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# EcoFire 2008

Report prepared March 2009  
Australian Wildlife Conservancy

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australian



wildlife  
conservancy

ALL NORTH  
HELICOPTERS



WESTERN AUSTRALIAN  
**environment**  
AWARDS 2008

**WINNER**



Department of Environment and Conservation

Fire and Emergency Services Authority of Western Australia

Department of Agriculture



Rangelands NRM  
Western Australia





### **EcoFire Steering Committee (organisation and primary contacts)**

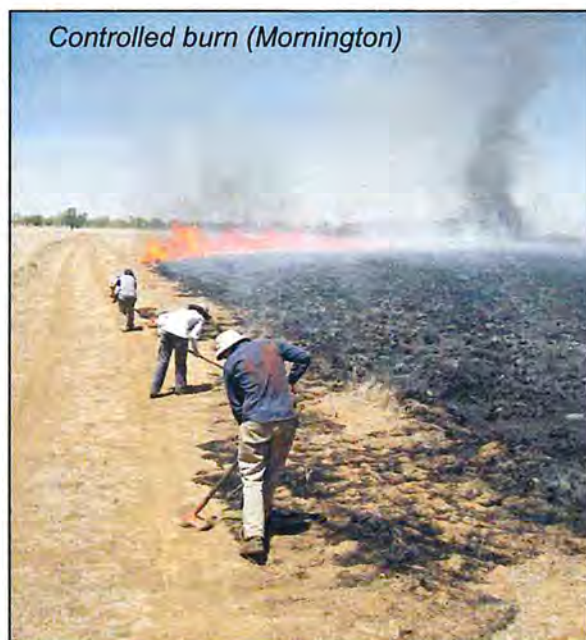
Rangelands NRM – Liz Brown, John Silver  
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All North Helicopters - Butch Maher  
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### **EcoFire participants 2008**

Mornington Wildlife Sanctuary - Australian Wildlife Conservancy  
Butch Maher - All North Helicopters  
Nigel and Cait Westlake - Mt House-Glenroy Stations  
Gerry Adamson, Phil Stoker, Joe Batista, Australian Wildlife Conservancy – Marion Downs Station  
Peter and Cheryl Camp – Charnley River Station  
Peter and Pat Lacy – Mt Elizabeth Station  
Alfie White, John and Linda Thurston - Ngallagunda Community, Gibb River Station  
Dwain Donation, Tony and Sue McCormick – Kupungarri Community, Mt Barnett Station  
Sammy Walker and family - Tirralintji Community, Mornington Sanctuary  
Wallace Madmee and family – Yulumbu Community, Tablelands Station  
Cici, Alan and Maria Myers, Susan Bradley – Theda and Doongan Stations  
Susan Bradley, Grollo family, Brian and Marcia Withell – Ellenbrae Station  
John, Anne, Joanna Koeysers – Drysdale Station



*Dwain Donation (Mt Barnett)*



*Controlled burn (Mornington)*





## Summary

The prevailing Kimberley fire pattern of extensive, mid-to-late dry season fires is damaging biodiversity, destroying pasture for cattle, causing poorer soil health, damaging cultural sites, and resulting in higher greenhouse gas emissions.

EcoFire aims to change these fire patterns in the central and north Kimberley. The project is outcome-focused: it delivers a strategic regional prescribed burning program and coordinates fire management across property boundaries and tenures. The effectiveness of the program is monitored using archived satellite imagery to describe fire patterns.

EcoFire is a collaborative project between a group of neighbouring landholders (pastoralists, Indigenous communities, government and non-government conservation agencies) and various regional bodies. The Australian Wildlife Conservancy manages the project from its base at Mornington Wildlife Sanctuary. Stage One of EcoFire (in 2007) covered 2,400,000 ha. Following the success of Stage One, in 2008 EcoFire was extended to cover 5 million hectares of the central and north Kimberley (see Figure 1).

This report provides an overview of the project during 2008. In particular, it presents an analysis of the success of the prescribed burning program at changing fire patterns during 2007 and 2008. The analysis demonstrates that EcoFire has met its targets and markedly changed fire patterns by

- limiting the extent of mid-to-late dry season (intense) fires
- increasing the number of unburnt vegetation patches through the project area

This change in fire patterns is expected to benefit biodiversity as well as short and longer-term pastoral production, reduce greenhouse gas emissions, and help protect cultural sites.

As well as the prescribed burning program, EcoFire helped project participants carry out some fire suppression work later in the year. During 2008 EcoFire also had an active communication program that sought to increase awareness about Kimberley fire management issues in the broader community.

EcoFire is administered by the Rangelands NRM Co-ordinating Group (RCG). It is guided by a Steering Committee made up of representatives from organisations and stakeholder groups with an interest in fire management in the Kimberley (the RCG; WA Department of Environment and Conservation; Fire and Emergency Services Authority; Department of Agriculture and Food WA; Kimberley Land Council; three Shires; Pastoralists and Graziers Association).

The project participants work closely with several partners during 2008, notably:

- WA Department of Environment and Conservation
- Fire and Emergency Services Authority
- Department of Agriculture and Food WA
- Kimberley Land Council





## Background - Fire Patterns in the Kimberley

Fire is a natural disturbance process in tropical savannas worldwide, including northern Australia, where the regular monsoonal climate promotes rapid grass growth, followed by a period of curing in the dry season, thus creating a highly flammable environment.

However, fire regimes have changed substantially since European settlement. Aboriginal fire management was probably dominated by small-scale fires, distributed patchily in time and space. In recent decades, the patterns have shifted towards extensive, relatively intense fire events in the mid-late dry season (July to December) that re-occur in the same area every 2-3 years. This change has occurred over large tracts of the northwest savannas (Vigilante 2001; Russell-Smith 2002; Edwards *et al.* 2003; Fisher *et al.* 2003; Russell-Smith *et al.* 2003).

### *Impacts on biodiversity*

Extensive fires remove spatial and temporal heterogeneity in vegetation. *Frequent* extensive fires also:

- Simplify the structure and diversity of the tree, shrub and grass layers in the woodlands (Bowman and Panton 1993; Williams *et al.* 1999; Liedloff *et al.* 2001; Rogues *et al.* 2001; Edwards *et al.* 2003; Crowley *et al.* 2009).
- Accentuate the impacts of weed and feral animals (Rossiter *et al.* 2003).
- Lead to increased soil loss, and higher sedimentation rates in rivers (Douglas *et al.* 2003).
- Degrade fire-sensitive vegetation in gullies and along creeks.
- Impact on fire-sensitive plants, including iconic species like Callitris Pine (Bowman and Panton 1993; Russell-Smith *et al.* 1998).
- Reduce the availability of keystone resources like flowers, fleshy fruits and grass seed (Crowley and Garnett 2001; Williams *et al.* 2003; Vigilante and Bowman 2004; 2004).

The changes in fire patterns also impact fauna. Particularly sensitive groups are:

- Species that live in the ground layer (small-to-medium sized mammals, grass-dwelling birds).
- Seed-eating species (small mammals, ants, many birds)
- Frugivores and nectarivores (Emus, flying foxes).
- Species that rely on rainforest patches or riparian vegetation (eg. Golden-backed Tree-rat; Purple-crowned Fairy-wren)

Some species have disappeared from vast tracts of northern Australia. For example - at least half of the tropical savanna's 40 small to medium sized mammals have undergone substantial declines in both distribution and/or density. The Gouldian Finch, once reported in flocks of thousands, now numbers fewer than 2500 breeding adults (O'Malley 2006). Of the 34 state and nationally threatened birds and mammals in the north, 24 list inappropriate fire as a key threatening process. Similarly, the Action Plan for Australian Birds (Garnett and Crowley 2000) lists 17 Critically Endangered, Endangered or Vulnerable species or subspecies for northern Australia, and for 12 of these fire is noted as a key threat.

### *Impacts on pastoral industry:*

Pastoral managers are also alarmed about the negative impacts of contemporary fire patterns on economic value caused by the short-term destruction of pasture, longer term changes to pasture quality (eg. by the replacement of perennial grasses with annuals), damage to fences and other infrastructure. Interviews carried out by the Kimberley Regional Fire Management Project (2000 – 2005) suggested that the annual cost of unplanned fires ranged from \$50,000 to \$400,000 per property (Palmer 2004). A study in Cape York Peninsula found the cost of an unplanned fire that





affected at least two-thirds of a 1,100 km<sup>2</sup> property (Kimberley properties are twice to three times this size) to be \$32,000 (Drucker *et al.* 2008).

*Impacts on Aboriginal communities:*

Aboriginal communities express concern over the effects of unplanned fires on cattle, pasture, and infrastructure, as well as damage to cultural sites and country, especially animals and plants that are important resources (Walsh and Cross).

