2. Managing fire in the southern Tanami Desert

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Shortened forms

ALT	Aboriginal Land Trust
APB	Aerial Prescribed Burning
APY	Anangu Pitjantjatjara Yankunytjatjara
BFC	Bushires Council
CLC	Central Land Council
CLMA	Centralian Land Management Association
EMS	Environmental Management System
FDI	Fire Danger Index
INRM	Integrated Natural Resources Management
IPA	Indigenous Protected Area
NT	Northern Territory
SLA	Statistical Local Area
UTKNP	Uluru–Kata Tjuta National Park

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2. Managing fire in the southern Tanami Desert

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2.1 Summary

This report provides an overview of fire in central Australia as a context for a regional focus on the southern Tanami Desert. A comparison of two periods of widespread fires, 1974–1977 and 2000–2002, shows a change in the patterns of fire, which have an association with changes in land use, population mobility and distribution. A re-evaluation of the link between fire occurrence and antecedent rainfall confirmed the correlation between area burnt and two-year cumulative rainfall in sub-regional areas in central Australia. The opportunity to burn and the potential for large wildfires increased when the 24-month cumulative rainfall exceeded 120% of the average two-year rainfall for July to June rainyears.

A more detailed investigation of fires in the southern Tanami Desert region, based on Landsat satellite images, highlighted the number of fires that occur. Nearly 3000 fires were mapped in an area of only 34 000 km² during the period from July 1997 to March 2005. The majority of fires were small, and nearly 63% of all fires were less than 1 km² in size. Only 2.5% of the fires were greater than 1000 km² but they represented 72% of the total area burnt. The largest area burnt by a single fire exceeded 5700 km². The occurrence of fires was fairly evenly distributed throughout the year, but August to October was the period when fires burnt the largest areas, with September being the peak of fire activity.

Discussions with the pastoral community provided an opportunity to report their experiences, issues and attitudes to fire. Pastoralists in the southern Tanami Desert region support the development of a regional fire management strategy and expressed a willingness to participate in this endeavour. Importantly, they stated that it needed to be a collaborative approach developed through cross-sectoral engagement. They also indicated that there was a need for efficiencies and actions to both develop and implement a program which had been lacking to date. Improved communication and an advocate to champion the cause of fire management were needed to achieve a positive result.

The essential elements of a southern Tanami Desert fire management strategy are described, as well as the major challenges to be addressed. These include:

- implementing effective fire management in remote areas without roads or tracks
- dealing with the issue of roadside ignitions without eliminating the importance of most ignitions as signals for assistance
- documenting the benefits of improved fire management in both economic and non-economic terms and exploring the opportunities for funding
- improving training and skill development in active fire management throughout the community.

2.1.1 Recommendations

- Maintain timely two- and three-year cumulative rainfall records to help more accurately monitor seasonal conditions and fuel loads in association with fire history information
- Follow up the outcomes of the research work by the students associated with the Desert Fire project
- Encourage more active and timely burning of spinifex in the areas surrounding mulga communities to reduce the impact of widespread fires on isolated mulga communities

- Encourage a representative from the Central Land Council (CLC) to be a regular guest at the Alice Springs East and West Bushfires Council Regional Committee biannual meetings and to present a summary of CLC fire-related activities
- Encourage all land managers to record fire information immediately after fires so that information is not lost
- Encourage all land managers to develop individual fire management strategies and include response plans for unscheduled fires
- Develop and hold fire technology workshops to improve land manager awareness of the advantages and limitations of fire information available via the Internet
- Develop a fire management strategy for the southern Tanami Desert region.

2.2. Introduction

A key element of land management in central Australia is fire. Unfavourable fire regimes have been implicated in the disappearance of many mammal species from central Australia and also in the ongoing decline of some plant and animal communities (see Duguid et al. 2009). Wildfires also impact heavily on commercial grazing businesses and on the bush resources that are important to the sustainable livelihoods of many Aboriginal people, as well as threatening life and property, including remote Aboriginal communities and cultural sites. The CLC and Northern Territory (NT) government agencies share a mutual recognition that the current fire regimes in parts of central Australia, including the Tanami Desert, are unfavourable for production, conservation and human habitation and that effective fire management is dependent upon a collaborative approach by stakeholders.

Recent wildfire events in central Australia have raised awareness as well as conflict about fire management. Consequently, as part of the Desert Fire project, a research initiative (subproject 3a, see Edwards & Allan 2009) was developed to promote the coexistence of fire, people and biodiversity in the Tanami Desert, with the long-term future goal of developing a collaborative regional fire strategy. The southern Tanami was chosen as a regional case study site for the following reasons:

- The region receives a relatively consistent annual rainfall that is linked to both regular opportunities to burn and frequent periods of increased fire risk.
- Within the region there is a mix of land uses and economic activities, vegetation communities and biodiversity assets including wetlands (Duguid et al. 2002) and sites of botanical significance (White et al. 2000a, b) that are likely to be threatened by adverse fire regimes.
- Frequent, large and uncontrolled wildfires occurred across different land tenures in the region over the period 2000–2002.
- On the basis of the widespread fires in central Australia during 2001 and 2002, it was known that fire was a contentious issue in the southern Tanami Desert, and it was expected that the Desert Fire project could improve the dialogue about fire and help to resolve some conflicts associated with fire.

Subproject 3a of Desert Fire – ‘Managing fire in the southern Tanami Desert’ – was a collaboration between the CLC and NRETAS (Bushfires NT and Division of Biodiversity Conservation). The objectives of the subproject were to:

- establish better communication between stakeholders through formal and informal processes (networks), including links with other DKCRC projects
- identify land use and fire management goals across land tenures, highlighting areas of conflict
- develop improved techniques for fire detection, mapping and dissemination of associated information; this will involve updating fire history and investigating associated issues of resolution, accuracy, distribution, use and interpretation of fire history mapping

- investigate the fire regimes through analysis of fire history, fire frequency and fire intervals
- develop a fire management strategy for the southern Tanami area, as a longer term objective, with the potential for applicability to other desert areas of Australia.

The anticipated outcomes from these objectives were to:

- improve our understanding of how different cultures and individuals perceive the benefits and impacts of fire
- reduce the current conflicts associated with fire between adjacent land managers and facilitate a more coordinated approach to fire management in regional areas
- contribute to our understanding of the extent of existing (traditional, ecological and contemporary) knowledge related to fire and its role in maximising the potential for Aboriginal land managers to use traditional bush resources
- contribute to better prevention and control of large wildfires and the consequential benefit of preventing negative impacts on stock, property, natural resource and biodiversity values
- contribute to sustainable ecosystems and associated ecotourism and traditional culture.

In meeting the above objectives, NRETA developed a detailed fire history of the southern Tanami region and evaluated the perspectives of pastoral land managers with respect to fire management issues. It is this work that is the subject of this chapter. The CLC evaluated the perceptions of non-Aboriginal fire specialists with respect to past and present use of fire by Aboriginal people and conducted a study devised to address fire issues from the perspective of Aboriginal people in the southern Tanami Desert (see Gabrys & Vaarzon-Morel 2009).

This chapter begins with an overview of fire in central Australia to provide a context for the regional focus on the southern Tanami Desert. It continues with a description of the southern Tanami Desert region, and a more detailed analysis of the region's recent fire history. The next section discusses the issues of online fire detection and mapping information, and is followed by perspectives about fire from members of the pastoral community. The next section describes the necessary elements of a southern Tanami Desert fire management strategy. The last section provides final comments and a set of recommendations from this research.

2.3. Fire in central Australia

2.3.1 General overview

Fire in central Australia is most commonly associated with spinifex (hummock grassland) vegetation communities, and their characteristics and fire regimes has been described in several other reports (Allan & Southgate 2002, Griffin 1991). Spinifex (*Triodia sp.*) dominates the non-pastoral desert regions beyond the leases of the Alice Springs pastoral district, but also occurs in patches within most pastoral leases (Figure 2.1). These patches of spinifex in the pastoral leases vary in size, and their value to pastoral enterprises is variable due to their very limited grazing value. In general, fuel loads in spinifex country are slow to recover from fire and the interval between fires usually ranges from 7 to 20 years, depending on rainfall and location. Fire intervals are shortest in the north-west of the Alice Springs pastoral district and increase along the decreasing rainfall gradient to the south-east.

Fire in the non-spinifex vegetation communities is constrained by grazing. These communities are predominantly a variety of *Acacia* woodlands and shrublands with an understorey of native grasses. The pasture understorey includes a variety of species, such as *Aristida*, *Enneapogon* and *Eragrostis*. Cattle grazing of native pasture is a primary economic activity in central Australia, although grazing also encompasses other herbivores, both native and feral, such as kangaroos and camels, as well as

invertebrates, such as termites. In most seasons, pasture growth is consumed, and both the threat and opportunity for fire is low. Therefore, it is only during or immediately after periods of widespread above average rainfall over two or three consecutive seasons that pasture growth and fuel accumulation dramatically exceeds consumption, and fire risk increases.

Exceptions to the general pattern of fire in non-spinifex landscapes are the areas dominated by buffel grass (*Cenchrus ciliaris*), a grass introduced to central Australia for pasture and landscape rehabilitation. Relatively large areas of buffel grass now occur on alluvial soils and also on rocky hillslopes. These areas can respond rapidly to relatively low amounts of rainfall, and their increased rate of biomass accumulation increases the potential for fires. Although the spatial patterning of buffel grass dominated areas restricts the potential for large scale landscape fires in these communities, buffel grass is continuing to spread across the landscape and poses a serious fire issue for the future (Friedel et al. 2006).

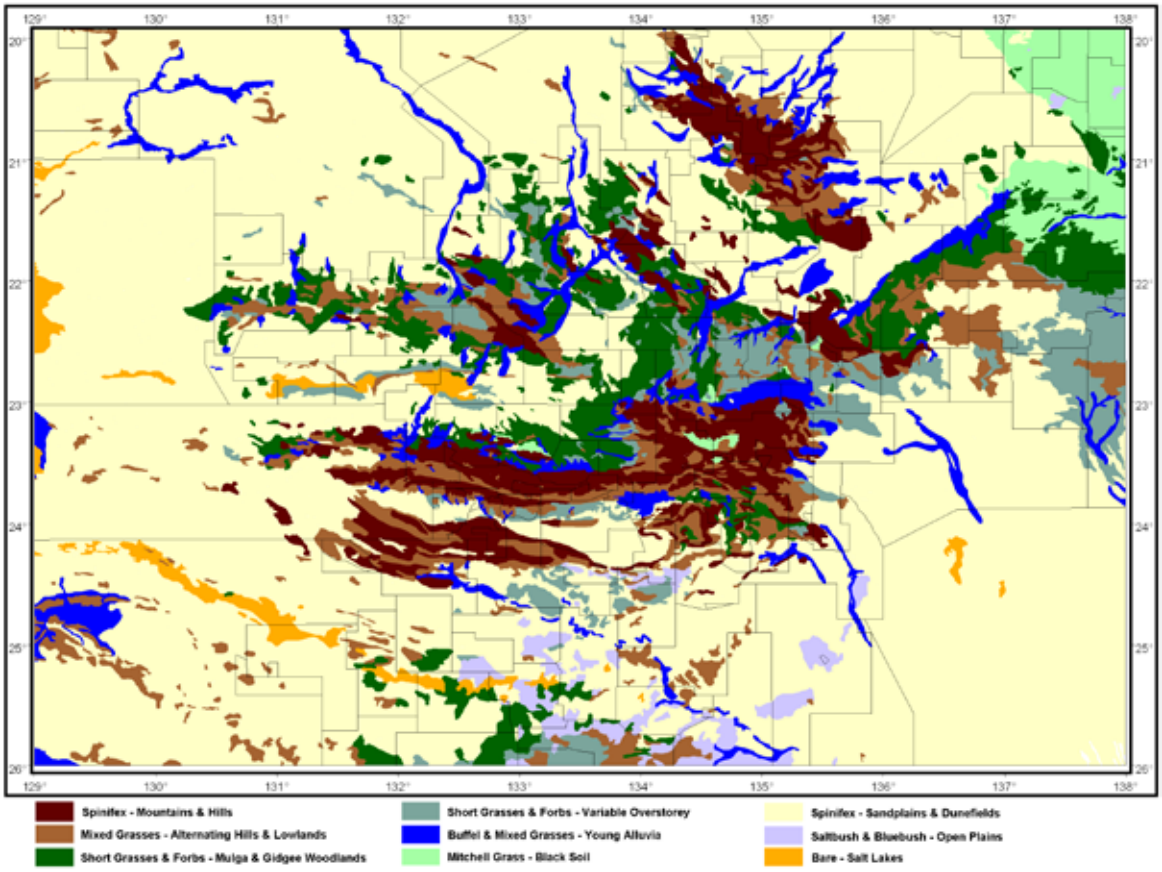

Figure 2.1: Pasture communities by landscape type in central Australia

Source: Derived from land system and vegetation maps (Perry et al. 1962, Wilson et al. 1990).

Note: The map covers the southern Northern Territory (south of -20°) and extends to the boundaries of Queensland, South Australia and Western Australia.

2.3.2 History of fires in central Australia: 1870s to 1970s

In contrast to the temperate southern regions of Australia, fire events in central Australia are driven by above average rainfall, rather than below average rainfall or drought. McArthur (1972) stated that several consecutive years of exceptional rains are required to produce enough fuel for wildfires in a semi-arid area – an insightful observation prior to the wet years throughout inland Australia during the mid-1970s.

Several periods of extensive fires in the pastoral region have been reported, both by early explorers and settlers, and coincide with the two wettest periods in the Alice Springs rainfall records (Figure 2.2):

Wildfires were not recorded in the 1870s, but were reported to be extensive in the 1920s (Whitlock 1924; informants) and were widespread in the 1970s ... The effective cessation of Aboriginal mosaic burning by 1920 and the institution of fire-bans by Europeans meant that without large scale stock grazing, fuel build-up could be quite rapid in high rainfall years. Exceptional rains in central Australia between 1920 and 1923 promoted rapid rainfall response and soon wildfires were being reported. Several informants referred to a big fire at the time, and a few spoke of a fire which burnt 'from Oodnadatta to the Barkly Tablelands' or even 'to the Gulf of Carpentaria'; but the year varied from 1920 to 1923 ... Wildfires did not feature again in the Northern Territory pastoral areas until the late 1960s after the break of the 1958–64 drought ... Following exceptional rains from 1973 to 1978, fuel loads increased greatly. In that period, over 33 percent (240,000 km²) of the Alice Springs Pastoral District burnt in almost 600 separate fires.

(Griffin & Friedel 1985)

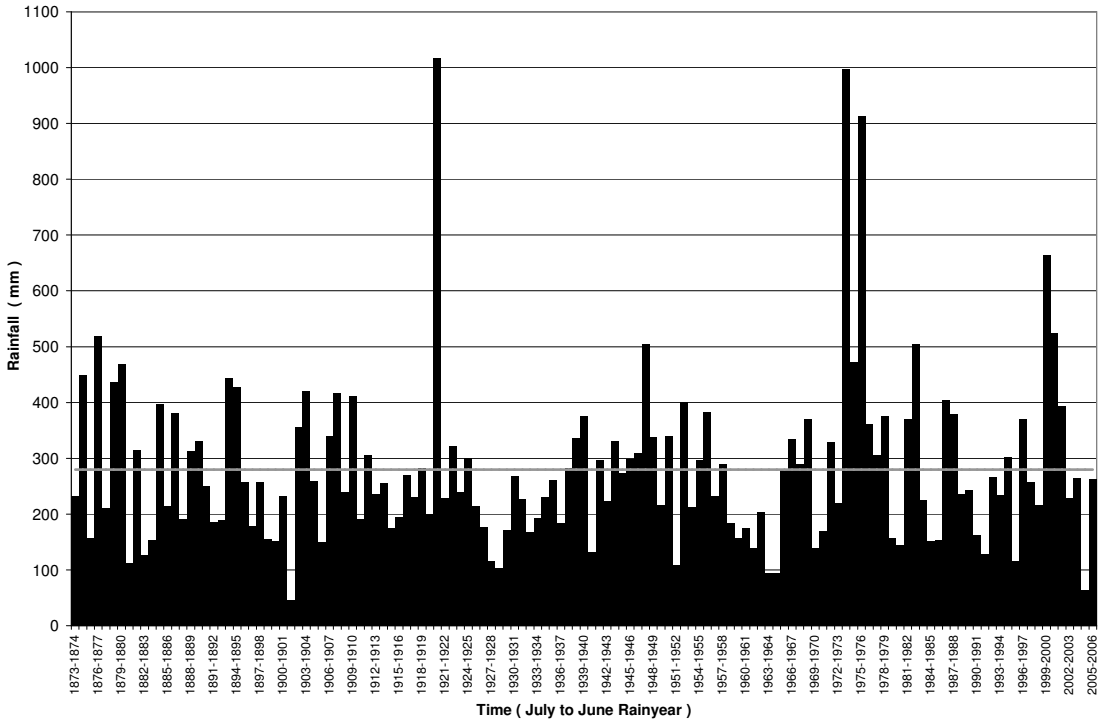

Figure 2.2: Alice Springs rainfall: 1873–2006, calculated for the July to June rainyear
Note: The rainyear average was 280 mm.

Although the previous comments regarding periods of extensive fires are generally applicable to the non-pastoral regions beyond the pastoral areas, especially during times of exceptional rainfall, the regular patterns of burning in the non-pastoral regions are less well known. Initially, our records of fires in these areas were more restricted than those of the pastoral areas. Gill (2000) provided a more detailed interpretation of the historical records and speculated on potential fire sizes.

The opportunity for the first spatial perspective on fires in the non-pastoral regions was associated with the first widespread aerial photography missions to map inland Australia in the 1950s. Allan (1984) used these photographs to map several large fires that burnt the country surrounding Uluṟu–Kata Tjuṯa National Park (UKTNP) in 1950 following a period of above average, but not exceptional, rainfall through the late 1940s. Burrows and Christensen (1990) also used aerial photographs taken in the 1950s to map and document the patterns of fires in the Gibson Desert region of Western Australia. The next extensive aerial photography missions over inland Australia were not until the early 1970s. However, there are few reports of their application to fire mapping due to their timing, which preceded the major fire events of the mid-1970s. Monitoring and understanding fire events through central Australia

improved dramatically after October 1979 with the commissioning of the Landsat satellite receiving station in Australia. The regular acquisition of satellite images changed the perspective on fires from isolated snapshots in time to regular monitoring and mapping. However, their application was slow to develop and reach its potential because of the high cost of the imagery and limited computer processing opportunities. The cost and processing limitations have now been reduced so that our spatial perspective and fire mapping capabilities can use a diversity of satellite data.

The information on fire throughout central Australia is no longer restricted to fire reports focused on the pastoral regions (Saxon 1983, Burrows & Christensen 1990, Allan 1993, Curry 1996, Pianka 1996, Masters et al. 1997). It is possible to recognise differences in fire regimes between the non-pastoral and pastoral regions. Fires are more common in the non-pastoral regions, and more closely linked to periods of above average but not exceptional rainfall. There are numerous factors associated with the higher fire occurrence, such as:

- the dominance of spinifex as the primary fuel type in the desert areas
- the relatively low degree of fuel removal by grazing animals
- an absence of fire suppression, except on the margins of the pastoral leases
- more fire ignitions from Aboriginal people who are burning for hunting and signalling
- an increased access to country, over the past 30 years, that has changed the balance from lightning to human-ignited fires.

2.3.3 Summary of fire occurrence during the 1970–1980 period

Knowledge of the fires in central Australia during the 1970s is derived mainly from fire reports of the Bushfires Council of the NT. The data in the fire reports were collated and analysed by Griffin et al. (1983). Other information derived from satellite imagery has also been used to complement the fire report data.

The primary information in the fire reports included fire date, ignition source, and estimated area burnt (usually derived by rough estimates from the limits of the fire and frequently assessed during aerial survey of the active fire). The fire reports were analysed for the central Australian portion of the NT south of -21°. It excluded fires in both the Simpson Desert and ‘western desert’ regions beyond the limit of pastoral leases because estimates of fire size were based primarily on aerial survey and fires that were reported or extended into these areas were not surveyed. A representation of the patterns of fires in central Australia has been shown as a map of the number of fires reported for each cadastral unit during the 10-year period from July 1970 to June 1980 (Figure 2.3) and as a map of area burnt by cadastral unit for the three-year period of greatest fire activity from July 1974 to June 1977 (Figure 2.4).

A summary of the fires illustrating area burnt by major vegetation community and ignition source is listed below in Table 2.1 (adapted from Griffin et al. 1983). Using the original data, the second half of the table provides a summary of the three-year period July 1974–June 1977. While 51% of the fires occurred in the three years, the mean fire size was larger in each major landscape type and the area burnt was 81% of the 10-year total. Also, the proportion of the fires caused by lightning increased from 58% over the 10-year period to 71% for the three-year period of higher rainfall and fuel loads.

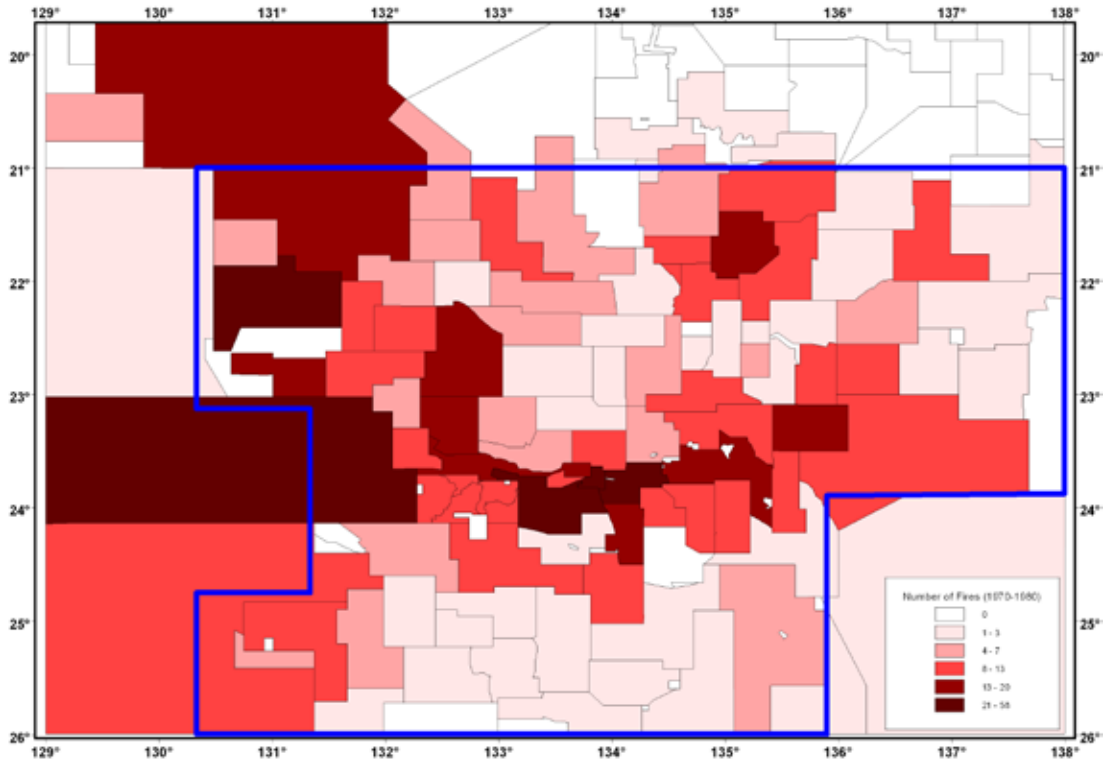

Figure 2.3: Bushfires Council NT records of the number of fires reported by cadastral unit in central Australia, July 1970 – June 1980

Note: The blue polygon is the approximate limit of the area defined by Griffin et al. (1983) as representing the majority of pastoral leases of the Alice Springs region. The map covers the southern Northern Territory (south of -20°) and extends to the boundaries of Queensland, South Australia and Western Australia.

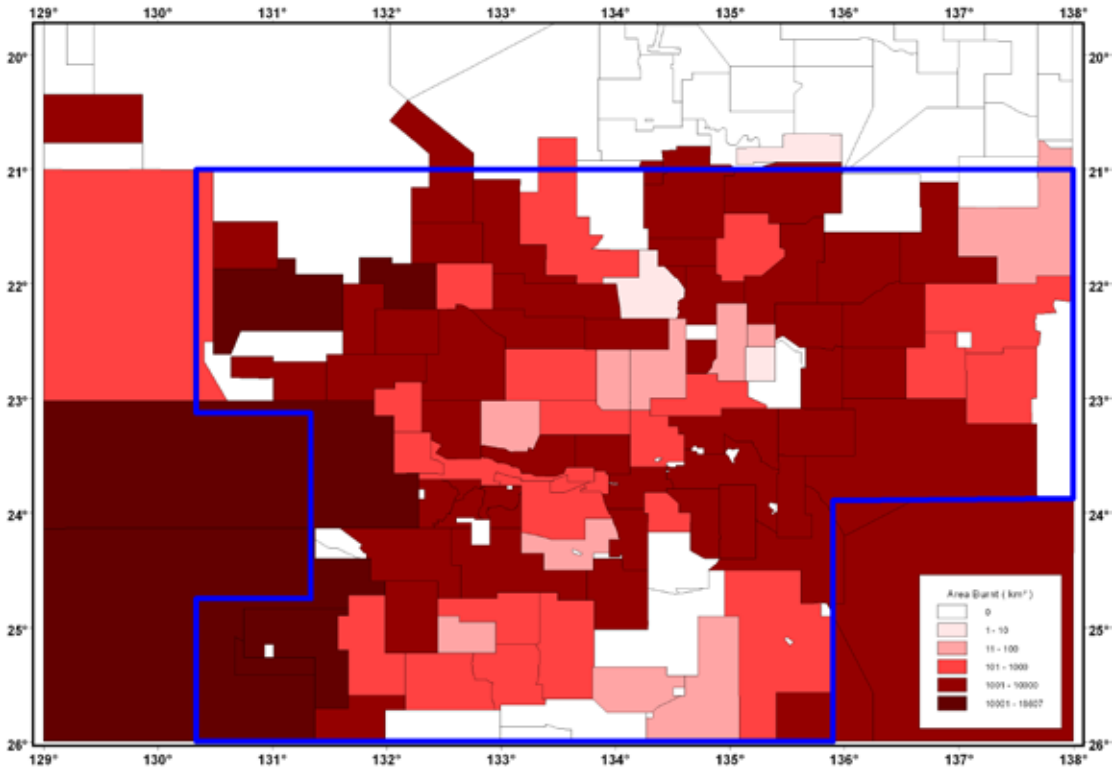

Figure 2.4: Bushfires Council NT records of the area burnt reported by land tenure in central Australia, July 1974 – June 1977

Note: The blue polygon is the approximate limit of the area defined by Griffin et al. (1983) as representing the majority of pastoral leases of the Alice Springs region. The map covers the southern Northern Territory (south of -20°) and extends to the boundaries of Queensland, South Australia and Western Australia.

