



Biodiversity  
Conservation  
Trust

# Managing Overabundant Kangaroo Guidelines

**For private land conservation agreements | June 2020**

# Objective

Population balance of native herbivores is an important part of maintaining a healthy ecosystem. Different land uses or management can directly and indirectly improve habitat suitability and subsequently population growth of native herbivores. These influences include increased accessibility to watering points, abundance of grassed areas, reduction of natural predators like dingoes, reduced hunting and shooting and reduced or eliminated competition from grazing livestock in many grasslands now reserved for conservation. Improved habitat suitability provides an opportunity for kangaroo populations to increase; potentially to a point that puts pressure on other components of the ecosystem, where their grazing habits degrade vegetation condition. Overgrazing can increase the risk of erosion and remove grassy ground cover needed by wildlife such as reptiles and some birds (Howland *et. al.* 2016, Howland *et. al.* 2014).

In some circumstances, and if implemented appropriately, management of kangaroos may be used to achieve biodiversity conservation goals. The NSW Biodiversity Conservation Trust (BCT) works in partnership with landholders to establish private land conservation agreements to conserve and manage high-value biodiversity on private land. These guidelines have been developed for landholders who enter into an agreement with the BCT to help determine whether kangaroo management is needed and if so, identify the most appropriate management actions. Different options are encouraged for different circumstances to maintain and enhance biodiversity in a broad range of ecosystems.

The purpose of the guide is to ensure that overabundant kangaroos affecting private land conservation agreements can be appropriately managed to help achieve the purpose of the agreement, that is biodiversity conservation. The BCT aims to provide greater consistency in the management of kangaroos and guidance on the suitability of different management options.

The BCT does not specify management actions on parts of the property outside the conservation area. These guidelines provide advice on possible management options within the private land conservation agreement to assist in the management of total grazing pressure.

## Kangaroo management in NSW

A Kangaroo Management Program operates in New South Wales with a goal to maintain ecologically sustainable populations of kangaroos throughout their ranges and humane harvesting practices for animal welfare.

The program is guided by the NSW Commercial Kangaroo Harvest Management Plan 2017–2021. This plan sets out the licensing and monitoring requirements for the commercial harvest of kangaroos for meat and skins. The management plan relates to the commercial harvest of red kangaroo, eastern grey kangaroo, western grey kangaroo and wallaroo.

Non-commercial licences under the Biodiversity Conservation Act to harm kangaroos for the purposes of damage mitigation and public safety are issued by DPIE (National Parks and Wildlife Service area offices).

This guideline does not seek to alter or make recommendations on existing commercial harvesting activities or the way licences are issued for non-commercial culling. Rather, the guideline provides a framework to support landholders who have private land conservation agreements with the BCT to manage impacts associated with overabundant kangaroo grazing.

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# Glossary

Term	Meaning
Conservation Area	An area of land to which a private land conservation agreement applies.
BAM	Biodiversity Assessment Method
BC Act	<i>Biodiversity Conservation Act 2016</i>
BCT	Biodiversity Conservation Trust
Biodiversity Stewardship Agreement (BSA)	An agreement for landholders wishing to generate and sell biodiversity credits under the Biodiversity Offsets Scheme. They provide permanent conservation and funded management of the biodiversity values on the land.
Conservation Agreement (CA)	An agreement relating to land for the purpose of conserving or studying the biodiversity of the land. May or may not have funding to undertake management actions.
Conservation culling	Intended to limit the effect of grazing on biodiversity to an acceptable level.
Deterrence options	Strategies to deter kangaroos to reduce population density in an area.
DPIE	Department of Planning Infrastructure and Environment.
Grass sward height	Method used to measure plant biomass. Using this method, the height of the grass sward is measured at the point where the same amount of grass biomass is above and below the average height.
Healthy condition threshold	A minimum condition of ground cover required (by region) using % ground cover and an average native grass sward height.

Management plan	Refers to the management plan included in the conservation agreement. This plan identifies the management actions required to be undertaken on the Conservation Area.
OEH	(former) NSW Government Office of Environment and Heritage. Currently part of DPIE.
Off-take	The rate at which pasture is removed by herbivores, measured as the amount removed per unit area per day (dry kg/ha/day).
Overabundant	Very high population densities that exceed the carrying capacity of the land and have a negative impact on biodiversity.
Private Land Conservation Agreement	Includes biodiversity stewardship agreements, conservation agreements and wildlife refuge agreements.
Total grazing pressure	The combined grazing pressure exerted by all grazing animals (domestic, native and feral) on the vegetation, soil and water resources.
% ground cover	Ground cover is the amount of plant material (dead or alive) that covers the soil surface. It is expressed as a percentage - including living vegetation, dry litter, coarse woody debris (logs), mosses and lichens, excluding bare ground surface and rock.

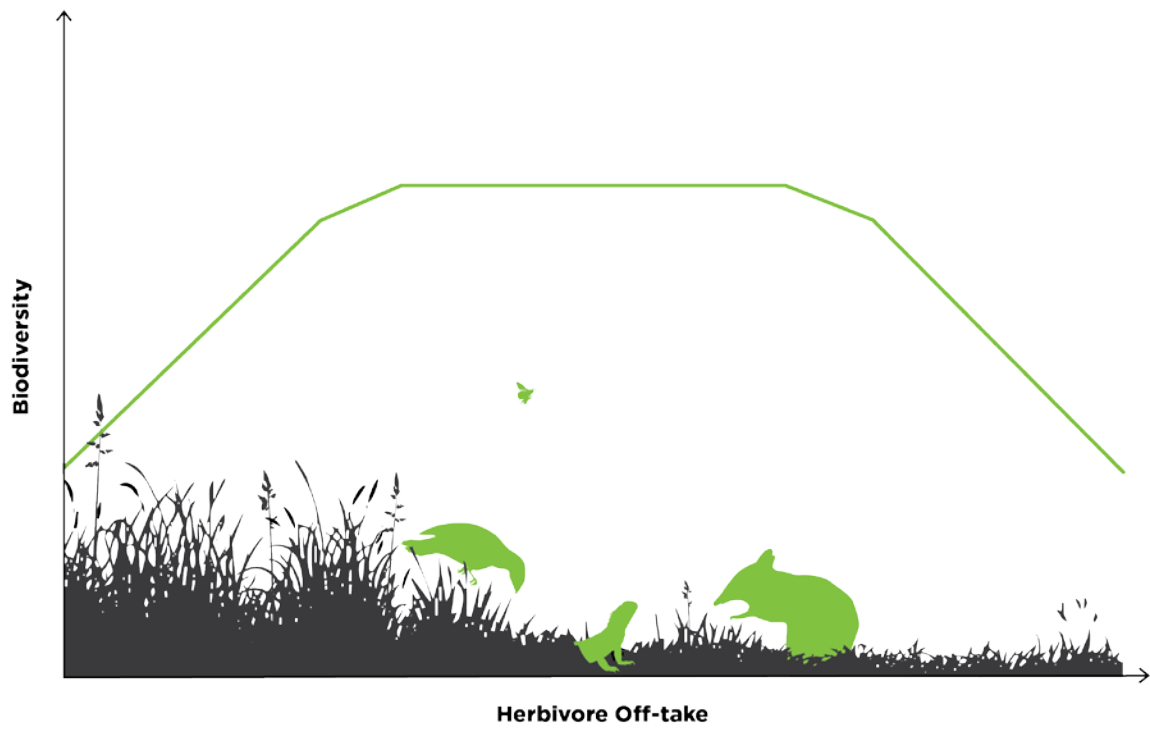
# Introduction

These guidelines provide landholders with options for managing grazing by kangaroos to support biodiversity conservation on their land. Acknowledging that each agreement area and the associated conservation goals present unique circumstances, these guidelines are deliberately non-prescriptive and should be used as a framework that can be tailored to a variety of situations. It is important to note in most cases, managing kangaroos in your agreement area is not a compulsory action. If, however kangaroos are having a negative effect on the conservation value of the conservation area, then it is an expectation of BCT that you will manage populations appropriately. Furthermore, specific BCT Programs e.g. Conservation Management Program in the Western Division, may include management of total grazing pressure as a compulsory for agreements established through those programs.