***"There is more fire now, right across the plains, hill, ranges, you know, we lose a lot of bush medicine, bush plants, some of the wildlife gets caught, you know like the mammals and all the trees that we know from before we don't see now because they all burnt down, our grass we don't get the grass medicine like the lemon grass anymore because of wildfire, bushfire, when someone light it at the wrong time of the year - that fire can travel travel, travel all the way."***

(Transcript from an interview with Betty Walker, Tirralintji Community)

All sectors of the resident Kimberley community are anxious about the contemporary fire patterns, but modifying these patterns has proved difficult. One of the impediments to improved fire management has been the lack of coordinated on-ground action across multiple tenures. These issues, and recommendations for addressing them, are set out in a review commissioned by the Environmental Protection Agency:

(<http://www.epa.wa.gov.au/template.asp?ID=55&area=Reviews&Cat=Kimberley+Fire+Review>).



*Sammy and Betty Walker, Tirralintji Community, Mornington discuss burn plans with Richard Kingswood (AWC).*





## The 2008 EcoFire Project

Stage One of EcoFire (in 2007) covered 9 properties (2,400,000 ha) and involved different land tenures including pastoral and Aboriginal pastoral leases, land managed for conservation, and Unallocated Crown Land. Following the success of Stage One, in 2008 EcoFire was extended to another 7 properties to cover 5 million hectares of the central and north Kimberley, and thus encompasses the entire membership of the North Kimberley Land Conservation District Committee (see Figure 1).

The project participants work closely with several partners:

- WA Department of Environment and Conservation
  - General support, liaison, and technical input; prescribed burning on the EcoFire properties is closely integrated with burning on neighbouring DEC-managed land
- Fire and Emergency State Authority
  - General support, including training, technical input
- Department of Agriculture and Food WA
  - Pasture monitoring
- Kimberley Land Council
  - Fire planning and implementation, Yulumbu community
- Rangelands NRM Co-ordinating Group
  - Project administration

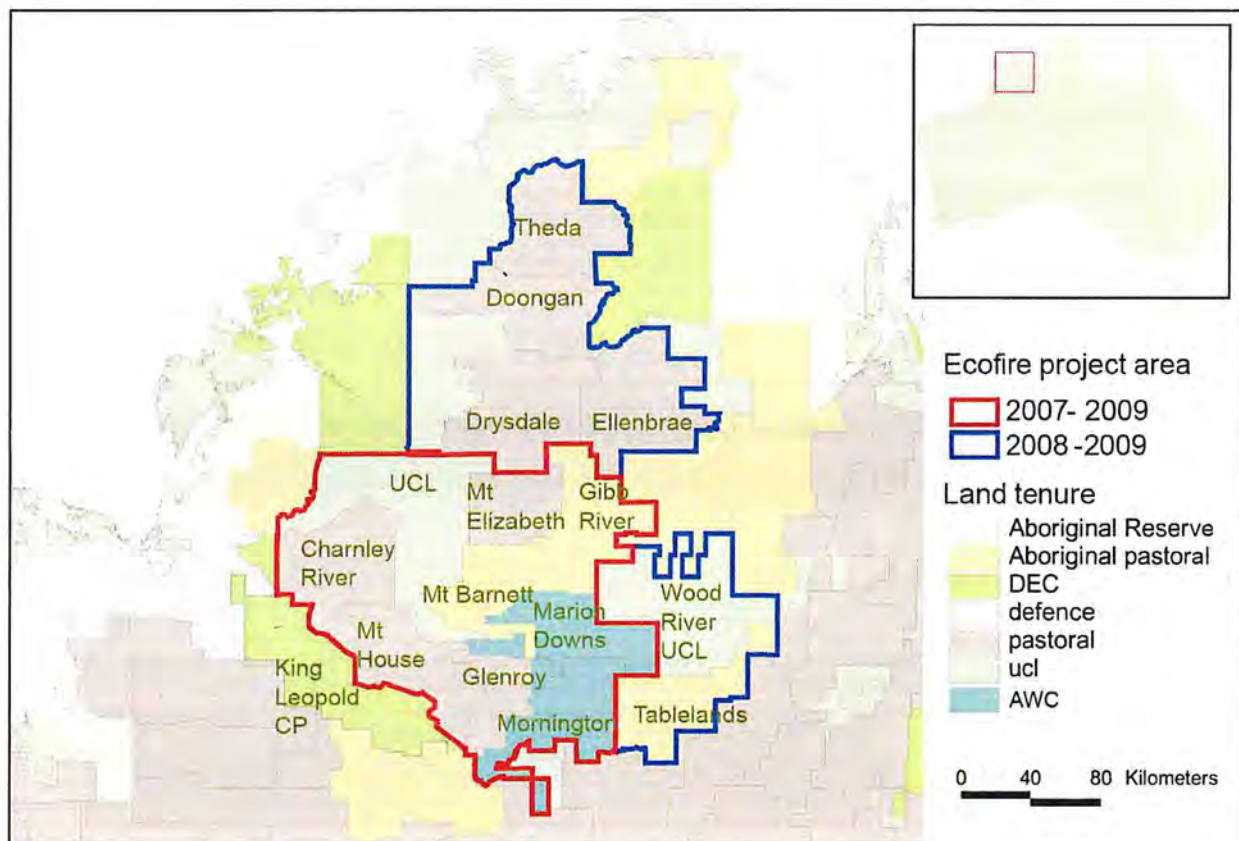


Figure 1. The properties involved in EcoFire. Note that fire management on Unallocated Crown Land (as well as national parks) is the responsibility of DEC, an EcoFire project partner.





## Prescribed burning operations

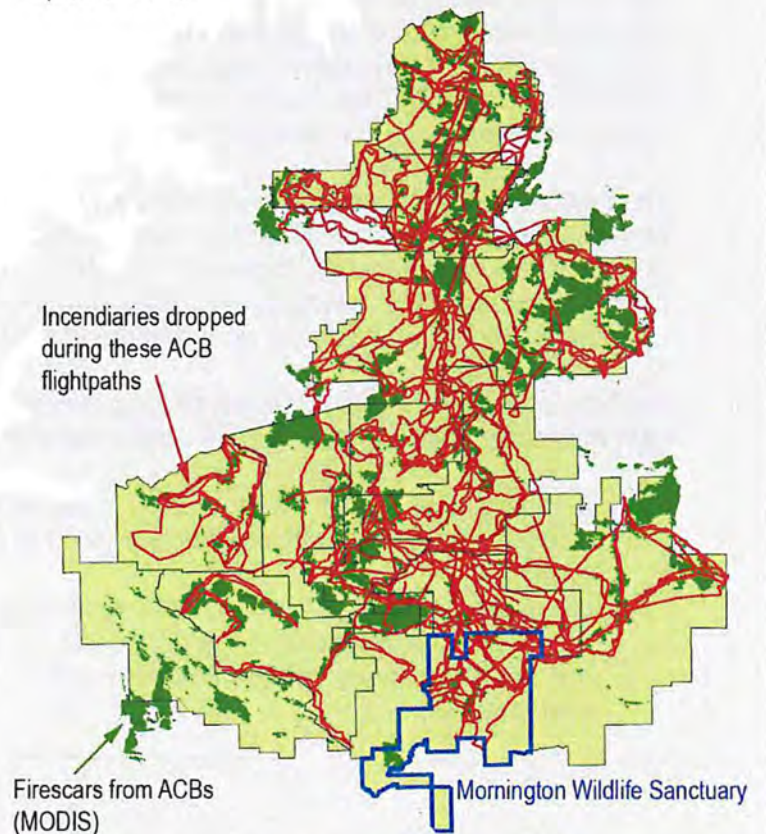
During April and May 2008, AWC staff worked with property managers to drop 30,000 incendiary devices along 24,000 km of flight lines. The flight lines were designed collaboratively by property managers with the explicit intent of co-ordinating strategic firebreaks in optimal locations regardless of property boundaries. Flight lines were flown at least twice, and sometimes five or even six times, in an iterative process that sought both to bolster firebreaks but also burn grass over time as it cured.

The aerial burning was supplemented by ground-based burning on almost all properties. In particular, the Yulumbu and Tirralintji communities carried out several days of burning on Tablelands Station, facilitated by the Kimberley Land Council (see "Yulumbu Fire Project Report June 2008").

