *Microlaena stipoides*), kangaroo density had a significant positive effect on total offtake (kg DM/ha/day), but this effect was the weakest of the three variables considered (Figure 10). Off-take by kangaroos showed a strong, significant increase with increasing rates of grass growth, with offtake rates being near equivalent to those of growth under average model conditions (especially in autumn/winter). 'Standing crop', a measure of the existing herbage mass, was also found to significantly influence kangaroo offtake rates, with offtake initially increasing with the availability of grass to approximately 500-1000 kg DM/ha, but with the model predicting negligible offtake above 1500 kg DM/ha under average conditions. This latter result provides strong evidence for a Type IV functional response for Eastern Grey Kangaroos, suggesting that greater consideration of current herbage mass conditions, and expected grass productivity, at the Kangaroo Management Unit scale would improve the basis for kangaroo management in the ACT's conservation estate.

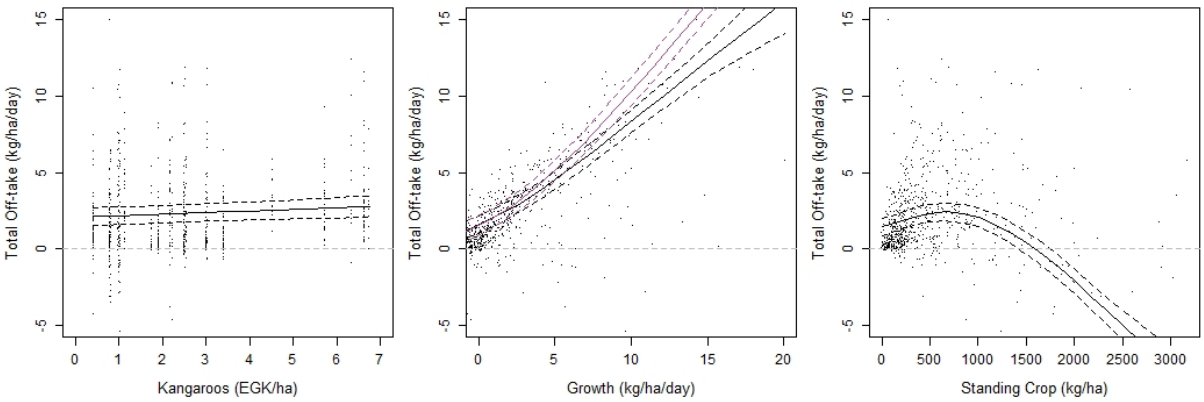

Figure 10. Kangaroo density, grass growth rates (autumn in purple, spring in black) and standing crop (existing herbage mass) were observed to significantly affect total pasture off-take by kangaroo populations (left to right).

USING MODELS TO PLAN GRAZING AND SET SUSTAINABLE STOCKING RATES

Doug Alcock

GrassGro is a valuable tool for modelling herbage growth and livestock production across a range of introduced pasture species, and a select group of native grasses (*Austrostipa* spp, *Rytidosperma* spp, *Poa sieberiana*, *Microlaena stipoidies* and *Bothriochloa macra*). GrassGro uses historical weather data to model variation in herbage production, in response to seasonal conditions, and can use current system state and a probabilistic approach to seasonal forecasts, to estimate near-term future pasture growth. Pasture growth data from GrassGro has been incorporated into spreadsheet-based feed budgeting tools which enable the user to estimate the impact of grazing strategies on residual herbage mass over time. Although insufficient information is currently available to directly parameterise the intake of kangaroos as a response to herbage quality and availability it would be possible to include kangaroos in the estimation of forage budgeting on the basis of their proportionality to commercial grazing animals.

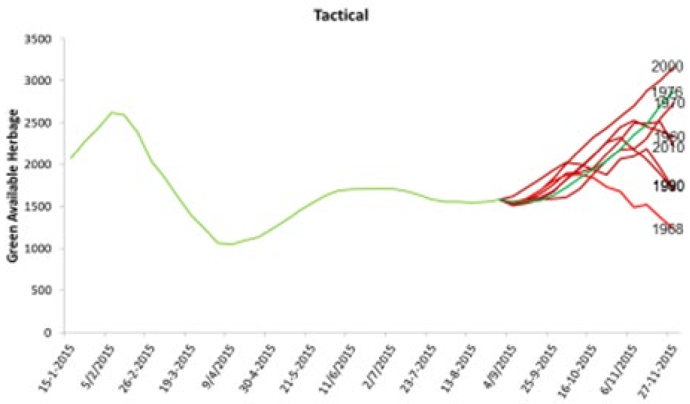

Figure 11. An example of near-term herbage productivity estimates produced by GrassGro models, to assist land managers in setting grazing densities appropriate to maintain target herbage mass conditions.