This guideline refers to the following species only; Eastern grey kangaroos *Macropus giganteus*, Western grey kangaroos *Macropus fuliginosus*, red kangaroos *Osphranter rufus* and wallaroos *Osphranter robustus*. The guideline will assist in determining when kangaroos are overabundant in the conservation area.

Deterrence methods (such as fencing) or conservation culling of overabundant kangaroos may be helpful in some circumstances to maintain, enhance or restore the biodiversity value of an agreement area. Management of kangaroos to reach an appropriate density can be used as a tool to achieve biodiversity conservation goals, such as improved pasture structure that can provide habitat for a range of native flora and fauna (Snape et. al 2018, Neave & Tanton 1989). Figure 1 shows how diverse vegetation structure provide habitat for a range of native animals.

Regular monitoring, as part of a long-term strategy for evaluating conservation outcomes from managing kangaroos, will be essential to help guide ongoing decision making.



*Figure 1. Herbivory off-take impact on biodiversity levels: different levels of 'off-take' influence vegetation structure and can impact levels of biodiversity*



# Principles for managing overabundant kangaroos in Conservation Areas

Managing kangaroos in conservation areas should be guided by the following principles:

1. Management of kangaroos occurs only where they are shown (or anticipated) to be negatively impacting on the conservation values of the site. If this is the case it is expected that they will be appropriately managed.
2. The aim is to manage native grassy vegetation in the conservation area to be in Healthy Condition (Appendix A) by managing Total Grazing Pressure.
3. Where appropriate, deterrence options (e.g. fencing, habitat restoration techniques) should be prioritised in managing kangaroos.
4. Vegetation condition is regularly monitored by the landholder or ecologist using methods outlined in the guidelines and included in annual reports to the BCT.
5. Funding of management actions will only occur where this is justified for a conservation outcome.
6. Conservation culling, if implemented, is only undertaken in accordance with legal requirements and it is the responsibility of the landholder to have relevant approvals and licences in place.
7. Conservation culling of kangaroos does not occur to facilitate domestic stock grazing and commercial benefits.

# Managing Overabundant Kangaroo Framework

This framework identifies three stages to help guide development of an overabundant kangaroo management strategy specific to your property. Figure 2 outlines a framework for managing overabundant kangaroos in conservation areas. BCT staff will support you in applying this framework.

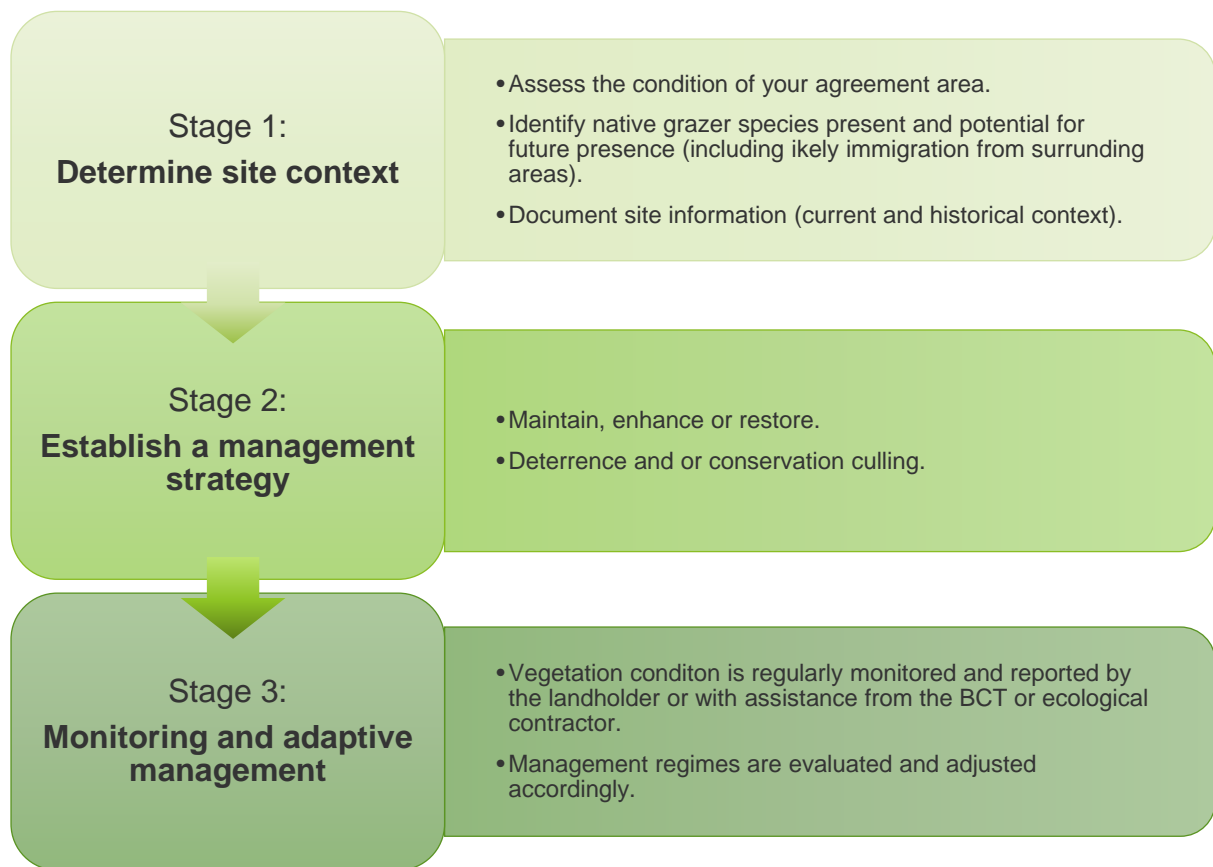


Figure 2. Managing Overabundant Kangaroo Framework

## Stage One – Determine site context

### Determine site condition and herbivores present

Native herbivores contribute in many ways to maintaining a healthy, functional ecosystem. They contribute to seed dispersal, trampling of vegetation (to create diverse structure), redistribution of organic material (eat in one location then excrete elsewhere) and are a food source for higher order predators and scavengers. Without native herbivores, grassland structure may become too dense and limit opportunities for other plant species to thrive. In turn, this reduces the availability of a diverse habitat for native animals.

Similarly, excessive population density of native herbivores can result in loss of vegetation and structural diversity, with similar detrimental impacts on biodiversity more broadly. It is acknowledged that various native herbivore species may be present in conservation areas but in the majority of cases kangaroo species are more likely to reach detrimental population densities.

Anthropogenic changes to the original landscape play a role in causing excessive increases in kangaroo population densities. For example, kangaroos are likely to benefit from pasture improvement, access to water and removal of natural predators (e.g. dingo). Landholders have the capability to reduce the negative impacts via deterrence options and conservation culling.

