# DESERT KNOWLEDGE CRC

The Working Paper Series

# Proceedings of the Desert Fire Symposium

Glenn P Edwards
Kathy McConnell

Working Paper
35

2009

BUSHFIRES NT

Northern Territory Government

CRC AUSTRALIA

DESERT KNOWLEDGE CRC

# Proceedings of the Desert Fire Symposium

Wednesday 1 November 2006

NRETA Conference Room

Alice Plaza Building, Alice Springs

Glenn P Edwards

Kathy McConnell

## Contributing author information

Glenn P Edwards is Director, Wildlife Use at the Northern Territory Department of Natural Resources, Environment, the Arts and Sport.

Kathy McConnell is Administrative Officer at the Northern Territory Department of Natural Resources, Environment, the Arts and Sport.

Desert Knowledge CRC Working Paper #35



ISBN: 1 74158 123 0 (Web copy)
ISSN: 1833-7309 (Web copy)

## Citation

Edwards GP and McConnell K. 2009. *Proceedings of the Desert Fire Symposium*. DKCRC Working Paper 35. Desert Knowledge CRC, Alice Springs.

The Desert Knowledge Cooperative Research Centre is an unincorporated joint venture with 28 partners whose mission is to develop and disseminate an understanding of sustainable living in remote desert environments, deliver enduring regional economies and livelihoods based on Desert Knowledge, and create the networks to market this knowledge in other desert lands.

## Acknowledgements

The Desert Knowledge CRC receives funding through the Australian Government Cooperative Research Centres Program. The views expressed herein do not necessarily represent the views of Desert Knowledge CRC or its Participants.

## For additional information please contact

Desert Knowledge CRC
Publications Officer
PO Box 3971
Alice Springs NT 0871
Australia
Telephone +61 8 8959 6000 Fax +61 8 8959 6048
www.desertknowledgecrc.com.au

## Contents

## List of figures



## List of tables

## List of shortened forms

| | |
|---|---|
| ALT | Aboriginal Land Trust |
| AMS | accelerator mass spectrometry |
| ANU | Australian National University |
| APB | Aerial Prescribed Burning |
| ASPIAC | Alice Springs Pastoral Industry Advisory Committee |
| AVHRR | advanced very high-resolution radiometer |
| CA | central Australia |
| CDU | Charles Darwin University |
| CLC | Central Land Council |
| DKCRC | Desert Knowledge Cooperative Research Centre |
| DLI | Western Australian Department of Land Information |
| DPIFM | Northern Territory Department of Primary Industry, Fisheries and Mines |
| FAA | fire-affected areas |
| FDI | fire-danger index |
| FHS | fire hotspots |
| GIS | geographic information system |
| MSS | multispectral scanner |
| NOAA | National Oceanic and Atmospheric Administration |
| NRETA | Northern Territory Department of Natural Resources, Environment and The Arts |
| PWSNT | Parks and Wildlife Service Northern Territory |
| SOM | soil organic matter |
| TM | Thematic Mapper (used with Landsat) |

# 1. Introduction and overview of Desert Fire

**Glenn P Edwards, Project Leader**
Department of Natural Resources, Environment, and the Arts, PO Box 1120, Alice Springs, Northern Territory 0871, Australia

## Overview of Desert Fire

Fire is a regular and widespread feature across many Australian landscapes, including the vast desert regions. Its occurrence and impact within the desert regions is as variable as the region itself and attitudes towards fire vary both locally and regionally, between and within community groups.

During the three-year period 2000–02, fires were common in the central and northern regions of Australia's desert lands, following a period of above-average rainfall that created exceptional grass growth and fuel production. This raised the awareness of fire but has also led to conflicts among sectors of the rural community.

The Desert Knowledge Cooperative Research Centre (DKCRC) attempted to address some of the key issues in managing fire in desert Australia through an initiative called 'Desert Fire'. Desert Fire was a collaborative project. It involved key partners of the DKCRC, including the Northern Territory Department of Natural Resources, Environment and The Arts (NRETA; participating divisions included Bushfires Council NT, Biodiversity Conservation Division and Parks Division), the Central Land Council (CLC), Charles Darwin University (CDU) and Adelaide University, as well as key stakeholder groups and collaboration with the Bushfire Cooperative Research Centre (Project B2.1) and the Australian National University (ANU). Desert Fire was made up of 10 projects under three subproject headings. These subprojects were linked together to meet the common goal (developed at the Arid Zone Fire Research & Management Workshop held at the DKCRC on 28 August 2003) to 'adapt and maintain appropriate fire regimes and their management based on robust research, planning, review and communication to support the diverse users and managers of desert lands to achieve a balance of their ecological, social and economic priorities'.

## Desert Fire subprojects

### Subproject 1: Fire regimes of the desert regions of Australia at a continental scale

This is a PhD research project by student Dorothy Turner through the University of Adelaide. The main aims were to build and maintain an accurate fire history database of where and when fires have occurred in arid Australia and to examine the factors influencing this fire regime.

### Subproject 2: Fire regimes of the desert regions of Australia at a regional scale: overview and priority setting

*2a. Identify priority areas for fire management research.*

The aim of this subproject was to identify priority regional areas for fire management research. This aim should be met through recommendations arising from subproject 1.

*2b. Review of current 'scientific' knowledge relating to environmental impacts and management of fire in desert areas.*

The aim of this subproject was to establish a bibliographic database of fire-related publications focusing on the arid zone of Australia. This was an NRETA (Biodiversity Conservation) initiative. As an adjunct to this subproject, a voiceover PowerPoint presentation in respect of fire management, featuring the views of Peter Latz, was developed.

## Subproject 3. Fire regimes of the desert regions of Australia at a regional scale: case studies

*3a. Managing fire in the southern Tanami Desert.*

At the time that Desert Fire was being developed, it was known within Bushfires Council NT and CLC that fire management within the southern Tanami Desert region of the Northern Territory was a contentious issue. Consequently, it was selected as a focal study site for an evaluation of stakeholder perspectives in relation to fire management. It was hoped that improving the dialogue with respect to fire would help to resolve some of the conflicts associated with fire. A detailed fire history of the region was developed by Bushfires Council NT in order to inform discussions with local stakeholder groups.

Linked to this subproject was a student (Kristen Maclean) PhD research project through the ANU. The project 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.

*3b. Pastoralists' perspectives on the costs of widespread fires in the pastoral lands of the southern Northern Territory region of central Australia during 2000 to 2002.*

The Centralian Land Management Association played a key role in this subproject in partnership with Bushfires Council NT. The aim of the subproject was to improve our understanding of the economic impact of fires in arid landscapes.

*3c. Review of fire management planning and implementation on parks and reserves in central Australia and development of 'best practice protocols'.*

Conservation reserves are areas where fire is a core part of land management practices and they provide opportunities to study the differing effects of fire on plants and animals. The aims of this subproject were to review the management of fire on conservation reserves in central Australia and to develop best practice protocols to guide the management of fire to enhance conservation outcomes. This was an NRETA (Biodiversity Conservation) initiative.

*3d. Using acacia shrublands landscape change as an indicator of ecosystem health.*

This subproject was carried out by CDU. Its aim was to evaluate the role that fire might play in determining the boundaries between spinifex grasslands and mulga woodland (*Acacia* spp.) communities in arid Australia.

Linked to this subproject was a student (Anstee Nicholas) Masters research project through CDU.

*3e. Impacts of fire on biodiversity in central Australia.*

The broad aim of this subproject was to examine the impacts of fire on the biodiversity of central Australia. Four research initiatives were undertaken in the context of this aim. The first was a desktop review of the vegetation of the Northern Territory with a view to classifying species as either 'obligate seeders' or 'non-obligate seeders'. This research initiative was a collaboration between the Tropical Savannas CRC (with funding through the National Heritage Trust) and the DKCRC (through NRETA (Biodiversity Conservation)).

The second research initiative was the development of a vegetation fire succession model for the major plant groups of central Australia. This research was a collaboration between the DKCRC and ANU in partnership with the Bushfire CRC, and was linked to subproject 3f (below).

The third research initiative was a case study on the impacts of fire on *Eremophila prostrata (Chinnock)* carried out by NRETA (Biodiversity Conservation). *E. prostrata* is nationally listed as vulnerable to extinction based on a very restricted area of occurrence and low population numbers.

The fourth research initiative is a student (Adam Leavesley) PhD research project through the ANU and in collaboration with the Bushfire CRC and the DKCRC. This project is examining the dynamics of mulga woodland bird communities in relation to fire in Central Australia.

*3f. Modelling fire events in the west MacDonnell Ranges.*

This research was a collaboration between ANU, the Bushfire CRC and the DKCRC. The aim was to develop a 'firescape' model of fire dynamics in the west MacDonnell Ranges region of central Australia.

*3g. Mulga woodland dynamics influenced by fire and rainfall during the 2000–02 period in central Australia.*

The aim of this subproject was to investigate the influence of intense fire and follow-up rain on mulga woodland dynamics in central Australia. This research was a collaboration between the NT Department of Primary Industries, Fisheries and Mines and Bushfires Council NT.

## Desert Fire symposium

The aim of this symposium is to communicate the results and findings of the various components of Desert Fire to the general community in a forum that provided for feedback and discussion. The papers presented during the symposium covered most aspects of Desert Fire. The symposium included two papers from researchers working on fire in arid Australia but who were not specifically a part of Desert Fire: Boyd Wright (PhD candidate, University of New England); and Louise Pastro (PhD candidate, University of Sydney).

An appendix to these proceedings lists the currently available products of Desert Fire.

## Acknowledgements

From my perspective, the symposium was a great success. More than 80 people attended over the course of the day and the level of audience participation was outstanding. I thank all of the speakers who presented papers at the symposium and all those who attended on the day. Many of the points raised at the end of presentations and during the general discussion helped to shape the final reports for Desert Fire and informed the subsequent development of scientific papers and other outputs from the project. The symposium would not have happened without the drive and dedication of Grant Allan and Neil Phillips, and I thank them wholeheartedly for their efforts.

# 2. Fire regimes of the desert regions of Australia at a continental scale

**Dorothy Turner**
PhD candidate, University of Adelaide
Email: dorothy.turner@adelaide.edu.au

Data from the advanced very high-resolution radiometer (AVHRR) of NOAA (National Oceanic and Atmospheric Administration) were used to assess the distribution, seasonality frequency, number and extent of fire hotspots (FHS) and fire affected areas (FAA) across the entire arid and semi-arid country of Australia for the first time.

Over the period studied (1998 to 2004), almost 27% of arid and semi-arid Australia burnt at least once. The main trends in fire distribution follow latitudinal rainfall gradients. The seasonality of fire events varied between climate zones in accordance with the varying distribution of precipitation and temperature, which influence fuel accumulation and curing. Over the study period there were several high-fire years in certain areas following above-average rainfall.

# 3. Fire in the southern Tanami Desert: overview of fire regimes and pastoral perspectives on fire

**Grant Allan**
Bushfires Council NT, Northern Territory Department of Natural Resources, Environment and The Arts (NRETA), Alice Springs
Email: grant.allan@nt.gov.au

## Introduction

This report is an extract of the final Desert Fire subproject 3a report (Allan 2009). It includes a summary of:

- a comparison of two periods of widespread fires in central Australia, 1974–77 and 2000–02
- a more detailed investigation of fires in the southern Tanami Desert region
- information learned from the analysis of fire patterns
- the experiences, issues and attitudes of pastoralists to fire
- the elements required for a southern Tanami Desert fire management strategy
- recommendations and opportunities for further work.

## Comparison of 1974–77 and 2000–02 fire events in central Australia

There was limited opportunity to directly compare the 1974–77 and the 2000–02 fire events in central Australia. Comprehensive fire reports collected by the Bushfires Council NT during the 1970s were not collected during 2000–02. The satellite images that were readily available in 2000–02 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 3.1). The greatest difference was the higher fire activity in the cooler months of March to August during 2000–02. These fires were associated with fires started by human ignition, often from roadsides.

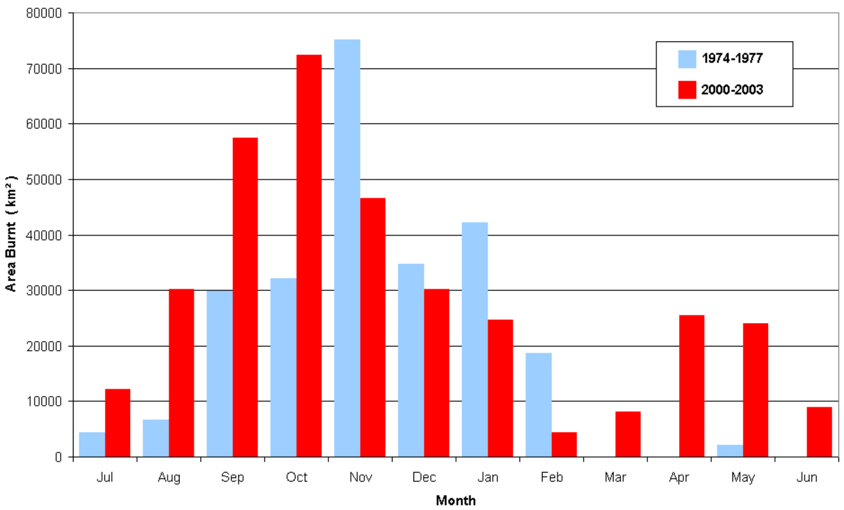



**Figure 3.1: Comparison of the frequency distribution of monthly area burnt in the pastoral area of central Australia for two three-year periods, July 1974 to June 1977**

1. Derived from Bushfire Council NT fire reports (Griffin et al. 1983), and July 2000 to June 2002 based on NOAA AVHRR satellite-derived fire history maps.

## Fires in the southern Tanami Desert region

Within the much larger area of the Tanami bioregion (Thackway & Cresswell 1995) that extends into WA, the southern Tanami Desert 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 $km^2$ (Figure 3.2). Within the southern Tanami Desert 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 $km^2$ (approximately 185 km x 185 km).

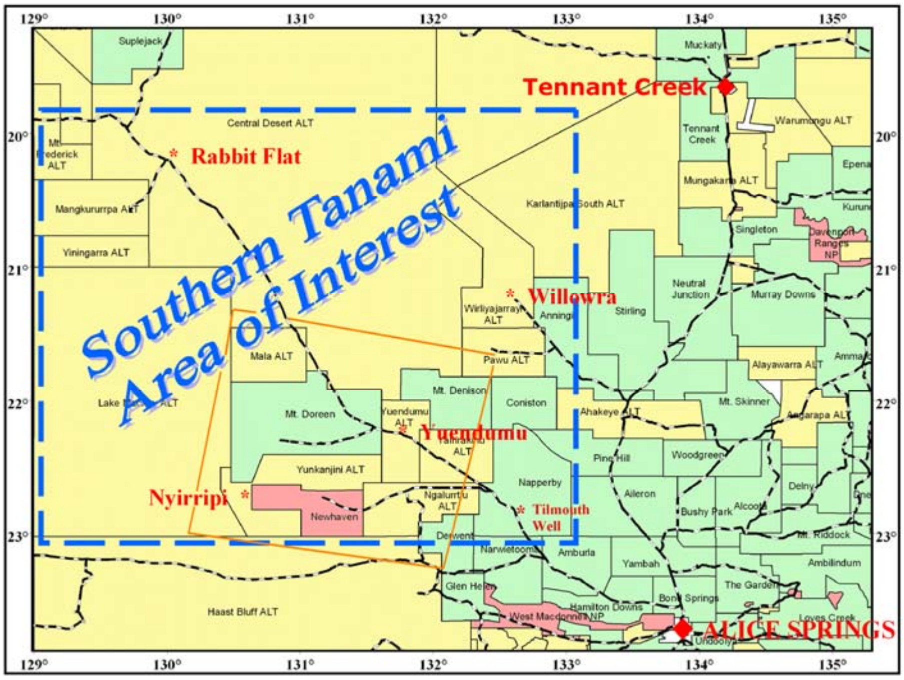



**Figure 3.2: A map of the land tenure and major locations in the southern Tanami Desert study area**

1. 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 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 $km^2$ in size. Only 2.5% of the fires were greater than 1000 $km^2$, but they represented 72% of the total area burnt (Figure 3.3). Many fires burnt into or beyond the image extent, and the largest area burnt by a single fire exceeded 5700 $km^2$.

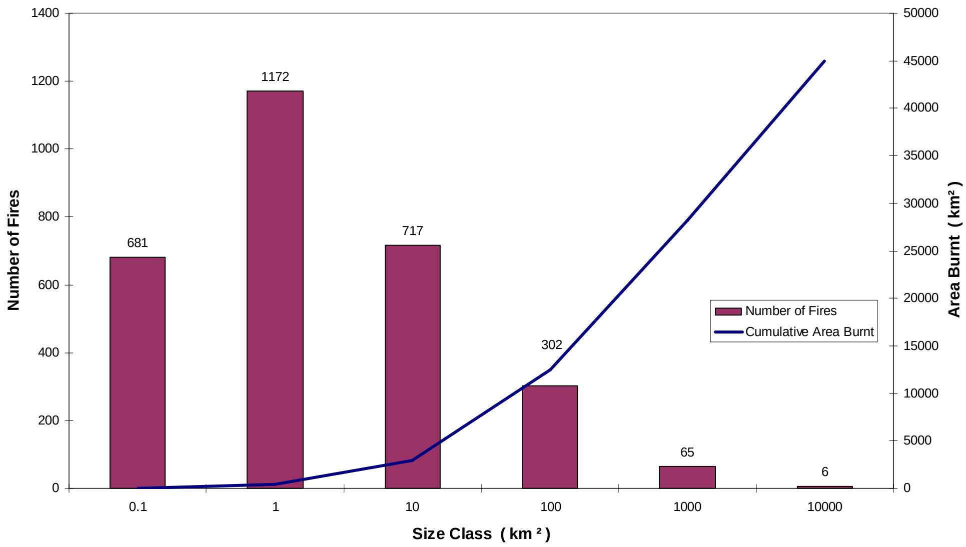



**Figure 3.3: Size-class distribution and cumulative area burnt by all fires between July 1997 and March 2005**

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 3.4); however, the largest fires occurred in September (Figure 3.5). 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.