Table 2.1: Comparison of fire numbers, area and causes in central Australia, July 1970 – June 1980

	Spinifex	Hills	Acacia shrubland	Plains	TOTAL
All fires 1970–1980					
Total number of fires	301	162	35	287	785
Total area burnt (km²)	177 908	34 068	13 357	78 939	304 272
Mean fire size (km²)	591	210	381	274	
Caused by lightning (%)	66	57	48	53	58
Caused by people (%)	23	36	43	42	34
Unknown (%)	11	7	9	5	8
All fires 1974–1977					
Total number of fires	158	87	17	160	422
Total area burnt (km²)	140 769	20 289	12 611	72 375	246 044
Mean fire size (km²)	890	233	741	452	
Caused by lightning (%)	68	64	59	69	67
Caused by people (%)	24	32	24	29	28
Unknown (%)	8	3	18	3	5

Source: Griffin et al. 1983

The first spatial fire history database for central Australia was compiled in 1985 from Landsat images (Allan 1993). It was created as a 'time since last fire' database. The study used a sequence of annual images between 1980 and 1985, usually acquired in April following the summer fire season. For the majority of central Australia the most recent fires were during the 1970s, and it was possible to map many of these areas using available images, which included both aerial photographs and the few available satellite images acquired during the period 1972–1979 (between the launch of the first Landsat satellite and the commissioning of the Australian receiving station).

Figure 2.5 is a map of areas burnt during the 1970s, extracted from the spatial fire history database. There were several limitations of the database as a representation of fire activity during the 1970s. The first was the research objective to compile a 'time since last fire' database. It only mapped the latest complete fires. Areas burnt by previous fires were only partially represented as unburnt fragments of the subsequent fire. A second limitation was due to the delay between the date of fires and the satellite images. Many burnt areas probably represented several fires that burned to a common edge, and therefore it does not represent the number of fires. Also, only a few fires in the non-spinifex vegetation communities of the pastoral leases were mapped, because subsequent rainfall and cattle grazing decreased the persistence of the burnt pattern. A third limitation was the irregularity of the satellite images and aerial photography acquired prior to 1979, which restricted the ability to date fire age. Therefore, time of fire occurrence was limited to the number of years between image dates or an estimate based on information from the Bushfires Council fire reports database in combination with the density of vegetation cover interpreted from the images. As a result there was no correlation of the area burnt data between the Bushfires Council fire reports and the satellite-derived fire history (Figure 2.6).

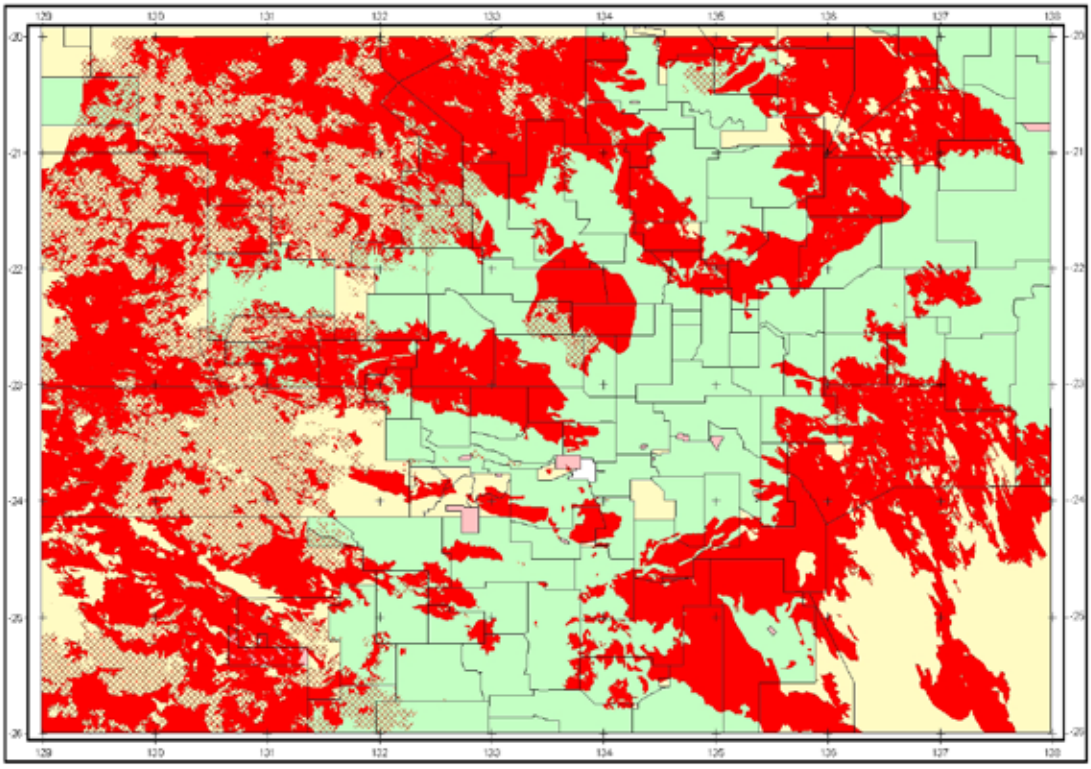

Figure 2.5: Fire history of central Australia, 1972–1984

Note: Image derived from Landsat images and created as time since burnt prior to 1985 (Allan 1993). Fires during the period 1972–1979 are solid red, and subsequent fires from 1980 to 1984 are hatched red. The fires have masked areas burnt by previous fires during the 1970s. Pastoral leases are green, Aboriginal Land Trusts are yellow and conservation areas are light red. The map covers the southern Northern Territory (south of -20°) and extends to the boundaries of Queensland, South Australia and Western Australia.

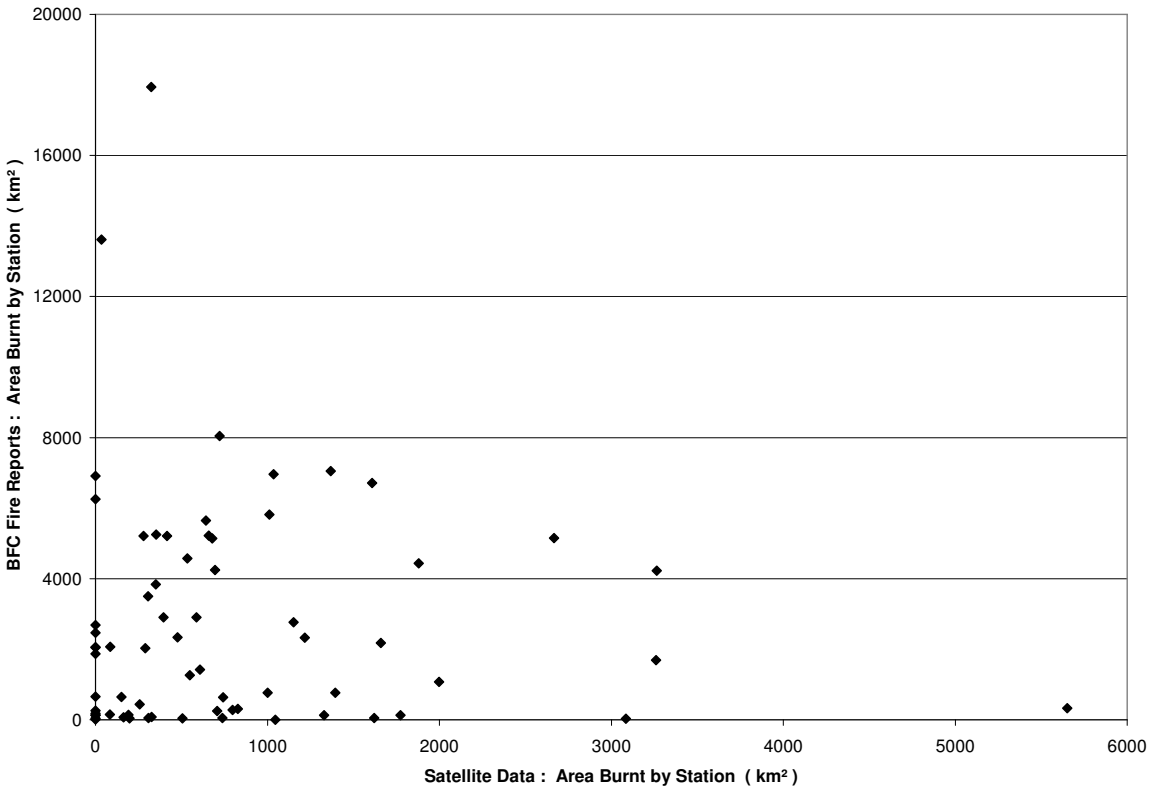

Figure 2.6: Scatter plot of the Bushfires Council NT records

Note: Plot shows the area burnt as reported by cadastral unit in central Australia for the period July 1974 – June 1977 (Griffin et al. 1983) against the area burnt by cadastral unit derived from the fire history of central Australia for the period 1972–1979 derived from Landsat images (Allan 1993).

2.3.4 Summary of fire occurrence during the 2000–2002 period

The start of the 'good' seasons, which were three years of above average rainfall across central Australia, began with early summer rainfall in October 1999. By May 2000, Alice Springs had received 660 mm of rain (average rainfall is 278 mm) and fuel loads of grasses and other herbage were increasing. The first fires began in July 2000 in the Tanami Desert region, primarily in areas that had not been burnt by previous fires in 1993/94 (Figure 2.7). The good rainfall had quickly increased the continuity of the fuel load with the addition of non-spinifex fuels, both annual grasses and forbs, between the spinifex hummocks. A second summer of above average rainfall over the six-month period October 2000–March 2001 continued to increase the fuel loads in the pastoral district where grass growth far exceeded cattle consumption. Almost all fires in 2001 occurred north of Alice Springs and began shortly after the rains stopped. Initially, most fires began in spinifex country, but by September all types of country were burning. Widespread rainfall in November and December 2001 suppressed the fires (Figure 2.8). This helped many burnt areas recover, but also increased the fuel loads in the unburnt areas. The summer rains ended abruptly in February 2002 and the third season of fires began. Winter 2002 was cold and dry, with many frosts which rapidly cured all the drying fuel loads. The fire danger increased with the warmer weather in September 2002. Fires were widespread throughout the Alice Springs district in September and October 2002, with the area south of Alice Springs experiencing its first fires, and many areas north of Alice Springs experiencing a second season of fires, with some areas burning a second time (Figure 2.9). November 2002 had the highest occurrence of fires (Figure 2.8), before rains between December 2002 and February 2003 suppressed the fires and ended the period of exceptional fires.

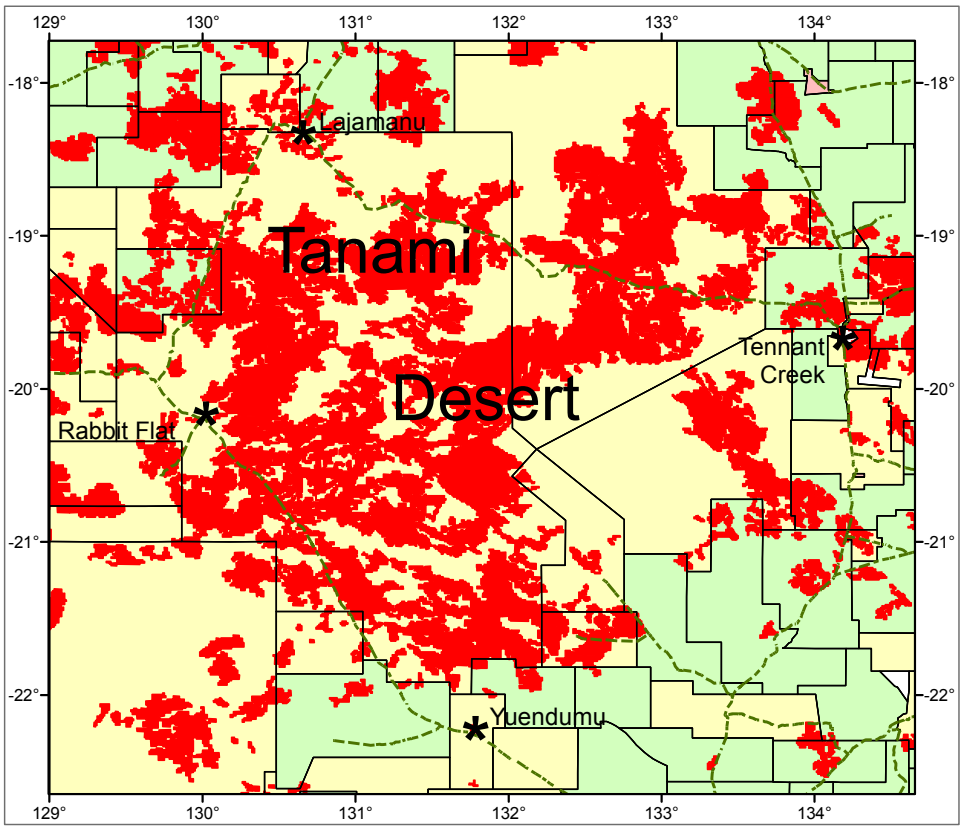

Figure 2.7: The pattern and extent of fires in the Tanami Desert between July and November 2000
Note: Image derived from NOAA AVHRR images. A total area of 81 000 km² was burnt during the five-month period.

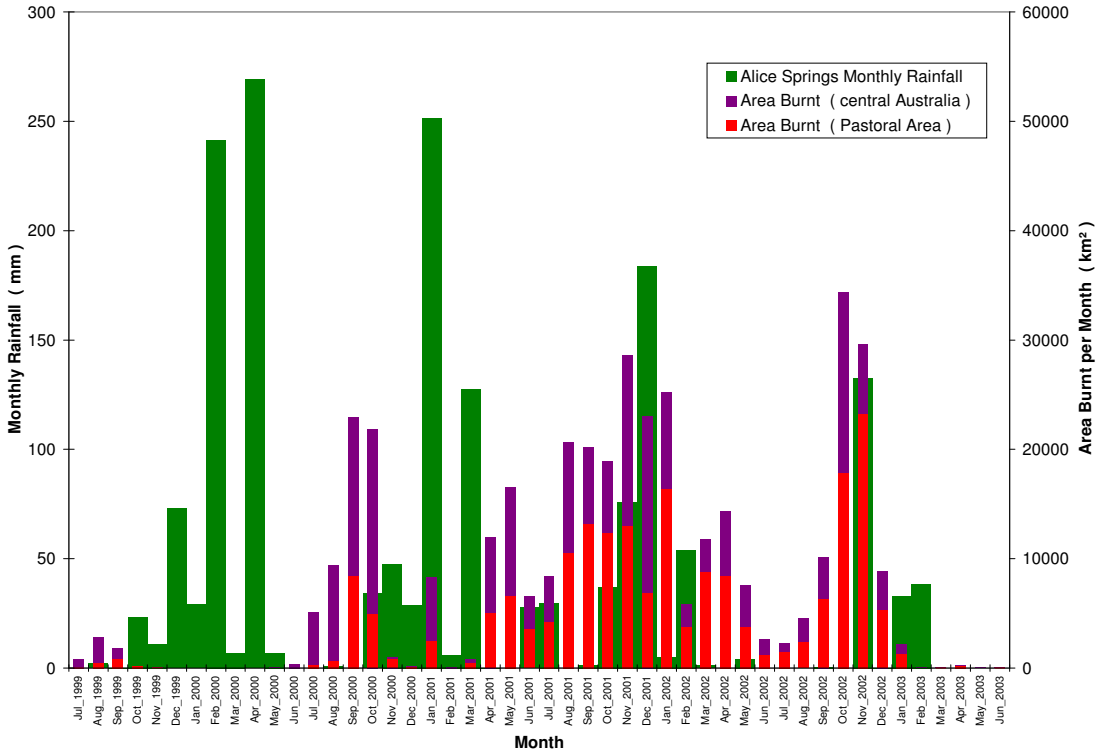

Figure 2.8: The pattern of fires in relation to rainfall in central Australia, four-year period July 1999 – June 2003

Note: The monthly area burnt data is shown for both the Alice Springs pastoral district (365 000 km²) and the total area of central Australia, the NT south of -20° (620 000 km²).

Table 2.2 provides a summary of the area burnt on pastoral properties in the Alice Springs pastoral district during 2001 and 2002. Only one station completely escaped the fires. A few others had minimal areas burnt. There was a clear separation of fire occurrence north and south of Alice Springs and the MacDonnell ranges. While 15 stations had greater than 50% of the property burnt in one season, the impact was greater for those burnt in 2002, especially for four stations south of Alice Springs. These stations did not receive sufficient rainfall to help with post-fire recovery of pasture.

Table 2.2: Area burnt on pastoral properties in the Alice Springs pastoral district of central Australia, 2001 and 2002

AS Pastoral District – 72 Stations	**2001**	**2002**	**Both**
no fires	27	2	1
< 15% burnt	20	38	10
15–50% burnt	18	24	11
> 50% burnt	7	8	0
North of MacDonnell Ranges – 45 Stations	**2001**	**2002**	**Both**
no fires	7	1	0
< 15% burnt	13	27	7
15–50% burnt	18	13	11
> 50% burnt	7	4	0
South of MacDonnell Ranges – 27 Stations	**2001**	**2002**	**Both**
no fires	20	1	1
< 15% burnt	7	11	3
15–50% burnt	0	11	0
> 50% burnt	0	4	0

Note: The data was derived from NOAA AVHRR imagery with a 1 km² minimum resolution.

Figure 2.9 shows the total area burnt in central Australia, including areas burnt twice during this three-year period. The majority of the landscape that burnt twice was spinifex-dominated, but the fuel loads of the second fire were predominantly non-spinifex grasses. Relatively few woody species in these areas are fire-sensitive to short inter-fire intervals and the results of recent studies of these vegetation communities should be used to improve fire management of these landscapes (Nicholas 2008, Wright 2007).

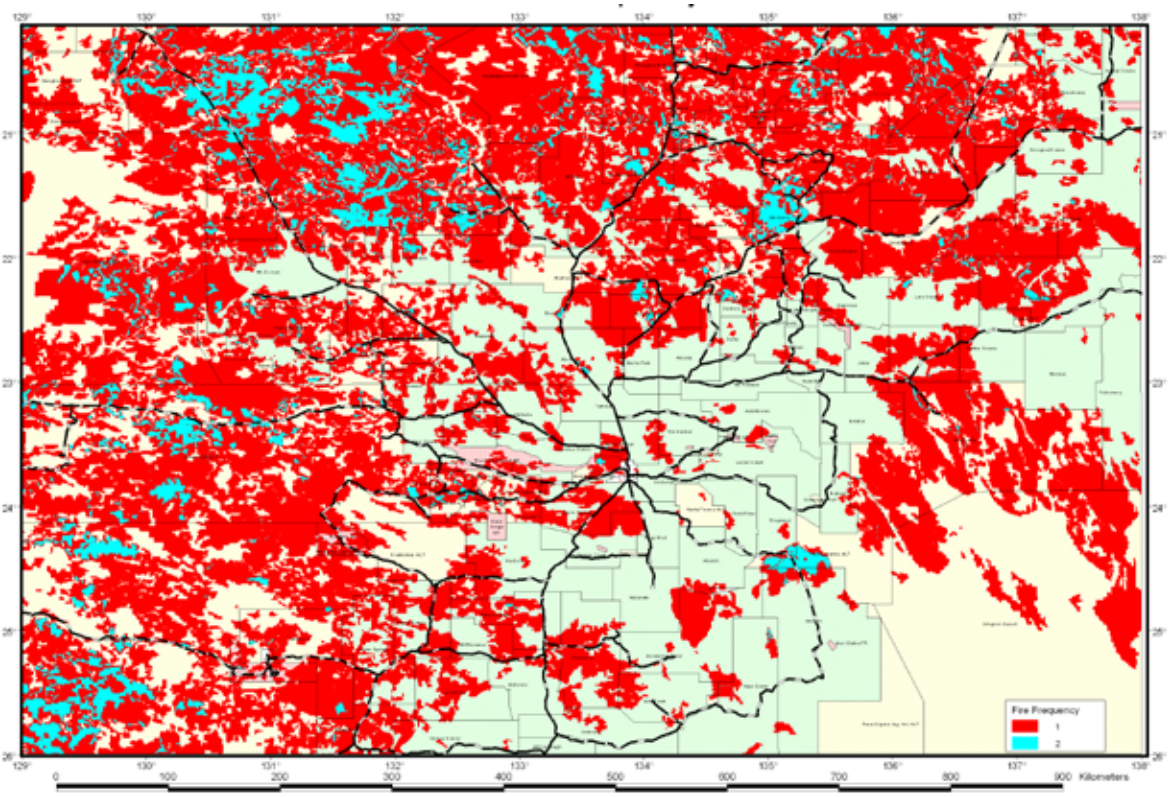

Figure 2.9: Fire history of central Australia, 2000–2002

Note: Areas burnt once are red and areas burnt twice are cyan. Data were derived from NOAA AVHRR images and provide a regional perspective only and have inaccuracies at fine scales. The map covers the southern Northern Territory (south of -20°) and extends to the boundaries of Queensland, South Australia and Western Australia.

2.3.5 Rainfall thresholds and fire events

Fires are a regular feature in the landscape of central Australia, occurring every year somewhere across the region. Episodes of extensive wildfires, however, are closely associated with periods of above average rainfall, when there is enough fuel to carry fires over large distances. Due to the erratic nature of rainfall in central Australia, this combination of above average seasons occurs sporadically. Based on Bushfires Council fire reports in the pastoral region of central Australia during the 10-year period of the 1970s, Griffin et al. (1983) established significant correlations between both annual wildfire numbers and area burnt and cumulative rainfall during the previous three years using Alice Springs as a representative location (Figure 2.10). Additional fire history information for central Australia derived from satellite images for the period 1980–2002 was combined with the 1970s data to further test the relationship for area burnt and cumulative rainfall. The satellite-derived fire history information was a combination of fire history data mapped from both Landsat and NOAA AVHRR images. Although the spatial resolution of the imagery is quite different, validation of area burnt data indicates its suitability at a regional scale (Collett et al. 2001, Yates 2001). A similar strong relationship was derived for annual area burnt (Figure 2.11), but the AVHRR-derived data was not able to be used to calculate number of fires to test both relationships. Nonetheless, an interpretation of the patterns of fire in the pastoral region

was supportive. It was only during the mid-1970s and 2001–2002 that fuel accumulation exceeded cattle consumption in the non-spinifex areas of the grazing lands and continuous fuel loads were able to accumulate and carry fires.

For the majority of years between the widespread fires of the mid-1970s and those of 2001–2002, the fires were mainly restricted to spinifex communities, rather than the non-spinifex pasture areas. Nonetheless, there was still a strong relationship between rainfall and fire. During these times the rainfall may be less extensive and more regionalised in central Australia. The fires are more aligned with only two years of above average rainfall, and the Alice Springs meteorological station is less representative. There are two peaks in the two-year cumulative rainfall record for Alice Springs between the large rainfall events of the mid-1970s and 2000–2002. These occurred in 1983–84 and 1988–89 (Figure 2.12).

Fires were associated with each of these events, although there was a significant difference in the distribution and extent of the fires (Figure 2.13). There was also a third period of fires in central Australia during 1993–94 that does not correlate with a rainfall peak in Alice Springs. In each case the largest fires were in the spinifex landscapes of the desert regions and patches within the pastoral leases, although some smaller fires did burn some non-spinifex pastoral leases. The fires were linked with both a rapid increase of spinifex cover and good pasture growth.

It is necessary to investigate the variability of the spatial patterning of the rainfall across central Australia to better understand the differences in area burnt between the three periods of fires. It is appropriate to focus on the two later fire periods, 1989–90 and 1994–95, to illustrate the importance of using other rainfall recording stations rather than relying on Alice Springs to be an adequate representative of central Australia. The 1989–90 event was in the south-west portion of central Australia and the 1994–95 event was in the Tanami Desert area north-west of Alice Springs (Figure 2.14).

Rather than relying on the two-year or three-year cumulative rainfall for the July to June rainyear as a predictor of fire numbers and area burnt as proposed by Griffin et al. (1983), an alternative approach to using these relationships is to track the monthly patterns of 24-month cumulative rainfall to better monitor seasonal conditions and use thresholds to predict the seasonal fire outlook. For sub-regional areas of central Australia, especially the desert areas, it is important to track the 24-month cumulative rainfall patterns in as many locations as possible. The potential for fires as well as opportunities to burn are increased when the 24-month cumulative rainfall exceeds 1.2 times average (120%). This potential may be restricted by the pattern of recent fires and the overall time since burnt across the landscape.