*Figure 2. Flightlines and resultant firescars from prescribed burning program in 2008.*

## EcoFire Aerial Control Burn Flightlines in the Kimberley

April-June 2008





## Analysis of fire patterns

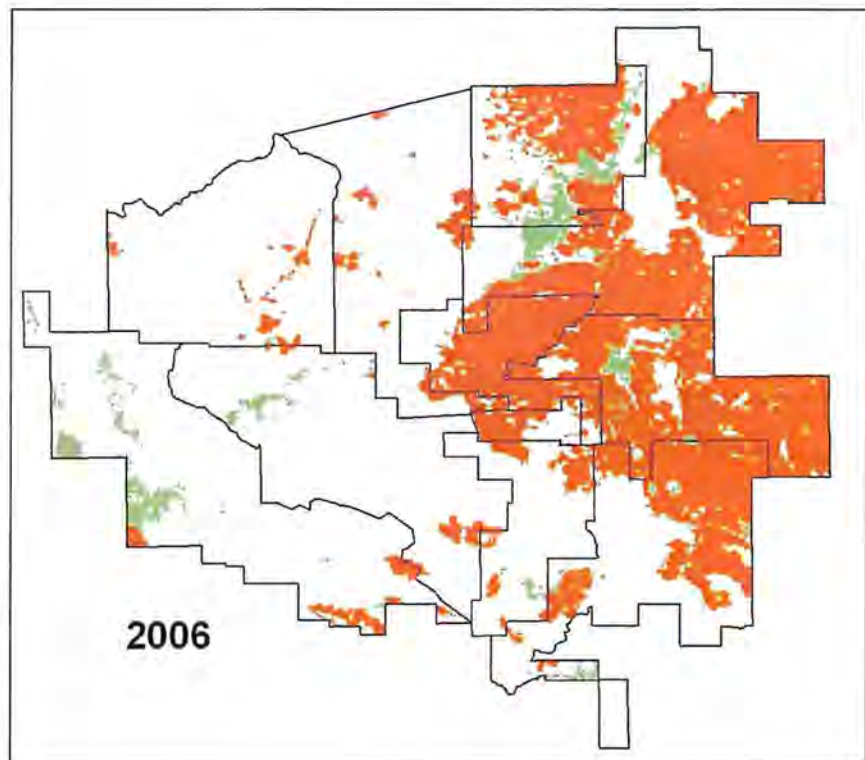
The principle aim of EcoFire is to change fire patterns by using a coordinated approach to fire planning and implementation. The following section presents evidence from satellite imagery to test whether the prescribed burning operation carried out by the project participants in the early dry season was effective at stopping the extent of mid to late dry season fires (July to December). The analysis uses MODIS-derived data from 2005 to 2008; archived MODIS-derived data is not available before 2005. The imagery available pre-2005 (NOAA-AVHRR) is of a coarser scale, making an among-year comparison of polygon size and shape impossible.

The first step in this analysis is to identify the key characteristics of fire patterns that Ecofire seeks to modify. Prior to coordinated management, extensive fires dominated annual burning patterns. Unburnt areas were generally those with insufficient fuel to carry a fire that year (normally because they burnt the previous year). After another wet season's growth such patches were usually capable of supporting an extensive fire in the following year.

For example, Figure 3 shows the fire affected areas (in green and red, for early and mid-late dry season fires respectively) during 2006 across the properties involved in EcoFire Stage One. Note:

- the majority of firescars were created in the mid to late dry season;
- individual properties (outlined in black) tend to either mostly burn in one year, or not burn at all;
- the average size of burnt (and unburnt) patches is large because it is dominated by a few very large fires that occur in the mid to late dry season; and
- the size of burnt and unburnt patches is highly variable (i.e. a few small and a few very large patches).

*Figure 3. Fire affected areas during 2006 in the project area are shown in green (early dry season fires) and red (late dry season fires). The extreme over-dispersion ('lumpiness') of firescars is typical of fire patterns in the region in the absence of management.*



**EcoFire aims to moderate this extreme 'see-saw' pattern by reducing the extent of single fires in a way that results in increased heterogeneity (or graininess) of unburnt and burnt patches across the landscape.**





To test whether EcoFire's prescribed burn program was effective in decreasing the size of unplanned fires and increasing the graininess of fires and unburnt areas across the region, we defined the change in patterns that we aimed to achieve in three metrics. These are:

***Proportion of fires that are early versus late:***

**Target 1.** A greater proportion of the fires each year should occur in the early dry season (i.e. before the end of June).

***Unburnt patches:***

**Target 2.** The density of unburnt patches in the project area should increase (ie. Number of unburnt patches per unit area).

**Target 3.** The average size and variance of unburnt patches should decrease.

Note that these targets relate to changing the *spatial distribution* of fires in any one year. Equally important is to change the *frequency* of fires, and thus to increase the availability of old-growth vegetation (ie. 3+ years) across the landscape. Testing for this change in patterns requires consistent fire management for several years. After two years of prescribed burning, we are unable to examine adequately the impact of EcoFire on the availability of old-growth vegetation. However, we present a similar analysis for Mornington (where fire management is in its 5<sup>th</sup> year) in the next section).

The sequence of maps in Figure 4 show the extent of fires that occurred in the whole Kimberley region for each of 2005 and 2006 (pre-EcoFire) plus 2007 and 2008 (during EcoFire). The transition between 'Early' and 'Late' fires is determined by the date of the last significant rain. Rainfall graphs appear in each figure for each year.

A simple visual inspection of this map sequence suggests the following changes to fire patterns in the EcoFire project area following the prescribed burning program:

- a substantially greater proportion of fires resulted from prescribed burns (early) rather than unplanned (late) fires;
- mid to late dry season fires during 2007 affected a large proportion of the Kimberley (greater than the proportion affected within the Ecofire project area);
- mid to late dry season fires within the project area in both years were 'contained' (i.e. individual fires were smaller in extent) compared with fires outside the project area; and
- prescribed burns within the Ecofire project area interacted with, and stopped, unplanned fires in several locations.

A numerical analysis of the three metrics listed above is given after Figure 4.



Steve Murphy (Mornington) lighting a prescribed burn



Figure 4a. Early and late dry season fires for 2005.

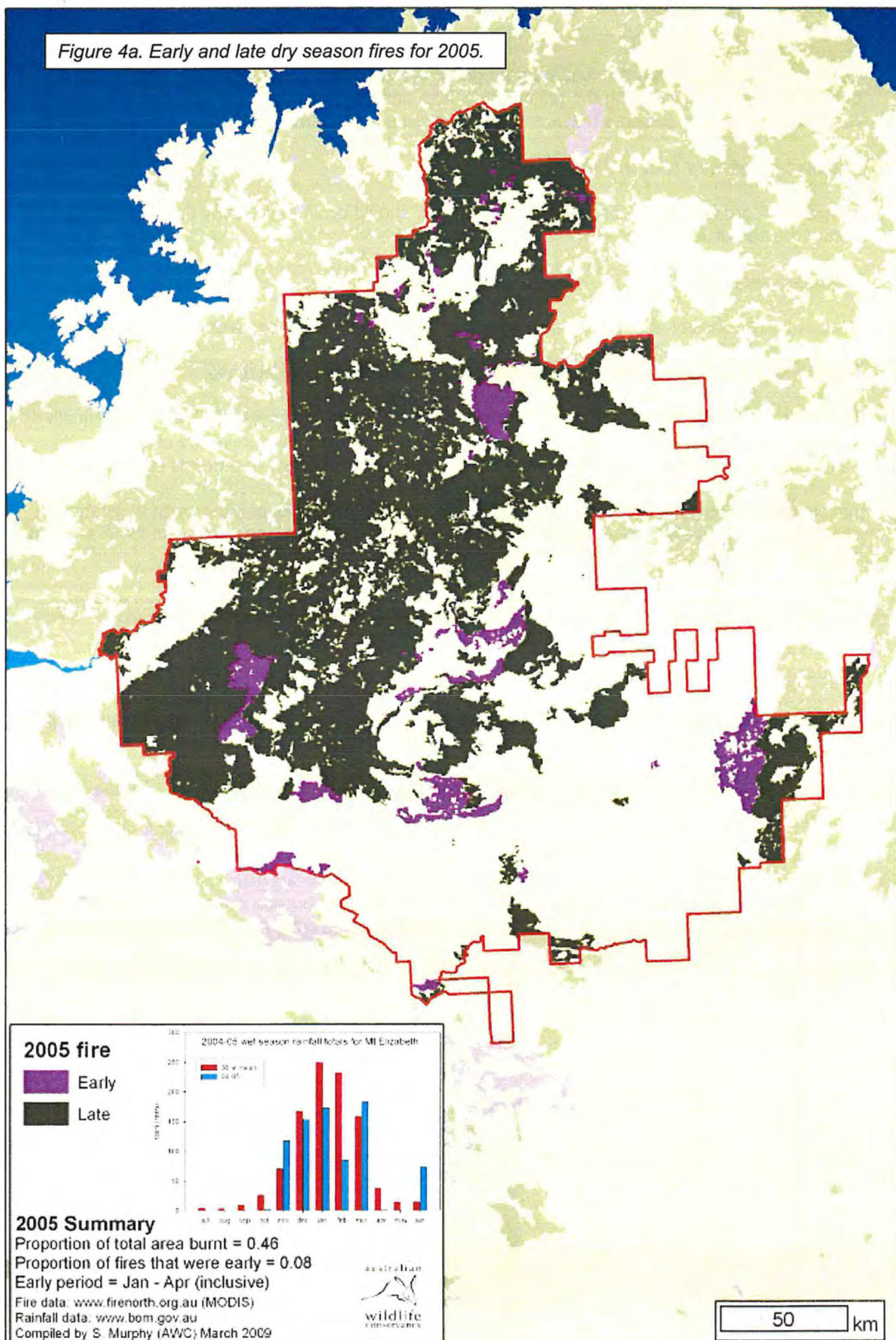




Figure 4b. Early and late dry season fires for 2006.