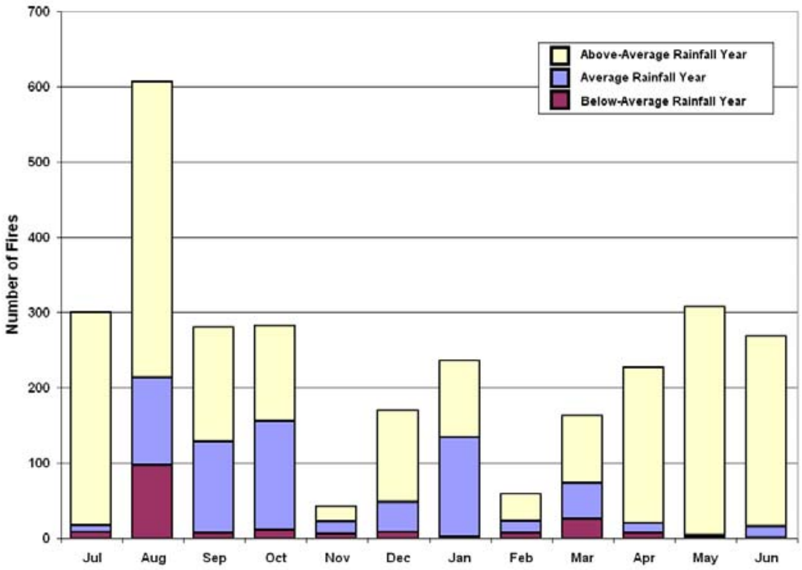



**Figure 3.4: The annual temporal distribution of the number of fires in the southern Tanami Desert region for the period from July 1997 to March 2005**

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

The temporal distribution of area burnt by fire size shows that the average area burnt each month during the period from July 1997 to March 2005 was evenly distributed throughout the year, with the exception of September and October (Figure 3.5). 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 km$^2$ and occurred during September and October. The largest fire, which burnt 5716 km$^2$, occurred in September 2000; the two next largest fires (that burnt 3969 km$^2$ and 3717 km$^2$) 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 km$^2$ occurred during August to October, with 18 occurring during 2001.

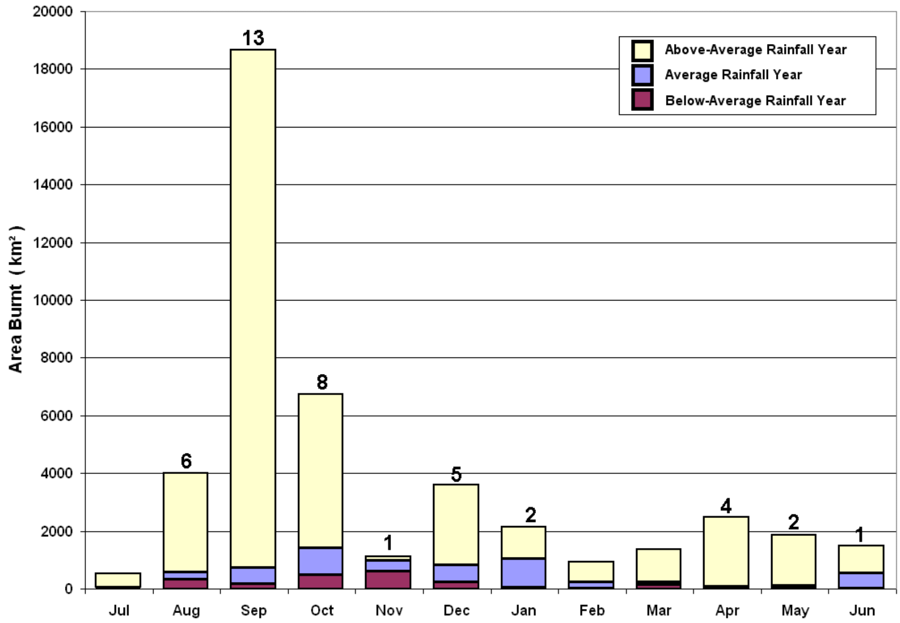



**Figure 3.5: The annual temporal distribution of the area burnt in the southern Tanami Desert region for the period from July 1997 to March 2005**

1. There were two years when the preceding 24-month cumulative rainfall was below average (July 1997 to June 1999 and July 1999 to June 2000), three years with average rainfall (July 1998 to June 1999; July 2003 to June 2005) and three years with above-average rainfall (July 2000 to June 2003).
2. The values above each column indicate the number of fires with an area burnt greater than 200 km$^2$.

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 total 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.

## Summary of information learned from the analysis of 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, which occurred over a five-year period within the 34 000 km$^2$ area of the study area defined by the extent of a single Landsat image. Griffin et al. (1983) had 785 fires within their analysis of a 10-year data set for the 365 000 km$^2$ of the pastoral area of central Australia; however, 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 $km^2$ to include the desert regions. The project mapped 1688 fires during the five-year period from 1979 to 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 3.4). 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 from 1940 to 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 to June 2002. The fires were not extensive and 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. Mulga areas are considered important to the majority of land managers and ecologists and therefore there is a need to be more proactive 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.

Only a relatively small portion of the landscape carried two fires with short fire intervals. They were primarily on spinifex sandplain and dunefield areas. The fuel loads for the second fire would have been a mix of regenerating spinifex and a diversity of 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 impacted by short-interval fires. Recent research has improved our understanding of the species response and sensitivities to fire within these communities (Wright 2007).

## Attitudes of pastoral land managers to fire

A significant theme within the DKCRC is community consultation and engagement. The Desert Fire project was encouraged to incorporate this theme in our project. This section provides 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). The next step in the process is to bring together aspirations both within and across the diverse range of land managers to improve fire management.

## Experiences

Pastoralists' experiences with fire during the 2001–02 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 property. 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 was described by Allan and Tschirner (2009).

A common sentiment expressed, with the advantage of hindsight, 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 several factors:

- a 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
- the lack of an explicit fire strategy that lists assets and priority protection areas and provides a containment rather than a suppression approach
- the lack of personnel available to help manage the fire, including collaboration with neighbours
- the lack of active burning to reduce the amount and continuity of fuel loads to reduce wildfire risk and assist in fire containment.

## 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. However, 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. As for 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 2001–02, the level of impact of these roadside ignitions changed considerably. As a result, the *Bushfires Act 1980* 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.

## Issues

Beyond the experiences and attitudes described from pastoralists across central Australia 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. 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 the role and impact of fire and that they were 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 Council 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 a need for greater awareness of both the occurrence and impact of large wildfires. More information is needed to be readily available to show the spatial patterns of fire in the landscape and associated patterns of wildfire risk.

The forum raised some issues of concern with regard to the Central Land Council (CLC). Pastoralists felt that the land management focus within the CLC was insufficient, both in terms of priorities and activities. The land management issues on ex-pastoral property Aboriginal Land Trusts (ALTs) were considered more significant to surrounding pastoral operations than those associated with adjacent desert ALT blocks. Their experience indicated that there were problems with the permit and approvals process for land management work in comparison to mining activities where financial benefits were considered too influential. Nevertheless, while pastoralists recognised the role of the CLC they 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.

## Elements of a southern Tanami Desert regional fire management strategy

The objective of this Desert Fire sub-project 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 timeframe of the project, but considerable progress was made to its formulation.

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 sandplains 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 lack of roads or tracks, the Aboriginal permit system, and the relatively high cost of access in terms of both time and money. A multi-scale approach that combines vehicle-based ground burning programs with helicopter-based access for further ground burning programs and with Aerial Prescribed Burning (APB) programs that use either helicopters or fixed-wing aircraft to drop aerial incendiaries is needed.

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 increasing acceptance that roadside ignitions play a significant role in 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 skill 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 natural resource management teams, involving the Aboriginal Rangers, could undertake a variety of management and monitoring activities throughout the southern Tanami Desert region.

## Final comments

The Desert Fire project was successful in meeting its initial objectives. It also established a basis for achieving anticipated outcomes that have a timeframe extending beyond the term of the project. Desert Fire helped to build a network between agencies. Most important was the improved interchange between Northern Territory Government agencies and the CLC. Maintaining the networks and communication within the community will be an ongoing challenge.

Through the combined results of the Desert Fire subprojects, 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 and begin to reduce areas of conflict and prepare the foundations for a coordinated approach and the development of a regional fire management strategy.

## Recommendations

Recommendations and opportunities for further work identified within this Desert Fire subproject 'Managing fire in the southern Tanami Desert' (DF-3a), were to:

- 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 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 (2008, PhD at ANU); Kirsten Maclean (2007, PhD at ANU); Anstee Nicholas (2007, MSc at CDU); Dorothy Turner (PhD at University of Adelaide); and Boyd Wright (2007, PhD at University of New England). 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 our 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 lose 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 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 rely on anticipated cycles, especially with consideration of the anticipated uncertainties associated with climate change predictions.
- Investigate the opportunity to establish a position as 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.
- Include a component on the benefits and limitations of on-line fire information in the new training programs being developed by Bushfires Council NT (‘Basic Wildfire Awareness’, ‘Basic Firefighter NT’ and ‘Advanced Firefighter NT’).
- 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.

## References

Allan GE. 1993. *The fire history of central Australia, CSIRO/CCNT Bushfire Research Project: Volume 4*. CSIRO/CCNT Technical Report, CSIRO, Alice Springs.

Allan GE. 2009. Managing fire in the southern Tanami Desert, in *Desert Fire: fire and regional land management in the arid landscapes of Australia*, Eds. GP Edwards and GE Allan, pp. 17–78, DKCRC Report 37, Desert Knowledge Cooperative Research Centre, Alice Springs.

Allan GE and Tschirner A. 2009. Pastoralists’ perspectives on the costs of widespread fires in the pastoral lands of the southern Northern Territory region of central Australia, 2000–2002, in *Desert Fire: fire and regional land management in the arid landscapes of Australia*, Eds. GP Edwards and GE Allan, pp. 187–208, DKCRC Report 37, Desert Knowledge Cooperative Research Centre, Alice Springs.

Gabrys K and Vaarzon-Morel. 2009. Aboriginal burning issues in the southern Tanami: towards understanding tradition-based fire knowledge in a contemporary context, in *Desert Fire: fire and regional land management in the arid landscapes of Australia*, Eds. GP Edwards and GE Allan, pp. 79–186, DKCRC Report 37, Desert Knowledge Cooperative Research Centre, Alice Springs.

Griffin GF, Price NF and Portlock HF. 1983. ‘Wildfires in the central Australian rangelands 1970–1980’. *Journal of Environmental Management*, vol. 17, no. 4, pp. 311–23.

Leavesley A. 2008. ‘The response of birds to the fire regimes of mulga woodlands in central Australia’. Unpublished PhD thesis, Australian National University, Canberra.

Maclean K. 2007. ‘Creating spaces for negotiation at the environmental management and community development interface in Australia’. Unpublished PhD thesis, Australian National University, Canberra.

Nicholas AMM. 2008. ‘Characteristics and dynamics of the mulga–spinifex boundaries at Mt Denison station’. Unpublished MSc thesis, School of Environmental Research, Charles Darwin University, Darwin, NT.

Taylor CA Jr. 2005. ‘Prescribed burning cooperatives: empowering and equipping ranchers to manage rangelands’. *Rangelands*, vol. 27, pp. 18–23.

Thackway R and Cresswell ID (eds). 1995. *An interim biogeographic regionalisation for Australia: a framework for setting priorities in the national reserves system cooperative program, version 4.0.* Australian Nature Conservation Agency, Canberra.

Wright B. 2007. 'Fire ecology of the spinifex hummock grasslands of central Australia'. Unpublished PhD thesis, School of Botany, University of New England, Armidale, NSW.

# 4. Aboriginal perceptions and practices concerning fire in the southern Tanami Desert: a report on a scoping study

**Petronella Vaarzon-Morel[1], Kasia Gabrys[2] and Richard Tuckwell[3]**
[1]Consulting Anthropologist, Alice Springs; [2]Biodiversity Conservation, NRETA, Alice Springs; [3]Central Land Council, Alice Springs
Email: pvmorel@ozemail.com.au

## Introduction

The following provides an overview of a scoping study designed to assess Aboriginal perceptions and practices with regard to fire use and management in the southern Tanami. The study formed part of the Desert Fire research project, which was created to promote the coexistence of fire, people, and biodiversity, with the long-term aim of developing a collaborative regional fire strategy (Duguid 2004). The project involved Parks and Wildlife Service Northern Territory (PWSNT), Bushfires Council NT and Central Land Council (CLC). The southern Tanami was chosen as the case study site due to concern about large and uncontrolled wildfires (most recently between 2000 and 2002); sites of cultural and biodiversity significance, which are likely to be threatened by such fires (Duguid et al. 2002; White et al. 2000a, b); and divergent views on burning practices among pastoral, Aboriginal and conservation managers of the different land tenures in the region.

Objectives of the study were to:

- gain an understanding of local people's current fire practices and attitudes towards burning
- assess people's fire knowledge and perceptions of fire issues and conflicts
- identify support required for better socio-economic and biodiversity outcomes related to fire
- increase people's fire awareness.

The predominantly Warlpiri-speaking communities of Yuendumu, Nyirrpi (also partly Pintupi) and Willowra were chosen as the case study sites due to local interest in the project expressed during preliminary consultations and their location between several non-Aboriginal pastoral lease properties. Fieldwork was subsequently undertaken by two core researchers, Kasia Gabrys (PWSNT) and Richard Tuckwell (CLC), and four consultants with long-term experience in the southern Tanami. The consultants were as follows: anthropologists Petronella Vaarzon-Morel and Dr Yasmine Musharbash for Willowra and Yuendumu respectively; and environmental consultant Rachel Paltridge (Desert Wildlife Services) and Peter Bartlett at Nyirripi. The research methodology involved semi-structured interviews and participant observation sessions with over 60 Warlpiri and Pintupi of different ages and experience. Prior to the fieldwork, a literature review was undertaken on fire in central Australia with a particular focus on Warlpiri. In addition, more than 30 non-Aboriginal professionals were consulted regarding their perceptions of Aboriginal fire practices in the southern Tanami and their suggestions for the development and implementation of the scoping study.

Guidelines for the study stressed that it should benefit Aboriginal participants. It sought to do so in a number of different ways including by: providing opportunities for employment as interpreters and co-researchers on the project; involving community ranger groups where possible; supporting people to visit country they wished to burn, thus also enabling observation of burning practices and discussion of relevant issues (Walsh & Mitchell 2002); and adhering to the CLC policy codes of research (CLC 2005). In addition, relevant fire information was exchanged with interested participants and opportunities were created for younger people to learn customary fire knowledge and practices from older role models.

The scoping study found that the primary focus of Warlpiri people with regard to current burning practices remains on natural and cultural resource management (Gabrys & Vaarzon-Morel 2009). It was also found that Warlpiri want to maintain control over when and where they burn with regard to their system of land tenure, cultural resources and customary practices and protocols. It was clear, however, that they require support to access more remote areas of traditional desert country in order to burn. It was suggested that, given the lack of employment opportunities and the range of socioeconomic issues faced by Aboriginal people today, the introduction of livelihood projects focused around fire could provide important support for Aboriginal communities. Increased opportunity for Aboriginal people to burn both more regularly and in more-remote areas will also benefit fire management in the southern Tanami region. It will also facilitate the transfer of skills and knowledge from older people, who are most experienced in customary fire management practices, to members of the younger generations (Gabrys & Vaarzon-Morel 2009).

The study highlighted the importance of knowledge exchange between Aboriginal and non-Aboriginal parties in order to promote better understanding of fire issues and for the development of an effective fire management strategy. If effective collaborative fire management is to take place in the southern Tanami region, then local Aboriginal perspectives on fire and managing country must be incorporated into planning processes. Lack of understanding about and willingness to incorporate Aboriginal systems of land management could result in damage to Warlpiri places of significance and undermine collaborative attempts for fire management in the region. In addition, whilst a number of Aboriginal people are interested in sharing knowledge about best practice burning from a non-Aboriginal fire ecology perspective, this information is not readily available to people outside of meetings, workshops and/or ranger programs with a focus on fire issues (Gabrys & Vaarzon-Morel 2009).

## References

Duguid A. 2004. ‘Desert Fire (DKCRC) collation of project information sorted by subproject.’ Internal Report for the Parks and Wildlife Commission of the Northern Territory, Alice Springs.

Duguid A, Barnetson J, Clifford B, Pavey C, Albrecht D, Risler J and McNellie M. 2002. *Wetlands in the arid Northern Territory. A report to Environment Australia on the inventory and significance of wetlands in the arid NT*. Parks and Wildlife Commission of the Northern Territory, Alice Springs.

Central Land Council. 2005. ‘Protocols for research on Aboriginal lands web site.’ <http://www.clc.org.au/media/publications/protocols/protocols.asp>.

Gabrys K and Vaarzon-Morel. 2009. Aboriginal burning issues in the southern Tanami: towards understanding tradition-based fire knowledge in a contemporary context, in *Desert Fire: fire and regional land management in the arid landscapes of Australia*, Eds. GP Edwards and GE Allan, pp. 79–186, DKCRC Report 37, Desert Knowledge Cooperative Research Centre, Alice Springs.

Walsh F and Mitchell P. 2002. *Planning for country: cross-cultural approaches to decision-making on Aboriginal lands*. Jukurrpa Books, IAD Press, Alice Springs.