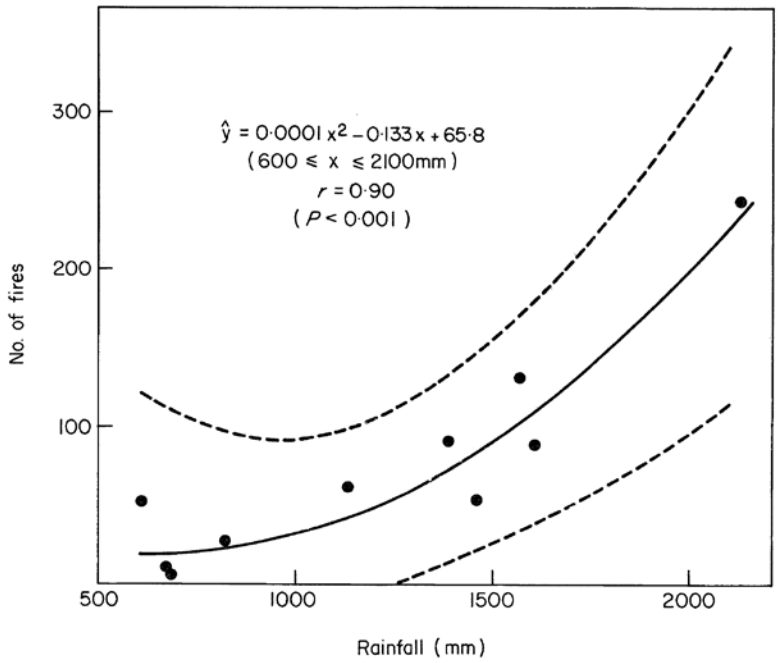

Figure 3. Comparison of total number of fires and 3 years of cumulative antecedent rainfall, for the period July 1970 to June 1980 in central Australia. Rainfall values from Alice Springs. – – –, 95% confidence limits.

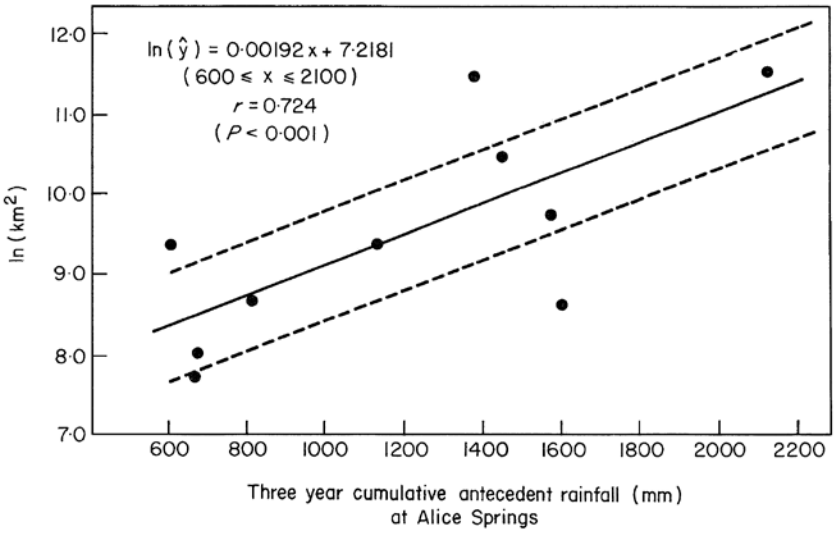

Figure 4. Comparison of total area burnt and 3 years of cumulative antecedent rainfall for the period July 1970 to June 1980 in central Australia. Rainfall values from Alice Springs. – – –, 95% confidence limits.

Figure 2.10: Relationship between number of fires and area burnt with 3-year antecedent rainfall

Source: Griffin et al. 1983

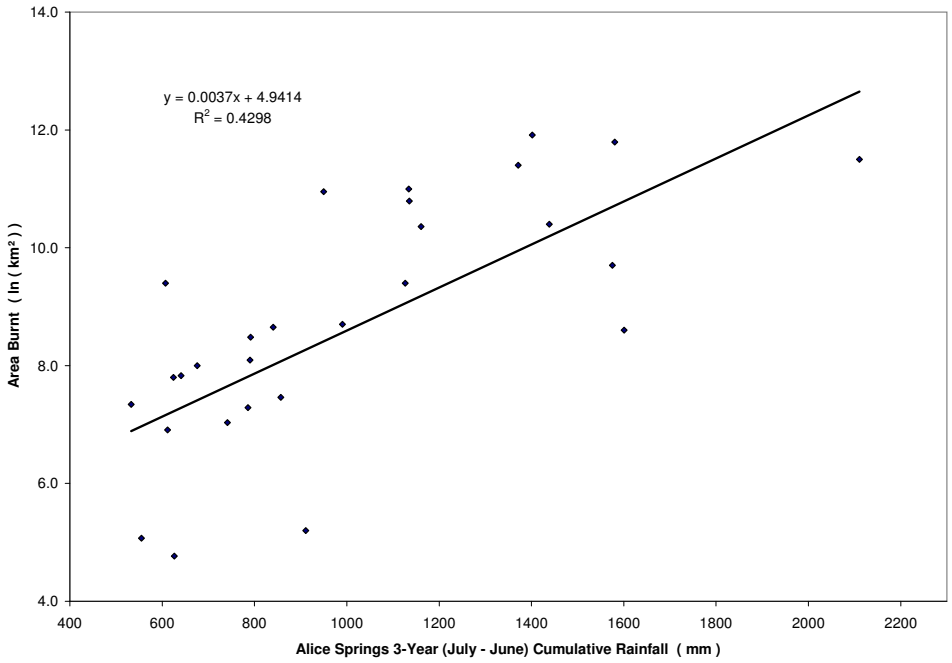

Figure 2.11: Relationship between area burnt in central Australia and three-year antecedent rainfall, 1970–2002
Note: The data used combined the 1970–1980 dataset used by Griffin et al. (1983) plus satellite derived area burnt data for the period 1980–2002.

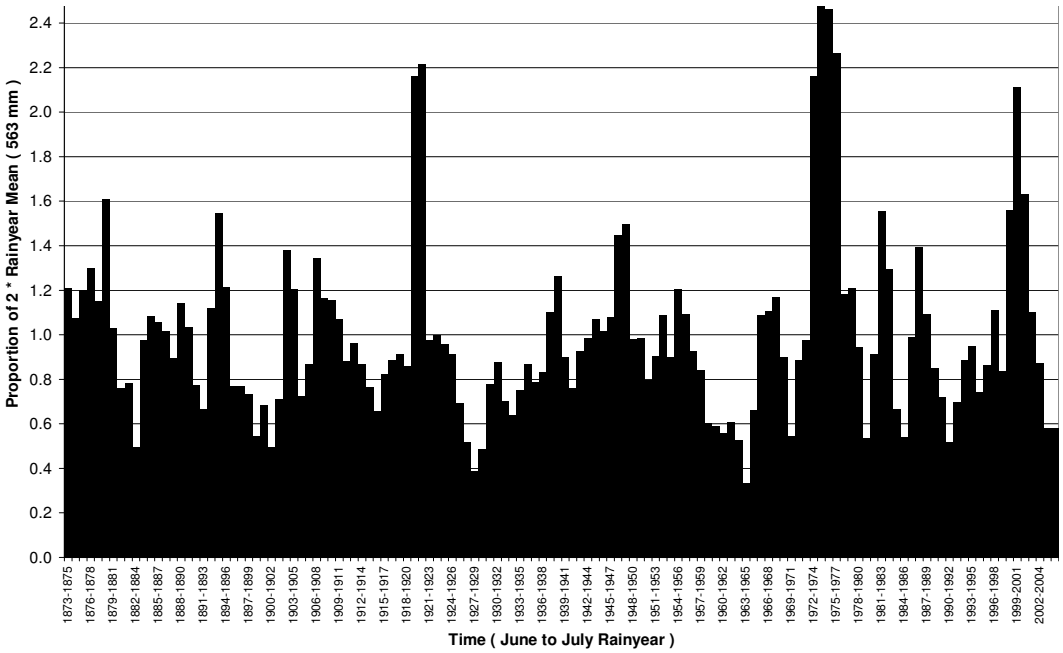

Figure 2.12: Alice Springs two-year cumulative rainfall 1873–2005 calculated for July to June rainyears and expressed as a proportion of the two-year average of 563 mm

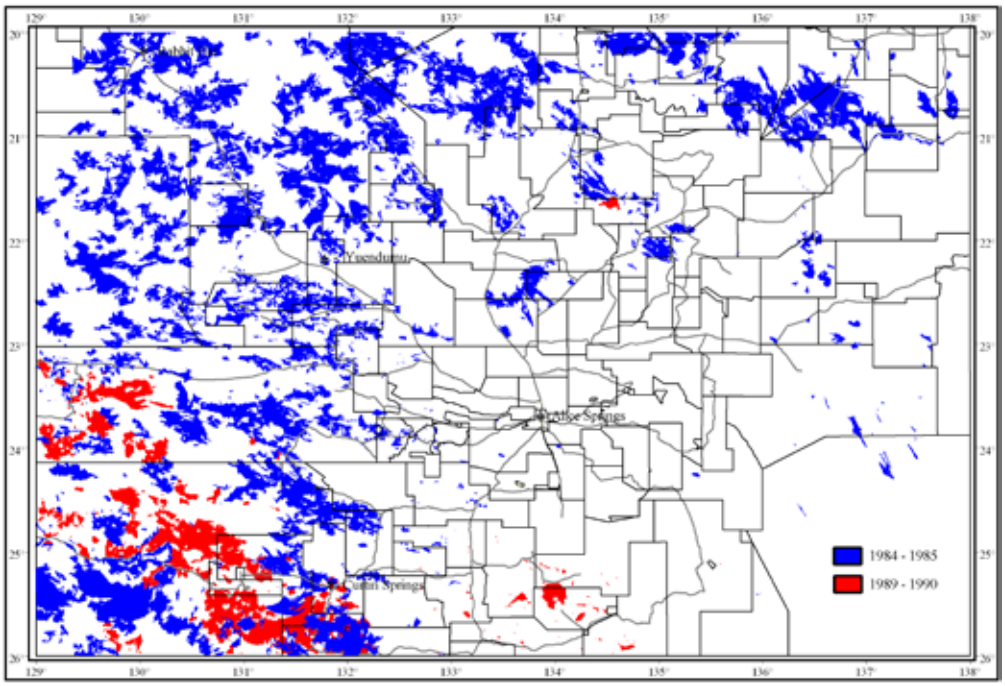

Figure 2.13: Burnt areas associated with the 1983–84 and the 1988–89 periods of above average two-year cumulative rainfall recorded at Alice Springs

Note: The map covers the southern Northern Territory (south of -20°) and extends to the boundaries of Queensland, South Australia and Western Australia.

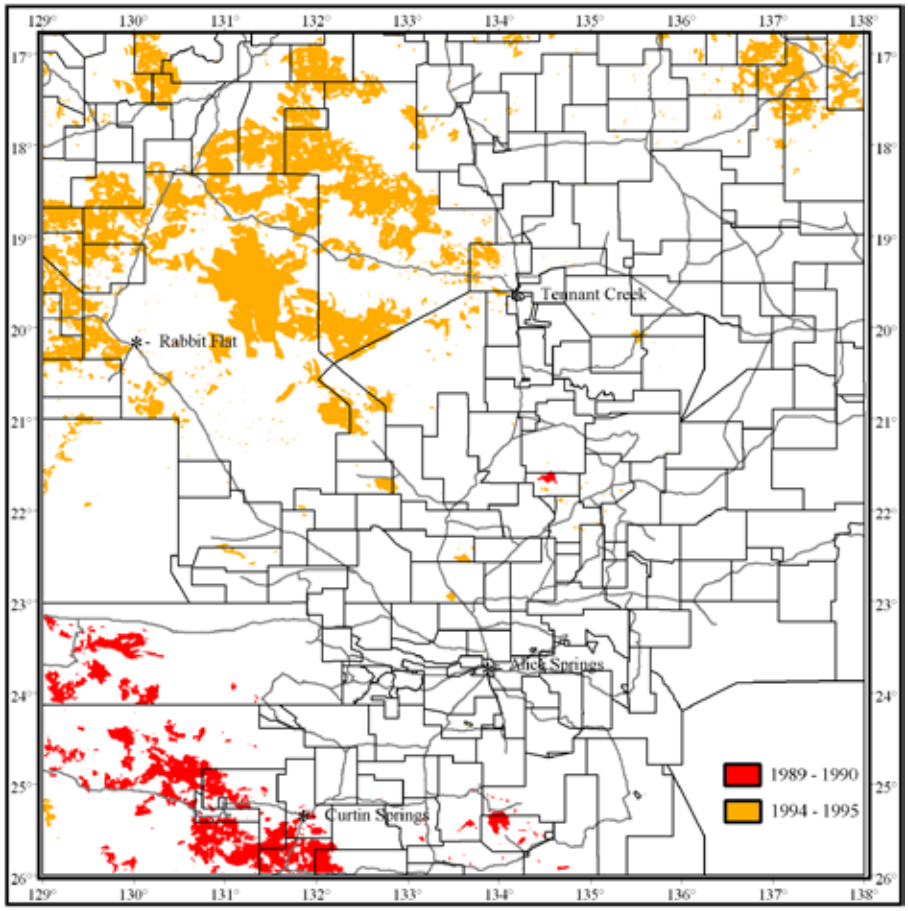

Figure 2.14: Burnt areas associated with above average two-year cumulative rainfall in sub-regional areas of central Australia

Note: The rainfall during 1988–89 was most effective in the south-west of the NT, whereas the 1993–94 rainfall was associated with a monsoonal depression across the central region of the NT. The map covers the southern Northern Territory (south of -17°) and extends to the boundaries of Queensland, South Australia and Western Australia.

The 24-month cumulative rainfall threshold and its variability between sub-regional fire events is described for two fire events. For the 1989–90 fires in the Uluru region south-west of Alice Springs the 120% 24-month cumulative rainfall threshold was reached at Curtin Springs and maintained for a considerable time period, whereas in Alice Springs the 120% threshold was exceeded only as a sharp peak associated with a major rainfall event in a single month and not for a sustained period (Figure 2.12). The difference was more effective rainfall that contributed to greater fuel accumulation in the south-west than near Alice Springs. For the 1993–94 fires in the Tanami Desert north-west of Alice Springs the 120% 24-month cumulative rainfall threshold was reached at Rabbit Flat but not in Curtin Springs or Alice Springs (Figure 2.15).

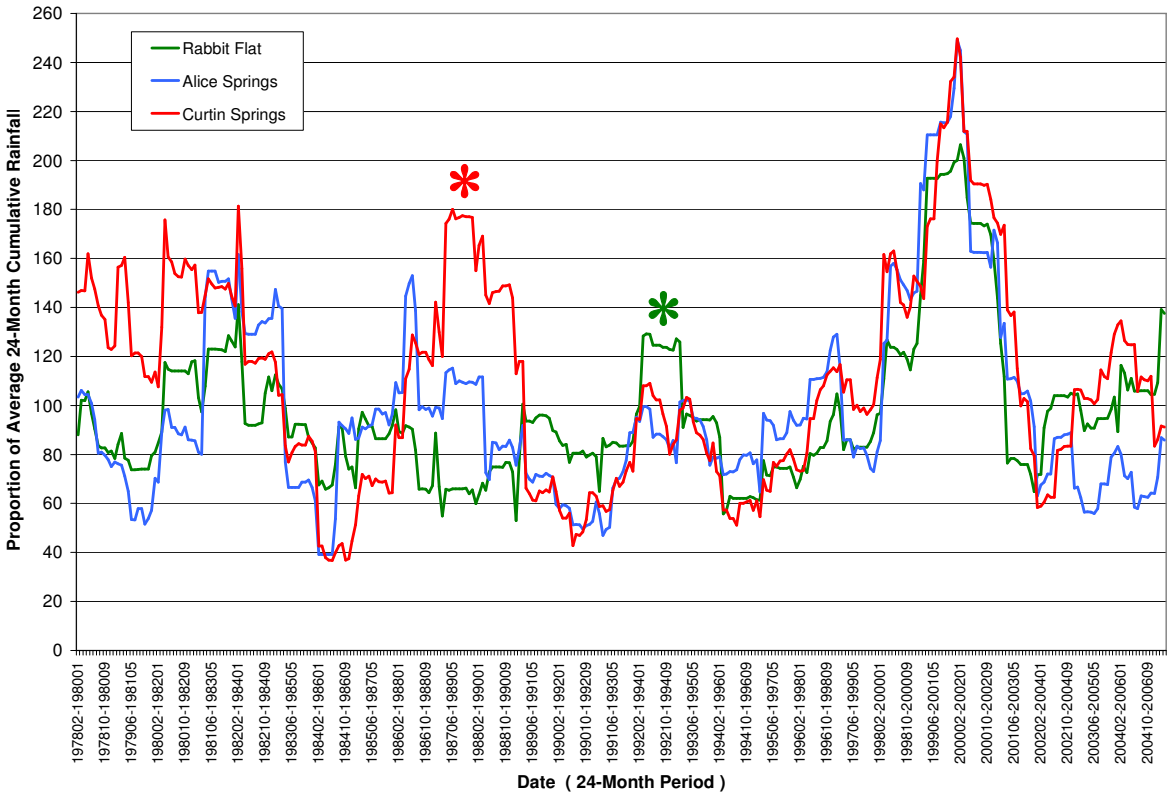

Figure 2.15: Rabbit Flat, Alice Springs and Curtin Springs Station Rainfall, 1980–2007

Note: Rainfall represented as the running total of 24-month cumulative rainfall expressed as a percent of the average 24-month cumulative rainfall for the available recording period. Average 24-month rainyear values were 918 mm for Rabbit Flat (1969–2006), 564 mm for Alice Springs (1873–2006) and 456 mm for Curtin Springs (1953–2006). The rainfall peaks associated with the 1989–90 fires in the south-west NT and the 1993–94 fires in the Tanami Desert are marked by the asterisks.

For the larger, more extensive fire events that affect all of central Australia, it is important to build on the relationship from Griffin et al. (1983) by tracking the monthly patterns of 36-month cumulative rainfall. The potential for fires as well as opportunities to burn, especially within the non-spinifex areas of the pastoral leases, are increased when the 36-month cumulative rainfall in Alice Springs, as representation of central Australia, exceeds 1.5 times average (150%). These events are much rarer than the 24-month sub-regional events, with only three recorded during the past century (Figure 2.16). Our experience with these events is really restricted to only the mid-1970s and 2000–2002 periods, and a higher threshold (175%) may be appropriate (Figure 2.17).

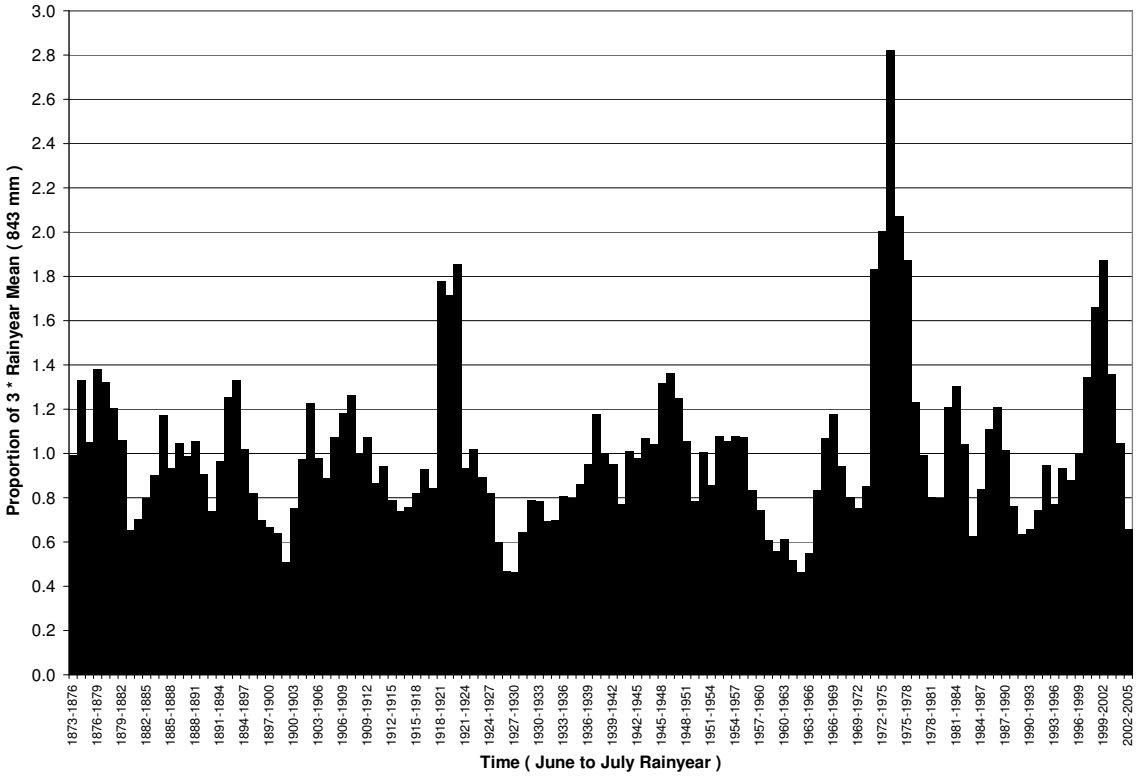

Figure 2.16: Alice Springs 3-year cumulative rainfall, 1873 to 2005

Note: Rainfall calculated for July to June rainyears and expressed as a proportion of the 3 x rainyear average of 843 mm. The three peaks where 3 x rainyear total exceeds 1.5 x average are the periods of widespread fires in central Australia: the early 1920s, the mid 1970s and 2000–2002.

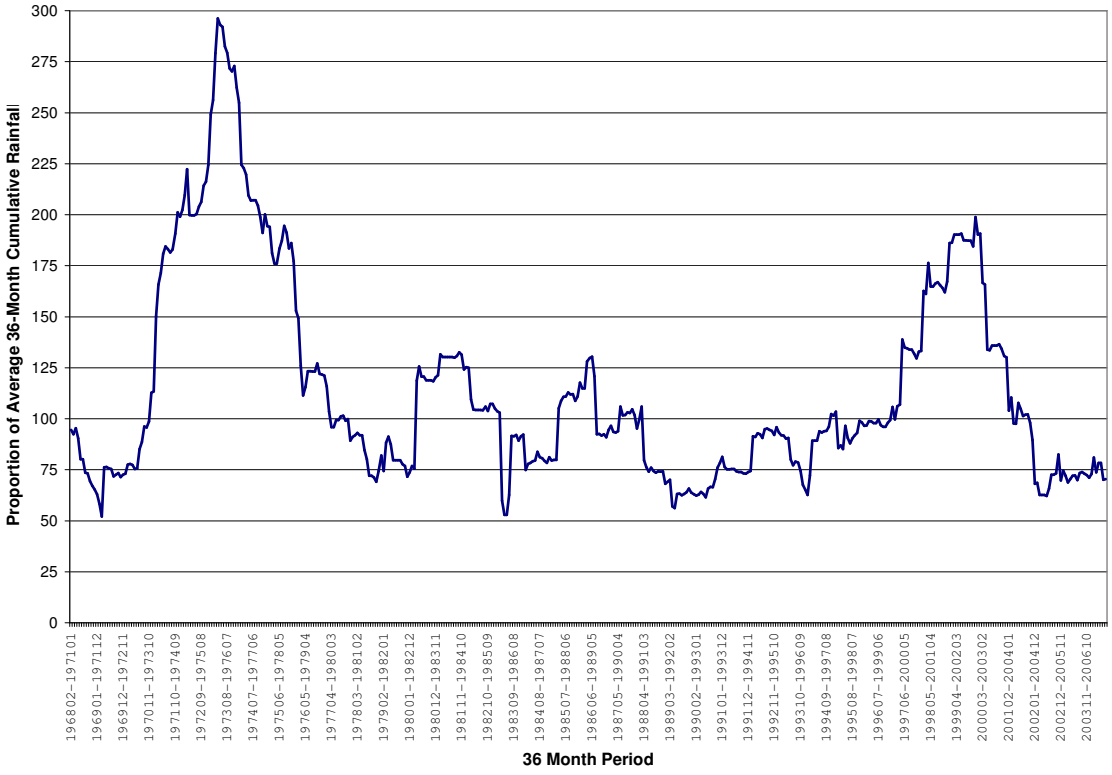

Figure 2.17: Alice Springs Rainfall, 1971–2006

Note: Rainfall represented as the running total of 36-month cumulative rainfall expressed as a percent of the average 36-month cumulative total for the July to June rainyear. The average 36-month cumulative rainfall was 843 mm for Alice Springs (1873–2006).

Another investigative approach to understanding seasonal patterns of rainfall and the significance of thresholds uses the sequence of rainyears relative to the average. Although fires are associated with periods of above average rainfall years, their occurrence with respect to periods of below average years may influence the occurrence and patterns of fire. The frequency distribution of periods of successive July to June rainyears relative to average shows there have been five periods when three or more years of above average rainfall were recorded at Alice Springs (Figure 2.18).

There are three periods of three consecutive years of above average rainfall (A3): the first two (1937–1940 and 1966–1969) are immediately after the major 12-year drought of 1925–1937 (B12) and the 8-year drought of 1958–1966 (B8). Both were also only relatively small above average events, only 120% of the long-term 3-year rainyear average. The inability of the landscape and fuel loads to recover rapidly after such long droughts probably contributed to the relatively low proportions of areas burnt and their absence in the records of periods of widespread fire described previously. In contrast, the 1999–2002 period was 190% of the long-term 3-year rainyear average and it followed only two years of below average rainyears (1997–1999) that had received 80% of the long-term 2-year rainyear average.