To maintain, enhance or restore conservation area quality, it is important to recognise when vegetation condition has deteriorated due to overgrazing by kangaroos rather than from other factors. Table 1 provides a list of actions to help determine if and what kangaroos are negatively impacting an agreement area.

*Table 1. How to determine if kangaroos are negatively impacting the condition of your conservation area*

Step	Explanation
1. Determine vegetation condition of your conservation area	<p>Assess the vegetation condition of your site (structure, composition and function). Use 'Appendix A: Healthy condition thresholds and indicators' to determine condition.</p> <p>If the vegetation is in healthy condition, no immediate herbivore management will be required.</p> <p>If the vegetation is not in healthy condition go to Step 2.</p> <p>(Note that as kangaroo populations are mobile, and numbers fluctuate with seasonal influences and availability of feed, you may need to consider the future potential for vegetation deterioration).</p>
2. Determine seasonality and historical context	<p>In some cases, a site will become degraded due to changes in seasonality, historical land use or low recent rainfall rather than grazing pressure. BCT ecologists can help you identify if lower vegetation condition is largely due to seasonal or management history reasons.</p>

Step	Explanation
3. Remove stock (if applicable)	<p>Stock grazing can lead to degraded vegetation condition. The BCT grazing guidelines can be used to identify an appropriate grazing regime for a conservation area including when and for how long stock exclusion is recommended.</p>
4. Determine which herbivore species are present in your agreement area	<p>Determine which native and feral herbivore species are present in your agreement area. You may:</p> <p>Use current knowledge. Some landholders may already know the species present on their land.</p> <p>Assess dung data from vegetation integrity plots to indicate the native herbivores present. Kangaroo dung is significantly larger than rabbit, goat or deer dung.</p> <p>Use, if available, camera traps to determine species present. BCT staff can assist with identifying the most appropriate locations to install the cameras.</p> <p>If it is uncertain that kangaroos are the main cause of low vegetation condition, monitoring plots (dung data) can help confirm this before management commences.</p> <p>If vegetation condition does not improve in 3-6 months and pest herbivores (such as feral pigs, goats, deer, horses, sheep etc) are the primary species present, the management response should focus on implementing pest control methods (BCT staff can assist you in making these decisions). If kangaroos are identified as being primarily abundant, go to step 5.</p> <p>If the site is below Healthy Condition thresholds, and there is evidence to support the impact of kangaroos being a problem and appropriate management is implemented, monitoring plots will help confirm the effectiveness of subsequent management.</p>
5. Determine which native herbivore species are present in your agreement area	<p>The Eastern Grey Kangaroo, Western Grey Kangaroo and Red Kangaroo are native herbivore species most likely to reach high densities that might lead to decline in vegetation condition. BCT staff can assist you in identifying kangaroo species present on their property.</p> <p>Some native herbivores may be threatened species (listed under BC and or EPBC Acts) and some species may only be present in low numbers, so it is important to differentiate between kangaroo species present to clearly identify the target species for management.</p>

**Note:** The BCT may agree to the release of rescued and rehabilitated native herbivores in your conservation area only if the species is native to the area and if vegetation condition has reached or exceeded the healthy condition threshold. This would be included in the agreement as a special condition. If vegetation condition is below the healthy condition threshold or deteriorates, native herbivores should not be released into the conservation area. The exception being that subject to having relevant licences, an EPBC or BC Act listed threatened species may be released into the conservation area.

## Documenting site information

Information specific to the proposed conservation area will help identify specific management actions. Site information to be collected is detailed in Table 2.

Table 2. Assessing site context

Action	Explanation
<b>Establishing baseline vegetation condition using rapid vegetation assessment (BCT officer) or BAM assessment for BSAs (accredited assessor)</b>	Examine dominant native and exotic vegetation cover. Any populations of threatened plants may need more intense protection.
	Examine vegetation condition (structure, composition and function). Use Appendix A: Healthy condition thresholds and indicators to determine healthy condition.
	Examine soil condition/productivity, stability, topography and aspect, all of which influence productivity and carrying capacity.
	Recent climate and rainfall as determined by your own rain gauge or nearest BOM weather station will need to be considered, including the effects of drought.
	BCT staff (or contractor) will erect a small enclosure in each community type as an ongoing reference site for assessment of vegetation condition without stock and native grazing pressure (see Figure 3). This will serve as an indicator of the key drivers of vegetation condition and inform appropriate management actions.
<b>Determine locality context</b>	What is the kind of landscape that bounds the property? For example, are there busy roads, water bodies or large neighbouring fences immediately adjacent to the site? Is this a relatively small property surrounded by a landscape that will attract and support large kangaroo numbers? This will influence appropriate management methods.
<b>Determine what portion of the agreement area overabundant</b>	The size of the area to be managed will influence cost and practicality of management options. Identify areas that are particularly sensitive. For example, creek lines or small patches of threatened flora may benefit from complete exclusion of kangaroos. In addition, depending on the

**kangaroos are negatively impacting.**

size of the agreement area, some native grassland may also benefit from fencing.

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**Determine if kangaroos are reducing habitat for threatened species**

Where threatened fauna or their habitat have been identified on the site, targeted habitat improvement may benefit threatened species.

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*Figure 3. Example of a small enclosure to use as reference site of vegetation without total grazing pressure*

*Photo Credit: Scott Jaensch - Chowilla Game Reserve grazing exclusion trials 2016*

## **Stage Two – Establish a management strategy**

The management strategy should involve implementing overabundant kangaroo management regimes that maintain, enhance or restore vegetation condition. This may cause an increase in flora species diversity, cover or structure, or an improved status of threatened native animal populations. Additionally, objectives may also be set to improve habitat for specific native animal species.

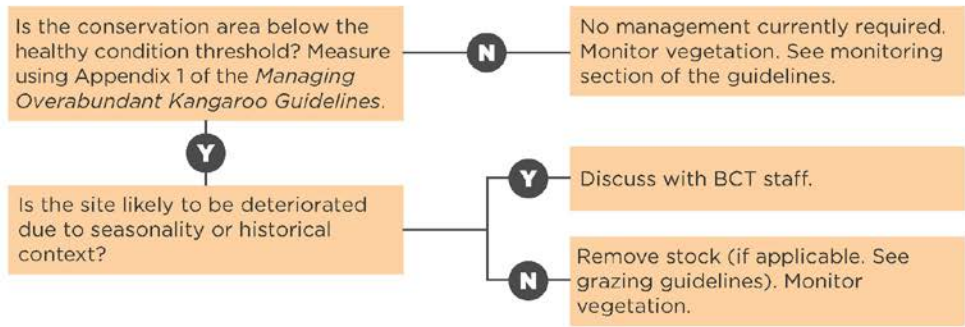
The decision tree in Figure 4 (as well as Table 4) can assist you in identifying appropriate strategies for managing kangaroos in your agreement area as part of managing total grazing pressure. Management options include: indirect management, deterrence and direct management options (Table 3). These may be used separately or together to achieve the management objective.

Whilst developing this guideline, other management options were considered and identified as not feasible for BCT agreements. These are listed in 'Appendix C: Management options deemed not feasible'. The Kangaroo Management Decision Tree (Figure 4), when applied with the support of BCT staff, and available monitoring data, provides guidance on selecting appropriate management options for herbivore management in a conservation area.