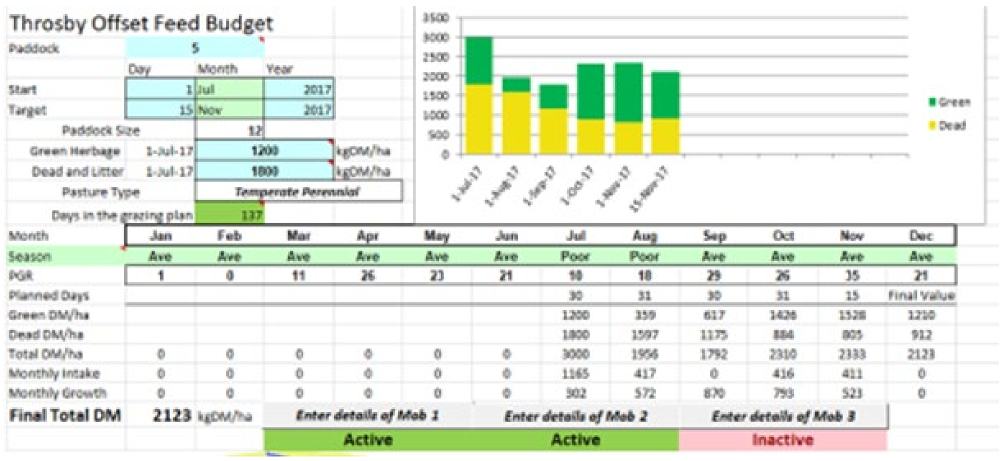

Figure 12. An example of the feed budgeting spreadsheets used to set appropriate grazing rates for achieving herbage mass targets.

KEY DISCUSSION POINTS RAISED IN THE WORKSHOP

REFLECTIONS ON CURRENT PROCESS

- Existing and new models should be seen as an exploratory tool, with predictions reflecting a generalized outcome under average conditions;
- The current modelling framework could be further improved to respond to seasonal and site-specific conditions, currently addressed based on the judgement of a professional ecologist;
- The influence of a Type IV functional response on achieving grassy layer targets through kangaroo management is worthy of further exploration;

MANAGEMENT GOALS

- The key management goal for Canberra Nature Park is the conservation of biodiversity. Biodiversity in grassy ecosystems is strongly linked to the ground layer vegetation, not the kangaroo density per se; therefore, the focus has to be on managing the grassy vegetation layer;
- An approach towards managing the grassy layer is determining the 'Safe Operating Environment' for key characteristics known to influence biodiversity responses, such as grass height, percentage of bare ground and thatch depth. Such 'Safe Operating Environments' are likely to be grassy community and/or reserve specific;
- The explicit definition of management & ecological objectives related to kangaroo management, in association with a targeted monitoring regime, will enable holistic evaluation of the program with respect to both management outcomes (feasible, achievable, challenges to implementation) & ecological outcomes (is biodiversity benefitting? How are other factors, like climate, influencing biodiversity responses?)

BASELINE KNOWLEDGE AND MONITORING

- Improved vegetation mapping of the ACT is required to provide improved reserve specific grassy layer targets, and subsequently EGK target density estimates and planning of other herbage mass management actions.
- Potentially, tracking to determine specific home ranges of EGK in different reserves would also aid in identifying carrying capacity estimates/appropriate management units (from an ecological perspective this information could be translated to a logistically feasible management unit);
- Weather predictions are important to assess future pasture growth. Improved weather forecasting information may be available from the Bureau of Meteorology. However, uncertainty still has to be included in the herbage growth predictions;
- The question of scale – are Kangaroo Management Units the scale at which vegetation responses occur? Kangaroo grazing patterns can vary greatly over several hectares leading to a single kangaroo management unit comprising very different grazing pressures (e.g. Majura West). A more accurate assessment of localised grassy layer condition, than at the Kangaroo Management Unit scale, is needed.
- Specific monitoring is required to provide information for decisions (support tool, mechanistic models) and to link actions vs outcomes through an adaptive management framework. Monitoring should include vegetation structure and composition,

threatened species (index) and kangaroo density such that knowledge of grazing within each reserve is known (or at least in those reserves considered priority).

- Monitoring program to track vegetation structure (as surrogate for threatened species habitat) needs to be designed to facilitate adaptive management.
- Kangaroo abundance estimates will also need to continue to enable culling recommendations to be made where relevant.
- Kangaroo management needs to consider other circumstantial info e.g. adjacent culling by rural lessees. This information will be strictly confidential and will not be provided publically.