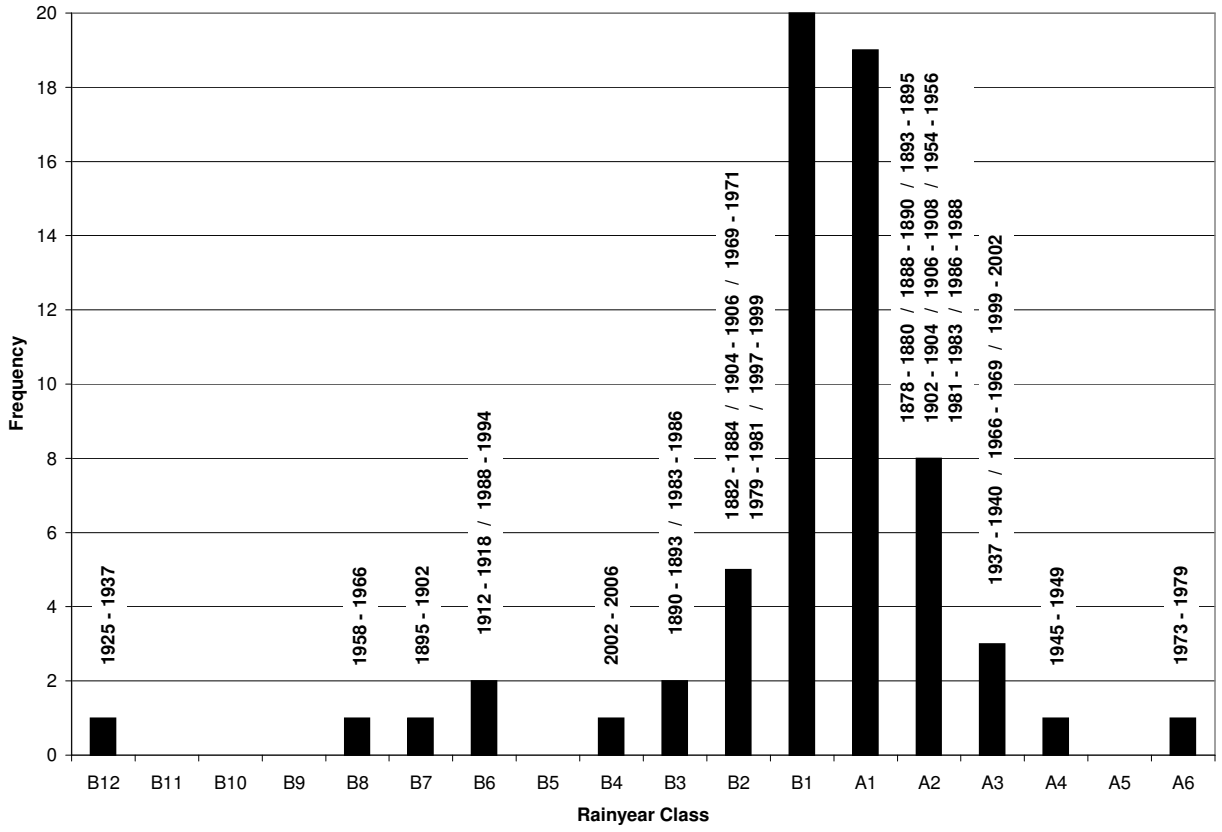

Figure 2.18: Frequency distribution of sequences of above and below average rainyear classes

Note: B12 indicates a period of 12 consecutive June to July rainyears with below average rainfall, and A6 indicates a period of 6 consecutive rainyears of above average rainfall. The years when each event occurred are shown above each column, with the exception of both the B1 and A1 classes.

The only four-year period of above average rainfall (A4; 1945–1949) was only a moderately wet period. The wettest three years (1946–1949) were only 140% of the long-term 3-year rainyear average, and the wettest two years (1947–1949) were 150% of the long-term 2-year rainyear average. Fires were known to have occurred in the desert regions of central Australia (Allan 1984, Burrows & Christensen 1990). The availability of aerial photography from 1950 for most of central Australia should be used to map fire patterns to improve our knowledge of fire events associated with that period of above average rainfall.

The fires of the early 1920s were not associated with any of the rainyear periods shown in Figure 2.18. It was an unusual event of one year of exceptional rainfall (1017 mm in Alice Springs) within a 7-year period of alternating below and above average rainyears. Unfortunately, there are only anecdotal records of the fires and a very limited opportunity (possibly through charcoal deposits or patterns of long-unburnt individual plants) to learn more about the areal extent and impact of these fires.

This figure challenges the popular idea that in central Australia periods of above average rainfall have occurred on cycles of approximately 30 years. Although periods of above average rainfall have occurred, the periodicity is less predictable. Land managers must be prepared to respond to seasonal conditions as they occur and not rely on anticipated cycles, especially with consideration of the anticipated uncertainties associated with climate change predictions.

2.3.6 Comparison of 1974–1977 and 2000–2002 fire events

There was limited opportunity to directly compare the 1974–1977 and the 2000–2002 fire events in central Australia. Comprehensive fire reports collected by the Bushfires Council NT during the 1970s were not collected during 2000–2002. The satellite images that were readily available in 2000–2002 were not available during the 1970s. However, monthly totals of area burnt provide an opportunity to compare the temporal patterns of fires between the two fire periods (Figure 2.19). During both fire periods the typically hot summer months were the dominant fire season; however, there was a slight difference in the peak month. During the 1970s the November peak was associated with fires started by lightning (Table 2.1). The greatest difference was the higher fire activity in the cooler months of March–August during 2000–2002. These fires were associated with fires started by human ignition, often from roadsides. The following discussion describes aspects of central Australia that changed between the mid-1970s and 2001 and contributed to the changes between the latest two periods of widespread fires associated with three-years of above average rainfall.

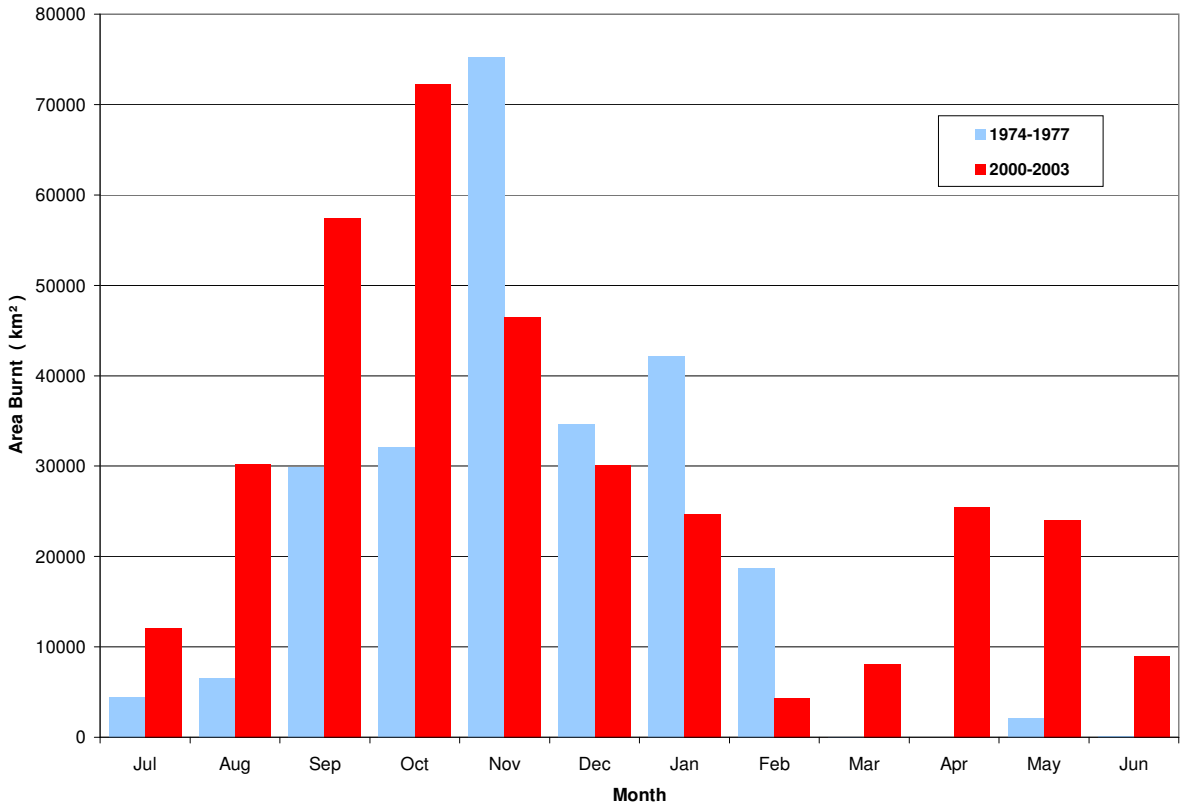

Figure 2.19: Frequency distribution of monthly area burnt in pastoral central Australia for two 3-year periods

Note: Periods are July 1974 – June 1977, derived from Bushfires Council fire reports (Griffin et al. 1983), and July 2000 – June 2002 based on NOAA AVHRR satellite-derived fire history maps.

The human population of central Australia has increased over the period. The non-urban population of central Australia grew from 6656 in 1976 to 10 618 in 2001. Census records of the Aboriginal population in central Australia have recognised inaccuracies, but the available figures show a decrease in the proportion of Aboriginal people in the non-rural area and an increase in Alice Springs. However, the main change has been in the distribution of the population. In 1975 there were 10 main Aboriginal communities, such as Papunya and Yuendumu, plus numerous Aboriginal camps associated with most pastoral homesteads. After the *Aboriginal Land Rights (Northern Territory) Act 1976* there were new opportunities for the development of communities and living areas on Aboriginal land. There was also a decrease in Aboriginal employment opportunities in the pastoral industry. Negotiation of Aboriginal living area excisions from pastoral leases shifted the location of many Aboriginal camps on pastoral properties and also increased their recognition as living areas. Currently there are 30 major centres, 33 minor centres and 220 family homestead locations in central Australia (Department of Planning and Infrastructure 2007) (Table 2.3).

Table 2.3: Aboriginal living areas in central Australia

	Alice Springs (ASP)	Pastoral area south of -21° (excluding ASP)	Central Australia south of -20° (excluding ASP)
Major (> 100 inhabitants)	1	21	29
Minor (20–100 inhabitants)	16	10	17
Family (< 20 inhabitants)	2	158	218

Source: Department of Planning and Infrastructure 2007

Note: The pastoral area matches the area of fire reports analysed by Griffin et al. (1983), and central Australia represents the extent of the fire history mapping of Allan (1993).

There has been a major change in the mobility of the population in central Australia since the 1970s. The network of roads and tracks has increased, and the number of vehicles, especially within Aboriginal communities, has increased. This has increased access to land, travel between communities and travel to Alice Springs. New opportunities, such as the Central Australia Community Football competition which hosts weekly games in Alice Springs, has increased regular travel patterns along the road network around Alice Springs. The unreliability of many vehicles owned by Aboriginal people contributes to roadside fire ignitions as travellers who have had a vehicle breakdown frequently light signal fires to draw attention to their plight (see Gabrys & Vaarzon-Morel 2009). Although the majority of roadside fires are small, some are not contained and can have a considerable impact, such as the time and costs of fire suppression or contributing to tension and ill-feeling toward the Aboriginal population as the fires consume pasture for cattle or damage infrastructure.

Information from the 2001 census indicated that approximately 5332 people live in the Tanami Statistical Local Area (SLA), which extends slightly beyond the southern Tanami study area. There are 27 major communities, 28 minor communities and 212 family outstations in the area. During the 20-year period 1981–2001, the population had increased by 31.3% from 4058. The Aboriginal population increased by 36.8%, which was significantly higher than the 3.5% increase of the non-Aboriginal population (Table 2.4). This changed the population ratio of Aboriginal to non-Aboriginal from 5.2:1 to 6.8:1.

Pastoralists have indicated that employment in the pastoral industry has declined and there are fewer permanent workers on the stations. Many major jobs, such as mustering, require the use of contract labour. Data from the 2001 census for the Tanami SLA indicated that there were only 29 people working in the industry category of agriculture, forestry and fishing from the total employed population of 938. There are 15 pastoral leases in the Tanami SLA. There are few people available to either implement management burning programs or respond to fires, either roadside ignitions or wildfires.

Table 2.4: Population change between 1981–2001 in the three rural census districts of central Australia

Census district	Aboriginal	% Change	Non-Aboriginal	% Change
Tanami	+ 1251	36.8	+ 23	3.5
Sandover	+ 494	29.7	- 224	- 37.3
Petermann	+ 610	109.3	+ 620	64.2
Total	**+ 2355**	**41.9**	**+ 419**	**18.8**

There was a cadastral change within the NT during the past 30 years after the *Aboriginal Land Rights (Northern Territory) Act 1976* NT provided the opportunities for Aboriginal people to acquire land through either the land claim process or by purchase. Within the central Australia pastoral area, which was defined by Griffin et al. (1983) as an area of 365 000 km² south of -21° and excluding the Simpson and Western Desert regions, there have been significant cadastral changes (Table 2.5). The area of Aboriginal Land Trusts has increased by 50 241 km²; a 13.8% increase from 18.4% to 32.2% of region, primarily through acquisitions of pastoral leases and Vacant Crown Land. The area of conservation land increased by 5908 km², which was a 1.6% increase from 0.6 to 2.2% of region. The main change was from pastoral leases, associated with an expansion was West MacDonnell Ranges National Park, the establishment of Watarrka National Park and the purchase of Newhaven Station by Birds Australia. There was a decrease of pastoral leasehold by 35,647 km², which was a 9.8% reduction from 75% to 65.2%. This was primarily associated with the purchase of stations by Aboriginal groups, but also included the expansion of the conservation reserves. There was also an associated change in land use as pastoral operations were only maintained on a few of the ex-pastoral leases purchased by Aboriginal groups.

Table 2.5: Changes in land use between 1975 and 2000 in the central Australia pastoral area

	Area in 1975 (km²)	%	Area in 2000 (km²)	%	Change of area (km²)
Aboriginal Land Trusts	67 398	18.4	117 639	32.2	+ 50 241
Conservation Reserves	2 107	0.6	8 015	2.2	+ 5 908
Pastoral Lease	274 035	75.0	238 387	65.2	- 35 648

Note: Pastoral area was defined by Griffin et al. (1983) as an area of 365 000 km² south of -21° and excluding the Simpson and Western Desert regions (Figure 2.3 and Figure 2.20).

Another feature of the changes in land ownership is the resulting spatial mix of land uses (Figure 2.20). The spatial patterning in 1975 was a few small scattered areas of conservation land within the large block of pastoral leases that was surrounded by non-pastoral land, primarily Aboriginal Land Trusts but also including areas of Vacant Crown Land. The new spatial patterning includes larger blocks of conservation land, areas of Aboriginal Land Trust surrounded by pastoral neighbours where pastoral leases were purchased by Aboriginal groups, and both pastoral leases and conservation reserves surrounded by Aboriginal Land Trusts. This has required a change in individual relationships between neighbours. These changes have not always been easy. New relationships are still being developed and the need for improvement, especially with respect to fire management, continues. This issue is further addressed in the description of the elements required in a regional fire management strategy for the southern Tanami Desert (Section 2.8).

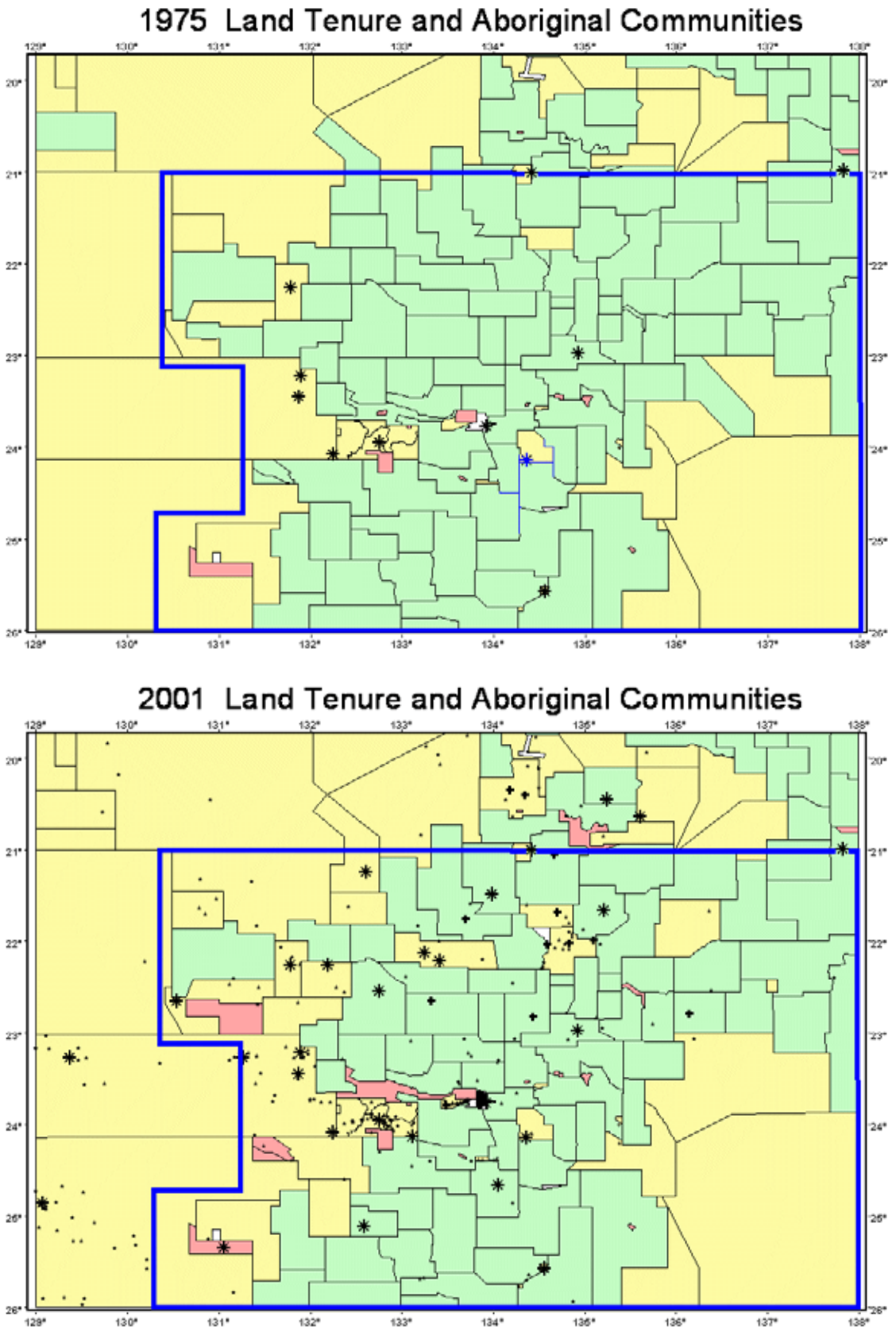

Figure 2.20: Change of land use and population centres in central Australia between 1975 and 2001

Note: Map A shows the major tenure patterns in 1975 and the major Aboriginal communities (✱).

Map B shows the major tenure patterns in 2001, plus the major Aboriginal communities (✱), minor Aboriginal communities (✚) and family communities (★). Aboriginal Land Trust areas are yellow, pastoral leases are green and conservation reserves are light red. The blue area delineates the pastoral area of central Australia (Figure 2.3 and Table 2.1) defined by Griffin et al. (1983).

2.4 Description of the southern Tanami Desert region

2.4.1 Selection of the study region

Within the much larger area of the Tanami bioregion (Thackway & Cresswell 1995) that extends into WA, the southern Tanami region has been loosely defined as a 4° by 3° (400 km x 350 km) block of country extending from the NT/WA border at 129°/-20° to 133°/-23° covering an area of approximately 140 000 km² (Figure 2.21). Within the southern Tanami area, a smaller core study area was defined for purposes of intensive fire history mapping using the area of a single Landsat satellite image. It corresponds to an area of nearly 34 000 km² (approximately 185 km x 185 km).

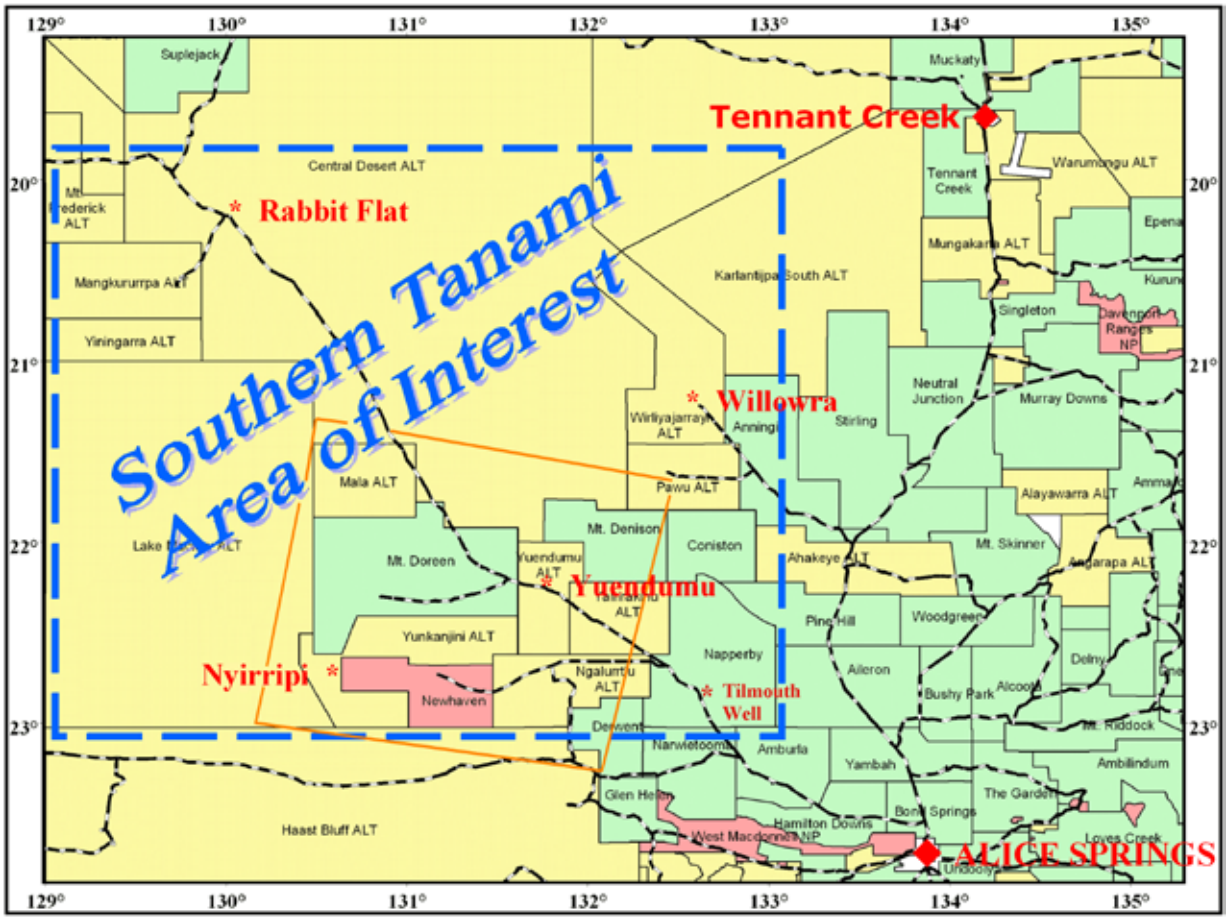

Figure 2.21: A map of the land tenure and major locations in the southern Tanami Desert study area

Note: Pastoral leases are green, Aboriginal Land Trusts are yellow and conservation areas are red. The orange rectangle outlines the area of a single Landsat image used to provide a detailed perspective on the fire regimes of the area.

The southern Tanami Desert is predominantly Aboriginal freehold land with fringing pastoral properties in the east and a conservation reserve in the south. It encompasses the Aboriginal township of Yuendumu, one of the largest communities in central Australia, as well as the communities of Nyirrpi and Willowra. All three communities, as well as the community of Lajamanu in the northern Tanami, are within Warlpiri country. Travel between the four communities and to Alice Springs, as well as movement around the communities, is closely linked to fire issues in the region. The characteristics of the population were described in the previous section.

Pastoralism is the second largest area of land use in the southern Tanami. Currently there are four pastoral leases wholly within the southern Tanami area of interest (Figure 2.21) with three other pastoral leases on the fringe of the area. In the last 30 years, five other pastoral leases in the southern Tanami were sold and changed to Aboriginal Land Trusts (ALT). One ALT is currently operating as a

cattle enterprise. A sixth pastoral lease, Newhaven Station, was purchased by Birds Australia in 2000 (currently managed by Australian Wildlife Conservancy) and is the only formal conservation reserve in the southern Tanami Desert area.

The southern Tanami contains known biodiversity hotspots, including wetlands (Duguid et al. 2002) and sites of botanical significance (White et al. 2000a, b) which are likely to be threatened by adverse fire regimes. The Central Land Council (CLC) has helped the Warlpiri community of Lajamanu establish an Indigenous Protected Area (IPA) in the northern Tanami to help address the land management needs of this area. The discussion and development process for a second IPA in the southern Tanami is currently underway. Its proposed extent is similar to the southern Tanami area of interest, excluding the existing pastoral leases and conservation areas (Figure 2.21).

