Fire Management Plan for the Mann Ranges and Musgrave Ranges Fire Management Regions of the Anangu Pitjantjatjara Yankunytjatjara Lands

CARING FOR OUR COUNTRY

A report prepared for Anangu Pitjantjatjara Yankunytjatjara
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Executive Summary

This Fire Management Plan has been produced to guide the burning activities to be conducted by APY Land Management in 2009-2010 in two Fire Management Regions (FMRs) within the Central Ranges Bioregion: the Mann Ranges and Musgrave Ranges FMRs. Burning proposals outlined in this plan are not intended to replace Traditional burning activities or dictate to Traditional Owners where they should and should not burn, but are suggestions for additional burning that could be conducted under a Land Management Program that aims to preserve and maximise biodiversity in the Mann and Musgrave Ranges FMRs.

The main priorities of this Fire Management Plan are: 1) protection of life, cultural sites and infrastructure from the impacts of fire, 2) protection of biological assets such as fire sensitive plant communities and rare plants and animals from the negative impacts of fire, and 3) minimising the potential for spread of hot summer wildfires. The Actions recommended also aim to strengthen the capacity of APY Land Management to manage fire in the region by assisting in the intergenerational transfer of knowledge about fire and integrating such knowledge with scientific principles and the use of modern technology to develop best practise fire management for the region.

Although particular cultural sites requiring fire management are not identified in this document, protecting sites of cultural significance is a high priority of the strategy. Management of cultural sites will be left to the discretion of Traditional Owners who may or may not wish to seek the assistance of APY Land Management. The main infrastructure requiring protection from fire are the outstations scattered throughout the region, particularly those infested with buffel grass.

The most significant biological asset in the region is the black-footed rock wallaby, which has severely declined in South Australia since the 1930s to become the state's rarest mammal. Many of the rock wallaby's favoured food plants are fire-sensitive species and when these are killed by fire they are replaced by unpalatable spinifex. Remnant pockets of rock wallaby habitat require protection from fire with patch burning to reduce fuel loads in adjacent spinifex communities.

The Central Ranges bioregion was once rich with emus, bustards, macropods and other medium-sized mammals. It supported diverse plant communities and a high biomass of trees and shrubs. The combined impacts of altered fire regimes, introduced predators and exotic herbivores have resulted in the extinction of many species and severe declines in others. As fire frequency and intensity increased following the cessation of widespread burning by A<u>n</u>angu, fire sensitive plant communities such as figs and pines on the hills, mulga woodland, ironwood woodland and saltbush communities have gradually been replaced by more uniform spinifex communities, reducing the extent of habitat for rock wallabies, kangaroos, birds and bats. In the richer soils buffel grass has replaced native grasses and herbs. As the dominance of highly flammable spinifex and buffel grass continues to increase, fire frequency and intensity will become further amplified. When significant rain events occur destructive wildfires can burn all the way from Ernabella to Pipalyatjara. The most recent period of widespread wildfires was in 2002, and the majority of fuels across the region are

now 7 years old, with some remnant patches of older vegetation. Little burning appears to have occurred since 2002.

The overall objective of this Fire Management Plan is to revert to a fire regime that is more like that which prevailed when Anangu were walking the country and continually lighting lots of small fires in a variety of seasons, every year. The resulting vegetation mosaic limited the spread of hot, summer wildfires and helped to protect fire-sensitive plant communities. It also ensured that there was always appropriate habitat available for the full spectrum of fauna, from those that require open, early regeneration stages of vegetation to those that are reliant on the cover of old-growth spinifex.

The strategy to achieve a vegetation mosaic involves initially protecting fire-sensitive plant communities with cool season burning of understorey vegetation, then patch-burning in adjacent spinifex communities. The easiest way to achieve a vegetation mosaic at the landscape scale would be to implement aerial incendiary burning.

Protection of fire-sensitive plant communities in the hills are the first priority for fire management. This involves cool season trickle burning of understorey tussock grass or spinifex, always starting at the top of the hills and burning downhill, as this burning technique produces a much slower, cooler fire. This is how people used to burn in the early days. Any additional information on locations of significant plant species collecting during the DEH Threatened flora surveys to be conducted this winter should be used to update this fire management plan prior to the 2010 burning season. However most of the foothills of the Musgrave Ranges that still contain *Callitris* pine communities would benefit from cool season downhill burning.

The second priority is to protect the best stands of mulga. After significant summer rainfall the grassy understorey may be thick enough to carry a fire and will require burning under mild conditions to reduce fuel loads under mulga trees. Spinifex adjacent to mulga stands can then be burnt, always burning away from the mulga to ensure a large fire front does not carry through the crown of mulga trees.

The tussock grassland habitat of the outwash plains will generally only carry fire after two successive years of good summer rainfall. When this situation occurs it will be important to conduct extensive patch burning during winter to avoid widespread fires in the following summer. The outwash plains around the Musgrave Ranges are currently dominated by rolypoly and will not carry a fire this summer, however there is more grass and less rolypoly at the western end of the Musgrave Ranges and it is recommended that roadside burning is attempted in this area this winter.

Spinifex communities will carry fire in any season once spinifex cover is sufficiently high. This may take about ten years after wildfire, depending on the cumulative rainfall. The aim of burning spinifex communities is to break up the largest stands of old spinifex with cool season burning, to prevent all the old growth spinifex being burnt in a single wildfire. Patch-burning can then conducted throughout the spinifex grasslands as soon as fuels are ready to carry fire. Patch-burning will increase the diversity in age structure of spinifex communities (and therefore maximise biodiversity) and help to limit the spread of wildfires during unfavourable conditions.

Introduction of aerial incendiary burning would increase the amount of patch-burning that could be achieved in a burning season. The concept of aerial burning requires thorough consultation with Traditional Owners but may one day involve Anangu travelling in aircraft and choosing appropriate sites to dispatch incendiaries.

It is recommended that annual burn plans are developed in consultation with Anangu in the first quarter of each calendar year. Current satellite imagery and fire scar maps are tools that can be used to assist in planning a winter burning program, but field surveys are also required to assess fuel loads. Aerial reconnaissance is an effective method of preliminary assessment of fuel loads across the region.

Key recommendations to improve implementation of this fire management plan are to:

- Significantly increase the resources directed at fire management in the Ranges of the APY Lands, to enable 3 months of prescribed burning activities to be conducted each winter
- Employ a full-time fire ecologist to coordinate fire management activities
- Employ seasonal Anangu fire ranger teams in each fire management region each winter
- Compile a digital fire history database and update annually
- Undertake regular monitoring programs to assess the effectiveness of the burning program in reducing impacts of wildfires on flora and fauna
- Improve vegetation mapping for the study area
- Develop a buffel grass management plan

This photograph shows the effect of spinifex encroachment of hillside vegetation. The right side of the hill does not yet have spinifex and still has good shrub cover whereas the shrubs on the left side of the hill have been eliminated by spinifex-fuelled fires.

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1.0 Introduction

1.1 Scope and Purpose

This fire management plan sets out the vision, approach and rationale for the management of fire in two areas of the A<u>n</u>angu Pitjantjatjara Yankunytjatjara (APY) Lands in north-western South Australia. It aims to protect the diversity of cultural, natural and built assets in the region, as well as its people. The strategy has been produced for APY Land Management primarily as a background document to guide the fire management works to be conducted by its staff. It provides guiding principles for long-term fire management, and recommends specific burns to be implemented in 2009-2010.

The two areas covered by this plan are the Mann Ranges and Musgrave Ranges Fire Management Regions (FMRs). These regions have been prioritised for fire management because they support key threatened species including South Australia's most endangered mammal – the black-footed rock wallaby (*Petrogale lateralis*), and because of their proximity to large Aboriginal communities.

Burning proposals outlined in this plan are not intended to replaced Traditional burning activities or dictate to Traditional Owners where they should and should not burn, but are suggestions for additional burning that could be conducted under a Land Management Program (implemented by Indigenous Ranger Groups) that aims to preserve and maximise biodiversity in the Mann and Musgrave Ranges FMRs.

Fire has been listed as a major threatening process for the biodiversity of the APY Lands (Robinson *et al*. 2003). This plan accepts that fire will continue to be common and widespread across the region, and makes no attempt to exclude fire from the landscape. However, it also recognizes prescribed management activities are required to minimise the ecologically destructive impacts of unchecked inappropriate burning and advocates that the most effective tool available to managers of predominantly spinifex landscapes, is fire itself.

We acknowledge that scientific knowledge of contemporary fire management is still evolving and even in relatively small and comparatively well resourced conservation reserves, fire management has had limited success in controlling the extent and intensity of wildfires in the years following high rainfall. Much research is still required into the most favourable fire regimes for many species of plants and animals, and there is limited information available on the distribution of fire-sensitive plant communities in the study area. However, this document seeks to bring together current knowledge on fire related issues for the protection of cultural and natural resources in the ranges of north-western South Australia. This information can be used to develop annual burn programs and guide other fire related decisions and operations. As new data emerges on the locations of significant species and communities it should be used to update this plan.

Information presented in this document has also been summarised and simplified into individual operational fire plans for each of the Mann and Musgrave Ranges FMRs. These have been written in plain language, and will be translated into Pitjantjatjara.

1.2 Fire management Objectives

This Fire Management Strategy is based on the premise that fires are now larger and more destructive than in the past when Anangu were living a nomadic lifestyle and continuously burning small patches of country. The change in fire regime from numerous small fires lit in a variety of seasons to a situation of less frequent but much larger wildfires predominantly occurring in the hot summer months is believed to have contributed to the loss of many medium-sized mammals from the arid zone, declines in various other fauna species and the contraction of fire-sensitive plant communities.

The overarching objective of this fire management strategy is to revert to a fire regime that is more like the fire regime that prevailed when Anangu were walking the country and continually lighting lots of small fires, in a variety of seasons, every year. The end result was a mosaic of vegetation in a variety of stages of recovery from fire. Of course it will not be possible to achieve this across the entire region but anywhere that a finer scale vegetation mosaic can be established will aid in stopping the spread of large, hot, destructive summer wildfires.

The overall goals of fire management in the ranges region of the APY Lands are to use fire to maintain and enhance ecological diversity in the area and to protect people, sites of cultural significance and infrastructure from the adverse effects of fire. This Fire Management Strategy is based on the following five key objectives:

1. **To protect human life, cultural sites and infrastructure from the adverse impacts of fire**
2. **To manage fire regimes to maintain or enhance species and habitat diversity in the area and increase populations of rare and threatened species and communities that may be at risk from inappropriate fire regimes**
3. **To minimise the potential for spread of uncontrolled wildfires**
4. **To integrate Traditional Knowledge about fire management with scientific principles and modern technology to develop best practice management for the region**
5. **To assist in the maintenance and intergenerational transfer of knowledge about fire management, and develop the capacity of APY land management to manage fire in the region**

1.3 Legislation relevant to Fire Management

In South Australia the Fire and Emergency Services Act 2005 establishes the legal framework and responsibilities for the prevention, control and suppression of fires. The Fire and Emergency Services Act requires owners of land “to take reasonable steps to protect property on the land from fire and to prevent or inhibit the outbreak of fire on the land, or the spread of fire through the land”.

Within South Australia there are specific controls upon the clearance of native vegetation. Under the Native Vegetation Act 1991 any works or activities that involve clearance of native vegetation (including clearance by burning) within an area more than 5m wide, requires the consent of the Native Vegetation Council (NVC) unless a fire break wider than 5m is authorised or required by another Act or Regulation. In exercising its powers to grant permission to clear native vegetation, the Native Vegetation Council is bound by a set of "Principles of clearance". These principles include broad objectives aimed at preserving biological diversity.

Anangu Pitjantjatjara Yankunytjatjara has received clear instruction and advice from the Native Vegetation Council, as per correspondence to the Alinytjara Wilurara Natural Resource Management Board on the 22 December 2006,

‘At its recent meeting the NVC … agreed to endorse the document ‘A fire Management Strategy for the Anangu Pitjantjatjara Yankunytjatjara Lands’ submitted by APY Land Management. The Council consider that clearance by ‘patchburning’, consistent with this management plan, to be authorised under Native Vegetation Regulations 5(1)(w), 5(1)(zi) and 5(1)(m).

In recognition of the long term nature of this program the plan has been endorsed for a period of 10 years. The plan will need to be reviewed and be subject to further endorsement at that time. Any clearance (burning) will need to be undertaken in accordance to the plan.’

The Pitjantjatjara Land Rights Act 1981 is the Act under which the APY Lands were established and which governs how they are controlled and administrated (Yates and Morse 2003). The intention underlying the Act was to enable Anangu to rekindle their culture through their relationship with the land which included patch burning.

Overarching the state legislation is the Commonwealth Environment Protection and Biodiversity Conservation Act 1999. This Act aims to protect Matters of National Environmental Significance which includes nationally listed threatened species (e.g. black-footed rock wallaby *Petrogale lateralis* and the naked mint bush *Prostanthera nudula*).

Patch-burning under mild conditions to protect fire-sensitive plant communities, establish a mosaic of fuel-reduced areas and prevent the passage of large, hot, summer wildfires is in the spirit of all the above-mentioned legislation.

1.4 Other relevant fire management plans and activities in the region

This fire management plan follows a previous fire management strategy that was compiled for the APY Lands (Yates and Morse 2003), and much of the background information in the current plan has been drawn from that document. A detailed fire history was compiled for the APY lands during that project, covering the period from 1984-2002. The current document builds on the recommendations of the previous fire strategy to develop operational fire management plans for the Mann and Musgrave Range Fire Management Regions that contain more specific burning proposals.

A similar fire management planning project was completed in the adjacent area of the Northern Territory in 2008, where a Fire Management Strategy for the Petermann Region was compiled for the Central Land Council (Paltridge and Latz 2008). The Petermann Fire Management Strategy was intended to guide the fire management works to be conducted by the Kaltukatjara (Docker River) Aboriginal Ranger group for a 5 year period extending from 2008-2013. The first year of the 5 year plan was successfully implemented in 2008.

A draft Fire and Vegetation Management Strategy (Morse and McAlpin in review) has also been produced for Uluṟu Kata Tjuṯa National Park (UKTNP). There is a wealth of knowledge and experience in cross-cultural fire management planning, training and implementation within the National Park that APY land management may be able to draw on during implementation of fire management activities.

Although a formal fire management strategy has not been prepared for the Ngaanyatjarra Lands Indigenous Protected Area which is situated directly west of the APY Lands, a number of communities in the region have active land management programs which include burning.

2.0 Description of Study Area

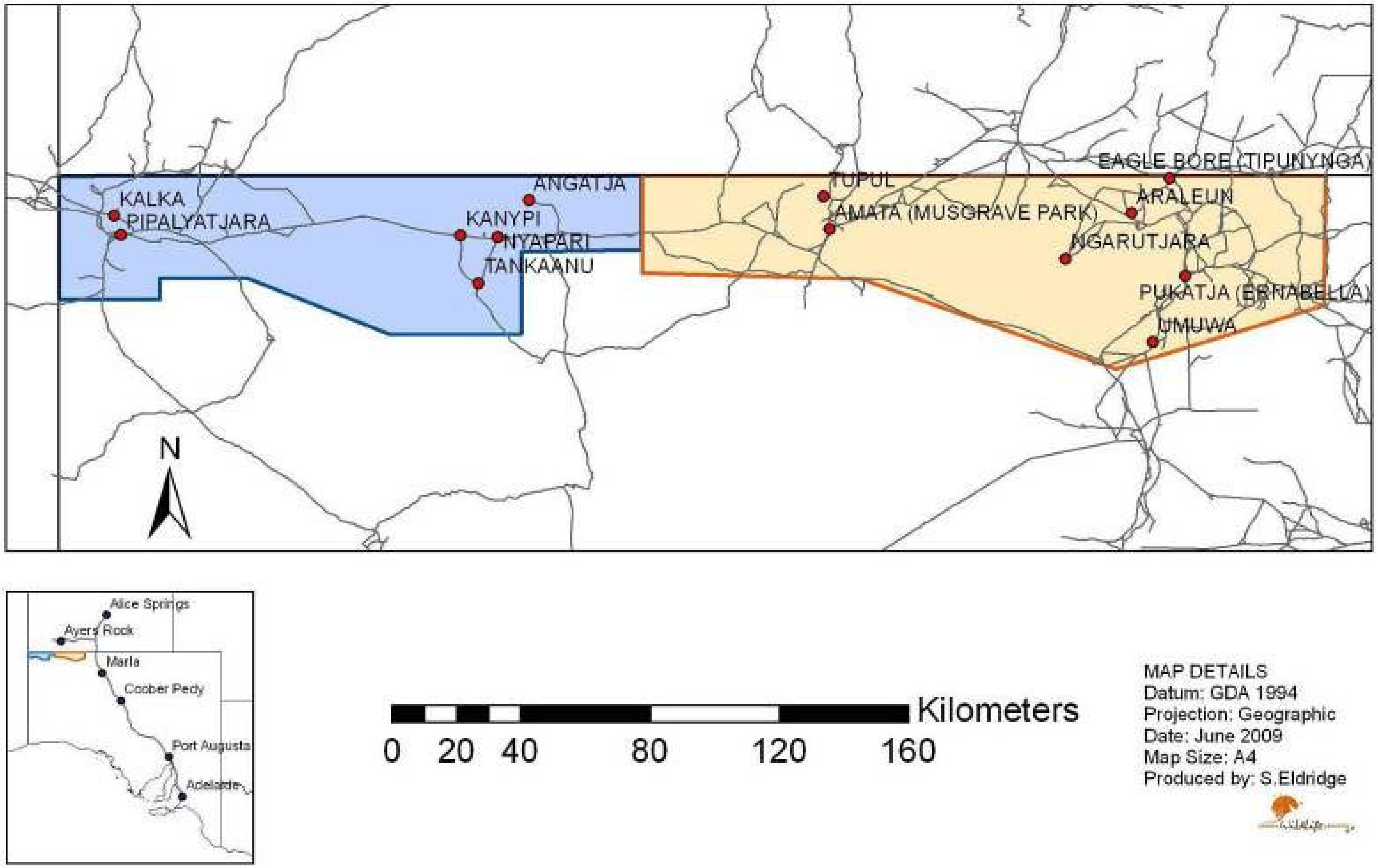
2.1 Location

The Mann and Musgrave Ranges Fire Management Regions are in the north-western corner of South Australia (figure 1), within the Anangu Pitjantjatjara Yankunytjatjara Lands. This area falls within the Central Ranges bioregion which is dominated by rugged, east-west trending mountain ranges (Mann, Musgrave and Petermann Ranges). The ranges are the result of a mountain building event approximately 600 million years ago. Granite and gneiss are the dominant rocks types in the Mann and Musgrave Ranges. Quaternary (less than 10 million years ago) red earth alluvial plains surround the ranges. Watercourses dissect the ranges, but do not extend far from them.

The Mann Ranges Fire Management Region incorporates the portions of the Tomkinson and Mann Ranges that occur within South Australia, extending south to the Deering Hills (fig. 1). Major communities in the Mann Ranges Fire Management Region include Kalka, Pipalyatjara, Kanypi and Nyapari. Angatja and Tankaanu outstations also fall within this region. The region is surrounded by Aboriginal land with the proposed Katiti-Petermann Indigenous Protected Area occurring across the northern boundary in the Northern Territory and the Ngaanyatjarra Lands Indigenous Protected Area in the adjacent part of Western Australia. The Mann Ranges FMR is part of the proposed Kalka/Pipalyatjara Indigenous Protected Area. There are currently no Land Management Staff based in the Mann Ranges FMR.

The Musgrave Ranges Fire Management Region comprises the majority of the Musgrave Ranges (the northern tip of these ranges extends into the Northern Territory) and the granitic inselbergs of the Sentinel Hill area. We have also included the flat country between the ranges and the Northern Territory border within this region. The major living areas within the Musgrave Ranges FMR are Amata, Pukatja (Ernabella) and Umuwa, but a number of outstations are also occupied in the region. The APY Land Management Unit is based at Umuwa in the Musgrave Ranges FMR. Northern Territory pastoral properties Mulga Park and Victory Downs adjoin the northern boundary of the Musgrave Ranges FMR, but it is surrounded by Aboriginal land in all other directions. Musgrave Park Pastoral Company, based at Yunarinyi (Kenmore Park), is located on the eastern side of the region.

Figure 1. Location of the Mann Ranges and Musgrave Ranges Fire Management Regions



3.0 Aboriginal Burning Patterns

3.1 Traditional fire management in central Australia

Aboriginal use of fire in central Australia is believed to have spanned at least 30,000 years (Williams 2002). Traditional burning was conducted for a variety of reasons including clearing the land for ease of travel or to prepare a campsite, removing vegetation that obscures burrows, encouraging game species that are attracted to the smoke (e.g. bustards) and later to the new growth (e.g. kangaroos), flushing game species hiding in the undergrowth, encouraging the growth of fire- stimulated food plants and signalling people's whereabouts to other family members (Latz 1995). Fire also has ceremonial uses, and is part of the Rain Dreaming, where a smoke-produced cloud is believed to bring rain (Nash 1990).

A review of Aboriginal fire regimes in the western desert, based on both explorer's records and archaeological/anthropological evidence, has revealed that traditional burning activity was widespread and the size of patches burnt typically ranged from a few square metres to about 500- 1,000 ha (Gill 2000). The most quantitative information of traditional burning patterns comes from a study of fire scars in the spinifex grasslands of the western desert (west of Lake Mackay) where 1953 aerial photographs were used to map the burning patterns of Pintubi Aboriginal people who were still living a traditional lifestyle at the time (Burrows *et al.* 2006). The photographs reveal a landscape mosaic of numerous small patches, 75% of which were less than 32 ha, and occasional large fires up to 6,000 ha. Analysis of satellite imagery from the 1970s to the present shows that the fine grained mosaic has been obliterated in recent times and replaced with a much simpler mosaic consisting of either vast tracts of long unburnt and senescing vegetation or extensive areas of vegetation recovering from a single fire (Burrows *et al.* 2006). From 1953 to 2000 the mean patch size increased from 64 ha to 444 ha, after peaking at 52,000 ha in the early 1980s (Burrows *et al.* 2006).

Although some authors have suggested that burning occurred primarily in the late winter and spring (Kimber 1983), the Pintubi have reported that hunting fires were lit on a daily basis, throughout the year (Burrows *et al.* 2006). Even when burning was not deliberately conducted, the mere act of carrying a firestick between camps would have inadvertently ignited fires wherever the fuels were adequate. The patchiness of the fuel load produced by traditional burning is thought to have reduced the likelihood of large fires ignited by lightning (Williams 2002). Although large tracts of country in dry, waterless areas may have been largely unoccupied by Aboriginal people and fired primarily by lightning strikes, periods of widespread rain would have facilitated access into such areas. As people travelled around, carrying their firesticks, firebreaks would have been created, impeding the passage of future wildfires during the most damaging fire seasons that follow significant rain events. Some large fires did still occur, however these are considered to be at least an order of magnitude less than the fires that have occurred since European settlement (Williams 2002).

3.2 Contemporary use of fire

Contemporary attitudes towards and use of fire in the APY lands have been described by Yates and Morse (2003). They suggest that although fire is widely recognised as a powerful tool and a "proper" thing to do with country, there remain few people in the region that possess a detailed knowledge of how fire can be used to manage the landscape. During their period of engagement with Anangu (primarily in the 1990s), Yates and Morse observed that a considerable amount of burning was occurring along roadsides and around communities, but most of the fires were considered to be either for signalling (car breakdowns or heralding the passage of "business" vehicles), arson (deliberately burning other peoples country out of spite) or accidental fires caused when cooking fires, (or children's fires lit during play) escaped to become wildfires (Yates and Morse 2003). "Traditional" burning to increase bush tucker/medicine/tobacco resources was only conducted by a small number of Traditional Owners, and was deemed to be less frequent than burning instigated by APY Land Management. Lightning is also a significant source of wildfires in the APY Lands, and although the incidence of lightning strikes is likely to have remained unchanged, the impacts of such ignitions have probably increased as the amount of Anangu burning has diminished.

Following the completion of the APY Fire Management Strategy in 2003, the amount of burning being conducted by Anangu (at least in the northern APY Lands) seems to have declined further. Since the vast wildfires of 2002 only a handful of fires have been detected in the study area by the Landgate Firewatch project (see Section 5.2), and the last of these were in 2005. While it is likely that other burns have been conducted that were too small to be detected by Landgate (which tends not to pick up fires smaller than $4km^2$ in size), very little evidence of recent burning was observed during the field survey of the Mann and Musgrave Fire Management Regions in March 2009.

The lack of burning by Anangu in the northern APY Lands is in contrast to areas of Aboriginal land in the Tanami and western deserts[1] of central Australia where Warlpiri and Pintubi people continue to burn accessible areas of country as soon as it is ready to carry fire. Their main reasons for firing the landscape are to make it easier to follow tracks and find burrows of small game species (primarily goannas, blue-tongues and cats) while hunting and to rejuvenate country, encouraging fresh growth and increasing the productivity of the area (Gabrys and Vaarzon-Morel 2006). That burning is less of a priority for the Anangu in the northern APY Lands at the current time may reflect diminished reliance on small game meats, a stronger influence of pastoral attitudes or relate to the dominance of (less flammable) tussock grasses compared with the spinifex dominated country of the Tanami and western Deserts. It has also been suggested that the onus to conduct natural resource management activities such as burning has increasingly been transferred from individual Traditional Owner obligations to the responsibility of Land Management units (Rodney Edwards, APY Land Management, personal communication, October 2009). Within the study area, Anangu are more likely to participate in burning activities organised through APY land management than instigate their own burning.

[1] By "Western Deserts" we are referring to the Great Sandy and Gibson Deserts

Consultations with Aṉangu during the current project revealed a reluctance to burn in the vicinity of sacred sites. Although people are concerned about important sites being burnt, they did not appear to be prepared to attempt fire management around culturally significant areas due to the perceived risk that the sites may be inadvertently damaged during burning activities. Such sites are therefore vulnerable to the impacts of large, hot, uncontrolled wildfires, but this is apparently less of a concern to Aṉangu because they consider such events out of their control. A fire ignited by lightning is considered a “neutral” event (Yates and Morse 2003), that no-one need feel responsible for.

Warlpiri people in the Tanami Desert of the Northern Territory also hold grave fears about damaging sacred sites during burning activities but are more likely to actively burn adjacent areas to protect sites from fire (Gabrys and Vaarzon-Morel 2006). For example men may burn to protect a patch of mulga where sacred objects are stored. However, if someone were to set fire to the sacred area itself, it is believed that they would suffer retribution not only from senior males but also from the spirits who look after the land (Gabrys and Vaarzon-Morel 2006). Other Warlpiri people discussed the importance of not burning culturally significant trees, but acknowledged that the trees occasionally got burnt during fires caused by lightning strikes. This was accepted as something that had always happened; after lightning strikes the men would go out and inspect the damage (Gabrys and Vaarzon-Morel 2006).

4.0 Fire and Biodiversity

4.1 Fire Ecology in central Australia

Fire is a natural phenomenon that pre-dates human occupation of Australia. Many “fire-tolerant” species have adaptations to help them survive fires, some even require fire to complete their life cycles. Other “fire-sensitive” species are killed by fire and can become locally extinct if burning is too frequent or too intense.

Central Australian ecosystems have been affected by fire for a long time with the earliest evidence of charcoal dating back as far as 350 000 years (Preece *et al*. 1989). Somewhere between 60,000 and 120,000 years ago there was a dramatic increase in fire frequency that was maintained during Aboriginal occupation of central Australia until about 100 years ago. Aboriginal people used fire for a variety of purposes, but the overall effects of their burning practices usually ensured maximum production of food resources.

Many of the vegetation and animal communities in the Australian arid zone appear to have been strongly influenced by a regime of Aboriginal burning and populations of most plant species are capable of surviving certain fire regimes. The effect of a particular fire on individuals of a species depends on the intensity and duration of the fire, the pre-fire condition of the biota, the period since the last fire and the pre- and post-fire weather (especially rain) which influences soil moisture. But the effect of a single fire is not as environmentally significant as changes to the fire regime and the consequential longer-term effects on the biota (Preece *et al*. 1989).

Many desert trees and shrubs are fire tolerant, having growth points under their bark either in their branches or at the base of the trunk which allow new growth almost immediately after a fire (Latz 1995). Major examples are eucalypts (*Eucalyptus* and *Corymbia*), grevilleas, hakeas, *Allocasuarina* (desert oaks) and some species of *Acacia*. Thick corky bark provides insulation from the heat of the fire for species such as corkwoods and desert oak while the smooth, white trunks of ghost gums help to reflect the heat. New growth may be from buds on trunks and branches or may be in the form of basal resprouts or from lateral roots. In the case of mallee eucalypts, resprouting is basal from a special type of swollen root (mallee root or lignotuber).

Other woody species, also including many Acacias, are typically killed by fire, but have hard seeds which are broken by the heat of the fire, resulting in mass germination after burning (Latz 1995).

Spinifex communities are particularly well adapted to being burnt. Although most species of spinifex are killed by fire they are able to regenerate from seed after the first effective rainfall, and some species are able to resprout from rootstock, allowing rapid recolonisation of sites that have been burnt (Latz 1990). *Triodia basedowii* regenerates only from seed, and is the slowest of the central Australian spinifex species to resume domination of an area after fire, taking about 4 years to attain 50 % composition. Nevertheless, like the other spinifex species, *T. basedowii* sets seed within 2-3 years of a fire. Most overstorey species in the spinifex communities are also well adapted to a variety of fire frequencies and intensities. The majority of plants that coexist with spinifex produce seed 2-3 years after a fire, even those which have to regenerate from seed (Latz 1990).

Other vegetation communities are less tolerant of fire. The frequency with which a plant community can be burnt without long-term changes to its floristic and/or structural composition is controlled by the relative rates of recovery of fuel loads in relation to the ability of all plant species in the community to regrow and mature to the stage where they can reproduce (Griffin and Friedel 1981). While a single fire event is unlikely to send species to local extinction, if the interval between successive fires is too short for seedlings to have matured to the seed production stage, seed banks may be depleted and species eliminated from an area. For example two fires through a mulga community within a period of 10-15 years can result in the demise of the community (Williams 2002).

The most fire-sensitive species cannot tolerate even a mild winter fire, and do not readily regenerate from seed after being burnt. Species such as the desert fig (*Ficus brachypoda*) appear to be mainly restricted to fire-protected areas such as cliff edges, boulder strewn areas and sheltered gullies where fuel loads are too low to carry a fire (Griffin *et al*. 1983).

Spinifex communities flourish in areas with poor or shallow soils, whereas non-spinifex communities generally occur on soils with higher nutrient or moisture levels. In more productive environments, exposure of the soil surface by frequent and intense fires can accelerate soil erosion and cause loss of soil nutrients when ash is carried away by wind or water. This can transform the habitat into an environment more conducive to the establishment of spinifex, which may then out-compete the species that previously occurred there.

Most of the central Australian grass species appear to thrive on fire and areas that are frequently burnt are dominated by grassy communities. Successions of plant species following fire and rainfall have been documented in spinifex communities (Griffin 1990, Latz 1990). Shortly after the first effective (>10 mm) rains occur on freshly burnt ground, spinifex and a variety of short-lived grasses and forbs establish, including many succulent herbs and plants that bear edible fruits, or produce abundant seed or nectar. It has been suggested that this flush of activity after burning is due to the availability of nutrients returned to the soil in ash and to the creation of space allowing light and heat to penetrate more of the ground surface (Griffin and Allan 1986), but reduced competition for soil moisture when other plants are removed is probably equally important. Of the 25 most important food plants for central Australian Aboriginal people, 50 % are promoted by regular burning (Latz and Griffin 1978).

Significant rainfall results in the establishment of obligate seed regenerating trees and shrubs, most of which grow quite slowly (Griffin 1990). Eventually spinifex and other perennial trees and shrubs replace the short-lived species. Spinifex cover continues to increase over time as the state of plant communities move towards maturity. If a population is left undisturbed by fire for a long period, the spinifex plants continue increasing in size to the point where they senesce, die from the centre and eventually die completely. When they are senescent other species of trees and shrubs have a greater chance of successfully competing and grow up through the old plants. This may result in a reduction in the abundance of spinifex at a site and when the cumulative rainfall since the preceding fire exceeds about 10,000mm, spinifex grasslands may start to be replaced by a more diverse climax community of tussock grasses, shrubs and trees. Thus species diversity is initially high with the flush of ephemeral species that appear after a fire, it then declines as the vegetation becomes dominated by spinifex, but if fire is excluded for long enough, diversity may again increase in the climax community (Allan and Griffin 1986).

Fire in spinifex communities is linked to rainfall on two time scales. Spinifex plants increase in biomass and cover in proportion to cumulative rainfall since the last fire. Spinifex plants can persist during dry periods of below average rainfall and can also increase their growth rates in response to above average rainfall amounts. Because spinifexes are long lived perennials they can keep accumulating biomass over several decades with an associated increase in potential fire intensity. There is also an associated increase in connectivity of fuels which affects the ability of fire to spread across the landscape as well as also influencing intensity.

In addition to cumulative rainfall, periods of widespread very high summer or annual rainfall have a strong influence on the incidence, size and intensity of fires in spinifex vegetation, regardless of time since fire. This is because the rain promotes a flush of annual and short-lived perennial grasses and forbs which dramatically increase biomass and connectivity of fine fuels. This fuel can connect gaps between spinifex plants regardless of time since fire and can greatly reduce the effectiveness of past prescribed burning in limiting the spread of wildfires (patch burn mosaics and burnt linear breaks). This fuel may only persist as standing vegetation for a few years and by 2-3 years after the flush a significant proportion will have been consumed by herbivores or broken down to litter. Widespread occurrences of above-average rainfall have occurred approximately every 25-35 years in central Australia since written records started.

Following a fire, individual spinifex hummocks tend to accumulate biomass after major rainfall events and lose little of it during the intervening dry periods. In the early stages of recovery spinifex cover is too low to carry a fire, and this may be the case for up to 15 years depending on regional and seasonal conditions (Allan and Southgate 2002). However, in high rainfall periods in the arid zone, spinifex communities have been observed to accumulate sufficient fuel to burn twice within 18 months (P. Latz personal observations). This is due to the rapid accumulation of short-lived annual grasses which can carry the fire between the spinifex clumps. Most spinifex species are capable of carrying fire after 7-10 average rainfall years, or about 2500 mm of cumulative rainfall since the previous fire event. An exception is the stoloniferous form of *Triodia pungens* that regenerates from rootstock and (in good conditions), can rapidly form continuous groundcover capable of carrying a fire within a 2 year interval (Latz 1990).

When Aboriginal People colonised central Australia, they learnt to use fire to maximise the food productivity of the land. Traditionally small patches were burnt as people travelled through the country. This controlled the build-up of fuel, thereby reducing the incidence of large, intense fires (Latz and Griffin 1978). The net result of traditional burning practices was a mosaic of vegetation in different stages of recovery from being burnt, which provided a range of food sources for both Aboriginal people and the animals they hunted (Latz and Griffin 1978). A tight mosaic of different states presented a range of niches for plants and animals and allowed many possible responses by the biota in an unpredictable climate. Mature or near mature patches could persist during dry times. Recently burnt patches could respond rapidly to minor rainfall events producing food and attracting animals (Griffin and Allan 1986). Long unburnt vegetation is often poor in food resources for people but may act as a refuge for animals that require cover, and as a seed source for the regeneration of plants in adjacent burnt patches.

With a reduction in traditional burning activities following European colonisation of Australia, the fire regime changed from numerous relatively small fires occurring in a variety of seasons to a situation of infrequent but extensive summer fires, with lightning the most common source of ignition (Burrows and Christensen 1990). Extensive wildfires have occurred in central Australia in the 1920's, 1950's, mid 1970's and 2001-2002. These periods have occurred in years following above average rainfall, and the associated biomass of ephemeral grasses. Single fires burn areas up to 30,000 km^2 with most fires burning more than 50 km^2 (Griffin *et al.* 1986, Allan and Southgate 2002). The changed fire regime is believed to have contributed to the unprecedented decline in medium-sized mammals during the last century (Bolton and Latz 1978, Burbidge *et al*. 1988) and the perceived contraction of some fire-sensitive plant communities (Start 1986, Duguid 1999, Pitts and Matthews 1999).

The impacts of fire have been exacerbated by the introduction of feral animals. Exotic herbivores, such as camels and rabbits, hamper the regeneration of plants that have germinated or resprouted after being burnt. This can lead to reduced plant diversity as the fire-encouraged and relatively non-palatable spinifex species become increasingly dominant. Exotic predators (cats and foxes) target the few remaining unburnt refugia for small prey species after a fire has swept through an area, and can potentially cause localised extinctions of mammalian prey.

4.2 Fauna

4.2.1. Limitations of the fauna data

The fauna of the APY Lands has been relatively well surveyed in comparison with other desert areas, with a ten year biological survey (comprising 17 field trips and 166 trapping sites) conducted by the South Australian Department for Environment and Heritage between 1991 and 2001 (Robinson *et al*. 2003). However, the survey team had limited access to the range country due to cultural sensitivities in some areas and general inaccessibility of the steep terrain. Consequently only a handful of sites were surveyed in the Musgrave Ranges and even fewer in the Mann and Tomkinson Ranges. The other main limitation of the fauna data is that the ecology of many of the rarer species is poorly known, making it difficult to recommend appropriate fire intervals and patch sizes.

4.2.2 Reptiles and Amphibians

Fifty two species of reptiles and 2 frogs have been recorded within the Mann Ranges Fire Management Region (Appendix A), and 56 species of reptiles and four frogs are known to occur within the Musgrave Ranges Fire Management Region (Appendix C).

Although many of the reptile species in the study area are habitat generalists, some are known to have specific fire regime requirements. Lizards which do not have underground burrows generally only occur in long unburnt habitat. Examples include litter-dwelling skinks (such as *Carlia triacantha and Morethia ruficauda*) which require a long interval between fires to allow accumulation of dense leaf litter, and two species of gecko (jewelled gecko *Strophurus elderi* and clawless gecko *Crenodactylus ocellatus*) which live in mature spinifex clumps. Burrowing reptiles, such as the central netted dragon (*Ctenophorus nuchalis*) are less dependent on vegetation for shelter and prefer open areas in recently burnt habitat. Many reptile species are thought to prefer medium-aged spinifex and fire studies in spinifex habitat at Uluṟu Kata Tjuṯa National Park have shown maximum diversity of reptiles in the 5-9 year old spinifex compared with older and younger aged spinifex communities (Steve McAlpin, personal communication).

Great desert skinks (*Egernia kintorei*) are known to occur south of the study area in mulga woodland habitat, and north of the study area in spinifex sandplain habitat. Aṉangu informants reported that they were previously widespread in sand dune country until the 1950s, and were known from the Musgrave Ranges FMR between New Well and the Mulga Park road (Robinson *et al.* 2003). It is therefore conceivable that they may still be present in either of these habitat types within the study area. If this species (ranked as Endangered within South Australia, and Vulnerable at the national level) is found to be present in the Ranges Fire Management Regions, specific burning activities will be required to ensure sufficient cover is maintained around the burrows.