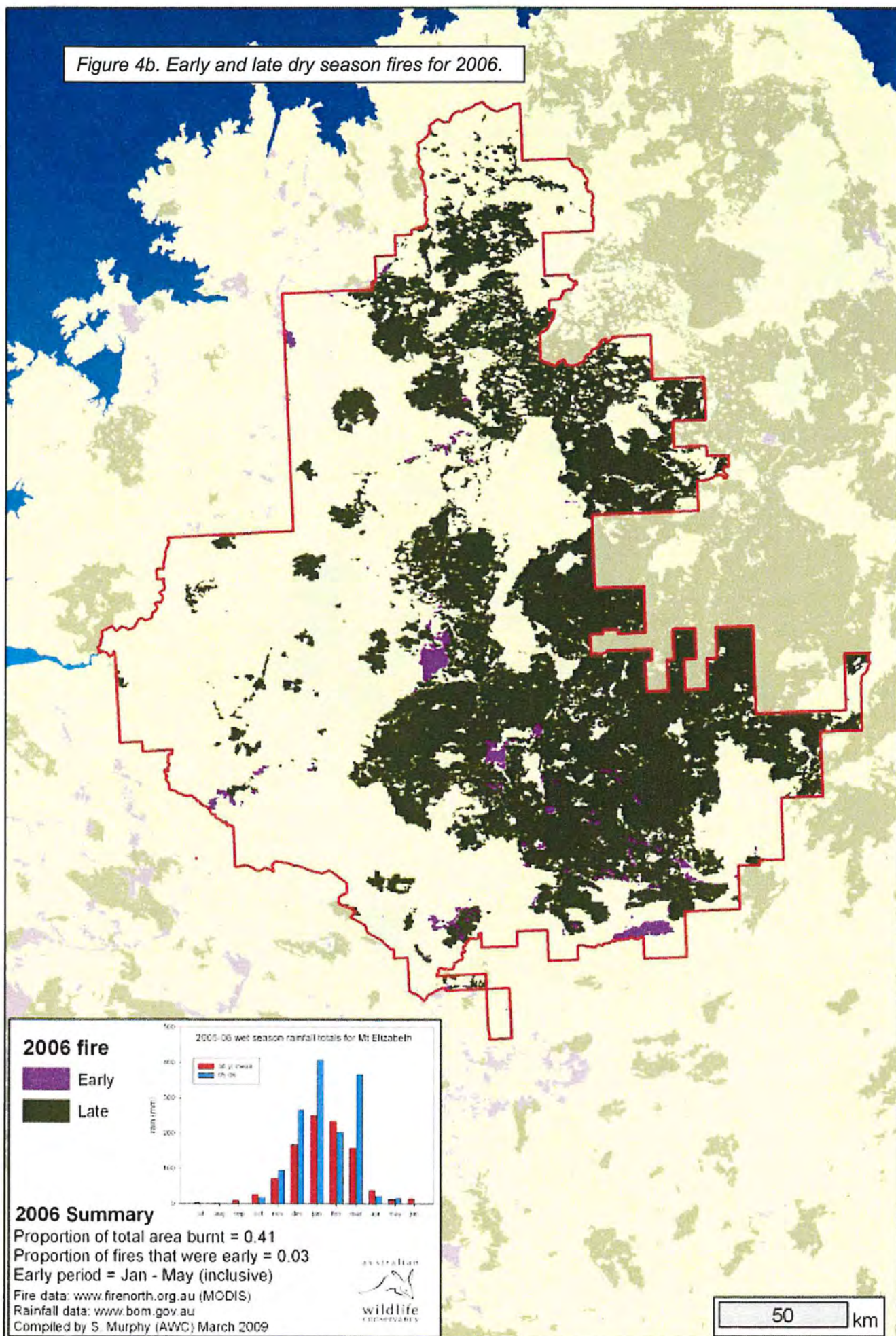




Figure 4c. Early and late dry season fires for 2007.

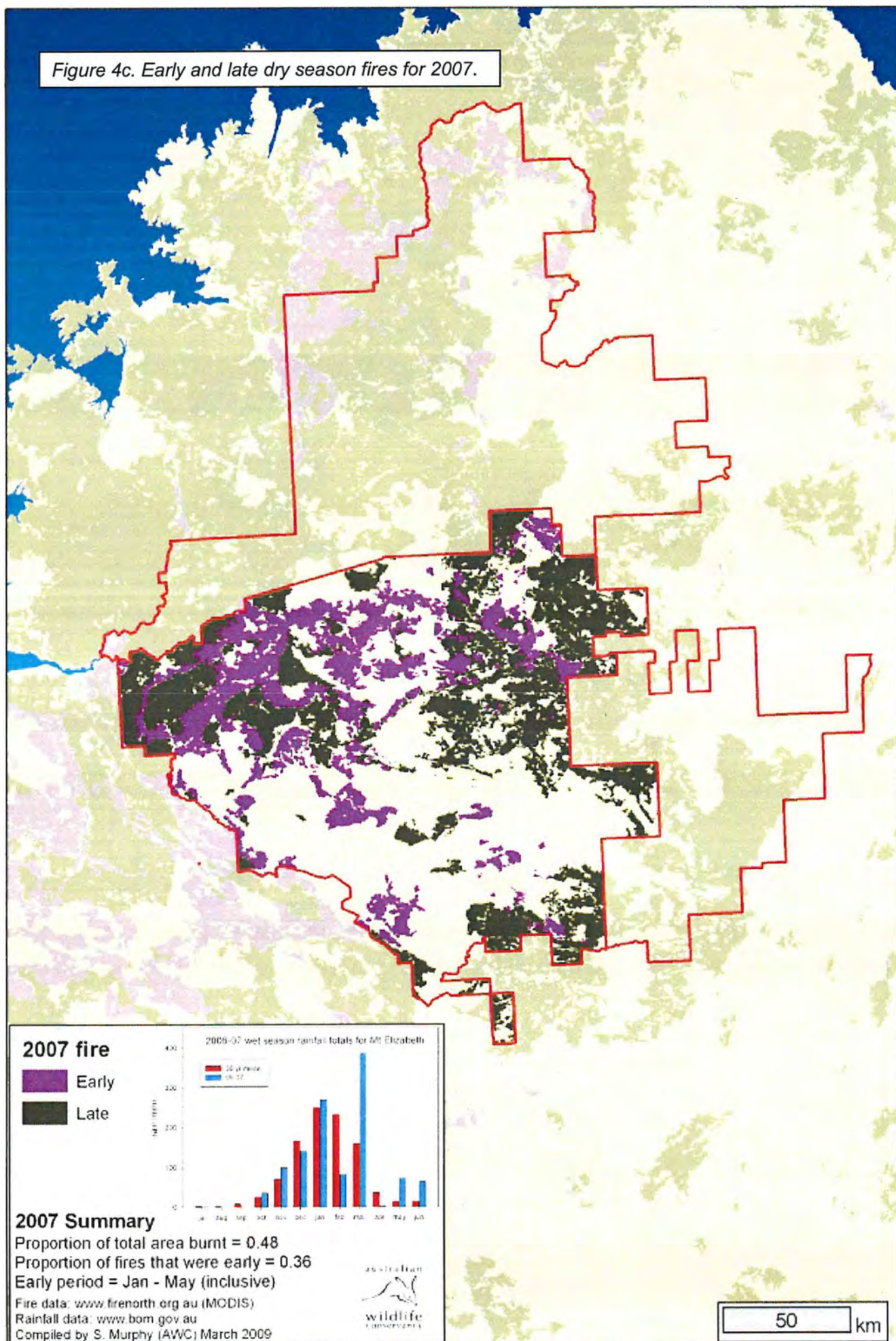
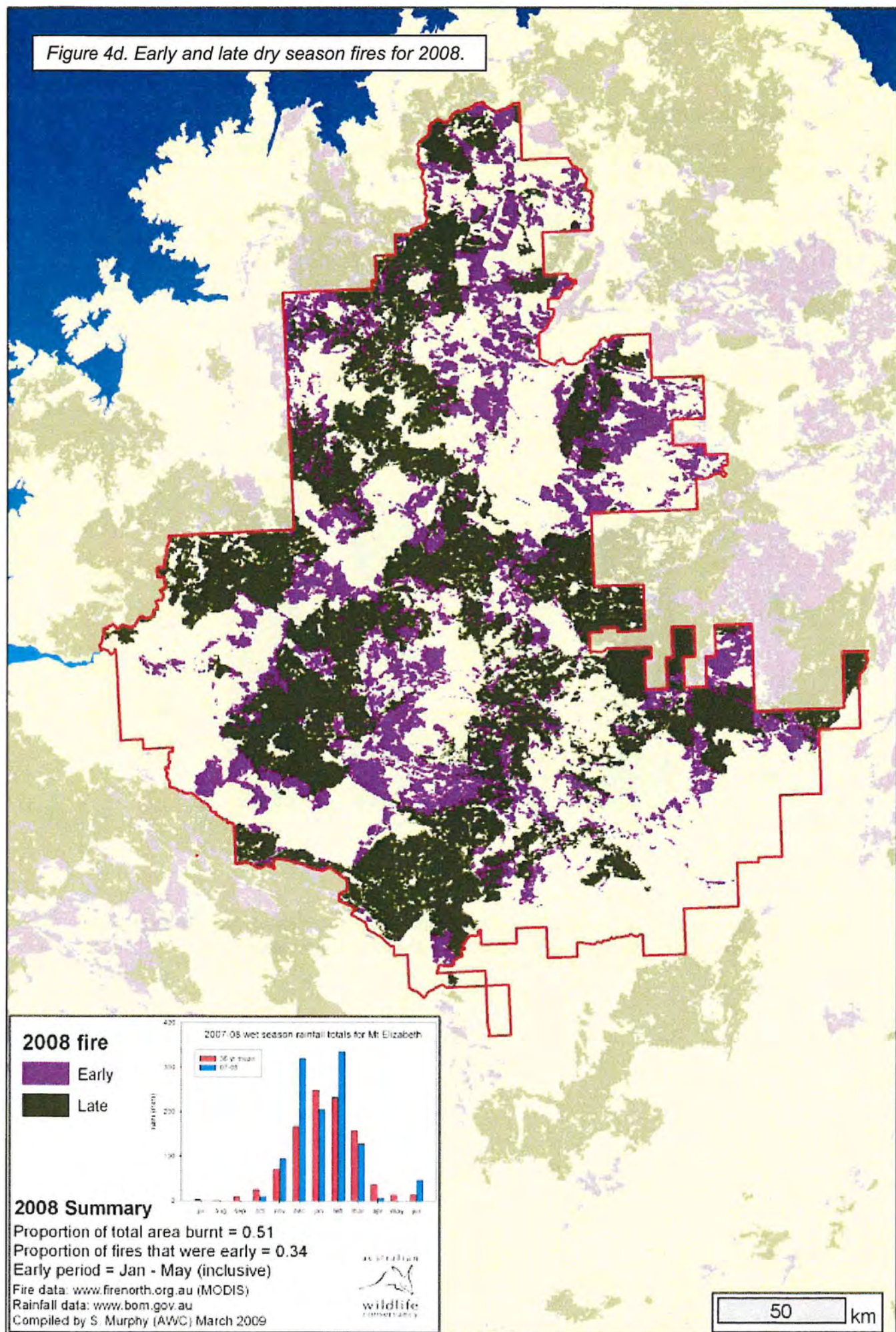