Frequent, large, uncontrolled wildfires are common in the southern Tanami Desert, and in recent years fire management in the area has become a topic of hot debate between local residents with differing land-use objectives as well as government and non-government (Centralian Land Management Association [CLMA], CLC) agencies. During the recent three-year period of high fire incidence in central Australia from 2000–2002, conflicts occurred between pastoral, Aboriginal and conservation land managers, especially with regard to uncontrolled roadside ignitions.

Mining is a significant economic activity in the southern Tanami region, with the largest mining operation at The Granites, just south of Rabbit Flat (Figure 2.21). Tourism also contributes to the local economy of the region, with many visitors travelling along the Tanami Highway from central Australia to the Kimberley region of WA.

Fire in central Australia is closely associated with spinifex-dominated plant communities, which are widespread in the southern Tanami region, both as sand plains and dunefields. Detailed maps of the vegetation communities in the area are not available, and the broad scale 1:1 000 000 Vegetation Map of the NT (Wilson et al. 1990) does not provide sufficient detail for improving the fire management in the region. Newhaven Reserve is the only area with a detailed vegetation map (Latz et al. 2003). As part of the fire management strategy developed for Newhaven, Paltridge and Latz (2006) described eight broad vegetation communities relevant to fire management in the area. These are water bodies, including salt lakes; chenopod shrublands; soft spinifex grasslands; open Eucalypt/Acacia shrubland with *Triodia basedowii* understorey; spinifex dunefields; Acacia shrubland with tussock grass understorey; mulga woodlands and hill communities.

2.5 Characteristics of fires in the southern Tanami Desert region

2.5.1 Description of methods

A series of Landsat images were acquired for the 34 000 km² core study area of the southern Tanami region (Figure 2.22). The sequence of image dates is listed in Table 2.6. The image area was a single Landsat scene (WRS Path 104 / Row 75 – 76 non-standard). The images and study area also contributed to the International GOFC/GOLD global burnt area mapping project as a validation site (Roy et al. 2002, Roy et al. 2005). The global burnt area mapping project developed an automated mapping algorithm based on MODIS satellite images with a 500 m resolution. The algorithm was refined on the basis of a network of areas with Landsat-based burnt area mapping at 30 m resolution. Australia established 10 validation areas in diverse areas around the country, including the core study area of the southern Tanami (Figure 2.21).

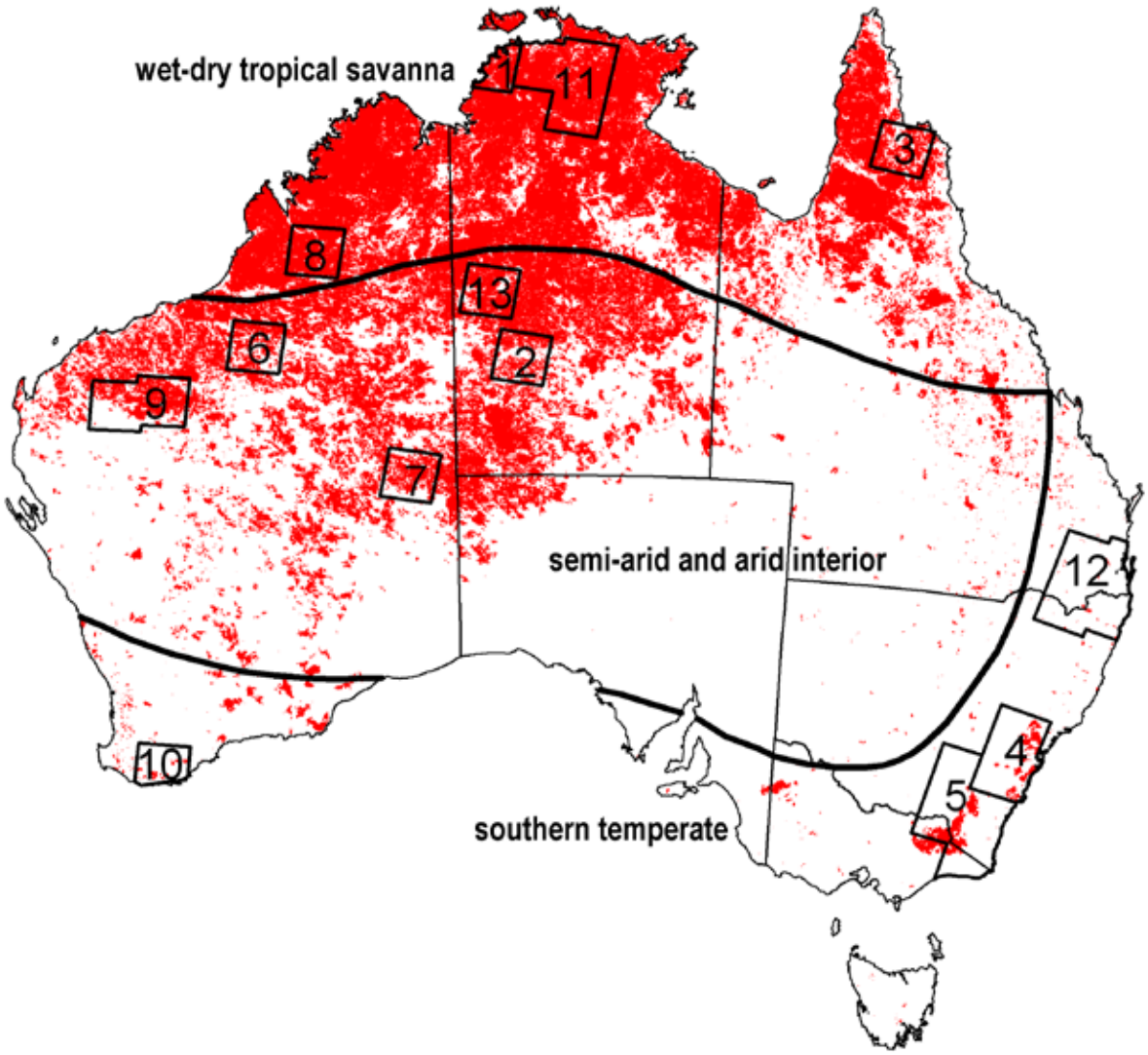

Figure 2.22: Australian validation sites for the international GOFC/GOLD global burnt area mapping project based on MODIS imagery

Note: Site 2 is the southern Tanami Desert study area. The red areas represent burnt areas mapped from NOAA AVHRR images during the period from 1997–2003 within each of the three major fire regions of Australia (Myers et al. 2004).

The process used for burnt area mapping required satellite image processing techniques, principally change detection between images, to identify areas of change between successive images. Each fire was delineated as an individual polygon and described with numerous attributes, including area burnt, pre-fire image date and post-fire image date. The pre- and post-fire image dates were based on the 16-day Landsat satellite orbit cycle, rather than the actual day or number of days each fire was burning. The image dates were based on the Landsat Online Image Catalogue Quicklooks available from the Geoscience Australia website (http://www.ga.gov.au).

Table 2.6: Information on Landsat Images used to map fires in the core study area of the southern Tanami region

Satellite	Image date	Source
Landsat 7 ETM+	19990829	NT Department of Minerals and Energy
Landsat 7 ETM+	20000612	NT Department of Infrastructure, Planning and Environment
Landsat 7 ETM+	20010701	Bushfires NT
Landsat 7 ETM+	20010818	Geoscience Australia
Landsat 7 ETM+	20011005	NASA
Landsat 7 ETM+	20020517	Geoscience Australia
Landsat 7 ETM+	20020805	NASA
Landsat 7 ETM+	20020906	Australia Greenhouse Office 2002 dataset
Landsat 7 ETM+	20030112	Bushfires NT
Landsat 5 TM	20041005	Geoscience Australia
Landsat 5 TM	20041106	Geoscience Australia
Landsat 5 TM	20050330	Bushfires NT

Note: All dates expressed in standard YYYYMMDD format.

2.5.2 Summary of fires

The compilation of a detailed fire history provides the basis for a consistent interpretation of past events. The fire history dataset mapped 2977 fires within the southern Tanami core study area. There were 115 fires mapped from the earliest image date, with 34 occurring before June 1997. Between July 1997 and June 2000 there were 218 fires. During the three-year period with the greatest fire activity, between July 2000 and June 2003, there were 2096 fires. In the subsequent period from July 2003 to March 2005 there were a further 640 fires.

The majority of fires were small, and nearly 63% of all fires were less than 1 km² in size. Only 2.5% of the fires were greater than 1000 km², but they represented 72% of the total area burnt (Figure 2.23). Many fires burnt into or beyond the image extent, and the largest area burnt by a single fire exceeded 5700 km² (Figure 2.24).

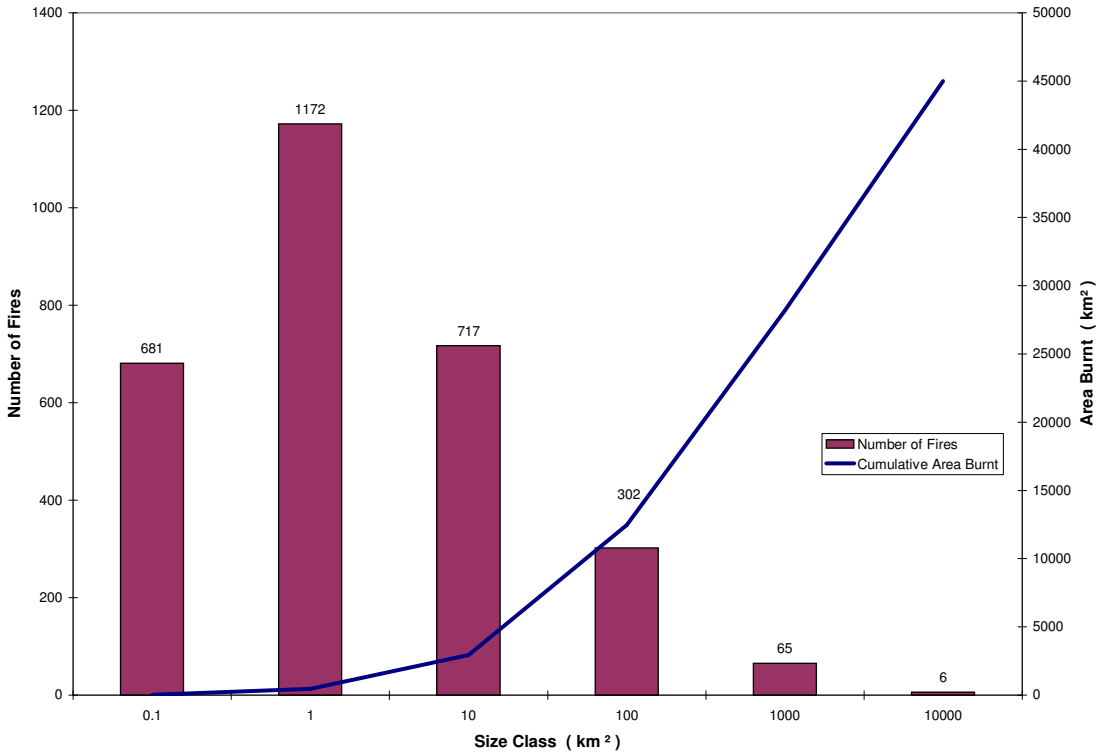

Figure 2.23: Size class distribution and cumulative area burnt by all fires, July 1997 – March 2005

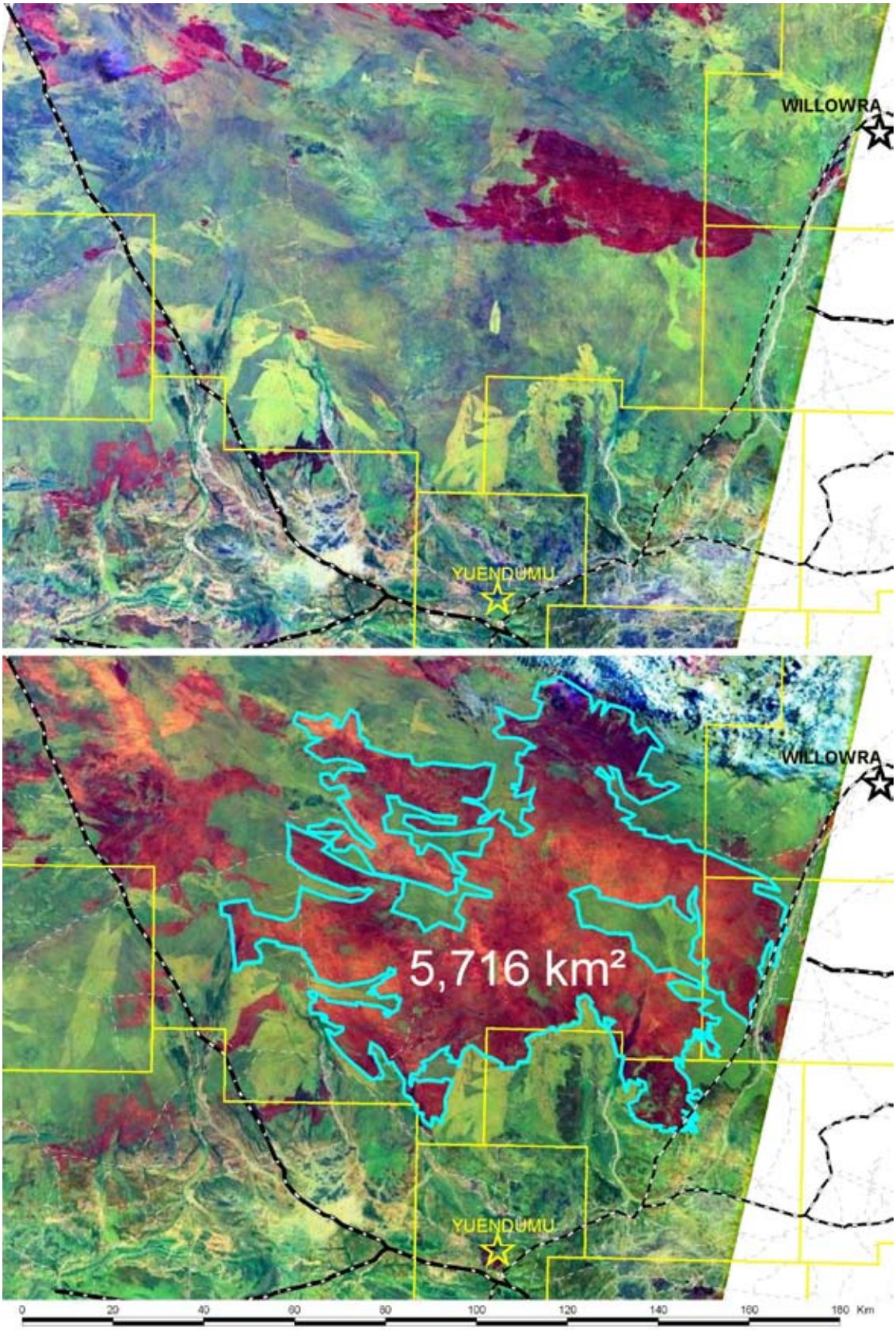

Figure 2.24: Landsat quicklook images from Geoscience Australia digital catalogue of the largest fire in the study area

Note: The fire (distinct red patches) was a roadside ignition along the Yuendumu–Willowra road that began just before the Landsat image on 16 September 2000 (top). The fire burnt an area of 5700 km² before the next Landsat overpass, 16 days later, on 2 October 2000 (bottom). The fire initially burnt to the west across the Central Desert ALT before a wind change carried the fire back to the south-east into Mount Denison station. Previous fires in the area occurred during 1983 and 1984, following the previous period of above average rainfall.

The incidence of fires shows that fires can occur at any time of year, and during the eight-year period from July 1997 to March 2005 were most numerous in August (Figure 2.25); however, the largest fires occurred in September (Figure 2.26). During periods associated with above average rainfall, the relative increase in the number of fires was greatest during the cooler months of April to August. This points to human ignition being a major source of fire in recent times. It also highlights the opportunity available to land managers to actively burn to reduce fuel loads in spinifex vegetation, as fire will spread in these areas even during cooler months.

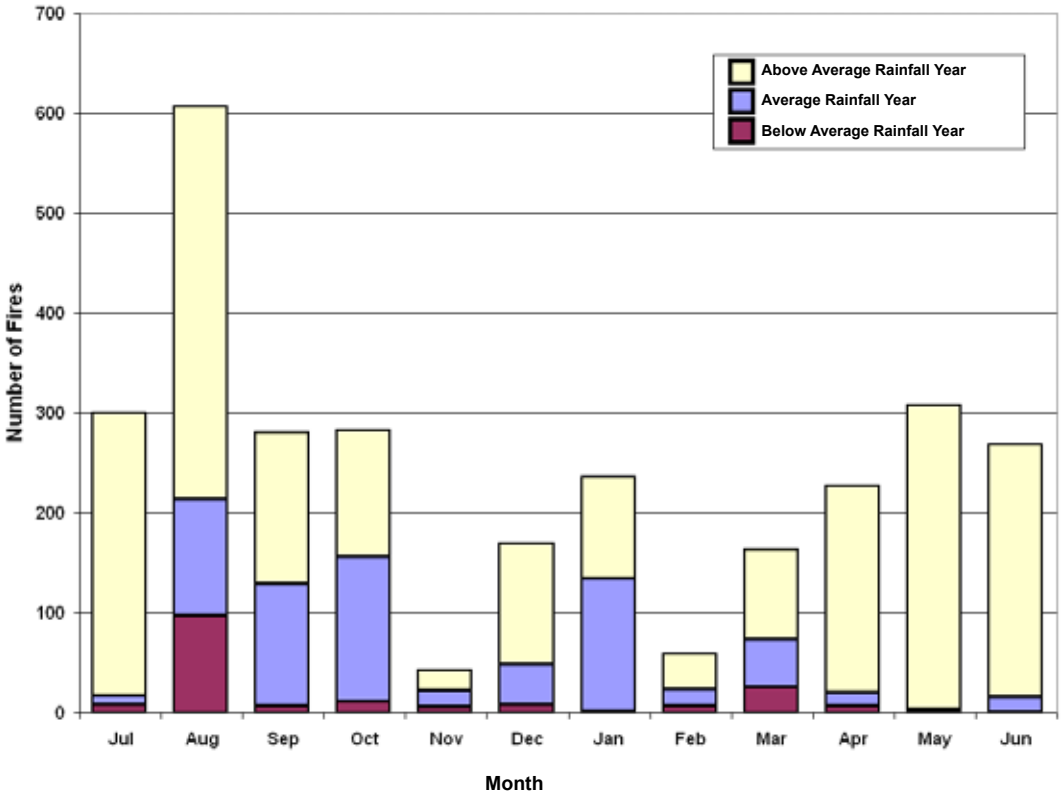

Figure 2.25: The annual temporal distribution of the number of fires in the southern Tanami Desert region, July 1997 – March 2005

Note: There were two years when the preceding 24-month cumulative rainfall was below average rainfall (July 1997 – June 1999 and July 1999 – June 2000), three years with average rainfall (July 1998 – June 1999; July 2003 – June 2005) and three years with above average rainfall (July 2000 – June 2003).

The temporal distribution of area burnt by fire size shows that the average area burnt each month during the period July 1997 – March 2005 was evenly distributed throughout the year, with the exception of September and October (Figure 2.26). The temporal distribution of area burnt shows a peak during the three-month period of August to October, accounting for 65% of the total area burnt. The six largest fires all burnt areas greater than 1000 km² and occurred during September and October. The largest fire, which burnt 5716 km², occurred in September 2000 and the two next largest fires that burnt 3969 km² and 3717 km² occurred in September 2001, which was the peak of fire activity in the southern Tanami Desert region during the study period. Twenty-seven of the 42 fires that were larger than 200 km² occurred during August to October, with 18 occurring during 2001.

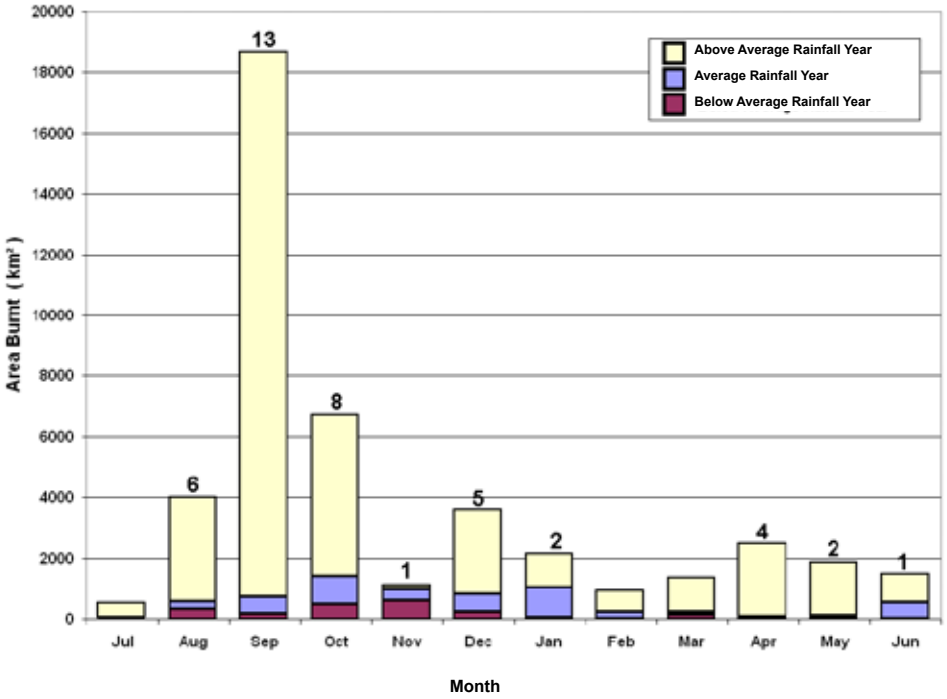

Figure 2.26: The annual temporal distribution of the area burnt in the southern Tanami Desert region, July 1997 – March 2005

Note: There were two years when the preceding 24-month cumulative rainfall was below average rainfall (July 1997 – June 1999 and July 1999 – June 2000), three years with average rainfall (July 1998 – June 1999; July 2003 – June 2005) and three years with above average rainfall (July 2000 – June 2003). The values above each column indicate the number of fires with an area burnt greater than 200 km².

Figure 2.27 illustrates that large fires can dominate the total area burnt. More than 95% of the total area burnt in September 2000 was a single fire, and the largest fire in September 2001 burnt one-third of the area burnt. There is concern that large fires can have a negative impact on biodiversity values and that improved fire management should aim to reduce the proportion of large fires in relation to total area burnt.

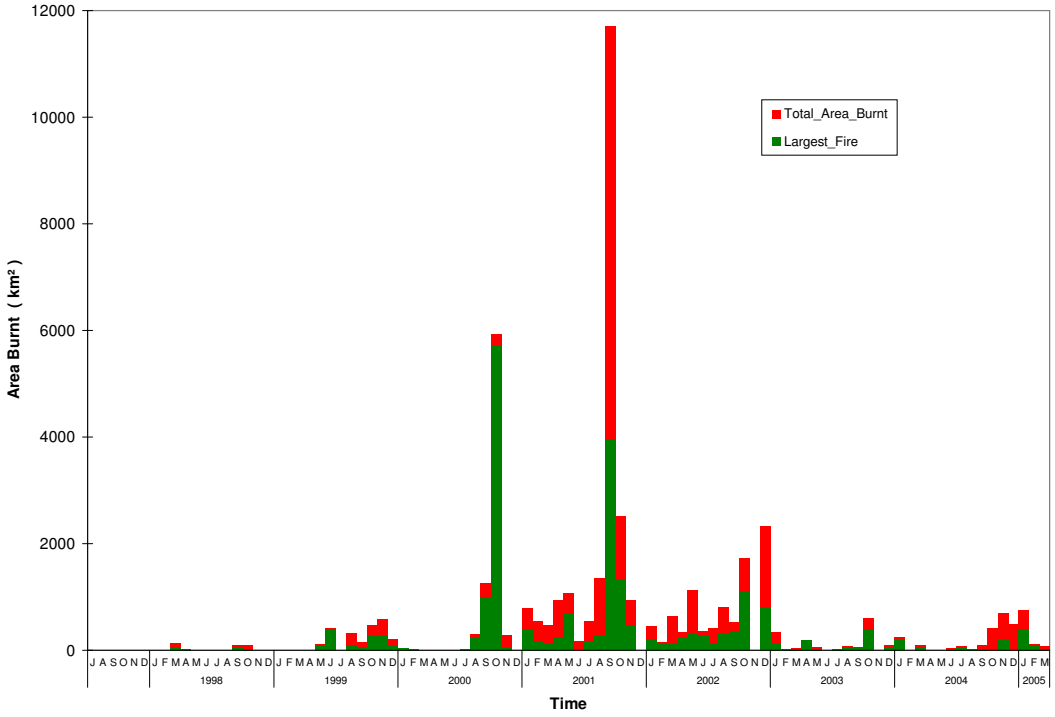

Figure 2.27: Relationship between the largest fire and the total area burnt each month

Figure 2.28 illustrates the timing of the peak of fire activity, represented by area burnt within a calendar month with respect to the cumulative rainfall over the preceding 24-month period recorded at Yuendumu. The annual summer-dominated rainfall pattern shows a six-month lag between April peaks in the 24-month cumulative rainfall and significant fire activity in September and October.