White M, Albrecht D, Duguid A, Latz P and Hamilton M. 2000a. *Plant species and sites of botanical significance in the southern bioregions of the Northern Territory; volume 1: significant vascular plants*. Report to the Australian Heritage Commission from the Arid Lands Environment Centre. Arid Lands Environment Centre and the Parks and Wildlife Commission of the Northern Territory, Alice Springs.

White M, Albrecht D, Duguid A, Latz P and Hamilton, M. 2000b. *Plant species and sites of botanical significance in the southern bioregions of the Northern Territory; volume 2: significant sites*. Report to the Australian Heritage Commission from the Arid Lands Environment Centre. Arid Lands Environment Centre and the Parks and Wildlife Commission of the Northern Territory, Alice Springs.

# 5. Working together to better manage country: four principles to improve knowledge sharing for the management of fire in the southern Tanami, Northern Territory

**Kirsten Maclean**
School of Resources, Environment and Society, Australian National University, ACT
Email: Kirsten.Maclean@anu.edu.au

This research works with a DKCRC project entitled *Desert Fire: managing fire in the southern Tanami, Northern Territory*. The project takes a specific area in the region to consider what it means to manage fire across different land tenures (see Figure 5.1). Semi-structured interviews and informal discussions with key individuals from the region were conducted between June 2004 and May 2005 to determine what a fire management plan should encompass.

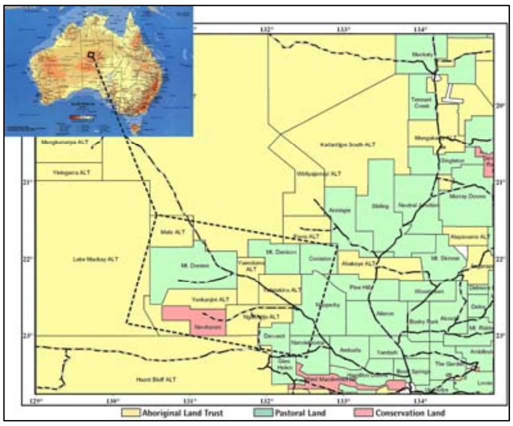



**Figure 5.1: Map showing case study region (map by K Maclean with Grant Allan)**

The findings show that the management of fire in the region is about tangible outcomes such as the reduction of wildfires to protect pastoral and conservation lands and increased Aboriginal employment on country. It is also about intangible social processes such as relationship building and knowledge sharing, as well as ongoing and adaptive learning. Four principles to improve knowledge sharing for the management of fire in the region were derived from these findings:

1. Unsettle current approaches to land management.

2. Identify ingredients for fire management.

3. Develop planning approaches.

4. Engage in activities for fire management.

## Principle 1: Unsettle current approaches to land management

*'The government and research agencies need to realise that they only get out what local people are prepared to put in'* (cited in Maclean 2007).

This principle is about engaging in practices that unsettle current approaches to land management in the region that have privileged science over other knowledge cultures. Science is extremely important in determining fire management in the region, but so too are, for example, Aboriginal and pastoral knowledge of place, of past land management practices and fire events. Figure 5.2 illustrates the many knowledge cultures necessary for sustainable and equitable fire management in the region. Each knowledge culture is equally important in very different ways for fire management in the southern Tanami. This is particularly the case considering the diversity of land uses and land managers in the region.

*'Most of the pastoralists have got knowledge, all sorts of knowledge, from fire to drought. They have got to put that knowledge forward as everyone's area is slightly different'* (cited in Maclean 2007).

## Principle 2: Identify ingredients for fire management

Individuals from the region identify various key ingredients for sustained fire management. These include:

- the valuing of local knowledge through ethical employment: people should be paid for their knowledge
- overcoming conflict by finding common ground and goals
- getting the right people together to talk about fire
- having frequent meetings to discuss fire management in places away from pastoral, conservation or Aboriginal infrastructure which may influence decision-making.

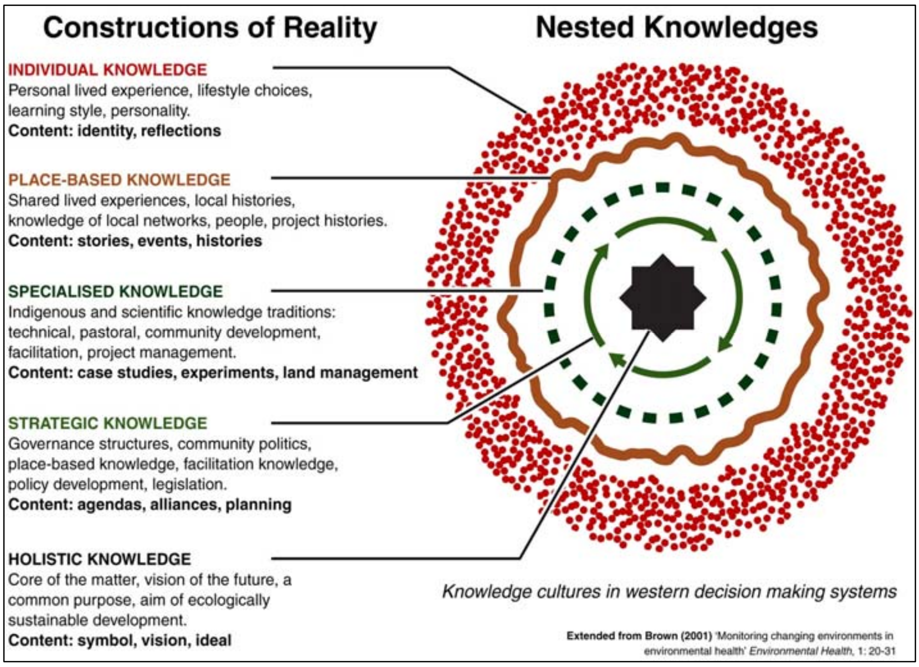



**Figure 5.2: Knowledge cultures necessary for sustainable land management**

## Principle 3: Develop planning approaches

The third principle ties in closely with the identified need to get the right people together to plan for future fire management. This is a fundamental aspect of fire management. Land managers speak of the importance of understanding what kind of management others are doing and the impetus behind these approaches. They also speak of a need for different land managers to be working together to manage fire in the region. There are many ways to conceive of the necessary steps for planning. Figure 5.3 shows the importance of recognising any planning process is about ongoing learning, or co-learning, between all those who choose to be involved. This learning occurs at all stages of a project. Planning for projects must celebrate the diverse and unpredictable learning that may occur.

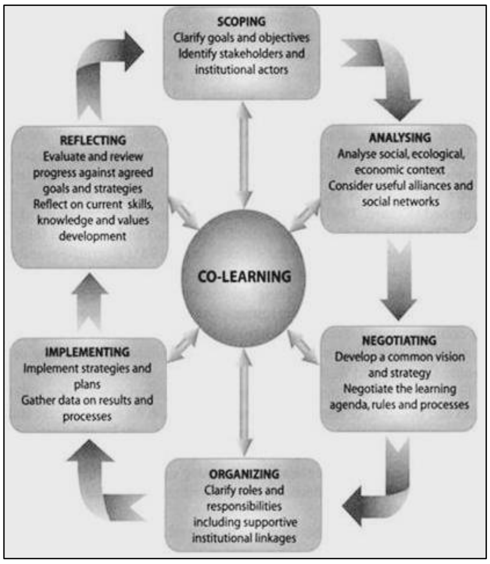



**Figure 5.3: The co-learning cycle (Keen & Mahanty, 2005)**

Figure 5.4 illustrates the fact that decision-making for project outcomes is not a one-off event that occurs at the start of a project. Rather, it is an ongoing cycle, and the kinds of decisions made will vary with the increasing knowledge of what fire management in the region should entail. This links back to Principle 2. Some of the ingredients identified by Principle 2 are based upon relationship building, which must be ongoing if it is to be successful; however, a project must also generate recognisable project outputs. These outputs can be aligned with different stages of a project.

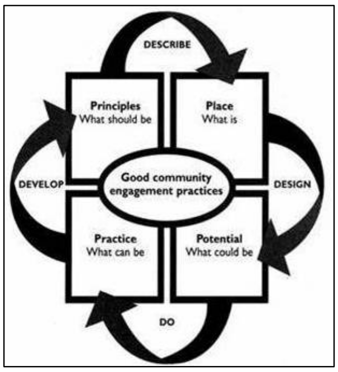



**Figure 5.4: The decision-making cycle (Aslin & Brown, 2004)**

Figure 5.5 provides a way to understand the various project stages.

## Principle 4: Engage in activities for fire management

Principles 1 to 3 highlight the necessary steps for developing innovative, dynamic and relevant approaches to ‘working together to better manage country’. Principle 4 considers the kinds of activities people wish to engage in: first, to develop appropriate planning approaches; and second, to develop a fire management strategy for the region. Activities identified by land managers from the region include:

- getting people together to speak about fire
- having a skilled facilitator present to assist in mediating meetings between the various land managers
- having language interpreters to assist with communication between land managers
- using various participatory tools such as values mapping to identify areas that people want to protect
- ensuring that the tools used for planning and to facilitate discussion are transparent and understood by all those involved
- getting people together to use fire for land management purposes and to discuss why and how different land managers use (or do not use) fire on their land.

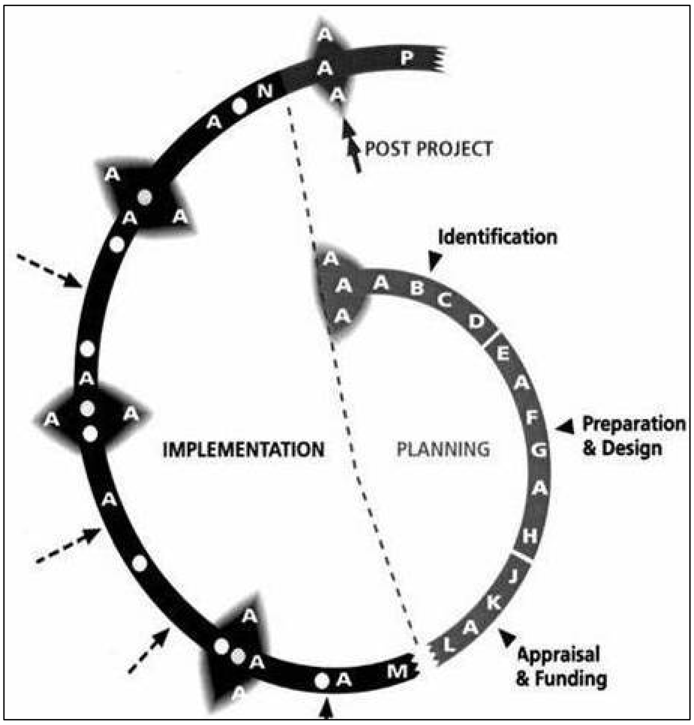



**Figure 5.5: The project management cycle (Piper, 2005)**

This information provides a brief summary of PhD research conducted through the Australian National University, Canberra and in conjunction with the DKCRC, from 2004 to 2006. I would like to acknowledge the invaluable contributions made by pastoral, Aboriginal and conservation land managers from the southern Tanami region of the Northern Territory.

For further information contact:

Kirsten Maclean
School of Resources, Environment and Society, Australian National University.
Kirsten.Maclean@anu.edu.au

## References

Aslin HJ and Brown VA. 2004. *Towards whole-of-community engagement: a practical toolkit*. Murray-Darling Basin Commission, Canberra.

Keen M and Mahanty S. 2005. 'Collaborative learning: bridging scales and interests'. In M Keen, VA Brown and R Dyball R (eds). *Social learning in environmental management. Towards a sustainable future*. Earthscan, London, pp. 104–22.

Maclean K. 2007. K. 'Creating spaces for negotiation at the environmental management and community development interface in Australia.' PhD thesis, Australian National University.

Piper C. 2005. 'Participatory project management workshop.' TorqAid, Melbourne.

# 6. Fire management on 'desert' conservation lands

**Angus Duguid**
Biodiversity Conservation, Northern Territory Department of Natural Resources, Environment and The Arts
Email: angus.duguid@nt.gov.au

## Introduction

The key elements of this talk were originally published in the DKCRC report *Desert Fire Final Report* (Duguid et al. 2009). Consequently only a summary is presented here.

The focus of this component of Desert Fire was fire management on conservation reserves (e.g. national parks) in the part of the Northern Territory known as central Australia (referred to here as CA). This roughly equates to the southern half of the Northern Territory, including the Mitchell Grass Downs biogeographical region. The fire management of most conservation reserves is different in many ways to that on other land uses or tenures. In general, there is a much greater focus on biodiversity values and visitor safety than on most other land areas in central Australia. Fire management on parks is also more intensive, with relatively high labour inputs per unit area. Furthermore, management is by professional rangers, predominantly with relevant tertiary level education.

The scope of investigation was broad, including the responses of plant and animal species to fires and fire regimes, as well as the practicalities of effective fire management. These were broadly brought together to document what constitutes 'best practice' fire management on conservation reserves. Key elements were:

- collaboration with Bushfires NT and the Northern Territory Herbarium to develop a database of plant species fire responses and related ecological attributes (Gardener et al. in prep.)
- a workshop to synthesise current understanding of the role of fire in vegetation dynamics in CA (Marsden-Smedley et al. in prep.)
- workshops with rangers (Duguid et al. 2005; Duguid 2004)
- experimental fire plots to test the fire response of the rare plant *Eremophila prostrata* at Rainbow Valley Conservation Reserve
- review of park fire history for individual reserves (e.g. Gabrys et al. 2009)
- a review of the effectiveness of past management practices
- development of new protocols for fire planning and reporting of fire management activities and associated information management (including fire history mapping and associated information on fire events) (Cowan et al. 2007).

## Fire response categories and fire regimes

The fire responses of plant species and of vegetation assemblages can be categorised in various ways. The terms 'fire sensitive' and 'fire tolerant' have continuing usage in CA despite some difficulty in definition and application. Fire-sensitive vegetation is typified by long-lived obligate seeder species which may be disadvantaged by some fire regimes.

The fire regime concept of a repeated pattern of fire occurrence (including frequency, intensity and time of year) is intuitively meaningful. However, quantifying past regimes in CA is extremely difficult. This is partly due to the episodic nature of rainfall. Fires may also be viewed as episodic and the influence of individual extreme fire events on the biota may overshadow cumulative or cyclical effects of several 'milder' fires. Past and contemporary human uses of fire have strongly influenced fire regimes in most vegetation types of CA. In many vegetation types, a build up of extremely flammable dense spinifex is inevitable in the absence of fire. As a result, periodic wildfires are also inevitable in the absence of prescribed burning. Therefore, the concept of 'fire management regimes' for particular vegetation types may be useful. Unfortunately, current knowledge of the ecology of individual species (e.g. age to reproductive maturity for obligate seeders) limits us to only defining very broad management regimes (e.g. mosaic burning in fire-tolerant spinifex communities). Participants in a workshop on vegetation dynamics and fire ecology in CA were able to define the key vegetation types for fire management but were unable specify 'minimum' or 'preferred' fire-free intervals for the ecological health of each vegetation type (Marsden-Smedley et al. in prep.).

Fire management for conservation outcomes would be greatly improved by better knowledge of fire history and species' fire responses. Fire history mapping and record keeping is essential if fire regimes are to be understood better, yet park managers have mostly been unable to do this effectively due to many institutional constraints.

## Examples from fire response studies

All available quantitative and expert opinion data were collated on fire responses of CA plant species. Some quantitative data were collected during field work for Desert Fire, with a focus on rare plants. For example, *Eremophila prostrata* is classified as Vulnerable under NT and Commonwealth legislation (under the name *Eremophila* sp. Rainbow Valley). Until recently it was considered very rare. However, very dense seedling recruitment occurred in and adjacent to Rainbow Valley Conservation Reserve in areas burnt by prescribed fires in 2001 and 2002 and the local population was estimated to be in excess of 1 000 000 individuals (Duguid & Barnetson unpublished data). Experimental fire plots were established to further test the response of individuals and populations to winter prescribed fire. Six plots (25 m x 25 m each) were burnt under conditions of saturated soil and damp litter, six plots were burnt under dry conditions and six plots were monitored as controls. Total germination counts were six seedlings in the control plots, 240 in wet burnt plots and greater than 6000 in the dry burnt plots. *E. prostrata* plants burnt in the experimental plots resprouted strongly, but subsequent survival of resprouting plants was quite variable and there was high mortality in some plots where severe browsing occurred.

*Ipomoea polpha* subsp. *latzii* is endemic to the NT and is restricted to a small area. It is classified as Vulnerable (under the name *Ipomoea* sp. Stirling). Fire has been identified as a potentially threatening process (Soos & Latz 1987). A survey of distribution and abundance conducted in 2005 included areas burnt by wildfires in 2001. Abundance was not correlated with recent fire history (Crase & Duguid in prep.); however, the survey was not able to measure longer-term effects of fire on seedling establishment. It is possible that litter and canopy shade increase survival rates of seedlings and that removal of litter and canopy shrubs, by fire, has an adverse effect.

Several rare plants of the MacDonnell Ranges were found to resprout strongly in at least some circumstances, including three that are classified as Vulnerable and for which fire has been previously stated as a possible threatening process: *Wrixonia schultzii* (13 of 20 plants with 100% crown scorch resprouted from the base); *Ricinocarpos gloria-medii* (11 of 13 plants with 100% crown scorch resprouted strongly from the base); and *Acacia undoolyana* (strongly resprouts from basal and lateral roots following both prescribed and wildfires). This does not disprove a negative influence of fire in these species but does indicate greater tolerance than had been expected. In contrast, a search of several hectares of burnt *Callitris glaucophylla* found very few surviving plants and minimal seedling recruitment three years after a severe wildfire in 2002. Narrow fire breaks (c. 5–20 m wide) had been burnt around this area as a protective measure in 1999 but had been totally ineffective in the circumstances of an extreme summer wildfire.