Two other herpetofauna species of conservation significance occur within the study area. The very rare South Australian form of the orange-crowned toadlet (*Pseudophryne occidentalis*) has been recorded at a few isolated rockholes in both the Mann and Musgrave Fire Management Regions while the Musgrave slider (*Lerista speciosa*) is known only from a single specimen collected at the base of Mt Morris, just west of Amata (Robinson *et al.* 2003). Both the orange-crowned toadlet and the Musgrave slider are classified as Vulnerable in South Australia. Although their preferred fire regimes are unknown, it is important that the habitats for these species are not unduly disturbed by any fire management activities implemented.

Unfortunately there has been little research into the dispersal abilities of arid zone reptiles, but few species are likely to be capable of travelling large distances to find suitable habitat. Consequently, species with specific fire regime requirements would be expected to benefit from a tight mosaic of fire-ages to facilitate recolonisation of patches of appropriate habitat after fire. Even if particular species can find enough food in burnt areas, the predation risk in areas that have been burnt in hot clean fires must be very high.

4.2.3 Birds

Of the 153 bird species recorded for the APY Lands 77 bird species have been recorded in the Mann Ranges Fire Management Region (Appendix A) and 98 in the Musgrave Ranges (Appendix C). Two bird species with a national conservation rating are known from the APY lands: the princess parrot (*Polytelis alexandrae*) and malleefowl (*Leipoa ocellata* or commonly referred to as Nganamara). The most recent record of princess parrots within the study area was in 1999 when a flock of 20 were seen north of Kalka (Robinson *et al.* 2003), however it is likely that princess parrots would visit the area sporadically during good seasons. Malleefowl were previously widespread through central Australia as far north as the southern Tanami Desert, and were recorded by Giles near the Mann Ranges in 1873. The most recent report of Nganamara in the study area came from a woman who had harvested eggs from a nest south of Kanypi in 1993 (Robinson *et al.* 1993). Currently the nearest known active mounds occur within the Walalkara and Watarru Indigenous Protected Areas, in the southern APY Lands. Malleefowl require long unburnt mulga or mallee habitat with a good accumulation of litter to use for their mounds. When their habitat is burnt, it may take 30 years before the area is suitable to recolonise again. Fire management to protect mulga is very important for this species that is classified as Vulnerable to extinction at both the national and state level.

The Grey currawong (*Strepera versicolor*) is probably extinct in central Australia. It was last recorded in the Petermann Ranges (in the Northern Territory) in the 1960s, but has not been seen in the Mann and Musgrave Ranges since the 1930s. It is reported to have mainly fed on the ground, foraging for invertebrates that inhabited leaf litter. Being a ground feeder would have made it vulnerable to predation by introduced predators, and it is possible that widespread fire events may have affected its food availability by destroying the litter layer.

Other bird species of conservation concern include the Australian bustard (*Ardeotis australis*; rated as Vulnerable in South Australia and Near Threatened nationally) and emu (*Dromaius novaehollandiae*) which have both suffered from over-hunting in central Australia, and a suite of rare bird species likely to be threatened by inappropriate fire regimes. These include birds that are reliant on long unburnt spinifex communities, and those that require intact mulga communities.

While rainfall is the primary determinant of bird abundance and diversity in the arid zone, fire also has a major influence on the structure of bird communities, particularly in spinifex and mulga communities (Reid *et al.* 1993). Many of the insectivorous and granivorous nomadic birds favour open, recently burnt habitats which produce an abundance of ephemeral plant life and insects after significant rains. Species such as the budgerigar (*Melopsittacus undulatus*), crimson chat (*Ephthianura tricolour*), white-winged triller (*Lalage suerii*) and masked woodswallow (*Artamus personatus*) all prefer the early successional stages after fire, whereas the rufous-crowned emu-wren (*Stipiturus ruficeps*), spinifex bird (*Eremiornis carteri*) and striated grasswren (*Amytornis striatus*) require mature spinifex hummocks for shelter and will only survive in old-growth spinifex habitats. The striated grasswren is classified as Vulnerable to extinction in SA, and Near Threatened nationally with its major threat believed to be extensive wildfires. Nevertheless, it was recorded at 9 sites through the APY Lands during the DEH biological survey, whereas the rufous-crowned emu wren was not recorded at all, and the spinifexbird only once. Both of these species are rated as Rare in SA. The spinifex pigeon (*Geophaps plumifera*) and the painted finch (*Emblema pictum*) are also rated as rare in South Australia. These birds are both granivorous species with food supplies likely to be affected by fire regimes.

A distinct suite of bird species occurs in mulga habitat, and many of these require the complex structure of mature mulga communities (Leavesly 2008). Fire management to protect stands of senescing mature mulga plants that support an abundance of mistletoes and grow in association with high densities of eremophilas will benefit species such as the redthroat (*Pyrrholaemus brunneus*), grey fantail (*Rhipidura albiscapa*) and western gerygone (*Gerygone fusca*; Leavesley 2008). Redthroats appear to have declined in the study area since the 1930s when they were commonly observed around the ranges. They are classified as Rare in SA, and were only recorded at 6 sites during the DEH biological survey. Western gerygones are also rated as Rare in SA. No grey fantails were recorded in the study area during the Biological survey (Robinson *et al*. 2003).

Another rare bird in the study area is the Rufous calomanthus (*Calomanthus campestrus*) which is dependent on saltbush habitat. Saltbush is vulnerable to browsing by cattle, camels and rabbits and is also fire sensitive. This vegetation community has become very rare across the border in the Petermann region, due to fire and camel browsing. This is likely to have impacted on the calomanthus population.

Many of the "Rare" birds in the APY lands are those that require long unburnt habitats, whether it be spinifex, mulga or saltbush. Frequent large hot wildfires obviously limit the amount of habitat available for such species. Fire management programs should therefore aim to reduce the probability and impacts of large fire events. This can only be achieved by cool season burning to reduce fuel loads and minimise the spread of hot summer wildfires, but ensuring that some stands of mature spinifex are left unburnt.

4.2.4 Mammals

Of the 44 native species known to have occurred in the APY Lands at the time of European settlement, 27 were recorded as extant during the DEH biological survey (Robinson *et al.* 2003). Sixteen of these have been recorded within the Mann Ranges Fire Management Region (Appendix A), and 23 in the Musgrave Ranges Fire Management Region (Appendix C). The additional 7 species within the Musgraves are all bats, and the higher species count in that region probably reflect increased search effort rather than a significantly richer bat fauna occurring within the Musgraves.

The mammal species of highest conservation significance in the study area is the Black-footed rock wallaby (*Petrogale lateralis*), also known as the black-flanked rock wallaby, or Warru. This is one of South Australia's rarest mammals, and is classified as Critically Endangered in SA, and Vulnerable to extinction nationally. Only two populations are currently known to occur in South Australia (figure 2), one in the Eastern Musgraves (in the Musgrave Ranges Fire Management Region), and the other in the Tomkinson Ranges (in the Mann Ranges Fire Management Region). The Eastern Musgrave metapopulation consists of as many as 100 animals spread out across ranges and isolated outcrops north, northeast and west of Pukatja, with a core population at New Well of potentially 40 animals (M.Ward, DEH personal communication, December 2009). The known distribution of the Tomkinson Ranges metapopulation is currently limited to two hills, with a core population at Kalka comprising 15-25 animals. A third colony at Sentinel Hill is believed to have gone extinct in 2006.

In the 1930s black-footed rock wallabies were one of the commonest mammals in the region, with abundant populations on nearly all the rocky outliers of the main ranges (Finlayson 1961). By 1961 severe declines had occurred, following the colonisation of the fox. While predation by exotic predators is undoubtedly the greatest threat to rock wallaby populations, the replacement of diverse fire-sensitive plant communities on the rocky hills by fire-promoted plant communities (dominated by unpalatable spinifex) must have also contributed to the fragmentation of wallaby populations. Fire sensitive plants such as spearbush and fig (fruits) are important in the diets of rock wallabies, which also eat a variety of other grasses, herbs and shrubs, (but not spinifex). The very low diversity of plants on spinifex covered hills makes them unsuitable for rock wallabies, but favours colonisation by euros, which can digest spinifex, and with their greater mobility are able to graze over larger areas. There is considerable overlap in the diets of euros and rock wallabies, and where both species coexist there may be competition for the most palatable food plants. When too many euros occur, favoured food plants such as spearbush may be eaten out of reach of the rock wallabies. This results in rock wallaby colonies being restricted to the steepest, rockiest parts of their habitat that are not accessible to euros or predators, and are also usually fire shadow areas. Such sites are rarely big enough to support large enough populations to be sustainable, and colonies become very susceptible to local extinction.

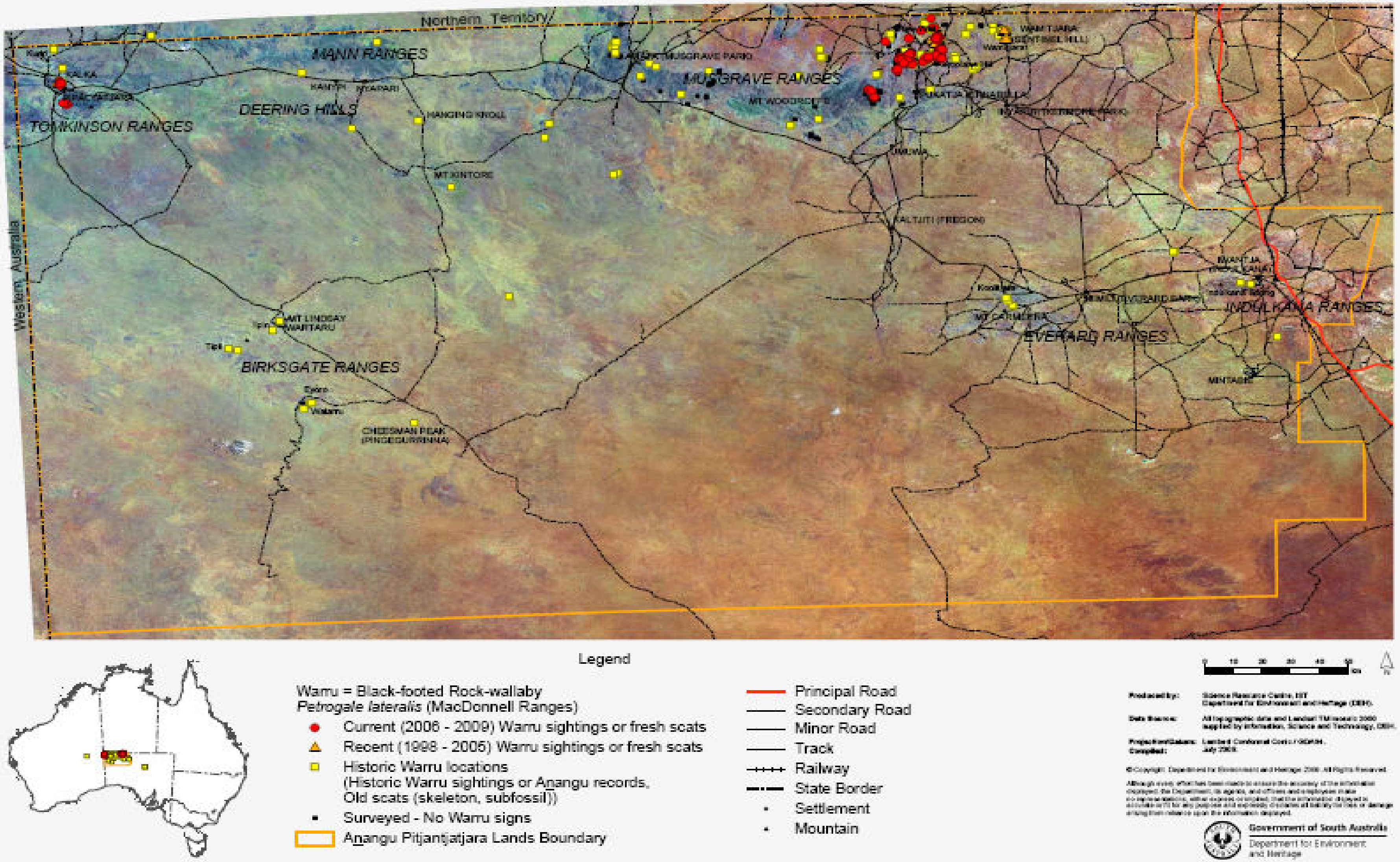
To date, rock wallaby management in the APY lands has focussed on predator management. Regular baiting campaigns have successfully reduced the threat of predation by foxes and dingoes, but predation by cats remains a problem, and competition with euros appears to have increased in the absence of dingoes. Judicious use of fire in the vicinity of rock wallaby colonies will be an important tool to prevent further spinifex colonisation of wallaby habitats (and loss of preferred food plants), and assist in the expansion of rock wallabies beyond their current patches. Allowing dingoes to recolonise areas may also assist in the regulation of euro and cat numbers.

Across the border into the Northern Territory, the distribution and abundance of black footed rock wallabies is considered to have remained stable, with the exception of localised extinctions occurring within Uluru Kata Tjuta National Park and around the Granites Goldmine in the past 20 years (Gibson 2000). Black-footed rock wallabies are most abundant in the MacDonnell Ranges, but a healthy population has also recently been recorded on the Mananana Range near Docker River. This hill has some of the best relictual fire sensitive vegetation left in the Petermann Region, and a densely vegetated gully searched in May 2009 revealed abundant sign of both rock wallabies and dingoes, but no sign of euros.

Another declining macropod species in the study area is the Red Kangaroo. Once common on the plains near the ranges, red kangaroos have become a rare species in the Central Ranges bioregion, despite being abundant in other parts of their distribution. The main reason for their decline is thought to be unsustainable hunting pressure from Anangu, however their preferred habitat in central Australia (mulga woodland) continues to decline as the frequency of large hot wildfires increases. As the mulga stands get burnt away and eventually replaced by spinifex communities, important food and shade resources for red kangaroos gradually disappear. Lack of kangaroos on the APY lands is of concern for Anangu (Robinson *et al.* 2003) and an important reason to conduct fire management to protect mulga communities.

The smaller mammals in the Ranges Fire Management Regions show a variety of responses to fire. Species without burrows (or possessing only shallow burrows) such as the wongai ningaui (*Ningaui ridei*) and desert mouse (*Pseudomys desertor*), are reliant on old-growth spinifex for shelter and may take more than ten years to recolonise burnt patches. In contrast, the bipedal gait of the spinifex hopping mouse (*Notomys alexis*) is suited to more open habitats, and this species is usually the first small mammal to recolonise sites after fire. Maintaining the full complement of small mammals is therefore dependent on creating a network of patches in different stages of recovery from fire, always ensuring that some mature habitat is present.

Fig. 2 Distribution of Warru in the Anangu Pitjantjatjara Yankunytjatjara Lands - 2009



Among the 8 species of bats that have been recorded in the study area, most are dependent on tree hollows for their daytime roosts, although several species have been recorded in caves. River red gums, coolibahs, bloodwoods and hill bloodwoods (*Eucalyptus eremaea*) are the best hollow-bearing trees in the study area. It can take hundreds of years for trees to reach sufficient size to form decent hollows, and then it is the hollow-bearing trees that are the first trees to be lost during hot wildfires. Protection of the best stands of old trees with hollows is important for the conservation of a range of bat, bird, reptile and invertebrate species.

4.3 Vegetation within the Ranges Fire Management Regions

4.3.1 Limitations of the vegetation data

Of the 900 plant species known to occur in the APY Lands 472 plant species have been recorded in the Mann Ranges Fire Management Region (Appendix B) and 525 in the Musgrave Ranges Fire Management Region (Appendix D). The vegetation communities of the range habitats have not been adequately surveyed however, and we have limited knowledge on the distribution of significant species or locations of the best stands of fire sensitive vegetation requiring protection from wildfire. The aerial survey conducted during the current project provided an opportunity to identify some of the older patches of unburnt vegetation, however more survey effort is required to determine where the best stands of significant plant species occur. This knowledge gap has been partially addressed by targeted rare plant surveys conducted for the "Threatened Flora Recovery on the APY Lands" project during 2009.

An accurate vegetation map is extremely important for fire management planning. At the very least, a vegetation map should broadly delineate the fire-promoted spinifex communities from the more fire-sensitive non-spinifex communities. At best, it would identify all the remnant patches of fire-sensitive vegetation. Although a vegetation map was produced for the APY Lands as part of the DEH Biological Survey project (figures 3 and 4), the map is of little use for fire management in the Ranges Fire Management Regions because it does not accurately reflect either the distribution of spinifex grassland or mulga woodland communities. For example, the map shows the Mann Ranges to be dominated by Callitris pine over tussock grassland when it is in fact dominated by spinifex, extensive areas of spinifex sandplain between the Mann and Musgrave Ranges have been mapped as tussock grassland, and the distribution of desert oaks is far greater than shown on the map. Revision of this map should be a priority for future land management planning in the region as knowledge of plant communities is relevant to cattle production and weed management as well as fire management planning.

Figure 3. Major vegetation communities in the Mann Ranges Fire Management Region, as mapped by DEH (2003)

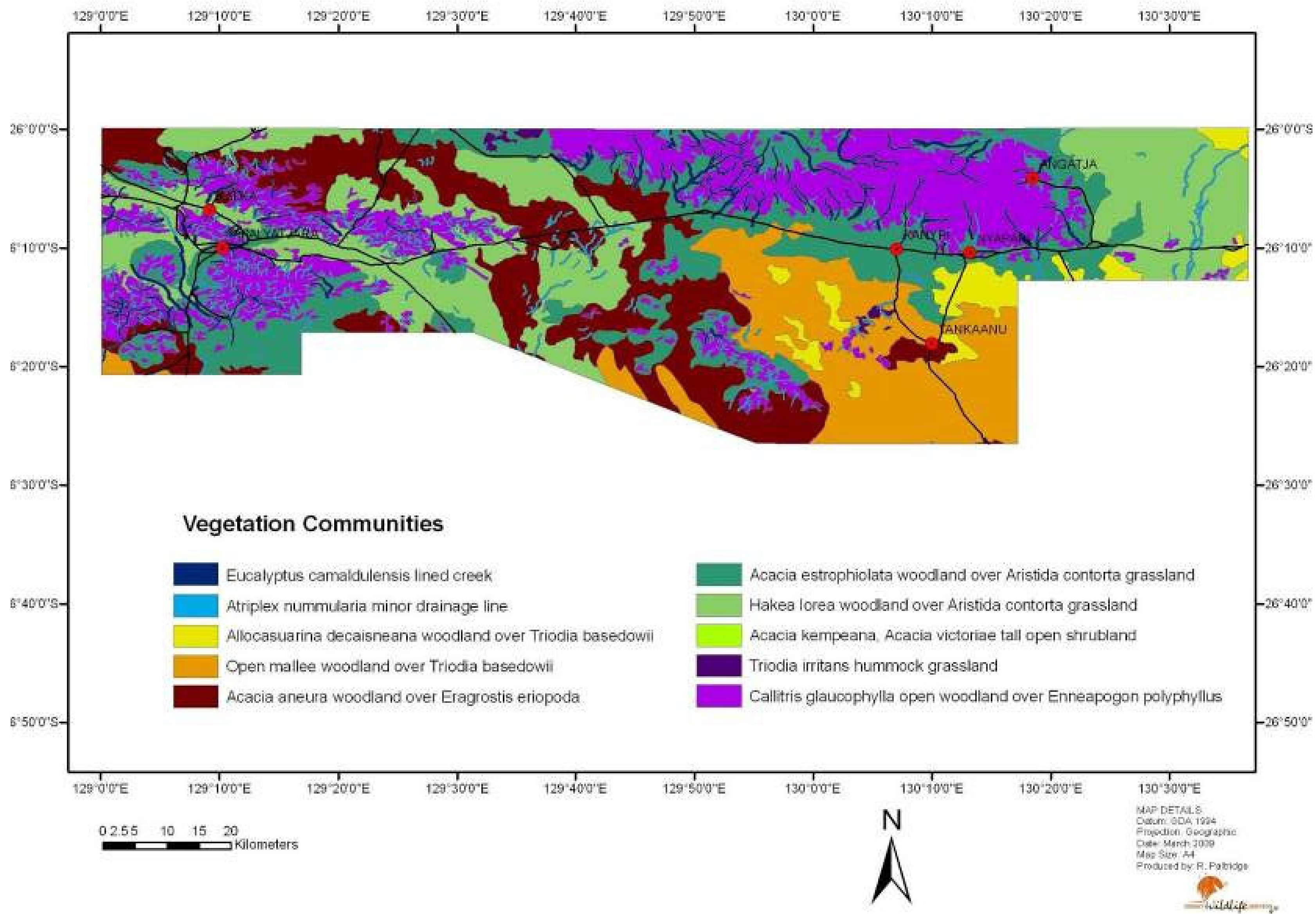
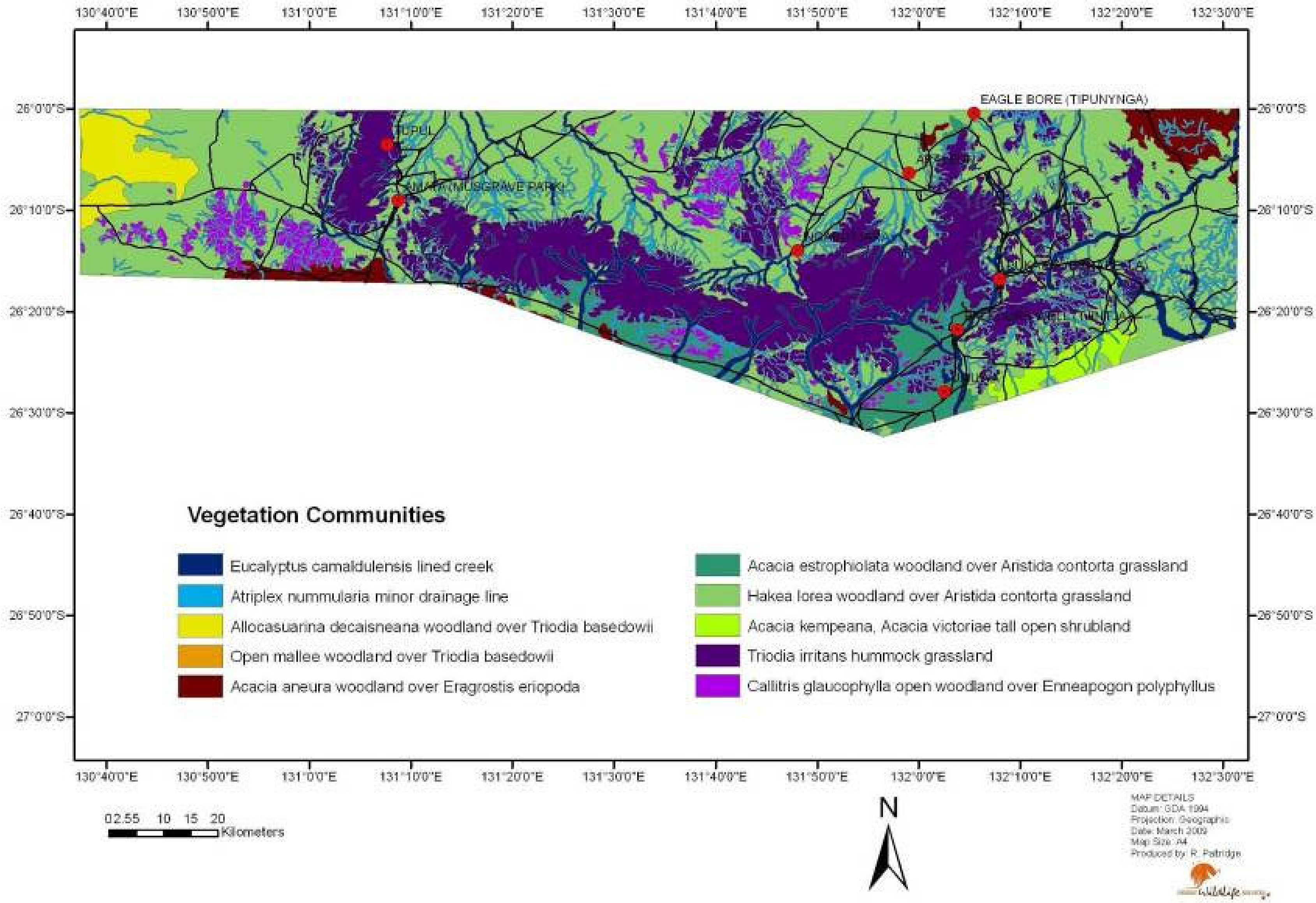


Figure 4. Major vegetation communities in the Musgrave Ranges Fire Management Region, as mapped by DEH (2003)



4.3.2 Significant Plant Species and Communities

Two nationally threatened plant species occur in the study area: a **daisy** (*Basedowia tenerrima*) and **naked mint bush** (*Prostanthera nudula*). Both species are endemic to the Central Ranges and both have been classified as Vulnerable to extinction under the EPBC Act. Although *Basedowia tenerrima* has a restricted range, no threats have been identified and in a good season it was found to be relatively abundant and widespread on the rocky slopes of the western Musgrave Ranges, suggesting that it may warrant delisting as a threatened species (Robinson *et al.* 2003).

The core distribution of naked mint bush occurs in the Everard Ranges but several small disjunct populations are located on granitic inselbergs at the eastern end of the Musgrave Ranges, in the Sentinel Hill region. Within the granite hills, naked mint bush occurs at the base of large rock slabs which provide maximum run-off during rain events, and also restrict the passage of fire. The mint bush is associated with a fire-sensitive plant community that includes Mt Olga wattle *Acacia olgana* and (often) the **central Australian rapier sedge**, *Lepidosperma avium.* Although both the naked mint bush and the rapier sedge are capable of resprouting after fire, Mt Olga wattle can survive only the mildest fires. The Mt Olga wattle community (which is often associated with rock-wallaby colonies) appears to have been diminished in the Sentinel Hill region by high intensity fires. Plants that occur at the base of rock slabs are vulnerable to soil erosion during heavy rainfall events, and when the vegetation in the catchment has been removed by fire, the velocity of water that is channelled down the rockslabs is even greater. If soil depth is reduced, sites may be more susceptible to spinifex colonisation, and diverse fire sensitive communities gradually become replaced by more flammable, species-poor, spinifex-dominated communities (P. Latz personal observations).

The **wrinkled honey myrtle** (*Melaleuca fulgens subsp. corrugata*), rated as Rare in South Australia is a shrub with an extremely fragmented distribution across a handful of known sites in South Australia, two sites in the Northern Territory and a single site in Western Australia. It has recently disappeared from the northern edge of its range in the Northern Territory (near Docker River), after a series of fires since the population was first recorded in 1973. The two other populations found in the Northern Territory each contain only 3 individual plants, and the total number of plants known to be alive across its distribution is less than 1000 individuals. Results of recent surveys for the wrinkled honey myrtle suggest that this species may warrant uplisting to Vulnerable to extinction (Paltridge *et al.*, in prep). Although it can resprout after fire, the wrinkled honey myrtle is restricted to fire-shadow areas where the amount of bare rock has limited the intensity and frequency of fires. The reduced impacts of fire in areas that it occurs in is reflected in the associated plant community which tends to contain a variety of fire sensitive species that soon disappear from frequently burnt areas. The mechanism by which fire is causing a decline in abundance of the wrinkled honey myrtle is not fully understood but is again thought to be associated with impacts of fire on soils as hills that are frequently burnt are vulnerable to losing their soil through wind and water erosion when the vegetation cover is removed. There are three known sites supporting wrinkled honey myrtle in the Musgrave Ranges Fire Management Region, and one site in the

Mann Ranges Fire Management Region. Although the plants recorded in the eastern Mann Ranges were actually just north of the Northern Territory border, it is considered likely that other plants would occur south of the border (but this area is currently inaccessible for cultural reasons).

Within the study area, the wrinkled honey myrtle was found only at very high altitudes, and is believed to be a relictual species of previous climatic conditions. Another highly restricted, endemic species that appears to be confined to the highest points of the ranges is the **central ranges wattle**, *Acacia tenuior*, which is also rated as Rare in South Australia. The central ranges wattle is known only from two populations in the Musgrave Ranges and two populations in the Mann Ranges with an overall abundance of about 6000 plants. It readily resprouts after fire, however inappropriate fire regimes may have contributed to its rarity, as it is currently only known from the least fire impacted areas of the Mann and Musgrave Ranges.

Other significant flora species in the Ranges Fire Management Regions include an undescribed subspecies of *Eremophila* (*E.willsii* subsp. indeterminate, or **Musgrave Ranges fuchsia**) known only from an area of 1km^2 on the lower slopes northeast of Mt Woodroffe, and the newly described **showy germander** (*Teucrium reidii*) which is most abundant in the Tomkinson Ranges, but has small outlying stands in both the Mann and Musgrave Ranges. The Musgrave Ranges fuchsia occurs in reasonably high densities on a frequently burnt hill dominated by spinifex, whereas the showy germander tends to be associated with fire-sensitive plants in habitats where spinifex cover never exceeds 5%. Various sub-populations of showy germander are potentially threatened by encroachment of spinifex and buffel grass into their habitats, and increased fire frequency will be both a cause and effect of the colonisation of these grasses. Showy germander is rated as Rare in South Australia, whereas the Musgrave Ranges fuchsia is yet to be classified.

One of the most locally threatened plants in the study area is the **quandong** tree (*Santalum acuminatum*), which was assessed as a Priority 1 species for flora management during the Rare Flora surveys (Paltridge et al., in prep..). Although the quandong has a large distribution across Australia and therefore a low probability of species extinction, it is highly vulnerable to becoming extinguished from central Australia, and many localised extinctions of sub-populations have already occurred. Camel browsing is the primary threat to quandong populations, but fire, rabbits and overharvesting for the wood carving industry have also caused population declines. The only quandong stand found in the Musgrave Ranges Fire Management Region during plant surveys in 2009 will require fire management in good seasons when grassy fuel loads build up.

Two vegetation communities in the study area have been classified as Vulnerable on the provisional list of threatened ecosystems of South Australia (Crofts 2001): the corkwood/ironwood open woodland fringing the ranges, and the Central Ranges mulga woodlands. Both are considered to be threatened by extensive fires in good seasons coupled with inhibited regeneration due to rabbit grazing. The non-spinifex hill communities supporting pines, figs and spearbush should also be recognised as a declining vegetation community threatened by increased fire frequency.

Locations of some of the biologically significant areas in the Mann and Musgrave Ranges Fire Management Regions are shown in Figures 5 and 6.

The extremely rare Wrinkled honey-myrtle, *Melaleuca fulgens subsp. corrugata*, west of Jackys Pass

The nationally threatened *Prostanthera nudula* in the foreground, growing in association with another rare fire-sensitive plant *Lepidosperma avium* in the Sentinel Hill area.

Acacia tenuior in the Mt Woodroffe area.

Figure 5. Sites of Biological Significance in the Mann Ranges Fire Management Region.

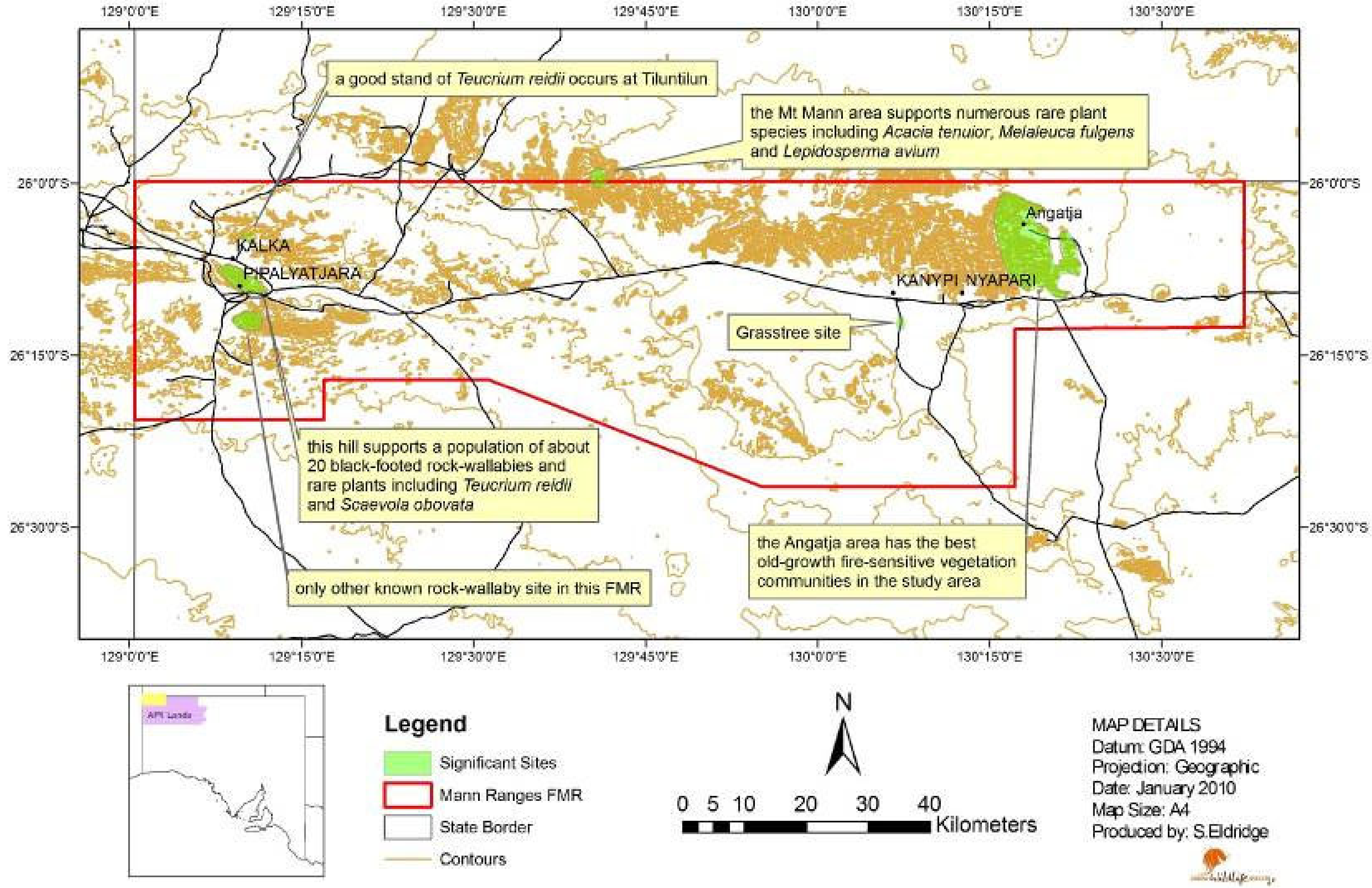
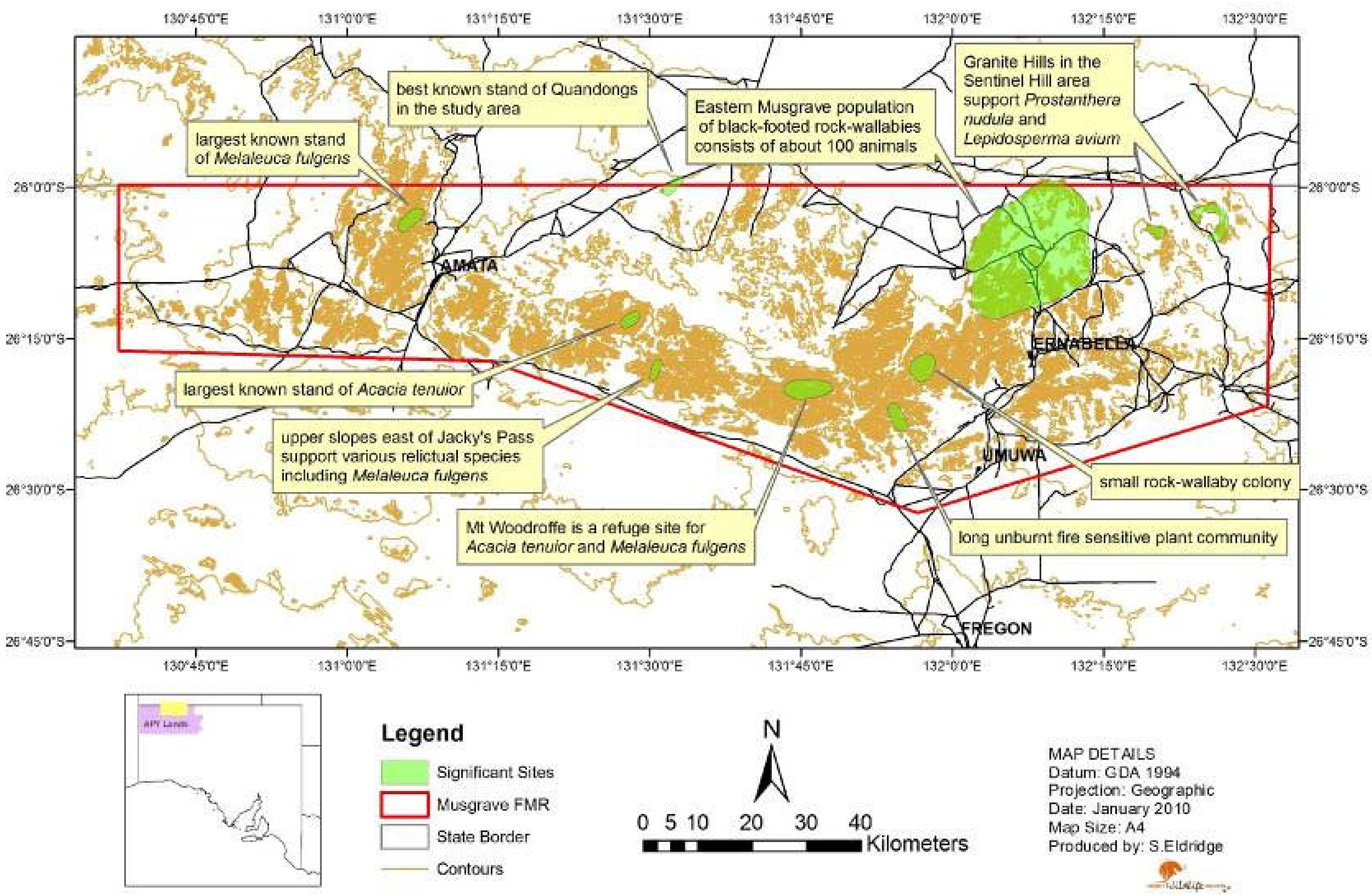


Figure 6. Sites of Biological Significance in the Musgrave Ranges Fire Management Region



4.3.3 Fire management priorities for broad vegetation communities

Hill Communities

1. Steep upper slopes of the major ranges

The steep upper slopes of the main ranges have been subject to frequent hot fires and are now dominated by spinifex (*Triodia scariosa* and *T.irritans*) with emergent hills bloodwood (*Corymbia eremaea*) and the low, shrubby Basedow's wattle (*Acacia basedowii*). Most of this habitat has a low diversity of plants. However, the highest altitudes appear to provide a refuge for species adapted to more temperate climates such as the broad-leafed flax lily (*Dianella revoluta* var. *divaricata*) which (in the APY Lands) is known only from the summit of Mt Woodroffe, as well as a variety of species within the Goodeniaceae family. The rare wrinkled honey myrtle (*Melaleuca fulgens subsp. corrugata*), central ranges wattle (*Acacia tenuior*) and curry bush (*Cassinia laevis*) also occur at high altitudes. More protected areas within deep gullies or with a high proportion of bare rock support fire sensitive plant communities comprising figs and native pines. Fire sensitive vegetation in gullies provides important rock wallaby habitat.