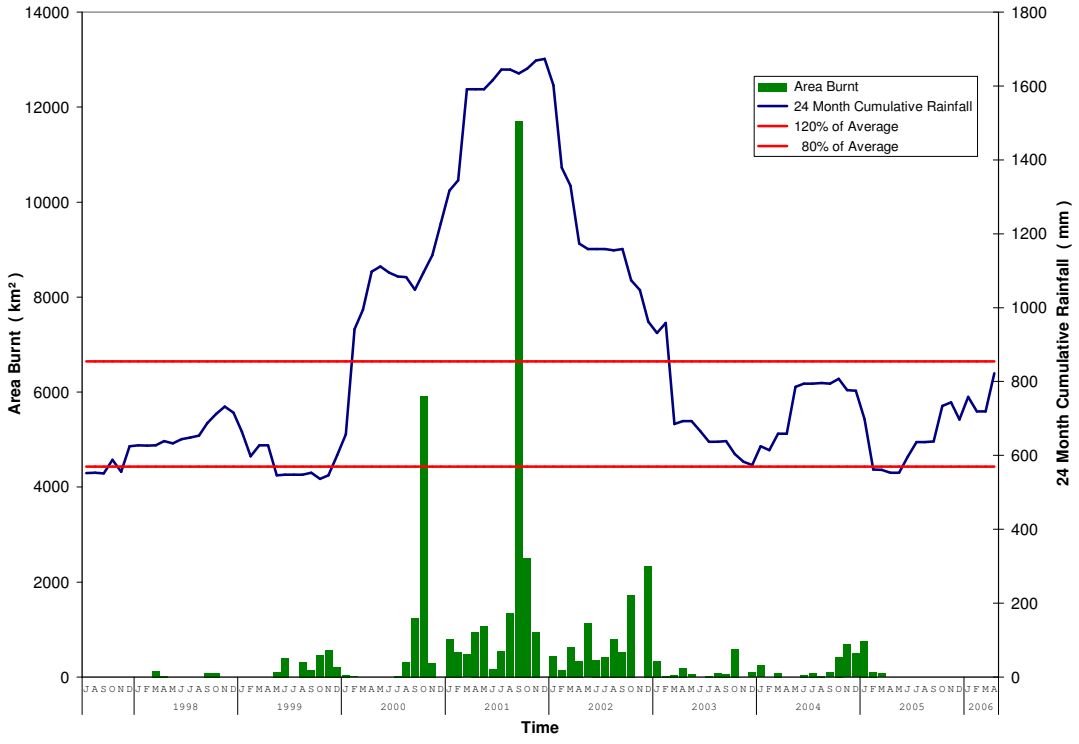

Figure 2.28: Area burnt by month in relation to cumulative rainfall over the preceding 24-month period recorded at Yuendumu

Note: The average 24-month cumulative rainfall for the period since 1952 was 710 mm. The horizontal red lines indicate threshold values of 120% and 80% of average.

The first year of above average rainfall, in 1999–2000, initiated the rapid build up of fuel loads, and the greenness of the biomass restricted any fires in the early months of 2000. The second year of above average rainfall, in 2000–2001, increased the fuel loads and both the number of fires and area burnt increased throughout 2001. The peak of fire activity in September 2001 continued until rainfall in December 2001 suppressed the fires (Figure 2.29). Fires continued through 2002 and, although the number of fires was high, the area burnt was less because the proportion of the landscape with fuel loads capable of burning was significantly reduced.

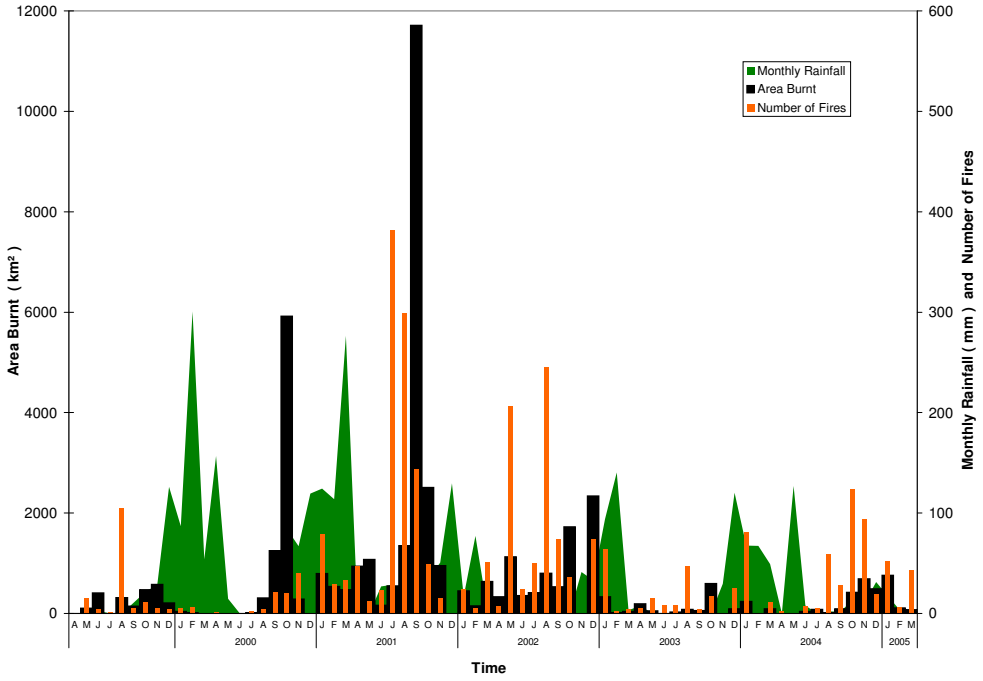

Figure 2.29: Number of fires and area burnt in relation to rainfall records for Yuendumu

2.5.3 Analysis of short interval fire occurrence

The fire history dataset provided information on fire frequency and the identification of areas where more than one fire had occurred between 2000 and 2005. During the initial period of widespread fires between May 1999 and January 2003, there were three main interval periods when relatively large areas of country were burnt by a second fire, with a short inter-fire interval. The occurrence of the second fire was primarily in the September–December period when fire weather conditions in central Australia are usually at their highest (Figure 2.30).

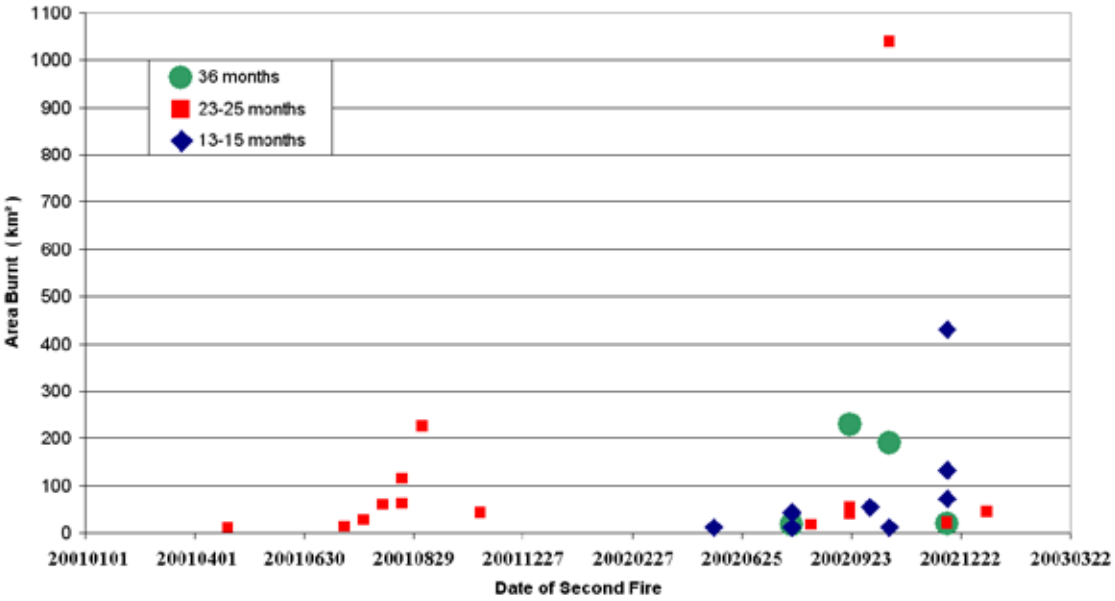

Figure 2.30: Timing and area burnt by fires with a short inter-fire interval, May 2001 – March 2003

The fires with the 13–15 month interval only occurred late in 2002. The first fires had been burnt during mid- to late 2001. The environmental conditions were positive for fuel load recovery. Soil moisture was available at the time of the fire to encourage an immediate response from resprouting plant species, and post-fire rainfall from November 2001 to February 2002 would have aided further plant growth and an increase of fuel loads. Subsequently, the cold dry winter of 2002 contributed to near complete curing of the fuel loads prior to the second fires. In general, the fires were relatively small, although one exceeded 400 km². This fire was in the south-west corner of the image north of the Papunya–Kintore Road. The first fire in September 2001 burnt an area of 4000 km² of sand dune country in the Lake Mackay ALT, between the Kintore Road and north into Newhaven Station Reserve. The second fire, which burnt an area of 800 km², only re-burnt the southern portion of the original fire; however, the area that was burnt twice does exceed 400 km², but the full extent is beyond our current image extent and mapping.

The largest area burnt with a 24-month interval was on the extensive spinifex sand plain of the Central Desert ALT, north of Mt Denison station and Yuendumu ALT and west of the Lander River, in 2002. The first fire was the 5700 km² fire (Figure 2.24) started from the Willowra road in September 2000. It was lit just prior to 20000916 (YYYYMMDD format) and was complete by 20001002. The second fire started north of Yuendumu in early October 2002 (it began after image date 20020922, was active on 20021008 and complete by 20021024); the whole area of the fire was within the area burnt by the first fire. The first fire to re-burn part of the initial fire began from a previously unburnt island and burnt across the 2000 fire on a south-west wind in September 2002 (between image dates 20020906 and 20020922). The area had received a total of 1150 mm of rain during the fire interval (785 mm during the first summer season of October 2000 to March 2001; with a further 55 mm of winter rain during June and July 2001, and then 313 mm of summer rain between October 2001 and March 2002; based on Yuendumu daily rainfall records).

The two large fires that burnt with a three-year fire interval were also on the spinifex sand plain north of Yuendumu ALT and Mt Denison station. Both fires were burnt with intervals from October 1999 and October 2002 – a period which received a total of 1930 mm of rain, nearly double the average.

The majority of the fires that occurred in the subsequent two-year period from January 2003 to March 2005 benefited from good rainfall in the preceding years to initiate the fuel load recovery. The largest fire was 74 km² in February 2005 (between 20050125 and 20050210) over a previous fire from May 2001 (between 20010428 and 20010514) on a sand plain/dunefield north of Newhaven in the Yunkanjini ALT. The interval between fires was 45 months.

A 390 km² fire in western Mt Doreen station occurred in November or December 2004 (between 20041106 and 20050109). It had a 39-month interval after the previous fire in September 2001 (between 20010919 and 20011005), which burnt 1215 km². It occurred in mixed country of spinifex sand plain and areas of low rugged hills west of the main Treuer Range of Vaughan Springs (headwaters of Ethel Creek), including some areas of mulga country.

There were three large fires on spinifex sand plain on the northern side of Mt Doreen station in the Mala ALT. The first burnt 208 km² in December 2004 (between 20041208 and 20050109). The previous fire age was mostly within a 4000 km² fire from September 2001 (between 20010903 and 20010919; a 39-month interval). The second fire was 211 km² in November 2004 (between 20041106 and 20041208). The previous fire age was mostly the same 2007 fire (4000 km² fire between 20010903 and 20010919) with other smaller fires closer to the Tanami Highway; a 38-month interval. The third fire, on the southern edge of the sand plain within Mt Doreen station, burnt 187 km² in October 2004 (between 20041005 and 20041106). The previous fire age was partly within the same 2007 4000 km² fire (between 20010903 and 20010919; a 37-month interval), but the majority was part of a 225 km² fire in August 2000 (between 20000730 and 20000815; a 50-month interval).

There were numerous fires on spinifex sand plain on the northern side of Mt Denison extending into the Central Desert ALT. Most fires were lit along the Willowra Road:

- A 105 km² fire burnt in September 2003 (between 20030901 and 20031003). The previous fire ages included fires in February 2001 (between 20010223 and 20010311; a 31-month interval) and September 2000 (20000916 and 20001002; a 36-month interval).
- A 97 km² fire burnt in September 2004 (between 20040919 and 20041005). The previous fire ages included fires in February 2001 (between 20010223 and 20010311; a 43-month interval) and September 2000 (between 20000916 and 20001002; a 48-month interval).
- A 30 km² fire burnt in October 2004 (between 20041005 and 20041021). The previous fire was in February 2001 (between 20010223 and 29919311; a 44-month interval).
- A 17 km² fire burnt in December 2004 (between 20041208 and 20050109). The previous fire ages were fires in July 2001 (between 20010701 and 20010818; a 41 month interval) and February 2001 (between 20010223 and 20010311; a 45-month interval).

There was also a moderate-sized fire of 116 km² further west on spinifex sand plain on the northern side of Mt Denison in the Central Desert ALT during October 2004 (between 20041021 and 20041106). The previous fire age was a mix of fire ages, including fires in September 2001 (between 20010903 and 20011005; a 37-month interval) and September 2000 (between 20000916 and 20001002; a 48-month interval) and a small fire in October 2002 (between 20021008 and 20021024; a 24-month interval). The area is immediately north of the floodout area of Cockatoo Creek. It received a total of 790 mm during the fire interval that would have contributed to the fuel load recovery, with an initial 320 mm in the first summer period, a further 333 mm during the second summer, and then 127 mm of winter rain in May 2004. The area would also have received additional moisture from Cockatoo Creek to assist its relatively rapid fuel load recovery.

A 382 km² fire burnt in September 2003 (between 20030901 and 20031019) on the spinifex sand plain north of the north-east corner of Mt Doreen station in the Central Desert ALT in an area influenced by run-on from Yaloogarrie and Atlee Creeks. The previous fires were during September 2000 (between 20000906 and 20001002; a 36-month interval) and September 2001 (between 20010903 and 20010919; a 24-month interval).

In the area south of Yuendumu on the eastern end of the Yunkanjini sand plain and dunefield there were three fires in late 2003. A 64 km² fire in September 2003 (between 20030901 and 20031019) burnt an area previously burnt in April 2001 (between 20010412 and 20010429; a 29-month interval). A 30 km² fire in May 2003 (between 20030418 and 20030520) also burnt a portion of country burnt by the same April 2001 fire (between 20010412 and 20010429; a 24-month interval). The area had also been previously burnt in September 1999 (between 19990829 and 19990914). The first 19-month interval received 1588 mm of rain while the second 24-month interval only received 682 mm of rain but would have benefited from continued high soil moisture levels to support rapid plant growth and fuel accumulation. A 10 km² fire in May 2004 (between 20040420 and 20040615) burnt country previously burnt in August 2001 (between 20010818 and 20010903; a 39-month interval) that had also been previously burnt in September 1999 (between 19990903 and 19991021; a 23-month interval).

Despite these examples of short-interval fires, many fires were constrained by previous burnt areas at periods exceeding these relatively short intervals. Further investigations on the patterns of fires and the weather conditions is required to better understand these patterns and improve our understanding of fuel load and associated fire risk.

2.5.4 Description of fires in relation to roads and tracks

The fire history database was intersected with a series of buffers along both the main roads and all the roads and tracks in the study area. Five buffer widths were used, out to a distance of 3 km², which was described as the maximum off-road distance travelled during hunting expeditions in the Patjarr community area of Western Australia (Simmonds 2003). The majority of fires within the study area were close to roads and tracks (Table 2.7 and Figure 2.31). Nearly 1200 fires were entirely within 1 km² of roads and tracks, which represents only 20% of the study area. This highlights the number of roadside fires that are lit by travellers. Our challenge is to better understand the conditions when roadside ignitions are not contained and therefore lead to large fires. It becomes important to extend that understanding to land managers and the community in order to minimise the impact of large fires.

There are many unmapped tracks in the Yuendumu region that are used irregularly and also provide an opportunity for ignition. A trip west from Willowra to Mt. Bennett in May 2005, as part of the Desert Fire project (Gabrys & Vaarzon-Morel 2009), provided an opportunity for several fires to be lit in an area without mapped tracks, whereas it could have been assumed that lightning was the most probable ignition source. Trips associated with providing sacred site clearance for subsequent mineral exploration also provide access to country, usually by helicopter. These trips provide an opportunity for human ignitions in areas without tracks and vehicle access. The timing of the trips may not be optimal for the Traditional Owners to safely use fire to protect or manage the sacred sites, but fires may still be lit despite the uncertainty of the outcome.

Table 2.7: Number and proportion of fires associated with main roads and tracks

	Buffer size (metres)	Percent of study area	Number of fires	Percent of total fires	Number of fires 100% within buffer	Number of fires > 90% within buffer	Number of fires > 80% within buffer
Main roads	100	0.6	905	30.4	26	48	61
	500	3.0	1063	35.7	304	372	423
	1000	5.9	1194	40.1	554	627	684
	2000	11.5	1403	47.1	897	974	1017
	3000	17.0	1586	53.3	1148	1224	1273
Tracks	100	2.3	1779	59.8	38	86	120
	500	10.9	2023	68.0	661	825	925
	1000	20.2	2224	74.7	1195	1351	1462
	2000	35.7	2453	82.4	1759	1893	1965
	3000	48.0	2586	86.9	2066	2183	2232

Note: The number of fires (column 3) is a count of the number of fires that intersected the buffer, whereas only fires with a burnt area completely within the buffer were included in the number of fires 100% within the buffer (column 5).

When 80% of the area burnt by a single fire was within the buffer it was counted in column 7. The total number of fires in the dataset was 2943.

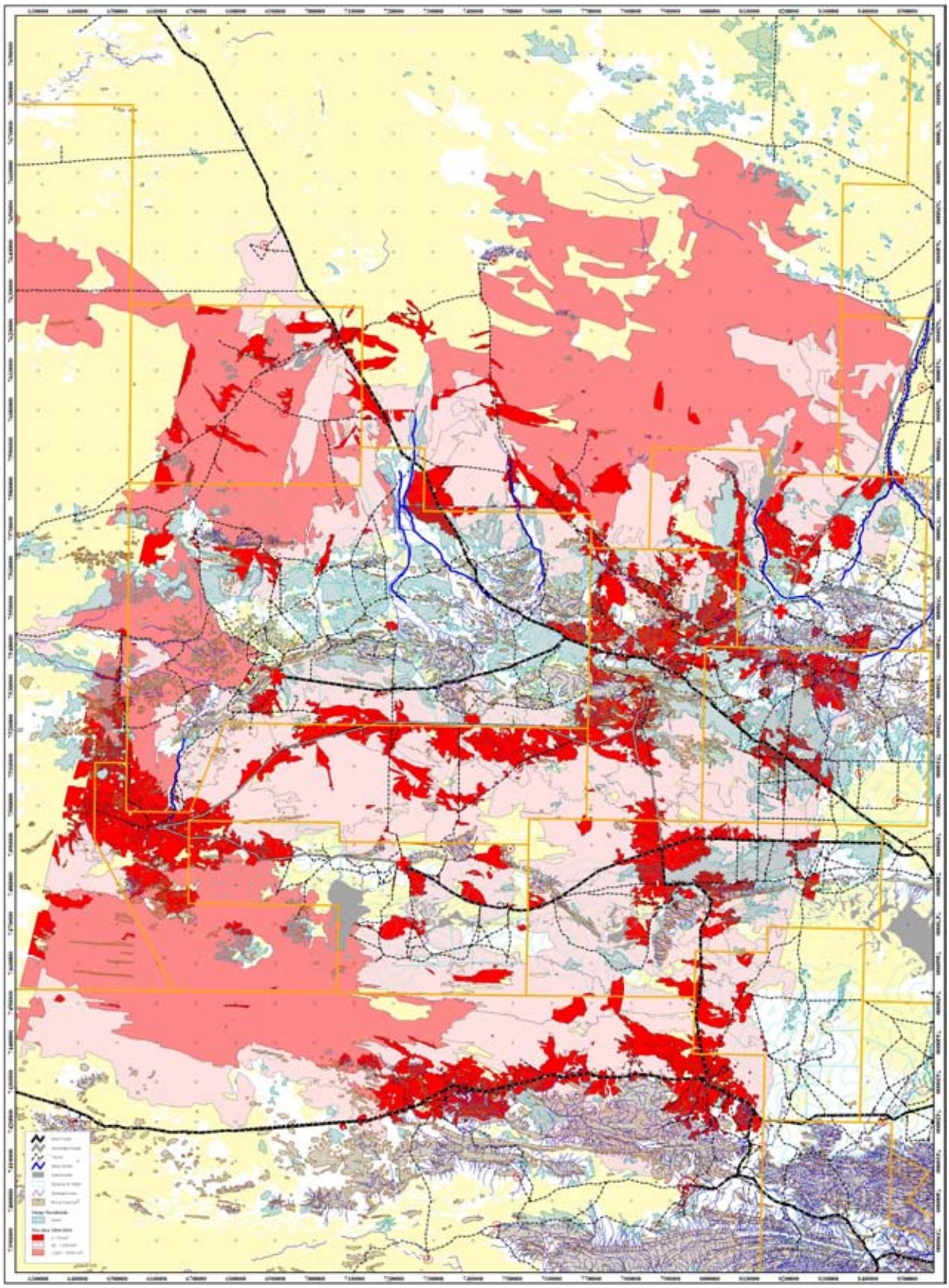

Figure 2.31: Pattern of fires, by fire size, within the southern Tanami Desert study area during the three-year period 2000–2002

Note: The fires smaller than 50 km² are dark red, fires between 50–1000 km² are light pink, and the fires larger than 1000 km² are a darker pink colour. The small fires occur in the areas of the Aboriginal communities of Yuendumu, Papunya, Mount Liebig and Nyirrpi, as well as along the main roads and travel routes between the communities. The map covers an area of 220 x 300 km.

2.5.5 Summary of information learned from analysing fire patterns

The number of fires was much higher than anticipated and significantly greater than previous records of the number of fires in central Australia. There were 2943 fires that occurred over a five-year period within the 34 000 km² area of the study area defined by the extent of a single Landsat image. Griffin et al. (1983) had 785 fires in their analysis of a 10-year data set for the 365 000 km² of the pastoral area of central Australia, although some additional fires were excluded due to missing estimates of area burnt. Allan (1993) demonstrated the value of annual satellite images to improve our awareness that many more fires occur than are reported (especially within the desert regions) and extended the central Australian study area to 600 000 km² to include the desert regions. The study mapped 1688 fires during the five year period from 1979–1984 and then added another 792 fires that occurred over the summer of 1984–85. Capturing a more complete fire history requires a greater temporal frequency of images, especially during periods of above average rainfall, high fire numbers and rapid post-fire recovery.

During the study period, which included the three years of above average rainfall, the fires were relatively evenly distributed through the year (Figure 2.25). This highlights the role of human ignition in a region where the potential for lightning ignition is strongly seasonal. Only 12% of thunder-days recorded in Alice Springs during the period 1940–1979 occurred during the five-month period of April to August (Griffin et al. 1983) and would rarely occur between March and August. Fires were more numerous during the July to October period and the largest fires occurred in September and October when the fire danger index (FDI) is highest.

Fires still occurred during the drier period of 2003, following the fires associated with the three-year period of above average rainfall from July 1999 – June 2002. The fires were not extensive and were less threatening to property and livelihoods, and they were primarily associated with the areas left unburnt during the preceding three years; although, some areas that had burnt in the early period of extensive fires did recover sufficient fuels to burn again. These fires pose a challenge to land managers if these areas are providing recovery habitat for organisms affected by the previous fires or are an important pasture area within pastoral properties.

Fires that burnt early in the period of extensive fires occurred when conditions were less severe. The fuel and soil moisture levels were higher, the fuel loads were less extensive or continuous, and post-fire rainfall contributed to a rapid post-fire vegetation response. The result was that the impact of the fires was reduced. The pattern of the fires was less continuous, and more fire-sensitive communities, such as the mulga communities, were not burnt. For example, on the spinifex sand plains of Mt Denison station the fires in 2000 and 2001 burnt around the isolated islands of mulga, whereas in 2002 the fires carried through the mulga islands and also into the more extensive mulga areas (Figure 2.32 and Figure 2.33).

Mulga areas are considered important to the majority of land managers and ecologists, and therefore there is a need to be more pro-active in burning programs to reduce the impact of fire in these ecosystems. Land managers should respond quickly with an active burning program in spinifex country following a season of above average rainfall and fuel accumulation. Ideally, fires should be lit before the fuel fully dries out, especially to protect non-spinifex areas. The intent is to create patches to break up any extensive fuel loads, with a potential to link the patches and create strategic linear breaks for future containment of wildfires if good seasonal conditions continue.

