



# Aboriginal fires in monsoonal Australia from historical accounts

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## Abstract

**Aim** Traditional management of fire in the world's savannas is of vital interest for contemporary management. This paper reviews the nineteenth century literature on Aboriginal application of fire in the Northern Territory of northern Australia, and relates the other studies of the historical record for the whole savanna region of northern Australia. The aim is to provide a comprehensive picture of historical traditional fire practices.

**Location** Northern Australia tropical (monsoonal) savanna region.

**Methods** All available journals of explorers in the nineteenth century in the Northern Territory were reviewed and analysed.

**Results** Twenty-five explorers' journals were identified and reviewed. Fifteen yielded information on aboriginal use of fire. Two hundred and six observations were recorded in the journals. Of these, 100 were of active landscape fires and fifty-two were of burnt landscapes. Other observations were discarded as they did not contribute to the understanding of traditional use of fire. The results were generally consistent with other studies completed in Queensland and Western Australia.

**Main conclusions** The historical record shows that Aboriginal people in the 'Top End' of the Northern Territory of Australia commenced burning early in the dry season, within weeks of the last rains, and continued throughout the dry season. Burning stopped only when the wet season rains prevented further burning. Little if any wet season burning was carried out. This picture is at variance with a previous historical study for the Northern Territory, but consistent with that for the whole northern Australian savannas using equivalent historical sources. The findings are important for ecological management of the savannas of northern Australia. Recent deleterious changes to the biota and landscape have been attributed to recent changes from traditional fire regimes. A reinstatement of traditional practices is proposed.

## Keywords

Burning; historical accounts, landscape change; land management; savanna; species declines; traditional practices.

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## INTRODUCTION

In order to manage the savanna landscapes of today, it is necessary to know how they were managed in the past, what

the fire regimes were and how they have changed, what aspects to manage for, and how relevant earlier management regimes are to current management intentions. Material evidence of past fire regimes (in contrast with evidence of fire) is rare (Bowman & Panton, 1993), so other sources of information must be relied upon to interpret the past.

Fire is an integral component of the savanna landscapes of northern Australia. Traditional burning practices may have persisted for thousands of years (Head, 1996). Fire regimes

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imposed over such time periods are certain to have substantially influenced the vegetation and other biota. Changes from traditional fire regimes, as recent as the last two or three decades of the twentieth century, have been implicated in downward trends in vegetation structure and composition (Russell-Smith & Bowman, 1992; Bowman & Panton, 1993; Price & Bowman, 1994; Russell-Smith *et al.*, 1998), in serious reductions of populations and ranges of granivorous birds across the northern Australian savannas (Franklin, 1999), and in loss of biodiversity, and in downward trends in savanna condition generally in Australia (Woinarski *et al.*, 2001).

Traditional fire practices, however, have been the subject of vigorous debate (Singh *et al.*, 1981; Horton, 1982; Flannery, 1990; Head, 1996; Benson & Redpath, 1997; Bowman, 1998), with much of the debate held in the absence of critical reviews of the historical record, that is in the absence of what traditional practices were likely to be.

Four studies of observations of Aboriginal fires in the northern Australian explorers' journals have been published [for the whole of Queensland (Fensham, 1997); for Cape York Peninsula (Crowley & Garnett, 2000); for the Kimberley of western Australia (Vigilante, 2001); and a short one for part of the 'Top End' of the Northern Territory (Braithwaite, 1991)]. They have served to correct the earlier views that Aboriginal people burnt the tropical savannas mostly in the early dry season (Stocker & Mott, 1981). The Queensland and Western Australian studies reviewed the complete historical record, whereas the Northern Territory study reviewed only some records (six in all) and neglected explorers, such as Gregory, who had been noted for their observational diligence (Fensham, 1997).

The Western Australian and Queensland studies each showed that anthropogenic fires in the nineteenth century were more or less evenly distributed through the dry season. The Northern Territory study also recognized a long fire season, but the limited data base led to the erroneous interpretation of a gradual increase in burning frequency from the beginning of the dry season in March or April, to peaks of burning in July and October, a trough in September, and decreased burning towards the wet season. This interpretation, while at variance with the other historical studies, has been cited as illustrative of historical practices (Andersen, 1996; Head, 1996; Russell-Smith *et al.*, 1997; Bowman, 1998).

European explorations around the north coast of Australia began in the 1600s, but did not intensify until the early 1800s, when sea-going journeys to map the coast and explore the country were conducted. English colonial settlements were established along the coast from the 1820s. The first exploration which traversed the continent from south to north was that of John McDouall Stuart in 1862, that from the east coast to the north coast by Ludwig Leichhardt in 1845. Explorations continued intermittently for the next 40–60 years. By this time much of the country had been taken up by pastoralists and miners.

In order to provide a comprehensive review for the Northern Territory tropical savannas, the journals and

historical records of explorers from 1801 to 1896 in the northern half of the Northern Territory are reviewed and analysed. Then the historical record of Aboriginal landscape fires prior to European settlement across the whole Australian monsoon savanna region is considered and a synthesis proposed.