Observations of *Acacia aneura* burnt in wildfires in 2001 and 2002 in many parts of CA confirmed that it is generally an obligate seeder that must re-establish from seed. Yet even this icon of fire-sensitive species was found to resprout in some circumstances. Along a transect through burnt juveniles on Stirling Station, 43% of individuals (with 100% crown scorch) had resprouted. This was in an area burnt in a winter fire with a relatively shallow watertable (c. 6 m). It is possible that relatively favourable soil-moisture conditions may have contributed to this unusually high proportion of resprouting.

## Park fire management

Park fire management has many elements, including training, planning, reporting, mapping fires, mapping and monitoring vegetation and fuels, prescribed burning, and wildfire suppression. In CA, the inevitability of fire in spinifex vegetation means that prescribed burning must be a major component of managing most parks. This involves imposing a fire regime by burning areas of native vegetation. Reasons for this include reducing the threat from wildfires to visitors, infrastructure and fire-sensitive components of the biota. In vegetation communities that are regarded as fire sensitive, the general strategy is to reduce fire frequency. This is because of widely held views that the extent of fire-sensitive vegetation dominated by long-lived woody obligate seeders has been declining due to unfavourable fire frequency and intensity and the floristic and faunal diversity of these areas increases when long unburnt.

Some research projects of recent years, including within Desert Fire, have addressed these issues. However, they continue to be a subject of debate among researchers and a source of confusion for park rangers.

Prescribed burning can be usefully divided into three broad types:

- *mosaics of patches* with presumed benefits for fauna, flora and wildfire mitigation and also assisting with traditional hunting, promotion of bush tucker and other aspects of traditional Aboriginal land management
- *burnt fire breaks* to limit spread of wildfires and reduce damage to localised features such as buildings, signs, visitor areas, fire-sensitive biota, cultural and historical sites
- *low-intensity burning below a fire-sensitive overstorey* to reduce fuel loads and promote fresh growth of food plants.

Important decisions in developing fire management strategies include the proposed frequency of burning, the size of areas to be burnt, time of year and preferred intensity of burning.

Following very high rainfalls in 2000 and 2001, heavy fuel loads resulted in many wildfires, especially in 2001 and 2002. As a consequence, past management practices on parks were re-evaluated. Conclusions included:

- Neither patches nor linear breaks will stop fires if burnt areas are not connected, are too narrow, or if too much fuel regrowth has occurred (there was too much emphasis on narrow and highly controlled burns based on a philosophy of ‘Burn the least to protect the most’).
- Both patches and linear breaks can provide safe access and possibilities for back-burning.
- Both did ameliorate fire intensity in many instances, theoretically providing fauna refuges.
- Following years of very high rainfall a lot of country will burn, so more extensive management burns should be implemented under prescribed conditions.
- Most parks did greatly increase the amount of time spent burning and the area burnt per annum, but could have increased it further or more strategically.
- Several escaped winter-prescribed burns became wildfires but were subsequently deemed very useful (although some caused expensive infrastructure damage).
- When fuel loads are high, caution is still needed so that prescribed burning does not have a negative biodiversity impact.

The following recommendations to rangers are central to improving fire management on conservation reserves in CA:

- Have courage: be prepared to let fires burn overnight in fire-tolerant vegetation.

- Look after fire-sensitive vegetation.
- Keep appropriate records (find the balance between doing and reviewing prescribed burning).
- Don't skimp on planning (a lack of planning and reconnaissance often leads to inefficient use of staff when implementing burns).
- Be realistic in annual plans.
- Adjust plans to changing weather and fuel conditions.
- Understand and use weather forecasts.
- Don't wait too many years before establishing strategic breaks and/or mosaics in regenerating spinifex; otherwise, fuel density will make fires very difficult to control.

It is common for the staff of individual parks to have minimal local experience in fire management. This leads to frustration, low levels of burning, higher risks of inappropriate burning, and may contribute to lack of job satisfaction and associated high levels of staff turnover (people leaving the parks services). The biggest gain would be provided by employing a specialist fire management ranger with assistants. This team could lead or assist with all aspects of park-based fire management across CA, including training. Associated with this would be more support and some centralisation of GIS data management.

## Acknowledgements

Many people contributed to the ideas and underlying research presented. Kasia Gabrys, Chris Brock and Phil Cowan were key members of the research effort. Mark Gardener coordinated the development of the database on fire-related ecological attributes of plants in the Northern Territory. Jason Barnetson was fundamental to establishing the research program into the fire ecology of *Eremophila prostrata* at Rainbow Valley, and many people assisted with establishing and monitoring the fire plots, particularly Cassie Wright, Mark Harris and Kasia Gabrys. Many rangers contributed their ideas and experience on park fire management, both in the field and at several workshops. Participants of a workshop on fire and vegetation dynamics all contributed to clearer understanding of this subject including the organiser, Dr Jon Marsden-Smedley. Other important contributors include Grant Allan, Peter Latz, Dr Margaret Friedel, Jock Morse and Dr Malcolm Gill. Chris Day, Dennis Matthews and Dr Catherine Nano all provided critical insights, ranging from the practicalities of effective prescribed burning and fire suppression through to ecological fire dynamics. Ben Kaithner, John Marsden-Smedley, Grant Allan and Ben Sparrow undertook satellite-based mapping of wildfires that contributed important understanding of the fire regimes. Carly Steen, Phil Cowan and Darren Schunke had important roles in reviewing data management protocols for fire history and planning.

## References

Crase B, Duguid A and the Anmatjerre community. In prep. Conservation status and distribution of a rare Aboriginal food plant from the Central Australian desert.

Cowan P, Duguid A and Steen C. 2007. Record feeping for Fire management on PWSNT reserves in central Australia. Version 1. Internal report. Northern Territory Government Department of Natural Resources Environment and the Arts, Alice Springs.

Duguid A. 2004. Report from Parks Fire Workshop, 6 & 7 May 2004 – Arltunga Historical Reserve. Internal report. Parks and Wildlife Service of the Northern Territory, Alice Springs.

Duguid A, Brock C and Gabrys K. 2009. A review of fire management on central Australian conservation reserves: towards best practice, in *Desert Fire: fire and regional land management in the arid landscapes of Australia*, Eds. GP Edwards and GE Allan, pp. 209–308, DKCRC Report 37, Desert Knowledge Cooperative Research Centre, Alice Springs.

Duguid A, Gabrys K, Morse J and Rodrigo M. 2005. Workshop proceedings: fire management for conservation reserves in central Australia, 5 & 6 December 2006, at Witcheties, Araluen Cultural Precinct, Alice Springs. Northern Territory Government Department of Natural Resources Environment and the Arts, Alice Springs.

Gabrys K, Cowan P and Duguid A. 2009. 'The fire history of Rainbow Valley Conservation Reserve 1984–2005'. Chapter 6, Desert Fire final report, Desert Knowledge CRC, Alice Springs.

Gardener MR, Lynch BT, Latz PK, Albrecht DE, Cowie ID, Brennan K, Nano C, Edwards AC, Duguid AW, Brock C and Russell-Smith J. Journal manuscript in prep. 'A landscape-scale assessment of the woody obligate seeder flora of the Northern Territory, Australia'.

Marsden-Smedley J, Albrecht D, Allan G, Brock C, Duguid A, Friedel M, Gill AM, King K, Latz P, Morse J, Ostendorf B and Turner D. Journal manuscript in prep. 'Vegetation-fire interactions in the central Australian arid zone: towards a descriptive ecology'.

Soos A and Latz P. 1987. The status and management of the native sweet potato *Ipomoea polpha* in the Northern Territory. Northern Territory Heritage Commission and the Conservation Commission of the Northern Territory, Alice Springs.

# 7. Fire studies in spinifex dunefields in the Haasts Bluff Aboriginal Land Trust

**Boyd Wright**
PhD candidate, University of New England
Email: Bwright3@une.edu.au

A fire history study in the Haasts Bluff Aboriginal Reserve examined Landsat MSS satellite imagery dating from 1979 to 2003. It was found that contemporary fire patterns in the reserve were characterised by intermittent but widespread fires that occur in response to fuel accumulations after extreme rain. Two large-scale fire events occurred during the study period, one between 1982–85 and the other between 2000–02. The mean size and total area burned by fires during these events was greatest during summer months, and short fire intervals of two to three years frequently occurred.

Mensurative field surveys were conducted in which natural combinations of fire recency, fire interval and fire season were sampled randomly across replicated patches in space. It was shown that all components of fire regime can influence the floristic composition of spinifex-dominated vegetation. Time-since-fire was found to regulate the abundance of ephemeral grasses and forbs and it was thought that this was primarily driven by the breaking of dormancies by fire-related cues such as heat and/or smoke. Populations of woody species groups – such as half-shrubs/shrubs, trees and resprouters – were not affected by time-since-fire, and this reflected the ability of most species to repeatedly resprout following fires.

In contrast to fire recency, proximate short fire intervals had surprisingly little impact on woody species composition and induced relatively little change in community structure. Conversely, short fire intervals reduced the abundance of *Triodia* spp. seedlings and fire-ephemeral species, although these effects were transient and could not be detected at sites that had experienced a short fire interval during the early 1980s. A more lasting effect was seen in the increased abundance of resprouting woody species after repeated fires in the 1980s, which resulted from enhanced recruitment, possibly as a result of decreased *Triodia* competition. Fire season had little effect on most functional groups, although an important finding was that summer fires increased the abundance of seedlings of woody species. This finding was accounted for by the apparently transient nature of the seed banks of hard-seeded seasonal fruiters, such as *Acacia melleodora*, which exhibit annual peaks (of duration < two to three months) in seed bank abundance after seeds are shed in late spring/early summer. The observed increase in seedling numbers after summer fires was explained by the synchrony of seed availability during summer with the heat shock from fire.

The results of the field surveys were explored more fully in field experiments in which four species of *Acacia* were burned under differing fire intervals, seasons and severities. These experiments demonstrated that the selected *Acacia* species could resprout repeatedly after short fire intervals, though high levels of mortality were observed for certain species under high severity and/or summer burns. Additionally, most woody species failed to be detected in the seed bank. This result was largely explained by seed removal and decay experiments, which revealed that seeds of these species would be removed by seed predators almost immediately after seed fall.

Overall, most life-history groups in the spinifex grasslands appeared to be resilient to fire-induced population crash, with all groups possessing adaptations or life-history characteristics that ensured persistence following pyric disturbance. Despite these findings, demographics of several plant groups were clearly affected under certain circumstances, and it is suggested that fire, in concert with pre- and post-fire rainfall, can act as a driving force in regulating plant community dynamics in spinifex grasslands.

# 8. Using *Acacia* shrublands landscape change as an indicator of ecosystem health

**Guy Boggs and David Bowman**
Charles Darwin University
Email: guy.boggs@cdu.edu.au

Soil organic matter (SOM) was sampled from soil profiles on a near-level sand sheet at the southern limit of the Tanami Desert in central Australia to determine if boundaries of *Triodia* hummock grassland – *Acacia aneura* shrublands had changed in the Holocene. Accelerator Mass Spectrometry (AMS) $^{14}C$ dating of 16 soil profiles showed that SOM that had accumulated at 100 to 140 cm depth (near the base of most profiles) had ages between 1175 and 2630 $^{14}C$ years, averaging 1906 $^{14}C$ years. The stable carbon isotopic ($\delta^{13}C$) composition of SOM from the upper 50 cm soil profiles in the *A. aneura* shrubland (inhabited by plants with predominantly C3 photosynthetic pathway) was significantly more $^{13}C$-depleted than the comparable soil interval beneath a *Triodia* grassland (predominantly C4 photosynthetic pathway). Mean age of SOM at 50 cm depth was 830 $^{14}C$ years, suggesting the vegetation has been stable for about 1000 years. However, soil profiles in *Triodia* grassland adjacent to the shrubland boundary had slightly more depleted $\delta^{13}C$ relative to sites > 0.5 km from the boundary. With respect to stable nitrogen isotopic values, only surface soils in the *Acacia* shrublands were found to be $^{15}N$-enriched relative to all other soil depths. Although there were no obvious environmental discontinuities, such as change in soil type or slope angle, associated with the ecosystem boundaries, the *Acacia* shrublands were found to occur on more clay-rich soils with higher concentrations of total phosphorus, nitrogen and potassium compared with the surrounding grasslands, and these trends became more pronounced with increasing distance from the ecotone. It is unclear if these differences are a cause or an effect of the vegetation mosaic. The concordance of the vegetation boundaries with the $\delta^{13}C$ and $\delta^{15}N$ and of soil nutrients are consistent with only minor attrition of the *A. aneura* shrublands in the late Holocene at this site.

Patches of fire-sensitive, closed-canopy *A. aneura* shrubland occur within a matrix of highly flammable *Triodia* grasslands in central Australia (< 400 mm mean annual precipitation). Digitised repeat aerial photography was used to chart the dynamics of these mosaics over 52 years (1950–2002). During this period, traditional Aboriginal fire management had largely ceased. The spatial extent of *A. aneura* shrubland patches varied over the 52-year study period, but the aggregated change was small (an increase of 3.1% from 1950 to 2002, with the largest excursion a 13.1% decrease between 1950 and 1983). This change was restricted to within 50 m of boundaries between the shrublands and grasslands. Statistical modelling for the period for which landscape fire activity was available (1980–2002) showed that the dynamism of the boundaries was associated with burning. Fire effects on boundaries were mediated by the size of *A. aneura* patches, with small patches most likely to contract, explaining the dynamic spatial arrangement of small patches in the landscape. It was concluded that a series of reinforcing fire, soil and vegetation feedbacks maintain the mosaic of shrubland patches. However, these feedbacks might eventually be overwhelmed by large and sustained changes to fire regimes, leading to the landscape-wide dominance of *Triodia* grasslands.

# 9. Characteristics and dynamics of *Acacia aneura – Triodia* boundaries at Mount Denison Station in the southern Tanami Desert, central Australia

**Anstee Nicholas**
MSc candidate, Charles Darwin University
Email: anstee.nicholas@cdu.edu.au

Mulga (*Acacia aneura*) and spinifex (*Triodia* spp.) are common throughout arid Australia, often dominating the landscape as discrete, abruptly alternating dominants of vegetation. The floristic, soil and fire frequency characteristics of the mulga- and spinifex-dominated vegetation in the flat sandplain country at the southern limit of the Tanami Desert were explored to identify factors that are contributing to the distribution and possible dynamics of these vegetation types.

A floristic survey revealed that most woody species occurred on both sides of the mulga–spinifex boundaries. The mulga-to-spinifex transition sat sharply across a diffuse soil surface textural gradient from loams through to sands. The woody species in both mulga and spinifex vegetation types shared functional life history and regeneration traits. Spinifex vegetation burnt on average three times more than mulga vegetation. A positive correlation was found between mulga structural diversity and time-since-fire. Summer fires are associated with stands dominated by younger mulga trees. The species richness of woody plants was higher in spinifex than mulga vegetation at the local scale, but similar at the landscape scale.

The landscape was overwhelmingly characterised by the dominant mulga and spinifex. I argue that the boundary between mulga and spinifex vegetation types is created and maintained by fire, with possible dynamics associated with a fire-driven soil gradient. The fire effect was deemed most important because of the high degree of shared soil and other floristic features across the mulga–spinifex boundary. The soil features argued to be reinforced by fire across the mulga–spinifex boundaries may be contributing to conditions that heighten mulga's capacity to regenerate after fire.

The reduction of structural complexity in frequently or intensely burnt mulga stands is of concern for the current mulga–spinifex vegetation matrix in the southern Tanami Desert. It is conceivable that it could indicate a reduced structural state that has future consequences for the current mechanisms that mostly allow mulga to maintain its boundary position under present conditions.

# 10. Some general patterns in the response of birds to fire

**Adam Leavesley**
PhD candidate, Australian National University
Email: adam.leavesley@anu.edu.au

This paper is a synopsis of work in progress aimed at exploring general patterns in the response of birds to landscape fire. The findings presented here are preliminary only. It is expected that results derived from the completed study will be submitted for publication in the scientific literature.

Studies examining the response of birds to wildfire come mainly from fire-prone regions of North America, the Mediterranean and Australia. A lesser volume of literature relates to ecosystems in southern Africa and South America. To my knowledge, a global review has never been published, but continental and regional syntheses have. The most recent of these are: Australia (Woinarski & Recher 1997; Woinarski 1999); North America (Smith 2000); the Mediterranean (Pons 2002); and southern Africa (Parr & Chown 2003).

Fully replicated, long-term studies of the response of birds to fire are scarce. Many studies are anecdotal or opportunistic having taken place when fire interrupted another project. Much of the literature either lacks replication, draws comparisons between treatments and sites that may not be comparable, is short-term, or fails to account for potentially important or confounding factors (such as the characteristics of the fire, fire history and landscape context) or potentially confounding factors such as salvage logging (Woinarski 1999; Parr & Chown 2003). Another major limitation of the literature is the failure to treat fire as a recurrent disturbance (Tasker et al. 2006). Instead, fire is treated as a one-off event with the implication that it is a catastrophic perturbation of a climax ecosystem. It is then apparently assumed that the ecosystem invariably recovers via a predictable succession. Despite the limitations of the literature, reviewers conclude that generalisations can be drawn because consistent trends do appear across studies (Woinarski & Recher 1997).

## The response of bird communities to fire

Time-since-fire is usually the most easily and therefore most commonly investigated effect that fire imposes on biota (Gill & Catling 2002), and avifauna appears to be no exception. The impact of fire on bird communities is considerable, with the strength of the effect strongest immediately post-fire and declining with time (Woinarski & Recher 1997; Smith 2000; Pons 2002). The effects of fire on birds can be placed into two categories: those associated with combustion at the time of the fire; and those associated with habitat changes caused by fire. Many of the direct effects of burning appear to subside soon after the flames are extinguished (Woinarski 1999; Smith 2000), while habitat effects may persist for decades or centuries (Woinarski 1999; Pons 2002).