Firescar mapping by Yates and Morse (2003) combined with 40 years of anecdotal observations (P. Latz pers. obs.) indicate that the Mann Ranges have burnt four times since 1975 whereas most of the Musgrave Ranges have only burnt twice during this period. The difference in fire frequency may be attributed to the growth patterns of the main spinifex species on the two ranges. The Mann Ranges is dominated by *Triodia scariosa* which regenerates relatively quickly after fire (both by resprouting and as seedlings, Friend *et al.* 1999) and can burn twice within a decade. The Musgrave Ranges is dominated by *Triodia irritans* however, with *Triodia scariosa* only occurring near the summits of the upper slopes. The Central Ranges form of *Triodia irritans* appears to regain cover slowly after burning, growing back as widely spaced hummocks that may not carry fire for many years (sometimes several decades). Individual hummocks accumulate extremely high densities of material however, and can attain very large sizes before there is sufficient connectivity between plants to carry fire. By this stage fuel loads are so high that fires burn with extreme intensity. This makes controlled burning in *Triodia irritans* communities extremely challenging, as in most situations it will be difficult to get fires to carry. Once the spinifex is sufficiently connected, it will be difficult to control the fire.

Priorities for fire management in the major ranges are protection of sites known to support rare plants (wrinkled honey myrtle, central ranges wattle) and declining fire-sensitive communities, and protection of rock-wallaby colonies. Small scale strategic burns should initially be conducted around these priority sites in preparation for broadscale patch-burning aimed at reducing the size of summer wildfires and creating a mosaic of habitat types to increase the diversity of plants and animals that can occur there. The only way to achieve this at a landscape scale across the Mann and Musgrave Ranges is with aerial burning from a helicopter.

2. Minor hills or foothills of major ranges

Apart from the most frequently burnt hills, which have been colonised by spinifex, most of the rocky habitats of the minor hills have a tussock grassland understorey that comprises species such as brush three-awn (*Aristida nitidula*), kangaroo grass (*Themeda triandra*) and leafy bottle-washers (*Enneapogon polyphyllus*). Cotton panic grass (*Digitaria brownii*) occurs in shady niches created by rock overhang or shrub canopies. The tree layer can be dominated by pine and fig trees although hills with acidic rocks support mulga and witchetty bush. (e.g. see mulga hills south of Eagle Bore). Frequent fires appear to lead to replacement of fire sensitive plant communities by spinifex and mallees. *Corymbia eremaea* occurs in the early transition from grass to spinifex. This small tree can survive several fires, assuming a mallee growth form after burning, but after successive fires it will be displaced by other more fire tolerant mallee species such as *Eucalyptus gamophylla*. Long unburnt *Corymbia eremaea* trees develop important tree hollows, but when this occurs they are particularly vulnerable to being killed by fire.

Many minor hills and foothills are accessible from the network of roads that circumvent the major ranges. Cool season fuel reduction burning on the hills will help to preserve the pine, fig and mulga trees. In most situations fuel reduction in the tussock grass habitat will only be required after two successive summers of good rain. To ensure a cool fire, that does not scorch the trees, it is important to initially climb the hills and try to burn downhill from the top. If fuel loads are not sufficient for the fire to carry downhill, then further attempts can be made part-way down the slope, but fires should never be lit from the base of the hill before test burns have been conducted from the tops of the hills.

During discussions about fire management for this project, several informants described how men used to climb to the tops of the hills and light fires from the top, using slow, controlled fires to hunt euros down the hill (Donald Fraser, Norah Ward, personal communications, March 2009). Burning was also conducted in the hill habitats to encourage growth of bush tobacco (*Nicotiana spp*.).

3. Granite Outliers

Most of the domed and exfoliating granitic hills and inselbergs (e.g. Sentinel Hill) are dominated by grey spinifex (*Triodia irritans*). The fire sensitive Mt Olga Wattle community occurs in fire shadow areas of granitic hills where large patches of bare rock impede the passage of fire. Mt Olga Wattle would have once been distributed throughout the granite hills, but now occurs as small pockets of remnant vegetation.

Hazard reduction burning in adjacent areas of spinifex will help to preserve remaining stands of *Acacia olgana* and perhaps allow it to expand out and recolonise areas of the hills it has contracted from. The grey spinifex is highly flammable and great care will be required to create a cool fire, always attempting to burn downhill. Sites where the rare naked mint bush (*Prostanthera nudula*) and central Australian rapier sedge (*Lepidosperma avium*) occur should be a priority for fire management in the granite hills.

Outwash Plains

4. Hill Frontage open woodland

The relatively fertile run-on areas at the base of the ranges can support a rich woodland of ironwoods, whitewoods, corkwoods and elegant wattle (*Acacia victoriae*) over tussock grasses. Buffel grass invasion is a serious issue in this habitat, potentially increasing the frequency and intensity of fires through the woodland communities. These trees are all relatively fire-sensitive and their seedlings are also vulnerable to the impacts of overbrowsing by rabbits and other exotic herbivores. Consequently much of the open woodland has been transformed into more open tussock grassland (below). The corkwood-ironwood open woodland fringing the ranges has been identified as a threatened ecosystem in the Provisional list of threatened ecosystems of South Australia (Crofts 2001).

Extensive cool season burning in the tussock grassland after two successive seasons of good summer rainfall will help to preserve the remaining hill frontage woodland habitat.

5. Tussock Grassland

Extensive tussock grasslands occur on the outwash plains adjacent to the ranges and isolated hills. The grasslands are generally dominated by perennial and semi-perennial grasses such as curly wire-grass (*Aristida contorta*) and woolybutt (*Eragrostis eriopoda*) and the highly palatable oatgrasses (*Enneapogon polyphyllus* and *E. avenaceus*). After significant winter rainfall this habitat can be dominated by annual plants and may effectively become a herbland. While annual herbs such as daisies dominate the understorey, this vegetation community is at low risk of carrying fire. In March 2009 rolypoly (*Salsola tragus*) was the dominant species in the tussock grasslands habitat in the vicinity of the Musgrave Ranges. The extensive coverage of rolypoly in this area indicates some degree of degradation, probably from past overgrazing by rabbits and other exotic herbivores. In such situations rolypoly is particularly abundant in the first year after drought-breaking rains. A second year of good summer rains is unlikely to yield as much rolypoly, but will produce more grasses with higher flammability.

Outwash plains around the Mann Ranges were found to have considerably less rolypoly and more grasses in March 2009. Whether this is due to a higher abundance of camels in the western APY lands (rolypoly is a favoured camel food plant) or less grass-eating exotic herbivores (cattle, horses, donkeys, rabbits) is unknown, but the relative dominance of rolypoly over grasses is important for fire management because rolypoly is significantly less flammable than tussock grasses. Areas dominated by rolypoly and pigweed (*Portulaca oleracea*) will not carry a fire this year, whereas the curly wire-grass dominated plains south of the Mann Ranges are at risk of large wildfires next summer, and require cool season fuel reduction burning this winter.

Long-unburnt patches of outwash plains support bladder saltbush (*Atriplex vesicaria*) and *Senna artemisioides* but the chenopod shrubland community has been much reduced due to the combined impacts of frequent fires and excessive camel browsing. Remnant patches of mulga are interspersed amongst the tussock grassland vegetation type, and care must be taken to avoid burning the mulga when conducting fire management in this habitat. Protection of mulga is a key reason to persist with controlled burning in the tussock grassland community.

The fire ecology of tussock grassland communities in central Australia is not well known because virtually all the tussock grassland habitat in the Northern Territory is under pastoral production, and grazing suppresses fuel loads to the extent that fire is a rare event in such habitats. However, it appears that two successive years of good summer rain is usually required for tussock grass growth to thicken up sufficiently for fires to carry. If grasslands remain unburnt, the annual grasses have generally broken down and blown away or been consumed by termites within two years of the rain, and the fire risk is much reduced. Fuel reduction burning is therefore really only required in the winter that follows a second summer of good rainfall. The effect of burning can be short-lived in this habitat however, compared with the slower-growing spinifex grassland communities.

Experimental burning is required in this vegetation community to determine fire return times, best practise burning techniques to create long-lasting fire-breaks and conditions under which chenopod communities can be enhanced or re-established.

Red Earth Plains

6. Mulga woodland

Mulga communities occur primarily on red-earth plains, but can also be present on hills with deeper soils and in the swales of sand-dune systems. Woolybutt (*Eragrostis eriopoda*) is the most common understorey species in mulga woodlands of the APY lands and the dominant shrubs are silky bluebush (*Maireana villosa*) and crimson emubush (*Eremophila latrobei*).

Mulga is regarded as a fire-sensitive species, as trees are usually killed by all but the mildest of winter fires. Although seed germination is stimulated by fire and mass recruitment may occur after burning if there is enough follow-up rain, mulga trees take up to 15 years to mature to reproductive stage, and if a second fire occurs within this period, the seedbank will be depleted and the mulga community will start to be replaced by other vegetation types. Wiregrass (*Aristida jerichoensis*) or buffel grass in areas with richer soils, often dominates mulga communities after a fire, producing very high fuel loads within a couple of years that can potentially carry another fire to eradicate any mulga regrowth. If drought follows the second fire, large patches of bare ground are vulnerable to being covered by sand blowing or washing in, changing the soil chemistry and making it more suitable for colonisation by spinifex. This appears to have occurred in many parts of the APY lands, and there are now few areas of high-quality, old-growth mulga in the study area.

Mulga communities generally only have a high fire potential in the years following significant rain events when a thick understorey of grasses develop. Within a few years the fuel loads have died or been reduced by grazing by termites and larger herbivores. Mulga communities adjacent to mature stands of spinifex are perennially fire prone however, as a large hot fire-front may carry into the mulga and continue through the crown of the mulga trees regardless of the cover of understorey species.

Desired fire frequencies in mulga communities are >50 years. Although recruitment is stimulated by fire, enough mulga gets burnt accidentally to ensure recruitment is constantly occurring, so wherever possible fire should be excluded from mulga stands indefinitely. Following 1/25 year rain events, fuel loads within mulga communities may require carefully controlled burning but only during rainy periods. Otherwise, the recommended fire management for mulga communities is to conduct hazard reduction burning in patches of spinifex adjacent to mulga stands. Burning in the vicinity of mulga should always be initiated close to the mulga, burning away from the woodland to avoid a large fire front approaching the mulga and carrying into the canopy.

Sandplains and dunefields

7. Hard spinifex sandplains and dunefields

Although mostly outside the Ranges Fire Management Regions, fuel loads in adjacent spinifex dominated communities can have a major influence on the potential for fire to carry into the ranges. Extensive hard spinifex (*Triodia basedowii*) dominated sandplains and dunefields surround the Mann Ranges. Common shrubs in the sandplain habitat include a variety of Acacias (e.g. *A. melleodora* and *A.murrayana*), and mallees (commonly *Eucalyptus gamophylla* and *E. oxymitra*). Desert Oaks (*Allocasuarina decaisneana*) are the dominant tree in the gap between the Musgrave and Mann Ranges, and occur patchily south of the Mann Ranges. Scattered desert kurrajongs and small patches of desert grasstree (*Xanthorrhoea thorntonii*) also occur south of the Mann Ranges. Most of the plants associated with spinifex communities are well adapted to fire and readily resprout after being burnt. Others such as the bloodwood (*Corymbia opaca*) can cope with occasional fires, but will be killed by hot fires or successive chimney fires within their trunks. Bloodwoods are the best hollow-producing trees in the region, providing important habitat for a range of birds, bats, reptiles and insects. Good stands of bloodwood trees were observed in the Angatja area.

Spinifex dominated sandplain and dunefield communities are extremely flammable and will readily carry wildfire in any season once the spinifex cover is sufficiently high. In contrast to the shorter lived annual grasses that will disappear within a couple of years of rainfall, spinifex plants continue to accumulate biomass over time. Small patches of soft spinifex (*Triodia pungens*) occur north of the Musgrave Ranges but in the western APY lands it is hard spinifex (*Triodia basedowii*) that occurs in the sandy country. This species of spinifex is killed by fire and can only regenerate from seed. It is slower to recolonise areas than other (resprouting) spinifex species and may not reappear for a couple of years after fire. Fuel reduction burning in hard spinifex communities will therefore have a more enduring impact than soft spinifex or tussock grass communities, which may be capable of carrying fire again two years after fire breaks have been established. The slower recolonisation of *Triodia basedowii* provides an opportunity for a diversity of short-lived species to grow on burnt sites before the spinifex regains its dominance. Many of these short-lived species produce seed, nectar or fruits that provide important foods for animals. Patch burning in this vegetation community will therefore increase biodiversity in the short-term. However, if fire can be excluded from some areas for long periods, there should eventually be an increase in some of the more fire sensitive trees and shrubs such as black gidgee, mulga and witchetty bush, which also create an important range of habitat types for a variety of fauna.

The recommended fire management in the spinifex sandplain and dunefield communities is to break up large areas of even aged spinifex with patch-burning to halt the spread of large wildfires and re-establish a mosaic of different aged vegetation. Patch-burning should commence as soon as the spinifex can carry fire, aiming for a fire frequency across at least 50% of this community of 10-20 years. Ideally some patches of spinifex that have remained unburnt for long periods should be protected from fire for at least 50 years to encourage fire sensitive shrubs to replace stands of spinifex. However, this is a time-consuming task and unless a particularly significant species is found to be utilising such habitat, constructing specific fire-breaks for the long-term protection of old-growth spinifex is not a priority. Nevertheless, it is recommended that the oldest stands of spinifex are not necessarily deliberately ignited during burning activities, particularly when early successional stages of vegetation dominate an area. It is important to leave some dense spinifex for species such as the desert mouse, wongai ningaui, sandhill dunnart, striated grasswren, rufous-crowned emu-wren, jewelled gecko and clawless gecko.

Table 1. Recommended fire regimes for broad vegetation communities in the Mann and Musgrave Ranges FMRs
[Explanation of Status Codes: V = Vulnerable (EPBC Act 1999); ce = Critically Endangered, v = vulnerable, R = Rare (South Australian NPW Act 1972); VC = Vulnerable Community (Threatened Ecosystems of South Australia, Crofts 2001) RC = Rare Community; I = Indicator Species of particular fire regime, *species that may potentially occur in the region, but there have been no official records since 1970]

Vegetation Community	Significant species and communities	Status	Fire ecology	Key ecological principles for fire management in this community
1. Hill communities	Black-footed rock-wallaby	V, ce	Many of its food plants are fire sensitive species;	• In consultation with Warru Recovery Team, burn strategic breaks around fire sensitive vegetation (stands of fig and spearbush and Mt Olga wattle communities) at rock wallaby sites but only under extremely mild fire-weather conditions • Ensure burning is always initially conducted from the tops of hills, working downhill. If the fire will not carry, retry at successively lower altitudes. • Burn strategic breaks around isolated granite outcrops supporting rock-wallaby colonies • Conduct cool-season burning to reduce fuel loads in spinifex communities adjacent to areas supporting rare plants and fire-sensitive plant communities • Reduce fuel loads in Mulga and *Callitris* pine communities on the hills when significant summer rainfall produces a thick grassy understorey • Treat other (spinifex-dominated) hills as for Vegetation Community 4, with patch-burning to create a diversity of vegetation ages • When the best stands of fire-sensitive vegetation have been protected, consider conducting cool-season aerial incendiary burning along the main ranges • Be aware of the locations of populations of orange-crowned toadlet and Musgrave slider to ensure their habitats are not disturbed during fire management activities
	Orange-crowned toadlet	v	Unknown	
	Musgrave slider	v	Unknown	
	Prostanthera nudula	V	Potentially outcompeted by spinifex when fire frequency is too high	
	Basedowia tenerrima	V	Unknown	
	Melaleuca fulgens	R	Can resprout but frequent fire appears to reduce habitat quality	
	Acacia tenuior	R	Can resprout but frequent fire appears to reduce habitat quality	
	Lepidosperma avium	R	Can resprout but frequent fires in catchment may result in soil erosion	
	Teucrium reidii	R	Increased fire frequency may increase competition from buffel grass and/or spinifex	
	Eremophila willsii subsp.	-	New species, appears tolerant of frequent fire but further research required	
	Goodenia brunnea	R	Short-lived species that appears after fire	
	Fig, pine, spearbush community	RC	Fire sensitive community, requires total fire exclusion;	
	Acacia olgana community	RC	Fire sensitive community, requires fuel reduction burning in adjacent spinifex	

2. Outwash Plains	Mature Ironwood, corkwood, whitewood woodland	VC	Succession from woodland to grassland under regime of frequent hot fires, particularly those fuelled by buffel grass and where rabbits inhibit recruitment	• When burning the outwash plains, ensure fires will not carry to (and up) the hills. This may necessitate fuel reduction burning on adjacent hills first, prior to any burning on the surrounding plains. • When thick grassy understorey develops after significant summer rainfall, use cool-season burning to reduce fuel loads under trees in the best areas of mature woodland • Stands of quandong trees are a high priority for fire management if a thick grassy understorey develops after significant summer rainfall • Burn breaks along roads as soon as grasslands are capable of carrying fire (but impact may be short-lived) • Tussock grasses (including buffel) will be more flammable after the first frosts of the season • Prevent fires carrying into mulga stands • Leave some old-growth stands of grasses unburnt to allow succession to chenopod shrubland • If patches of chenopod shrubland are located, burn adjacent areas of grassland to protect the saltbush
	Chenopod shrubland	RC	Replaced by grasses when fire frequency is too high, particularly with added pressure from camel and rabbit browsing	
	Quandong trees	RC	Primary threat is overbrowsing by camels but trees are also killed by fire; habitat only likely to carry fire after successive years of above-average summer rainfall	
	Rufous calomanthus	R	Dependent on (fire-sensitive) saltbush habitat;	
	Bloodwood trees	I	Too much fire results in loss of mature hollow-bearing trees.	
3. Mulga woodlands	Old growth mulga stands	VC	Fire sensitive. Old trees will be killed by fire. If seedlings are burnt before attaining maturity (approx. 15 years) mulga habitat may be replaced by spinifex communities;	• Aim for a fire frequency of 50-100 years in this vegetation community • Protect old growth stands of mulga from fire by reducing spinifex fuel loads in adjacent areas • Fuel load reduction of dense understorey grasses within the mulga woodland may occasionally be required after two successive years of high summer rainfall, but should only be attempted under very mild conditions • If any great desert skink colonies or malleefowl nests are discovered in the study area, these sites would be a priority for fire management in the mulga woodlands
	Malleefowl	V*	Requires old growth mulga habitat, still occurs further south in the APY Lands;	
	Great desert skink	V*	Occurs in long-unburnt Mulga woodlands further south in APY Lands	
	Redthroat	R	Requires mature mulga habitat;	

	Red Kangaroo	I	Prefers mulga habitat, but has declined due to a combination of overhunting and loss of mulga habitat;	
	Honey ants	I	Indicator of healthy mulga community	
4. Spinifex sandplains and dunefields	Marsupial Mole	E	Fire ecology unknown	• Apply a patch-burning fire regime where many narrow patches (< 500m wide) of different aged vegetation are created • Patches can be a variety of sizes, with the distribution of patch sizes skewed towards the smaller (<20 ha) end of the scale • Areas of spinifex adjacent to non-spinifex habitats (e.g. mulga woodland, hill communities) are a priority for fuel reduction • For ecological burns, fires should be cool and patchy, rather than hot clean burns • Long-term strategic breaks will last longer if fires are hotter and cleaner • Aim to burn 10 % of the spinifex each year • Aim to leave some remnant patches of old-growth spinifex (>50 ha) scattered across the region • Restrict areas of spinifex >10 years old to <10km wide
	Striated Grasswren	v	Occurs in mature spinifex > 15 years	
	Rufous-crowned Emu-wren	R	Occurs in mature spinifex > 15 years	
	Spinifexbird	R	Occurs in mature spinifex > 15 years	
	Desert Mouse	I	Occurs in mature spinifex > 10 years	
	Desert Myrtle (*Aluta maisonneuvei*)	I	Desert Myrtle is a fire-sensitive shrub occurring in sand dune habitat >15 yrs after fire	
	Grass Tree community	RC	Although it readily resprouts after fire, when fire is too frequent recruitment may be affected	

Box 1. The importance of old growth spinifex

Many reptiles and small mammals that live in the sandy deserts take refuge in underground burrows to hide from predators and survive searing summer daytime (and freezing winter night-time) temperatures. Other animals do not have burrows but rely on spinifex clumps for protection from predators and extreme temperature fluctuations.

To provide adequate shade, insulation and an effective barrier against predators, the spinifex clumps must be either very large (such as mature *Triodia irritans* clumps) or grow very close together. Most spinifex communities in this area take at least 15-20 years after being burnt to attain the old-growth form suitable for species such as the desert mouse, wongai ningaui, jewelled gecko, Jean's gecko, striated grasswren and rufous-crowned emu-wren.

Old-growth spinifex is very flammable and any ignitions in this habitat are likely to burn the whole patch in a very hot fire, unless conducted in extremely mild burning conditions (e.g. rain). Without burrows to retreat to, the spinifex dwelling small mammals and reptiles are very vulnerable to being killed by fire.

In situations where spinifex communities are dominated by younger, regenerating stages of spinifex, it is recommended that:

- **Prescribed burning activities avoid the oldest stands of spinifex**
- **Significant stands of old-growth spinifex located near major roads are protected with a linear break along the edge of the road**
- **In remote areas conduct patch-burning in regenerating spinifex adjacent to the mature spinifex stands, if it can be done without risking burning the old spinifex.**

Old growth Triodia basedowii *in south-western Northern Territory, last burnt in 1976. Clumps grow outwards rather than upwards, eventually dying out in the centre to form rings. Plant diversity is very low but at least 6 species of small mammal occur at this site including the mulgara, desert mouse and wongai ningaui.*

4.3.5 Priority weeds in relation to fire management

Only 23 exotic plant species have been recorded in the Ranges fire management regions. Most of these are insignificant and confined to disturbed areas (e.g. roadsides and outstations) and will have little effect on the fire ecology of the area. However, the region has well established populations of one of Central Australia's most significant environmental weeds: buffel grass (*Cenchrus ciliaris*).

Buffel grass can withstand long periods of drought and frequent fires. It displaces native plant communities, significantly reducing biodiversity. Buffel grass occurs in the more fertile soils and could potentially colonise most of the hill, hill frontage and alluvial habitats. It is already a problem in the hill frontage woodland communities, producing excessive fuel loads which threaten the survival of ironwood, corkwood and whitewood trees.

Buffel grass can have dramatic effects on fire regimes by increasing the frequency and intensity of fires. Its colonisation is aided by fire, further reason to protect the non-spinifex communities from fire as much as possible. Once established, buffel grass fuel loads require frequent management if trees are to be protected as it is capable of accumulating biomass so rapidly. With average rainfall, dense buffel grass can redevelop enough fuel to re-burn intensely only two years after a fire. With above-average rainfall, fires can recur after only one year.

Buffel grass can be difficult to burn while green. The best time to try burning it is after the first frost of the season. Frost dries off the grass, increasing its flammability.

The distribution of buffel grass in the APY Lands has not been mapped. It is recommended that a combination of aerial and ground based surveys are conducted to map the distribution and density of buffel Grass in the APY Lands. This information could then form the basis of a **Buffel Grass Management Strategy** which would prioritise control efforts at sites where maximum biodiversity benefits will occur and that have the greatest chance of enduring impact.

Dead mulga trees killed by a buffel grass-fuelled fire

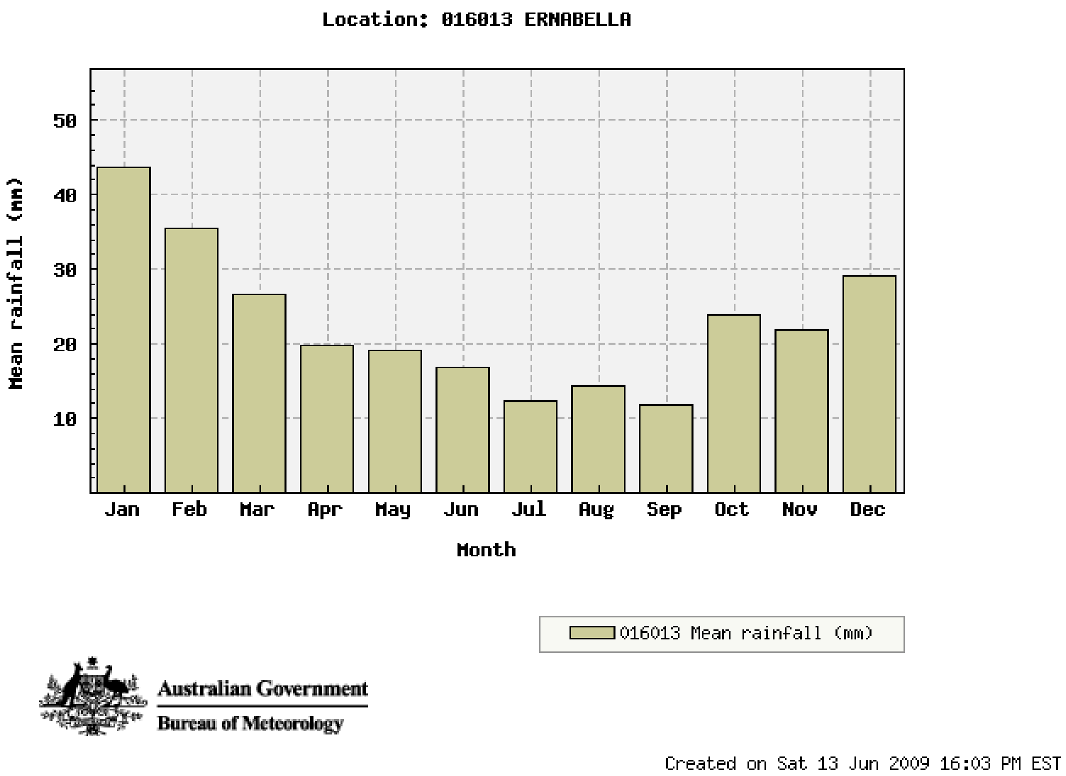
5.0 Fire Environment

The basic components of any landscape contributing to the bushfire potential include terrain, slope and aspect, climate and weather, vegetation and land use. The amount of flammable spinifex grasslands in the ranges combined with the extensive tussock grasslands on the outwash plains makes the Ranges Fire Management Regions of the APY Lands a particularly fire-prone environment. While cattle grazed the tussock grasslands around Amata, the fire potential was reduced in this area to some extent, but fuel loads will soon increase in the absence of cattle. The switch from managing cattle herds to camel herds will further promote grass-dominated communities as camels selectively feed on herbs, forbs and shrubs in preference to grasses. The continuous nature of fuels in both the ranges and outwash plains allows fires to carry vast distances when seasonal conditions are suitable; there are very few natural fire breaks. Unlike the quartzite formations of the Macdonnell Ranges which contain numerous deep rocky gullies that stop the passage of fire, there are few significant gullies in the Musgrave and Mann Ranges to act as fire breaks.

5.1 Climate and Weather

Climate information is based on data collected from Ernabella since 1935. The region has a dry climate with hot summers and mild winters. The annual average rainfall is 275 mm which falls over an average of 48 days. Rain may occur at any time of the year, but is more likely to occur between October and March (figure 7) associated with low pressure systems extending south from the tropics. January is on average the wettest month, with a mean monthly total of 44mm. September is the driest month with an average of 12mm.

Figure 7. Mean monthly rainfall at Ernabella.

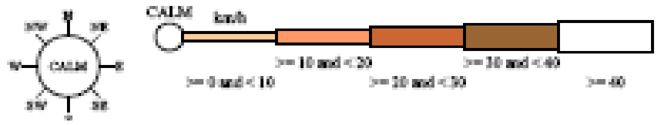


January is the hottest month, with an average maximum temperature of 35° C and an average minimum of 20° C. Temperatures above 40.0°C occur 2-3 days per month on average at Ernabella in January and once a month in November, December and February. In contrast, winters are mild with June average maximum and minimum temperatures being 18°C and 4°C respectively. Cold wet days with maxima below 15.0°C only occur about once every winter on average. Frost days, (when overnight temperatures fall below 2.0°C), occur between May and August with an average of 7 frosts per month in June and July (and 4 nights where minimum temperature is below zero). Frosts tend to occur on clear nights following a day of cool southerly winds. Average daily sunshine varies from 10.5 hours in January to 8.5 hours in July.

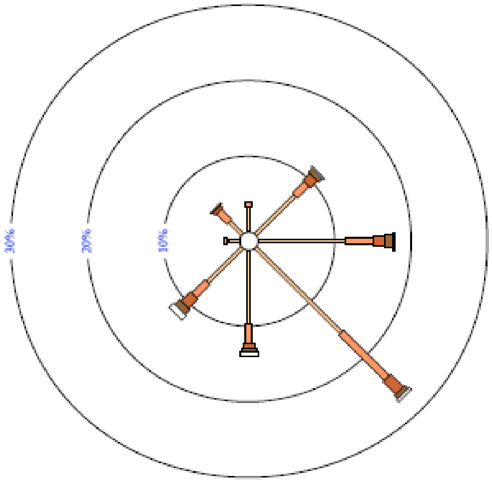
Average annual evaporation at Ernabella is around 3200mm varying from a monthly average in excess of 400 mm in January to around 125 mm in July. Prevalence of thunderstorms was not available for Ernabella, but is likely to be similar to Giles (approximately 250km to the north-west), which has an average of 32 thunderstorm days per year, with the peak months for thunderstorm activity being November to February.

Wind Frequency Analyses based on more than 20 years of data from Ernabella are presented in Figure 8. The wind roses for each month summarise the strength, direction and frequency of winds at that site. Each branch of the rose represents wind coming from that direction and the branches are divided into segments of different thickness and colour, which represent wind speed ranges from that direction. The length of each segment within a branch is proportional to the frequency of winds blowing within the corresponding range of speeds from that direction. It can be seen that the strongest winds occur between July and October, with regular northwesterly and southwesterly winds at speeds greater than 20km/h. South-easterly breezes usually less than 20km/h predominate between January and April. In May and June, and November and December, winds may be from any direction (but rarely from due north or due west), however the north-westerlys and south-westerlys tend to be stronger than the north-easterly and south-easterly.

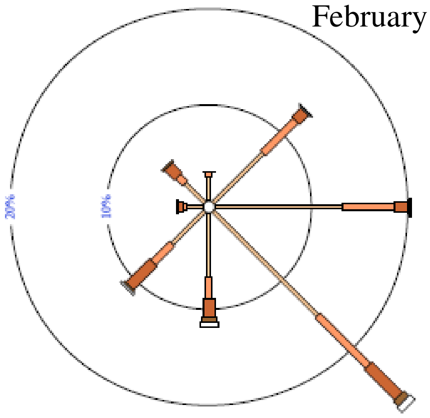
Figure 8. Monthly wind roses for Ernabella Meteorological Station (Bureau of Meteorology)



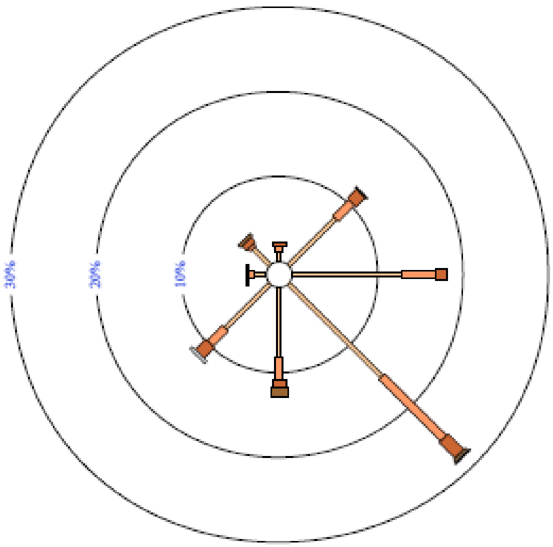
January (Calm 6%)



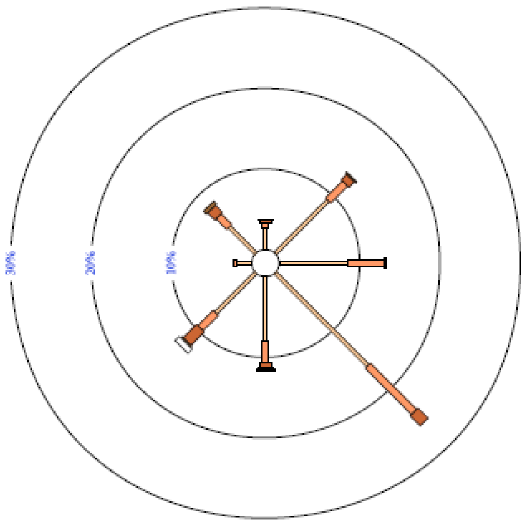
February (Calm 3%)



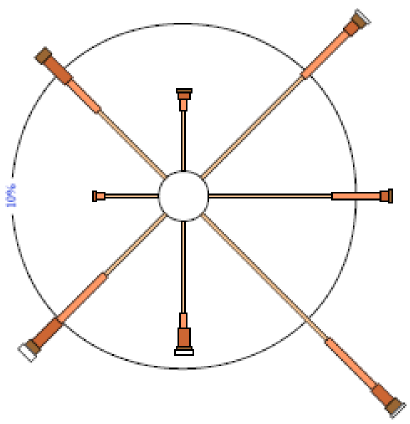
March (Calm 8%)



April (Calm 8%)



May (Calm 8%)



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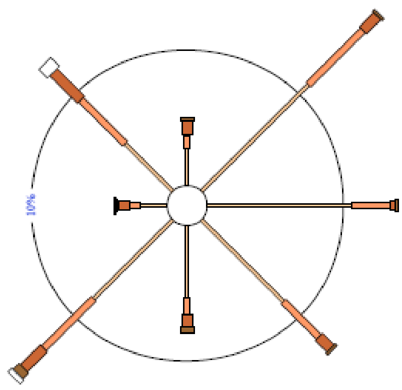

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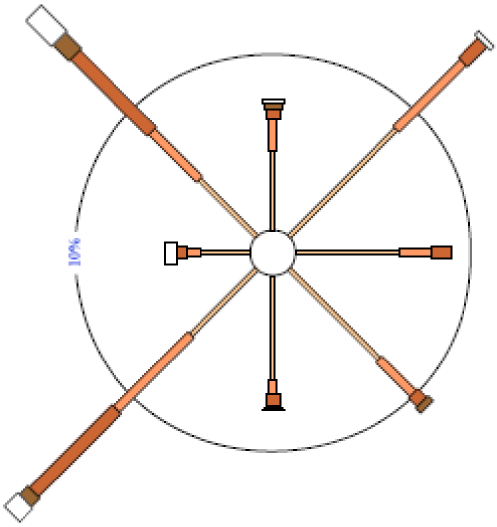
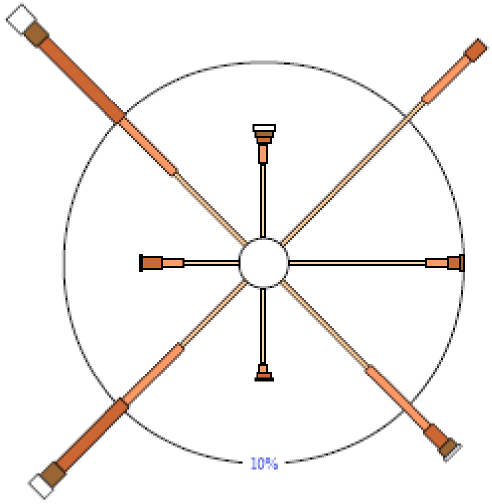
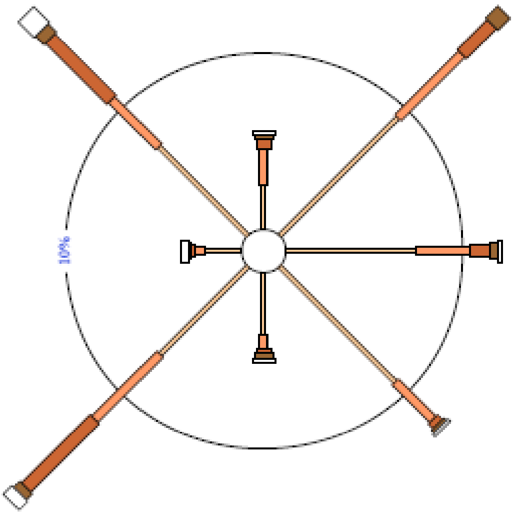


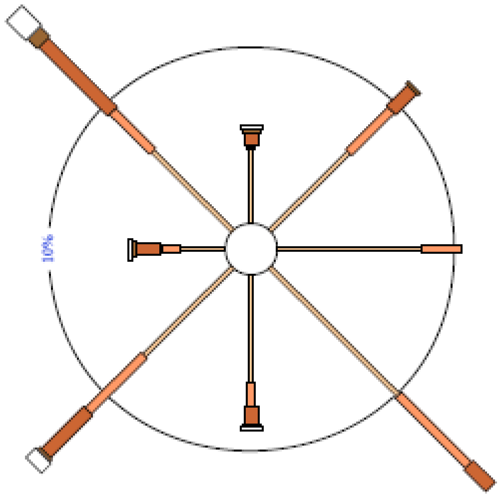
August (Calm 7%)



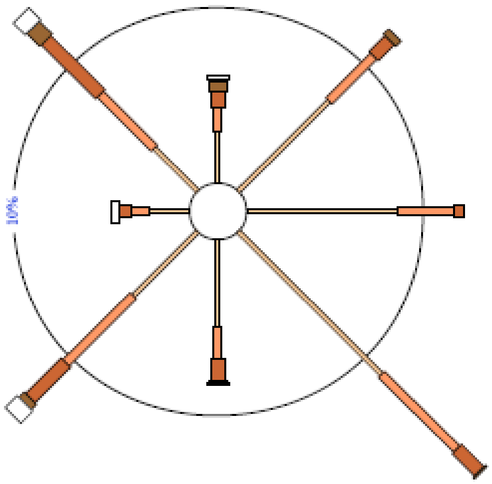
September (Calm 6%)



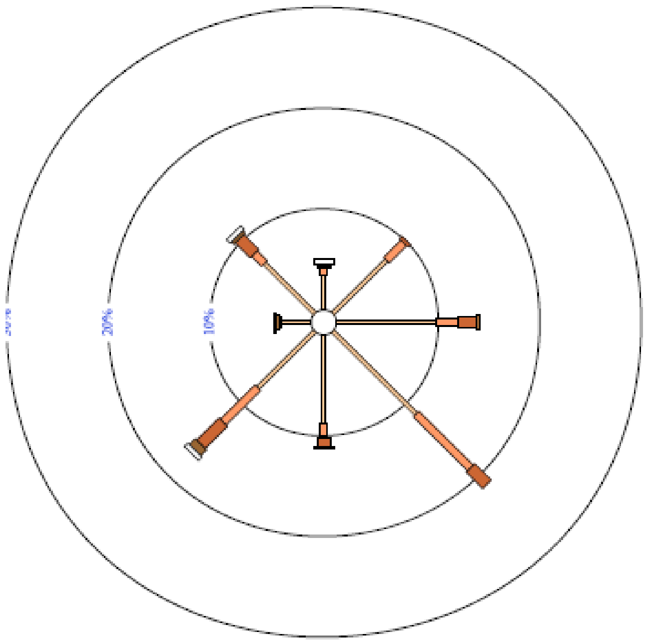
October (Calm 7%)



November (Calm 8%)



December (Calm 6%)



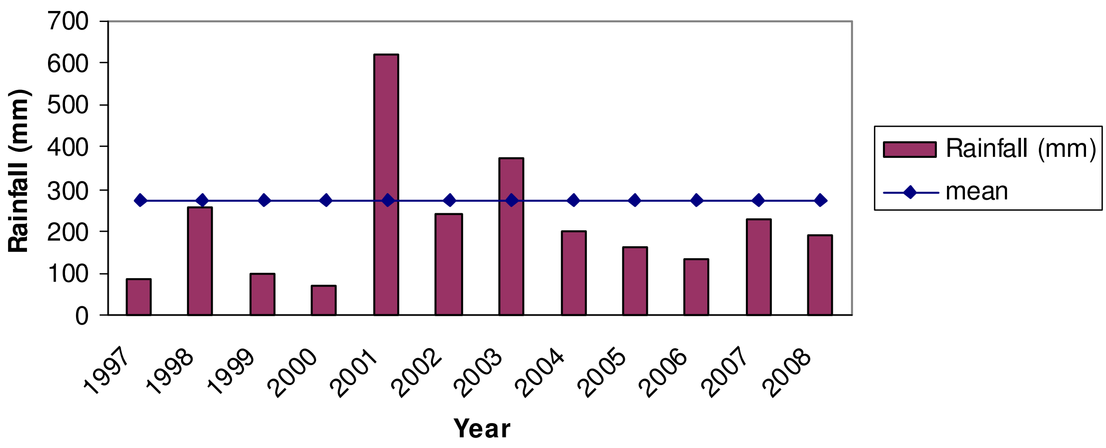
5.2 Current Seasonal Conditions

Annual rainfall totals for Ernabella from 1997-2008 are presented in Figure 9. The wettest year during this period was 2001 when the area received twice its annual average rainfall. Annual rainfall has been below average since 2004.