## STUDY AREA

The study region is the Australian monsoonal tropical savanna (Russell-Smith *et al.*, 2000), half of which lies within Queensland, one-third in Northern Territory and one-sixth within Western Australia.

Savannas are generally characterized by a continuous or semicontinuous grassy landscape, with or without trees, and subject to frequent fire (Solbrig, 1993). Australian savanna formations include tall forest, forest, woodland, open woodland and grassland, and inliers of smaller vegetation associations such as monsoon rainforest, and sandstone heath vegetation (Bourliere & Hadley, 1983; Dunlop & Webb, 1991). The northern savanna varies physiognomically and structurally across its range. Major vegetation units are shown in Fig. 1.

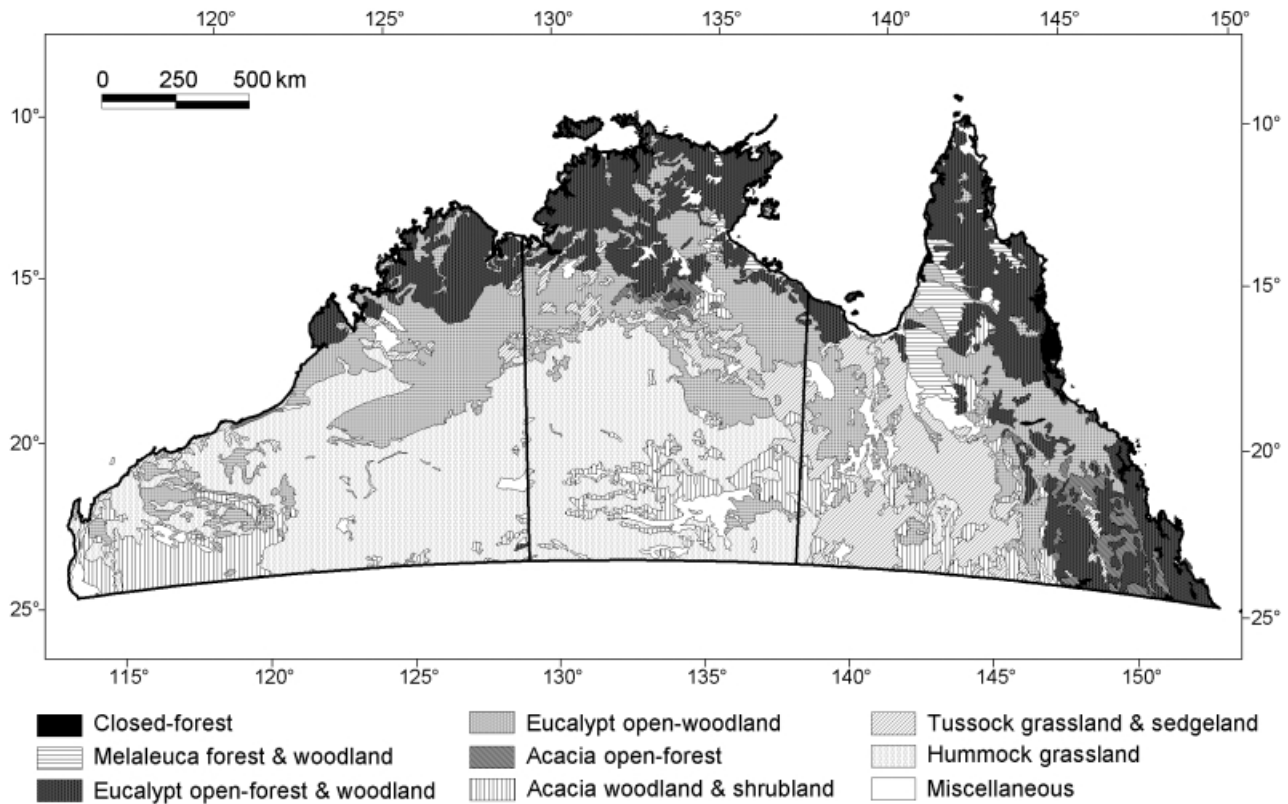
The Northern Territory region of study extends from the north coast (9.5° S) to between 18.5 and 20° S (Fig. 1). The region is subject to a tropical monsoonal environment which experiences distinct wet and dry seasons, with little to no rain for at least 6 months of the year. Annual average rainfall, which ranges from 1600 mm per annum in the north to 300 mm in the south-east of the Northern Territory savanna region, is highly variable from year to year. The beginning and end of the wet seasons are also very variable from year to year. The Northern Territory lies in the central portion of the map, with Queensland to the east and Western Australia to the west.

## METHODS

Explorers from the earliest exploration period of the 1600 s until the late 1800 s were identified from works by historians (Bauer, 1964; Powell, 1982; Favenc, 1983) and from library searches (Table 1). Journals were included where daily journal entries and reliable indications of their locations were made by the explorers. In some few cases, locations recorded by the explorers were inaccurate by up to 2° of longitude (because of their instruments), and were thus corrected for accuracy. Records were included where they were between 129° and 138° East, and north of 18° South, which coincides approximately with the 600 mm annual isohyet, or the general limit of the savanna region. Coastal explorers were included where they sailed between the two meridians.