Figure 4d. Early and late dry season fires for 2008.

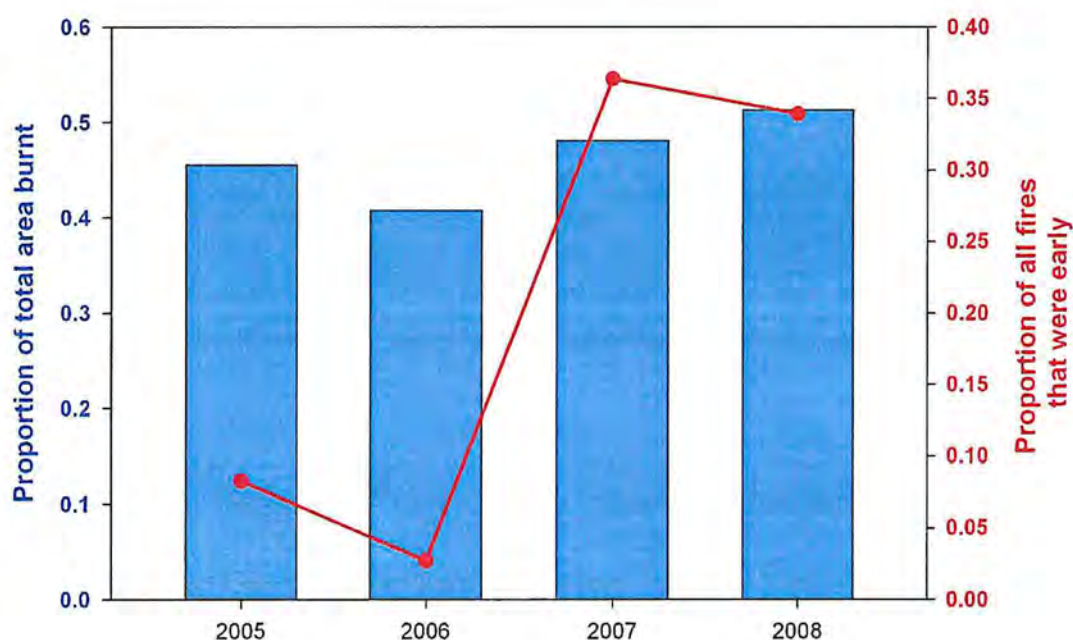




**Early versus late fires:**

**Target 1.** A greater proportion of the annual fires should occur in the early dry season (ie before the end of June).

In the four years of 2005 to 2008, a similar proportion of the study area burnt each year 41-51%; see the blue bars in Figure 5). However, there is a marked increase in the relative proportion of early (compared to late burns) in the two years of EcoFire. Before EcoFire (2005-2006), early dry season fires made up less than 1% of the annual total burnt area. That figure jumps to 36% and 34% in 2007 and 2008 respectively (see red line in Figure 5).



**Figure 5.** The total area burnt (blue bars) and the proportion of all fires that were early (as opposed to late) dry season fires in the EcoFire project area.



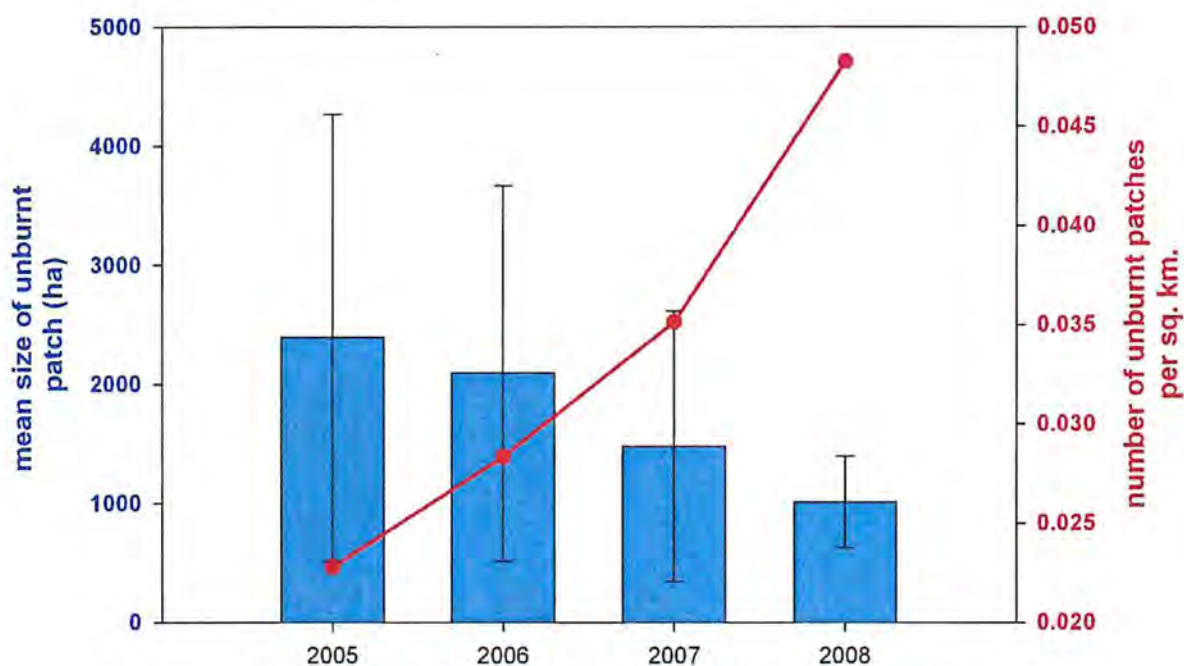
**Unburnt patches:**

**Target 2.** An increase in the density of unburnt patches in the project area, coupled with

**Target 3.** A decrease in the average size and variance of unburnt patches.

The density of unburnt patches has increased over the two years of EcoFire (see red line in Figure 6). There are over twice as many unburnt patches per unit area at the end of 2008 compared with the end of 2005.

The mean size of patches, and the variability in patch size, has also markedly reduced, indicating a more even spread of smaller burnt and unburnt patches through the study area, in contrast to the over-dispersed or 'see-saw' pattern of the previous two years. This pattern of patches is more likely to limit the extent of unplanned fires.