Significant summer rainfall in the APY lands at the end of 2008 (150mm at Ernabella and 184mm at Pipalyatjara in Nov-Dec) has led to prolific growth of rolypoly in the outwash plains of the Musgrave Ranges. Further west the germination has been dominated by tussock grasses, which may carry a fire this summer, but will probably require a second summer of significant rainfall before the grasses thicken up enough to be a serious wildfire hazard.

A further 43mm of rain fell at the end of May. This is likely to stimulate germination of herbs such as daisies which are not very flammable. In areas with a predominantly herbland understorey, winter burning is unlikely to be effective, and resources should instead be focussed on burning in spinifex-dominated habitats.

Figure 9. Annual rainfall at Ernabella 1997-2008



5.3 Recent Fire History

Fire History Mapping in the APY Lands was conducted by Yates and Morse (2003) for the period 1984-2002. Using low resolution annual Quicklook images they were able to map firescars down to 2 km^2 in size. As occurs in most of central Australia, they found that the most serious wildfires tended to occur in the 1-2 years after unusually high rainfall events. The most recent period of widespread wildfires throughout central Australia was in 2002. This followed a very wet year in 2001 when more than twice the annual average rainfall was recorded at Ernabella. Extensive wildfires also occurred in the mid-seventies and mid-eighties. Yates and Morse recorded "hotspot" areas close to settlements and roads that have been burnt three or four times between 1984 and 2002.

For this fire management plan, we sourced broadscale firescar data from the Firewatch website (http://firewatch.dli.wa.gov.au/landgate_firewatch_public.asp) which collects data from the NOAA-AVHRR satellite at nine day intervals to produce monthly fire scars. These data are coarse as they do not detect fires smaller than 4 km^2, however they are a useful indication of the extent of wildfires. Annual firescar data for the period 1987-2008 for the Mann and Musgrave Ranges Fire Management Regions are shown in Figures 10 and 12 and the composite fire scar maps showing time of last fire are displayed in figures 11 and 13.

It can be seen that the entire Tomkinson Ranges area has been affected by fire during the period, with an area west of Pipalyatjara appearing to have burnt three times between 1999 and 2002. The only area of the Mann Ranges that appears to have escaped the impacts of fire during this period is the easternmost tip around Angatja. The rest of the Mann Ranges burnt in 2000, with the area north of Nyapari burning again in 2002.

Within the Musgrave Ranges Fire Management Region, an extensive fire occurred south of Amata in 2000, but the only large fires affecting the ranges since 1997 were in 2002, and according to the mapping only about half of the Musgraves were burnt. Firescar mapping by Yates and Morse (2003) shows the Musgrave Ranges remained largely fire-free between 1984 and 1997; extensive fires in the region in 1989-90 and 1994-95 were primarily in the tussock grasslands habitats north and south of the range. If the mapping is correct, there is a considerable amount of range country west of Ernabella that has remained unburnt for a long period of time and would now be highly flammable.

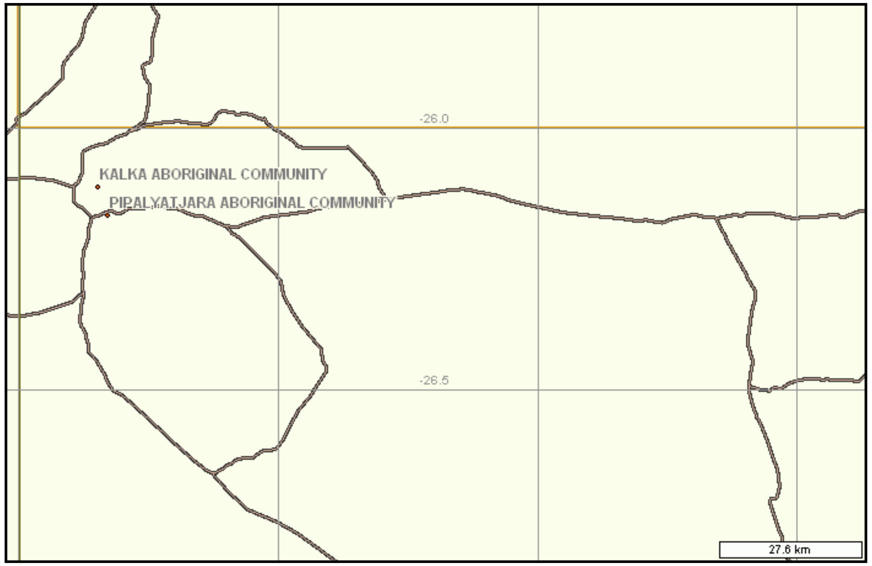
5.4 Current Fuel Loads

Spinifex communities through most of the Mann Ranges and Musgrave Ranges FMRs are still recovering from the 2002 fires, and not yet a high fire risk. However large patches of older spinifex are believed to occur on the slopes of the Musgrave Ranges between Ernabella and Mt Woodroffe. Small patches of older flammable spinifex also occur east and south of the eastern end of the Mann Ranges.

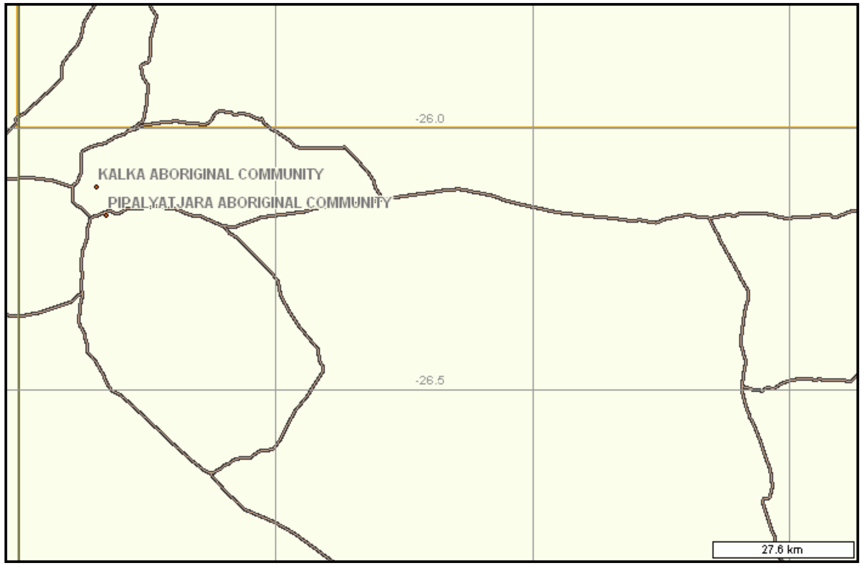
Most of the outwash plains tussock grassland habitat was also burnt in 2002. Where rolypoly is the dominant species in this community it will not carry a fire this year, but the outwash plains west of Amata are dominated by *Aristida contorta*, and considerably more flammable. Elsewhere grassy communities dominated by wiregrasses (*Aristida spp.*) and oatgrasses (*Enneapogon spp.*) that have emerged since the rains at the end of 2008 are likely to be difficult to burn in mild winter conditions, but may carry a fire in warm windy conditions. If significant rain occurs next summer, the tussock grassland communities will be at risk of large wildfires. Where buffel grass occurs, tussock grassland communities are already vulnerable to high intensity wildfires.

Figure 10. Mann Ranges Firescars recorded by the Landgate Firewatch Project 1997-2008

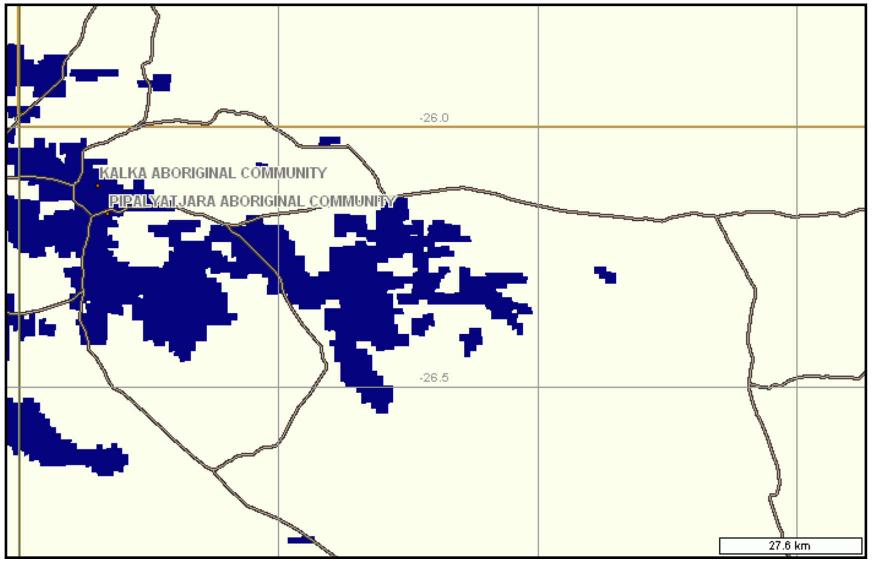
1997



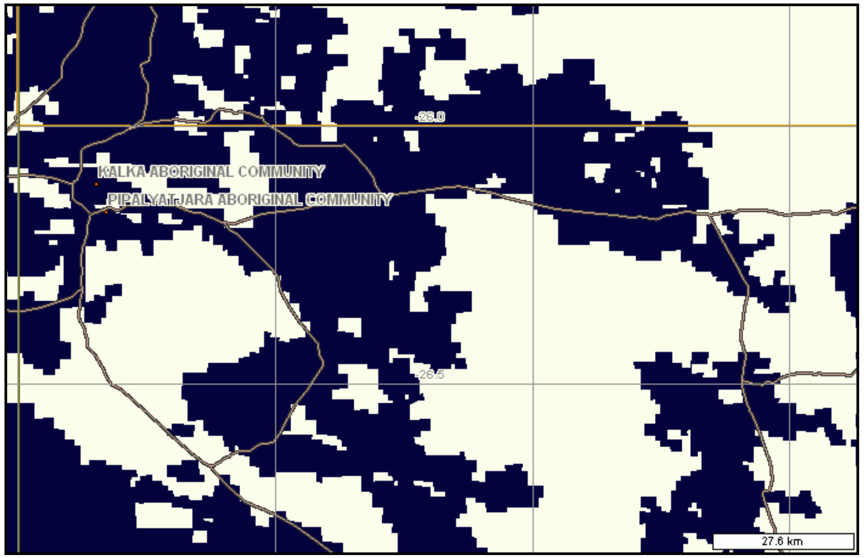
1998



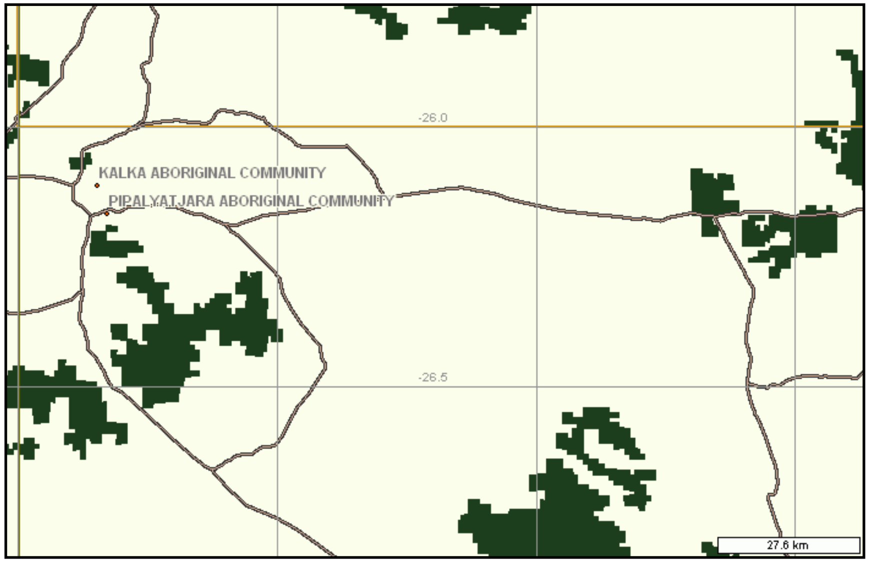
1999



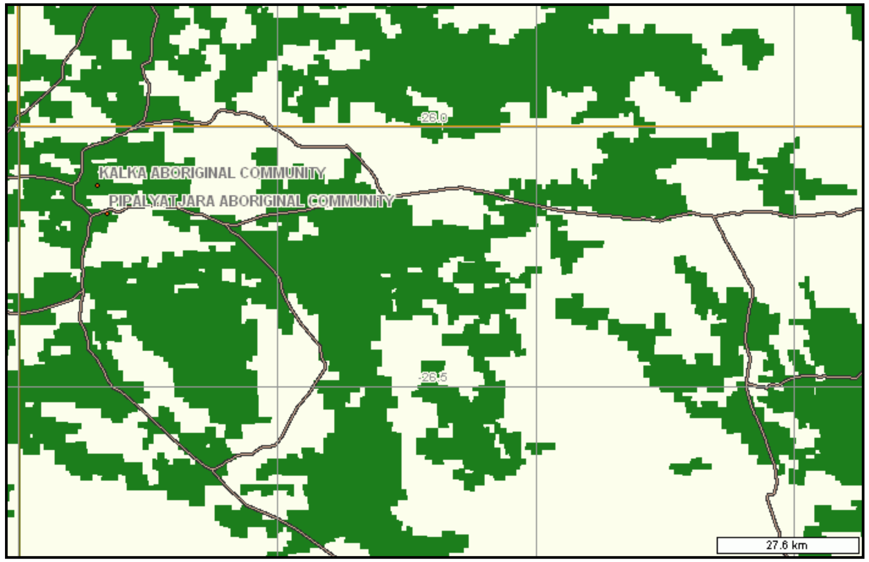
2000



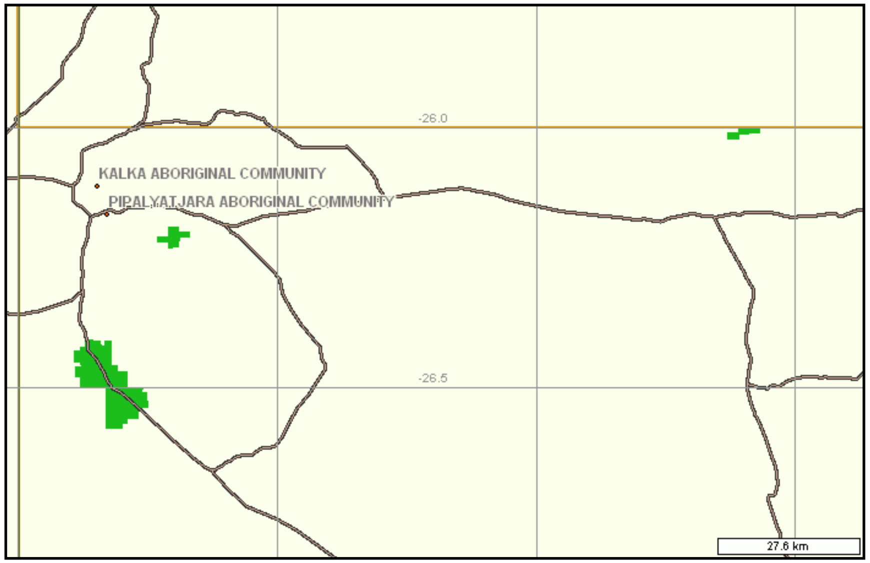
2001



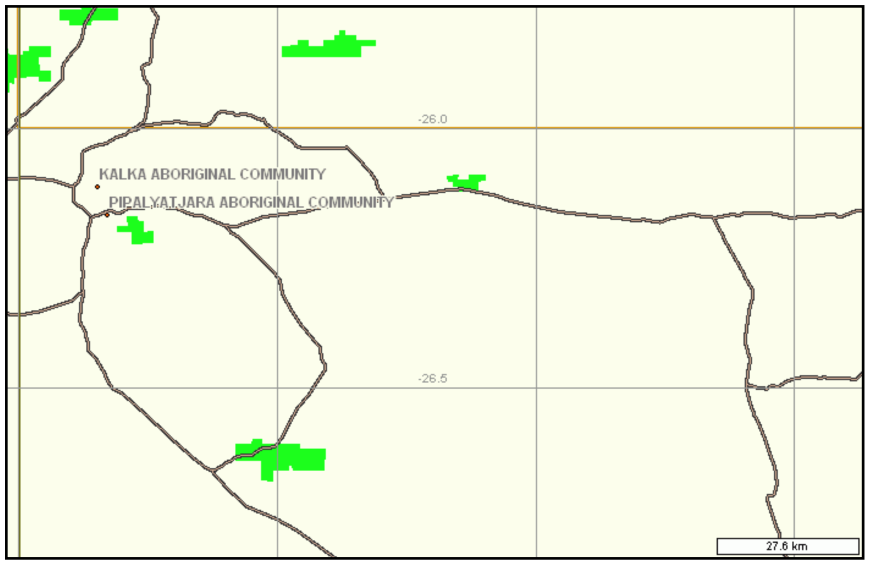
2002



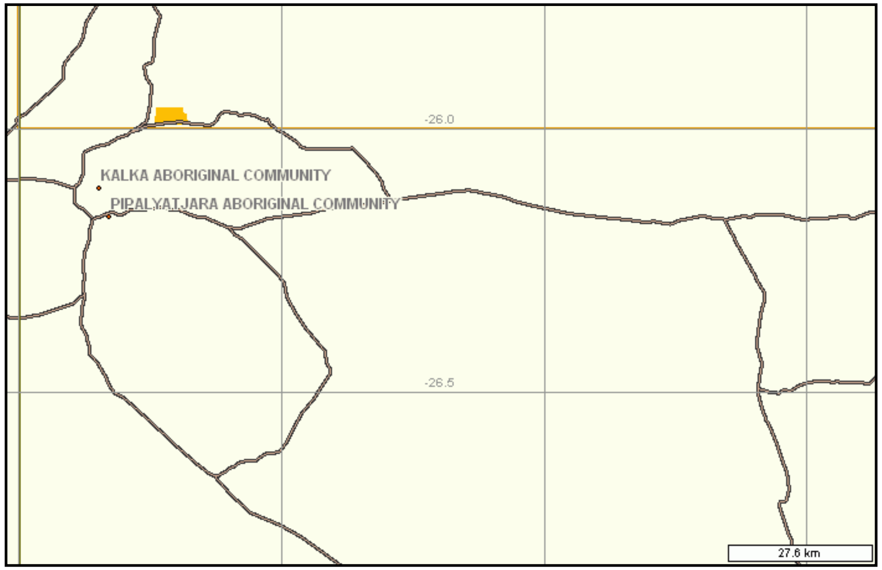
2003



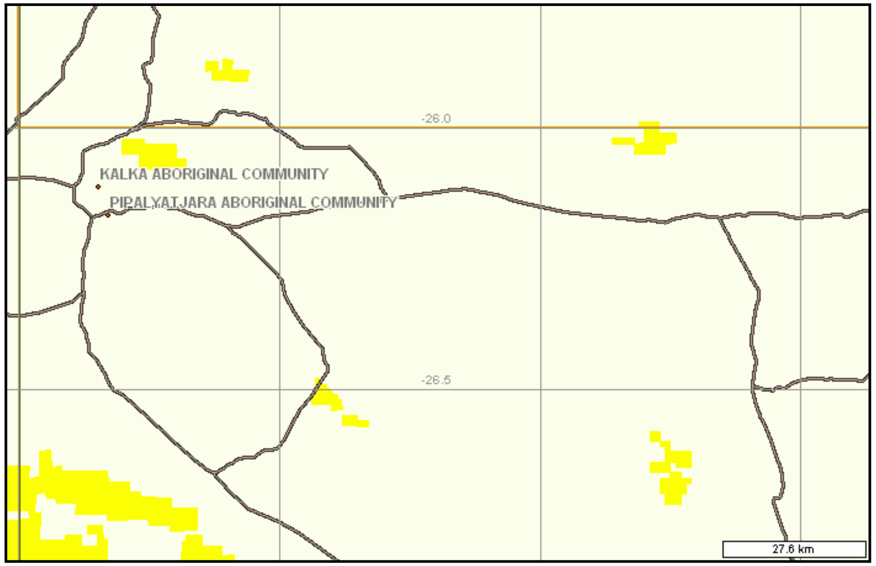
2004



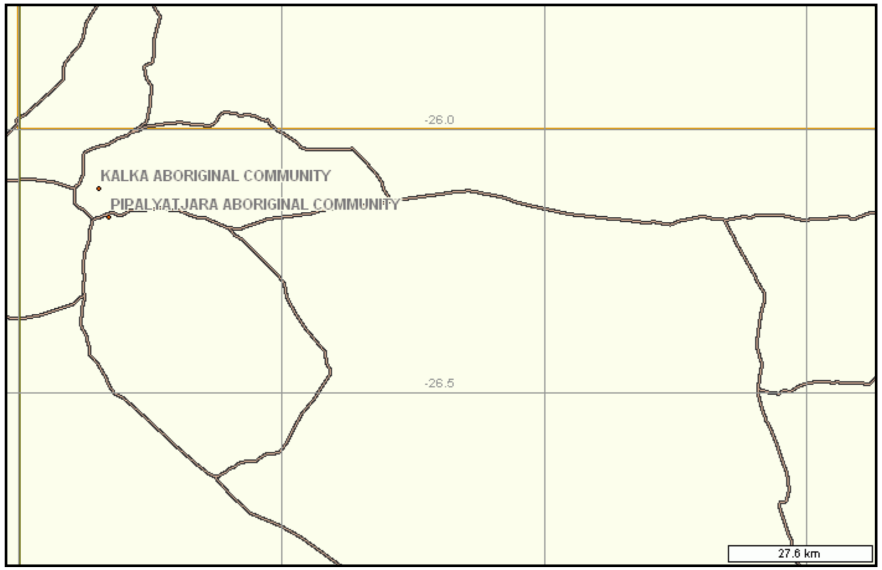
2005



2006



2007



2008

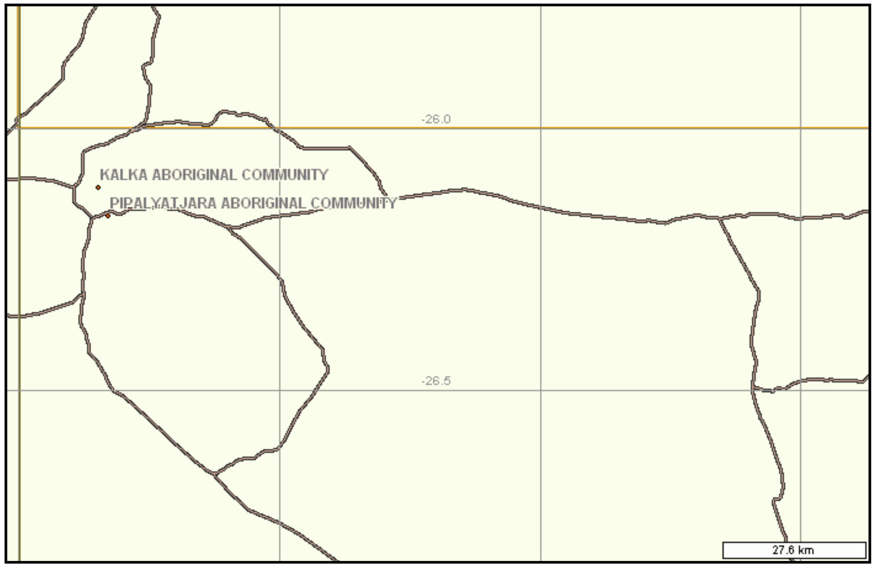


Figure 11. Fire history of the Mann Ranges Fire Management Region, 1997-2008

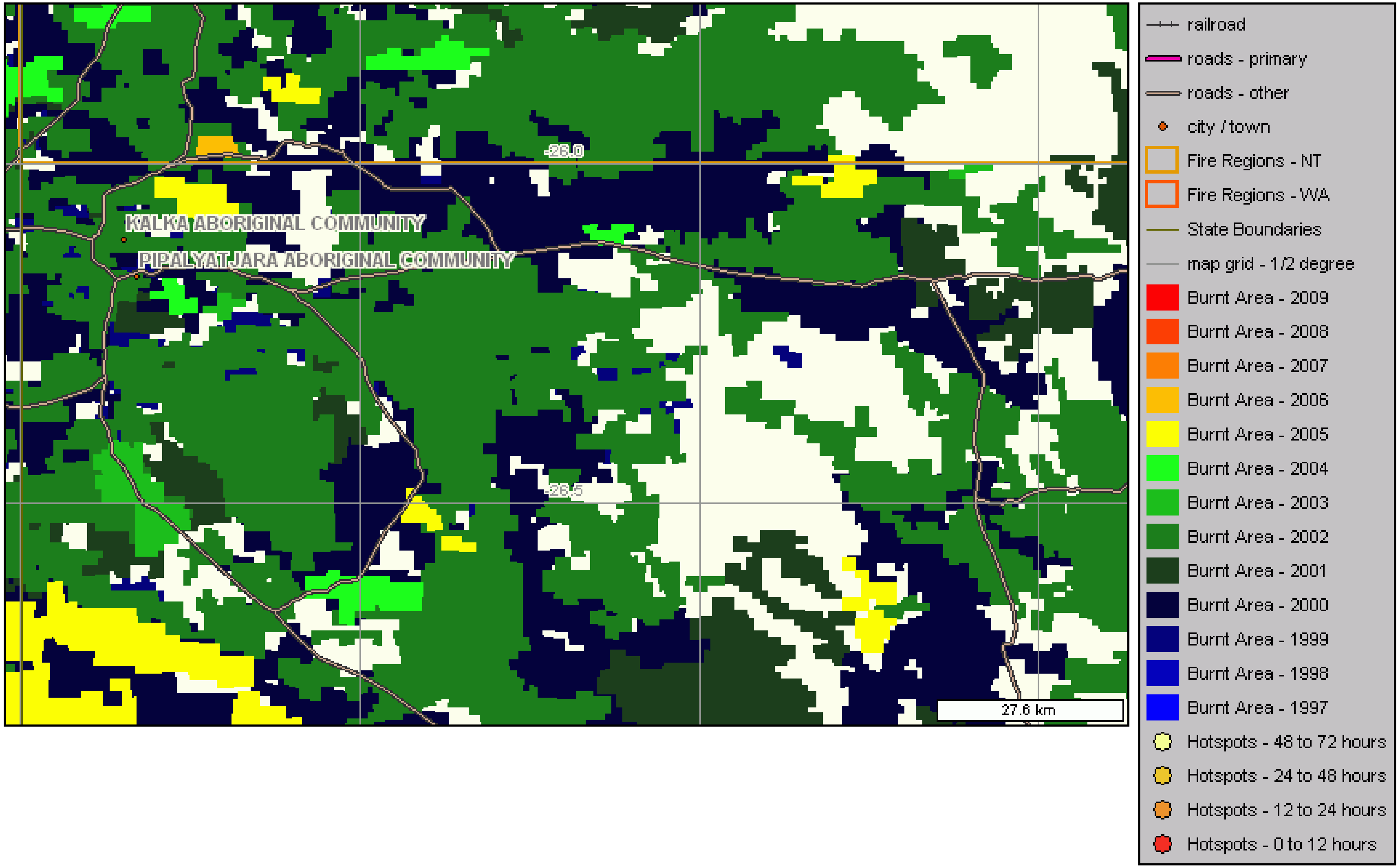
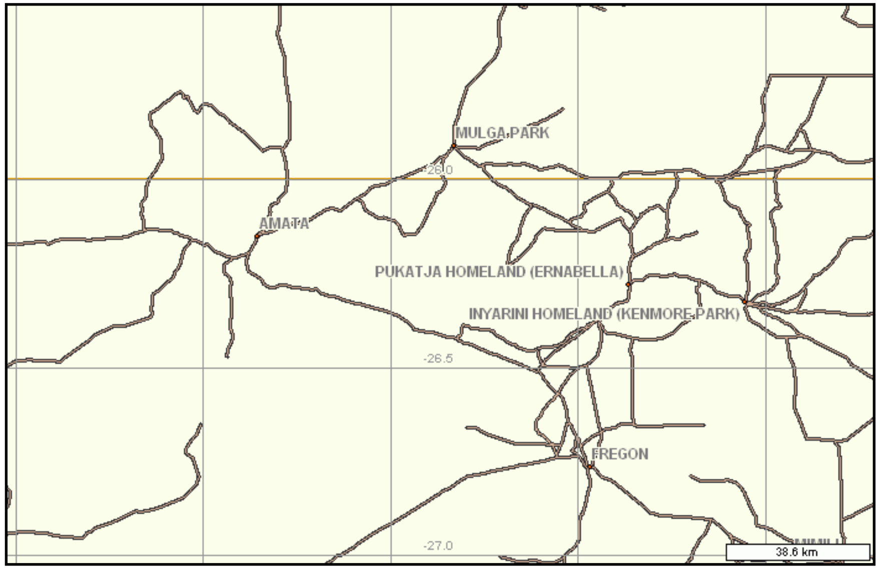
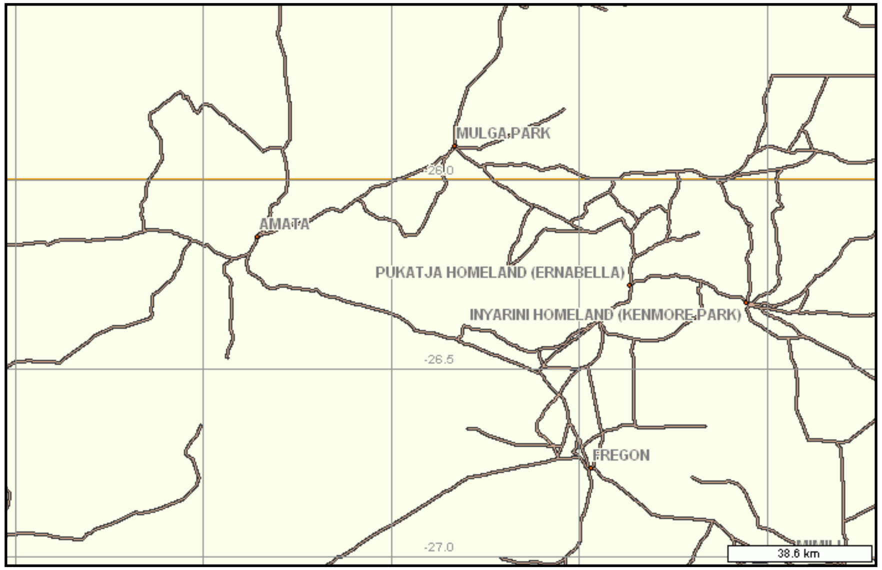


Figure 12. Musgrave Ranges Firescars recorded by the Landgate Firewatch Project 1997-2008