OPERATIONAL AND IMPLEMENTATION CONSIDERATIONS

- In terms of Eastern Grey Kangaroo (EGK) management, the concept of risk is key to culling decisions. This should be related to the Safe Operating Environment, particularly at the lower threshold of the height or biomass of the grassy layer. The risk appetite is likely to be reserve specific;
- There may be a benefit to maintaining some level of culling in all years to retain expertise and keep a cap on populations to prevent the need for very large culls in “good” grass growth years, or high populations at the start of drought years, which would make dealing with “overgrazing” extremely difficult;
- In the reserves where past livestock grazing has been eliminated, or reduced, for even the most grazing sensitive species, the effects of current kangaroo grazing on ground-layer plant diversity are not strong. The provision of grass sward structural heterogeneity, through a selective grazing regime, is likely to be appropriate to maintain current fauna and plant diversity (McIntyre et al. 2003; McIntyre 2005). If possible, more precise grazing management (e.g. the use of repeated spring resting) would be needed to restore floristic composition (Mavromihalis et al. 2013). This may require additional management to keep mobile kangaroos from the area;
- Not all reserves can be culled every year. There is a need to prioritise which areas to cull. The decision framework for prioritisation could include:
    - The biodiversity values of the site
    - The threatened species present, the importance of the population of threatened species, their vulnerability to overgrazing
    - The size of the threatened ecological community on the site
    - The Safe Operating Environment for the site (thresholds)
    - The operational difficulty of EGK management on the site
    - The political context in which management will take place
- Within and between KMU/reserve options may be considered to promote biodiversity across the Canberra National Park, with different areas being managed to achieve different habitat and biodiversity outcomes.
- The operationalisation of reserve specific kangaroo culls has to take into account management feasibility, e.g. culling costs, migration into reserves, logistics, and uncertainty (sensitivity of parameters to error in estimation).
- It may be beneficial to identify the specific population elements to target to reduce post-cull rates of population increase, e.g. young females. However, this would require further research to assess the most effective demographic to target (NB: some data may exist from ACT cull records).

INTEGRATED MANAGEMENT

- Fire, slashing and livestock grazing could be used to maintain plant and animal diversity by reducing tall, dense or high biomass swards in high rainfall years. Fire could potentially also be used to balance sward composition when selective grazing favours the dominance of unpreferred species, but this application would require a high level of responsiveness in burning practices and expertise in sward composition;
- GrassGro could be used to inform grassland response (incorporation of other native species e.g. *Themeda* spp., *Austrostipa* spp.) The predictions from GrassGro need to be tested with local data. Observation by the GrassGro modelers suggests GrassGro over-predicts the growth of native grass species.
- In the reserves where past livestock grazing has been eliminated, or reduced, for even the most grazing sensitive species, the effects of current kangaroo grazing on ground-layer plant diversity are not strong. The provision of grass sward structural heterogeneity, through a selective grazing regime by kangaroos, is likely to be appropriate to maintain current fauna and plant diversity (McIntyre et al. 2003; McIntyre & Tongway 2005). If possible, more precise grazing management (e.g. the use of repeated spring resting), of both kangaroos and domestic stock, would be needed to restore floristic composition (Mavromihalis et al. 2013). This may require additional management to keep mobile kangaroos from the area.

SETTING KANGAROO CULLING TARGETS

1. Assess starting state of the vegetation at each reserve;
2. Assess if the reserve is a priority for culling (based on vegetation state, importance to conservation – see prioritization list above, likely influence of immigration (may need to cull cooperatively with neighbouring properties or cull to lower density if immigration is likely to be high), likely benefits of reducing grazing pressure, etc.)
   - If reserve is identified as a priority for culling, then;
3. Identify reserve-specific vegetation 'Safe Operating Environment' based on reserve-specific conservation values;
4. Identify reserve-specific target kangaroo density based on current herbage mass of native grassy layer and predicted growth/weather forecast;
5. If reserve is expected to pass appropriate grassy layer thresholds, cull kangaroos based on maximum per capita off-take predicted by the Kangaroo Culling Model;
6. Monitor effectiveness through measurements of key variables such as grass height, grass height variability, proportion of bare ground, depth of unattached grass thatch and the proportion of grass which is green. Whilst these measures will provide information of threatened species habitat, periodically, it will be important to also directly monitor threatened species abundance and diversity. NB - sometimes surrogate-target relationships break down due to different responses to underlying drivers → need to make sure that alterations to this relationship are detected so there are not perverse outcomes from management.

RECOMMENDATIONS

- Adopt management goal for grassy ecosystems based on the Safe Operating Environment (likely to be based on grass height between 5 and 15 cm);
- Improve understanding of the impacts of under-grazing on biodiversity
- Adopt risk-based management philosophy with the focus on the bottom end of the Safe Operating Environment (i.e. 5cm), noting that excessive herbage mass is likely an equal risk to some conservation values;
- The current model for the assessment of the kangaroo cull targets relies on 'expert ecological judgement' to enable sufficiently prescriptive culling recommendations to be made. The formula used to calculate the number of kangaroos to cull could be updated to consider current ecosystem condition with the new information as outlined above;
- Adopt a model such as 'GrassGro' to assess the requirement for any additional grazing pressure by sheep and cattle (current offtake and future targets);
- Consider demographic modelling (using age and sex structure data) to assess likely population responses to different culling models (e.g. biasing culling towards females to slow rate of increase);
- Operate the cull within an adaptive management framework (inform, act, monitor, review).
- Develop/refine a monitoring program with specific objectives (e.g. improve grassy layer habitat associated with positive biodiversity outcomes). The monitoring programme itself will have to be evaluated every 5 years.