**Figure 6.** The size of unburnt patches (blue bars show mean and standard error) and the density of unburnt patches (red line) in the EcoFire project area.

**This analysis demonstrates that EcoFire's prescribed burn program resulted in a substantial change to spatial fire patterns in both years of implementation: we achieved clear improvements in our target metrics.**

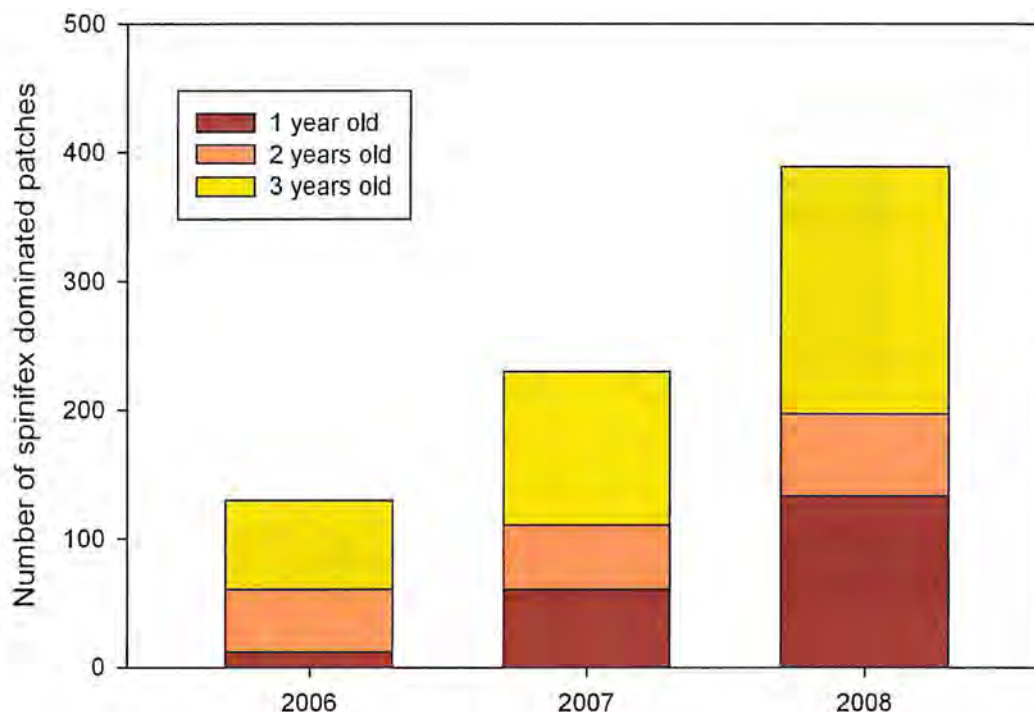




### Increasing the availability of old-growth vegetation

The analysis presented so far demonstrates a substantial change in the *spatial* pattern of firescars within a year. However, we also need to influence the *age* distribution of vegetation patches in order to increase heterogeneity of vegetation (and faunal) succession, and provide opportunities for species that require long-unburnt vegetation. Over most of the Kimberley, vegetation is less than three years old because it is burned on a 1-2 year cycle. This impacts on any species with a lifecycle longer than 2 years (such as *Callitris* and several spinifex species), or species that depend on 'old-growth' habitat for at least part of their life cycle (such as small mammals and Gouldian Finches).

We are unable to test whether EcoFire has resulted in a shift in the age distribution of vegetation patches, because the prescribed burning program has only operated for two years. However, we can begin to examine patterns from Mornington, where fire management with similar objectives has operated for 5 years. One of the management targets there has been to increase the availability of 3+ year old spinifex, because older spinifex produces greater seed yields, and the seed is an important resource for many animal species. Figure 7 shows that the number of patches of spinifex that are one, two and three plus years old (as opposed to 0 years old, or just burnt), for each year between 2006 and 2008, has increased.