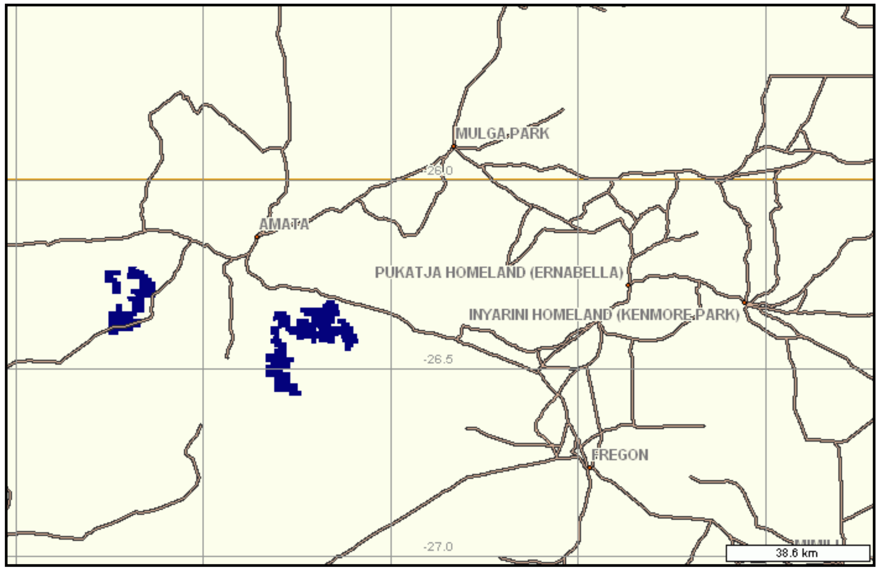
1997



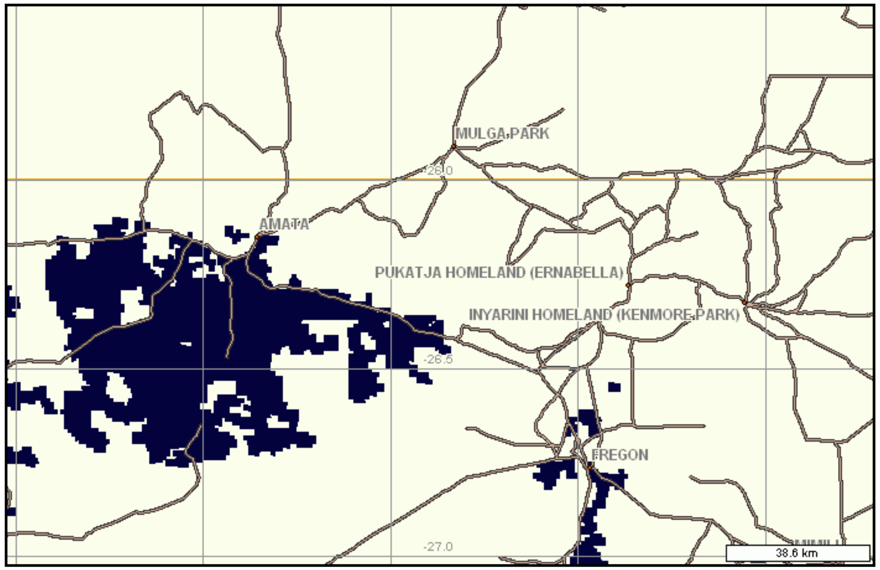
1998



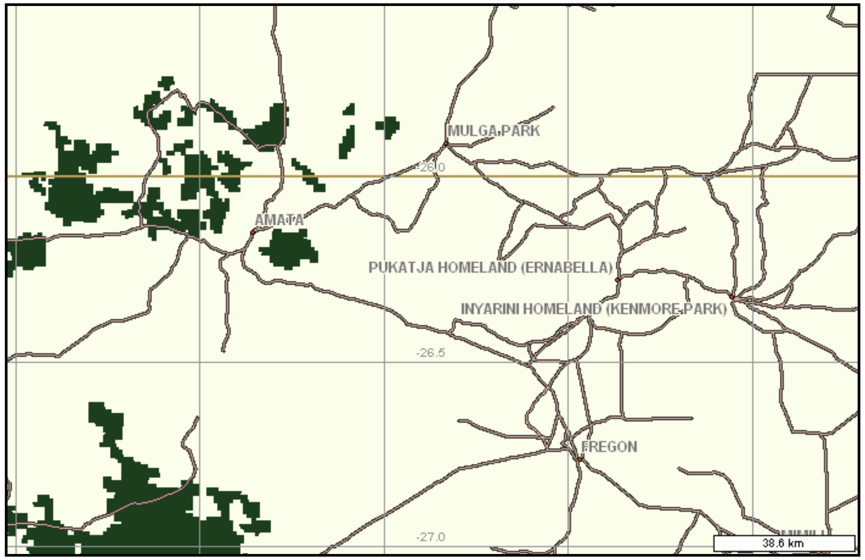
1999



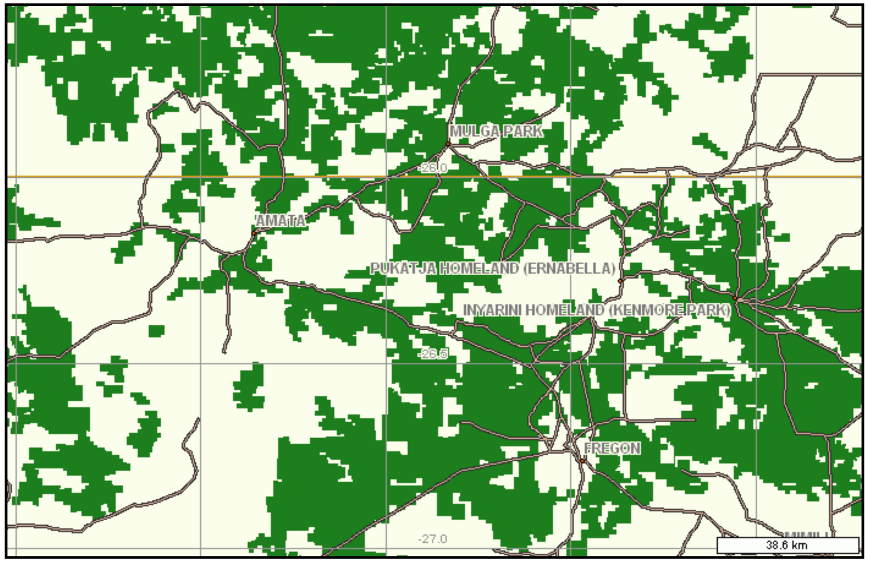
2000



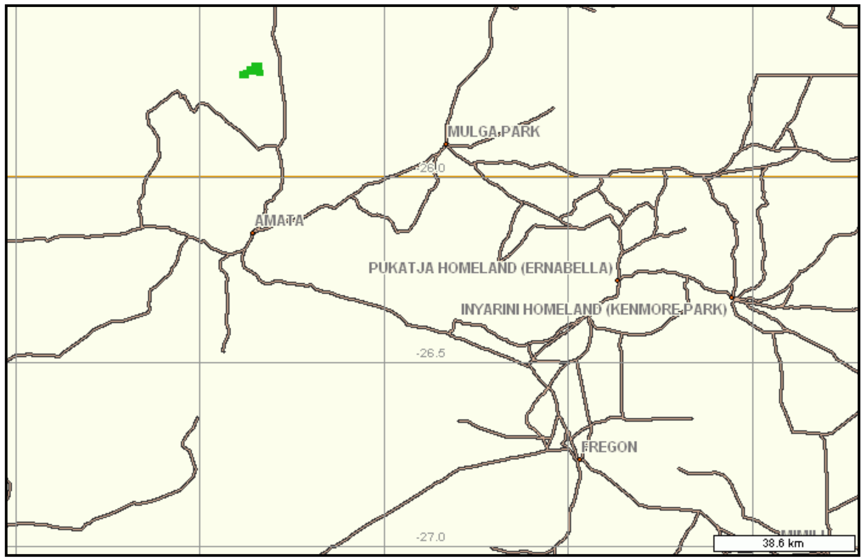
2001



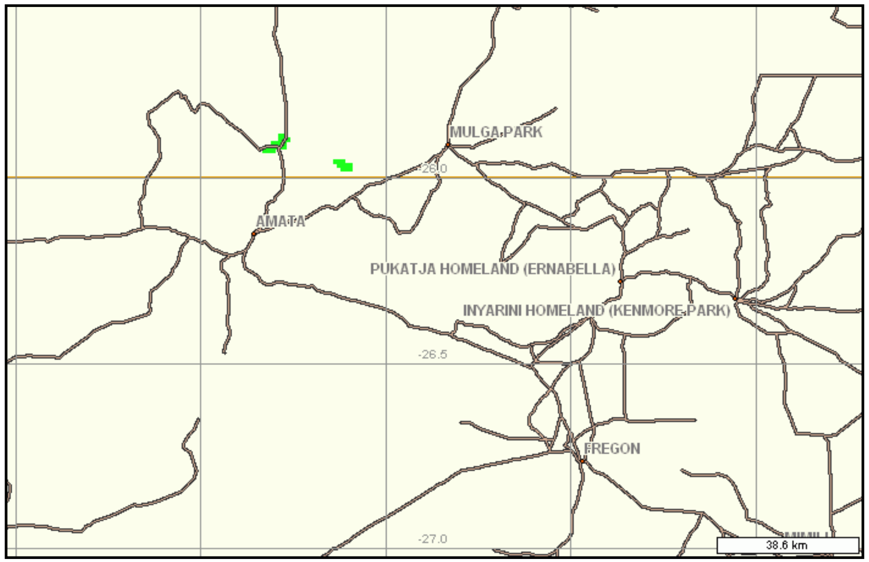
2002



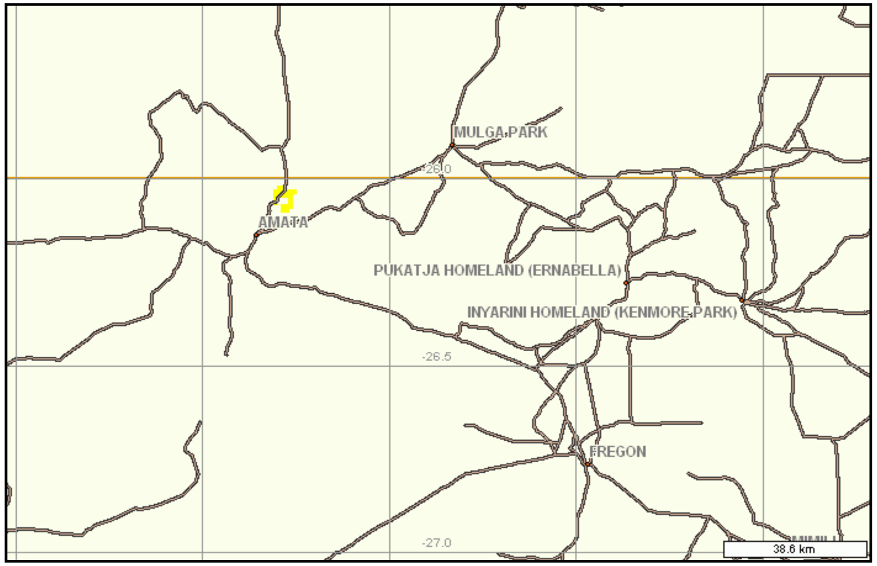
2003



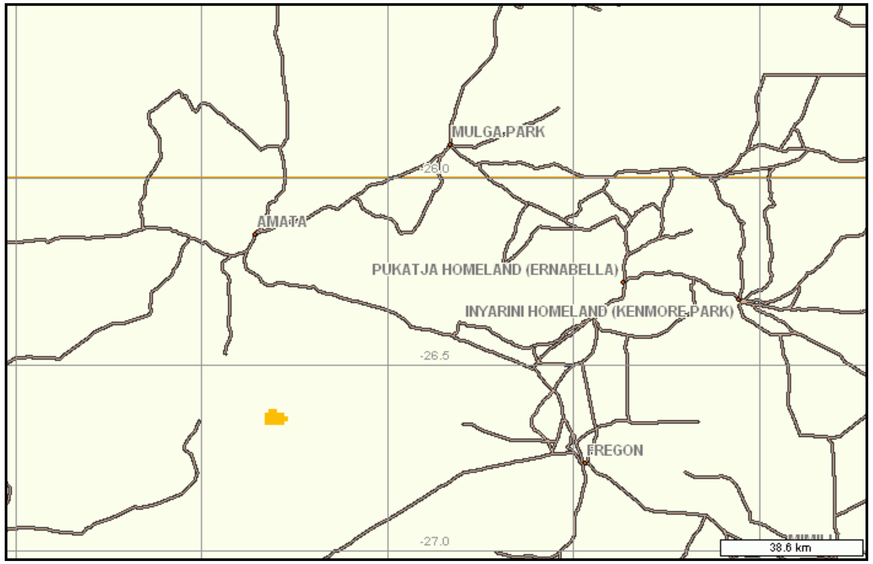
2004



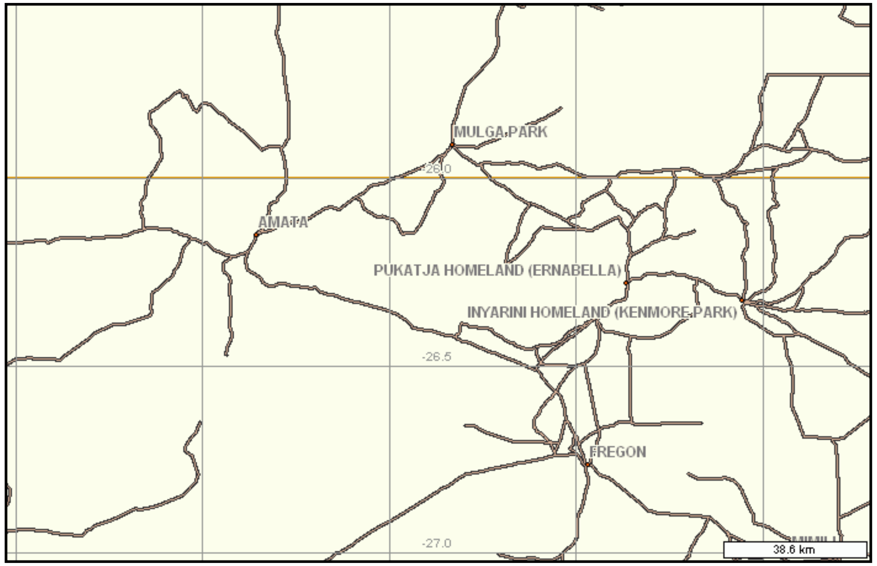
2005



2006



2007



2008

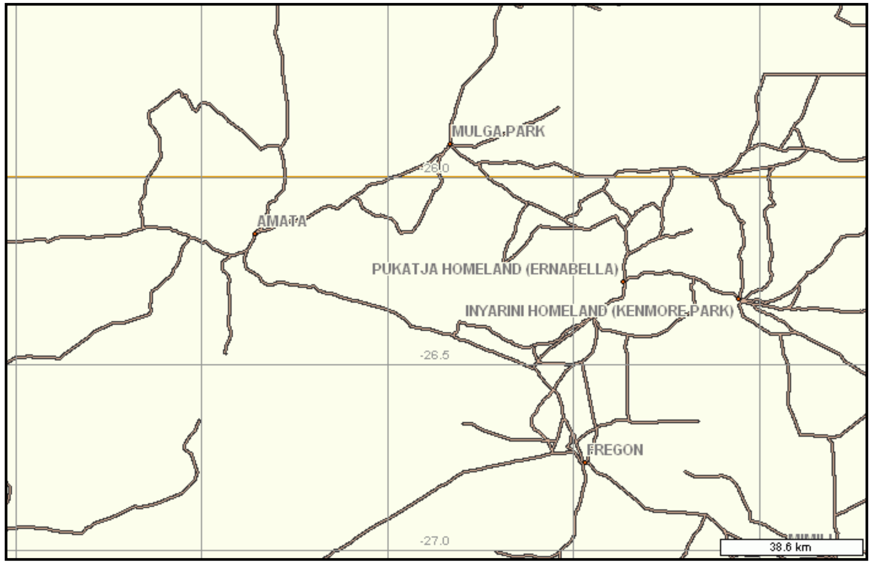
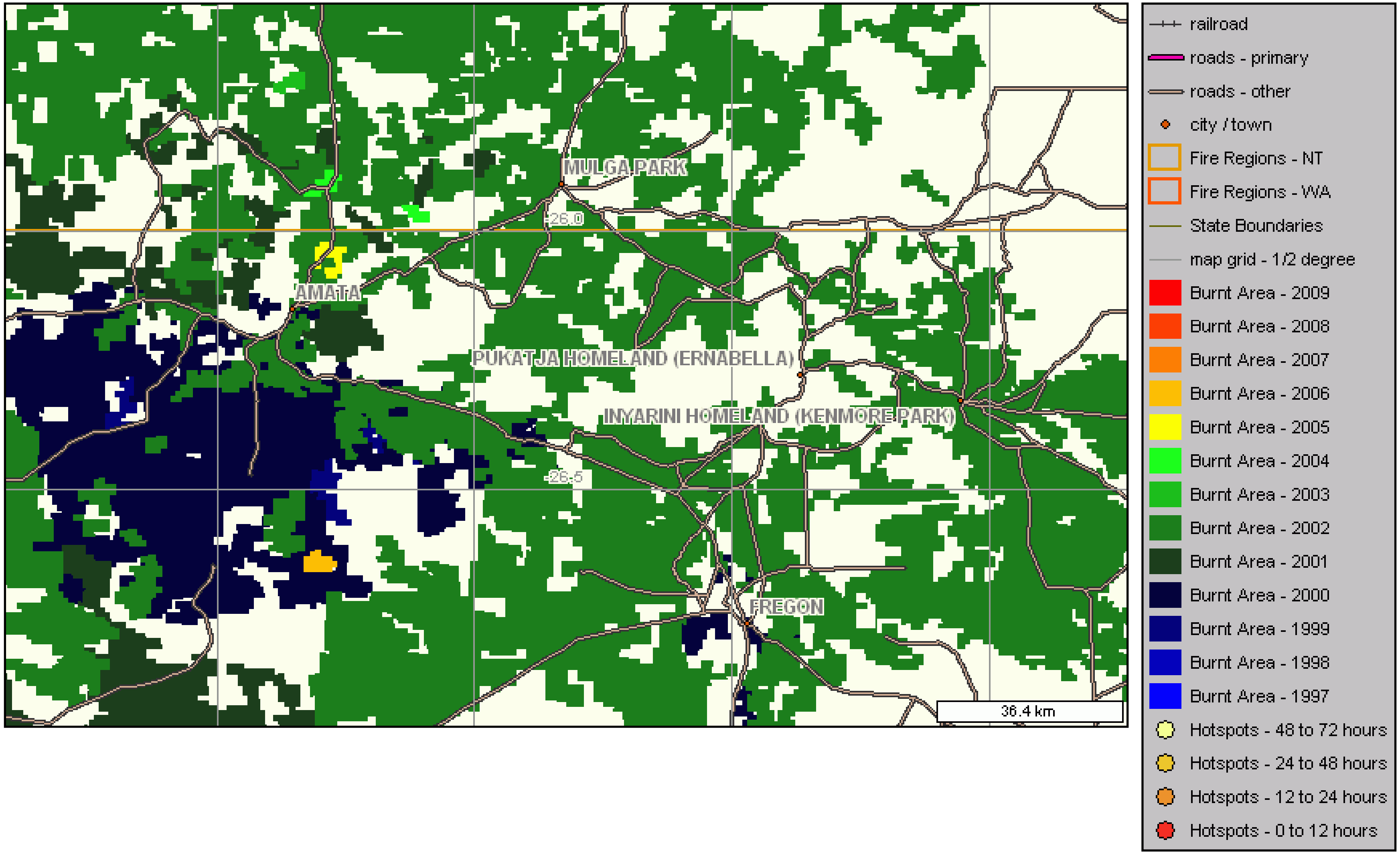


Figure 13. Fire history of the Musgrave Ranges Fire Management Region, 1997-2008



6.0 Fire Management Practices

6.1 Annual reconnaissance and planning

This strategy recommends that a Fire Action Plan is developed annually which reports on all fires (planned and unplanned) that have occurred in the previous 12 months, current seasonal conditions and fuel loads, and the intended burning program for the following 12 months. The Fire Action Plan would be compiled by APY Land Management staff in consultation with Traditional Owners, the Alinytjara Wilurara Fire Management Officer, the DEH regional ecologist and the Warru Recovery Team. While this strategy can be used to prioritise burning actions, any new information obtained during the year regarding the locations of significant species and communities should be incorporated into the Annual plan. Information to include in the plan for each intended burning action includes its priority, what it is intended to protect, proposed patch size, terrain and fuel characteristics, preparation required, preferred weather conditions, contingencies and risk assessment and estimate of resources required.

Strategic fire management requires knowledge of where the flammable material is. Satellite imagery and fire history maps are important tools for understanding fuel loads but field observations are also required. If funds are available, aerial survey from an aeroplane or helicopter is an effective method of preliminary assessment of the fuel loads across the region. It requires an experienced observer and for an area of this size, about 6 hours flying time is recommended. The patchiness and recovery of vegetation within previous burns can also be observed from the air.

While aerial survey identifies areas likely to require burning, ground checking is essential to assess actual fuel loads, species on site, slope and potential problem areas (Preece *et al*. 1989). This information determines the conditions under which the burn should proceed and whether control lines need to be established.

It is recommended that the annual fire management planning is completed by 1st April each year. A current satellite photograph should be purchased annually at the end of February (after the main wildfire season) and fire history maps updated. These tools will be utilised during annual planning meetings to be conducted each March. If funding is available an aerial survey of fuel loads will follow soon after the planning meeting.

6.2 Prescribed burning: patches and lines

A glossary of fire management terms is presented in Appendix E.

This strategy is based on the belief that the biodiversity values of the Mann and Musgraves FMRs can be protected and enhanced with active fire management including prescribed burning (i.e. deliberately lit fires in strategic areas, burning in prescribed conditions to achieve specific outcomes). The majority of prescribed burns should be in fire tolerant vegetation characterised by the presence of spinifex and the absence of long-lived woody obligate seeders (trees and shrubs which do not resprout when their canopies are killed by fire).

Prescribed burns should be a combination of linear fire breaks aimed at limiting the spread of and damage from wildfires and protecting natural, cultural and built assets, and patches aimed at diversifying the age of vegetation. Linear fire breaks to limit the spread of wildfires need to be relatively continuous, or connect with natural fire breaks. Other smaller linear breaks can be established around biodiversity assets.

Prescribed burning can also be conducted in vegetation less tolerant of fire, under restricted conditions. The low-intensity scattered burning technique aims to burn ground fuels with minimal disturbance to overstorey species. This is usually only required after significant, prolonged rainy periods when flushes of annual growth occur. It is appropriate for the hill communities that still have Callitris pines, mulga woodland communities and the hill frontage woodland.

Prescribed burning in continuous heavy fuels is very time consuming because substantial control lines (e.g. with rakehoes) are required to limit the spread of the fires unless weather conditions are extremely mild (e.g. a cold rainy day which is a rare occurrence in the study area). Burning is most efficient if you can start establishing strategic breaks when fuel levels are still recovering and just ready to start carrying fire. Most of the spinifex sandplain communities in the region are approaching this situation, so the next few years will be an ideal time to start putting those breaks in.

In the Mann and Musgrave Fire Management Regions strategic firebreaks will mainly be established along the major roads and tracks. It is recommended that as much burning as possible is conducted along the main roads in the cooler months and while fuel loads are relatively low. It is obviously not feasible to make continuous firebreaks along all these roads over such vast distances, but if a series of patches are burnt along the roads each year, after a few years some areas will start to resemble linear firebreaks. Ideally these breaks will be reburnt as soon as they are capable of carrying fire. If some burns can be conducted when soil moisture levels are low and with moderate intensity, the recovery of the spinifex will take longer, and the impact of the break will last longer. This is of course more damaging to the plants and animals, however effective strategic firebreaks are essentially ecological sacrifice zones as they are burnt with a higher frequency and intensity than would normally be desirable in that vegetation type, and vegetation is limited to early successional stages.

The main road linking Ernabella to Amata and west to Pipalyatjara is a logical place for a strategic firebreak to be established by conducting intensive burning along the road each winter. With frequent traffic along this road, there is considerable potential for roadside ignitions in unfavourable conditions, and strategic burning in this area will protect the ranges from fires coming up from the south. Prior to any roadside burning however, it is important to protect the fire-sensitive communities which are mainly limited to the foothills of the major ranges. This can only be achieved by climbing the hills and trickle burning downhill to remove the grassy fuels.

Strategic firebreaks in spinifex country need to be at least 200m wide to stop a good proportion of summer wildfires. Along tracks it is recommended that fires are lit on both sides of the track (in successive years). It doesn't matter if its too time consuming to make the burn this wide initially, even a much narrower burn conducted in low fuel times will provide a control line to burn against the following year, and by the time conditions are quite flammable, a decent sized break will have been constructed.

Strategic firebreaks may also be established in areas remote from tracks, to protect significant sites and vegetation communities. Such breaks are often recommended along the boundaries between fire-tolerant and fire-sensitive communities to prevent large spinifex-fuelled fire fronts from entering non-spinifex communities. These breaks may be burnt less frequently, but in successive years new strips can be burnt in adjacent areas of spinifex. This produces a system of linear patches and is a useful way of diversifying vegetation age and breaking up country using the previous burn as a control line to burn against.

Further survey work is required to identify precise areas of fire-sensitive vegetation that require strategic firebreaks. Until more detailed vegetation mapping is available we can really only recommend breaking up the country with relatively continuously burnt firebreaks along roads, and conducting as much patch-burning as possible in between.

Active patch-burning in spinifex communities can usually be done without attempting to tightly control fire extent, but using weather conditions to limit intensity and size. It is probably desirable that patch-burning occurs under a range of conditions to ensure both trickly fires (better for most flora and fauna) and hotter, cleaner burns (better firebreaks) are effected.

It is important to try to preserve some of the remnant patches of unburnt spinifex after widespread fire events by resisting the urge to start fire management with those patches, or if they are big enough, it may be possible to burn a break through the middle and then conduct low-intensity trickly burns through one half under very mild conditions. A safer way to protect remnant patches may be to burn linear breaks through regenerating vegetation adjacent to the remnant patches. This can be very time-consuming, and may not be viewed as a high priority. It is probably not worth attempting to burn up against remnant patches in remote areas, but along roadsides where the chance of ignition is high, it might be worth trying to burn a firebreak along the edge.

6.3 Where to burn

Some priority areas of conservation significance to protect with prescribed burning have been suggested in Section 7 (see Actions 2.2, 2.3, 2.4). After that burning can be conducted almost anywhere in the fire tolerant (spinifex-dominated) vegetation, particularly while fuels are still recovering from previous fires and Traditional Owners can dictate where patch-burning expeditions are directed. Providing that burning occurs during relatively mild conditions, patch-burning in any of the spinifex communities will be advantageous in diversifying the age structure of the spinifex and preventing the spread of destructive hot-season fires. The more patch-burning that can be conducted in conditions promoting low intensity fires (cool winter weather and relatively low fuel loads), the more opportunities there will be for a range of fauna species to find appropriate habitat.

6.4 When to burn

In central Australian Parks and Reserves, prescribed burning is usually conducted in the cool winter months. Although dry winter burns can be as damaging as dry summer burns, they are usually easier to control. N.T. Parks and Wildlife recommend that an ideal time to burn is during a stable, slow-moving high pressure system, which generally lasts 4-5 days and is usually characterised by light southerly breezes in the order of 10km/hour (when you can feel the wind in your face and the leaves flutter but there is no significant branch movement). It is advisable to burn early in the 4-5 day high-pressure system because the end of the system brings less stable conditions with frequent changes in wind direction and often higher temperatures. The 4-day forecast on the Bureau of Meteorology website is useful to track the location of approaching highs and lows.

Rainy conditions are ideal for hazard reduction burning within fire-sensitive communities, or adjacent to their boundaries. Burning as soon as possible after rainfall causes minimal damage to soil crusting organisms as well as woody plants which are afforded some degree of protection by their increased moisture content and the moisture in the soils (Pitts and Matthews 1999). Rainfall events of at least 10 mm provide sufficient dampness to control a fire and assist in the subsequent recovery of the burnt area, however in cooler winter conditions, a smaller amount of rainfall may be sufficient.

Rainy conditions can also be utilised to burn control lines through heavy spinifex. When fuel loads are very high, such control lines can be created most efficiently during light rain or the day after heavy rain. Once good control lines have been established, you can come back later in less mild conditions and safely burn the rest of the desired area. Priority areas for prescribed burning after rainfall should be identified in the Annual Fire Action Plan, so the work can be initiated as soon as the appropriate climatic conditions prevail.

Ideally burning should be conducted when daytime temperatures are no higher than 25ºC and overnight lows of ≤5ºC are predicted. For higher risk burns (when fuel loads are higher, slope is a significant factor and it is regarded as important to contain the fire to a narrow line) temperatures should be no higher than 15-20 ºC with a high likelihood of frost. If the weather forecast predicts a frost one can assume that there will be no wind before sunrise and all fires, except those in very dense spinifex, will go out in this time. After a frost there are usually several hours of calm, after first light, to extinguish any remnant burning vegetation.

Guidelines prepared to assist inexperienced NT Parks and Wildlife Rangers assess the riskiness of particular burns (in spinifex) based on prevailing conditions are shown in Table 3. The table is based on estimates rather than quantitative models and is at best a guide. The number of severity points for each cell of each of the indicator elements is shown in the first column. The idea is to select the appropriate cell in each column, look up its severity points value, and then total the points across the seven indicator elements.

Table 3. Potential severity of fire based on fuel cover, slope, time of day and climatic factors

	INDICATOR ELEMENTS						
	FIXED				VARIABLE		
SEVERITY POINTS	Spinifex diameter (cm)	% cover spinifex	Slope °	Time of day	Temp. (°C)	Relative Humidity %	Wind speed kph
1	-	-	0	1730	<13	>70	1
2	-	-	1-3	1700	13	50-69	2
3	-	10-14	4-5	1630	14	40-49	3
4	-	15-19	6	1600	15-16	30-39	4
5	30-34	20-24	7	1530	17-18	26-29	5
6	35-39	25-29	8	1500	19	23-25	6-8
7	40-44	30-34	9-10	1430	20	20-22	9-10
8	45-49	35-39	11-12	1400	21-22	18-19	11-13
9	50-54	40-44	13-15	1330	23-24	16-17	14-17
10	55-59	45-49	16-17	1300	25	15	18
15	>60	>50	>17		>25	<15	>18

Guidelines for burning based on Severity points calculated from Table 3

<25 points	will not burn without a lot of effort
25-45 points	ideal conditions for burning
45-55 points	only experienced people should attempt burning
>55 points	only experienced people should attempt a burn in conditions of less than 4°C or wet, calm conditions and very late or early in the day

Factors for controlling or losing a fire include topography (slope), speed and direction of wind, and how it changes during the day, temperature when fire is lit and subsequent temperatures through the day and night, humidity, characteristics of the fuel including soil moisture and size and cover of spinifex clumps and how it changes through the landscape. Conditions are generally most suitable for burning early in the morning when humidity is usually high, temperatures are low and winds are relatively calm until about 9 or 10 am. However, if an early morning fire gets away, it may continue to burn unchecked for the remainder of the day with maximum severity points. This may be acceptable when spinifex cover is low, and the fire is likely to be relatively mild or if it is not considered important to contain a fire precisely. However, if fuel loads are high and the aim is to create a narrow firebreak through the middle of a large area of dense spinifex, it is probably advisable to burn in the late afternoon and evening, minimising the interval before nightfall when the fire will have more chance of being brought under control.

6.5 Burning Techniques

There are many ways of achieving patch-burning, ranging from walking through country with a fire-stick or drip-torch, throwing matches from a moving vehicle or dropping incendiaries from aircraft. In particularly remote, inaccessible areas a helicopter may be required to access areas for ground-burning. The most efficient method of conducting a large amount of patch-burning in the inaccessible range country would be to initially use a helicopter to access areas that require protection from fire with the establishment of strategic fire-breaks, and then conducting aerial incendiary burning in the country in between to increase the vegetation mosaic and create reduced fuel buffers around the assets.

Aerial burning can be conducted from either a helicopter or light fixed-wing aircraft and the Civil Aviation Safety Authority (CASA) has operational regulations including use of an approved chute for dispatching the incendiaries. DEH has a fixed wing aircraft with aerial incendiary capabilities that may be available for use in the APY Lands. Although it is relatively expensive it can be a cost-effective way of prescribed burning in extensive inaccessible areas. Typically it involves lighting fires and letting them burn, so is most suitable for fire tolerant spinifex vegetation. It has been successfully used by the Central Land Council in the southern Tanami Desert in the Northern Territory. If a helicopter is used for aerial burning, it can subsequently be used to transport ground crews if it is decided to limit fire extent with active suppression (e.g. to protect fire-sensitive vegetation).

Prescribed burns are often contained by control lines that are prepared prior to ignition or during the burn. These are the boundaries to which a fire may burn and are defined by areas of low fuel. They may be natural barriers to the spread of fire (such as bare rock, salt lakes or the crests of sandhills), areas that have been recently burnt and have insufficient fuel to carry a fire or lines that have been mechanically or manually cleared of vegetation (Preece *et al.* 1989). Wherever possible naturally existing control lines should be used. Recently burnt areas are the safest and most effective control lines, as they are usually broad enough to reduce the risk of the fire jumping to unburnt areas.

Manually/mechanically constructed control lines may be prepared by hand tools such as rake-hoes or machinery such as tractors or graders. Creating a control line with rake-hoes is very time consuming, and requires a large team of people. This technique is often required in hills or particularly thick spinifex. Control lines can also be created by burning a line (several meters wide) through vegetation, in preparation for ignition of the main area to be burnt. This is best achieved in very mild conditions (either during light rain, soon after rain or in dewy or frosty conditions). The intention is to totally eliminate all fuel along the narrow line. Fuel reduction can then be conducted in adjacent areas during less mild conditions.

The main equipment used for lighting fires are the drip torch and gas flame thrower. When areas to be burnt need to be walked into over some distance, the back-pack style of flame throwers are more useful as a 2kg bottle of gas can last up to 4 hours before needing to be refilled. A drip torch will only last between 20 minutes and 1 hour. Both the drip torch and flame thrower can be potentially dangerous and should only be used after adequate training and with sufficient personal protective equipment. The flame throwers and drip torches have ‘O’ rings that require regular checking. A Gas Fitter should maintain the flame thrower as required.

In addition to the slip-on fire unit, flappers (pieces of leather 500mm x 500mm) and two-stroke blowers are useful items of equipment to assist in controlling prescribed burns (Matthews 2005). Both can be used to extinguish flames, although incorrect use will result in additional oxygen which will facilitate the spread of fire. Burning material is extinguished by cooling to the point that combustion stops. This will only work in fine fuels, not burning branches and logs. The two-stroke blowers produce wind speeds of more than 300 kph. Some blowers have water tanks, which assists in cooling the air and extinguishing fire more effectively. Blowers can also be used to create bare earth breaks in leaf litter, both for control lines and to protect trees before and during a fire by removing leaf litter from around the trunks.

Box 2: General Tips for Controlled Burning

1. Fires love going uphill; always burn downhill when burning on slopes
2. Be very aware of wind speed, especially in discontinuous fuels such as spinifex. Wind 'leans' the flame closer to adjacent clumps and increases the ability of the fire to carry.
3. Fires create their own wind and two close fires will often encourage each other
4. Old spinifex (generally > 15 years old) will only be extinguished by heavy rain, heavy frost or dew, or human intervention
5. Always consider where there is a fall-back line, eg a road, sandhill crest, or salt-lake that will halt the fire if it gets away.
6. Always assess the consequences of the fire escaping before you light up.
7. Burning mallees can produce spot fires up to 20 m away, even on a still night
8. Burning hollow trees can fall across your fire-break and start a fire on the unburnt side; they need to be watched as they are almost impossible to put out using water sprays etc.
9. Never burn when thunderstorms are predicted as they can produce severe changeable winds.
10. Changes in wind direction can be very dangerous as the flank of a fire can suddenly become the intense front of the fire.
11. If ever in doubt of your safety, quickly walk away from the fire. If a fire escapes, stand back and assess the situation. Don't panic, sometimes the fire that gets away is the one which turns out to be most useful in the long-term.
12. Always be aware of where everyone is and make sure you don't light a fire upwind of the people around you
13. Think carefully about your fire before you light it to make sure its not going to burn out someone else's country

6.6 Record keeping, monitoring and evaluation

6.6.1 Information to record during burning

Ideally records should be kept of all prescribed burns conducted by APY Land Management. At the very least all ignition sites should be recorded on a GPS so they can be later mapped. It is also useful to record information about the weather conditions during the burn (which can be obtained from the Bureau of Meteorology website) and the state of the fuels. Such information is useful to increase our understanding of how far fires in particular fuel types and under particular conditions are spreading, which helps with future fire management planning. An example of a proforma for the minimum data recorded after a burning attempt is given below.

BOX 3: Minimum data to record after each burning attempt

Objective of the burn:

Start date: End date: No. of person_days:	Weather conditions:
People Present (Indicate if TO, ranger, APYLM staff or external party)	List dominant plant species and describe most common fuel type (ave hummock height, cover, in flower?) Ignition methods: Waypoints recorded: Approximate area burnt:
Neighbours notified Name____________________Date_____	Was the burning activity implemented as prescribed?

After a burn has been implemented it is worthwhile checking either the Landgate or Sentinel websites to see if any hotspots have been detected by the satellites. Although the Hotspot data is only accurate to within 1.5km and very small burns may not be detected, extracting a copy of the hotspot map after each burning activity gives an instant record of the extent of larger burns that can be used in follow-up discussions with Anangu, and also assists in the interpretation of satellite imagery when mapping fire scars at the end of the burning season.

6.6.2 Monitoring and Evaluation

Monitoring is an important component of any fire management program to ensure burning activities are meeting desired objectives, and not resulting in any unwanted consequences. Monitoring allows the effectiveness of a management program to be assessed and improved. This is the basis of adaptive management where managers learn about a system by monitoring responses to management actions.

Key monitoring questions to be addressed include:

- Is the burning program sufficient to reduce the size and extent of wildfires?
- Is the burning program protecting and enhancing biodiversity values?
- Is the burning program affecting the abundance and distribution of buffel grass?
- Are Traditional Owners happy with the outcomes of the burning program?

Effectiveness of the burning program in reducing the size and impact of wildfires should be assessed at the beginning of each burning season as part of the Annual Fire Planning process. Any wildfires that have occurred in the previous 12 months should be analysed with respect to location of previously burnt patches to determine whether management burns were large enough and 'clean' enough to stop the passage of wildfires, and the time period that burnt patches in different vegetation types remain effective fire breaks. If a detailed fire-history database is maintained incorporating firescars from both management burns and wildfires, this can be done as a desktop assessment.

Monitoring the effectiveness of the burning program on biodiversity values should initially focus on the health of rare and threatened species and communities, but may also extend to other indicator species of various fire regimes. Priority species to monitor are black-footed rock-wallaby, *Prostanthera nudula, Melaleuca fulgens, Acacia tenuior, Teucrium reidii, Lepidosperma avium*, and *Santalum acuminatum.* Monitoring programs are already in place for these species, and it is important that they are continued. Specific questions to be addressed in the assessment of the effectiveness of the burning program to protect black-footed rock-wallabies and their Key Evaluation Indicators (KEI) are:

- Are rock-wallabies persisting at sites where fire management has occurred nearby (KEI – annual trapping surveys show abundance of rock-wallabies remains the same or increases)
- Are prescribed burns successfully preventing occupied habitats from being burnt? (KEI – vegetation at occupied sites remains intact, i.e. prescribed burns

are not escaping into occupied sites and prescribed burns are preventing wildfires carrying into occupied sites)

- Are prescribed burns facilitating an expansion in habitat use by rock-wallabies? (KEI – radio-tracking and scat surveys reveal that rock-wallabies are utilising recently burnt areas to feed on green pick)

- Is prescribed burning facilitating an expansion in predator utilisation of occupied sites by removing thick spinifex cover in adjacent areas? (KEI – tracking, spotlighting and predator scat surveys do not reveal an increase in predator levels at rock-wallaby sites).

A series of plant monitoring sites were established in the Mann and Musgrave Ranges Fire Management Regions in 2009 through the Threatened Flora Survey and Monitoring Project. Monitoring sites comprise photopoints at quadrats where target species are counted and health of individual plants is assessed. A 5-year schedule for the monitoring program has been developed (Paltridge *et al*., in prep.), whereby some species are monitored annually and others at 5 year intervals, however it is stressed that monitoring should be brought forward if any sites are affected by fire. Specific questions to be addressed in the assessment of the effectiveness of the burning program to protect rare plants and their Key Evaluation Indicators are:

- Are rare plant species persisting at sites where fire management has occurred nearby (KEI – follow-up surveys show abundance of target species in quadrats remains the same or increases)

- Are prescribed burns successfully preventing occupied habitats from being burnt? (KEI – vegetation at occupied sites remains intact, i.e. prescribed burns are not escaping into occupied sites and prescribed burns are preventing wildfires carrying into occupied sites)

- If sites are affected by fire, what is the response of species within the quadrat to being burnt? (KEI – increased number of species where information is known about fire responses (i.e. ability to resprout or germinate) under different environmental conditions)

In Section 4.3.5 it was recommended that at Buffel Grass Management Strategy should be developed for the APY Lands. This would involve mapping the distribution and density of buffel grass. This baseline data could then be used to assess the effects of burning on buffel grass. Specific questions to be addressed in the assessment of the impacts of fire on buffel grass include:

- Under what conditions does fire carry through buffel grass communities? (KEI – increased knowledge about how to conduct prescribed burning in buffel grass communities)

- ➢ Is conducting prescribed burning in tussock grassland vegetation communities encouraging the spread of buffel grass (KEI – follow-up mapping of buffel grass distribution shows colonisation has not increased in recently burnt areas relative to unburnt areas)

- ➢ Is prescribed burning in buffel grass communities successfully protecting fire-sensitive trees and shrubs (KEI – ironwood, whitewood, corkwood and mulga trees still alive after prescribed burning of buffel grass understorey).

As well as monitoring the biodiversity outcomes of the burning program it is important to regularly appraise community level of satisfaction about the fire management program. Follow-up trips to sites where fire management has been conducted are useful to determine the extent of the burns, ensure no sites of cultural significance were affected, try to work out what stopped the fire and look at the response of plants and animals to the burn (i.e. have any bush tucker, bush medicine or bush tobacco species emerged after the fire). This provides an opportunity to discuss the burning program with Anangu to gauge satisfaction with their level of consultation and involvement in the burning work and whether their aspirations are being met. This topic would also be on the agenda of the annual fire planning meetings.

6.7 Resources Required

6.7.1 Personnel

The significance of fire as a threatening process in the APY Lands warrants **employment of a full-time fire management officer** based on the lands, to coordinate fire management activities. The role of this position would be to:

- Compile and maintain an up to date fire history database
- Facilitate annual fire management planning with Traditional Owners and other agencies
- Coordinate burning activities
- Document information about individual burns in the field
- Coordinate post-fire monitoring of fauna and flora responses
- Report back to Traditional Owners on outcomes of fire management
- Coordinate training for Anangu in fire management and monitoring
- Access funding to continue fire management

In addition it is recommended that seasonal Anangu fire rangers are employed between May and July for approximately 6 weeks per year in the Musgrave Ranges FMR and four weeks per year in the Mann Ranges FMR.

6.7.2 Aircraft hire

One day of aerial survey in each FMR would assist in the annual fire planning process. This could be conducted from either a helicopter or fixed wing aircraft. A helicopter is also required for aerial assisted burning, to transport people up into the ranges to conduct (ground) burning around rare plant populations at high altitudes. At least 5 days helicopter hire would be required for the Musgrave Ranges each year, and 2-4 days in the Mann Ranges. If aerial incendiary burning is approved for the ranges, a fixed-wing aircraft with incendiary capabilities would be required for 1-2 days in each FMR.