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RELEVANT ACTS AND POLICY DOCUMENTS

Nature Conservation Act (2014)

https://www.legislation.act.gov.au/View/a/2014-59/current/PDF/2014-59.PDF

Eastern Grey Kangaroo: Controlled Native Species Management Plan (EGK: CNSMP; Disallowable Instrument under the Nature Conservation Act 2014).

https://www.legislation.act.gov.au/View/di/2017-37/current/PDF/2017-37.PDF

Nature Conservation (Eastern Grey Kangaroo) Conservation Culling Calculator Determination 2018 (Notifiable Instrument under the EGK: CNSMP)

https://www.legislation.act.gov.au/View/ni/2018-141/current/PDF/2018-141.PDF

Nature Conservation (Eastern Grey Kangaroo) Rural Culling Calculator Determination 2017 (Notifiable Instrument under the EGK: CNSMP)

https://www.legislation.act.gov.au/View/ni/2017-224/current/PDF/2017-224.PDF

ACT Kangaroo Management Plan (2010)

https://www.environment.act.gov.au/__data/assets/pdf_file/0020/902423/Kangaroo_Management_Plan_complete_for_web.pdf

APPENDIX

Attendee list

Dr Melissa Snape (organiser) (Melissa.Snape@act.gov.au) - Senior Fauna Ecologist, ACT Government Conservation Research Unit; responsible for oversight of kangaroo research (including new functional response models) and provision of kangaroo management advice for the ACT.

Dr Peter Caley (Peter.Caley@data61.csiro.au) – Senior Research Scientist at CSIRO Mathematical and Information Sciences (Data61); co-author and key collaborator on new kangaroo functional response model.

Dr Don Fletcher (don.fletcher@emailme.com.au) – former Senior Fauna Ecologist – Conservation Research; expert in kangaroo ecology, responsible for development of previous ACT kangaroo management framework.

Prof. Iain Gordon* (iain.gordon@anu.edu.au) – Honorary Professor, Fenner School of Environment and Society; expert in grazing management for conservation of natural resources and ecosystems.

Prof. Marco Festa-Bianchet (Marco.Festa-Bianchet@USherbrooke.ca) – Professor of Ecology, University of Sherbrooke; expert in population dynamics and conservation biology.

Dr Graeme Coulson (gcoulson@unimelb.edu.au) – Honorary Principal Fellow in the School of BioSciences, University of Melbourne; expert in kangaroo biology including population management.

Dr Tony Pople (Tony.Pople@daf.qld.gov.au) – Research Scientist for Department of Agriculture and Fisheries, Queensland Government; expert in population dynamics and wildlife management.

Dr Sue McIntyre (Sue.Mcintyre@csiro.au) – former Senior Principal Research Scientist at CSIRO Sustainable Ecosystems, and fellow at the Fenner School ANU; expert botanist, with background in the management of grazing for conservation in native vegetation.

Doug Alcock <doug@grazprophet.com.au> – Principal Consultant for Graz Prophet Consulting; expert in development (whilst at CSIRO) and now application of 'GrassGro' decision support tool for grazing management.

Claire Wimpenny (Claire.Wimpenny@act.gov.au) – Ecologist, ACT Government Conservation Research Unit; expert in urban kangaroo biology and management (including fertility control), and ACT kangaroo management policy.

Greg Baines (Greg.Baines@act.gov.au) – Senior Vegetation Ecologist, ACT Government Conservation Research Unit; expert in vegetation management.

Dr Margaret Kitchin (Margaret.Kitchin@act.gov.au) – Senior Manager, ACT Government Conservation Research Unit.

Dr Brett Howland (Brett.Howland@act.gov.au) – Ecologist, ACT Government Parks and Conservation Service; working in grassy habitat management, expert in kangaroo grazing impacts and grassland ecology.

Dr Richard Milner (Richard.Milner@act.gov.au) – Ecologist, ACT Government Parks and Conservation Service; working in habitat restoration

Dr Chloe Sato (Chloe.Sato@act.gov.au) – Ecologist, ACT Government Parks and Conservation Service, PhD in landscape ecology and biodiversity conservation

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*Professor Iain Gordon drafted the report on the workshops discussions and decisions, to assist ACT Government in achieving an evidence based and transparent process of policy development in this controversial space.

+ Julian Seddon (Conservation Research) was the workshop chair.