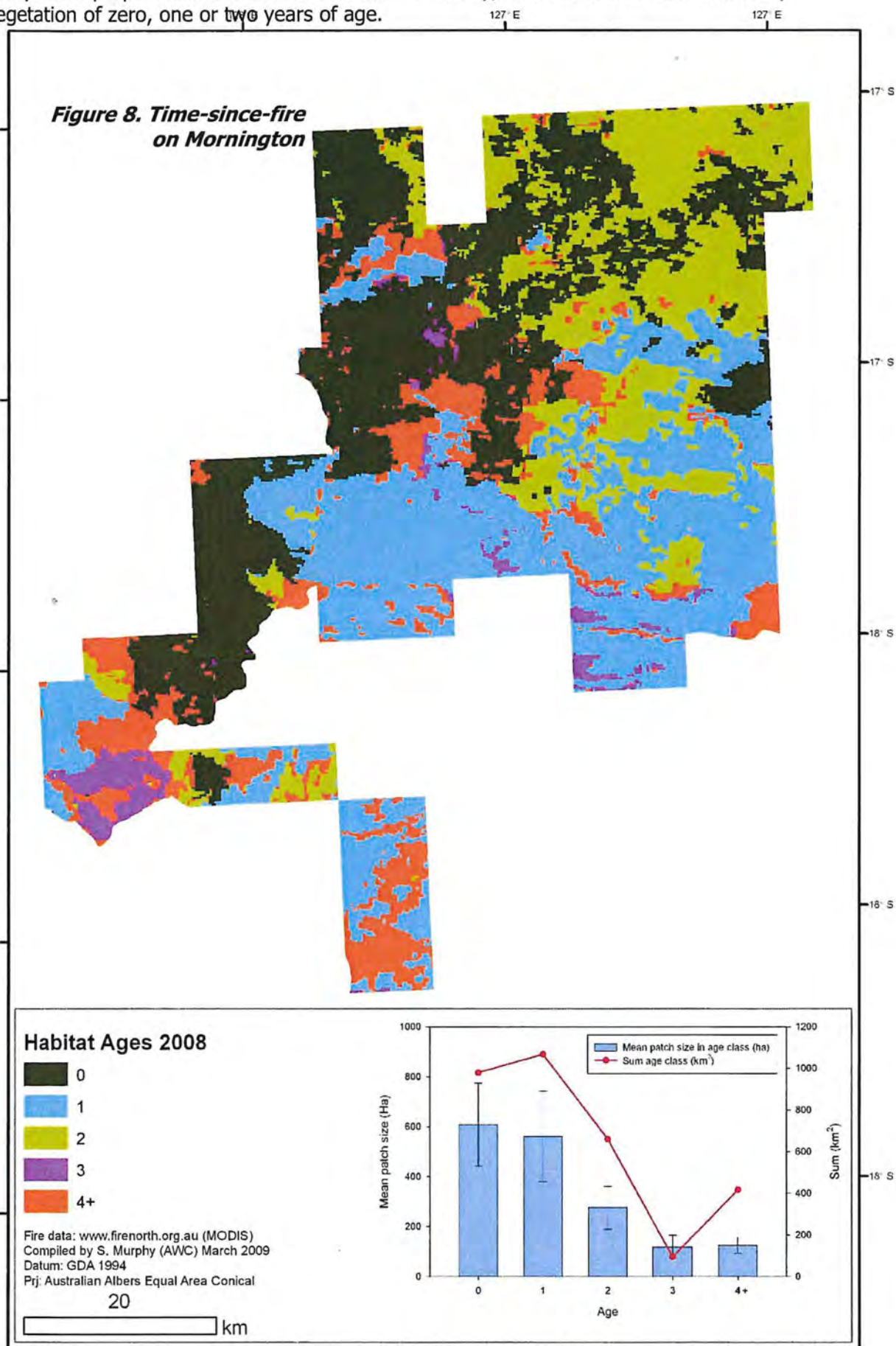


**Figure 7. Distribution of spinifex patches of different ages between 2006 and 2008 on Mornington Wildlife Sanctuary.**





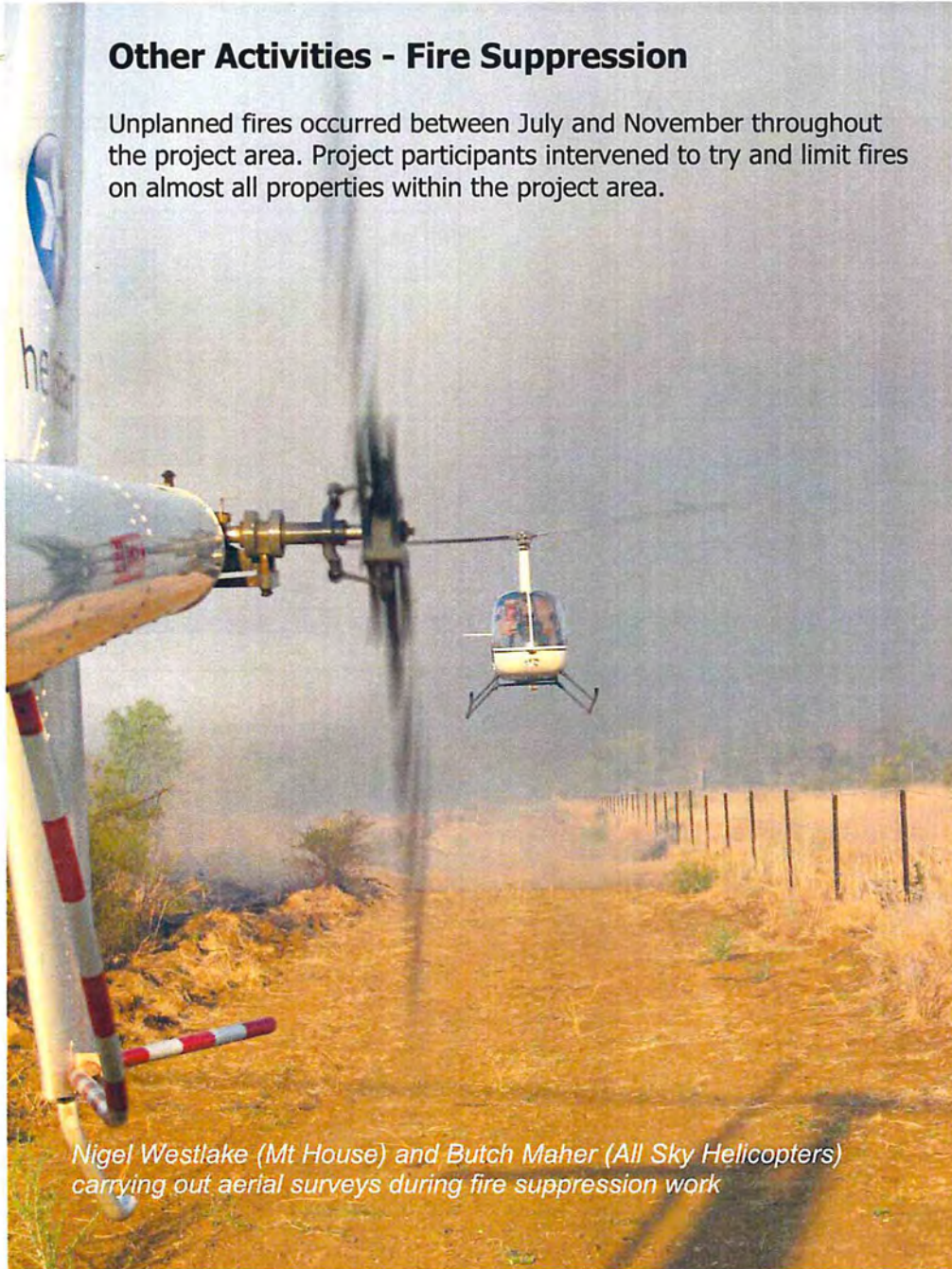
The net effect of these patterns is an increase in the spatial and temporal heterogeneity of vegetation across the landscape (Figure 8). Mornington's time-since-fire map is now patchier than many other properties in the central and north Kimberly, which tend to be dominated by vegetation of zero, one or two years of age.





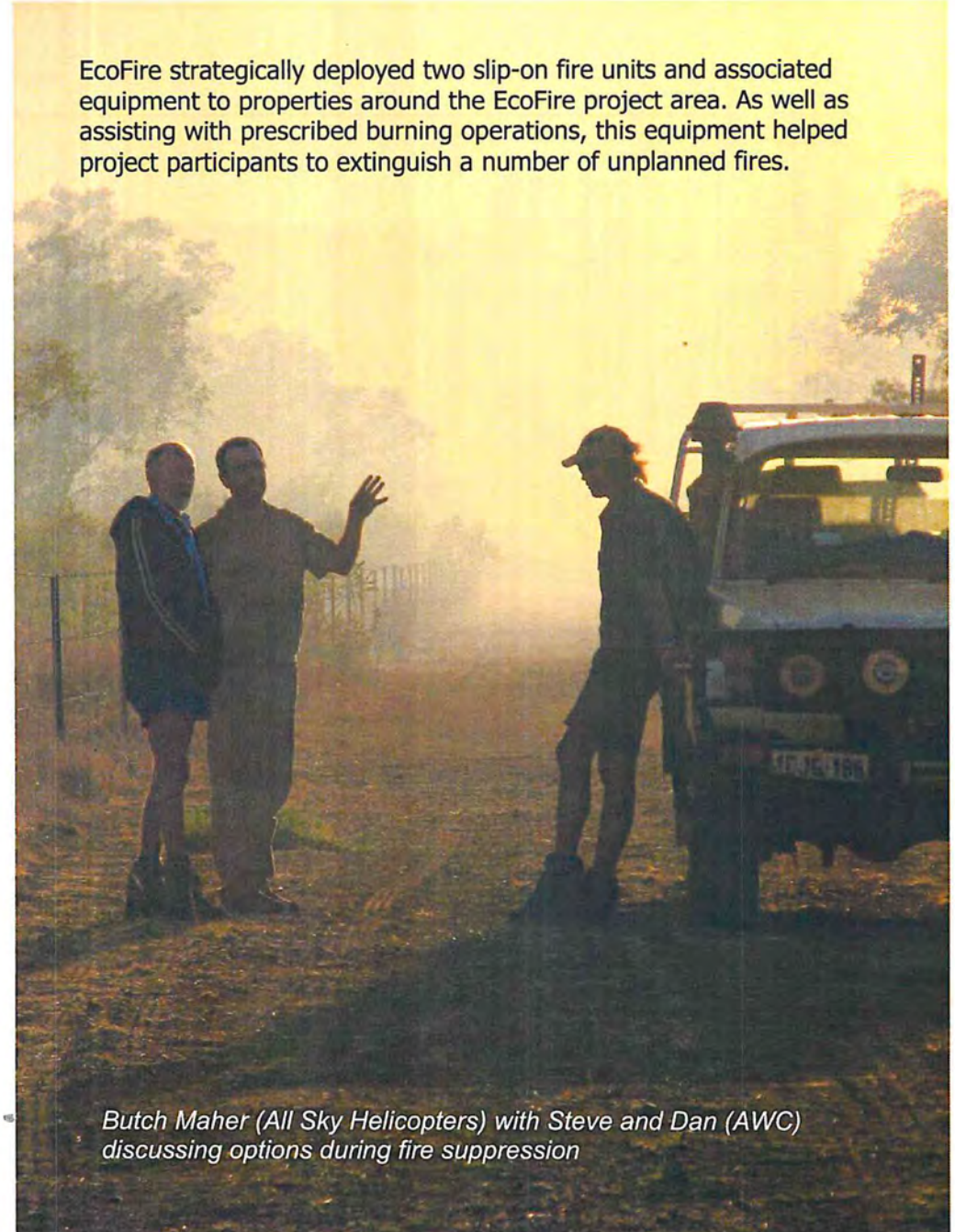
## Other Activities - Fire Suppression

Unplanned fires occurred between July and November throughout the project area. Project participants intervened to try and limit fires on almost all properties within the project area.



*Nigel Westlake (Mt House) and Butch Maher (All Sky Helicopters) carrying out aerial surveys during fire suppression work*

EcoFire strategically deployed two slip-on fire units and associated equipment to properties around the EcoFire project area. As well as assisting with prescribed burning operations, this equipment helped project participants to extinguish a number of unplanned fires.



*Butch Maher (All Sky Helicopters) with Steve and Dan (AWC) discussing options during fire suppression*