# Overabundant kangaroo management decision tree

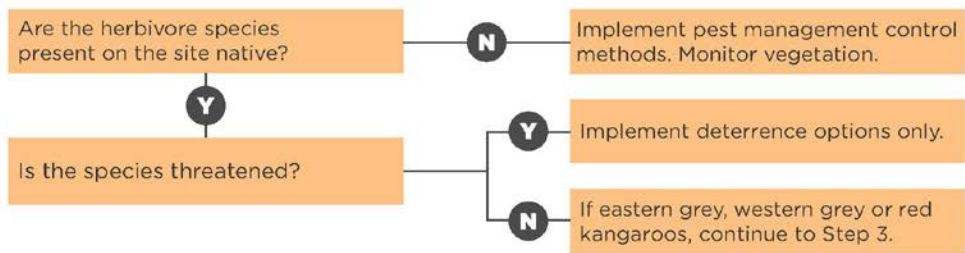
## STEP 1

### Assessing site condition



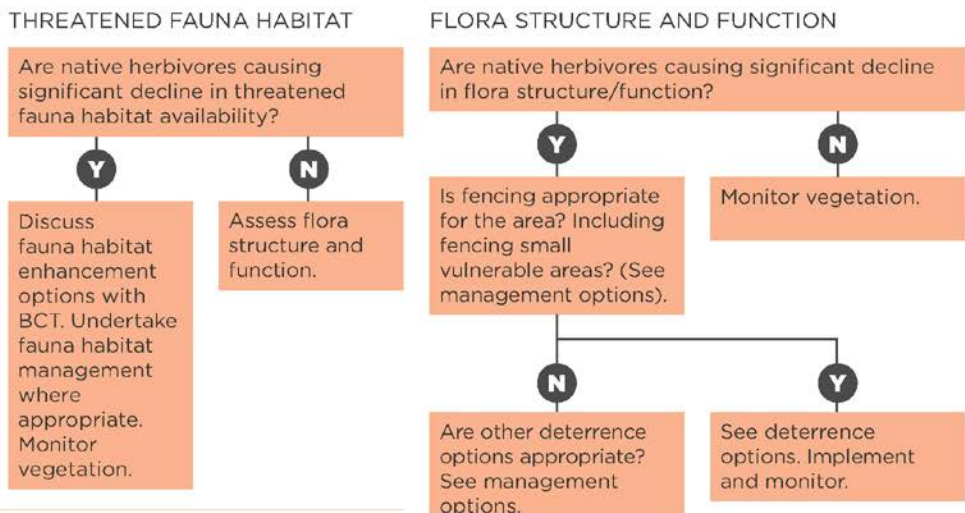
## STEP 2

### Determining the herbivore species on your site



## STEP 3

### Assessing site context



## STEP 4

### Assessing the outcomes of management actions

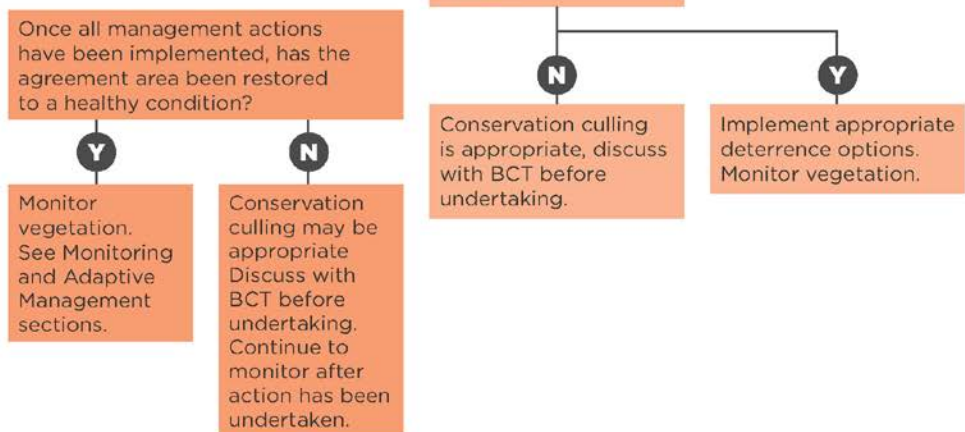


Figure 4. Decision tree to identify appropriate strategies for managing overabundant kangaroos.



Table 3. Management options (to determine the appropriate options see Table 4)

Indirect management options	
<b>Increase shelter availability for target native species</b>	<p>This approach may be suitable if native herbivores in the agreement area have caused loss of shelter for native and or threatened species. Effects of habitat loss may be mitigated for by providing replacement of shelter. For example, inclusion of logs and woody debris in some grassy ecosystems can lessen the impact of overgrazing by kangaroos on ground-dwelling fauna such as invertebrates or small reptiles (Barton <i>et. al.</i> 2011). This method may work to assist in providing adequate shelter for target species (on a very small physical scale) if native herbivore populations remain in low density. If populations persist in high densities, this method is unlikely to be adequate on its own; concurrent kangaroo population control may be necessary to re-establish habitat quality.</p> <p>For BSAs, this management option needs to be considered in relation to habitat requirements for species credits being generated at the site.</p>
Deterrence options	
<b>Vegetation manipulation</b>	<p>This strategy aims to change the vegetation structure to discourage kangaroos inhabiting the conservation area by planting new shrub and over story vegetation. Kangaroos prefer to graze open grasslands for their availability of food, and shelter where there is some vegetation cover. If you increase tree and shrub cover you may reduce availability of preferred grazing habitat (KAC, 1997). This strategy can be used if biodiversity goals allow for structural change and the expansion of habitat for arboreal species. Improvement in vegetation structure must also be appropriate for the relevant vegetation class or plant community type.</p>
<b>Remove artificial watering points</b>	<p>Munn <i>et al</i> (2013) found that kangaroo home ranges in arid areas are relatively small (<math>36.7 \pm 8.4</math> Ha). An individual will travel up to 4km per day in search of water. Due to their highly efficient excretory system, kangaroos can survive several days without water. Assuming a kangaroo would travel ~12 km over three days for water, a kangaroo is unlikely to inhabit an area more than 12km from a dependable water source. Kangaroos living in more fertile areas are likely to live within even smaller home ranges and travel less distances.</p> <p>Access to artificial watering points, such as dams and irrigation in a developed landscape, can contribute to increased kangaroo population density. Removing or fencing dams and irrigated areas such as lawns may decrease habitat suitability and consequently population density for most kangaroo species.</p>

**Density Fencing**

Fencing conservation areas is an effective and humane option for discouraging or excluding kangaroos from entering an area. Some parts of the conservation area may be more vulnerable to over-grazing than others and require different management. There are several kinds of fencing that can be used to manage kangaroo population density, each appropriate for different conservation goals.

Density fences are standard fences with additional sparse overhead lines to increase height but allow some movement. The additional line wires must not be barbed and must be of sufficient structural integrity to maintain their line and prevent native herbivores getting caught up in the wires. They can be installed as new fences or existing standard stock fencing can be modified to the equivalent standard.

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**Total Grazing Pressure Fencing**

Total grazing pressure (TGP) fences allow landholders to more effectively manage grazing pressure on their property to achieve healthy groundcover (especially perennial plants), better habitat and more sustainable grazing outcomes. There are several alternative TGP fence designs Figure 5 illustrates one example. You should consider where they can link in with existing TGP fencing or utilise structurally sound fences that can be upgraded to the equivalent TGP standard.