Records of fire were categorized into five possible types, modified from those used by Vigilante (2001). These are:

1. campfires – active and extinct,
2. ambiguous fires – where the observer could not determine the type of fire,



**Figure 1** Vegetation types of northern Australia savanna region (reproduced with permission, Parks and Wildlife Commission of the Northern Territory).

3. active fires – as landscape fires, but not defensive or repelling fires lit to ward off the invaders,
4. fires lit specifically to repel, intimidate or attack the explorers, and
5. burnt vegetation – all burnt country (regardless of age of recent or old burns, which was never mentioned by the explorers).

Only the data on active landscape fires and burnt vegetation (categories 3 and 5), lit by people during the normal course of their daily activities, have been analysed. Other observations of fires could not be verified as lit by Aboriginal people in their traditional manner. Lightning may light fires in the late 'build-up' at the commencement of the wet season, during November and December (Stocker, 1966; Braithwaite & Estbergs, 1985), although only one study of a small area has been completed which demonstrates a link between lightning frequency and fires in northern Australia (Bowman, 1988). There being no means to eliminate such fires from explorers' observations, they have been included as if they were lit by the Aboriginal people. Many verified observations of Aboriginal-lit fires in November and December, but no mention of fires lit by lightning, were recorded in the explorers' records.

Some records, despite falling slightly outside the geographical limits set, have been included for completeness of the monthly records of some explorers. Multiple records of

fires on any day were treated as one fire observation only, because with few exceptions, explorers did not note the number of fires observed. Records included daily locations by coordinates where they were stated (to the nearest minute where recorded), or by inferred coordinates where they were described as a geographical location. Coordinates were grouped into 1° cells as this was the best level of accuracy for all observations. Daily journal entries were summed into months for analysis.

The number of days each explorer was in the region have been tabulated against the number of fires reported, in order to eliminate the difference between an explorer's null record and the absence of any explorer in any month or grid cell. Null records were difficult to interpret, because there is no way of knowing whether no fires were seen, or whether the explorers simply did not record them.

Because the data were relatively scant overall, and scattered widely over time and space, statistical tests were useful for only the analysed subsets of active fires and burnt country. These were subject to Kolmogorov-Smirnoff tests for goodness of fit (Zar, 1982). Spearman rank correlations tests were performed to examine correlations between the number of explorers and the numbers of fires (active and burnt) per month and degree.

Fensham (1997) analysed the frequency of burning in different vegetation types as a direct relationship between

**Table 1** Northern Territory explorers

Explorer	Years	Period in Savanna region (NT)	Source
<i>Sea explorers</i>			
M. Flinders	1801–03	December 1802–6 March 1803	Flinders (1814)
N. Baudin	1801–03	June–July 1803	Baudin (1972)
P.P. King	1818–1819	March–May 1818, 26 July–September 1819	King (1827)
J.L. Stokes	1839–42	July–December 1839	Stokes (1846)
<i>Land explorers</i>			
L. Leichhardt*	1844–45	September–December 1845	Leichhardt (1847)
A.C. Gregory	1855–56	October 1855–August 1856	Gregory & Gregory (1884)
T. Baines (with Gregory's party) <sup>1</sup>	1855–56	March 1856; October–5 December 1856	Baines (1856)
J. McD. Stuart*	1860–62	3 May–July 1861 April–September 1862 (September at 18° S)	Stuart (1865)
B.T. Finnis*	1865	April–December 1864	Finnis <i>et al.</i> (1865)
J. McKinlay*	1865–66	April–June 1866	McKinlay (1866)
F. Cadell	1867	May–August	Cadell (1868)
G.W. Goyder	1869	February–September	Goyder (1870)
A. Giles	1871–72	April 1871–May 1872	Giles (1926)
A.C. Ashwin	1870–71	Late year 1871	Ashwin (1930)
A. Forrest	1879–80	1 August–mid-September 1879	Forrest (1880)
K. Dahl*	1895	Not recorded	Dahl (1927)
F. Hann	1895–96	April–July 1896	Donaldson & Elliot (1998)
<i>Outside NT</i>			
J. Davis*	1863	In Qld, April–May 1862	Davis (1863)
W. Landsborough	1861–62	In Qld, not in NT, November–January	Landsborough (1862)
<i>Explorers with no recorded interest in fire</i>			
John Sweatman	1845–47		Allen & Corris (1977)
David Lindsay	1883	Not stated, not a journal	Lindsay (1887)
David Lindsay	1886	April–October	Lindsay (1889)
<i>Sea explorers without surviving journals</i>			
William Jansz	1606		Powell (1982) – no journal
Carstentz (ship <i>Pera</i> )	1623	21 January–8 June ex Bantam	Powell (1982) – no journal
Van Colster (Coolsterdt) (with Carstentz–ship <i>Arnhem</i> )	1623	21 January–8 June ex Bantam	Powell (1982) – no journal
Abel Tasman	1642–44	No journal survives	Sharp (1968)