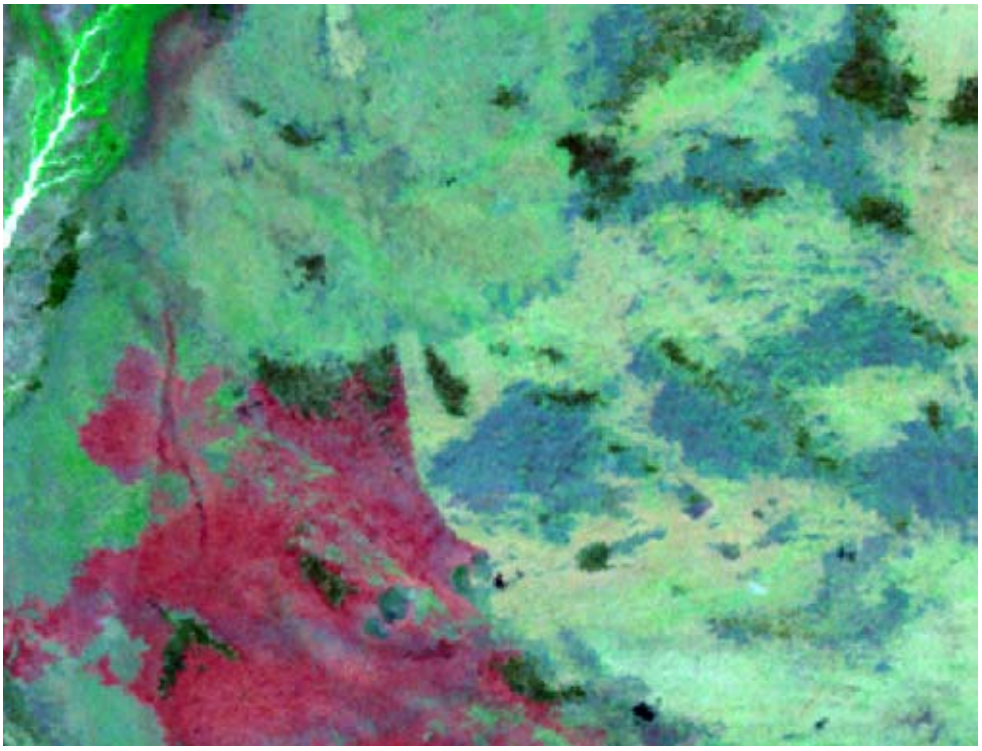

Figure 2.32: Landsat image, recorded on 1 July 2001, of the spinifex sand plain, with isolated islands of mulga, on Mt Denison station

Note: The red pattern in the south-west (lower right) was burnt by a fire in April 2001 (between 20010412 and 20010428). The burnt area surrounded or burnt to the edge of the islands, and the mulga communities (dark green patches) remained unburnt. The light yellow pattern in the north-west was burnt by a fire in September 2000 (between 20000916 and 20001002). The mulga islands were unburnt and the bluish patches are unburnt areas of spinifex. The floodout of Cockatoo Creek is in the north-west. The image area is 10 km x 7.5 km.

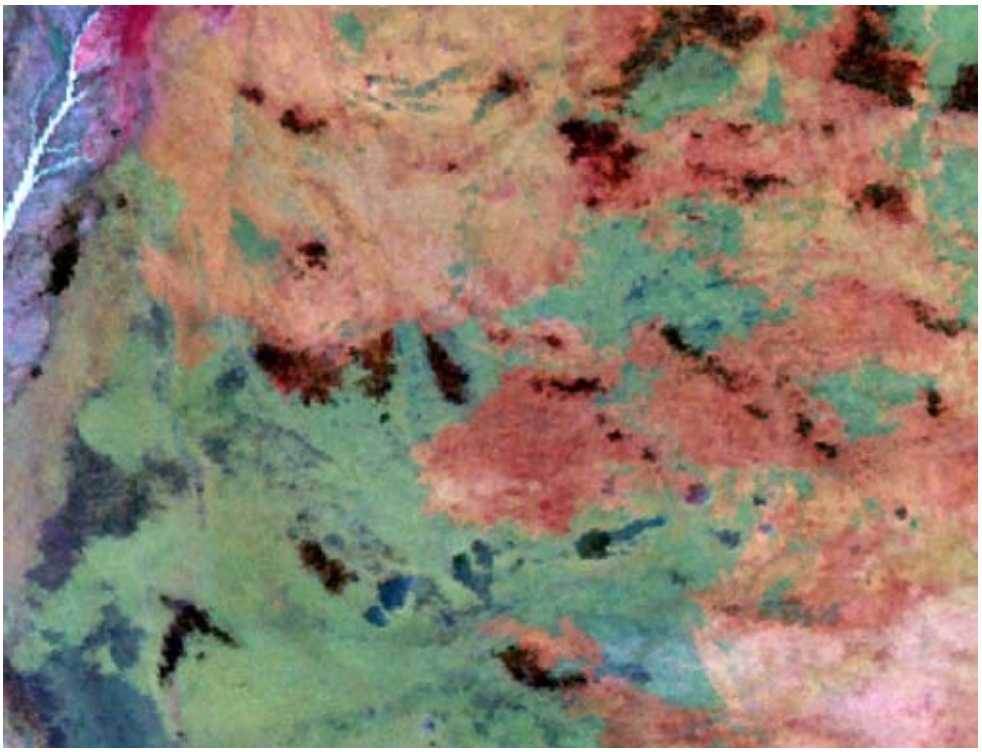

Figure 2.33: Landsat image, recorded on 12 January 2003, of the spinifex sand plain, with isolated islands of mulga, on Mt Denison station

Note: The red pattern in the north and east (top and right) was the area burnt by a fire in October 2002 (between 20021008 and 20021024). The fire carried through the majority of the mulga islands. The reddish brown mulga patches were burnt and the brown to black mulga patches remained unburnt.

Only a relatively small portion of the landscape carried two fires with short fire intervals. They were primarily on spinifex sand plain and dunefield areas. The fuel loads for the second fire would have been a mix of regenerating spinifex and diverse other short-lived grasses, probably dominated by *Aristida* and *Eragrostis* species. These areas are dominated by relatively robust species and contain few species or individuals that would be significantly affected by short interval fires. Recent research has improved our understanding of the species' response and sensitivities to fire within these communities (Wright 2007). Further studies are warranted, but the opportunities to undertake the work in the arid zone can be restricted by climatic and seasonal conditions.

2.5.6 Recent fire patterns in the Tanami Desert region: 2006–2007

Following the formal period of the Desert Fire project and the previous detailed analysis of the fire patterns from 1997–2005, there has been another period of two years of above average rainfall and extensive fires in the Tanami Desert. Rainfall in both Rabbit Flat and Yuendumu exceeded the 120% threshold over a 24-month period (Figure 2.34), which was in contrast to the conditions in Alice Springs.

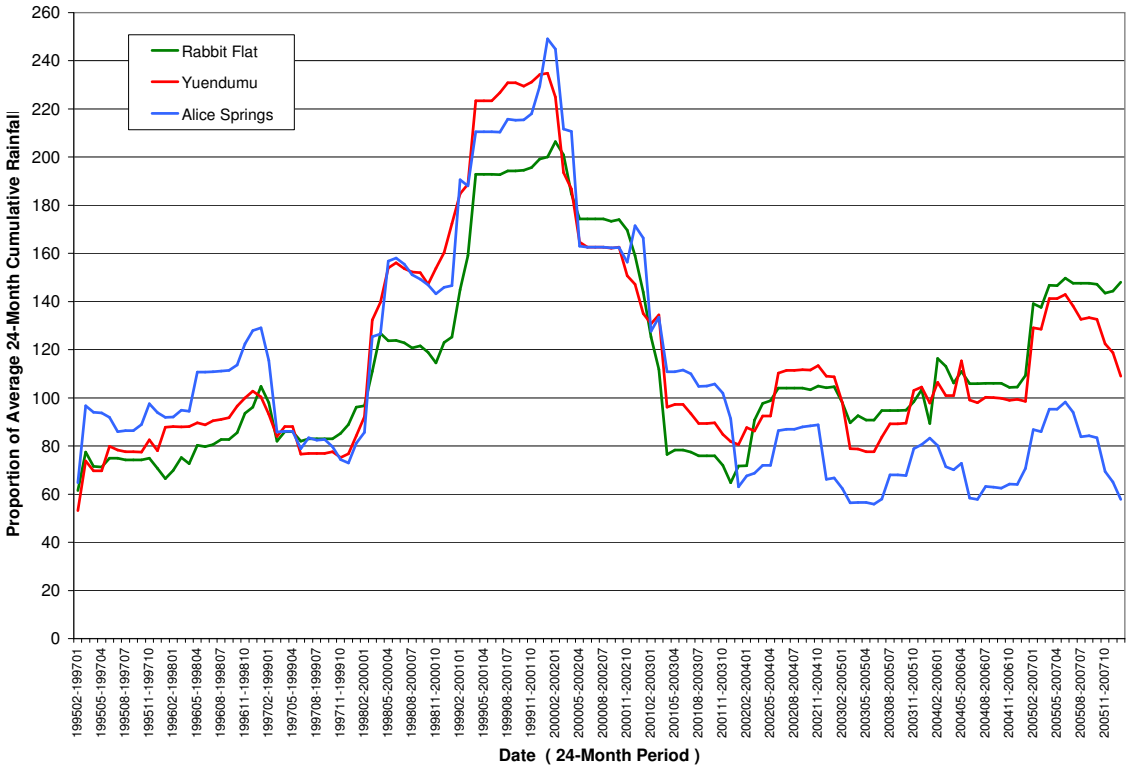

Figure 2.34: Rabbit Flat, Yuendumu and Alice Springs Station Rainfall, 1997–2007

Note: Represented as the running total of 24-month cumulative rainfall expressed as a percent of the average 24-month cumulative rainfall for the available recording period. Average 24-month rainyear values were 918 mm for Rabbit Flat (1969–2006), 717 mm for Yuendumu (1952–2006) and 564 mm for Alice Springs (1873–2006). The rainfall peaks above the 120% threshold for Rabbit Flat and Yuendumu during 2007 are associated with extensive fires in the Tanami Desert during 2007.

As a result there were numerous fires during the latter part of 2006, which were caused by both lightning and roadside ignitions (Figure 2.35). The roadside ignitions caused concern for some pastoralists. More extensive fires occurred during the second half of 2007. The most significant one began as three separate fires in early September 2007. The first was lit on the eastern side of the Tanami Desert near Tennant Creek, the second on the northern edge of the Tanami Desert near Lajamanu and the third near Rabbit Flat. The fires coalesced in the central Tanami Desert and over a period of eight weeks burnt an area exceeding 75 000 km² (Figure 2.35).

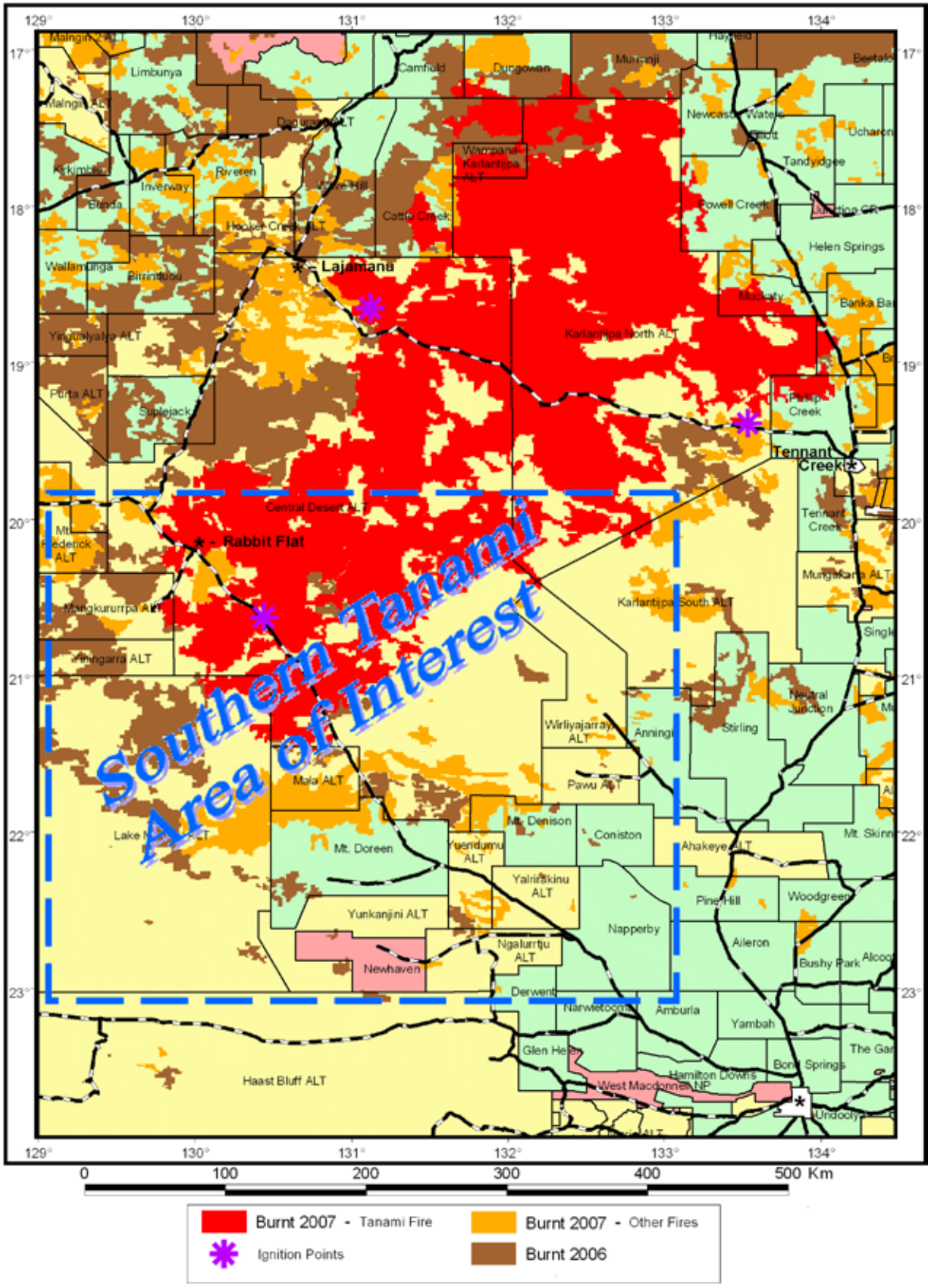

Figure 2.35: A map of areas burnt during 2006 and 2007 in the Tanami Desert

Note: The fires were mapped from NOAA AVHRR images. The combined area burnt by the three fires that began in early September 2007 is shown in red with their ignition points highlighted as purple asterisks. Other areas burnt during 2007 are shown in orange, and areas burnt in 2006 are brown. The background map shows pastoral leases as green, Aboriginal Land Trusts as yellow and conservation areas as red.

2.6 Online fire information

The availability of online fire information (via the Internet) has increased substantially since 2002. The active fire Internet sites were expanded and improved as computer technology and Internet capabilities suitable for the remote areas of Australia became more readily available. In 2008 there are three Australian websites that provide online fire information, plus at least one international site (Table 2.8). Although the primary focus of the websites is to monitor the locations of active fires that are detected by orbiting satellites, each site also provides diverse other information relevant to fire management, including previous fire history and current weather conditions.

One of the initial objectives of the Desert Fire project was 'the development of improved techniques for fire detection, mapping and dissemination of associated information. This will involve updating fire history, investigation of associated issues of resolution, accuracy, distribution, use and interpretation of fire history mapping'.

The objective was conceived in response to the period of widespread fires in central Australia during 2001 and 2002 and the demands put on staff in fire agencies to provide timely information to assist fire operations. This involved downloading active fire information detected by satellites and providing customised maps that provided greater contextual information than was available from the active fire websites at the time. It was also at a time when few rural and remote locations were connected to the Internet, and transmission of information relied on faxes. It was also anticipated that Desert Fire staff could facilitate feedback from land managers to improve the information provided on the websites and ensure that users understood the benefits and limitations of the information.

The objective was partially superseded by technological change and a dramatic improvement of the online fire websites. Satellite-based and other methods for the delivery of Internet services became more readily available. The increased diversity of available information helped to promote the utility of the Internet and improved its acceptance and use in rural and remote areas of Australia. Although a portion of rural land managers are not regular users of Internet services, many have the capabilities and it is expected that they would access active fire information as required, especially with assistance and encouragement from fire agency support staff (i.e. regional fire control officers of Bushfires NT).

A second factor that limited our engagement with rural land managers in this area was the recent absence of fires in central Australia. The extensive areas burnt in 2001 and 2002 were slow to recover during the subsequent period of low rainfall and the fire risk stayed at a low level. This translated to a general lack of interest and concern for fire issues as priorities, especially on pastoral properties, moved into other areas. Fortunately, the perennial issue of fire in northern Australia provided the impetus for website managers to improve their websites. Feedback was provided by land managers and fire agencies in northern Australia. The improvement of the North Australia Fire Information (NAFI) and Fire Watch websites (Table 2.8) has been dramatic, as has been their increased usage. The Tropical Savannas Cooperative Research Centre (TSCRC) reported a significant increase in user access to the NAFI website in 2004. NAFI was generating over 2000 fire maps for users on most days (TSCRC 2004).

Although few land managers in central Australia regularly check the online fire websites, all regional fire control officers in the NT access the websites daily. Feedback from pastoralists in central Australia has indicated that if they see smoke on the horizon their first action is to either check one of the websites themselves or contact Bushfires NT for the appropriate fire information from the Internet. Despite the availability of online help, including the NAFI Help Guide, it is recognised that there is some misinformation and misunderstanding about the capabilities of the active-fire information and burnt area maps. The Desert Fire team proposed that it would be appropriate to hold 'fire technology' workshops. The objective was to provide an update on new information available on the Internet and within the websites, as well as to describe the issues associated with active-fire detection and burnt area mapping, including their limitations.

Table 2.8: Summary of online fire information websites

Site Name	Address (URL)	Host agency	Characteristics

NAFI	www.firenorth.org.au	Tropical Savannas CRC, Darwin	Focus on northern savannas
			Developed for dial-up connections
			Optional email notification
			Data download options:
			• Active fires (hotspots)
			  • Shapefile format
			  • Geo-referenced images
			  • Selectable by date
			• Burnt area maps
			• Fire frequency map

Fire Watch	www.firewatch.dli.wa.gov.au	WA Department of Land Information, Perth	Australia-wide coverage Optional email or fax notification Lightning strike data Data download options: • Active fires (hotspots) • Shapefile or Geo-Tiff • Burnt area maps • Vegetation greenness images
Sentinel	sentinel2.ga.gov.au	GeoScience Australia, Canberra	Australia-wide coverage Data download options: • Active fires (hotspots) • KML or GPX format
RapidFire	maps.geog.umd.edu/firms	University of Maryland/NASA, Baltimore, USA	Global coverage Optional email notification Data download options: • Active fires (hotspots) • All formats • MODIS image subsets

Note: All websites are continually being refined and expanded. Most include a variety of selectable background layers and current weather condition overlays.

It was proposed that fire technology workshops should be delivered to personnel within the main land management support agencies, such as NT Government, CLC, CLMA, Anangu Pitjantjatjara Yankunytjatjara (APY) Lands in northern South Australia) and UKTNP. Other groups invited to attend could include mining companies, such as Newmont, and community education officers and after-school program officers in Aboriginal communities. These agencies could then help to disseminate the information to their clients. This proposal is still relevant and has been included in the recommendations for further work. It was also recommended that the fire technology workshop information should be included as a component of the new training programs being developed by Bushfires NT: Basic Wildfire Awareness, Basic Firefighter NT and Advanced Firefighter NT. The Basic Wildfire Awareness course is expected to be delivered to Aboriginal communities as a precursor to the Basic Firefighter NT course, which has a formal assessment process with English literacy and numeracy requirements.

2.7 Community consultation – attitudes of pastoral land managers to fire

A significant theme in the DKCRC is community consultation and engagement. The Desert Fire project was encouraged to incorporate this theme wherever possible. Providing a summary of the attitudes of pastoral land managers to fire addresses significant aspects of two objectives: 'the identification of land use and fire management goals across land tenures highlighting areas of conflict and the establishment of better communication between stakeholders through formal and informal processes (networks) and including other DKCRC themes: governance and sustainable communities'.

This section of the report provides a description of the process and a summary of the fire-related issues and attitudes to fire that were expressed by pastoralists. A companion report provides the perspectives on fire from the Aboriginal communities of the southern Tanami Desert (Gabrys & Vaarzon-Morel 2009). This next step in the process is to bring together the aspirations both within and across the diverse range of land managers to improve fire management. An important aspect of improved fire management is cooperation. An effective demonstration of this cooperation will be the development of a regional fire management strategy that identifies fire management issues, based on an understanding of other values, and provides an approach to achieve diverse objectives. Elements that will contribute to a southern Tanami Desert regional fire management strategy are described in Section 2.8.

2.7.1 Description of the process

Desert Fire created the opportunity for increased communication between land management agencies as well as a framework for more focused discussions on fire with land managers. The Desert Fire project coincided with a shift in attitudes and interrelationships both within and between the NT Government and the CLC which contributed significantly to increased interactions. Previous interactions between NT government agencies and the CLC had been limited to personal officer exchanges rather than official project-based collaboration. In addition there were diverse other land management projects in progress, including the development of an Integrated Natural Resource Management (INRM) plan for the NT. The timing of these activities, following the period of widespread fires in central Australia between 2000 and 2002, ensured that fire was an issue of discussion and concern.

Discussions about fire were held with pastoralists in association with a variety of projects, including a number of Desert Fire subprojects and CLMA's Environmental Management System (EMS) project and their contribution to the development of the INRM plan for the NT. Pastoralists representing 51 stations were contacted during these different projects. This represents the majority of pastoral leases in the southern NT. A summary of these interactions is provided in Table 2.9. More detailed descriptions of these meetings follow.

Table 2.9: Summary of Desert Fire (DF) and other project interactions to discuss fire management issues with pastoralists in central Australia

Activity	Purpose	Number of pastoral stations contacted: within/beyond Southern Tanami	Project officers
DF-3a subproject Meetings at Tilmouth Well in May 2004 & May 2005; DF-3d subproject Field Work	Introduce DKCRC & DF; DF Update; Introduce Regional Fire Management Strategy; Collect soil and vegetation data	5/1	Grant Allan, Kirsten Maclean, Andrea Tschirner, Dionne Walsh, Coral Allan, Dave Bowman, Guy Boggs, Anstee Nicholas
Bushfires Council Regional Committee Meetings	Introduce DF; DF Update and Future	1/5	Grant Allan
DF-3a subproject Station Visits and Telephone Contacts	Interview Pastoralists	6/0	Kirsten Maclean, Grant Allan
DF-3b subproject Station Visits; and NHT INRM Plan	Collect economic information on fires during 2001–2002; Identify NRM issues	6/40	Andrea Tschirner
CLMA EMS Project Station Visits	Discuss and distribute NRM information; Collect information on fires during 2001–2002	0/15	Dionne Walsh
DF-3g subproject Field Work	Introduce DF; Discuss fire issues; Measure impact of fire on mulga communities	2/8	Grant Allan, Coral Allan, Chris Materne

Note: A summary of each DF subproject (DF-3a to DF-3g) is provided by Edwards and Allan (2009).

Two meetings were hosted by Desert Fire for the southern Tanami region group of pastoralists at Tilmouth Well in May 2004 and May 2005. The first meeting provided an important opportunity to introduce both the DKCRC and the Desert Fire project. The pastoralists were unanimous in endorsing Desert Fire and willingly provided information on fire and permitted field work to be undertaken on their properties. The second meeting was an opportunity to provide feedback to the pastoralists on the progress of Desert Fire and to discuss issues associated with fire management in the region that needed to be addressed in the progression toward a regional fire management strategy.

Bushfires NT holds biannual meetings for the Alice Springs East and West Regional Committees. Presentations to introduce and summarise the progress of the Desert Fire were given at three successive meetings: October 2004, March 2005 and October 2005. The meetings also provided the opportunity for the pastoralists on the committees to identify issues of concern. One specific issue, the impact of the 2001–2002 fires on mulga country, was considered significant to the pastoral community. As a result, a new Desert Fire subproject, 'Mulga woodland dynamics influenced by fire and rainfall during the 2000–02 period in central Australia (DF-3g)', was initiated. Members of the Regional Committees invited a Fire/Land Management officer representative from the CLC to be a regular guest at the biannual meetings and to present a summary of CLC fire-related activities.

Kirsten Maclean's PhD project titled 'Creating spaces for negotiation at the environmental management and community development interface in Australia' (Maclean 2007) was linked to this Desert Fire subproject. Maclean's work was a social perspective on community engagement in land management activities and contrasted the processes of engagement of local community conservation groups in rural Victoria with the involvement of pastoralists, Aboriginal communities and park managers in fire and land management issues in central Australia. Information on fire and land management was collected through interviews and meetings with pastoralists, park rangers, land management officers and Aboriginal community members. Also, information on the planning and engagement process will be valuable to the process of developing a regional fire management strategy.

The CLMA's EMS project involved 15 pastoral properties across central Australia. The properties involved were Aileron, Alcoota, Amburla, Andado, Erldunda, Hamilton Downs, Lilla Creek, Lyndavale, Mt Ebenezer, Mt Riddock, Murray Downs, Palmer Valley, Temple Bar, Tieyon and Umbeara. Natural resource information was collated for each property, with support from NT government agencies, and individual interviews were conducted with all pastoralists. A specific component of the interviews focused on fire, based on a series of questions and maps of the station's fire history prepared by Grant Allan, Bushfires NT. The questions were:

- Are the locations and boundaries of the fires accurate?
- What and where was the likely source of ignition? Which direction did the fire/s travel?
- Would it be useful to know how much country was burnt per paddock/grazing area?
- Did we suffer loss of infrastructure or stock? To what value?
- What are the short-term and long-terms effects of fires on our pasture management?
- What has been the response of the country since the fires? How is this influenced by pre- and post-fire rainfall?
- Do we think fire is good or bad? Why?
- Do we use the hotspot website? Do we need more information and training to use this?
- Are the hotspot maps faxed by BFC [Bushfires Council] accurate and useful? How could they be improved?
- Would we use an on-station Geographic Information System?
- Would we be interested in developing a fire management plan with BFC?

The level of feedback on fire issues varied considerably between stations, and was dependent on the number of fires and the level of impact from the fires. Several properties had been unaffected by fires.

A second CLMA project was funded by the Natural Heritage Trust (NHT) program to collect information for the development of an INRM plan for the Northern Territory. The project provided an opportunity for another Desert Fire subproject (DF-3b) to collect additional information on the economic aspects of fire in central Australia during the 2000–2002 period (Allan & Tschirner 2009). The study involved personal interviews and discussions with pastoralists representing 36 stations in central Australia (Figure 2.36). The report captured a range of fire experiences, from those who only experienced a single fire event to those affected by repetitive fires during the three-year period. It covered properties involved in active use of fire as well as those involved only in fire suppression. Other data associated with fires on national parks and tourist facilities were also included.