## During a fire

Bird mortality during fires appears to be related to fire extent and intensity (Whelan 1995; Smith 2000; Pons 2002). Low-intensity fires apparently cause minimal mortality, as do intense fires of limited extent (Whelan 1995; Woinarski & Recher 1997; Pons 2002). In contrast, large, intense fires appear to cause greater mortality (Woinarski & Recher 1997). Fires provide foraging opportunities for some species (Woinarski & Recher 1997; Smith 2000; Pons 2002). In particular, carnivores may be attracted to an easy meal of dead and dying victims, and aerial insectivores may be attracted to prey displaced by the disturbance (Woinarski & Recher 1997; Smith 2000).

## Post-fire

Birds respond to habitat structure (McArthur & McArthur 1961), and fire can cause a rapid and profound change (Whelan 1995; Smith 2000). In addition, fire can create favourable growing conditions for a suite of relatively short-lived plants, which in turn provide resources for invertebrates and birds (Whelan 1995; Woinarski & Recher 1997; Smith 2000). The birds present at a site immediately after a fire are likely to be a combination of those individuals which have survived the fire and are able to persist in the new habitat and those which can exploit the pulse of resources released by the fire (Pons 2002).

Fire often causes a large, sometimes near-complete turnover of bird species. This occurs in many North American habitats (Smith 2000), including conifer forests, oak savannas and chaparral. Similar patterns have been described in Australian heathlands, *Acacia* woodlands, hummock grasslands, mallee woodlands and eucalypt forests and woodlands (Woinarski & Recher 1997); in the forests, woodlands, shrublands and open habitats of the Mediterranean (Pons 2002); in savanna woodlands and shrublands of southern Africa (Skowno & Bond 2003); South American tropical rainforest (Barlow et al. 2002), and tall grassland of South America (Isaach et al. 2004). In most instances, species with greater habitat breadth (generalists) benefit from fire at the expense of those with narrow habitat requirements (specialists) (Woinarski 1999; Pons 2002). In Mediterranean habitats, some of the species that occupy burnt country change their diet seasonally from plant-based to insect-based, while those that occupy the unburnt sites rely on insect food year-round (Pons 2002). Studies which report little change in the avifauna following fire have taken place in structurally simple habitats (Smith 2000). The bird community composition of African savanna grasslands remains unchanged following fire. The result is attributed to the short fire return interval. Highland grassland sites with two contrasting fire management regimes in South Africa share three times as many bird species as are present under either single regime. The bird community composition of *Juncus* salt marsh in South America shows little difference between burnt and unburnt plots a year after fire.

## Later after fire

Many studies of birds and fire appear to assume that, in time, burnt habitats will return to their pre-fire state and that the bird community will do so as well. Rarely is data presented to demonstrate that this is the case. Fire regime theory and empirical evidence suggests that the assumption is not valid (Gill 1975; Bond & Keeley 2005). Nonetheless, the vegetation present prior to a fire is an important factor determining the development of vegetation after a fire (Egler 1954). It therefore appears reasonable to generalise about changes in the bird communities.

The composition of the bird community changes after fire as vegetation regenerates and the structure of the habitat changes (Woinarski & Recher 1997; Smith 2000; Pons 2002). Open-country birds that benefit from fire are gradually replaced by foliage gleaners as the shrub layer or saplings develop. Shrubs may eventually form forests. The density and species-richness of foliage-gleaning birds increases as the volume of foliage increases. A big milestone in North American post-fire avian dynamics is the closure of the canopy (Smith 2000). Once this occurs, roughly 40-100 years after fire, the structure of the forest stabilises and so do the bird communities. A case that does not appear to exhibit a gradual return toward the pre-fire bird community is South American rainforest. Although only conducted over a three-year period, the study found that the bird community maintained a trajectory away from the pre-fire structure.

## Acknowledgements

This study was funded by the Desert Knowledge CRC, Bushfire CRC, Norman Wettenhall Foundation, Stuart Leslie Bird Research Award and the Gould League of NSW.

## References

Barlow J, Haugaasen T and Peres CA. 2002. ‘Effects of ground fires on understorey bird assemblages in Amazonian forests’. *Biological Conservation*, vol. 105, no. 2, pp. 157–69.

Bond WJ and Keeley JE. 2005. 'Fire as a global "herbivore": the ecology and evolution of flammable ecosystems'. *Trends in Ecology and Evolution***,** vol. 20, no. 7, pp. 387–94.

Egler F. 1954. 'Vegetation science concepts I. Initial floristic composition, a factor in old-field vegetation development'. *Vegetatio*, vol. 4, pp. 412–17.

Gill AM. 1975. 'Fire and the Australian flora'. *Australian Forestry***,** vol. 38, pp. 5–30.

Gill AM and Catling PC. 2002. 'Fire regimes and biodiversity of forested landscapes of southern Australia'. In RA Bradstock, JE Williams and AM Gill (eds). *Flammable Australia: the fire regimes and biodiversity of a continent*. Cambridge University Press, Cambridge.

Isaach JP, Holz S, Ricci L and Martinez MM. 2004. 'Post-fire vegetation change and bird use of a salt marsh in coastal Argentina'. *Wetlands*, vol. 24, no. 2, pp. 235–43.

MacArthur RH and MacArthur JW. 1961. 'On bird species diversity'. *Ecology*, vol. 42, no. 3, pp. 594–8.

Parr CL and SL Chown. 2003. 'Burning issues for conservation: a critique of faunal fire research in Southern Africa'. *Austral Ecology*, vol. 28, pp. 384–95.

Pons, P. 2002. 'The population responses of birds to fire in Mediterranean ecosystems'. In G Pardini and J Pinto (eds). *Fire, landscape and biodiversity: an appraisal of effects and effectiveness*. pp 57-68. Servei de Publicacions de la Universitat de Girona, Girona.

Skowno AL and Bond WJ. 2003. 'Bird community composition in an actively managed savanna reserve, importance of vegetation structure and vegetation composition'. *Biodiversity and Conservation*, vol. 12, no. 11, pp. 2279–94.

Smith JK (ed). 2000. *Wildland fire in ecosystems: effects of fire on fauna.* Gen. Tech. Rep. RMRS-GTR-42, US Department of Agriculture, Forest Service, Rocky Mountain Research Station, Ogden, Utah.

Tasker EM, Baker J and Whelan RJ. 2006. 'Applying recent advances in vital attributes analysis to management of fire for biodiversity conservation'. In C Tran (ed). *Life in a fire-prone environment: translating science into practice*. Bushfire Conference 2006, Griffith University and the South East Queensland Fire and Biodiversity Consortium, Brisbane.

Whelan RJ. 1995. *The ecology of fire*. Cambridge University Press, Cambridge.

Woinarski JCZ. 1999. 'Fire and Australian birds: a review'. In A York, JCZ Woinarski and AM Gill. 1999. *Australia's Biodiversity – responses to fire*. pp. 55–112. Department of Environment and Heritage, Canberra.

Woinarski JCZ and Recher HF. 1997. 'Impact and response: a review of the effects of fire on the Australian avifauna'. *Pacific Conservation Biology*, vol. 3, pp. 183–205.

# 11. Modelling fire regimes in the West MacDonnell Ranges, central Australia

**Karen King**
Bushfire CRC and Australian National University
Email: karen.king@anu.edu.au

*This project is a collaboration of the Desert Knowledge and Bushfire CRCs.*

In many landscapes, fire management objectives include reducing the negative impacts from unplanned fires on people, property and ecological values. Therefore it is essential to have a clear understanding of existing fire regimes and the effects on them from any modifications to the landscape. This will assist in predicting the implications for fire risk of various fire management options in particular landscapes.

In arid Australia it is anticipated that fire regimes could be modified by the spread of exotic pasture grasses, including buffel grass, and projected changes in climate, in addition to fire management. Computer simulation modelling is a useful methodology for investigating our current understanding of fire regimes and their sensitivity to landscape modification through changes in flammability, climate and/or management.

The present study has focused on developing a process-based fire regime and vegetation dynamics simulation model for a large landscape (approximately 4.1 million hectares) centred on the West MacDonnell Ranges in arid Australia (Figure 11.1). The modelling framework is based on the FIRESCAPE suite of landscape fire regime models that have been used in a range of landscapes to investigate both ecological and management issues (Cary & Banks 1999; Cary 2002; McCarthy & Cary 2002; Keane et al. 2003; Keane et al. 2004, Cary et al. 2006; King et al. 2006). It is envisaged that the FIRESCAPE model developed for arid Australia could be used to investigate the implications of a range of fire management options, the sensitivity of the fire regime to the spread of buffel grass and hence increased landscape flammability, and the implications of projected climate change on the fire regime.

As an integral part of this project, a workshop was held over three days in Alice Springs in November 2005 to synthesise the present knowledge regarding the interactions between fire and vegetation communities in arid Australia. This workshop was attended by a diversity of people recognised as experts in fire, botany, and ecological processes for arid Australia. A refereed journal paper providing a descriptive ecology of the vegetation and fire interactions in the central Australian arid zone is currently being prepared for publication. Principles pertaining to vegetation and fire interactions for arid Australia developed in the workshop have been incorporated into the FIRESCAPE model.

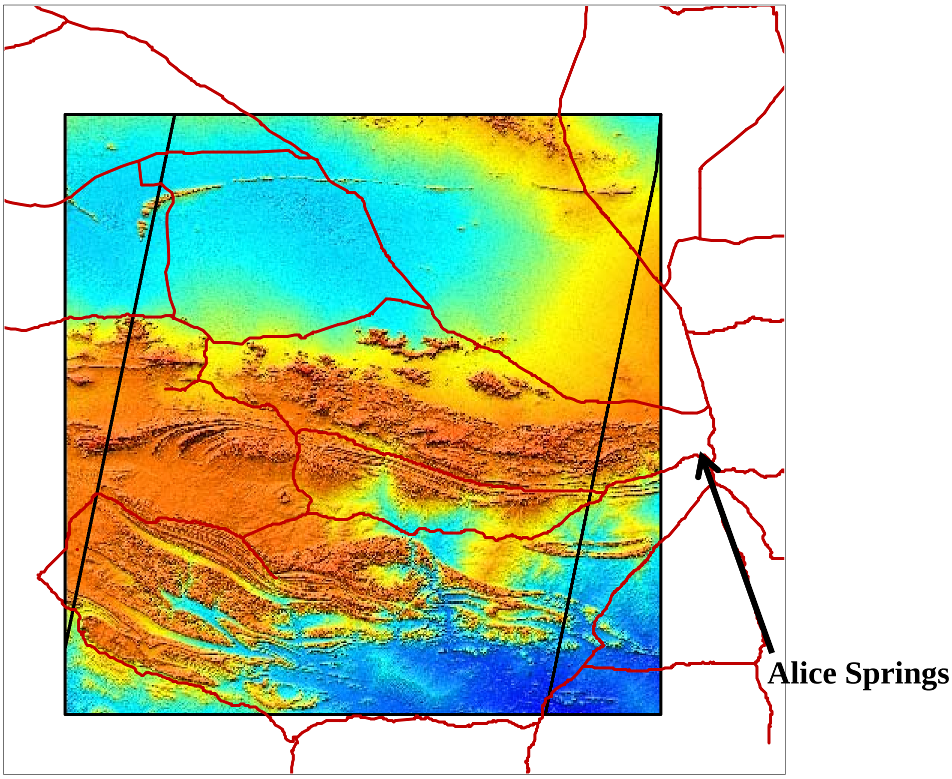



**Figure 11.1: Central Australia fire regime simulation project study area centred on the West MacDonnell Ranges**

1. Elevation is depicted, with the study area represented by the black polygon created by the two vertical black lines, and major roads depicted in red.

As part of the model development process it was necessary to derive a number of detailed GIS maps for the study region, each with a resolution of 1 hectare. A map identifying significant vegetation communities on different landforms was derived from five existing vegetation maps, each with independent vegetation classifications and covering different parts of the study area. These classification systems were standardised to remain consistent across the study area. Where data was lacking, interpretation of Landsat imagery of vegetation was necessary (Figure 11.2). On completion, extensive ground-truthing was performed to validate this map. Additionally, a fire history map was derived by interpretation of fire scars on Landsat imagery collated between 1959 and 2003 (Figure 11.3). GIS layers were also developed for elevation, slope, roads, bores, and land tenures.

In the form of the FIRESCAPE model developed for arid Australia, weather data for Alice Springs extending from 1955 to 2005 is used. This data set includes two above-average rainfall periods that are associated with big fire seasons. This weather string is repeated for the length of each simulation. Local meteorological conditions are represented by extrapolation of weather parameters across the landscape based on observed spatial variability. Hourly weather parameters are derived from three-hourly data sets provided by the Bureau of Meteorology, and using identical extrapolation methods.

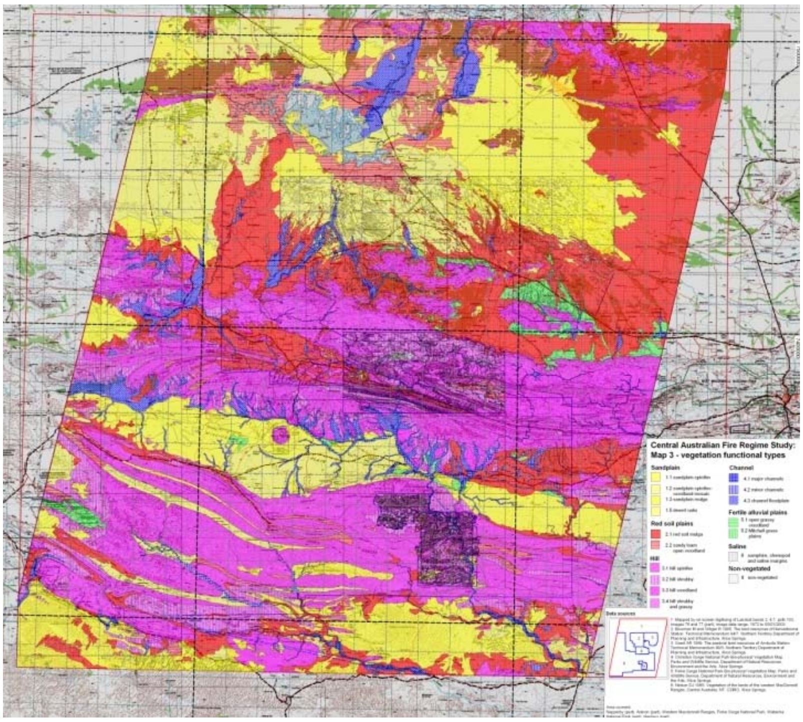



**Figure 11.2: Vegetation communities for the west MacDonnell study area**

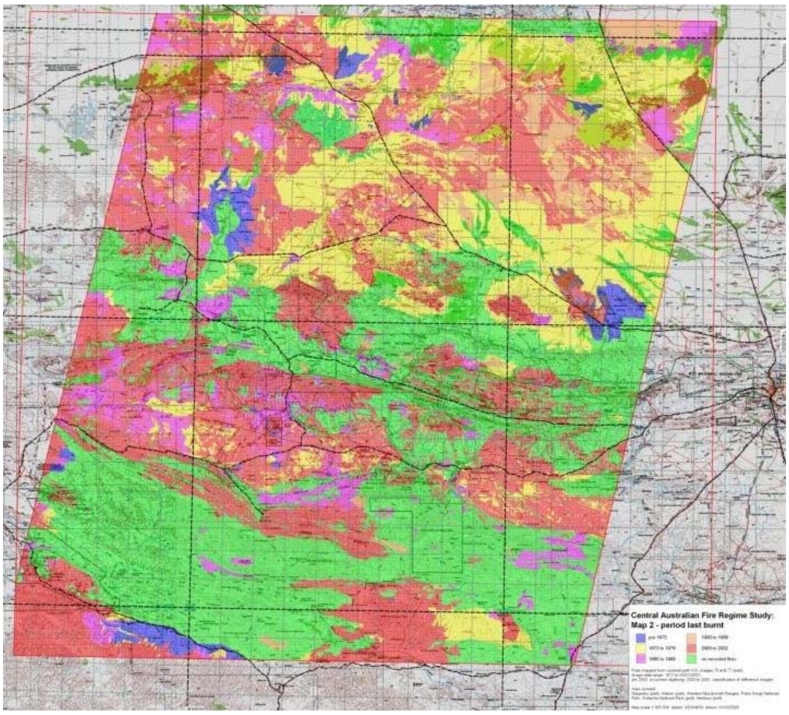



**Figure 11.3: Map depicting period last burnt for the West MacDonnell Ranges study area**

Both lightning and unplanned anthropogenic ignitions are simulated. Additionally, there is the potential in this form of FIRESCAPE to include a range of prescribed burning management options. Fuel accumulation is determined for each vegetation community (for spinifex see Griffin & Allan 1984 and Burrows et al. 2006; for grass see Friedel 1981, Griffin et al. 1983, Griffin & Friedel 1984, Friedel & Shaw 1987a, Friedel & Shaw 1987b, Stafford-Smith & Morton 1990, Allan & Southgate 2002, Miller 2003, Clarke et al. 2005), and is determined from both the time-since-fire and the pattern of rainfall since the previous fire. The transient presence of annual grasses following above-average rainfall and their contribution to fuel loads is also modelled. Fires spread across the landscape is modelled according to published fire behaviour algorithms for spinifex (Burrows et al. 2006) and grass communities (Cheney et al. 1993).

Validation of model functioning is important for verifying the predictive power of model outputs. A number of validation tests were performed to determine the accuracy of simulated outputs from this version of FIRESCAPE to represent the fire regimes in arid Australia. Simulated fires were shown to spread in the correct direction and produce realistic fire shapes. The distribution of fire sizes produced in a 100-year simulation compared well with those observed in the fire history for the study area (Figure 11.4).