6.7.3 GIS resources

It is recommended that the full dataset of firescar data (NOAA burnt areas) from 1997-present is obtained from Landgate to compile a digital fire history of the APY Lands. At least one new satellite image should be purchased each year, or downloaded (free) from the United States Geological Survey website.

6.7.4 Operational equipment

Equipment required for fire management includes drip-torches, rakehoes, knapsack spray units, Personal Protective Equipment for all rangers (overalls, boots, caps) and ideally a 600L slip-on fire-fighting unit.

7.0 Actions under this strategy

Objective 1: To protect human life, cultural sites and infrastructure from the adverse impacts of fire

Action 1.1 Protect human life

Ensure any fire management work organised through APY Land Management is conducted with appropriate **Personal Protective Equipment** (PPE), and adequate **training** and supervision from both western and Anangu fire practitioners.

At a minimum, recommended PPE includes covered shoes (preferably boots), long-sleeved cotton shirt, long cotton pants and a cap. Ideally brightly coloured, fireproof overalls should be worn. Other safety equipment that is essential to carry when conducting burning is adequate fluids and a first aid kit.

Accredited fire-fighting training may be available through the Country Fire Service (see Action 5.2).

Action 1.2 Protect cultural sites

Although particular cultural sites requiring fire management are not identified in this document, protection of **sites of cultural significance** is a high priority of this fire management strategy. Management of cultural sites will be left to the discretion of Traditional Owners who may or may not wish to seek the assistance of APY Land Management to protect certain areas.

Protecting cultural sites includes always consulting (and whenever possible involving) senior Traditional Owners prior to any burning to ensure burning is not conducted in inappropriate areas and encouraging and supporting Traditional Owners to visit and maintain cultural sites.

Consultations to date have revealed that Anangu in the northern APY lands are very reluctant to conduct burning in the vicinity of culturally significant sites in case sites become damaged, but are less concerned about the potential for wildfires to impact upon sacred sites. Their strength of conviction that no fires may be lit anywhere near particular cultural sites may significantly limit the amount of prescribed burning that can be achieved under this plan. A field trip to the western desert where senior Traditional Owners could demonstrate protective burning around important sites prior to broadscale patch burning, may help to allay the concerns of Anangu in relation to this matter.

Protection of cultural sites may involve removal of fuel from under significant trees before any burning is conducted in the vicinity (either with a rake-hoe or even a lawnmower) or back-burning away from waterholes or other important areas.

Visiting cultural sites with senior Traditional Owners is obviously a good way of building enthusiasm for a burning trip which may provide opportunities to conduct patch-burning along the way in areas that are not normally accessed. When younger rangers participate in such trips with senior Traditional Owners there are also valuable opportunities for intergenerational knowledge transfer.

Action 1.3 Protect Infrastructure

Many communities and homelands occur in the Ranges Fire Management Regions of the APY Lands and a number of these are infested with Buffel Grass. Thick grass (buffel or spinifex) located too close to buildings poses a fire risk. It is recommended that all outstations are surveyed for fuel hazards around infrastructure, and that hazard reduction burning is implemented where necessary. This will be particularly important if prescribed burning is to be conducted in the vicinity of outstations, to prevent any accidental damage to built assets by the burning program. Unfortunately buffel grass will readily resprout after being burnt, however the fresh growth will be more susceptible to application of herbicide than rank old growth. It is therefore recommended that where buffel grass poses a fire risk to buildings, the plants are firstly burnt and then sprayed.

Objective 2: To maintain or enhance species and habitat diversity in the area and increase populations of rare and threatened species and communities

Action 2.1 Conduct surveys to determine the status of fire sensitive communities

Additional biological survey is required in the APY Ranges to determine locations of significant plant and animal species and communities that require specific fire management. Significant progress was made towards achieving this goal during the plant surveys conducted for the Threatened Flora Survey and Monitoring Project during 2009, with the identification of a number of populations of rare and threatened species. However our knowledge of the distribution of fire-sensitive plant communities is far from complete and more comprehensive mapping is required before broadscale fire management can be implemented. Areas known to support fire-sensitive plant communities require ground survey to collect information on current fuel loads to determine the current threat of wildfire.

Action 2.2 Protect fire-sensitive vegetation communities

Based on current knowledge, the best known stands of fire-sensitive communities in the major ranges are: south of Mt Mann and the Angatja area (in the Mann Ranges) and west of Tupul, east of Jacky's Pass, and Sentinel Hill (in the Musgrave FMR).

Numerous foothills and inselbergs supporting fire sensitive pine, fig and mulga vegetation have been identified as requiring fire management to prevent loss of trees and displacement by spinifex/mallee communities.

Protection of fire-sensitive vegetation communities may involve initially reducing fuel loads (usually tussock grasses) within the fire-sensitive community, and then conducting burning to reduce fuel loads in adjacent areas, particularly if large stands of spinifex are present.

Action 2.3 Protect significant fauna

Within the Mann and Musgrave Ranges regions the priority fauna species vulnerable to the impacts of fire is the Black-footed Rock Wallaby. Two meta-populations are known, one in the Eastern Musgraves and the other in the Tomkinson Ranges. Rock wallabies depend on fire-sensitive plant communities for a diversity of food items including spearbush and figs. All the rock-wallaby sites are located in fire-sensitive vegetation communities on hills which also contain large expanses of spinifex. These areas of spinifex require patch-burning to create a mosaic of vegetation in varying stages of recovery from fire. This will help to prevent wildfires from impacting on rock wallaby habitat and new growth in the regenerating spinifex habitats may also provide additional feeding areas for wallabies. Burning close to rock-wallaby colonies carries some risk however and should only be attempted by experienced fire management practitioners, after thorough consultation with the Warru Recovery Team. Burning should only be conducted under very mild conditions and fires should be lit from the tops of the hills. For some very small isolated rock-wallaby colonies occurring on small granite outcrops, burning spinifex on the hills may be assessed as too risky, and fire management may be confined to strategic burns around the outcrops. However, it must be remembered that this leaves the vegetation on the hill vulnerable to the impacts of lightning strikes, and extreme care must be taken to ensure prescribed burns around the base of hills do not escape and race up the hills.

Other significant fauna species would also benefit from a reduction in the scale and frequency of wildfires at the broad landscape scale. Burning to protect mulga woodland will help to maintain habitat for malleefowl (Vulnerable) and the redthroat (Rare). Burning to protect remnant pockets of bladder saltbush will help to protect habitat for the rufous calomanthus (Rare). Patch-burning in spinifex will help to ensure appropriate habitat is always available for the spinifexbird (Rare), striated grasswren (vulnerable in South Australia) and rufous-crowned emu-wren (Rare).

Action 2.4 Protect remnant patches of old-growth spinifex

Because certain animals rely on mature spinifex habitat, it is important to leave some remnant patches of thick old senescing spinifex unburnt, particularly when the region is dominated by early successional stages of vegetation after the extensive 2002 fires. Remnant patches located directly on roadsides may have to be sacrificed for fire breaks, however when travelling cross-country it would be good if travellers could resist the temptation to always clean up the oldest patches of "rubbish" spinifex. The value of old spinifex (from a western science point of view) needs to be effectively communicated to Aṉangu so that they are able to make informed decisions about what to burn and what to leave unburnt for habitat.

Some of the oldest stands of spinifex sandplain habitat in the region occur east of the Mann Ranges. Old growth blue mallee and spinifex occur close to the eastern edge of the range. Further east there appears to be a large area of old-growth spinifex interspersed with mulga that requires investigating. Where possible large areas of old spinifex should be cut in half with a firebreak, however it is obviously difficult to control fires in heavy fuels. This type of burning would be best achieved in extremely mild conditions, either soon after rain when the spinifex is still wet or late in the day when a frost is expected to increase the chance that the fire will go out of night if it gets away.

Action 2.5 Re-establish the vegetation mosaic with extensive patch-burning

Patch-burning can be conducted in fire-tolerant (spinifex dominated) vegetation communities throughout the region, provided the basic fire regime principles in Table 1 are followed. The more patch-burning that can be conducted in conditions promoting low intensity fires (cool winter weather and relatively low fuel loads), the more opportunities there will be for a range of fauna species to find appropriate habitat. Traditional Owners can dictate where patch-burning expeditions are directed.

The first areas of regenerating spinifex likely to be able to carry fire are those last burnt in 2000. However, anywhere that small burns can be implemented will help to reduce the spread of future patch-burns in adjacent areas when conditions are more flammable. Delaying patch-burning until fires are carrying readily is very risky, and likely to result in larger than desirable fire-scars.

Objective 3: To minimise the potential for spread of uncontrolled wildfires

Action 3.1 Burn strategic breaks along major travel routes

The main road across the northern APY Lands that links Ernabella with Amata and Pipalyatjara is the main priority for a long-term firebreak that will protect both the Mann and Musgrave Ranges from fires coming up from the south. Trying to maintain low fuels along major travel routes will also reduce the chance of roadside ignitions (lit to warn other vehicles of the passage of a business trip for example) causing major fires. Although fuel loads may still be too low along most of this road, test-burns should be conducted each year to ensure that burning does commence at the first available opportunity, rather than waiting until conditions are too flammable and difficult to control. If the fires are carrying, it is important to initially protect hill vegetation or other fire sensitive communities (mulga or saltbush) in the area first, and then conduct as much roadside burning as possible. The first areas that should be ready to burn along this road are west of Amata (tussock grassland) and further west (south of the Mann Ranges) in patches of older spinifex. If this burning can be initiated in 2009, the fire breaks can be added to in subsequent years to make relatively long, continuous areas of low fuels.

The long-term linear breaks will become less important to maintain when a good vegetation mosaic has been established throughout the region.

Action 3.2 Use aerial prescribed burning to break up spinifex in remote areas

Even if there were continuous firebreaks around the entire circumference of the major ranges, the hills would still be in danger of being burnt out from fires ignited by lightning strikes on the hills themselves. The best way to prevent an entire range system from being burnt out in a single fire is to break up large areas of spinifex on the hills with patch-burning. The easiest way to achieve broadscale patch-burning through the inaccessible and rugged Mann and Musgrave Ranges is to drop incendiaries from an aeroplane (or helicopter). Aerial burning should not commence until the area has firstly been surveyed (from a helicopter) for fire-sensitive plant communities, and any sites of biological or cultural significance protected with ground-burning. The timing of aerial burning is very important for it to be a good use of money – if spinifex cover is too low the size of the burnt patches will be too small to stop any wildfires, but if cover is too high in homogenous spinifex habitat fires will too large.

Action 3.3 Conduct collaborative fire management with neighbours

With the Mann Ranges straddling the SA/NT border, effective fire management of this Fire Management Region will require cooperation and collaboration with the neighbours in the Northern Territory. The Central Land Council has already produced a Fire Management Strategy for the Petermann Land Trust that aims to halt the spread of fires through the south western corner of the Northern Territory. If successfully implemented, this should reduce the likelihood of large fires approaching the Mann Ranges from the north. Similarly, prescribed burning conducted in the Mann Ranges FMR (in SA) will help to protect important areas within the proposed Petermann/Katiti IPA in the Northern Territory.

There are many benefits to conducting collaborative fire management planning with neighbouring communities and land management agencies. If burning along major travel routes to form strategic long-term breaks could be coordinated with other groups outside the region, the longer fire-breaks created would provide a more effective barrier to wildfires. Ranger groups and senior Traditional Owners could each burn along their own roads in opposite directions until they meet up with each other and then conduct a particular fire management activity together, perhaps around a site of cultural significance. Information shared between the different groups may provide new ideas for fire management, or even help to raise awareness between communities about the far-reaching implications of roadside ignitions during summer and how it might effect land management programs being conducted by neighbouring ranger groups. The scattered distribution of Traditional Owners across the various communities is another logical reason to collaborate with neighbouring communities. There are also likely to be efficiencies in sharing expertise and resources (e.g. satellite imagery, access to training and even the use of aircraft for incendiary burning) in cross-border collaborations.

It is proposed that a cross-border meeting and survey is conducted in the western Mann Ranges in 2009 involving the Central Land Council, APY Land Management, DEH consultant botanists and Traditional Owners currently living on either side of the state border. A Central Land Council fauna and flora survey of the northern Mann Ranges has been timed to coincide with the DEH threatened plant survey of the southern Mann Ranges to enable such a meeting to occur.

Objective 4: To integrate Traditional Knowledge about fire management with scientific principles and modern technology to develop best practice management for the region

Action 4.1 Engage senior Traditional Owners to direct fire management activities

Traditional Aboriginal knowledge about burning has much to contribute to fire management in central Australia. Much of the patch-burning recommended in this strategy can be conducted anywhere and should be left to the direction of Traditional Owners. However, where possible, the guiding principles detailed in this strategy should be integrated with traditional management practises to develop best practice fire management for the region.

Action 4.2 Broaden perspectives with modern technology

Aerial reconnaissance, satellite photography and firescar maps can be used to broaden the perspective of Anangu regarding the extent of large wildfires and the distribution of fuel loads in relation to significant areas. Recent satellite imagery and current firescar maps should always be available during fire management planning and implementation, with an explanation of how to interpret them.

A GPS should also always be taken into the field during burning trips conducted under the Land Management program to record the locations of all ignitions. These waypoints can be compared with the hotspot data downloaded from the Landgate website to determine how far fires in particular fuel loads were spreading.

Objective 5: To assist in the intergenerational transfer of knowledge about fire management, and develop the capacity of APY Land Management to manage fire in the region

Action 5.1 Encourage and support the transfer of knowledge between senior Traditional Owners and younger rangers

Senior Traditional Owners experienced in fire management should be taken out on burning trips with younger rangers as much as possible to provide advice to the rangers on where and how burning should be conducted. The rangers should be encouraged to document this knowledge in some way for future generations, perhaps with a digital camcorder. In turn, the rangers should be able to explain western fire management perspectives to the older people regarding the protection of old-growth stands of various vegetation types that have no value to Anangu.

Action 5.2 Train younger Anangu in all aspects of fire management planning and implementation

The ultimate aim of land management programs conducted by APY land management is for Traditional Owners to eventually manage their own programs using best practice techniques that integrate Traditional and contemporary knowledge about land management.

Fire management training provided by senior Anangu knowledgeable about fire, experienced park rangers, and Conservation Land Management Course providers will all help to develop the capacity of the ranger group to manage fire in their region. There are two relevant units in the TafeSA Conservation and Land Management Certificate II course: Reduce Wildfire Hazards and Respond to Wildfire. Formal training may also be available through the SA Country Fire Service's (CFS) Rural Fire-fighting Training Project. Basic Fire-Fighting 1 is the introductory course delivered by the CFS. It consists of 13 units including topics covering use and maintenance of fire-fighting equipment, injury prevention, communications and OH&S procedures.

8.0 Burning Proposals

8.1 Mann Ranges Region

Values: Frequent fires since the 1950s (and possibly earlier) has reduced most of the Mann Ranges to relatively uniform, spinifex dominated communities. No plant or animal species of conservation significance have been recorded within the South Australian portion of the Mann Ranges, but there has been little survey work conducted in the region. The DEH Biological Survey of the APY Land included only a couple of sites on the lower slopes of the foothills of the ranges. A number of rare plants have been found within 1km of the SA border on the NT side of the western Mann Ranges however, in the vicinity of Mt Mann. Populations of *Melaleuca fulgens, Acacia tenuior* and *Lepidosperma avium* are considered likely to extend into South Australia, but this area is currently inaccessible due to cultural reasons. Traditional Owners have indicated that the restricted access is temporary, and may be lifted after the next significant rain event in the area. When the area south of Mt Mann does become accessible, this will be a high priority for botanical surveys.

Aerial survey of the Mann Ranges revealed that the eastern end of the range appeared least affected by fire, containing the largest areas of remnant, fire-sensitive vegetation. The Angatja area is therefore currently the main priority for fire management in the Mann Ranges.

In addition to the high value remnant vegetation communities in the hills, old growth mallee occurs on the eastern side of the range below the hills. Further to the east is a large area of old growth spinifex interspersed with pockets of mulga. Extensive spinifex plains occur south of the Mann Ranges, and the rare desert grass-trees are scattered through this area. A good stand of bloodwood trees (important for their hollows) occurs in the Angatja valley.

A number of settlements occur around the base of the Mann Ranges including Angatja (which supports a tourism enterprise), Umpukulu, Ngaltajara and the larger communities of Nyapari and Kanypi. Tankaanu homeland is located south of the Mann Ranges, near the Deering Hills.

Fuels: Most of the spinifex dominated Mann Ranges was last burnt in 2000 and should just about be ready to carry fire again. The area north of Kanypi and Nyapari was last burnt in

2002, but the eastern edge of the range (which has a tussock grass understorey) appears long unburnt. There are patches of highly flammable old-growth spinifex (*T. basedowii*) east and south of the eastern end of the Mann Ranges.

Fire Management Priorities for the Angatja area:

1. Protect the old-growth fire-sensitive plant communities on the north-eastern corner of the Mann Ranges by burning a break through the adjacent spinifex dominated vegetation. This will require helicopter assistance and should be conducted under very mild conditions.

2. Assess communities and homelands for fuel hazards around infrastructure. Where buffel grass, spinifex or other native grasses pose a fire risk to infrastructure reduce fuel loads either mechanically or by burning, prior to any other prescribed burning in the region.

3. Protect fire-sensitive vegetation in the hills with cool season burning of the tussock grass understorey on a selection of hills. Always try burning from the top of the hills downhill first. Aim for trickly fires that do not scorch the trees.

4. Once the hills have been protected (or burning attempts have revealed that the hill habitat is not yet capable of carrying fire), burn the buffel grass in the vicinity of Angatja homeland to help protect the infrastructure, mature bloodwood trees and hill vegetation from uncontrolled summer wildfires.

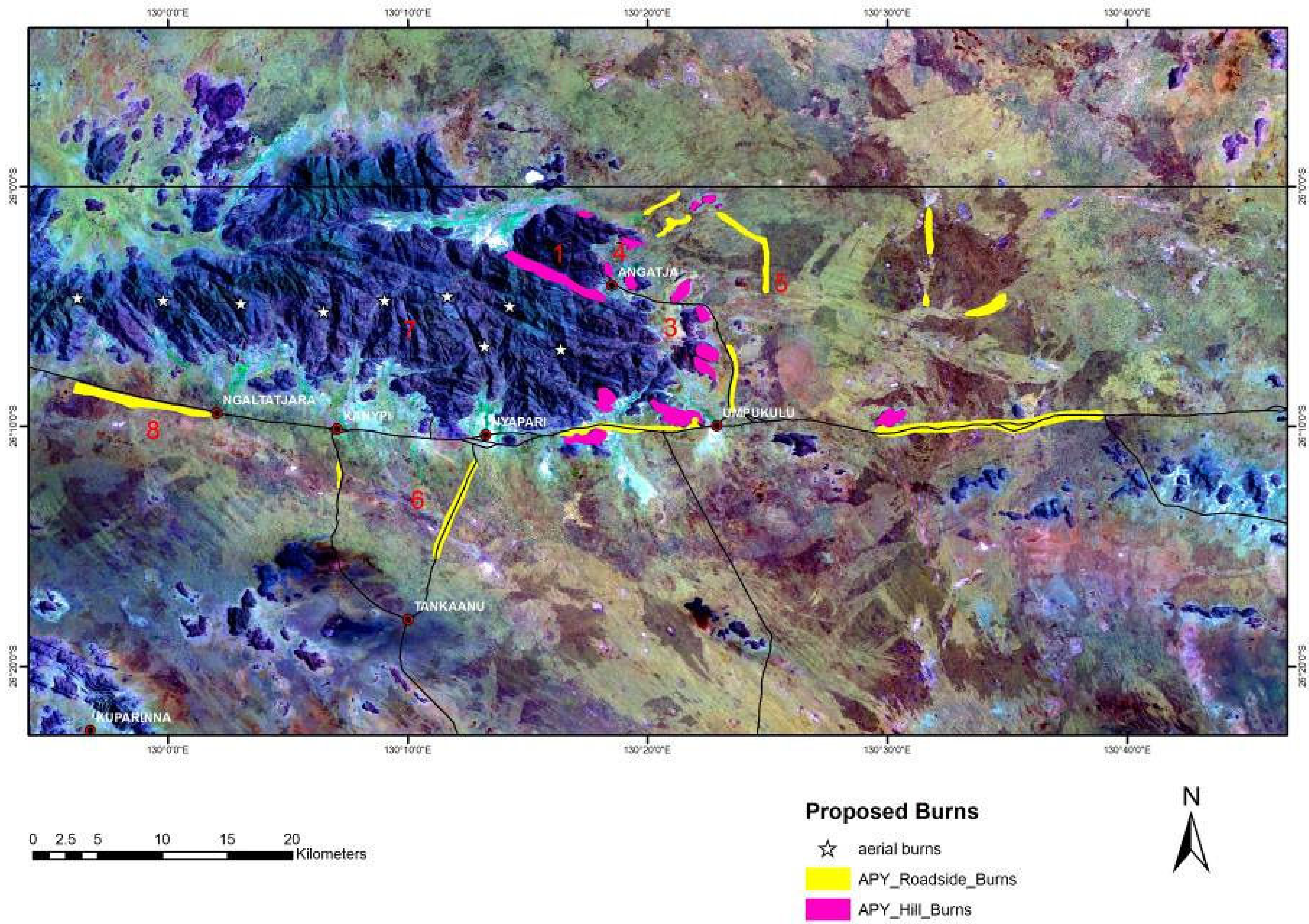
5. When the infrastructure and hill vegetation have been protected, it will be safe to start patch-burning the spinifex on the plains to increase the patchiness of the vegetation mosaic. Aim to leave the oldest patches of mallee unburnt, but break up large areas of even aged spinifex. Conduct burning close to the range first and then move further east to the large patch of mulga/spinifex and break this up with patch-burning.

6. Conduct patch-burning along the road to Tankaanu as soon as it's ready to carry fire. This will help to protect the grass-tree population, and increase the diversity of habitats for flora and fauna to colonise. It should also help to prevent large wildfires approaching the Mann Ranges from the south. Fuel loads are currently highest on the western arm of this loop road, and would be the most appropriate place to commence a patch burning program, however the presence of sacred sites in this area may preclude any fire management work. The potential consequences of not burning around sacred sites requires further discussion with Anangu.

7. After further biological survey work is conducted to determine locations of significant plants and animals on the Mann Ranges, consider conducting aerial incendiary burning along the main range. This could involve initially using the helicopter to access sites of cultural or biological significance to protect with ground burning, and then dropping incendiaries elsewhere to help break up spinifex fuel loads. Aim to burn 10% of the spinifex each year (in small patches).

8. Continue patch-burning in the spinifex communities along the main road to break up fuel loads and provide a diversity of habitats for flora and fauna.

Figure 14. Mann Ranges Burning Proposals for 2009-10



8.2 Tomkinson Ranges and Western Mann Ranges

Values: Most of the hills in the Tomkinson cluster of ranges are dominated by spinifex and appear to have relatively uniform vegetation, with few plant species present. However some richer patches of long unburnt vegetation occur on the hill positioned between Kalka and Pipalyatjara communities. Located within deep gullies are diverse stands of fire-sensitive vegetation comprising plumbush, spearbush, pittosporum, jasmine, figs and pines and the newly described *Teucrium reidii* occurs in fire-shadow areas at the base of rock-slabs. Black-footed rock wallabies also occur at this site. A rock-wallaby colony was also recorded on the hill to the south-east of Pipalyatjara, during surveys in 2009.

Similarly, most of the Mann Ranges are spinifex dominated, and appear to have low plant diversity, but significant plant communities occur at either end of the main part of the range in South Australia. The area around Mount Mann, on the NT border supports many rare plant species including *Melaleuca fulgens, Acacia tenuior, Lepidosperma avium* and an undescribed species of lily.

North of the Tomkinson Ranges remnant patches of mulga occur, but a considerable amount of mulga woodland was burnt in recent fires. Regenerating mulga is threatened by high fuel loads of buffel grass and spinifex.

Fuels: Spinifex throughout this area was mostly all burnt in 2002, and has not yet regained sufficient cover to carry fire. Patches of older (senescing) spinifex (*Triodia helmsii*) were observed along the road north of Kalka, adjacent to mulga. Tussock grassland along this road comprised dense buffel grass and kangaroo grass close to the road, and sparser Aristidas further from the road. These fuels should burn with a wind behind them.

Fire Management Priorities for the Tomkinson / Western Mann Ranges area

1. If permission can be obtained from Traditional Owners, conduct survey of the hill south-east of Pipalyatjara to determine whether any fire threatened plants occur there. (However, even if permission is obtained to survey the area, it is unlikely that burning would be allowed on the hill).

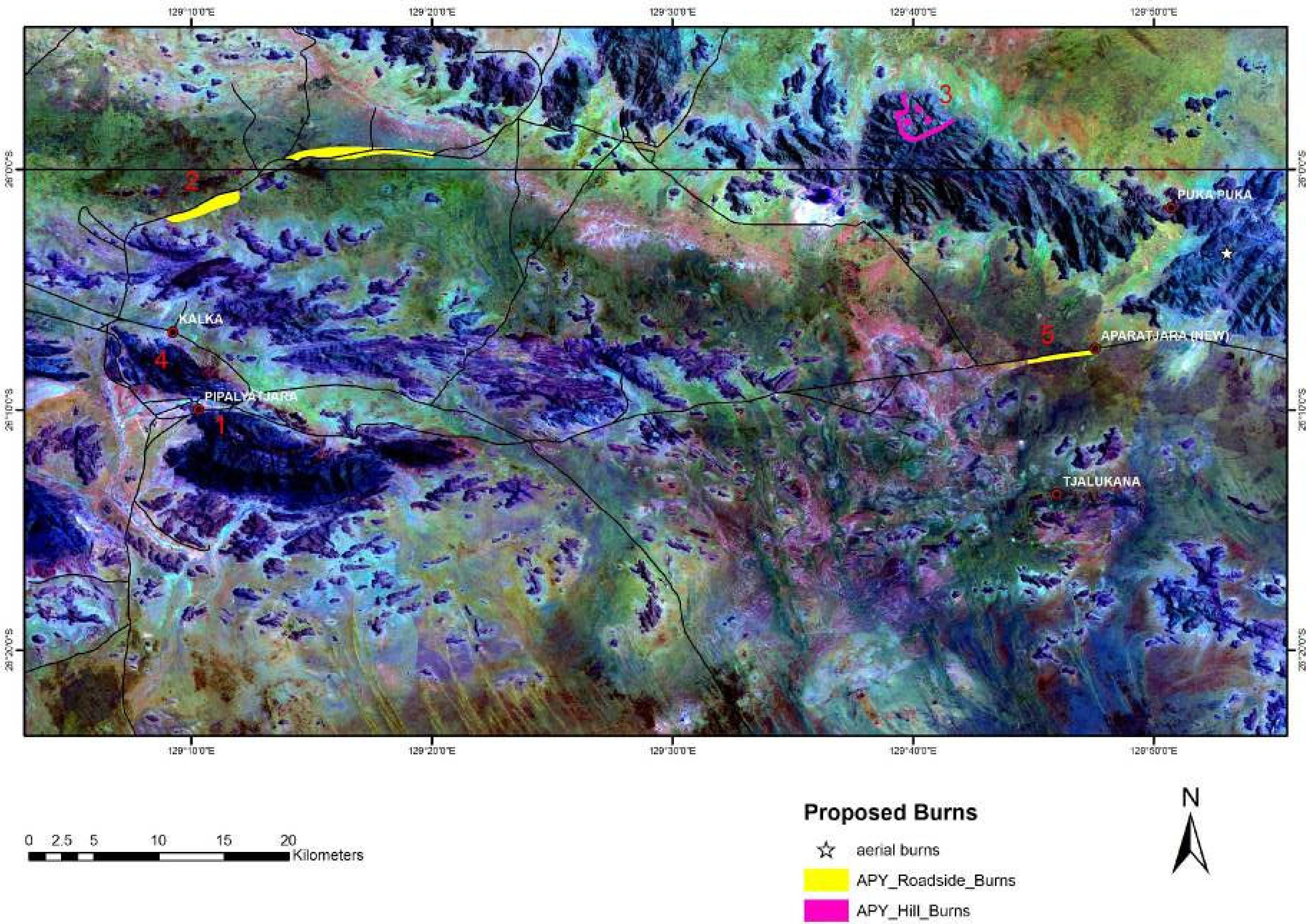
2. Protect regenerating mulga by managing fuel loads along road north of Kalka. This will involve patch-burning old spinifex, buffel grass and native tussock grasslands. Some of these fuels should be ready to burn this winter.

3. Protect rare plant community at Mt Mann. In conjunction with the Central Land Council burn the spinifex north of Mt Mann, to protect important rare plants that occur on the state border, south of Mt Mann. Survey the vegetation south of the border, when cultural restrictions are lifted.

4. Protect rock wallaby habitat. When spinifex has regained sufficient cover on the hill between Kalka and Pipalyatjara (possibly in the winter of 2011) conduct patch-burning in the spinifex (burning down from the upper slopes) to re-establish a mosaic of vegetation in different stages of recovery from fire. This will help to protect the fire-sensitive plant communities in the valleys, and may provide additional food resources for rock wallabies. NB this should be discussed with the Warru Recovery Team before implementation.

5. Continue patch-burning in the hard spinifex/desert oak community along the main road west of Kanypi to join up with a recent (2008) firescar along the road (near turnoff to Lake Wilson).

Figure 15. Burning proposals for the Tomkinson and Western Mann Ranges 2009-10



8.3 Western Musgrave Ranges – Amata region

Values: Important rare plant communities (containing fire-sensitive plants such as *Melaleuca fulgens*) occur in fire-shadow areas in the ranges north-west of Amata and east of Jacky's Pass. Many of the foothills on the southern side of the range are largely spinifex-free and are still well vegetated with fire sensitive plant communities including pines and figs. Productive grazing country (for cattle production enterprises) occurs north and south of the range in Tussock Grassland habitat. Remnant patches of mulga, ironwood, witchetty bush and elegant wattle are scattered through the open grassland habitat, and pockets of bladder saltbush can be found in drainage areas. The best stand of quandongs in the study area occurs near the NT border south of the Mulga Park road.

Fuels: The amount of rolypoly in the tussock grassland habitat diminishes as you travel west along the main road, and in March 2009 the understorey was dominated by grasses – wiregrasses, oatgrass and button grass with a considerable amount of buffel grass close to the edge of the road.

Fire Management Priorities for the Amata area:

1. Map areas of fire-sensitive vegetation in the ranges and conduct strategic fine-scale burns under mild conditions to reduce fuel-loads in spinifex communities adjacent to stands of rare plants. Stands of *Melaleuca fulgens* east of Jackys Pass and west of Tupul are priority sites to attempt prescribed burning.

2. Assess communities and homelands for fuel hazards around infrastructure. Clear flammable material from areas around buildings, yards and other vulnerable infrastructure prior to any other prescribed burning in the region.

3. Protect fire-sensitive vegetation in the foothills with cool season burning of the tussock grass understorey on a selection of hills. Always try burning from the top of the hills downhill first. Aim for trickly fires that do not scorch the trees. If the fires are not carrying from the top of the hills, retry from half way down.

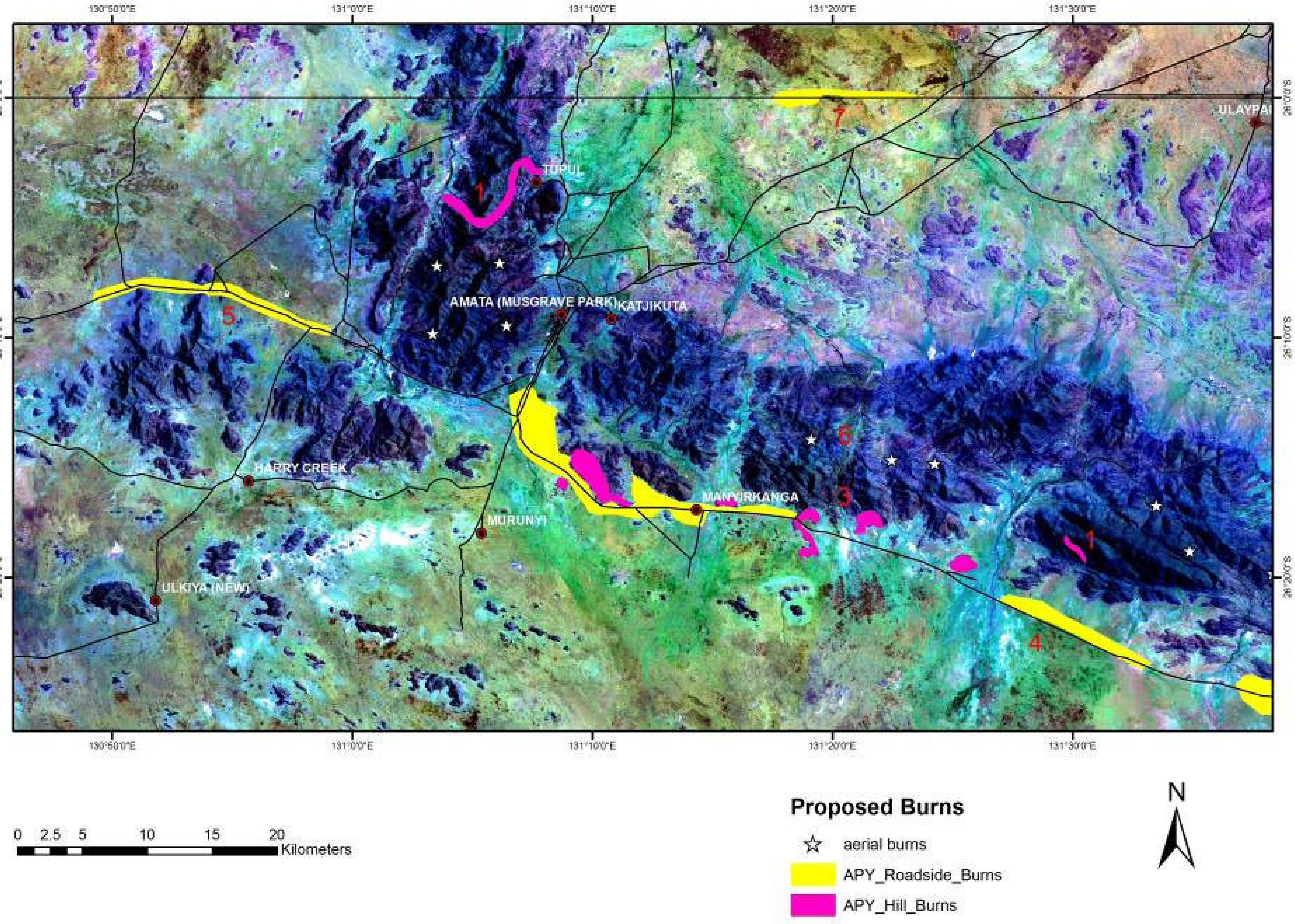
4. When the hills are safe, commence burning in the hill frontage country between the road and the hills (east of Amata). Concentrate on reducing fuel loads in areas with (or adjacent to) mulga, ironwood and witchetty bush, and adjacent to patches of saltbush.

5. West of Amata, there is virtually no rolypoly in the tussock grassland habitat, and the grasses should be ready to carry fire this year. Commence patch-burning along the road, concentrating on reducing fuel loads in areas with (or adjacent to) mulga, ironwood and witchetty bush, and adjacent to patches of saltbush.

6. After further biological survey work is conducted to determine locations of significant plants and animals in the western Musgrave Ranges, consider conducting aerial incendiary burning along the main range. This could involve initially using the helicopter to access sites of cultural or biological significance to protect with ground burning, and then dropping incendiaries elsewhere to help break up spinifex fuel loads. Aim to burn 10% of the spinifex each year (in small patches).

7. Patch burn spinifex along the border, to protect remnant mulga communities.

Figure 16. Western Musgraves Burning Proposals 2009-10



8.4 Eastern Musgrave Ranges (Ernabella region).

Values: The eastern Musgrave Ranges and their outliers are largely spinifex dominated. The best area of remnant fire-sensitive vegetation appears to be about 15km northwest of Umuwa. Important rare plants occur near the summit of Mt Woodroffe (South Australia's highest peak).

The granitic inselbergs of the Sentinel Hill area provide refuge for a number of fire-sensitive species including the *Acacia olgana* community and the rare mintbush (*Prostanthera nudula*) and Central Australia rapier sedge (Lepidosperma avium). Black-footed rock wallabies inhabited this area until recently. Rock wallabies still occur in the hills around New Well.

The best hill frontage country occurs in the Araleun area, in the floodout area of the major creeks draining Mt Woodroffe. Good stands of Ironwood and corkwood can be found here, but this habitat is vulnerable to buffel grass invasion. The extensive tussock grasslands surrounding the eastern Musgrave Ranges provide productive grazing country for cattle production enterprises.

Several mulga covered hills occur south of Eagle Bore. Remnant patches of mulga woodland occur north and south of the eastern end of the Musgrave Ranges.

Fuels: According to the Landgate fire scar data, large areas of the eastern Musgrave Ranges escaped the widespread fires of the early 2000s. Spinifex fuel loads in this area are likely to currently be very high. Most of the surrounding flat country was burnt in 2002 however the majority of the hill frontage country surrounding the eastern end of the Musgraves is currently dominated by rolypoly, and not particularly flammable. This will change when the next significant summer rainfall occurs after the rolypoly has blown away. Areas with buffel grass already have high fuel loads however.

Fire Management Priorities for the Eastern Musgraves area:

1. Protection of life and infrastructure – Assess communities and homelands for fuel hazards around infrastructure. Clear flammable material from areas around buildings, yards and other vulnerable infrastructure prior to any other prescribed burning in the region.

2. Protect rock wallaby habitat from wildfire – Patch-burn spinifex habitats on hills adjacent to known wallaby sites, always burning downhill from the tops of hills to create a controlled fire. Individual burns on hills occupied by wallabies should be limited to 1 ha in size. Cool season burning is required to reduce fuel loads in highly flammable stands of *Triodia irritans* that occur in close proximity to the fire-sensitive *Acacia olgana*, particularly at the New Well site. Burning is not recommended on the lower slopes of the rock wallaby site at New Well, as it is possible that the dense, virtually impenetrable *Triodia irritans* is helping to keep euros and cats out of the main rock wallaby site. Patch-burning should be conducted around Mt Olga wattle stands on the eastern and western outer slopes of the New Well hill however, to reduce spinifex fuel loads. Recommended patch size is in the order of 1ha. The western side of the hill has particularly good patches of Mt Olga wattle, figs and spearbush, with highly flammable *Triodia irritans* below. For some very small isolated rock-wallaby colonies occurring on small granite outcrops, burning spinifex on the hills may be assessed as too risky, and fire management may be confined to strategic burns around the outcrops. However, it must be remembered that this leaves the vegetation on the hill vulnerable to the impacts of lightning strikes, and extreme care must be taken to ensure prescribed burns around the base of hills do not escape and race up the hills. It is important to establish fire breaks between local populations of rock wallabies to minimise the amount of occupied habitat lost in a single fire.