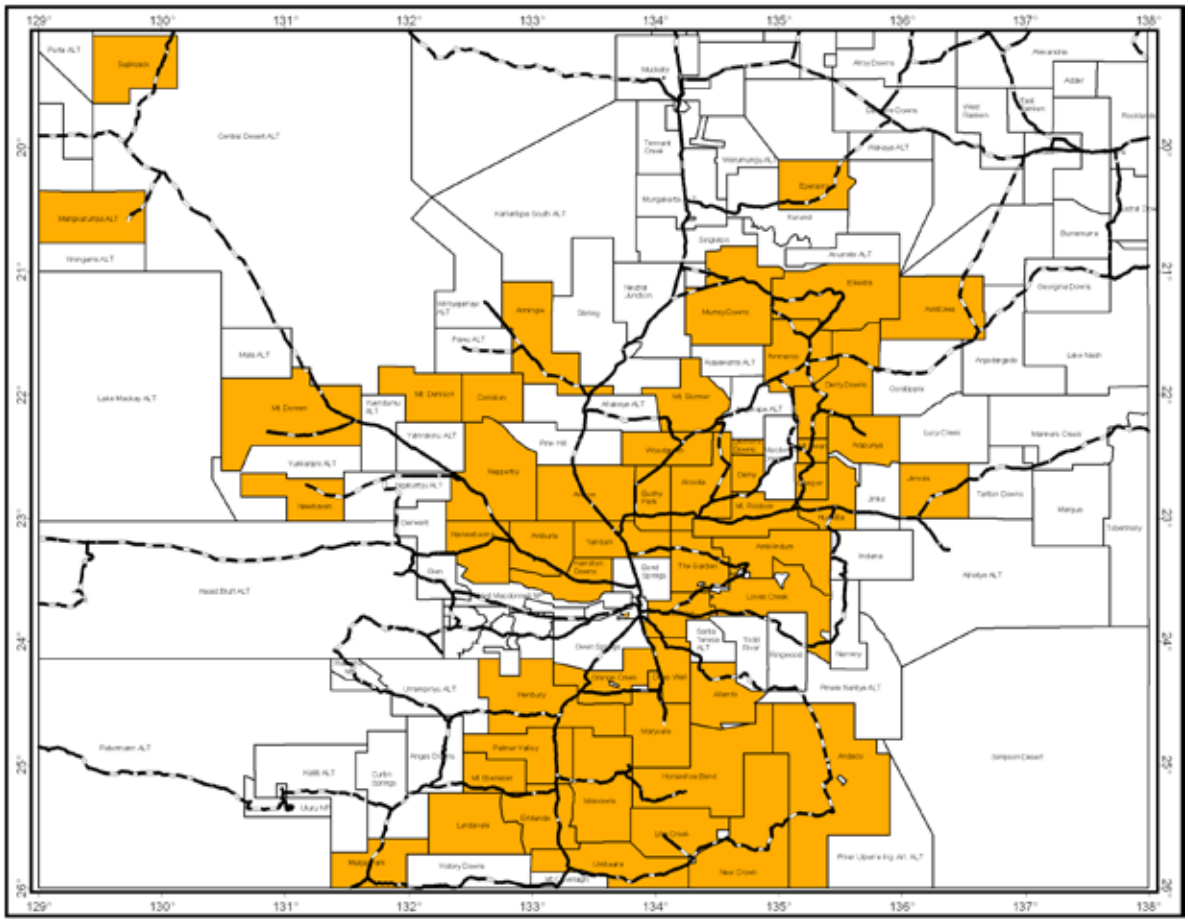

Figure 2.36: Pastoral properties in central Australia contacted to provide information on fire management to the Desert Fire project and CLMA's EMS and NHT INRM projects

Note: The map covers the southern Northern Territory (south of -19°) and extends to the boundaries of Queensland, South Australia and Western Australia.

In addition to the more formal interactions with pastoralists, there were opportunities for discussions with pastoralists when teams from other Desert Fire subprojects (DF-3a, DF-3d and DF-3g) visited pastoral properties during field work programs. These visits helped to increase the pastoralists' awareness of Desert Fire and contributed more information on fire management issues and interests on pastoral properties.

2.7.2 Summary of experiences, attitudes and issues

2.7.2.1 Experiences

Pastoralists' experiences with fire during the 2001–2002 period of fires were diverse. A few pastoral properties were not affected by fire; a few properties experienced wildfires but the impact was minimal; and several properties were seriously affected by wildfires as their pastures were very slow to recover from the fires due to the subsequent low rainfall. One property actively used fire as a management tool and, as a result, was relatively unaffected by wildfires that occurred on their land. Although some fires were known to have been started by lightning, there was greater concern associated with fires started by human ignition, usually from roadsides. Additional information on the impacts associated with these experiences were described by Allan and Tschirner (2009).

The experiences of pastoralists south of Alice Springs were different from those to the north. Fire was a much rarer event in the south and only occurred in 2002. There tended to be less use of fire as a management tool due to lower fuel loads and opportunities to burn; nonetheless, fire was seen in a positive light. Less preparation for wildfires, establishing fuel breaks and clearing fence lines meant that some fires were difficult to contain. The post-fire recovery of burnt areas was generally disappointing, principally due to dry conditions at the time of the fire and subsequent below average rainfall. This required unplanned changes to management, including unscheduled movement of stock as well as agistment.

To the north of Alice Springs, fires occurred throughout both 2001 and 2002, so most pastoralists were more aware of the threat of fire and took some preparatory actions. Despite these preparations many were more affected by the fires than they anticipated. There were many roadside ignitions; most were considered more a distraction than a problem, but some fires became larger and were more difficult to contain than expected. The impact of the 2001 fires on pastoral enterprises was generally less significant, due to the subsequent rainfall and recovery of pasture, than those of 2002.

A common sentiment expressed by several pastoralists, with the advantage of hindsight several years after the fires, was that considerable effort, energy and money was wasted fighting the fires. The fires were difficult to contain and the focus of the efforts could have been more wisely deployed on other activities. The longer-term impact of the fires was less than anticipated and had considerable positive benefits, despite some short-term costs. The approach of rapid suppression was due to:

- lack of fire experience: most pastoralists did not experience the extensive fires in the mid-1970s and relatively few fires have occurred on the pastoral leases in the subsequent 25 years
- an awareness of their land management responsibility to not allow fires to extend beyond their boundaries
- lack of an explicit fire strategy that lists assets and priority protection areas and provides a containment rather than a suppression approach
- lack of personnel available to help manage the fire, including collaboration with neighbours
- lack of active burning to reduce the amount and continuity of fuel loads to reduce wildfire risk and assist in fire containment.

2.7.2.2 Attitudes

The attitudes of pastoralists to fire in central Australia are very diverse, although all are aware of the threat of fire to their pastures. Most pastoralists recognise and accept the risk and impact of wildfires started by lightning. In general they prefer not to prepare for those events. The seasonal variability in central Australia, combined with the standard program of fuel reduction by cattle grazing, means that widespread fire risk is a rare event. Therefore, in the vast majority of years, wildfire risk management is not a standard operation, and very few pastoralists have a regular and active fire management program.

Most pastoralists are not so accepting of the risk and impact of fires started by human ignition, primarily lit from roadsides and mostly by Aboriginal travellers. They also do not prepare adequately for these events. Similar to the threat of lightning-initiated wildfires, the usual lack of continuity of fuel within their grazed landscapes in most years means that the impact of these roadside fires is more of an annoyance than a financial impact. However, during the years of widespread high fuel loads, such as the mid-1970s and 2001–2002, the level of impact of these roadside ignitions changed considerably. As a result, the Bushfires Act was changed to increase the financial penalties associated with these types of fires, and pastoralists encouraged police to prosecute people responsible for lighting illegal fires.

2.7.2.3 Issues

There were a number of fire management issues in the southern Tanami Desert region raised by pastoralists at the second Tilmouth Well meeting in May 2005. Participants at the meeting supported the objective of Desert Fire to develop a regional fire management strategy and expressed a willingness to participate. Importantly, they stated that it needed to be a collaborative approach developed through cross-sectoral engagement to improve the understanding and aspirations of land managers in the region and of the role and impact of fire. They also indicated that there was a need for efficiencies and actions to both develop and implement a program which had been lacking to date.

Community engagement was identified as an important issue, and the pastoral community was willing to meet with Aboriginal community members to discuss fire issues. They also felt that there was a need to engage the right people to be involved in the process, and that included Bushfires NT's regional fire control officers.

Communication was seen as a part of the community engagement process. This included ensuring everyone was aware of their responsibilities and liabilities with respect to fire under the Bushfires Act. There was also need for greater awareness of both the occurrence and impact of large wildfires. More readily available information was needed to show the spatial patterns of fire in the landscape and associated patterns of wildfire risk. Importantly, the information needed to be appropriately presented to be readily understood without being accusatory. The preliminary maps prepared for discussion at the second Tilmouth Well meeting in May 2005 depicted the recent fires in red, and it was recommended that more neutral colours would be appropriate.

The forum raised some issues of concern with regard to the CLC. Pastoralists felt that the land management focus with the CLC was insufficient, both in terms of priorities and activities. The land management issues on ex-pastoral property ALTs were considered more significant to surrounding pastoral operations than those associated with adjacent desert ALT blocks due to the range of issues associated with fire, feral animals, weeds and degradation of infrastructure. Despite some initiatives, such as IPAs and development of community ranger programs, the pastoralists felt that progress was too slow and too few people were involved. It was also felt that there should be a greater push toward better fire management across the broad landscape. Their experience indicated that there were problems with the permit and approvals process for land management work compared with mining activities where financial benefits were considered too influential. Nevertheless, the pastoralists recognised the role of the CLC but indicated that establishing a direct relationship with members of the Aboriginal community was important and needed to be encouraged.

The last important issue that was raised was advocacy. The challenge remains to find the most effective means to champion the cause of fire management and raise awareness of issues to a level that increases the urgency, support and actions required. Funding was also discussed with a realisation that money was usually a limiting factor in many land management programs. Funding is also closely linked to advocacy. It was hoped that an increased awareness of fire issues in the Tanami region could attract money from Newmont's mining operations and from IPA programs to facilitate better fire management programs across the Tanami region.

2.8 Elements of a southern Tanami Desert regional fire management strategy

The final objective of subproject 3a was 'as a longer term objective, to develop a fire management strategy for the southern Tanami area, with potential for applicability to other desert areas of Australia'.

The strategy was unable to be developed within the allotted timeframe, but considerable progress was made to its formulation. The background information on the patterns of fire in central Australia and the southern Tanami Desert described in the previous sections of this report provide a starting point. The information provided in this report by pastoralists and from Aboriginal communities (Gabrys & Vaarzon-Morel 2009) will contribute significantly to the issues that need to be addressed. Other important information from central Australia will come from the guidelines for best practice fire management on parks and reserves (Duguid et al. 2009), the fire management strategy for Newhaven Reserve (Paltridge & Latz 2006) and the draft fire and vegetation management strategy for Uluru–Kata Tjuta National Park. There are also diverse fire management strategies from other areas of Australia that need to be considered. This collation of information will form the elements of the fire management strategy for the southern Tanami Desert. An outline of elements that should be included in the Strategy is summarised in Table 2.10.

Table 2.10: Elements of a southern Tanami Desert fire management strategy

Delineate the strategy area	The boundaries of southern Tanami Desert region need to be defined, possibly by both landscape features and tenure boundaries, as well as by the interests of participants, both individuals and communities.
Engage the community in the development of the strategy process and annual activities	Individuals and communities need to be involved in the process. Participation can be by either direct participation at meetings or less directly through information exchange and contributions. • Information distribution requirements: A network to distribute information appropriately needs to be established to ensure all participants receive the information in a timely and appropriate format. • Timing and location of facilitated meetings: A schedule of meetings should be planned and announced to ensure good participation. The venue should be in a neutral location, and the dates should be timely with respect to seasonal burning opportunities.
Describe the recent fire history and spatial patterns	Maps of fire history and interpretations of their patterns and relationships to driving forces need to be prepared in a suitable format that can be readily understood by all community members.
Outline fire management aspirations and objectives	Community members should contribute to statements which identify the objective of the strategy and the aspirations of the participants. • Identify issues of conflict: Areas of conflict or concern should be identified with an aim to reduce or eliminate the problems.
Create a list of fire management responsibilities	Summary of responsibilities under the *Bushfires Act* (2004) and Bushfires Regulations (2005) must be provided.

Establish an appropriate zoning/landscape stratification scheme	A zoning scheme allows areas requiring specific fire management needs or actions to be delineated and increases community awareness of their values.
	• Review zone definitions used in other areas
	• Adopt or create appropriate zones, such as:
	  • Asset protection zones
	  • Wildfire mitigation zones
	  • Conservation zones
	  • Cultural heritage zones
	  • Priority pastoral zones
	  • Fire exclusion areas
	  • Travel corridors
	• Identify current information limitations and future needs to improve the zoning scheme.

Table 2.10: Elements of a southern Tanami Desert fire management strategy (cont'd)

Identify assets and resources	Assets are primarily associated with built infrastructure that can be readily identified and mapped. Assets can also be non-infrastructure features, which are less point-specific, as well as sacred site areas that it may be culturally inappropriate to accurately delineate.
	• Infrastructure and water sources
	• Non-infrastructure
	  • High value areas – pastoral, conservation, Aboriginal
	  • Culturally sensitive areas – Aboriginal sacred sites

Identify and map natural and artificial fire breaks	These features can be strategic locations for both active burning and suppression operations. • Major drainage features, major roads, persistent low fuel areas
Describe major vegetation communities and fire sensitivities	The mapping of the major vegetation communities provides important data for landscape stratification and defining fire management activities. The eight broad vegetation communities mapped at Newhaven (Latz et al. 2003) should be mapped across the southern Tanami Desert region. The guideline for appropriate fire regimes in each community should be adopted and refined over time. • Review of past fire histories and vegetation state/health The fire history with the major vegetation communities should be assessed to determine if the fire regime is suitable to maintain the vegetation in a healthy state. • Small areas of significant vegetation, not adequately delineated within the broad vegetation communities, should also be identified and mapped.
Describe fauna assemblages and individual species	Information on the fire management sensitivities of fauna in the region should be collated and incorporated into the fire regime requirements, similar to the vegetation communities. • Describe species habitat preferences and fire sensitivities • Identify current data limitations and future needs • Link with the Newmont/CLC Tanami Monitoring Project analysis

Define the strategy process	The strategy must be an active document. Although its objective should remain constant, the information and activities associated with the strategy should be dynamic but follow a regular schedule. The program of fire management on parks in the NT is an appropriate model, which includes an annual review of seasonal conditions, preparation of burn plans with implementation priorities and an active burning program. It should include:
	• Periodicity of review and assessment
	  • Annual planning of active burning programs
	  • Annual review of suppression and containment options and priorities
	  • Review of the strategy, on a 5- to 10-year basis
	• Information requirements and provision
	  • Current 'static' information
	  • Assets, zones, vegetation communities, etc
	  • 'Dynamic' information
	  • Rainfall, seasonal conditions, time since fire, fuel state, etc.: The draft Uluṟu–Kata Tjuṯa National Park fire and vegetation management strategy has adopted five fuel-state categories applicable across the range of vegetation communities. It provides the opportunity to combine fire history and time since fire and assess fire risk linked to continuity of fuel on a landscape scale. A modification of the decision rules to determine fuel-state category could be adopted in the southern Tanami Desert.
	  • Description of seasonal fire potential: The Bureau of Meteorology, in association with the Bushfire CRC, hosted the first national Seasonal Bushfire Assessment workshop in June 2006 (Lucas et al. 2006) and subsequently the first Northern Australia Seasonal Bushfire Assessment workshop in May 2007 (Lucas et al. 2007). The workshops are expected to be held annually, and the information should be incorporated into this strategy.
	• Plan proposed programs of active fire management
	  • Reduce seasonal risk
	  • Establish fire breaks
	  • Protect assets
	  • Schedule active fire management
	  • Meet vegetation and fauna community fire regime requirements
	  • Plan suppression and containment options
	• Process of operations
	  • Requirements for coordination, potentially by Bushfires NT
	  • Identify individual land management responsibilities and activities
	  • Identify opportunities for collaborative activities
	  • Determine complementary program activities

The strategy must be relevant to the complexities of fire in the southern Tanami Desert and suitable for both the western and Aboriginal cultures of the region. A major challenge is to assess the opportunities and options for active burning programs across the extensive areas of spinifex sand plains and dunefields, which are mainly on Aboriginal land. These areas have had a recent history of relatively large fires. Although these landscapes are relatively robust, there are minor components with greater fire sensitivities that are not being adequately protected. Fires have spread from these areas into adjacent areas and can have negative impacts on assets, such as affecting grazing pastures, threatening infrastructure, burning sacred sites or impacting on biodiversity values. Implementing active burning programs in these areas must deal with the issues of restricted access, due to both the lack of roads or tracks and the Aboriginal permit system, and the relatively high cost of access in terms of both time and money. The approach should be multi-scaled, combining vehicle-based ground-burning programs with helicopter-based access for further ground burning programs, and also Aerial Prescribed Burning (APB) programs that use either helicopters or fixed-wing aircraft to drop aerial incendiaries.

A second challenge is to address the issue of roadside ignitions. Unwanted and unconstrained roadside ignitions were identified as a significant issue to both the pastoral and Aboriginal community members in the region. Information and education programs are required to increase awareness of the social issues associated with roadside ignitions, including an increased acceptance that roadside ignitions play a significant role to the wellbeing of many travellers. Active management is required to reduce the chances for roadside ignitions to cause undesirable impacts without eliminating the importance of most ignitions as signals for assistance.

A third challenge is to identify and document the benefits of improved fire management in both economic and non-economic terms and explore the opportunities for funding management activities. Economic activities in the region include mining, bushfood industries, tourism and pastoralism. These activities are linked to the natural biodiversity and cultural values of the region and benefit from the maintenance of intact ecosystem processes, which includes fire.

A fourth challenge is to incorporate training and skills development in active fire management into the Aboriginal Ranger land management programs. The suite of skills and activities should also include fauna survey, weed management, feral animal control and pastoral skills associated with cattle production. Subsequently, the burning cooperative approach being used in the rangelands of the United States (Taylor 2005) might serve as a useful model in this regard. Regional NRM teams, involving the Aboriginal Rangers, could undertake a variety of management and monitoring activities throughout the southern Tanami Desert region.

Maclean (2007) suggested that the process of creating and implementing the strategy has to go beyond fire management and should contribute to:

- improved communication between interest groups
- increased knowledge sharing between interest groups
- further development of knowledge networks.

Table 2.11 describes what the overall Desert Fire project is about, from the perspective of a social scientist (Maclean 2007). This demonstrates the importance of a range of social interactions and planning processes that go well beyond the mapping of and managing of fire on the ground.

Table 2.11: What is this Desert Fire project about?

Developing a plan	An endorsed fire management strategy, different people, doing different things, in different land tenures, with some level of agreement
Awareness raising	Learning more about fire and management outcomes
Networking	People networking, and using those networks collaboratively
Sharing technology	Maintaining and distributing information on fire patterns with use of satellites Making sure everyone is aware of the technology
Community development	Building regional capacity, not doing it alone
Acknowledging the social	It's about people and it can't be solved by only using satellites and mapping fire
Acknowledging the political	It's about getting everyone together and working out the politics and social aspects of fire management
Working together	On country to manage country better

Source: Maclean 2007

Maclean (2007) noted that the regional fire management strategy also needs to provide a range of implementation opportunities. It should allow people to work in isolation, whereby an initial systematic reduction of fuel loads allows land managers to burn on their own land for their own purposes. It should also facilitate people working together. This will bring Aboriginal communities and their knowledge together with western scientists to exchange what they know about fire and how to use it.

2.9 Final comments and recommendations

This aspect of subproject 3a was successful in meeting its initial objectives (see Section 2.2). It also established a basis for achieving our anticipated outcomes that have a timeframe extending beyond the term of Desert Fire.

Desert Fire 3a helped to build a network between agencies. Most important was the improved interchange between Northern Territory Government agencies and the CLC to address fire and other land management issues in the region. Interactions between organisations involved in the subproject, including Charles Darwin University and the University of Adelaide, and supporting graduate students, have been mutually beneficial. Desert Fire 3a also improved communication and interest about fire within the general community. Maintaining the networks and communication within the community will be an ongoing challenge.

Through the combined results of the two initiatives undertaken in this subproject of Desert Fire, our understanding of land and fire management goals across land tenures was increased. Our approach was to discuss the regional fire issues with the Aboriginal, pastoral and conservation communities groups separately. The next step must bring the three groups together, with a facilitator, to discuss fire issues, begin to reduce areas of conflict and prepare the foundations for a coordinated approach and the development of a regional fire management strategy.

The coincidental improvements in technology for fire detection via satellites and the rapid expansion of the Internet into the remote areas of central Australia helped to increase the communities' awareness of active fires. Our knowledge of fire regimes in the southern Tanami Desert region has increased through the detailed mapping and analysis presented in this report. It provides the basis to continue to improve both active fire management and fire suppression activities.

Our objective to engage the Aboriginal community ranger programs in active fire management was our least successful achievement. Discussions and interactions were successfully achieved, but the delivery of accredited training to all ranger groups remains outstanding. Training is an important first step to improving knowledge about the control of fire and developing safe and strategic burning programs across the region.

Our final objective, to develop a fire management strategy for the southern Tanami area, is unfinished. This report, in conjunction with other fire management strategies under development in central Australia, provides the basis for a new strategy. The next step is to engage with the community to capture their input and build the strategy with their ownership.

2.9.1 Detailed recommendations

Recommendations and opportunities for further work that were identified within this Desert Fire subproject were:

- Maintain timely two- and three-year cumulative rainfall records for all daily weather recording stations in central Australia to more accurately monitor seasonal conditions and fuel loads. The information should also be linked to daily Keetch-Byram Drought Index (KBDI) grids available from the Bureau of Meteorology, National Climate Centre, Melbourne.
- Map and analyse fire patterns on the 1950 aerial photos of central Australia to improve our knowledge of the spatial patterning of fires associated with periods of above average rainfall years.
- Follow up on the outcomes of the research work by the students associated with the Desert Fire project: Adam Leavesley (PhD at ANU); Kirsten Maclean (PhD at ANU); Anstee Nicholas (M.Sc at CDU); Dorothy Turner (PhD at the University of Adelaide) and Boyd Wright (PhD at UNE). Incorporate their results into the fire management strategy for the southern Tanami Desert region and other relevant management programs.
- Update the Landsat-derived fire history of the core study area of the southern Tanami Desert region to help develop the fire management strategy. If possible, extend the database back to 1979 when the regular acquisition of Landsat images became available.
- Encourage more active and timely burning of spinifex in the areas surrounding mulga communities to reduce the impact of widespread fires on isolated mulga communities. The patches should be burnt when fuel loads in the mulga are either green or below a level that will carry a fire.
- Further investigate the occurrence and impact of short-interval fires on vegetation communities. Study the patterns of the fires in relation to the weather conditions to improve understanding of the rate of fuel load recovery and associated fire risk.
- Encourage the invited Fire/Land Management representative from the CLC to be a regular guest at the Alice Springs East and West Bushfires Council Regional Committee biannual meetings and to present a summary of CLC fire-related activities. It would also be relevant to investigate the potential to extend this opportunity to the Elliott/Wauchope and Barkly Regional Committee meetings.
- Encourage land managers to record fire information immediately after fires, as delays cause loss of information. Land managers should be encouraged to report all fires and provide information on ignition source, suppression efforts, costs and impacts, as well as their own attitudes. It is also worthwhile to follow up on the longer term impacts and capture the value of hindsight.
- Encourage land managers to develop individual fire management strategies, similar to those being developed for parks and proposed for the southern Tanami Desert region, and include response plans for unscheduled fires.

- Encourage land managers to respond to seasonal conditions as they occur and not to rely on anticipated cycles, especially with consideration of the anticipated uncertainties associated with climate change predictions.
- Investigate the opportunity to establish a position of a fire management advocate to improve fire management in the southern Tanami Desert and across central Australia. Responsibilities of the position could include facilitating community meetings, applying for external funds, encouraging timely fire management activities and distributing relevant information.
- Encourage CLC to increase their land management capabilities.
- Encourage CLC to address the perceptions and issues of concern raised by the pastoral community to improve relationships and cooperatively address land management challenges.
- Develop and hold fire technology workshops to improve land manager awareness of the advantages and limitations of fire information available via the Internet.
- The new training programs being developed by Bushfires NT (Basic Wildfire Awareness, Basic Firefighter NT and Advanced Firefighter NT) should include a component on the benefits and limitations of online fire information.
- Develop an improved landscape stratification for the southern Tanami Desert region, based on the eight broad vegetation communities identified for Newhaven Reserve. Use the landscape stratification to review the fire history patterns of the region to contribute to a more effective fire strategy.
- Develop a fire management strategy for the southern Tanami Desert region.

2.9.2 Afterword

A significant first step has been taken by the CLC with the appointment of a fire management officer, whose role is to increase dialogue about fire, coordinate fire training and skill development and support improved fire management throughout the Aboriginal lands of central Australia. They have also received funding from the Natural Resource Management Board (NT) Regional Investment Strategy 2007–2008 to establish two Aboriginal Fire Management Committees to represent Aboriginal people's interest in fire management issues across the vast tracts of Aboriginal land in the western CLC region, one for the Tanami Desert and the second for the Petermann area in the south-west NT.

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