The version of FIRESCAPE developed in this project is based on the present day understanding of fire regimes and vegetation dynamics in arid Australia. Outputs have been validated to confirm that they are a realistic representation of fire regimes in arid Australia. The FIRESCAPE model is now ready for performing specific analyses pertaining to management, climate change or buffel invasion.

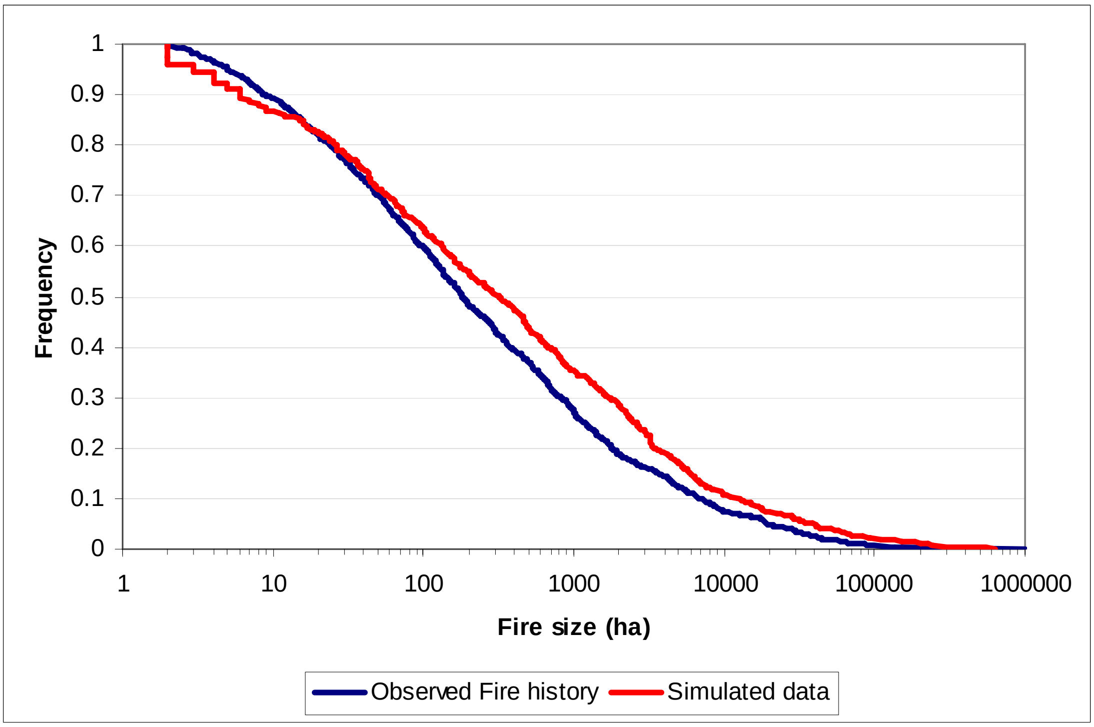



**Figure 11.4: Comparison of observed and simulated fire sizes**

## References

Allan GE and Southgate RI. 2002. 'Fire regimes in the spinifex landscapes of Australia'. In RA Bradstock, J Williams and AM Gill (eds). *Flammable Australia: the fire regimes and biodiversity of a continent*. pp 145–76. Cambridge University Press, Cambridge

Burrows ND, Ward B, Robinson AD and Behn G. 2006. 'Fuel dynamics and fire behaviour in spinifex grasslands of the western desert'. In C Tran C (ed). *Life in a fire-prone environment: translating science into practice*. Bushfire Conference 2006, Griffith University and South East Queensland Fire and Biodiversity Consortium, Brisbane.

Cary GJ. 2002. 'Importance of a changing climate for fire regimes in Australia'. In RA Bradstock, J Williams and AM Gill (eds). *Flammable Australia: The fire regimes and biodiversity of a continent*. pp. 26–48. Cambridge University Press, Cambridge.

Cary GJ and Banks JCG. 1999. 'Fire regime sensitivity to global climate change: an Australian perspective'. In JL Innes, MM Verstraete and M Beniston. *Advances in global change research*. pp. 233–46. Kluwer Academic Publishers, Dordrecht and Boston.

Cary GJ, Keane RE, Gardner RH, Lavorel S, Flannigan MD, Davies ID, Li C, Lenihan JM, Rupp S and Mouillot F. 2006. 'Comparison of the sensitivity of landscape-fire-succession models to variation in terrain, fuel pattern, climate and weather'. *Landscape Ecology*, vol. 21**,** pp. 121–37.

Clarke PJ, Latz PK and Albrecht DE. 2005. 'Long-term changes in semi-arid vegetation: invasion of an exotic perennial grass has larger effects than rainfall variability'. *Journal of Vegetation Science*, vol. 16**,** pp. 237–48.

Cheney NP, Gould JS and Catchpole WR. 1993. 'The influence of fuel, weather and fire shape variables on fire-spread in grasslands'. *International Journal of Wildland Fire*, vol. 3**,** pp. 31–44.

Friedel MH. 1981. 'Studies of central Australian semidesert rangelands. I. Range condition and biomass dynamics of the herbage layer and litter'. *Australian Journal of Botany*, vol. 29**,** pp. 219–31.

Friedel MH and Shaw K. 1987a. 'Evaluation of methods for monitoring sparse-patterned vegetation in arid rangelands. I. Herbage'. *Journal of Environmental Management*, vol. 25**,** pp. 297–308.

Friedel MH and Shaw K. 1987b. 'Evaluation of methods for monitoring sparse-patterned vegetation in arid rangelands. I. Trees and shrubs'. *Journal of Environmental Management*, vol. 25**,** pp. 309–18.

Griffin GF and Allan GE. 1984. 'Fire behaviour'. In EC Saxon (ed). *Anticipating the inevitable: a patch-burn strategy for fire management at Uluru (Ayers Rock – Mt Olga)*. CSIRO, Melbourne.

Griffin GF and Friedel MH. 1984. 'Effects of fire on central Australian rangelands. I. Fire and fuel characteristics and changes in herbage and nutrients'. *Australian Journal of Ecology*, vol. 9**,** pp. 381–93.

Griffin GF, Price NF and Portlock HF. 1983. 'Wildfires in the central Australian rangelands 1970–1980'. *Journal of Environmental Management*, vol. 17**,** pp. 311–23.

Keane RE, Cary GJ and Parsons P. 2003. 'Using simulation to map fire regimes: an evaluation of approaches, strategies and limitations'. *International Journal of Wildland Fire*, vol. 12, pp. 309–22.

Keane RE, Cary GJ, Davies ID, Flannigan MD, Gardner RH, Lavorel S, Lenihan JM, Li C and Rupp TS. 2004. 'A classification of landscape fire succession models: spatial simulations of fire and vegetation dynamics'. *Ecological Modelling*, vol. 179, pp. 3–27.

King KJ, Cary GJ, Bradstock RA, Chapman J, Pyrke A and Marsden-Smedley JB. 2006. 'Simulation of prescribed burning strategies in south-west Tasmania, Australia: effects on unplanned fires, fire regimes and ecological management values'. *International Journal of Wildland Fire*, vol. 15**,** pp. 527–40.

McCarthy MA and Cary GJ. 2002. 'Fire regimes of landscapes: models and realities'. In RA Bradstock, JE Williams and AM Gill (eds). *Flammable Australia: the fire regimes and biodiversity of a continent*. pp. 77–93. Cambridge University Press, Cambridge.

Miller G. 2003. 'Ecological impacts of buffel grass (*Cenchrus ciliaris* L.) invasion in central Australia: does field evidence support a fire-invasion feedback?' Unpublished honours thesis, School of Biological, Earth and Environmental Sciences, Faculty of Science, University of New South Wales, Sydney.

Stafford Smith DM and Morton SR. 1990. 'A framework for the ecology of arid Australia'. *Journal of Arid Environments*, vol. 18**,** pp. 255–78.

# 12. Post-fire recruitment dynamics of mulga communities in central Australia

**Grant Allan[1], Coral Allan[2], Chris Materne[2] and Doug Wilson[2]**
[1]Bushfires NT, NRETA, Alice Springs; [2]Pastoral Division, Primary Industries, Fisheries and Mines, Alice Springs
Email: Grant.allan@nt.gov.au; Coral.allan@nt.gov.au; Chris.materne@nt.gov.au

## Background

Fires in the mulga landscapes of the pastoral areas of central Australia occur at infrequent intervals. They are generally restricted to periods when two to three years of above-average rainfall contribute to the production of sufficient grass growth to provide a continuity of fuel loads (McArthur 1972; Griffin et al. 1983; Allan 2009). The two most recent periods of fires were during the mid 1970s and during 2001–02.

As a species, mulga (*Acacia aneura*) is considered an obligate seeder. The mature plants are killed by fire and regeneration is from seed, not by resprouting. The seed has a hard exterior coat and fire is a main stimulus for regeneration. Mulgas are also known to have a relatively long juvenile period, typically considered to be seven to 10 years, before individuals are capable of flowering and setting seed to replace the seed source. Therefore, mulga communities are considered vulnerable to short fire intervals.

Another concern about mulga communities is the issue of woody thickening. Areas of mulga in the pasture lands of western NSW and western Queensland have increased in density over the past 50 years (Hodgkinson & Harrington 1985). This increase is attributed to grazing which has removed the opportunity for fire and the competitive effect of grasses on the tree and shrub components of the ecosystem. A similar concern has been expressed in central Australia, although the geographic extent of mulga communities is a smaller proportion of the pastoral lands. Nonetheless, historic photographs (Figure 12.1) illustrate that some areas of central Australia have changed in both density and size of individual plants.

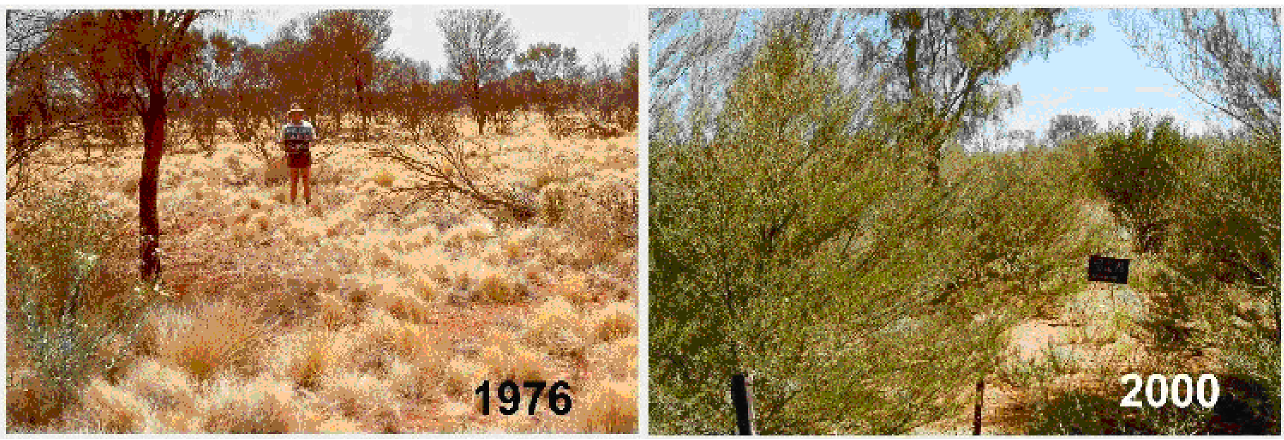



**Figure 12.1: Fixed-point photographic example of a change in both density and size of individual mulga plants in Central Australia**

Rain years were measured from July to June in order to avoid splitting the period of summer rainfall. Over the three-year period July 1999 to June 2002, Alice Springs, as a representative of the central Australia region, recorded rainfall of 1580 mm. This was 1.9 times the three-year average. As a comparison, the three-year total for the July 1973 to June 1976 period was 2380 mm, or 2.8 times the three-year average, the highest on record. Both rainfall periods contributed to abundant vegetative growth and consequently extensive wildfires.

A significant impetus for the project came from the pastoral industry. There had been considerable variation in the experience of the pastoralists in relation to the fires, and only a few pastoralists had experienced the mid 1970s fire events. Fire was a topic of discussion within the Alice Springs Pastoral Industry Advisory Committee (ASPIAC), who raised the issue for investigation by the Pastoral section of the NT Department of Primary Industry, Fisheries and Mines (DPIFM). In addition to their variable experiences during the fires, pastoralists also indicated there was considerable variation in their post-fire observation of the woody vegetation communities. These observations ranged from 'the mulga were not recovering' to 'abundant regeneration was potentially greater than the pre-fire density'. The two extremes were expressed as management concerns to their pastoral enterprise, with the increased woody thickening of greatest concern.

## Project aim and objectives

The aim of the project was to record and analyse information on the dynamics of mulga woodland communities after the period of fires during 2001 and 2002 in central Australia. Differences in the timing of the fires with respect to rainfall and the regional locations of the fires during 2001 and 2002 were used to create the experimental design. In 2001 the fires in the pastoral lands of central Australia were all north of Alice Springs and there was good rainfall both prior to and subsequent to the fires. During 2002 there were fires both north and south of Alice Springs but the fires occurred after a relatively long dry period through the winter of 2002 with many heavy frosts that cured the fuel loads. Although rain at the end of 2002 did extinguish any fires that were still active, some areas did not receive sufficient rainfall to stimulate a post-fire recovery.

The objectives of the project were to:

- provide an objective description of the number and density of individuals within mulga communities on pastoral properties in central Australia
- compare the regeneration of mulga communities after the 2001 and 2002 fires and test for differences based on seasonal conditions, principally pre- and post-fire rainfall
- identify potential management implication associated with fire and mulga communities
- recommend further studies to extend the results of this project.

The focus was restricted to red-earth mulga communities, mainly groved mulga communities with understorey of a variety of short-grasses. Some areas of mulga islands within spinifex sandplains were also sampled. Both areas are readily identifiable from available satellite images or as unique areas within land unit maps. Areas of mulga over spinifex were not sampled. Maps of mulga–spinifex communities are not uniformly available across central Australia. These communities have been mapped at the land unit level, but only a minority of stations in central Australia have been mapped at this level.

## Methods

### Study sites and transect locations

The selection of study sites was based on a regional fire history created from NOAA AVHRR satellite images by WA Department of Land Information (DLI) in combination with the land systems map of the Alice Springs region (Perry et al. 1962). The location of transect locations for on-ground sampling required additional information on the individual fire and landscape patterns using Landsat TM and Ikonos Quicklook images. Both image types were used to identify areas of mulga communities affected by fire, as well as associated unburnt areas, either adjacent to the burnt area, or as unburnt islands within the fire perimeter. Based on the image patterns, transect locations were identified as 500 m lines in close proximity to readily accessible areas along roads, tracks or fencelines. The coordinates of the transect endpoints were then converted to waypoints and uploaded into a GPS for use in the field.

### Data collection

Data was collected as belt transects, with three replicate transects of both burnt and unburnt for each fire sampled within each pastoral property. A total of 90 transects were sampled. These represented 15 individual fires and associated unburnt reference areas.

Each belt transect was 5 m x 250 m divided into 100 quadrats as two parallel and contiguous lines of 2.5 m x 5 m quadrats. Within each quadrat, perennial tree and shrub woody vegetation was counted by species within six size–class categories for both dead and alive individuals (Table 12.1). Observations on fire damage and method of fire recovery (e.g. seedling, basal resprouting) were also recorded. Initially a GPS location was recorded for the centre position of each pair of 2.5 m x 5 m quadrats. This was subsequently reduced to every fifth quadrat location.

| Height class | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Description | < 0.5 m | 0.5 – 1 m | 1 – 2 m | 2 – 5 m | > 5 m thin basal stem | > 5 m thick basal stem |

**Table 12.1: Height classes used to collect woody vegetation data**

At every fifth quadrat, woody vegetation cover (by Bitterlich gauge) was recorded by species for all live individuals and pasture data (using the BOTANAL, or dry-weight, rank method) was collected within a 1 m x 1 m quadrat. The included:

- composition (the three dominant species)
- biomass (a visual estimate based on photo standards)
- cover (both as a visual estimate plus a near-vertical digital photograph)
- grazing activity (of both cattle and other species, mainly kangaroos and camels).

## Data analysis

MS Excel was used for data entry, and the preliminary analysis presented in this report. Each row in the spreadsheet contained relevant attribute data for each species, including location and extent of fire damage. Each data point, representing a 2.5 m x 5 m quadrat, was based on the number of individuals of a specific species within a size-class category by life status (‘Alive’ or ‘Dead’).

## Results

Only a preliminary analysis of the data has been completed. The following results are only for the mulga component of the woody species data and are only a simple summary. Further analysis and interpretation of the full dataset will be completed for the final report.

## All mulga data

Of the 27 573 individuals of woody vegetation recorded on all transects, 13 119 were mulga. There were 7318 live mulgas, or 56%, and 5801 dead mulgas, or 44%. There were 2799 live juvenile mulga recorded (height classes 1, 2 and 3), or 52% of the total live mulga. The distribution of mulga by height class for all transects is shown in Figure 12.2. A regeneration ratio for mulga was calculated as the ratio of the number of juveniles less than 1 m (height classes 1 and 2) to the number of non-juvenile mulgas killed by the fire (height classes 3 to 6). For all transects the regeneration ratio was 0.71, indicating that regeneration was less than the number of adults killed by the fires.