Depending on the design, TGP fences are primarily used to manage livestock and feral herbivores. They also have the advantage of deterring kangaroos making it less likely they will reach high densities leading to decline in vegetation condition. In some cases, specific type(s) of TGP fencing can be constructed to protect an identified patch of particularly vulnerable vegetation or to manage access to water sources from grazing animals. The BCT may fund TGP fences for conservation agreements where there is a demonstrated need and it is proportional to the total value of the agreement and risk to the conservation asset(s).

This approach must not be used to facilitate stock grazing or contain kangaroos within a conservation area to reduce impacts on adjoining grazing or cropping land.

Large scale exclusion fencing, such as cluster fencing initiatives will not be funded by the BCT.

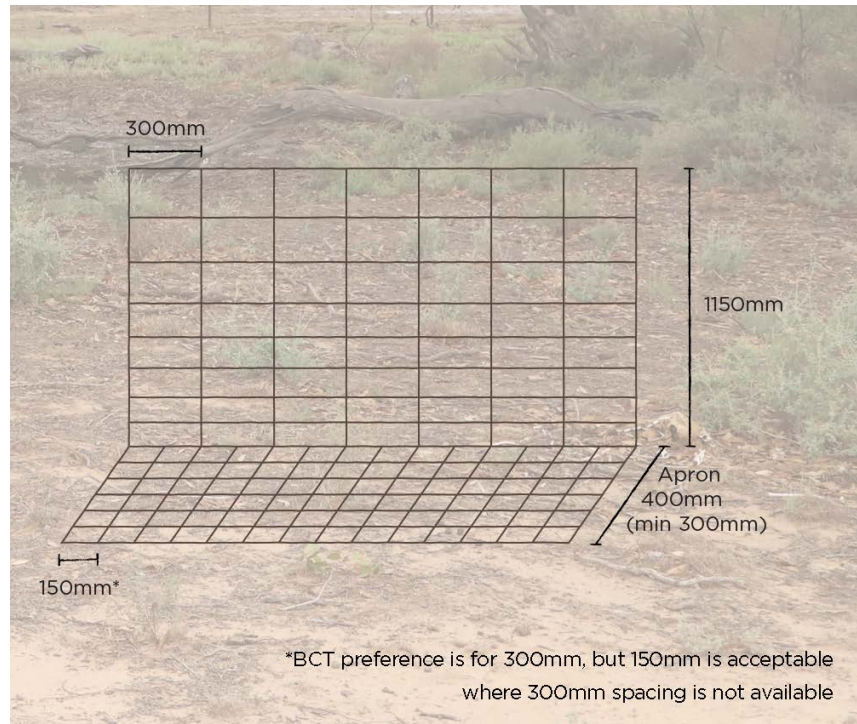


Figure 5. Illustration of TGP fencing

## Direct management of kangaroo population density

### Conservation culling

If vegetation condition in the conservation area remains in a deteriorated condition after suitable deterrence options are implemented and monitoring indicates kangaroos are still the primary source of impact, conservation culling may be appropriate. In certain circumstances culling may be the most effective and cost-efficient option. Culling kangaroos to an appropriate density attempts to fill the role of natural predators that are now missing from the ecosystem and can provide the opportunity for other fauna to thrive in a more diverse vegetation structure.

Conservation culling of kangaroos should not occur to facilitate stock grazing in an agreement area or to manage numbers to reduce impacts on adjoining areas (such as crops). Landholders are responsible for ensuring all required licences are in place and document this in their annual report. If conservation culling has taken place in an agreement area grazing of stock should be excluded for a minimum of 12 months to allow the area to regenerate.

**Note:** Although conservation culling may be permitted in the conservation area it is not a management action that would be funded through BCT programs. For BSAs conservation culling may be a management action funded by the TFD.

It is recommended that you follow these steps before conservation culling commences.

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### *1. Determine current and target kangaroo population density*

In NSW the National Parks and Wildlife Service (NPWS) set limits on the number of kangaroos that may be culled, based on property size and population estimates from the commercial kangaroo management program. The maximum limits per non-commercial licence are based on updated kangaroo population estimates and commercial harvest quotas for the year.

In commercial harvesting zones quotas are set and tags are issued in accordance with the NSW Commercial Kangaroo Harvest Management Plan.

### *2. Conservation culling*

Once prescribed cull number is calculated and tags issued by NPWS, culling can commence in accordance with the 'National Code of Practice for the Humane Shooting of Macropods and Wallabies for Non-commercial Purposes'. For properties where commercial harvesting is being undertaken the 'National Code of Practice for the Humane Shooting of Kangaroos and Wallabies for Commercial Purposes' applies. It is recommended that culling be carried out by professional shooters.

### *3. Carcass management*

Once culling is complete the preference in most cases is for carcasses to be removed from the site as carcasses may attract feral animals and pose risks to biosecurity. Current licence conditions for commercial harvest and non-commercial culling regarding carcass management are:

Commercial harvesting – carcasses must be tagged, stored at registered chiller, and only sold to licensed dealers.

Non-commercial culling – carcasses may be used for any non-commercial purpose.

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## **Funding overabundant kangaroo management**

There are several programs through which a landholder can apply to receive funding for implementing management actions in their conservation area: fixed price offers, conservation tenders and conservation grants. Whether funding is available to undertake kangaroo management in accordance with this guideline will be dependent on the specific suite of management actions that are identified for each individual tender, or fixed price offer program.

If funding is available, applications for a conservation grant or a conservation tender must cost management options as accurately as possible. For BSAs, kangaroo management would be funded by the TFD. The BCT supports adaptive management if attempts at management are unsuccessful. Contingency funding should be considered when costing actions in management plans. Appendix B outlines BCT programs where funding may become available for management of kangaroos.

**Note:** Conservation culling can be undertaken as part of managing the conservation area through inclusion of a special condition in the agreement. It is recommended this be undertaken when

thresholds fall below healthy condition and other management options are not suitable for the conservation area. Although conservation culling may be permitted in the conservation area it is not a management action that would be funded through BCT programs.

Table 4. Management options: Suitability of different management options

Option	Desired outcome	When to use this option	When this approach is less appropriate	Considerations
<b>Vegetation manipulation</b>	Change in vegetation structure such as increase in shrub layer leading to kangaroos being deterred from site.	The benchmark state of the vegetation in your agreement area includes a denser shrub/canopy layer. The area is small enough to effectively revegetate to improve vegetation structure. Vegetation condition is not immediately critical. Fencing or removing watering points is not feasible.	<p>The extant vegetation community is naturally a grassland, lacking a mid-story and canopy.</p> <p>The area exceeds a viable size for replanting.</p> <p>The size of the area is small enough to viably fence.</p>	Consider using seedling guards while plants are establishing. More intensive management of introduced herbivores during vegetation establishment phase. This is a longer-term solution as vegetation takes time to establish.
<b>Remove artificial watering points</b>	Removal of artificial water sources, reducing water source/habitat attractive to kangaroos and therefore population density.	<p>When there is not a network of water holes nearby.</p> <p>Watering points are not required on site for domestic livestock.</p>	<p>Watering holes are easily accessible nearby (within 12 km).</p> <p>Domestic livestock need to utilise your dam.</p>	<p>If watering points are required for stock on the property, making watering points exclusive to domestic livestock is an option. Replacing dams with tanks and troughs may be an alternative if stock are on the property. Exclusion fencing (with gates that can be opened if stock need access during the grazing window) may also be used to manage access to water. Closure of water points outside of the agreement area would be at the landholder's discretion.</p> <p>Access to water for other native animals inhabiting the agreement area.</p>