\* Land Explorers reviewed by Braithwaite 1991.

frequency of observations and distance travelled across Queensland, but found that his analyses were limited in value because there were too few data ( $n = 195$ ) from which to draw firm conclusions. The Northern Territory data were fewer than those available to Fensham, so only 1° cells could comfortably be used for locating the explorers at any time. Rates of daily travel could not be determined with certainty and, in some cases, the explorers were stationary for a time, while still recording fires. Fensham also lumped his time periods into seasons. Monthly data have been retained here, which is consistent with Crowley & Garnett (2000) in Queensland, and Vigilante (2001) in Western Australia.

In contrast with Fensham's approach, the Northern Territory records did not allow separation of observations of burnt country into old (more than 2 months), and recently burnt.

Sources of error were common. For instance, locations were often interpreted from the explorers' journals. Some explorers were diligent in recording their daily locations, including latitude and longitude, but even here there were

major errors (up to 2° of longitude) because of the inaccuracy of the equipment in use. Others did not give coordinates, but only geographical descriptions. Others, such as Alfred Giles and Finnis were semiresident in the region for long periods, during which they did not record fires at all during several dry season months. It could be assumed that fires were being lit during these months because many other explorers' observations recorded that fires were being lit throughout the dry season. In the latter cases, long periods with nil records when the explorers were idle or resident were excluded from the statistical analyses to avoid biasing the results.

## RESULTS

Of the twenty-five explorers identified over the century, only fifteen journals yielded observations of fires which could be used for analysis. These records were widely scattered in time and place. Table 2 shows the periods in which each of the fifteen explorers was present.

The reporting rate for each of the explorers was variable, as shown in Table 3. Over the century, 206 records of fires and evidence of fires were made in journals. Of these, only the active landscape fires ( $n = 100$ ) and burnt vegetation ( $n = 52$ ) were used for further analysis.

### Active landscape fires

Fires were active during all the dry season months in most regions of the savannas traversed by explorers of the Northern Territory (Tables 4 and 5). In the 17th parallel (17°–18° S), explorers ( $n = 2$ ) traversed only during April and May, so no records were available outside that period. In other latitudes, if explorers were present, they usually observed fires, except for the months January–March (the wet season), as shown in Fig. 2. Burnt vegetation was recorded in every month in which fires were recorded, except for October, when burnt country was recorded regularly but fires were recorded only once.

The rate of explorers reporting any fires in any month was high (mean = 80%, s.d. = 27, range 33–100%) (Table 3) but this decreased substantially when the reporting rate was compared with the number of days present (mean = 22%, s.d. = 14, range 8–67). Three explorers who were resident in the region for long periods recorded no fires during several months of residency: Alfred Giles who was in the region for over 13 months continuously in 1871–72, Goyder (1870) from February to September 1869, and Finnis from July to December 1864. They recorded no fires for these long periods whereas fires were recorded by others during equivalent periods. These null records were excluded from analysis as they would have strongly biased the results without providing information.

Observed fires were spread evenly throughout the fire season (March–December) when compared with expected

equal distribution of fires (Kolmogorov–Smirnov:  $P > 0.05$  for averaged number of fires; and  $P > 0.05$  for actual number of fires). This was despite the apparently low number of fires in October. A bimodal distribution (as in Braithwaite, 1991) would also probably not be significantly different from an equal distribution, given the sample size. The Kolmogorov–Smirnov test works well if the distributions vary from the expected at either end of the range. These data do not vary in this way, so the rigour of the test is open to uncertainty.

There was a correlation between the number of explorers and the number of fires observed in any month (Spearman rank correlation:  $n = 10$ ,  $r_s = 0.8105$ ,  $P < 0.05$ ). Figure 3 shows the relationship of the number of monthly fire observations to the number of explorers in each month. The figure illustrates an artefact of the data – that the dependent variable, fire frequency per month, was highly correlated with ‘search effort’, the explorers’ records.

The frequency of fire across latitudes by 1° squares was evenly distributed (Kolmogorov–Smirnov:  $P > 0.05$ ), while across longitudes the distribution of fires was uneven ( $P > 0.05$ ) (Table 6). This is probably related to the number of explorers across longitudes, which showed a correlation with the numbers of fires observed (Spearman rank correlation:  $n = 9$ ,  $r_s = 0.93$ ,  $P < 0.05$ ). There was a marginally significant correlation between number of fires observed and number of explorers by degrees of latitude south ( $n = 7$ ,  $r_s = 0.54$ ,  $P > 0.05$ ). Both these results must be treated with caution because of low values for ‘ $n$ ’ (Zar, 1982). The north–south trend is illustrated in Fig. 4.