3. With helicopter assistance, burn fire-breaks through the spinifex to protect fire-sensitive vegetation between Mt Woodroffe and Ernabella. Black-footed rock wallabies occur in this area, and the burns would need to be carefully negotiated with the Warru Recovery Team. The burns marked are only approximate, and require ground-truthing.

4. Protect mulga on hills south of Eagle Bore. These hills are unusual in the region for their dominance of mulga and witchetty bush. Large ironwoods occur on the flats below but both the Ironwood and mulga communities are threatened by high fuel loads in thick stands of buffel grass on the flats. It is therefore necessary to firstly attempt cool season burning on the mulga hills (burning downhill from the hilltops if possible) and then burning to reduce fuel loads in the buffel grass.

5. Reduce fuel loads around stands of *Prostanthera nudula* and *Lepidosperma avium* in the Sentinel Hill region by patch-burning spinifex on the hills (again burning downhill initially to see how well it carries) and then the tussock grasses on surrounding flat country.

6. Protect Women's cultural site north-east of Itjinpiri. The women's site is situated in a stand of old ironwoods which are not currently threatened by fire due to the predominance of rolypoly in the surrounding vegetation. In future years if the grassy understorey thickens burning may be required in the valley to protect the ironwoods. Good remnant vegetation comprising Mt Olga Wattle, fig trees and spearbush occurs on the hill to the east of the women's site, but has a spinifex understorey. This area would be worth searching for sign of rock-wallabies, and if none are found, burning the spinifex (from top of the hill down) to protect fire sensitive trees and shrubs.

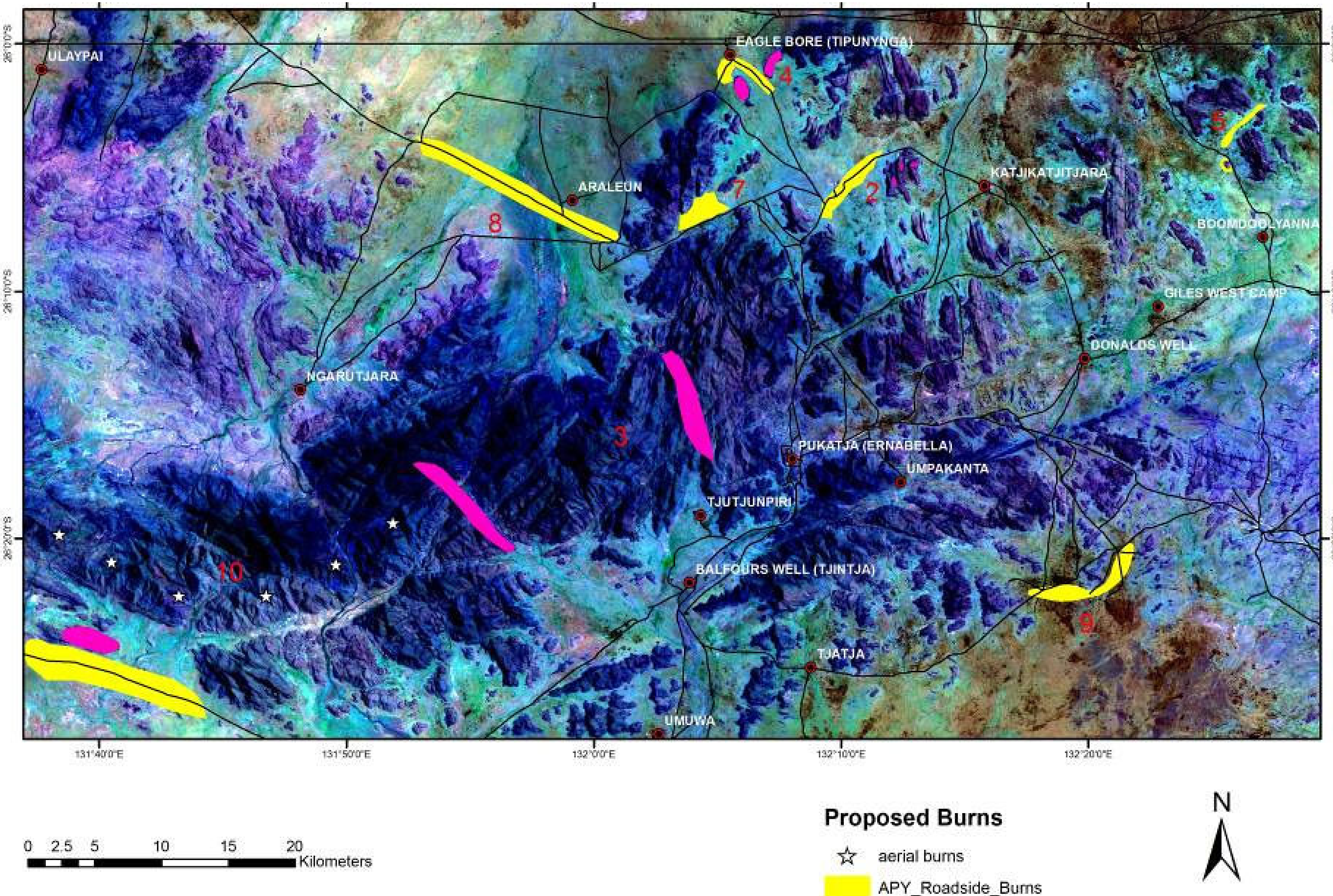
7. Protect remnant patches of mulga and witchetty east of Araleun. The gap in the range south-east of Araleun is ready to burn this winter. Ideally the hills on either side of the valley should be burnt first, although there is little fire-sensitive vegetation left to protect on these hills. The aim is to burn across the narrowest section of the gap, and then along the roadsides to the northeast, to protect a mulga and witchetty bush stand south of the road.

8. Protect best known hill frontage woodland in the study area. The area south of Araleun has some of the most intact Ironwood/corkwood woodland left in the vicinity of the Musgrave Ranges. It is not currently under threat from wildfire due to the dominance of rolypoly in the understorey, but in situations where two successive years of good summer rainfall occur, it will be important to reduce fuel loads in this habitat.

9. Protect remnant patches of mulga east of Umuwa by burning grassy understorey under mild conditions when fuel loads build up, and patch-burning spinifex nearby. Similar fire management is also required along the NT/SA boundary between Alpara and Rocket Bore. Closer to Alpara the understorey alternates between tussock grasses and *Triodia pungens*, with increasing dominance of *T. irritans* as you get closer to Rocket Bore

10. Consider conducting Aerial Incendiary burning to break up even aged stands of spinifex in inaccessible parts of the range.

Figure 17. Eastern Musgraves Burning Proposals 2009-2010



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10.0 Appendices

Appendix A. Mann Ranges fauna species list

Birds

Acanthagenys rufogularis	Spiny-cheeked Honeyeater
Acanthiza apicalis	Inland Thornbill
Acanthiza chrysorrhoa	Yellow-rumped Thornbill
Acanthiza uropygialis	Chestnut-rumped Thornbill
Accipiter cirrhocephalus	Collared Sparrowhawk
Aegotheles cristatus	Australian Owlet-nightjar
Amytornis purnelli	Dusky Grasswren
Amytornis striatus	Striated Grasswren
Anthus novaeseelandiae	Richard`s Pipit
Aphelocephala leucopsis	Southern Whiteface
Aphelocephala nigricincta	Banded Whiteface
Aquila audax	Wedge-tailed Eagle
Artamus cinereus	Black-faced Woodswallow
Artamus personatus	Masked Woodswallow
Barnardius zonarius	Australian Ringneck, (Ring-necked Parrot)
Cacatua leadbeateri	Major Mitchell`s Cockatoo
Cacatua roseicapilla	Galah
Calamanthus pyrrhopygius	Chestnut-rumped Heathwren
Certhionyx variegatus	Pied Honeyeater
Cheramoeca leucosternus	White-backed Swallow
Chlamydera sp.	Bowerbird sp.
Chrysococcyx basalis	Horsfield`s Bronze-cuckoo
Cincloramphus cruralis	Brown Songlark
Cincloramphus mathewsi	Rufous Songlark
Colluricincla harmonica	Grey Shrike-thrush
Coracina maxima	Ground Cuckoo-shrike
Coracina novaehollandiae	Black-faced Cuckoo-shrike
Corvus bennetti	Little Crow
Corvus orru	Torresian Crow
Cracticus nigrogularis	Pied Butcherbird
Cracticus torquatus	Grey Butcherbird
Cuculus pallidus	Pallid Cuckoo
Daphoenositta chrysoptera	Varied Sittella
Dicaeum hirundinaceum	Mistletoebird
Emblema pictum	Painted Finch
Epthianura tricolor	Crimson Chat
Falco berigora	Brown Falcon
Falco cenchroides	Nankeen Kestrel
Falco peregrinus	Peregrine Falcon
Geophaps plumifera	Spinifex pigeon
Gerygone fusca	Western Gerygone
Gymnorhina tibicen	Australian Magpie
Haliastur sphenurus	Whistling Kite
Hamirostra melanosternon	Black-breasted Buzzard
Hieraaetus morphnoides	Little Eagle
Hoplopterus tricolor	banded lapwing
Lalage tricolor	White-winged Triller
Lichenostomus penicillatus	White-plumed Honeyeater

Lichenostomus plumulus	Grey-fronted Honeyeater)
Lichenostomus virescens	Singing Honeyeater
Malurus lamberti	Variegated Fairy-wren
Malurus leucopterus	White-winged Fairy-wren
Manorina flavigula	Yellow-throated Miner
Melanodryas cucullata	Hooded Robin
Melopsittacus undulatus	Budgerigar
Merops ornatus	Rainbow Bee-eater
Microeca fascinans	Jacky Winter
Neopsephotus bourkii	Bourke`s Parrot
Ninox novaeseelandiae	Southern Boobook
Ocyphaps lophotes	Crested Pigeon
Oreoica gutturalis	Crested Bellbird
Pachycephala rufiventris	Rufous Whistler
Pardalotus rubricatus	Red-browed Pardalote
Petroica goodenovii	Red-capped Robin
Phaps chalcoptera	Common Bronzewing
Phylidonyris albifrons	White-fronted Honeyeater
Podargus strigoides	Tawny Frogmouth
Pomatostomus superciliosus	White-browed Babbler
Porzana fluminea	Australian Crake
Psephotus varius	Mulga Parrot
Psophodes occidentalis	Chiming Wedgebill
Rhipidura leucophrys	Willie Wagtail
Smicrornis brevirostris	Weebill
Taeniopygia guttata	Zebra Finch
Todiramphus pyrrhopygia	Red-backed Kingfisher
Turnix velox	Little Button-quail
Tyto alba	Barn Owl

Mammals

Tachyglossus aculeatus	Short-beaked Echidna
Ningaui ridei	Wongai ningaui
Pseudantechinus macdonnellensis	Fat-tailed Pseudantechinus
Sminthopsis ooldea	Ooldea Dunnart
Notoryctes typhlops	Marsupial Mole
macropus robustus	Common Wallaroo
Macropus rufus	Red Kangaroo
Petrogale lateralis	Black-footed Rock-wallaby
Nyctophilus geoffroyi	Lesser Long-eared Bat
Vespadelus finlaysoni	Finlayson`s Cave Bat
Leggadina forresti	Forrest`s Mouse
Mus musculus	House Mouse
Notomys alexis	Spinifex Hopping-mouse
Pseudomys desertor	Desert Mouse
Pseudomys hermannsburgensis	Sandy Inland Mouse
Canis lupus dingo	Dingo
Felis catus	Cat
Vulpes vulpes	Fox
Oryctolagus cuniculus	Rabbit
Camelus dromedarius	One-humped Camel
Equus caballus	Horse

Reptiles/Amphibians

Frogs	
Neobatrachus centralis	Trilling Frog
Neobatrachus sutor	Shoemaker Frog
Agamids	
Amphibolurus longirostris	Long-nosed Dragon
Ctenophorus isolepis	Military Dragon
Ctenophorus nuchalis	Central Netted Dragon
Ctenophorus rufescens	Rusty Dragon
Moloch horridus	Thorny Devil
Pogona minor	Dwarf Bearded Dragon
Tympanocryptis centralis	Centralian Earless Dragon
Tympanocryptis lineata	Five-lined Earless Dragon
Geckonids	
Diplodactylus conspicillatus	Fat-tailed Gecko
Diplodactylus stenodactylus	Sandplain Gecko
Gehyra montium	Central Rock Dtella
Gehyra purpurascens	Purple Dtella
Gehyra variegata	Tree Dtella
Heteronotia binoei	Bynoe`s Gecko
Nephrurus levis	Smooth Knob-tailed Gecko
Rhynchoedura ornata	Beaked Gecko
Strophurus ciliaris	Northern Spiny-tailed Gecko
Varanids	
Varanus eremius	Desert Pygmy Goanna
Varanus giganteus	Perentie
Varanus gouldii	Sand Goanna
Scincids	
Carlia triacantha	Desert Rainbow Skink
Ctenotus brooksi	Sandhill Ctenotus
Ctenotus calurus	Blue-tailed Skink
Ctenotus dux	Narrow-lined Ctenotus
Ctenotus leonhardii	Common Desert Ctenotus
Ctenotus pantherinus	Leopard Skink
Ctenotus quattuordecimlineatus	Many-lined Ctenotus
Ctenotus saxatilis	Centralian Striped Skink
Ctenotus schomburgkii	Sandplain Ctenotus
Cyclodomorphus melanops	Spinifex Slender Bluetongue
Egernia inornata	Desert Skink
Egernia striata	Night Skink
Eremiascincus fasciolatus	Narrow-banded Sandswimmer
Lerista bipes	Western Two-toed Slider
Lerista desertorum	Great Desert Slider
Lerista labialis	Eastern Two-toed Slider
Menetia greyii	Dwarf Skink
Morethia boulengeri	Common Snake-eye
Morethia butleri	Butler`s Snake-eye
Morethia ruficauda	Fire-tailed Skink
Tiliqua multifasciata	Centralian Bluetongue
Tiliqua occipitalis	Western Bluetongue
Tiliqua scincoides	Eastern Bluetongue
Pygopods	
Pygopus nigriceps	Black-headed Scaly-foot

Delma butleri	Spinifex Snake-lizard
Elapids	
Demansia reticulata	Desert Whipsnake
Pseudechis australis	Mulga Snake
Pseudonaja modesta	Five-ringed Snake
Simoselaps sp.	
Pythonids	
Antaresia stimsoni	Stimson`s Python
Aspidites ramsayi	Woma

Appendix B. Mann Ranges flora species list. (*denotes introduced species)

Species	Common Name
Abutilon cryptopetalum	Hill Lantern-bush
Abutilon fraseri ssp. fraseri	Dwarf Lantern-bush
Abutilon leucopetalum	Desert Lantern-bush
Abutilon macrum	Slender Lantern-bush
Abutilon malvaefolium	Scrambling Lantern-bush
Abutilon otocarpum	Desert Lantern-bush
Acacia aneura	Mulga
Acacia basedowii	Basedow`s Wattle
Acacia calcicola	Northern Myall
Acacia cibaria (NC)	Turpentine Mulga
Acacia coriacea ssp. sericophylla	Wirewood
Acacia dictyophleba (NC)	Net-veined Wattle
Acacia estrophiolata	Ironwood
Acacia kempeana	Witchetty Bush
Acacia ligulata	Umbrella Bush
Acacia maitlandii	Maitland`s Wattle
Acacia minyura	Desert Mulga
Acacia murrayana	Colony Wattle
Acacia nyssophylla	Spine Bush
Acacia pachyacra	Shiny-pod Wattle
Acacia paraneura (NC)	Weeping Mulga
Acacia pruinocarpa	Black Gidgee
Acacia ramulosa (NC)	Horse Mulga
Acacia rigens	Nealie
Acacia strongylophylla	Round-leaf Wattle
Acacia tenuissima	Slender Wattle
Acacia tetragonophylla	Dead Finish
Acacia validinervia	Veined Wattle
Acacia victoriae ssp.	Elegant Wattle
Acacia victoriae ssp. arida	Downy Elegant Wattle
Acacia victoriae ssp. victoriae	Elegant Wattle
*Acetosa vesicaria	Rosy Dock
Actinobole uliginosum	Flannel Cudweed
Adriana tomentosa var. hookeri	Mallee Bitter-bush
Allocasuarina decaisneana	Desert Oak
Alternanthera nana	Hairy Joyweed
Alyogyne pinoniana var. pinoniana	Sand Hibiscus
Amaranthus interruptus	Native Amaranth
Amaranthus mitchellii (NC)	Boggabri Weed
Amphipogon caricinus var. caricinus	Long Grey-beard Grass
Amyema gibberula var. gibberula	Twin-flower Mistletoe
Amyema maidenii ssp. maidenii	Pale-leaf Mistletoe
Amyema miquelii	Box Mistletoe
Amyema preissii	Wire-leaf Mistletoe
Amyema sanguinea var. sanguinea	Bloodwood Mistletoe
Arabidella trisecta	Shrubby Cress
Aristida capillifolia	Needle-leaf Three-awn
Aristida contorta	Curly Wire-grass
Aristida holathera var. holathera	Tall Kerosene Grass
Aristida latifolia	Feather-top Wire-grass

Aristida nitidula	Brush Three-awn
Astrebla lappacea	Curly Mitchell-grass
Astrebla pectinata	Barley Mitchell-grass
Atriplex elachophylla	
Atriplex limbata	Spreading Saltbush
Atriplex nummularia ssp. nummularia	Old-man Saltbush
Atriplex spongiosa	Pop Saltbush
Austrostipa nitida	Balcarra Spear-grass
Austrostipa scabra group	Falcate-awn Spear-grass
Austrostipa scabra ssp. scabra	Rough Spear-grass
Austrostipa trichophylla	
Boerhavia coccinea	Tar-vine
Boerhavia repleta	
Boerhavia schomburgkiana	Schomburgk`s Tar-vine
Bonamia rosea	
Bothriochloa ewartiana	Desert Blue-grass
Brachiaria piligera	Hairy Arm-grass
Brachiaria praetervisa	Large Arm-grass
Brachychiton gregorii	Desert Kurrajong
Brachyscome ciliaris var. ciliaris	Variable Daisy
Brachyscome ciliaris var. lanuginosa	Woolly Variable Daisy
Brachyscome iberidifolia	Swan River Daisy
Brachyscome tesquorum	Shrubby Desert Daisy
*Brassica tournefortii	Wild Turnip
Brunonia australis	Blue Pincushion
Calandrinia balonensis	Broad-leaf Parakeelya
Calandrinia eremaea	Dryland Purslane
Calandrinia polyandra var. polyandra	Parakeelya
Calandrinia sp.	Purslane/Parakeelya
Callitris glaucophylla	White Cypress-pine
Calocephalus platycephalus	Western Beauty-heads
Calotis erinacea	Tangled Burr-daisy
Calotis hispidula	Hairy Burr-daisy
Calotis latiuscula	Leafy Burr-daisy
Calotis plumulifera	Woolly-headed Burr-daisy
Calytrix carinata	Keeled Fringe-myrtle
*Cenchrus ciliaris	Buffel Grass
Chamaesyce centralis	
Chamaesyce drummondii	Caustic Weed
Chamaesyce inappendiculata	
Chamaesyce wheeleri	Wheeler`s Spurge
Cheilanthes lasiophylla	Woolly Cloak-fern
Cheilanthes sieberi ssp. pseudovellea	
Cheilanthes sieberi ssp. sieberi	Narrow Rock-fern
Chenopodium cristatum	Crested Goosefoot
Chenopodium curvispicatum	Cottony Goosefoot
Chenopodium desertorum ssp.	Desert Goosefoot
Chenopodium desertorum ssp. anidiophyllum	Mallee Goosefoot
Chenopodium desertorum ssp. desertorum	Frosted Goosefoot
Chenopodium desertorum ssp. rectum	Erect Goosefoot
Chenopodium melanocarpum f.	Black-fruit Goosefoot
Chenopodium truncatum	
Chloris pectinata	Comb Windmill Grass
Chrysocephalum apiculatum	Common Everlasting

Chrysocephalum eremaeum	Sand Button-bush
Chrysocephalum pterochaetum	Shrub Everlasting
Chthonocephalus pseudevax	Ground-heads
*Citrullus colocynthis	Colocynth
Cleome viscosa	Tickweed
Codonocarpus cotinifolius	Desert Poplar
Comesperma viscidulum	Varnished Milkwort
Commicarpus australis	Pink Gum-fruit
Convolvulus erubescens (NC)	Australian Bindweed
Convolvulus remotus	Grassy Bindweed
Coopernookia strophiolata	Sticky Coopernookia
Corymbia eremaea ssp. eremaea	Hills Bloodwood
Crassula sieberiana ssp. tetramera (NC)	Australian Stonecrop
Crotalaria eremaea ssp. strehlowii	Smooth Loose-flowered Rattle-pod
Crotalaria medicaginea var. neglecta	Trefoil Rattle-pod
Cullen australasicum	Tall Scurf-pea
Cymbopogon ambiguus	Lemon-grass
Cymbopogon obtectus	Silky-head Lemon-grass
Cyperus bulbosus	Bulbous Flat-sedge
Cyperus centralis	Inland Flat-sedge
Cyperus difformis	Variable Flat-sedge
Cyperus gymnocaulos	Spiny Flat-sedge
Cyperus rigidellus	Dwarf Flat-sedge
Cyperus vaginatus	Stiff Flat-sedge
Cyperus victoriensis	Yelka
Dactyloctenium radulans	Button-grass
Dampiera roycei	
Datura leichhardtii	Native Thorn-apple
Daucus glochidiatus	Native Carrot
Dichanthium sericeum ssp. humilius	Annual Silky Blue-grass
Dichanthium sericeum ssp. sericeum	Silky Blue-grass
Dicrastylis beveridgei var. beveridgei	Sand-sage
Digitaria ammophila	Spider Grass
Digitaria brownii	Cotton Panic-grass
Digitaria coenicola	Spider Grass
Dissocarpus paradoxus	Ball Bindyi
Dodonaea viscosa ssp. angustissima	Narrow-leaf Hop-bush
Dodonaea viscosa ssp. mucronata	Northern Hop-bush
Duboisia hopwoodii	Pituri
Dysphania plantaginella	Plantain Crumbweed
Dysphania rhadinostachya ssp. rhadinostachya	Green Crumbweed
Einadia nutans ssp.	Climbing Saltbush
Einadia nutans ssp. eremaea	Dryland Climbing Saltbush
Einadia nutans ssp. nutans	Climbing Saltbush
Einadia nutans ssp. oxycarpa	Pointed-fruit Climbing Saltbush
Enchylaena tomentosa var. tomentosa	Ruby Saltbush
Enneapogon avenaceus	Common Bottle-washers
Enneapogon caerulescens var. caerulescens	Blue Bottle-washers
Enneapogon clelandii	Cleland`s Nineawn
Enneapogon cylindricus	Jointed Bottle-washers
Enneapogon nigricans	Black-head Grass
Enneapogon oblongus	Purple-head Nineawn
Enneapogon polyphyllus	Leafy Bottle-washers
Enteropogon acicularis	Umbrella Grass

Enteropogon ramosus	Umbrella Grass
*Eragrostis barrelieri	Pitted Love-grass
Eragrostis dielsii var. dielsii	Mulka
Eragrostis eriopoda	Woollybutt
Eragrostis kennedyae	Small-flower Love-grass
Eragrostis laniflora	Hairy-flower Woollybutt
Eragrostis setifolia	Bristly Love-grass
Eragrostis xerophila	Knotty-butt Neverfail
Eremophea spinosa	
Eremophila alternifolia	Narrow-leaf Emubush
Eremophila arenaria	
Eremophila clarkei	Turpentine Bush
Eremophila duttonii	Harlequin Emubush
Eremophila elderi	Elder`s Emubush
Eremophila gibsonii	Gibson`s Emubush
Eremophila glabra ssp. glabra	Tar Bush
Eremophila latrobei ssp. glabra	Crimson Emubush
Eremophila longifolia	Weeping Emubush
Eremophila neglecta	
Eremophila platythamnos ssp.	Munyun#pa
Eremophila platythamnos ssp. exotrachys	Munyun#pa
Eremophila serrulata	Green Emubush
Eremophila willsii var. integrifolia	Will`s Emubush
Eremophila willsii var. willsii	Sandhill Emubush
Eriachne helmsii	Woollybutt Wanderrie
Eriachne mucronata	Mountain Wanderrie
Eriochiton sclerolaenoides	Woolly-fruit Bluebush
Erodium angustilobum (NC)	
*Erodium aureum	
Erodium crinitum	Blue Heron`s-bill
Erodium cygnorum ssp. cygnorum (NC)	Blue Heron`s-bill
Erodium cygnorum ssp. glandulosum (NC)	Clammy Heron`s-bill
Eucalyptus camaldulensis var. obtusa	Northern River Red Gum
Eucalyptus gamophylla	Twin-leaf Mallee
Eucalyptus glomerosa	Jinjulu
Eucalyptus intertexta	Gum-barked Coolibah
Eucalyptus mannensis ssp. mannensis	Mann Ranges Mallee
Eucalyptus oxymitra	Sharp-cap Mallee
Eucalyptus socialis (NC)	Beaked Red Mallee
Eucalyptus sparsa	Northern Ranges Box
Eucalyptus trivalvis	Three-valve Mallee
Euchiton sphaericus	Annual Cudweed
Eulalia aurea	Silky Brown-top
Euphorbia parvicaruncula	Rough-seeded Spurge
Euphorbia tannensis ssp. eremophila	Desert Spurge
Evolvulus alsinoides var. villosicalyx	
Exocarpos sparteus	Slender Cherry
Ficus brachypoda	Native Fig
Frankenia foliosa	Leafy Sea-heath
Glischrocaryon aureum var. angustifolium	Golden Pennants
Glycine canescens	Silky Glycine
Gnephosis arachnoidea	Spidery Button-flower
Goodenia brunnea	
Goodenia centralis	

Goodenia cycloptera	Serrated Goodenia
Goodenia fascicularis	Silky Goodenia
Goodenia gibbosa	
Goodenia heterochila	Serrated Goodenia
Goodenia modesta	
Goodenia mueckeana	
Goodenia ramelii	Purple-spike Goodenia
Goodenia triodiophila	
Goodeniaceae sp.	Goodenia Family
Gossypium sturtianum var. sturtianum	Sturt`s Desert Rose
Grevillea eriostachya	Orange Grevillea
Grevillea juncifolia ssp. juncifolia	Honeysuckle Grevillea
Grevillea pterosperma	Dune Grevillea
Grevillea stenobotrya	Rattle-pod Grevillea
Gyrostemon ramulosus	Bushy Wheel-fruit
Gyrostemon tepperi	Tepper`s Wheel-fruit
Hakea divaricata	Corkbark
Hakea lorea ssp. lorea	Long-leaf Corkwood
Hakea minyma	Minyma-minyma
Halgania cyanea	Rough Blue-flower
Halgania erecta	Erect Blue-flower
Haloragis aspera	Rough Raspwort
Haloragis gossei	Gosse`s Raspwort
Haloragis odontocarpa f.	Mulga Nettle
Haloragis uncatipila	Shrubby Raspwort
Halosarcia indica ssp. bidens	Brown-head Samphire
Halosarcia sp.	Samphire
Hannafordia bissillii ssp. bissillii	Grey Felt-bush
Harmsiodoxa blennodioides	Hairy-pod Cress
Harmsiodoxa puberula	Scented Cress
Heliotropium asperrimum	Rough Heliotrope
Hibiscus solanifolius	Solanum-leaf Hibiscus
Hibiscus sturtii var. grandiflorus	Sturt`s Hibiscus
Hydrocotyle trachycarpa	Wild Parsley
Indigofera georgei	George`s Indigo
Indigofera leucotricha	Silver Indigo
Iseilema membranaceum	Small Flinders-grass
Isolepis congrua	Slender Club-rush
Isotropis centralis	Central Australian Poison-sage
Ixiochlamys filicifolia	
Ixiochlamys nana	Small Fuzzweed
Jasminum didymum ssp. lineare	Native Jasmine
Kennedia prorepens	Kal#pil-kal#pilpa
Keraudrenia sp. North West (J.Z.Weber 6475)	Common Firebush
Lawrencella davenportii	Davenport Daisy
Leiocarpa semicalva ssp. semicalva	Scented Button-bush
Leiocarpa tomentosa	Woolly Plover-daisy
Leiocarpa websteri	Narrow Plover-daisy
Lepidium muelleri-ferdinandi	Mueller`s Peppercress
Lepidium oxytrichum	Green Peppercress
Lepidium phlebopetalum	Veined Peppercress
Leptosema chambersii ssp. chambersii	Upside-down Plant
Leucochrysum stipitatum	Salt-spoon Daisy
Lotus cruentus	Red-flower Lotus

Lysiana exocarpi ssp. exocarpi	Harlequin Mistletoe
Lysiana murrayi	Mulga Mistletoe
Maireana aphylla	Cotton-bush
Maireana appressa	Pale-fruit Bluebush
Maireana georgei	Satiny Bluebush
Maireana planifolia	Flat-leaf Bluebush
Maireana scleroptera	Hard-wing Bluebush
Maireana villosa	Silky Bluebush
Malvastrum americanum var. americanum	Malvastrum
Marsilea exarata	Swayback Nardoo
Melaleuca bracteata	River Tea-tree
Melaleuca dissitiflora	
Melaleuca glomerata	Inland Paper-bark
Melhania oblongifolia	Velvet Hibiscus
Menkea lutea	
Menkea sphaerocarpa	
Menkea villosula	
Micromyrtus flaviflora	Yellow Heath-myrtle
Minuria leptophylla	Minnie Daisy
Minuria multiseta	
Monachather paradoxus	Bandicoot Grass
Muehlenbeckia florulenta	Lignum
Muelleranthus stipularis	Sand Pea
Mukia maderaspatana	Snake Vine
Myoporum montanum	Native Myrtle
Neobassia proceriflora	Desert Glasswort
Newcastelia cephalantha var.	
Nicotiana excelsior	Native Tobacco
Nicotiana gossei	Native Tobacco
Nicotiana occidentalis ssp. obliqua	Western Tobacco
Olearia stuartii	Stuart`s Daisy-bush
Olearia subspicata	Spiked Daisy-bush
Omphalolappula concava	Burr Stickseed
Ophioglossum polyphyllum	Large Adder`s-tongue
Osteocarpum dipterocarpum	Two-wing Bonefruit
Oxalis perennans	Native Sorrel
Oxalis radicosa	Downy Native Sorrel
Pandorea pandorana	Spearwood
Panicum decompositum var. decompositum	Native Millet
Panicum effusum var. effusum	Hairy Panic
Panicum laevinode	
Panicum sp.	Panic/Millet
Paractaenum refractum	Bristle-brush Grass
Paraneurachne muelleri	Northern Mulga-grass
Parietaria debilis (NC)	Smooth-nettle
Petalostylis cassioides	Cassia Butterfly Bush
Pimelea simplex ssp. continua	Desert Riceflower
Pimelea trichostachya	Spiked Riceflower
Pittosporum angustifolium	Native Apricot
Plantago drummondii	Dark Plantain
Pleurosorus subglandulosus	Clubbed Blanket Fern
Pluchea dentex	Bowl Daisy
Podolepis canescens	Grey Copper-wire Daisy
Polycarpaea arida	

Pomax umbellata	Pomax
Poranthera microphylla	Small Poranthera
Portulaca oleracea	Common Purslane
Prostanthera striatiflora	Striated Mintbush
Pseudognaphalium luteoalbum	Jersey Cudweed
Psydrax ammophila	
Psydrax suaveolens	Narrow-leaf Native Currant
Pterocaulon sphacelatum	Apple-bush
Ptilotus aervoides	
Ptilotus decipiens	
Ptilotus exaltatus var. exaltatus	Pink Mulla Mulla
Ptilotus helipteroides var. helipteroides	Hairy Mulla Mulla
Ptilotus nobilis var. nobilis	Yellow-tails
Ptilotus obovatus var. obovatus	Silver Mulla Mulla
Ptilotus polystachyus var. polystachyus	Long-tails
Ptilotus polystachyus var. polystachyus f. polystachyus	Long-tails
Ptilotus sessilifolius var. sessilifolius	Crimson-tails
Ptilotus sp.	Mulla Mulla
Ptychosema anomalum	
Pycnosorus pleiocephalus	Soft Billy-buttons
Rhagodia eremaea	Desert Saltbush
Rhagodia parabolica	Mealy Saltbush
Rhagodia spinescens	Spiny Saltbush
Rhodanthe charsleyae	
Rhodanthe floribunda	White Everlasting
Rhodanthe stricta	Slender Everlasting
Rhodanthe tietkensii	Tietken`s Daisy
Rhyncharrhena linearis	Bush Bean
Rhynchosia minima	Rhynchosia
*Ricinus communis	Castor Oil Plant
Rostellularia adscendens ssp.	Pink Tongues
Rostellularia adscendens var. pogonanthera	Pink Tongues
Rulingia loxophylla	Pur#ar-pur#arpa
Rutidosis helichrysoides ssp. helichrysoides	Grey Wrinklewort
Salsola tragus	Rolypoly
Samolus eremaeus	Desert Samolus
Santalum acuminatum	Quandong
Santalum lanceolatum	Plumbush
Sauropus trachyspermus	Rough-seed Spurge
Scaevola amblyanthera var. centralis	
Scaevola basedowii	Leafless Fanflower
Scaevola collina	Hill Fanflower
Scaevola depauperata	Skeleton Fanflower
Scaevola parvifolia ssp. parvifolia	Camel Weed
Schoenia ayersii	Ayer`s Button-daisy
Schoenia cassiniana	Pink Everlasting
Sclerolaena calcarata	Redburr Bindyi
Sclerolaena convexula	Tall Bindyi
Sclerolaena costata	Ribbed Bindyi
Sclerolaena diacantha	Grey Bindyi
Sclerolaena divaricata	Tangled Bindyi
Sclerolaena johnsonii	Johnson`s Bindyi
Sclerolaena obliquicuspis	Oblique-spined Bindyi
Sclerolaena parviflora	Small-flower Bindyi

Sclerolaena patenticuspis	Spear-fruit Bindyi
Senecio gregorii	Fleshy Groundsel
Senecio helichrysoides	George`s Groundsel
Senecio magnificus	Showy Groundsel
Senecio pinnatifolius	Variable Groundsel
Senna artemisioides ssp.	Desert Senna
Senna artemisioides ssp. alicia	Desert Senna
Senna artemisioides ssp. artemisioides	Silver Senna
Senna artemisioides ssp. filifolia	Fine-leaf Desert Senna
Senna artemisioides ssp. helmsii	Blunt-leaf Senna
Senna artemisioides ssp. petiolaris	Flat-stalk Senna
Senna artemisioides ssp. sturtii	Grey Senna
Senna glutinosa ssp. glutinosa	Sticky Senna
Senna pleurocarpa var. pleurocarpa	Stripe-pod Senna
Setaria clementii	Clement`s Paspalidium
Setaria constricta	Knotty-butt Paspalidium
Setaria dielsii	Diel`s Pigeon-grass
Setaria reflexa	
Sida ammophila	Sand Sida
Sida calyxhymenia	Tall Sida
Sida fibulifera	Pin Sida
Sida goniocarpa	Angled Sida
Sida phaeotricha	Hill Sida
Sida rohlenae ssp. rohlenae	Shrub Sida
Sida sp. B (C.Dunlop 1739)	
Sida sp. Wakaya Desert (C.Dunlop 1984)	
Sigesbeckia australiensis	Australian Sigesbeckia
Solanum centrale	Desert Raisin
Solanum centrale x orbiculatum	
Solanum cleistogamum	Shy Nightshade
Solanum coactiliferum	Tomato-bush
Solanum ellipticum	Velvet Potato-bush
Solanum ferocissimum	Spiny Potato-bush
Solanum lasiophyllum	Flannel Bush
Solanum orbiculatum ssp. orbiculatum	Round-leaf Nightshade
Solanum petrophilum	Rock Nightshade
*Sonchus oleraceus	Common Sow-thistle
Spartothamnella teucriiflora	Bead Bush
Sporobolus blakei	
Stackhousia sp.	Candles
Stemodia viscosa	Clammy Stemodia
Stenopetalum lineare	Narrow Thread-petal
Stenopetalum nutans	Nodding Thread-petal
Stenopetalum velutinum	Velvet Thread-petal
Swainsona acuticarinata	Burke`s Swainson-pea
Swainsona canescens	Grey Swainson-pea
Swainsona colutoides	Bladder Swainson-pea
Swainsona disjuncta	
Swainsona microphylla	Small-leaf Swainson-pea
Swainsona tenuis	
Swainsona villosa	Villous Swainson-pea
Synaptantha tillaeacea (NC)	
Tephrosia sphaerospora	Mulga Trefoil
Tephrosia supina	

Teucrium grandiusculum ssp. grandiusculum	
Teucrium racemosum	Grey Germander
Thelymitra rubra	Salmon Sun-orchid
Themeda avenacea	Tall Oat-grass
Themeda triandra	Kangaroo Grass
Thryptomene maisonneuvei (NC)	Desert Thryptomene
Thyridolepis mitchelliana	Window Mulga-grass
Thysanotus exiliflorus	Inland Fringe-lily
Thysanotus sp.	Fringe-lily
Tietkensia corrickiae	
Trachymene glaucifolia	Blue Parsnip
Trianthema triquetra	Red Spinach
Tribulus macrocarpus	
*Tribulus terrestris	Caltrop
Trichanthodium skirrophorum	Woolly Yellow-heads
Trichodesma zeylanicum	Camel Bush
Trigonella suavissima	Sweet Fenugreek
Triodia basedowii	Hard Spinifex
Triodia helmsii	Helm`s Spinifex
Triodia irritans	Spinifex
Triodia longiceps	Giant Grey Spinifex
Triodia scariosa	Spinifex
Tripogon loliiformis	Five-minute Grass
Triraphis mollis	Purple Plume Grass
Velleia connata	Cup Velleia
Vittadinia arida	
Vittadinia dissecta var. hirta	Dissected New Holland Daisy
Vittadinia eremaea	Desert New Holland Daisy
Vittadinia pustulata	Ridged New Holland Daisy
Vittadinia sulcata	Furrowed New Holland Daisy
Wahlenbergia communis	Tufted Bluebell
Wahlenbergia sp.	Native Bluebell
Wahlenbergia tumidifructa	Swollen-fruit Bluebell
Wedelia stirlingii	Sunflower Daisy-bush
Wurmbea deserticola	Desert Nancy
Xanthorrhoea thorntonii	Desert Grass-tree
Xerochrysum bracteatum	Golden Everlasting
Zaleya galericulata ssp. australis	Hogweed
Zygophyllum ammophilum	Sand Twinleaf
Zygophyllum eichleri	
Zygophyllum eremaeum	Pale-flower Twinleaf
Zygophyllum ovatum	Dwarf Twinleaf
Zygophyllum simile	White Twinleaf
Zygophyllum tesquorum	