Option	Desired outcome	When to use this option	When this approach is less appropriate	Considerations
<b>Density Fencing</b>	A physical barrier making kangaroo entry into the site difficult but not impossible. Reduced population density of target species but free movement of other smaller native herbivores.	<p>A fence line already exists that could be easily modified.</p> <p>Landscape scale connectivity across the property is important.</p>	The agreement area perimeter is long, and cost/effort will be excessive.	<p>Include wildlife doors/tunnels.</p> <p>Barbed top wire is dangerous for wildlife and not recommended.</p> <p>300mm mesh (space between horizontal lines in hinge joint) to allow movement of reptiles and small mammals.</p> <p>Ensure there are gates that can be opened if a wildfire passes through or an ecological burn is undertaken to allow wildlife to escape.</p>
<b>TGP Fencing</b>	A physical barrier deterring grazing native herbivores from entering the area but maintaining some permeability.	<p>The area is in a low rainfall zone &lt;400mm / annum.</p> <p>A small specific patch of vegetation needs protecting.</p> <p>A fence line already exists.</p> <p>There are particularly vulnerable species on site.</p> <p>Water point management (as above)</p>	<p>The agreement area perimeter is long, and cost/effort will be excessive.</p> <p>Native turtles and other ground dwelling species are known to migrate through your property.</p> <p>The agreement area is essential for landscape connectivity of habitat.</p>	<p>Fencing benchmarks and equivalent standards are detailed in the BCT Fencing Guidelines (contact BCT for more info). Include wildlife doors/tunnels.</p> <p>If appropriate, open gates occasionally and fence small threatened patches.</p> <p>Barbed top wire is dangerous for wildlife and not recommended. Sighter wire may be useful in areas habitually used as routes.</p> <p>Apron (300mm).</p> <p>300mm mesh to allow movement of reptiles and small mammals.</p>

Option	Desired outcome	When to use this option	When this approach is less appropriate	Considerations
				<p>Ensure there are gates that can be opened if a wildfire passes through or an ecological burn is undertaken to allow wildlife escape.</p>
<p><b>Conservation culling</b></p>	<p>Direct removal of grazing pressure via culling of kangaroos.</p>	<p>When deterrence or exclusion options have not been successful or are not appropriate for the area.</p> <p>There is a specific management target.</p>	<p>When it is dangerous (high likelihood of people accessing the property).</p> <p>When high levels of immigration from surrounding areas are likely to result in a return of high population densities within a short time frame.</p>	<p>Not a funded management action through BCT programs. Culling may need to extend out of the agreement area to be effective.</p> <p>Undertaken in accordance with national codes of practice for humane shooting.</p> <p>Appropriate disposal of carcasses.</p> <p>Licence to hold firearms and appropriate training and safety.</p> <p>Licences from DPIE.</p> <p>Refer to the Relevant Literature section for more information regarding culling.</p>



## Stage Three – Monitoring and adaptive management

For any management strategy to be successful, clear goals, ongoing monitoring and adaptive management are required to ensure conservation outcomes are being met. Monitoring of agreements will be undertaken in accordance with the BCT's Ecological Monitoring Module and in accordance with the conditions of the agreement.

### Landholder monitoring

The BCT will be working with landholders to assist with monitoring healthy condition. Landholders are an important part of the monitoring process and you will be required to monitor key condition indicators on a regular basis. Monitoring will include measurements of the % ground cover and average grass sward height (see Appendix A: Healthy condition thresholds and indicators) to ensure ground cover meets healthy condition thresholds for the site.

Regular monitoring and appropriate management responses are crucial for ensuring that healthy condition is maintained (Appendix A). It is important that you can identify the dominant native grass species on their site, as these will be used as an indicator to determine when to reassess overabundant kangaroo management strategies. The BCT will assist you in monitoring of healthy condition through the landholder technical support package.

Should monitoring determine that condition has fallen below the required threshold, the kangaroo management strategy must be reassessed. If condition remains deteriorated after employing deterrence options, monitoring can inform whether conservation culling should be initiated. Assuming all other potential causes of deterioration in vegetation condition have been considered (e.g. pest animals, drought), kangaroo population density must then be reduced in a timely manner to a point where the vegetation meets or exceeds the healthy condition thresholds. This may involve triggering a special condition for conservation culling clause in your agreement. If the condition of the conservation area further deteriorates the you should, in consultation with the BCT, consider the need for a long-term adjustment to kangaroo management or identify other management actions to increase ground cover.

Each year landholders with funded BCT agreements have standard monitoring requirements to submit to the BCT:

1. Ground cover measurements (before and after management actions)
2. Photo points (before and after management actions).

Agreements that include conservation culling would also need to record and submit the number of kangaroos culled per year. In the case of BSAs ecological consultants may undertake the required monitoring and annual reporting.

Agreements with new fences should ensure fences are monitored regularly, especially for the first three months. Fences that are unfamiliar and exclude individuals from resources they would normally have access to pose a higher risk to animal getting caught and suffering.

## BCT monitoring

Monitoring will include an ecological baseline assessment and ongoing monitoring consistent with BCT's Ecological Monitoring Module. Additional monitoring may be required in response to events such as drought or fire. The results of monitoring will be analysed to evaluate the effectiveness of management at the sites, in conjunction with records of relevant management activities (including weed and kangaroo management, and pest animal control). If monitoring shows that key conservation goals are not, or are unlikely to be met, management will be evaluated and may be adjusted to improve performance. This information will assist the BCT in detecting how management on a larger scale (along with climate) is influencing conservation outcomes and will be important to use as the basis for adapting any overabundant kangaroo management guidance into the future.

## Adaptive management

If monitoring results indicate that conservation of biodiversity is not being achieved and healthy condition thresholds are not being met, management may need to be adjusted.

### **Example:**

***An original agreement scoped for the cost of density fencing around the property. This was granted, and density fencing established.***

***Outcome:*** *Vegetation condition has improved but still does not meet the healthy condition threshold within reason considering climatic influences. Herbivore exclusion plots demonstrated the capacity for ground layer vegetation to recover where TGP was reduced, and thus adaptive management requires that culling now be implemented in the agreement area. The original agreement included conservation culling as a special condition, which may now be enacted, and culling implemented after obtaining necessary licences.*

BCT staff will support you in making these types of management decisions and will be able to draw on additional monitoring data to inform such decisions.

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# List of relevant literature

These guidelines rely on extensive published material. This information has been used to identify, support and highlight the current understanding of best practice grazing management in NSW. The NSW BCT does not necessarily endorse all opinions or ideas contained within these references.

ACT Government (2010). **ACT Kangaroo Management Plan**, Territory and Municipal Services (TAMS), Canberra, ISBN 978-0-642-60523-8.

ACT Government (2017). **Conservation Research, programs report 2015-2017**. Environment, Planning and Sustainable Development Directorate, ACT Government, Canberra.

ACT Government (2017). **ACT native grassland conservation strategy and action plans**. Environment, Planning and Sustainable Development, Canberra.

Barton, P.S., Manning, A.D., Gibb, H., Wood, J.T., Lindenmayer, D.B., and Cunningham, S.A. (2011) **Experimental reduction of native vertebrate grazing and addition of logs benefit beetle diversity at multiple scales**. *Journal of Applied Ecology* 48, 943-951, in Lindenmayer, D., Michael, D., Crane, M., Okada, S., Florance, D., Barton P., and Ikin, K (2016). *Wildlife Conservation in Farm Landscapes*. CSIRO Publishing.