### Burnt vegetation

Of the journals reviewed, eleven contained records of burnt country. Records of burnt vegetation demonstrated similar patterns to those of fire records within the region

**Table 2** Presence of explorers in the region

Explorer	Period in region											
	J	F	M	A	M	J	J	A	S	O	N	D
Stuart				1	1	1	1	1				
King			0	1	1		0	1	1			
Leichhardt									1	1	1	1
Gregory	0	1	1	0	1	1	1	1		0	1	0
Giles	0	0	1	1	1	1	1	0	0	0	0	0
Baines			1							1	1	1
Cadell					1	1	1	1				
Forrest								1	1			
Stokes									1	1	1	
McKinlay	0	0	0	1	1	1						
Flinders	1											1
Finnis							1	0	0	0	1	0
Goyder		1	0	0	0	1	1	0	0			
Hann						1						
Baudin						1						

0 = did not record fire in that month of journal entries.

1 = at least one record of fire or fire evidence in that month.

**Table 3** Fires and evidence recorded by explorers

Explorer	Five type					No. days of the observations	No. fire observations	Days present in region	Months present in region	Number of months in which fires were recorded	Reporting rate (% months when fire reported of total months)	Reporting rate fires observed per days present (%)
	Campfires	Ambiguous fires	Active landscape fires	Attack/defense fires	Burnt veget'n							
Stuart	2	1	20	4	17	40	44	128	5	5	100	34
King	3	1	20	0	6	27	30	113	6	4	67	27
Leichhardt	4	1	12	1	7	22	25	97	4	4	100	26
Gregory	4	2	5	2	5	16	18	117	11	7	64	15
Giles	0	2	8	3	2	13	15	138	12	5	42	11
Baines	6	0	9	0	0	15	15	50	4	4	100	30
Cadell	0	5	5	0	5	13	15	68	4	4	100	22
Forrest	0	0	4	1	4	8	9	45	2	2	100	20
Stokes	2	1	4	0	2	7	9	73	3	3	100	12
McKinlay	0	0	4	1	2	6	7	55	6	3	50	13
Flinders	0	2	4	0	0	6	6	31	2	2	100	19
Finiss	2	1	1	0	1	5	5	61	6	2	33	8
Goyder	0	1	1	1	0	3	3	31	8	2	38	10
Hann	1	0	1	0	1	3	3	19	1	1	100	16
Baudin	0	0	2	0	0	2	2	3	1	1	100	67
Totals	24	17	100	13	52	186	206	1029	75	50		
										Mean =	80	22
										s.d. =	27	14
										Range =	33–100	8–67

**Table 4** Active fires and burnt country by degree cell and month

129 F	B	T	130 F	B	T	131 F	B	T	132 F	B	T	133 F	B	T	134 F	B	T	135 F	B	T	136 F	B	T	137 F	B	T
			May 3	0	19	May 1	0	3	Apr 1	0	30	Aug 3	2	17	Aug 1	0	5				Nov 1	0	9			
						Jun 1	0	1	Aug 1	0	1															
						Sep 1	0	30	Dec 1	0	3															
			Jul 1	0	31	Jun 1	0	2	May 3	3	32				Jul 2	5	37	May 2	0	22	Dec 1	0	5			
			Sep 1	0	1	Jul 3	4	38	Nov 2	0	52															
Sep 2	1	11				Apr 2	0	30	May 1	0	2	Nov 1	0	4			Aug 1	0	9							
						Jul 0	2	2	Jul 1	6	16															
			Aug 2	0	2																					
Oct 1	0	31				Jun 1	0	30				Jun 3	1	30	Oct 3	2	11	Oct 0	1	17						
												Jul 1	2	31												
												Aug 2	2	6												
												Nov 1	1	2												
			May 1	0	31	Mar 6	0	31	Jul 0	1	10	Mar 1	0	31	Jul 1	0	12	Oct 0	1	2	Oct 0	1	1			
			Nov 2	2	12	Jun 1	1	30	Aug 1	1	5	May 1	0	2												
						Jul 0	1	3	Sep 0	1	13	Jul 1	0	3												
						Aug 0	1	12				Aug 0	1	17												
Jun 0	1	13	Aug 1	1	5	Jun 1	0	6				Sep 1	0	1												
Aug 1	0	9										May 3	1	36	Jul 0	1	4	Jul 0	1	4	Aug 0	1	8	Dec 1	0	22
												Aug 0	1	3												
												Apr 7	0	30												
												May 3	0	23												

F: Sum active fires/mth/grid cell, B: Sum burnt veg/mth, T: Sum days per month in grid cell.

**Table 5** Months of active fires in each degree of latitude

Latitude S	J	F	M	A	M	J	J	A	S	O	N	D
11				■	■	■		■	■		■	■
12					■	■	■		■		■	■
13				■	■		■	■	■		■	
14						■	■	■		■	■	
15			■			■	■	■	■		■	
16					■	■	■	■	■			■
17				■	■							

(Table 7, Fig. 5). Burnt country was observed in all months from May to December. There appears to be a strong correlation between explorers' presence and observations of burnt country, but the data on burnt country were too few ( $n = 52$ ) for further analysis. A graph of the records against the number of explorers who recorded burnt country demonstrates the apparent relationship (Fig. 6).