Appendix C. Musgrave Ranges fauna species list

Birds

Acanthagenys rufogularis	Spiny-cheeked Honeyeater
Acanthiza apicalis	Inland Thornbill
Acanthiza chrysorrhoa	Yellow-rumped Thornbill
Acanthiza robustirostris	Slaty-backed Thornbill
Acanthiza uropygialis	Chestnut-rumped Thornbill
Accipiter cirrhocephalus	Collared Sparrowhawk
Accipiter fasciatus	Brown Goshawk
Aegotheles cristatus	Australian Owlet-nightjar
Amytornis purnelli	Dusky Grasswren
Anthus novaeseelandiae	Richard`s Pipit
Aphelocephala leucopsis	Southern Whiteface
Aphelocephala nigricincta	Banded Whiteface
Aquila audax	Wedge-tailed Eagle
Artamus cinereus	Black-faced Woodswallow
Artamus minor	Little Woodswallow
Artamus personatus	Masked Woodswallow
Barnardius zonarius	Australian Ringneck
Cacatua leadbeateri	Major Mitchell`s Cockatoo
Cacatua roseicapilla	Galah
Cacatua sanguinea	Little Corella
Certhionyx variegatus	Pied Honeyeater
Charadrius australis	Inland Dotterel
Cheramoeca leucosternus	White-backed Swallow
Chlamydera guttata	Western Bowerbird
Chlamydera maculata	Spotted Bowerbird
Chrysococcyx basalis	Horsfield`s Bronze-cuckoo
Cincloramphus cruralis	Brown Songlark
Cincloramphus mathewsi	Rufous Songlark
Circus assimilis	Spotted Harrier
Colluricincla harmonica	Grey Shrike-thrush
Conopophila whitei	Grey Honeyeater
Coracina maxima	Ground Cuckoo-shrike
Coracina novaehollandiae	Black-faced Cuckoo-shrike
Corvus bennetti	Little Crow
Corvus orru	Torresian Crow
Coturnix pectoralis	Stubble Quail
Cracticus mentalis	Black-backed Butcherbird
Cracticus nigrogularis	Pied Butcherbird
Cracticus torquatus	Grey Butcherbird
Cuculus pallidus	Pallid Cuckoo
Dicaeum hirundinaceum	Mistletoebird
Dromaius novaehollandiae	Emu
Egretta novaehollandiae	White-faced Heron
Elanus axillaris	Black-shouldered Kite
Emblema pictum	Painted Finch
Epthianura aurifrons	Orange Chat
Epthianura tricolor	Crimson Chat
Falco berigora	Brown Falcon
Falco cenchroides	Nankeen Kestrel
Falco hypoleucos	Grey Falcon
Falco longipennis	Australian Hobby

Falco peregrinus	Peregrine Falcon
Falco subniger	Black Falcon
Geopelia cuneata	Diamond Dove
Geophaps plumifera	Plumed Pigeon
Gerygone fusca	Western Gerygone
Grallina cyanoleuca	Magpie-lark
Gymnorhina tibicen	Australian Magpie
Haliastur sphenurus	Whistling Kite
Hamirostra melanosternon	Black-breasted Buzzard
Hieraaetus morphnoides	Little Eagle
Lalage tricolor	White-winged Triller
Lichenostomus keartlandi	Grey-headed Honeyeater
Lichenostomus penicillatus	White-plumed Honeyeater
Lichenostomus virescens	Singing Honeyeater
Lichmera indistincta	Brown Honeyeater
Malurus lamberti	Variegated Fairy-wren
Malurus leucopterus	White-winged Fairy-wren
Malurus splendens	Splendid Fairy-wren
Manorina flavigula	Yellow-throated Miner
Melanodryas cucullata	Hooded Robin
Melopsittacus undulatus	Budgerigar
Merops ornatus	Rainbow Bee-eater
Neopsephotus bourkii	Bourke`s Parrot
Ninox novaeseelandiae	Southern Boobook
Nymphicus hollandicus	Cockatiel
Ocyphaps lophotes	Crested Pigeon
Oreoica gutturalis	Crested Bellbird
Pachycephala rufiventris	Rufous Whistler
Pardalotus rubricatus	Red-browed Pardalote
Petrochelidon ariel	Fairy Martin
Petrochelidon nigricans	Tree Martin
Petroica goodenovii	Red-capped Robin
Phaps chalcoptera	Common Bronzewing
Phaps histrionica	Flock Bronzewing
Phylidonyris albifrons	White-fronted Honeyeater
Podargus strigoides	Tawny Frogmouth
Pomatostomus superciliosus	White-browed Babbler
Psephotus varius	Mulga Parrot
Psophodes occidentalis	Chiming Wedgebill
Rhipidura leucophrys	Willie Wagtail
Smicrornis brevirostris	Weebill
Taeniopygia guttata	Zebra Finch
Todiramphus pyrrhopygia	Red-backed Kingfisher
Todiramphus sanctus	Sacred Kingfisher
Turnix velox	Little Button-quail
Tyto alba	Barn Owl
Vanellus tricolor	Banded Lapwing

Mammals

Tachyglossus aculeatus	Short-beaked Echidna
Pseudantechinus macdonnellensis	Fat-tailed Pseudantechinus
Sminthopsis ooldea	Ooldea Dunnart
Ningaui ridei	Wongai ningaui
Petrogale lateralis	Black-footed Rock-wallaby

macropus robustus	Common Wallaroo
Macropus rufus	Red Kangaroo
Chalinolobus morio	Chocolate Wattled Bat
Vespadelus finlaysoni	Finlayson`s Cave Bat
Chalinolobus gouldii	Gould`s Wattled Bat
Taphozous hilli	Hill`s Sheathtail Bat
Scotorepens balstoni	Inland Broad-nosed Bat
Vespadelus baverstocki	Inland Forest Bat
Nyctophilus geoffroyi	Lesser Long-eared Bat
Scotorepens greyii	Little Broad-nosed Bat
Mormopterus spp. (3 species complex)	Southern Freetail-bats
Tadarida australis	White-striped Freetail-bat
Pseudomys desertor	Desert Mouse
Leggadina forresti	Forrest`s Mouse
Mus musculus	House Mouse
Pseudomys hermannsburgensis	Sandy Inland Mouse
Notomys alexis	Spinifex Hopping-mouse
Felis catus	Cat
Canis lupus dingo	Dingo
Vulpes vulpes	Fox
Oryctolagus cuniculus	Rabbit
Bos taurus	Cattle
Equus asinus	Donkey
Equus caballus	Horse
Camelus dromedarius	One-humped Camel

Reptiles/Amphibians

Frogs	
Cyclorana maini	Main`s Frog
Limnodynastes spenceri	Spencer`s Burrowing Frog
Neobatrachus centralis	Trilling Frog
Pseudophryne occidentalis	Orange-crowned Toadlet
Agamids	
Amphibolurus longirostris	Long-nosed Dragon
Ctenophorus isolepis	Military Dragon
Ctenophorus nuchalis	Central Netted Dragon
Ctenophorus rufescens	Rusty Dragon
Moloch horridus	Thorny Devil
Tympanocryptis centralis	Centralian Earless Dragon
Tympanocryptis lineata	Five-lined Earless Dragon
Geckonids	
Crenadactylus ocellatus	Clawless Gecko
Diplodactylus conspicillatus	Fat-tailed Gecko
Diplodactylus stenodactylus	Sandplain Gecko
Gehyra montium	Central Rock Dtella
Gehyra purpurascens	Purple Dtella
Gehyra variegata	Tree Dtella
Heteronotia binoei	Bynoe`s Gecko
Nephrurus levis	Smooth Knob-tailed Gecko
Rhynchoedura ornata	Beaked Gecko
Strophurus ciliaris	Northern Spiny-tailed Gecko
Strophurus elderi	Jewelled Gecko
Varanids	
Varanus giganteus	Perentie

Varanus gilleni	Pygmy Mulga Goanna
Varanus gouldii	Sand Goanna
Varanus tristis	Black-headed Goanna
Scincids	
Cryptoblepharus plagiocephalus	Desert Wall skink
Ctenotus leonhardii	Common Desert Ctenotus
Ctenotus pantherinus	Leopard Skink
Ctenotus regius	Eastern Desert Ctenotus
Ctenotus saxatilis	Centralian Striped Skink
Ctenotus schomburgkii	Sandplain Ctenotus
Ctenotus septenarius	Gibber Ctenotus
Cyclodomorphus melanops	Spinifex Slender Bluetongue
Egernia inornata	Desert Skink
Egernia margaretae	Masked Rock Skink
Eremiascincus richardsonii	Broad-banded Sandswimmer
Lerista desertorum	Great Desert Slider
Lerista elongata	Woomera Slider
Lerista labialis	Eastern Two-toed Slider
Lerista muelleri	Dwarf Three-toed Slider
Menetia greyii	Dwarf Skink
Morethia boulengeri	Common Snake-eye
Morethia ruficauda	Fire-tailed Skink
Tiliqua occipitalis	Western Bluetongue
Tiliqua scincoides	Eastern Bluetongue
Pygopods	
Delma australis	Barred Snake-lizard
Delma butleri	Spinifex Snake-lizard
Delma nasuta	Centralian Snake-lizard
Delma tincta	Black-necked Snake-lizard
Lialis burtonis	Burton`s Legless Lizard
Typhlopids	
Ramphotyphlops bituberculatus	Rough-nosed Blind Snake
Ramphotyphlops endoterus	Centralian Blind Snake
Elapids	
Demansia reticulata	Desert Whipsnake
Pseudechis australis	Mulga Snake
Pseudonaja modesta	Five-ringed Snake
Pseudonaja nuchalis	Western Brown Snake
Simoselaps bertholdi	Desert Banded Snake
Simoselaps semifasciatus	Half-girdled Snake
Pythonids	
Antaresia stimsoni	Stimson`s Python

Appendix D. Musgrave Ranges flora species list. (*denotes introduced species)

Species	Common Name
Abutilon fraseri	
Abutilon leucopetalum	Desert Lantern-bush
Abutilon macrum	Slender Lantern-bush
Abutilon otocarpum	Desert Lantern-bush
Acacia aneura complex	Mulga
Acacia aneura var. aneura (NC)	Mulga
Acacia aneura x minyura	
Acacia basedowii	Basedow`s Wattle
Acacia cibaria (NC)	Turpentine Mulga
Acacia estrophiolata	Ironwood
Acacia kempeana	Witchetty Bush
Acacia ligulata	Umbrella Bush
Acacia maitlandii	Maitland`s Wattle
Acacia murrayana	Colony Wattle
Acacia nyssophylla	Spine Bush
Acacia olgana	Mount Olga Wattle
Acacia oswaldii	Umbrella Wattle
Acacia paraneura (NC)	Weeping Mulga
Acacia stowardii	Bastard Mulga
Acacia strongylophylla	Round-leaf Wattle
Acacia symonii	Symon`s Wattle
Acacia tenuior	
Acacia tetragonophylla	Dead Finish
Acacia validinervia	Veined Wattle
Acacia victoriae ssp.	Elegant Wattle
Acacia victoriae ssp. arida	Downy Elegant Wattle
Acacia victoriae ssp. victoriae	Elegant Wattle
*Acetosa vesicaria	Rosy Dock
Actinobole uliginosum	Flannel Cudweed
Adriana quadripartita (NC)	Rare Bitter-bush
Adriana tomentosa var. hookeri	Mallee Bitter-bush
Agrostis avenacea var. avenacea	Common Blown-grass
Agrostis avenacea var. perennis	Perennial Blown-grass
Allocasuarina decaisneana	Desert Oak
Alternanthera sp.	Joyweed
Amaranthus interruptus	Native Amaranth
Amaranthus mitchellii (NC)	Boggabri Weed
Amphipogon caricinus var. caricinus	Long Grey-beard Grass
Amyema gibberula var. gibberula	Twin-flower Mistletoe
Amyema maidenii ssp. maidenii	Pale-leaf Mistletoe
Amyema miquelii	Box Mistletoe
Amyema preissii	Wire-leaf Mistletoe
Amyema sanguinea var. sanguinea	Bloodwood Mistletoe
Anemocarpa saxatilis	Hill Sunray
Arabidella trisecta	Shrubby Cress
Aristida capillifolia	Needle-leaf Three-awn
Aristida contorta	Curly Wire-grass
Aristida holathera var. holathera	Tall Kerosene Grass
Aristida nitidula	Brush Three-awn
Aristida obscura	Brush Three-awn

Arthropodium strictum	Common Vanilla-lily
Arundo donax	Giant Reed
Atriplex elachophylla	
Atriplex holocarpa	Pop Saltbush
Atriplex limbata	Spreading Saltbush
Atriplex nummularia ssp. nummularia	Old-man Saltbush
Austrodanthonia caespitosa	Common Wallaby-grass
Austrostipa nitida	Balcarra Spear-grass
Austrostipa scabra ssp. scabra	Rough Spear-grass
Austrostipa trichophylla	
Basedowia tenerrima	
Bergia trimera	Three-part Water-fire
Bidens pilosa	Cobbler`s Pegs
Blennodia pterosperma	Wild Stock
Boerhavia coccinea	Tar-vine
Boerhavia schomburgkiana	Schomburgk`s Tar-vine
Bonamia rosea	
Bothriochloa ewartiana	Desert Blue-grass
Brachyscome blackii	Black`s Daisy
Brachyscome ciliaris var. ciliaris	Variable Daisy
Brachyscome ciliaris var. lanuginosa	Woolly Variable Daisy
Brachyscome iberidifolia	Swan River Daisy
*Brassica tournefortii	Wild Turnip
Bromus arenarius	Sand Brome
Bulbostylis barbata	
Calandrinia balonensis	Broad-leaf Parakeelya
Calandrinia disperma	Two-seed Purslane
Calandrinia eremaea	Dryland Purslane
Calandrinia remota	Round-leaf Parakeelya
Calandrinia reticulata	
Callitris glaucophylla	White Cypress-pine
Calocephalus knappii	Knapp`s Beauty-heads
Calocephalus platycephalus	Western Beauty-heads
Calotis cymbacantha	Showy Burr-daisy
Calotis erinacea	Tangled Burr-daisy
Calotis hispidula	Hairy Burr-daisy
Calotis kempei	Kemp`s Burr-daisy
Calotis latiuscula	Leafy Burr-daisy
Calotis plumulifera	Woolly-headed Burr-daisy
Cassinia laevis	Curry Bush
*Cenchrus ciliaris	Buffel Grass
Centipeda thespidioides (NC)	Desert Sneezeweed
Chamaesyce centralis	
Chamaesyce drummondii	Caustic Weed
Chamaesyce inappendiculata	
Cheilanthes lasiophylla	Woolly Cloak-fern
Cheilanthes sieberi ssp. pseudovellea	
Cheilanthes sieberi ssp. sieberi	Narrow Rock-fern
Chenopodium auricomum	Golden Goosefoot
Chenopodium cristatum	Crested Goosefoot
Chenopodium desertorum ssp. anidiophyllum	Mallee Goosefoot
Chenopodium desertorum ssp. desertorum	Frosted Goosefoot
Chenopodium desertorum ssp. microphyllum	Small-leaf Goosefoot
Chenopodium melanocarpum f. melanocarpum	Black-fruit Goosefoot

Chenopodium murale	Nettle-leaf Goosefoot
Chrysocephalum apiculatum	Common Everlasting
Chrysocephalum eremaeum	Sand Button-bush
Chrysocephalum pterochaetum	Shrub Everlasting
Chthonocephalus pseudevax	Ground-heads
*Citrullus colocynthis	Colocynth
Clematis microphylla var. microphylla	Old Man`s Beard
Cleome viscosa	Tickweed
Codonocarpus cotinifolius	Desert Poplar
Convolvulus erubescens (NC)	Australian Bindweed
Convolvulus remotus	Grassy Bindweed
Conyza bonariensis	Flax-leaf Fleabane
Corymbia eremaea ssp. eremaea	Hills Bloodwood
Crassula sieberiana ssp. tetramera (NC)	Australian Stonecrop
Crotalaria eremaea ssp. eremaea	Downy Loose-flowered Rattle-pod
Crotalaria eremaea ssp. strehlowii	Smooth Loose-flowered Rattle-pod
*Cucumis myriocarpus	Paddy Melon
Cullen australasicum	Tall Scurf-pea
Cullen patens	Spreading Scurf-pea
Cuscuta victoriana	
Cymbopogon ambiguus	Lemon-grass
Cymbopogon obtectus	Silky-head Lemon-grass
*Cynodon dactylon	Couch
Cynoglossum australe	Australian Hound`s-tongue
Cyperus bulbosus	Bulbous Flat-sedge
Cyperus centralis	Inland Flat-sedge
Cyperus difformis	Variable Flat-sedge
Cyperus exaltatus	Splendid Flat-sedge
Cyperus gymnocaulos	Spiny Flat-sedge
*Cyperus hamulosus	Curry Flat-sedge
Cyperus squarrosus	Bearded Flat-sedge
Cyperus vaginatus	Stiff Flat-sedge
Cyperus victoriensis	Yelka
Dactyloctenium radulans	Button-grass
Daucus glochidiatus	Native Carrot
Dianella revoluta var. divaricata	Broad-leaf Flax-lily
Dichanthium sericeum ssp. sericeum	Silky Blue-grass
Digitaria ammophila	Spider Grass
Digitaria brownii	Cotton Panic-grass
Digitaria coenicola	Spider Grass
Dissocarpus paradoxus	Ball Bindyi
Dodonaea viscosa ssp. angustissima	Narrow-leaf Hop-bush
Dodonaea viscosa ssp. mucronata	Northern Hop-bush
Dodonaea viscosa ssp. spatulata	Sticky Hop-bush
Drosera indica	Indian Sundew
Duboisia hopwoodii	Pituri
Dysphania glomulifera ssp. eremaea	Globular Crumbweed
Dysphania rhadinostachya ssp. rhadinostachya	Green Crumbweed
*Echium plantagineum	Salvation Jane
Einadia nutans ssp. eremaea	Dryland Climbing Saltbush
Einadia nutans ssp. nutans	Climbing Saltbush
Einadia nutans ssp. oxycarpa	Pointed-fruit Climbing Saltbush
Enchylaena tomentosa var. tomentosa	Ruby Saltbush
Enneapogon avenaceus	Common Bottle-washers

Enneapogon caerulescens var. caerulescens	Blue Bottle-washers
Enneapogon clelandii	Cleland`s Nineawn
Enneapogon cylindricus	Jointed Bottle-washers
Enneapogon intermedius	Tall Bottle-washers
Enneapogon nigricans	Black-head Grass
Enneapogon oblongus	Purple-head Nineawn
Enneapogon polyphyllus	Leafy Bottle-washers
Enteropogon ramosus	Umbrella Grass
Eragrostis australasica	Cane-grass
*Eragrostis barrelieri	Pitted Love-grass
Eragrostis dielsii var. dielsii	Mulka
Eragrostis eriopoda	Woollybutt
Eragrostis eriopoda/laniflora	
Eragrostis kennedyae	Small-flower Love-grass
Eragrostis laniflora	Hairy-flower Woollybutt
Eragrostis parviflora	Weeping Love-grass
Eragrostis setifolia	Bristly Love-grass
Eragrostis xerophila	Knotty-butt Neverfail
Eremophea spinosa	
Eremophila clarkei	Turpentine Bush
Eremophila elderi	Elder`s Emubush
Eremophila freelingii	Rock Emubush
Eremophila gibsonii	Gibson`s Emubush
Eremophila gilesii	Hairy-fruit Emubush
Eremophila glabra ssp. glabra	Tar Bush
Eremophila latrobei ssp. glabra	Crimson Emubush
Eremophila latrobei ssp. latrobei	Grey-leaf Crimson Emubush
Eremophila longifolia	Weeping Emubush
Eremophila macdonnellii	Macdonnell`s Emubush
Eremophila neglecta	
Eremophila serrulata	Green Emubush
Eremophila sp. nov. `Musgrave Range`	
Eremophila sturtii	Turpentine Bush
Eremophila willsii var. willsii	Sandhill Emubush
Eriachne helmsii	Woollybutt Wanderrie
Eriachne mucronata	Mountain Wanderrie
Eriachne pulchella ssp. pulchella	Pretty Wanderrie Grass
Eriochlamys behrii	Woolly Mantle
*Erodium aureum	
Erodium cicutarium	Cut-leaf Heron`s-bill
Erodium crinitum	Blue Heron`s-bill
Erodium cygnorum ssp. glandulosum (NC)	Clammy Heron`s-bill
Eucalyptus camaldulensis var. obtusa	Northern River Red Gum
Eucalyptus dumosa	White Mallee
Eucalyptus eucentrica (NC)	
Eucalyptus gamophylla	Twin-leaf Mallee
Eucalyptus gypsophila	Kopi Mallee
Eucalyptus intertexta	Gum-barked Coolibah
Eucalyptus leucoxylon ssp. pruinosa	Inland South Australian Blue Gum
Eucalyptus mannensis ssp. mannensis	Mann Ranges Mallee
Eucalyptus minniritchi	Round-leaf Mallee
Eucalyptus oxymitra	Sharp-cap Mallee
Eucalyptus socialis (NC)	Beaked Red Mallee
Eucalyptus sparsa	Northern Ranges Box

Eucalyptus trivalvis	Three-valve Mallee
Euchiton sphaericus	Annual Cudweed
Eulalia aurea	Silky Brown-top
Euphorbia tannensis ssp. eremophila	Desert Spurge
Evolvulus alsinoides var. decumbens	Tropical Speedwell
Evolvulus alsinoides var. villosicalyx	
Exocarpos sparteus	Slender Cherry
Ficus brachypoda	Native Fig
Fimbristylis dichotoma	Common Fringe-rush
Glossocardia bidens	Native Cobbler`s-pegs
Glossostigma diandrum	Two-anther Mud-mat
Glycine canescens	Silky Glycine
Glycine rubiginosa	Twining Glycine
Gnephosis arachnoidea	Spidery Button-flower
Gnephosis tenuissima	Dwarf Golden-tip
Gomphrena lanata	
Goodenia berardiana	Split-end Goodenia
Goodenia brunnea	
Goodenia chambersii	
Goodenia cycloptera	Serrated Goodenia
Goodenia glauca	Pale Goodenia
Goodenia heterochila	Serrated Goodenia
Goodenia lunata	Stiff Goodenia
Goodenia ramelii	Purple-spike Goodenia
Goodenia saccata	Flinders Ranges Goodenia
Goodenia vilmoriniae	
Gossypium sturtianum var. sturtianum	Sturt`s Desert Rose
Grevillea lavandulacea var. sericea (NC)	Spider-flower
Grevillea nematophylla ssp. nematophylla	Water Bush
Grevillea pterosperma	Dune Grevillea
Grevillea stenobotrya	Rattle-pod Grevillea
Grevillea striata	Beefwood
*Gypsophila tubulosa	Annual Chalkwort
Hakea carinata	Erect Hakea
Hakea divaricata	Corkbark
Hakea leucoptera ssp. leucoptera	Silver Needlewood
Hakea lorea ssp. lorea	Long-leaf Corkwood
Hakea minyma	Minyma-minyma
Haloragis aspera	Rough Raspwort
Haloragis uncatipila	Shrubby Raspwort
Heliotropium asperrimum	Rough Heliotrope
Hibbertia glaberrima	Central Australian Guinea-flower
Hibiscus solanifolius	Solanum-leaf Hibiscus
Hibiscus sturtii var. grandiflorus	Sturt`s Hibiscus
Hybanthus aurantiacus	Yellow Slender Violet
Hybanthus monopetalus	Slender Violet
Hydrocotyle trachycarpa	Wild Parsley
Indigofera basedowii	Showy Indigo
Indigofera colutea	Sticky Indigo
Indigofera helmsii	Helm`s Indigo
Indigofera leucotricha	Silver Indigo
Indigofera linnaei	Birdsville Indigo
Indigofera psammophila	Sand Indigo
Isoetes muelleri	Mueller`s Quillwort

Isolepis congrua	Slender Club-rush
Isotoma petraea	Rock Isotome
Isotropis centralis	Central Australian Poison-sage
Ixiochlamys cuneifolia	Silverton Daisy
Ixiochlamys filicifolia	
Jasminum didymum ssp. lineare	Native Jasmine
Juncus bufonius	Toad Rush
Kennedia prorepens	Kal#pil-kal#pilpa
Keraudrenia sp. North West (J.Z.Weber 6475)	Common Firebush
*Lactuca serriola	Prickly Lettuce
Lawrencella davenportii	Davenport Daisy
Leiocarpa semicalva ssp. semicalva	Scented Button-bush
Leiocarpa semicalva ssp. vinacea	Red-stem Button-bush
Leiocarpa tomentosa	Woolly Plover-daisy
Lepidium foliosum	Leafy Peppercress
Lepidium muelleri-ferdinandi	Mueller`s Peppercress
Lepidium oxytrichum	Green Peppercress
Lepidium phlebopetalum	Veined Peppercress
Lepidosperma avium	Central Australian Rapier-sedge
Leptorhynchos baileyi	Bailey`s Buttons
Leucochrysum fitzgibbonii	Fitzgibbon`s Daisy
Leucochrysum stipitatum	Salt-spoon Daisy
Lobelia gibbosa	Tall Lobelia
Lotus cruentus	Red-flower Lotus
Lysiana exocarpi ssp. exocarpi	Harlequin Mistletoe
Lysiana murrayi	Mulga Mistletoe
Lysiana subfalcata	Northern Mistletoe
Lythrum hyssopifolia	Lesser Loosestrife
Lythrum paradoxum	
Maireana aphylla	Cotton-bush
Maireana appressa	Pale-fruit Bluebush
Maireana astrotricha	Low Bluebush
Maireana coronata	Crown Fissure-plant
Maireana georgei	Satiny Bluebush
Maireana planifolia	Flat-leaf Bluebush
Maireana scleroptera	Hard-wing Bluebush
Maireana turbinata	Top-fruit Bluebush
Maireana villosa	Silky Bluebush
*Malva parviflora	Small-flower Marshmallow
Malvastrum americanum var. americanum	Malvastrum
Marsdenia australis	Native Pear
Marsilea drummondii	Common Nardoo
Marsilea hirsuta	Short-fruit Nardoo
Melaleuca bracteata	River Tea-tree
Melaleuca dissitiflora	
Melaleuca fulgens ssp. corrugata	Wrinkled Honey-myrtle
Melaleuca glomerata	Inland Paper-bark
Melhania oblongifolia	Velvet Hibiscus
*Melinis repens	Red Natal Grass
Menkea crassa	Fat Spectacles
Menkea sphaerocarpa	
Menkea villosula	
Microcorys macrediana	
Micromyrtus flaviflora	Yellow Heath-myrtle

Minuria denticulata	Woolly Minuria
Minuria leptophylla	Minnie Daisy
Mollugo cerviana	Wire-stem Chickweed
Monachather paradoxus	Bandicoot Grass
Muehlenbeckia florulenta	Lignum
Mukia maderaspatana	Snake Vine
Myoporum montanum	Native Myrtle
Myriophyllum verrucosum	Red Milfoil
Nicotiana excelsior	Native Tobacco
Nicotiana goodspeedii	Small-flower Tobacco
Nicotiana gossei	Native Tobacco
Nicotiana occidentalis ssp. obliqua	Western Tobacco
Nicotiana simulans	Native Tobacco
Nicotiana velutina	Velvet Tobacco
Olearia ferresii	Central Australian Daisy-bush
Olearia stuartii	Stuart`s Daisy-bush
Olearia subspicata	Spiked Daisy-bush
Omphalolappula concava	Burr Stickseed
Ophioglossum lusitanicum	Austral Adder`s-tongue
Oxalis perennans	Native Sorrel
Oxalis radicosa	Downy Native Sorrel
Pandorea pandorana	Spearwood
Panicum decompositum var. decompositum	Native Millet
Panicum effusum var. effusum	Hairy Panic
Paraceterach reynoldsii	Scaly Rock-fern
Parietaria debilis (NC)	Smooth-nettle
Petalostylis cassioides	Cassia Butterfly Bush
Pittosporum angustifolium	Native Apricot
Plectranthus intraterraneus	Inland Spur-flower
Pleurosorus rutifolius	Blanket Fern
Pleurosorus subglandulosus	Clubbed Blanket Fern
Pluchea dentex	Bowl Daisy
Pluchea rubelliflora	
Podolepis canescens	Grey Copper-wire Daisy
Podolepis capillaris	Wiry Podolepis
Polycalymma stuartii	Poached-egg Daisy
Polycarpaea arida	
Polygala isingii	Central Australian Milkwort
Polypogon monspeliensis	Annual Beard-grass
Pomax umbellata	Pomax
Portulaca filifolia	Slender Purslane
Portulaca oleracea	Common Purslane
Prostanthera nudula	Mount Illbillee Mintbush
Prostanthera striatiflora	Striated Mintbush
Pseudognaphalium luteoalbum	Jersey Cudweed
Pteridium esculentum	Bracken Fern
Pterocaulon serrulatum	Scented Apple-bush
Pterocaulon sphacelatum	Apple-bush
Ptilotus decipiens	
Ptilotus exaltatus var. exaltatus	Pink Mulla Mulla
Ptilotus gaudichaudii var. gaudichaudii	Paper Fox-tail
Ptilotus helipteroides var. helipteroides	Hairy Mulla Mulla
Ptilotus nobilis var. nobilis	Yellow-tails
Ptilotus obovatus var. griseus	Silver Mulla Mulla

Ptilotus obovatus var. obovatus	Silver Mulla Mulla
Ptilotus polystachyus var. polystachyus	Long-tails
Ptilotus polystachyus var. polystachyus f. polystachyus (NC)	Long-tails
Ptilotus schwartzii var. schwartzii f. schwartzii	
Ptilotus sessilifolius var. sessilifolius	Crimson-tails
Ptilotus spathulatus f. spathulatus	Pussy-tails
Radyera farragei	Desert Rose Mallow
Rhagodia eremaea	Desert Saltbush
Rhagodia parabolica	Mealy Saltbush
Rhagodia spinescens	Spiny Saltbush
Rhodanthe charsleyae	
Rhodanthe citrina	Pale Immortelle
Rhodanthe floribunda	White Everlasting
Rhodanthe microglossa	Clustered Everlasting
Rhodanthe stricta	Slender Everlasting
Rhodanthe stuartiana	Clay Everlasting
Rhodanthe tietkensii	Tietken`s Daisy
Rhynchosia minima	Rhynchosia
*Ricinus communis	Castor Oil Plant
Rostellularia adscendens	Pink Tongues
Rulingia magniflora	
Rutidosis helichrysoides ssp. helichrysoides	Grey Wrinklewort
Salsola tragus	Rolypoly
Samolus eremaeus	Desert Samolus
Santalum acuminatum	Quandong
Santalum lanceolatum	Plumbush
Sarcostemma viminale ssp. australe	Caustic Bush
Sauropus trachyspermus	Rough-seed Spurge
Scaevola albida	Pale Fanflower
Scaevola collina	Hill Fanflower
Scaevola glabrata	
Scaevola humilis	Inland Fanflower
Schoenia ayersii	Ayer`s Button-daisy
Schoenia cassiniana	Pink Everlasting
Sclerolaena birchii	Galvanised Burr
Sclerolaena convexula	Tall Bindyi
Sclerolaena costata	Ribbed Bindyi
Sclerolaena diacantha	Grey Bindyi
Sclerolaena johnsonii	Johnson`s Bindyi
Sclerolaena obliquicuspis	Oblique-spined Bindyi
Sclerolaena parallelicuspis	Western Bindyi
Sclerolaena patenticuspis	Spear-fruit Bindyi
Sclerolaena uniflora	Small-spine Bindyi
Senecio glossanthus	Annual Groundsel
Senecio gregorii	Fleshy Groundsel
Senecio laceratus	Cut-leaf Groundsel
Senecio magnificus	Showy Groundsel
Senna artemisioides ssp. artemisioides	Silver Senna
Senna artemisioides ssp. coriacea	Broad-leaf Desert Senna
Senna artemisioides ssp. filifolia	Fine-leaf Desert Senna
Senna artemisioides ssp. helmsii	Blunt-leaf Senna
Senna artemisioides ssp. oligophylla	Limestone Senna
Senna artemisioides ssp. petiolaris (NC)	Flat-stalk Senna

Senna artemisioides ssp. sturtii	Grey Senna
Senna cardiosperma ssp. gawlerensis	Gawler Ranges Senna
Senna pleurocarpa var. pleurocarpa	Stripe-pod Senna
Setaria clementii	Clement`s Paspalidium
Setaria constricta	Knotty-butt Paspalidium
Setaria dielsii	Diel`s Pigeon-grass
Setaria reflexa	
Setaria verticillata	Whorled Pigeon-grass
Sida ammophila	Sand Sida
Sida calyxhymenia	Tall Sida
Sida cardiophylla	
Sida corrugata var. angustifolia	Grassland Sida
Sida cunninghamii	Ridge Sida
Sida fibulifera	Pin Sida
Sida phaeotricha	Hill Sida
Sida sp. B (C.Dunlop 1739)	
Sida sp. Wakaya Desert (C.Dunlop 1984)	
Sigesbeckia australiensis	Australian Sigesbeckia
*Sisymbrium orientale	Indian Hedge Mustard
Solanum centrale	Desert Raisin
Solanum cleistogamum	Shy Nightshade
Solanum coactiliferum	Tomato-bush
Solanum eardleyae	Eardley`s Nightshade
Solanum ellipticum	Velvet Potato-bush
Solanum ferocissimum	Spiny Potato-bush
*Solanum nigrum	Black Nightshade
Solanum orbiculatum ssp. orbiculatum	Round-leaf Nightshade
Solanum petrophilum	Rock Nightshade
Solanum quadriloculatum	Plains Nightshade
*Sonchus oleraceus	Common Sow-thistle
*Sonchus tenerrimus	Clammy Sow-thistle
Sorghum bicolor	Grain Sorghum
Stackhousia clementii	Limestone Candles
Stemodia florulenta	Bluerod
Stemodia viscosa	Clammy Stemodia
Stenopetalum anfractum	Inland Thread-petal
Stenopetalum lineare	Narrow Thread-petal
Stenopetalum nutans	Nodding Thread-petal
Stenopetalum velutinum	Velvet Thread-petal
Stylidium inaequipetalum	
Swainsona acuticarinata	Burke`s Swainson-pea
Swainsona campylantha	
Swainsona canescens	Grey Swainson-pea
Swainsona flavicarinata	Yellow-keel Swainson-pea
Swainsona lessertiifolia	Coast Swainson-pea
Swainsona microphylla	Small-leaf Swainson-pea
Swainsona phacoides	Dwarf Swainson-pea
Swainsona swainsonioides	Downy Swainson-pea
Swainsona tenuis	
Swainsona villosa	Villous Swainson-pea
Tephrosia sphaerospora	Mulga Trefoil
Tephrosia supina	
Tetragonia eremaea	Desert Spinach
Teucrium corymbosum	Rock Germander

Teucrium racemosum	Grey Germander
Themeda avenacea	Tall Oat-grass
Themeda triandra	Kangaroo Grass
Thryptomene maisonneuvei (NC)	Desert Thryptomene
Thyridolepis mitchelliana	Window Mulga-grass
Trachymene glaucifolia	Blue Parsnip
Tragus australianus	Small Burr-grass
Trianthema triquetra	Red Spinach
Tribulus eichlerianus	Eichler`s Caltrop
Tribulus hystrix	Spiky Caltrop
*Tribulus terrestris	Caltrop
Trichodesma zeylanicum	Camel Bush
Triodia basedowii	Hard Spinifex
Triodia irritans	Spinifex
Triodia pungens	Gummy Spinifex
Triodia scariosa	Spinifex
Tripogon loliiformis	Five-minute Grass
Triraphis mollis	Purple Plume Grass
Typha domingensis	Narrow-leaf Bulrush
Utricularia beaugleholei	Beauglehole`s Bladderwort
Vaccaria hispanica	Cow Soapwort
Velleia glabrata	Smooth Velleia
Vittadinia arida	
Vittadinia cervicularis var. cervicularis	Waisted New Holland Daisy
Vittadinia dissecta var. hirta	Dissected New Holland Daisy
Vittadinia eremaea	Desert New Holland Daisy
Vittadinia sulcata	Furrowed New Holland Daisy
Wahlenbergia aridicola	Dryland Bluebell
Wahlenbergia communis	Tufted Bluebell
Wahlenbergia gracilenta	Annual Bluebell
Wahlenbergia gracilis	Sprawling Bluebell
Wahlenbergia queenslandica	
Wahlenbergia tumidifructa	Swollen-fruit Bluebell
Waitzia acuminata var. acuminata	Orange Immortelle
Wedelia stirlingii	Sunflower Daisy-bush
Wurmbea centralis ssp. centralis	Inland Nancy
Xerochrysum bracteatum	Golden Everlasting
Zaleya galericulata ssp. australis	Hogweed
Zygophyllum ammophilum	Sand Twinleaf
Zygophyllum eichleri	
Zygophyllum eremaeum	Pale-flower Twinleaf
Zygophyllum iodocarpum (NC)	Violet Twinleaf
Zygophyllum simile	White Twinleaf

Appendix E: Glossary of Terms

(The majority of definitions have been adapted from the Best Practice Fire Management report by Duguid, Brock and Gabrys)

Aerial Assisted Burning: burning conducted in remote areas where a helicopter is used to transport people to a site for the purpose of conducting ground burning to protect particular assets.

Aerial Incendiary burning: Prescribed burning where fires are ignited in strategic areas by dispatching incendiaries from aircraft.

Control line: a preliminary break in the fuel that is prepared prior to ignition of the main area to be burnt. It may be an area of naturally low fuels or a line that has been mechanically or manually cleared of vegetation. Control lines are typically between 30 centimetres and 2 metres wide.

Firebreak: Any area, natural or created, that may slow or halt the spread of fire or from which fire suppression activities could be conducted. These may be areas of naturally sparse fuel, roads and tracks, lines of mechanically or chemically reduced fuel, and areas that have been burnt under a prescription.

Patch burn: The primary purpose of such prescribed burns is to create a diversity of fire ages, typically in spinifex communities. Over time, the result of many patch burns is a mosaic of fire ages. While an individual "patch" may have little chance of halting a wildfire, a mosaic of recently burnt patches of vegetation should help to halt the spread of wildfires. This term encompasses a broad range of patch sizes and fire intensities.

Patchy and patchiness: Used to indicate that within the perimeter of a burnt area, patches of unburnt fine fuels remain. Residual fine fuels may reduce the effectiveness of a firebreak in a wildfire, but unburnt patches can be important in the survival and recovery of wildlife.

Prescribed Burn: a deliberately lit fire in a strategic area, burnt in prescribed conditions to achieve specific outcomes.

Proposed burn: A prescribed burn that hasn't yet been implemented

Strategic firebreak: Any burn that is intended to exclude fire entering one area from another. To be effective, such burns must connect ('tie off') to other natural or created breaks. Strategic firebreaks should be 200m wide in spinifex.