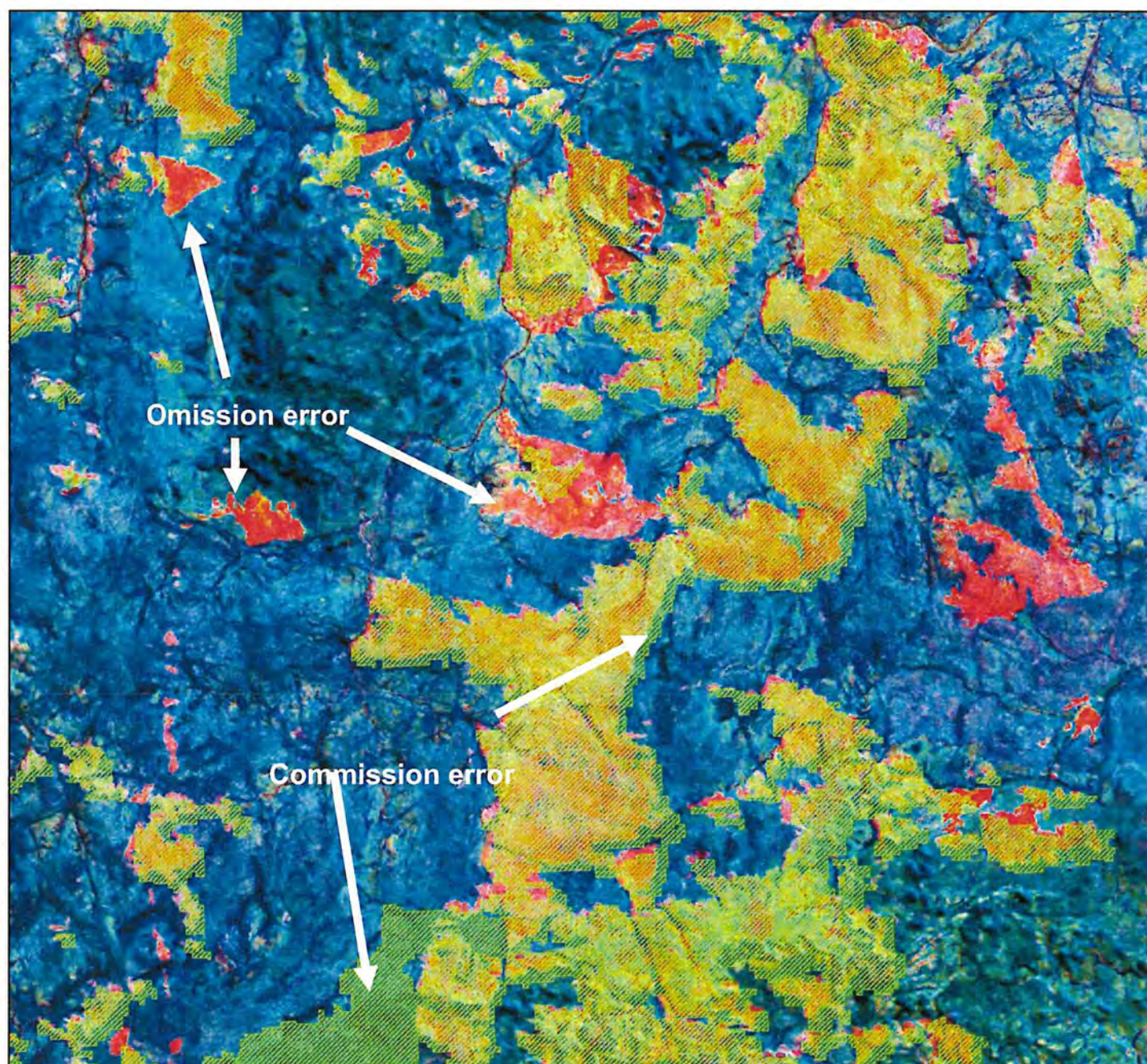




## Other Activities - Improving the satellite-based firescar mapping

The analyses of fire patterns presented here rely on imagery collected from NASA's MODIS satellites. These collect frequent images of the earth's surface in 2330 km swaths. MODIS imagery has a resolution of 250m. The imagery is processed by hand and made available in a processed form for GIS analyses by North Australia Fire Information <http://www.firenorth.org.au/>. Due to land surface anomalies and the size of the area being mapped commission and omission errors can occur (Figure 9; <http://www.firenorth.org.au/nafi/app/init.jsp>). Nevertheless, such data is perfectly suited for analysing fire patterns at a regional scale.

**Figure 9a. MODIS-derived firescar maps (in green hatching) overlain onto a Landsat image, demonstrating commission and omission errors.**







In contrast to MODIS, NASA's Landsat 5 satellite collects images every 16 or so days in 185 km swaths. These images have a resolution of approximately 30m. AWC has the capacity to process and interpret Landsat 5 images to generate more accurate, higher resolution fire scar maps. 2008 has been mapped using Landsat 5 imagery, and the intention is to map previous years so that more accurate, longer-term analyses can be performed.

***Figure 9b. Landsat-derived firescar maps (in green hatching) overlain onto the original Landsat image, demonstrating a much better agreement between mapped areas and the image. In addition, the edges of firescars are more finely aligned with a high-resolution Landsat image.***







## Other Activities - Yulumbu Fire Project

In April 2008 the Kimberley Land Council, with funding from the EcoFire Project, facilitated a fire management planning workshop at Imitji community with the Traditional Owners for Tableland Pastoral Lease (Yulumbu).

A Fire Management Plan was developed which reflects the aspirations of the Traditional Owners for Yulumbu to look after country through fire management. Resources involved in the fire management planning process included fire scar & frequency maps, topographic maps and satellite imagery. These maps were provided by AWC. The Plan (which has been provided to the Traditional Owners) incorporates cultural aspects and indigenous management of fire into a pastoral-based fire management plan. It sets out why, where, when, how and who is going to do controlled burning. The Plan included a Burn Plan for 2008, which incorporated the primary objective of the EcoFire Project, namely, to reduce the frequency and extent of mid to late dry season fires in the central Kimberley for the benefit of biodiversity, pastoral and cultural values. The following prescribed burning activities were carried out:

- Along Boab Creek between Reed Springs and the Little Fitzroy River
- Between Tullewa Creek and the Little Fitzroy River



## Other Activities - Pasture monitoring program

To examine the interaction between prescribed fire and grazing by cattle, the Department of Agriculture and Food established seventeen sites on five properties across the EcoFire project area between April and June 2008. Sites were established on a range of highly to moderately productive soils with varying fire history and grazing pressures, in consultation with the land holders. Pasture quality and quantity information, soil moistures, land condition and species composition data were collected from each site during April/May/June, and then again in the late dry season. Data collection will continue during 2009.



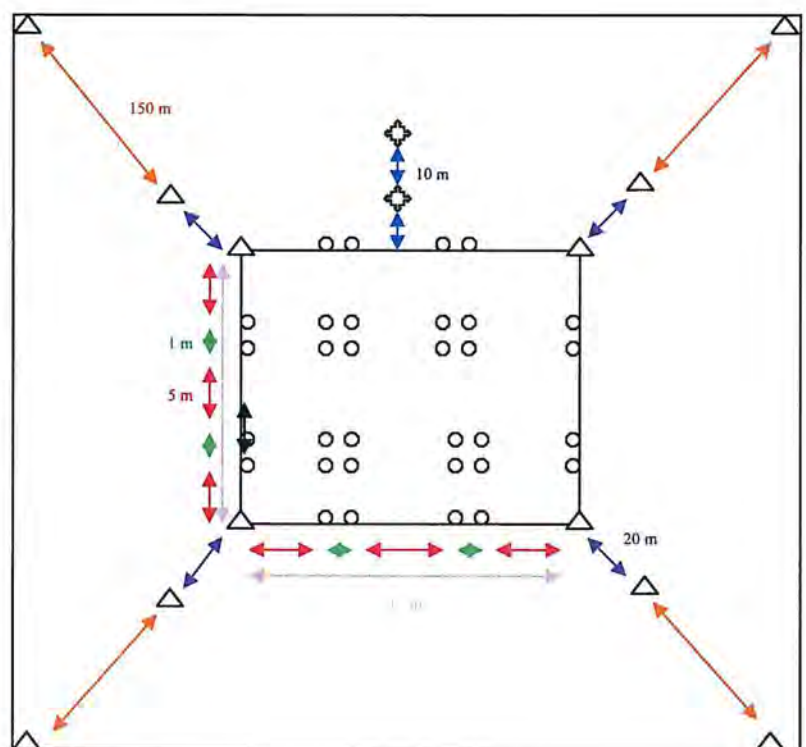
Star picket



Full length fence dropper



Half length fence dropper







## Other Activities - Communications outputs

During 2008, we broadened our communication strategy to include a range of activities, summarised below:

- An extensive qualitative survey about fire awareness and perceptions from tourists and transient workers. The purpose of the survey was to understand the specific knowledge gaps about fire in these target groups; this will allow us to design more effective information products (see separate report: Axford and Legge, 2008; "EcoFire - A survey of public perceptions about fire in the Kimberley, WA")
- A trial schools program at the community schools in the project area. The students were presented information about fire and EcoFire in a lively, interactive way, and designed posters and logos for the project.
- Newspaper articles
  - The Muddy Waters June 2008
  - Broome Advertiser October 2008
  - Western Australian October 2008
- Popular articles in
  - Savanna Links 2008
  - Northern Pastoral Memo September 2008
  - The Landcare Magazine December 2008
- Five radio interviews –with Sarah Legge, Richard Kingswood and Cait Westlake.
- Development of an EcoFire webpage on
  - The Australian Wildlife Conservancy website.
  - The Savanna Explorer website
- Presentations at:
  - Kimberley Fire Forum
  - North Australia Fire Manager's Forum
  - Visitor interpretation program at Mornington
  - Agricultural Shows and Markets



*Gill Basnett (AWC) at the Wananimi School, where students designed posters and logos for EcoFire*

## Awards

- EcoFire won the 2008 Western Australian Overall Environment Award and the Community Group Achievement Award.
- EcoFire report to be featured on the Global Restoration Network website: Highly Commended Project (Young Project with Promise) by the Society for Ecological Restoration International







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