Dorrough, J., McIntyre, S., Brown, G., Stol, J., Barrett, G., Brown, A. (2012). **Differential responses of plants, reptiles and birds to grazing management, fertilizer and tree clearing**. *Austral Ecology* 37, 569-582.

Howland, B, Stojanovic, D, Gordon, I et al (2016) **Birds of a feather flock together: Using trait-groups to understand the effect of macropod grazing on birds in grassy habitats**, *Biological Conservation*, 194, 89-99.

Howland, B, Stojanovic, D, Gordon, I et al (2016) **Habitat preference of the striped legless lizard: Implications of grazing by native herbivores and livestock for conservation of grassland biota**, *Austral Ecology*, 41(4), 455-464.

Howland, B. Stojanovic, D & G, Iain, J. Manning, Adrian D. Fletcher, Don and Lindenmayer, David B. (2014) **Eaten Out of House and Home: Impacts of Grazing on Ground-Dwelling Reptiles in Australian Grasslands and Grassy Woodlands** *PLoS ONE* 9(12): e105966.

KAC (ACT Kangaroo Advisory Committee) (1997). **Living with Eastern Grey Kangaroos in the ACT – Public Land**. Third Report to the Minister for the Environment, Land and Planning (ACT Government, Canberra).

Letnic M. & Crowther M. S. (2013) **Patterns in the abundance of kangaroo populations in arid Australia are consistent with the Exploitation Ecosystems Hypothesis**. *Oikos* 122, 761-9.

Manning A. D., Cunningham R. B. & Lindenmayer, D.B. (2013) **Bringing forward the benefits of coarse woody debris in ecosystem recovery under different levels of grazing and vegetation density**. *Biological Conservation*. 157, 204-14.

Manning, A., Wood, J., Cunningham, R., McIntyre, S., Shorthouse, D., Gordon, I. & Lindenmayer, D. (2011). **Integrating research and restoration: The establishment of a long-term woodland experiment in south-eastern Australia.** Australian Zoologist. 35. 633-648. 10.7882/AZ.2011.016.

Munn, A.J., Dawson, T.J., McLeod, S.R., Dennis, T., Maloney, S.K. (2013). **Energy, water and space use by free-living red kangaroos *Macropus rufus* and domestic sheep *Ovis aries* in an Australian rangeland.** Journal of Comparative Physiology B: Biochemical, Systemic, and Environmental Physiology. 183. 6. 843-858. 10.100

Neave, H. M. and M. T. Tanton (1989). **The Effects of Grazing by Kangaroos and Rabbits on the Vegetation and the Habitat of Other Fauna in the Tidbinbilla Nature Reserve, Australian-Capital-Territory.** Australian Wildlife Research 16(3): 337-351.

Read, J.L. and Wilson, D. (2004). **Scavengers and detritivores of kangaroo harvest offcuts in arid Australia,** Wildlife Research 31(1) 51 – 56.

Snape, M. Caley, P. Baines, G and Fletcher, D. (2018). **Kangaroos and Conservation: Assessing the effects of kangaroo grazing in lowland grassy ecosystems,** Conservation Research, Environment, Planning and Sustainable Development Directorate, ACT Government.

#### **ACT Gov: Kangaroos**

<https://www.environment.act.gov.au/parks-conservation/plants-and-animals/urban-wildlife/kangaroos>

#### **ACT Gov: Kangaroo Research**

<https://www.environment.act.gov.au/cpr/conservation-research/research>

#### **ACT Gov: 2019 Kangaroo Cull page**

<https://www.environment.act.gov.au/parks-conservation/plants-and-animals/urban-wildlife/kangaroos/2019-kangaroo-cull>

**Australian Government (2008a)** *National code of practice for the humane shooting of kangaroos and wallabies for non-commercial purposes*, Endorsed by the Natural Resource Management Ministerial Council.

**Australian Government (2008b)** *National code of practice for the humane shooting of kangaroos and wallabies for commercial purposes*, Endorsed by the Natural Resource Management Ministerial Council.

#### **NSW OEH Kangaroo Management**

<https://www.environment.nsw.gov.au/topics/animals-and-plants/wildlife-management/kangaroo-management>

<https://www.environment.nsw.gov.au/licences-and-permits/wildlife-licences/licences-to-control-or-harm/licences-to-harm-kangaroos>

#### **NSW OEH Kangaroo Management Advisory Panel**

<https://www.environment.nsw.gov.au/topics/animals-and-plants/wildlife-management/kangaroo-management/kangaroo-management-advisory-panel>

# Appendix A: Healthy condition thresholds and indicators

(excerpt from BCT Livestock Grazing Guidelines for Private Land Conservation)

Condition	Thresholds	Other indicators	Landholder action
Native grassy vegetation is considered in <b>Healthy Condition</b> if:	<ul style="list-style-type: none"> <li>  % Ground cover is maintained at or above the minimum threshold for the region (<i>Table 1</i>).</li> <li>  Average leaf height of dominant native grass species is maintained at or above the minimum threshold (<i>Table 2</i>).</li> </ul>	<ul style="list-style-type: none"> <li>  All Vegetation Integrity attributes are at or close to benchmark. Vegetation Integrity = &gt;80</li> <li>  During spring and summer, a range of native wildflowers should be visible along with evidence that following suitable climatic conditions the key native grasses have successfully flowered &amp; set seed.</li> <li>  Soils should be intact - the bare areas are usually covered by lichen, moss, an algal crust or leaf litter</li> <li>  There should be little or no cover of High Threat Weeds and those present are being actively suppressed (&lt;1% summed foliage cover)</li> <li>  Open spaces between the taller grass tussocks should be maintained for a diversity of native plants and fauna habitat.</li> </ul> <p><i>Additionally</i>  <b>In grassy woodlands:</b></p> <ul style="list-style-type: none"> <li>  There may be evidence of tree and shrub recruitment</li> <li>  Vegetation Integrity function attributes at or close to benchmark</li> </ul> <p><b>Where wetlands, marshes, streams and soaks are present:</b></p> <ul style="list-style-type: none"> <li>  Little or no evidence of soil pugging and bank erosion or browsing on unpalatable species</li> <li>  Little or no evidence of water contamination and turbidity caused by livestock and livestock faeces.</li> </ul>	Regular monitoring to ensure condition is maintained and/or further improved towards benchmark for all Vegetation Integrity attributes and target groundcover maintained at or above threshold.
Native grassy vegetation is considered in <b>Deteriorated Condition</b> if:	<ul style="list-style-type: none"> <li>  % Ground cover falls below the minimum threshold for the region (<i>Table 1</i>).</li> <li>  Average leaf height of dominant native grass species falls below the minimum threshold (<i>Table 2</i>)</li> </ul>	<ul style="list-style-type: none"> <li>  Many Vegetation Integrity attributes are below benchmark &lt;80</li> <li>  Soil crust may not be intact and evidence that some surface litter are transported (indicating poor resource conservation and potential soil erosion).</li> <li>  Increased browsing by livestock of plants that are normally less preferred becomes evident</li> <li>  erosion, soil pugging and water contamination in Wetlands, marshes, streams and soaks may be evident</li> </ul> <p><i>Additionally</i>  <b>In grassy woodlands:</b></p> <ul style="list-style-type: none"> <li>  Vegetation Integrity function attributes below benchmark</li> <li>  Lack of tree and shrub recruitment (noting episodic nature of recruitment)</li> </ul> <p><b>Where wetlands, marshes, streams and soaks are present:</b></p> <ul style="list-style-type: none"> <li>  Soil erosion, soil pugging and water contamination in wetlands, marshes, streams and soaks is being caused by grazing livestock</li> </ul>	<p>Stock must be removed from paddock and it rested for an extended period, usually until the next Grazing Window.</p> <p>Stock should not be reintroduced until the vegetation meets or exceeds the Healthy Condition thresholds.</p> <p>If a paddock becomes degraded then the Landholder should consult the BCT to consider the need for a long-term adjustment to the grazing regime or other strategies to prevent these circumstances from repeating.</p>