**The written word**

The journals provide only limited insight into Aboriginal burning practices of the time because the explorers in northern Australia were searching for new land routes, pastures, and glory, among other intentions. Recording fires was incidental to these purposes, so the journals were not systematic records of observations of fires. The explorers' enthusiasm for recording probably diminished with time and familiarity with burnt country or too-frequent observations of active fires and smoke across the landscape.

McKinlay, for instance, observed from the Arnhem escarpment:

In every direction in the distance from westward to the north we see daily innumerable bush-fires, showing the whereabouts of the natives, who must be numerous. We

occasionally see recent traces of them even on the tops of these rugged walls, where they have been firing for the purposes of getting wallaby (McKinlay, 1866, p. 18; 24 May).

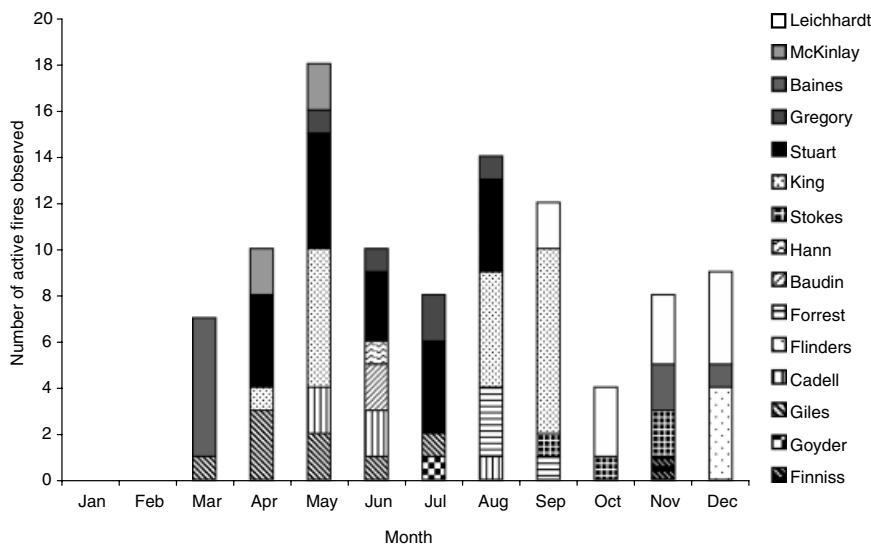
Fires were a daily event, but McKinlay did not record fires or burnt ground on every day of his journal. Earlier in his journey, on 24 April 1866, he noted that the Aboriginals were 'commencing to burn grass' (p. 12), the first fire seen since the departure on 14 January 1866 from the Adelaide River. But this astute observation highlighted the less diligent recording of observations in the next few months.

Many of the journal entries were also necessarily brief, and fire reports were not the highest priority. For example, Cadell's journal was a 'hastily written narrative, thrown off in the public room of a bush inn' (p. 6). The explorers, with a few minor exceptions, did not record frequency nor the numbers of fires or smoke they observed. Nor was the extent of fire or burnt ground described in many journals, with occasional exceptions:

The fires which had been lighted in the course of the day by the natives, had rapidly spread over the summit of the hills, and at night, the whole island was illuminated, and presented a most grand and imposing appearance. (King, 1827, p. 291, 17 September).

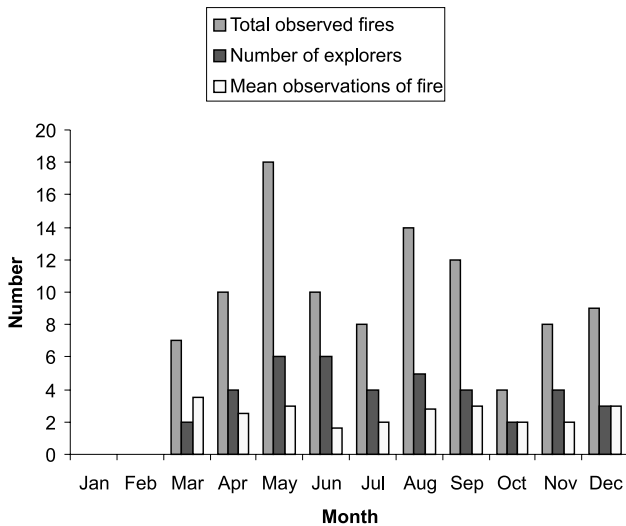
The explorers were dependent on grass for their horses to eat. Because of this dependence, they frequently noted the condition and availability of grass. It was rare in the journals for explorers to note an absence of grass, although one complained:

(the Aboriginals) have been following us to-day, but keeping on the other side of the river and setting fire to the grass as they go along. I wish it would rain and cause the grass to become green, so as to stop them burning, as well as to give me some fresh food for the horses, for they now begin to show the want of it very much; it is so dried up there is very little nourishment in it (June) (p. 374) (Stuart, 1865).