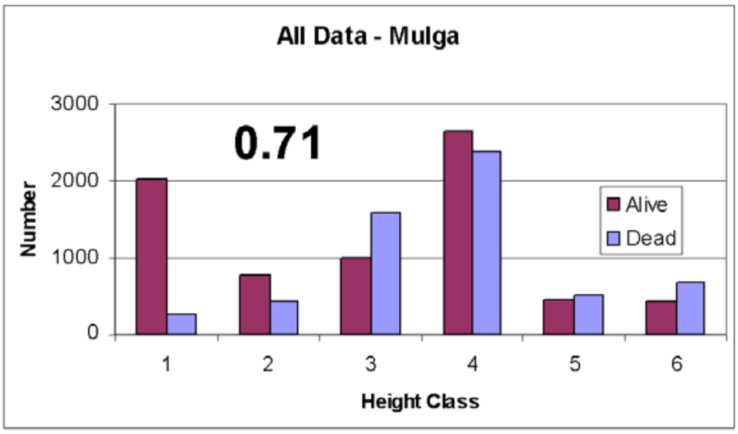
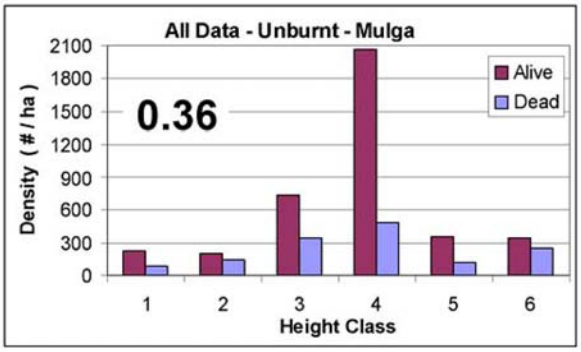


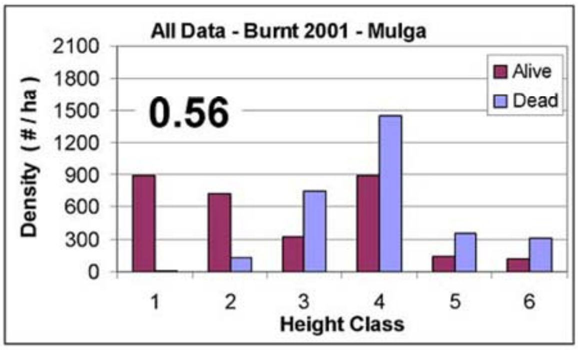

**Figure 12.2: Distribution of mulga by height class for all transects**

1. The regeneration ratio for all transects was 0.71.

## All mulga by fire history

The mulga dataset was separated in the three categories of 'unburnt', 'burnt in 2001' and 'burnt in 2002' (Figure 12.3). There was considerably less regeneration of mulga within the unburnt areas, and the regeneration ratio was 0.36. The impact of the 2001 fires, represented as the number of adults killed by fire was less than the 2002 fires, and the regeneration ratio for 2001 was only 0.56 in comparison to 0.73 for 2002.



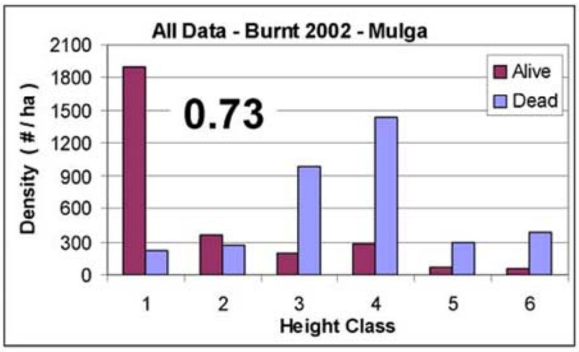



**Figure 12.3: Distribution of mulga by height class separated into 'unburnt', 'burnt 2001' and 'burnt 2002' transects**

1. The regeneration ratio is shown for each group of transects

## Mulga by fire history for the area northwest of Alice Springs

There was considerable variation in the density of mulga between the fire history states for transects sampled on three pastoral properties northwest of Alice Springs (Figure 12.4). However, the relationships were consistent with the results for all sites combined (Figure 12.3). The regeneration ratio was lowest in the unburnt sites, and the fires in 2002 killed a greater proportion of the mulga than the fires in 2001. There was a less significant difference in the regeneration ratio between the burnt 2001 and burnt 2002 sites; however, this was influenced by the reduced density of mulga within the burnt 2001 sites.

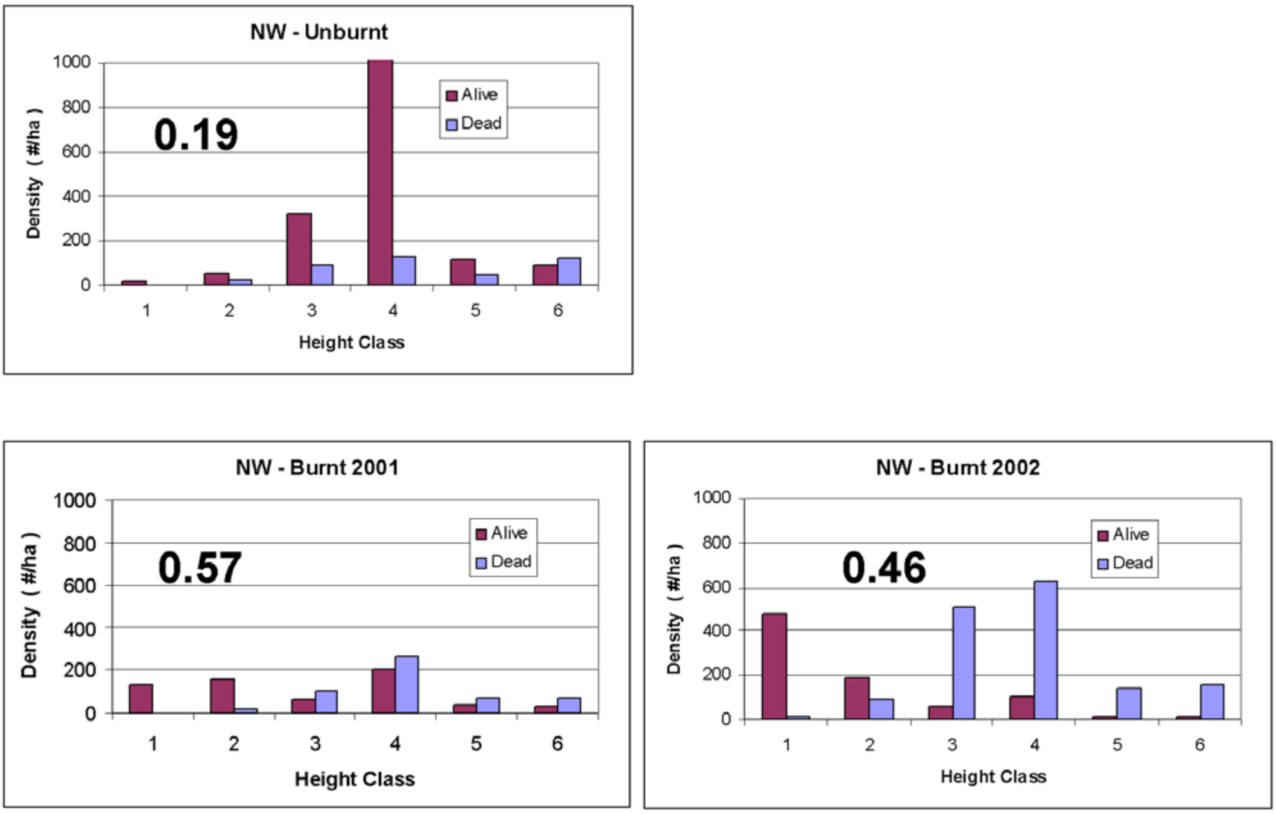



**Figure 12.4: Distribution of mulga by height class separated into 'unburnt', 'burnt 2001' and 'burnt 2002' transects for transects on three pastoral properties northwest of Alice Springs**

1. The regeneration ratio is shown for each group of transects.

## Recommendations for further work

The focus of this study was restricted to red-earth mulga communities, mainly groved mulga communities with an understorey of a variety of short-grasses. Areas of mulga over spinifex were not sampled. Maps of mulga–spinifex communities are not uniformly available across central Australia. Local knowledge from pastoralists and other ecologists in central Australia could be used to identify sample areas. The impact of the fires on the mulga communities is still identifiable but will continue to diminish with time. It is recommended that a subsequent study of these areas should be done. Future work must be aware of the potential for confusion to arise with respect to the timing of the post-fire recruitment event and the survival rate.

It is also recommended that some of the transects, especially those which showed high amounts of recruitment and also those with high proportions of resprouting, be resampled in the future to test the survivorship of the regeneration.

Following the more detailed analysis of the data collected, the information must be incorporated into extension material for pastoral land managers on the role of fire in mulga landscapes of central Australia. The information will be presented to ASPIAC and incorporated into the Meat & Livestock Australia Grazing Land Management package for central Australia.

## References

Allan GE. 2009. Managing fire in the southern Tanami Desert, in *Desert Fire: fire and regional land management in the arid landscapes of Australia*, Eds. GP Edwards and GE Allan, pp. 17–78, DKCRC Report 37, Desert Knowledge Cooperative Research Centre, Alice Springs.

Griffin GF, Price NF and Portlock HF. 1983. 'Wildfires in the central Australian rangelands 1970–1980'. *Journal of Environmental Management*, vol. 17, no. 4, pp. 311–23.

Hodgkinson KC and Harrington GN. 1985. 'The case for prescribed burning to control shrubs in eastern semi-arid woodlands'. *Australian Rangelands Journal*, vol. 7, pp. 64–74.

McArthur AG. 1972. 'Fire control in the arid and semi-arid lands of Australia'. In N Hall (ed). *The use of trees and shrubs in the dry country of Australia*. pp. 488–515. Australian Government Publishing Service, Canberra.

Perry RA, Mabbutt JA, Litchfield WH, Quinlan T, Lazarides M, Jones NO, Slatyer RO, Stewart GA, Bateman W and Ryan GR. 1962. *General report on lands of the Alice Springs area, Northern Territory, 1956–57*. Land Research Series 6, CSIRO, Melbourne.

# 13. Fight or flight: vertebrate responses to wildfire in the Simpson Desert, Australia. Project outline and preliminary results

**Louise A Pastro[1] and Chris R Dickman[2]**
[1]PhD candidate, School of Biological Sciences, University of Sydney, Sydney, New South Wales, Australia 2006; [2]Professor in Terrestrial Ecology, School of Biological Sciences, University of Sydney, New South Wales, Australia 2006
Email: lpastro@bio.usyd.edu.au

## Introduction

The Australian arid and semi-arid zones support the richest known communities of insectivorous mammals (Dickman 2003) and the most diverse known reptile assemblages of any desert worldwide (Pianka 1996). However, more than one-third of the mammal species originally inhabiting the central deserts have become extinct in the past 50 years (Burbidge et al. 1988), and more than half of Australia's endangered mammal species currently reside there (James et al. 1999). Several reptile species have also declined (Sadlier & Pressey 1994), and future reptile declines are thought likely to follow those of the mammals (Recher & Lim 1990). Changes to the predominant fire regime are thought to be a key factor causing this sudden and massive species decline (Bolton & Latz 1978; Burbidge 1985; Burbidge et al. 1988).

As the Aboriginal people left their traditional lands for European settlements and missions, the dominant fire regime changed from one characterised by frequent, small-scale fires (Reid et al. 1993) to one of infrequent, widespread wildfires (Griffin et al. 1983). Such broadscale wildfires have a dramatic effect on desert ecosystems, burning vast tracts of hummock grassland and depriving animals of the diversity of shelter and foraging areas they require (Burbidge et al. 1988). Studies conducted in the north-eastern Simpson Desert following a major wildfire in 2001–02 indicated that small mammal and lizard populations plummeted in the months after the fire and remained at very low densities for a considerable period of time (CR Dickman, personal observation, n.d.). In the last year, vertebrate communities have recovered gradually in unburnt areas, but they are still slow to respond in burnt areas and the speed of their recovery has not been consistent across the study area.

Suggested causes for animal declines in burnt areas include increased predation, a lack of food or shelter, and the influence of low rainfall and grazing (Masters 1993, 1996; Letnic 2003; Letnic et al. 2004). The relative importance of each of these factors and any interactions between them are not well understood, however. Previous studies have generally examined animal responses to small-scale and/or experimental fires (e.g. Masters 1993, 1996; Letnic 2003; Letnic et al. 2004; Letnic & Dickman 2005), and few studies have extended their data collection into the extensively burnt areas that exist after a major wildfire. In addition to this, the results of these studies are conflicting and the preferences of some species, such as the lesser hairy-footed dunnart (*Sminthopsis youngsoni*) and the sandy inland mouse (*Pseudomys hermannsburgensis*) for unburnt or regenerating habitats, are inconsistent both between and within studies (e.g. Masters 1993; Southgate & Masters 1996; Letnic & Dickman 2005; Letnic et al. 2005).

Given the pivotal role that changes in fire regimes are thought to have played in the extinction of arid zone faunas so far, a sound knowledge of the ecological interactions influencing animal responses to wildfire is essential for the future conservation of Australia's desert species. In this project, we seek to understand the broad impacts of wildfire and the processes that drive change in the post-fire environment. This information will provide guidance for the future management and conservation of these species and will allow fire to be managed effectively for the conservation of vertebrates in the arid zone.

The aims of the project are as follows:

- 1. To describe the distribution, abundance and diversity of vertebrates in burnt and unburnt areas and across burn ecotones within the large areas of the north-eastern Simpson Desert burnt in the summers of 2001 and 2002.
- 2. To experimentally identify the factors that are most important in facilitating vertebrate recovery in burnt areas.
- 3. To build models that effectively predict the vertebrate assemblages present when the vegetation has regained its pre-fire levels of cover. These models will be used to develop sound management practices that will greatly assist in the conservation of Australia's desert vertebrate species.

As the study is still in its preliminary stages, results pertaining only to the first of these aims are presented below.

## Methods

### Study area

The study sites are located in three spatially independent regions across two conservation reserves in the north-eastern Simpson Desert: Kunnamuka Swamp on Cravens Peak Reserve (23°16'S, 138°17'E); Field River on Ethabuka Reserve (23°45'S, 138°28'E); and Main Camp on Ethabuka Reserve (23°34'S, 138°28'E). Two replicate study sites are nested within each region. The reserves are owned by Australian Bush Heritage.

The major landforms in the region are longitudinal, parallel sand dunes running NNW–SSE. The dunes are 8–10 m high and are spaced 100–1000 m apart (Purdie 1984). The vegetation in the swales, on dune slopes and dune crests in long unburnt areas (> 25 years after fire) is characterised mainly by the hummock grass spinifex (*Triodia basedowii*). Common shrub species in long unburnt swales include gidgee (*Acacia georgineae*), *A. ligulata*, *Grevillea* spp. and *Eremophila* spp. Common shrub species on long unburnt crests include *G. stenobotrya, Crotalaria* spp, and *Sida* spp. An abundance of ephemeral forbs and grasses is also present on dune crests and in swales after rain. Burnt habitats support more diverse vegetation than unburnt habitats and are dominated by grasses, herbs and small shrubs. Common species include *Aristida contorta*, *Eragrostis eriopoda* and *Trachymene glaucifolia*. Wildfires in the Simpson Desert burnt some 3 000 000 hectares of hummock grassland in the summer of 2001–02.

The Simpson Desert is classified as a hot desert. The study area lies along a north–south rainfall gradient, between the 100 mm and 150 mm median annual rainfall isopleths (Purdie 1984). Rainfall is variable both spatially and temporally, and is highly unpredictable. The temperature ranges between -6°C and 49°C over the course of the year.

### Trapping

Animals are live-trapped at six sites (two sites nested within in each region). At each site 60 pitfall traps are arranged in three parallel transects of 20 traps spaced 20 m apart. One transect is located along the ecotone between a burnt and an unburnt area, one transect is located 100 m from the ecotone in the burnt area, and one transect is located 100 m from the ecotone in the unburnt area. Each trap consists of a 60 cm (length) x 16 cm (diameter) piece of PVC pipe sunk flush with the ground. A 5 m length of aluminium flywire drift fence is positioned over the top of each trap to improve capture efficiency, and a smaller piece is placed underneath to prevent the animals from escaping. Each trapping session is conducted for three consecutive nights (Dickman et al. 1999a; Dickman et al. 1999b; Dickman et al. 2001) and captured animals are identified, weighed, measured, given a unique mark and released after capture. Traps are closed using metal lids between trapping sessions.

Resource availability data in burnt, unburnt and ecotone areas are collected during all trapping sessions. Data collected include the extent of vegetation cover around trapping stations, the availability of above-ground and below-ground seeds, and the presence and abundance of invertebrate prey. Spotlighting is undertaken at night to determine the level of predator activity, and monthly cumulative rainfall totals are collected via automated weather stations.

### Radio-telemetry

Data on the proportions of burnt and unburnt habitats that animals utilise are collected via radio tracking. Mammal tracking is conducted on the two most common mammal species: the lesser hairy-footed dunnart (*S. youngsoni*) and the sandy inland mouse (*P. hermannsburgensis*). Reptile tracking is conducted on the panther skink (*Ctenotus pantherinus*) and the sand goanna (*Varanus gouldii*). Mammals are tracked between dusk and dawn and reptiles are tracked both diurnally and nocturnally.

### Fluorescent-pigment tracking

Fine-scale data on the activity and foraging trails of animals are collected by tracking using fluorescent pigments. This technique reveals the precise movements of animals, thus allowing activity and use of shelter between burnt, unburnt and ecotone areas to be compared.

### Experiment manipulations

Experimental manipulations will be undertaken to explain the patterns observed in the trapping and animal-tracking components of the study. The manipulations may include the addition of artificial lighting (to increase the perceived risk of predation), the addition of food resources, and an increase in shelter in burnt areas. Animal responses will be determined using radio tracking and giving-up-density (Brown 1988) techniques.