% Ground cover - including living vegetation, dry litter, coarse woody debris (logs), mosses and lichens, excluding bare ground surface and rock

**Table 1 – Ground cover thresholds and monitoring requirements per region**

IBRA region	Agro-climatic Description	Rainfall (mm) <sup>2</sup> .	Healthy Condition Threshold (% Ground Cover)
Australian Alps	Cold winters, summers short	1025	80
Brigalow Belt South	Winters mild, even growth throughout year	644	80
Broken Hill Complex	Semi-arid, moisture highest in winter	206	50-60
Channel Country	Desert, water limited	175	50-60
Cobar Peneplain	Semi-arid, moisture highest in winter	379	50-70
Darling Riverine Plains	Semi-arid, moisture highest in winter	379	50-60
Mulga Lands	Semi-arid, moisture highest in winter	297	50-60
Murray Darling Depression	Semi-arid, moisture highest in winter	254	50-60
Nandewar	Summer moisture limiting, winters cool	721	80
New England Tablelands	Max moisture availability winter-spring	824	80
NSW North Coast	Warm and wet	1104	80
NSW South Western Slopes	Summer moisture limiting, winters cool	595	80
Riverina	Dry cool winters	327	70-80
Simpson Strzelecki Dunefields	Desert, water limited	149	50-60
South East Corner	Temperate wet	807	80
South Eastern Highlands	Max moisture availability winter-spring	682	80
South Eastern Queensland	Warm and wet	1297	80
Sydney Basin	Temperate wet	881	80

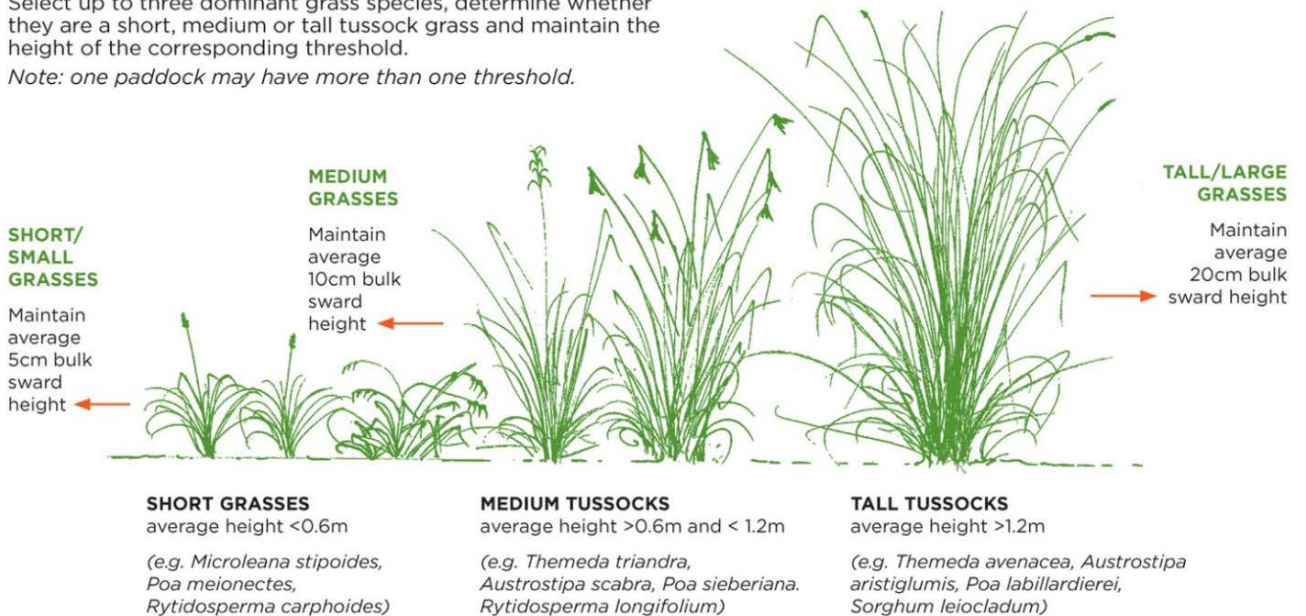
% Ground cover - includes living vegetation, dry litter, coarse woody debris (logs), mosses and lichens, excluding exposed bare ground surface and rock

\*where a range is specified, use rainfall gradient to determine appropriate threshold

**Table 2 – Native grass sward height thresholds**

Select up to three dominant grass species, determine whether they are a short, medium or tall tussock grass and maintain the height of the corresponding threshold.

Note: one paddock may have more than one threshold.



## Appendix B: Funding management options through BCT programs

Table 5 - Funding available for implementing overabundant kangaroo management options under BCT Programs.

Management option	Availability of funding		
	Conservation tender	Fixed price offer	Grants
Vegetation manipulation	Yes	Yes	Yes
Remove artificial watering points	Program specific	Yes	Yes
Density Fencing	Program specific	Site specific*	Site specific
TGP Fencing	Program specific	Yes*	Yes
Conservation culling	No	No	No

\*'Essential Conservation Fencing' - Fixed Price Offer Application one-off payment. The BCT will contribute either a) up to 50% of direct fencing costs or, b) up to the relevant BCT cost benchmark, whichever is the lower. There is no specified limit to the scale of individual requests, however requests of a BCT contribution of greater than \$50,000 for a property will be specifically reviewed.

Conservation tender and fixed price offer program design involves identifying suitable management actions for the relevant region/ecosystems that the BCT would support via funding. The landholder guide would identify the management activities or deterrence options from the table above. Justification would be needed in accordance with the decision tree for all agreement types and programs above and where relevant BCT staff and the landholder would also discuss this during the site visit.

For Biodiversity Stewardship Agreements, kangaroo management would be identified in the management plan and costed into the Total Fund Deposit.

## Appendix C: Management options unsuitable for BCT private land conservation agreements.

Option	Why not supported
<b>Translocation</b>	<p>The target native herbivores are not threatened species requiring conservation for population security.</p> <p>Concerns around survival rates after translocation – unlikely to support further grazing pressure.</p> <p>Stress to the animal.</p>
<b>Fertility control</b>	<p>Time, skill and cost intensive.</p> <p>Only successful in small enclosed areas.</p> <p>Not an immediate solution. Requires ongoing monitoring and maintenance.</p>
<b>Surgical sterilisation</b>	<p>Although castration is a permanent and effective method of reducing population growth, it is deemed non-feasible as it is time and resource expensive, as well as requiring expert veterinary involvement.</p>
<b>Reintroduction of native predators</b>	<p>Conservation areas are generally too small to manage a predator population.</p> <p>Risk of predating domestic animals on the property.</p>
<b>Orally ingested poison</b>	<p>No known toxin and delivery system meet requirements for safety, animal welfare and target specificity. No poisons are approved for use on kangaroos under national and NSW pesticides laws.</p>
<b>Noise deterrents</b>	<p>An experimental option which has not yet been proven effective.</p> <p>Native herbivores quickly become accustomed to the noise deterrents.</p>