**Figure 2** Number of observations of fire per month.





**Figure 3** Total fires, explorer numbers and mean fire numbers by month across region, normalized to proportion of highest score for each category for comparison.

Augustus Gregory also recorded the relevance of past fires to his horses' food supply:

The grass was inferior, but from having been burnt had grown up fresh and green (August 1865, p. 166) (Gregory & Gregory, 1884).

Alexander Forrest, too, noted the importance of fire to the condition of the grass:

Well covered with the feed as the country is along the banks of the river, it would be useless on consequence of this rankness of growth, unless kept constantly burnt (7 August, p. 28, 16°40' S, 129° E) (Forrest, 1880).

The impression gained from the journals was that the country was patchily burnt, and that fresh green 'pick' was relatively common. There were very few records of large areas of country having been burnt.

It was not unusual in the journals for the sources and purposes of fires to be misinterpreted, as also noted by Fensham (1997). Cadell recounted in his journal of 1868, for instance, that he:

made west ...over an open country that has recently been burnt by the blacks; the smoking, and still burning embers were frequently mistaken by us for native fires (22 June 1867, p. 17) (Cadell, 1868).

Thomas Baines, while in the Victoria River area of western Northern Territory (Baines, 1856) did not report any fires to the end of February, but on 1 March reported that the long grass was now dry enough to burn in patches. He reported a series of events which reveal detail of how the people were burning, and provide some insight into the misinterpretation of Aboriginal burning practices:

15th March: In the afternoon ... a fire rising on the south side of the creek below the camp ... as it rapidly approached we could see a number of blacks running with fire brands and carrying on the line as if with the intention of encircling us with flame. .... taking cover of the trees as I went, approached near enough to see that they had left the fire and that the grass was not yet dry enough to burn without the continual application of the brand ...

16th March: saw smoke still hanging among the trees .... saw that the blacks were burning the country four or five miles to the South-east and in the afternoon perhaps eight miles to the south by East

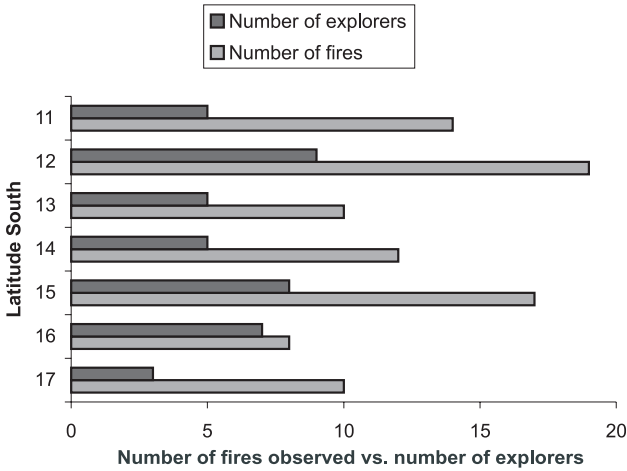
24th March: saw smoke up the creek ... followed to the hills the fire coming down close to us, and the blacks standing on the hill south of the gorge .... they retreated. ... saw them ... along the hill 300 yards from us with the deep gorge between. I fired and think my second shot went very near one .... At night from (our camp) could see the light of the burning plain to the southward, we could see that they had been painting themselves which Fahey says is a sign of war...

25th March: saw no blacks nor any smoke, but in places they burnt three weeks ago found grass six or eight inches high

Baines interpreted these fires as intended by the Aboriginals to threaten or burn him out. A more likely interpretation, considering his detailed descriptions and our present understanding of Aboriginal burning skills, is that the people were simply burning their country. Some of the burning near the horses might have been to deter the invaders, but fires several miles to the south and east were more likely to have been part of normal burning activities.

**Table 6** Number of fires across one degree cells (number of fires recorded overall was 100, while within the boundaries of the Northern Territory, 90 were observed. Shaded squares are of open sea)

Latitude	Longitude									Sum by deg S
	129	130	131	132	133	134	135	136	137	
11	☒	3	3	3	3	1	☒	1	☒	14
12	☒	2	4	8		2	2	1	☒	19
13	2		4	2	1		1		☒	10
14	1			1	7	3			☒	12
15		3	7	1	4	1		1	☒	17
16	1	1	1		3			1	1	8
17					10					10
Sum by deg E	4	9	19	15	28	7	3	4	1	<i>n</i> = 90



**Figure 4** Number of fires compared with number of explorers by degrees south.

It was also clear from some journals that fires were being lit in different topographic parts of the environment at different times of the year. Baines (1856) observed fires along the creeks in March, and also in the hills and adjacent plains. Cadell (1868) reported:

... headed the burnt country. The soil here being of better quality, and the vegetation greener, seemed to have checked the fire (22 June 1867, p. 17)

It was also observed that fires were being lit very early in the dry season, as soon as the grass was sufficiently dry to burn. For example, McKinlay reported that the rain ceased from about 5 April, and burning started less than 3 weeks later on 24 April 1866 (McKinlay, 1866, p. 12). Giles, in March 1872 (Giles, 1926), observed that the country was starting to dry up, although the Birdum, one of the rivers where he was working, was flowing strongly:

There were large smokes to the south-east and east in the evening – the first we had seen that year – and it was a sure indication of the drying-up of the grass and swamps and the end of the tropical wet season. (12 March, 1872, p. 140)

They were being lit very late in the year also. Matthew Flinders, surveying the coast of the Gulf of Carpentaria and Arnhem Land in 1802 and 1803, observed fires relatively frequently, even during December, and plotted observations of ‘smokes’ on his charts (Flinders, 1814, p. 158, 9).