## Preliminary results and discussion

As the research is continuing, preliminary trapping results only will be presented in this paper. Three trapping sessions, each of three days, have been conducted at each site to date, giving a total of 3240 trap nights (1080 trap nights in each of the burnt, ecotone and unburnt habitats). Six mammal species and 19 reptile species have been trapped, 324 sand seed-bank samples and 648 invertebrate pitfalls have been collected, and 432 vegetation plots have been surveyed. Pilot trials for radio-telemetry and fluorescent-pigment tracking have been undertaken and, together with the planned experimental manipulation work, will commence in detail in 2007.

### Preliminary trapping results and discussion: mammals

Most mammal individuals have been trapped in unburnt habitats, followed by ecotone habitats and burnt habitats (pooled data for all sites and species: Figure 13.1). Species-specific data for the two most common mammal species, the sandy inland mouse (*P. hermannsburgensis*) and the lesser hairy-footed dunnart (*S. youngsoni*) follow this trend, with individuals of both species appearing to avoid the open, burnt areas (Figure 13.2). These results contrast with those of previous studies, which have found that these species show either no preference for burnt or unburnt habitats (Southgate & Masters 1996; Letnic 2003) or that they prefer regenerating, burnt habitats (Masters 1993, Letnic & Dickman 2005). Most of these previous studies were conducted on a much smaller scale than the present study, and this may have influenced the results. These trends will be explored further in the radio-telemetry and experimental manipulation components of the study. The effect of the habitat, rainfall and resource availability variables on small mammal behaviour will also be determined.

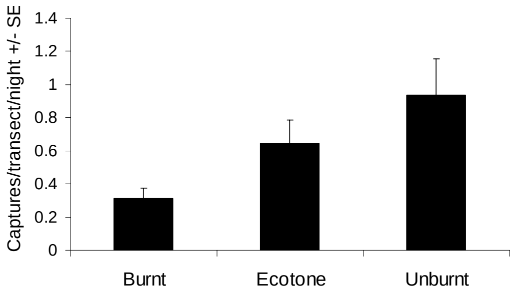



**Figure 13.1: Mammal captures across burnt, ecotone and unburnt habitats**

1. Means are shown ± SE. Preliminary data.

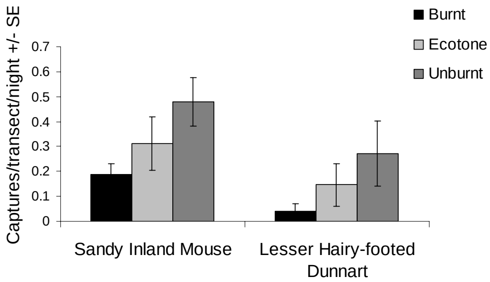



**Figure 13.2: Sandy inland mouse (*Pseudomys hermannsburgensis*) and lesser hairy-footed dunnart (*Sminthopsis youngsoni*) captures across burnt, ecotone and unburnt habitats**

1. Means are shown ± SE. Preliminary data.

## Preliminary trapping results and discussion: reptiles

Unlike the mammal data, the pooled preliminary reptile data show no general trends. Only two species show a clear habitat preference: the central netted dragon (*Ctenophorus nuchalis*) and the southern sandslider (*Lerista labialis*), the latter species a fossorial skink. The central netted dragon is more abundant in burnt habitats (Figure 13.3), a result which is expected and in accordance with previous research (Masters 1996, Letnic et al. 2004). Central netted dragons are tolerant of high body temperatures, construct deep burrows, and make use of the bare ground in their thermoregulatory and territorial displays (Bradshaw 1986). The tendency for the southern sandslider to be most abundant in the ecotone habitat is less easy to interpret, however, as this species has been found previously to associate with increasing spinifex cover (Letnic et al. 2004) which is provided in the present study only by long unburnt habitats. This trend will be further explored through experimental manipulation and the analysis of habitat and resource data. The habitat preferences of other reptiles are expected to become clearer as the study progresses.

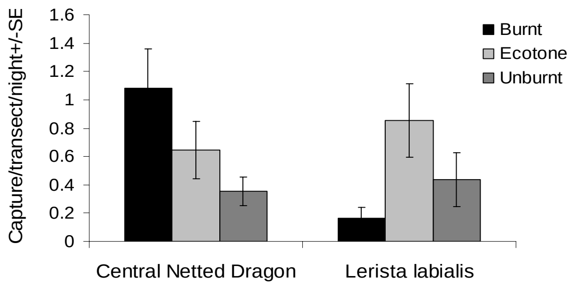



**Figure 13.3: Central netted dragon (*Ctenophorus nuchalis*) and southern sandslider (*Lerista labialis*) captures across burnt, ecotone and unburnt habitats**

1. Means are shown ± SE. Preliminary data.

## Acknowledgments

The authors thank G Wardle, B Tamayo, A Greenville and many volunteers for assistance in the field. Thanks also to Australian Bush Heritage for allowing us to work on Cravens Peak Reserve and Ethabuka Reserve. The research is supported by grants from the Royal Zoological Society (to L Pastro), the Wildlife Preservation Society of Australia (to L Pastro), the University of Sydney (to L Pastro) and the Australian Research Council (to C Dickman). The research is being conducted under the appropriate approval and permits from the Queensland Environmental Protection Agency (scientific licence no. WISP02994105) and University of Sydney Animal Care and Ethics Committee (approval no. L04/4-2004/3/3896).

## References

Bolton BL and Latz PK. 1978. 'The western hare-wallaby *Lagorchestes hirsutus* (Gould) (Macropodidae), in the Tanami Desert', *Australian Wildlife Research*, vol. 5, pp. 285–93.

Bradshaw SD. 1986. *Ecophysiology of desert reptiles*. Academic Press, Sydney.

Brown JS. 1988. 'Patch use as an indicator of habitat preference, predation risk and competition'. *Behavioral and Ecological Sociobiology*, vol. 22, pp. 37–47.

Burbidge, AA. 1985. 'Fire and mammals in hummock grasslands of the arid zone'. In JR Ford, (ed.). *Fire ecology and the management of ecosystems in Western Australia*. Proc. Fire Symp., WAIT Environmental Studies Group Report No. 14, pp. 91–4. Western Australian Institute of Technology, Perth.

Burbidge AA, Johnson KA, Fuller PJ and Southgate RI. 1988. 'Aboriginal knowledge of the mammals of the central deserts of Australia'. *Australian Wildlife Research*, vol. 15, pp. 9–39.

Dickman CR. 2003. 'Distributional ecology of dasyurid marsupials'. In M Jones, CR Dickman and M Archer (eds). *Predators with pouches: the biology of carnivorous marsupials*. pp. 318–31. CSIRO Publishing, Melbourne.

Dickman CR, Haythornthwaite AS, McNaught GH, Mahon PS, Tamayo B and Letnic M. 2001. 'Population dynamics of three species of dasyurid marsupials in arid central Australia: a 10-year study'. *Wildlife Research*, vol. 28, pp. 493–506.

Dickman CR, Letnic M and Mahon PS. 1999a. 'Population dynamics of two species of dragon lizards in arid Australia: the effects of rainfall'. *Oecologia*, vol. 119, pp. 357–66.

Dickman CR, Mahon PS, Masters P and Gibson DF. 1999b. 'Long-term dynamics of rodent populations in arid Australia: the influence of rainfall'. *Wildlife Research*, vol. 26, pp. 389–403.

Griffin GF, Price NF and Portlock HF. 1983. 'Wildfires in the central Australian rangelands, 1970–1980'. *Journal of Environmental Management*, vol. 17, pp. 311–23.

James CD, Landsberg J and Morton SR. 1999. 'Provision of watering points in the Australian arid zone: a review of effects on biota'. *Journal of Arid Environments*, vol. 41, pp. 87–121.

Letnic M. 2003. 'The effects of experimental patch burning and rainfall on small mammals in the Simpson Desert, Queensland'. *Wildlife Research*, vol. 30, pp. 547–63.

Letnic M and Dickman CR. 2005. 'The responses of small mammals to patches regenerating after fire and rainfall in the Simpson Desert, central Australia'. *Austral Ecology*, vol. 30, pp. 24–39.

Letnic M, Dickman CR, Tischler M, Tamayo B and Beh CL. 2004. 'The responses of small mammals and lizards to post-fire succession and rainfall in arid Australia'. *Journal of Arid Environments*, vol. 59, pp. 85–114.

Letnic M, Tamayo B and Dickman CR. 2005. 'The responses of mammals to La Niña (ENSO)-associated rainfall, predation and wildfire in arid Australia'. *Journal of Mammalogy*, vol. 86, pp. 689–703.

Masters P. 1993. 'The effects of fire-driven succession and rainfall on small mammals in spinifex grasslands at Uluṟu National Park, Northern Territory'. *Wildlife Research*, vol. 20, pp. 803–13.

Masters P. 1996. 'The effects of fire-driven succession on reptiles in spinifex grasslands at Uluṟu National Park, Northern Territory'. *Wildlife Research*, vol. 23, pp. 39–48.

Pianka ER. 1996. 'Long-term changes in lizard assemblages in the Great Victoria Desert'. In ML Cody and JA Smallwood (eds). *Long-term studies of vertebrate communities*. pp. 191–215. Academic Press, New York.

Purdie R. 1984. *Land systems of the Simpson Desert region*. CSIRO Division of Water and Land Resources, Natural Resources Series No. 2, Melbourne.

Recher HF and Lim L. 1990. 'A review of current ideas of the extinction, conservation and management of Australia's terrestrial vertebrate fauna'. *Proceedings of the Ecological Society of Australia*, vol. 16, pp. 287–301.

Reid JRW, Kerle JA, and Morton SR. 1993. *Uluṟu fauna. The distribution and abundance of vertebrate fauna of Uluṟu (Ayers Rock – Mount Olga) National Park, NT Kowari 4*. Australian National Parks and Wildlife Service, Canberra.

Sadlier RA and Pressey RL. 1994. 'Reptiles and amphibians of particular conservation concern in the Western Division of New South Wales: a preliminary review'. *Biological Conservation*, vol. 69, pp. 41–54.

Southgate R and Masters P. 1996. 'Fluctuations of rodent populations in response to rainfall and fire in a central Australian hummock grassland dominated by *Plectrachne schinzii*'. *Wildlife Research*, vol. 23, pp. 289–303.

# 14. Discussion

The key points to come out of the discussion are summarised below.

## Things that can be done now to improve fire management outcomes

- Build on foundations laid in the Tanami. The Tanami is being adversely affected by large wildfires and we need to turn this around. The appointment of a CLC fire management officer is an important step forward in addressing this issue.
- Deliver appropriate information back to stakeholders, especially rangers, pastoralists and Aboriginal groups.
- Foster wider adoption of appropriate technologies, e.g. satellite monitoring of fire and use of aerial incendiaries.
- Conduct inclusive annual meetings to discuss fire risk and to map out appropriate actions. Bushfires Council NT is the appropriate vehicle for achieving this outcome in the Northern Territory.

### Areas requiring further work

- Clarify the role of buffel grass in fire promulgation.
- Clarify whether FIRESCAPE supports ranger-based decision-making.
- Explore the linkage between continuity and livelihoods. Who will be in arid Australia in 20 years?
- Identify the important assets at a range of scales.
- Document the aims of fire management across a range of tenures and land use activities.
- Document the barriers to improving fire management outcomes.
- Develop a strategy to address negative perception of fire in some quarters.
- Document ecological understandings in respect of fire in final report.
- Develop mechanism for Desert Fire to make impact.
- Translate research into operational guidelines and new policy.

### Livelihood possibilities

- Carbon sequestration.
- Stewardship programs.
- Contract jobs linked to programs with clearly defined outputs and deliverables.

### A new paradigm and institutional change

- Adopt a new paradigm for how we address the management of fire in arid Australia.
- The new paradigm must allow for the injection of funds at key times to address wildfire issues. This requirement could be met by setting up a strategic reserve.
- The new paradigm must allow for appropriate decision-making at crucial times.
- The new paradigm must support appropriate monitoring of fuel loads and existing fires.
- There is a need to improve both capacity and ability of land managers to engage in appropriate fire management.
- There is a need to change organisational cultures if we wish to improve fire management outcomes.

# 15. Appendix: DKCRC Desert Fire project publication list

## DKCRC project reports (posted on DKCRC website)

Edwards GP and Allan GE. 2009. Executive summary, in *Desert Fire: fire and regional land management in the arid landscapes of Australia*, Eds. GP Edwards and GE Allan, pp. 1–8, DKCRC Report 37, Desert Knowledge Cooperative Research Centre, Alice Springs.

Edwards GP and Allan GE. 2009. Introduction and overview of Desert Fire, in *Desert Fire: fire and regional land management in the arid landscapes of Australia*, Eds. GP Edwards and GE Allan, pp. 9–16, DKCRC Report 37, Desert Knowledge Cooperative Research Centre, Alice Springs.

Allan GE. 2009. Managing fire in the southern Tanami Desert, in *Desert Fire: fire and regional land management in the arid landscapes of Australia*, Eds. GP Edwards and GE Allan, pp. 17–78, DKCRC Report 37, Desert Knowledge Cooperative Research Centre, Alice Springs.

Gabrys K and Vaarzon-Morel. 2009. Aboriginal burning issues in the southern Tanami: towards understanding tradition-based fire knowledge in a contemporary context, in *Desert Fire: fire and regional land management in the arid landscapes of Australia*, Eds. GP Edwards and GE Allan, pp. 79–186, DKCRC Report 37, Desert Knowledge Cooperative Research Centre, Alice Springs.

Allan GE and Tschirner A. 2009. Pastoralists' perspectives on the costs of widespread fires in the pastoral lands of the southern Northern Territory region of central Australia, 2000–2002, in *Desert Fire: fire and regional land management in the arid landscapes of Australia*, Eds. GP Edwards and GE Allan, pp. 187–208, DKCRC Report 37, Desert Knowledge Cooperative Research Centre, Alice Springs.

Duguid A, Brock C and Gabrys K. 2009. A review of fire management on central Australian conservation reserves: towards best practice, in *Desert Fire: fire and regional land management in the arid landscapes of Australia*, Eds. GP Edwards and GE Allan, pp. 209–308, DKCRC Report 37, Desert Knowledge Cooperative Research Centre, Alice Springs.

K Gabrys, P Cowan, A Duguid. 2009. The fire history of Rainbow Valley Conservation Reserve 1984–2005, in *Desert Fire: fire and regional land management in the arid landscapes of Australia*, Eds. GP Edwards and GE Allan, pp. 309–338, DKCRC Report 37, Desert Knowledge Cooperative Research Centre, Alice Springs.

### Published papers

Bowman DMJS, Boggs GS, Prior LD and Krull ES. 2007. 'Dynamics of *Acacia aneura – Triodia* boundaries using carbon (14C and $\delta^{13}C$) and nitrogen ($\delta^{15}N$) in soil organic matter in central Australia'. *The Holocene*, vol. 17, pp. 1–10.

Bowman DMJS, Boggs GS and Prior LD. 2008. 'Fire maintains an *Acacia aneura* shrubland- *Triodia* grassland mosaic in central Australia'. *Journal of Arid Environments*, vol. 72, pp. 34–47.

Edwards GP, Allan GE, Brock C, Duguid A, Gabrys K and Vaarzon-Morel P. 2008. 'Fire and its management in central Australia'. *Rangeland Journal*, vol. 30, pp. 109–22.

Turner D, Ostendorf B and Lewis M. 2008. 'An introduction to patterns of fire in arid and semi-arid Australia 1998-2004'. *Rangeland Journal*, vol. 30, pp. 95–108.

Vaarzon-Morel P and Garbrys K. In press. 'Fire on the horizon: contemporary Aboriginal burning issues in the southern Tanami'. *Knowledge and Development in Sparsely settled arid regions*, *Geojournal* Special edition.

### Theses

Maclean K. 2007. 'Creating spaces for negotiation at the environmental management and community development interface in Australia.' Unpublished PhD thesis. Australian National University, Canberra.

Nicholas AMM. 2008. 'Characteristics and dynamics of the mulga–spinifex boundaries at Mt Denison station.' unpublished MSc thesis. School of Environmental Research, Charles Darwin University, Darwin.

Leavesley A. 2008. 'The response of birds to the fire regimes of mulga woodlands in central Australia.' Unpublished PhD thesis. Australian National University, Canberra.

## Working papers

Duguid A, Gabrys K, Morse J and Rodrigo M. 2008. *Fire management for conservation reserves in central Australia*. Workshop proceedings 5–6 December 2005, Working Paper 21, Desert Knowledge CRC, Alice Springs. URL <http://www.desertknowledgecrc.com.au/publications/workingpapers.html>.

King K, Marsden-Smedley J, Cary G, Allan GE, Bradstock RA and Gill AM. 2008. *Modelling fire dynamics in the West MacDonnell Range area*. Working Paper 20, Desert Knowledge CRC, Alice Springs. URL <http://www.desertknowledgecrc.com.au/publications/workingpapers.html>.

## Databases

Fire-related publications focusing on the arid zone of Australia, URL <http://www.desertknowledgecrc.com.au>. Obligate and non-obligate seeders of the NT, Northern Territory Herbarium

## PowerPoint presentations

Latz PK. 2008. 'Fire in central Australia'. URL <http://www.desertknowledgecrc.com.au>.

# DKCRC Partners

AIATSIS

Australian Government Department of Families, Community Services and Indigenous Affairs

ANU The Australian National University

Centre for Remote Health
A joint centre of Flinders University and Charles Darwin University

Charles Darwin University

CSIRO

Curtin University of Technology

desert peoples centre

Government of South Australia Department of Water, Land and Biodiversity Conservation

Government of Western Australia

Griffith University

JCU James Cook University

Murdoch University Perth, Western Australia

Northern Territory Government

Newmont The Gold Company

NSW Department of Primary Industries

Southern Cross University

Tangentyere Council

The University of Adelaide Australia

Tjuparntjarra

University of South Australia

The University of Queensland Australia

The University of Western Australia

University of Wollongong

Waltja Tjutangku Palyapayi "doing good work with families"