**DISCUSSION**

Fire is one of the key ecological processes in the world’s tropical savannas. A comprehensive understanding of these processes is needed if the savannas are to be managed sustainably. This requires not only analysis of contemporary processes, but also of the historical and evolutionary context of fire, particularly that of anthropogenic fire, because the biota have adapted to historical fire regimes (Stocker & Mott, 1981).

**Table 7** Explorers’ observations of burnt vegetation

Explorer Month	Finmiss	Giles	Cadell	Forrest	Hann	Stokes	King	Stuart	Gregory	McKinlay	Leichhardt	Sum	No. explorers in region and recording burnt country	Mean number of burnt patches per month per explorer
Jan												0	0	0
Feb												0	0	0
Mar												0	0	0
Apr												0	0	0
May							1	1		2		4	3	1
Jun				1			1	1				7	4	2
Jul	1	2	4	1			11	3				18	5	4
Aug							2	4	1			10	4	3
Sep							3					4	2	2
Oct												5	1	5
Nov						2						3	2	2
Dec					1							1	1	1
Totals	1	2	5	4	1	2	6	17	5	2		52		

This study, like the studies in Queensland and Western Australia reviewed all the explorers' journals on land and sea (Fensham, 1997; Crowley & Garnett, 2000; Vigilante, 2001). The results expand on and correct the previous Northern Territory study which used the records of only three explorers of the 19th century in the north-eastern savanna region of the Northern Territory, and three other records to support the findings (Braithwaite, 1991).

Explorers' observations of fires provide information about Aboriginal fire practices before European colonists were able to influence those practices. But, as sources of information on Aboriginal burning practices in the 19th century, they must be treated with a certain degree of skepticism. Explorers' principal purposes were exploration of new country for their financiers and supporters, and for their own glory and promotion of their standing in the colonial society (Ryan, 1996). None expressed the intention of recording and mapping Aboriginal application of fire.

The explorers' historical records universally considered Aboriginal people as being of observational interest. Their observations were fleeting, and they never evolved from discourse with Aboriginal people about the purposes of burning or fire regimes. Explorers were little inclined to engage with the Aboriginal inhabitants of the country they traversed, other than to negotiate friendly passage or to defend themselves against hostile inhabitants. Augustus Gregory, for instance, noted in his journal (Gregory & Gregory, 1884) of his traverses across the coast of the Gulf of Carpentaria:

Some of the party walked down the river and came to the camp of some blacks; but only one lame old man remained, who made a great noise to frighten away the invaders of his country. (p. 170)

Their observations of Aboriginal people's habits and activities were ad hoc and inconsistent, and they also mostly lacked understanding of what they were actually seeing. Their perceptions were coloured by their expectations (Ryan, 1996) and they saw landscapes in terms familiar to them from their origin in Europe, as pastures, fields, and glens, for instance, rather than as distinct Australian ecosystems.

### A patchy record

There are difficulties with interpreting a patchy historical record (Russell, 1983; Denevan, 1992; Benson & Redpath, 1997; Fensham, 1997; Boucher & Moody, 1998; Bowman, 1998). Despite a century of exploration, very little of the country was actually traversed by the explorers. The data can be relied on only as far as the positive observations allow. If an explorer recorded a fire, then it was an actual observation. The converse is not true. This raises the problem of using data from non-systematic sources. Much of the data cannot be analysed statistically. The data are also scattered across time (a century), are numerically very poor ( $n = 206$ ), and are sparse for any location and period. They were also recorded by many different observers, further reducing their robustness.

### Aboriginal fires in the Northern Territory

Despite these shortcomings, the historical records do reveal valuable information on the ways in which Aboriginal people burnt the country during the nineteenth century. Fires were lit by Aboriginal people throughout the dry season. No clear peaks nor troughs in burning could be detected, apart from an uncertain lull in burning during October. No fires were recorded for January and February. Beyond these key findings, the record is difficult to interpret. Frequency and numbers of fires, the actual extent or proportion of country burnt at any time and throughout the year, the purposes of burning, and the vegetation types burnt can hardly be inferred from the written historical record. It cannot be inferred that every vegetation type was burnt every month, only that fires were observed on at least some days every month of the dry seasons.

The selected data from the previous Northern Territory study showed a distinct bimodal fire season, with a peak of burning in June–July and a later one in October (Fig. 7), which is inconsistent with the source data. The present study appeared to show just the opposite – a trough of burning in October – but this has been shown to be not significant. This

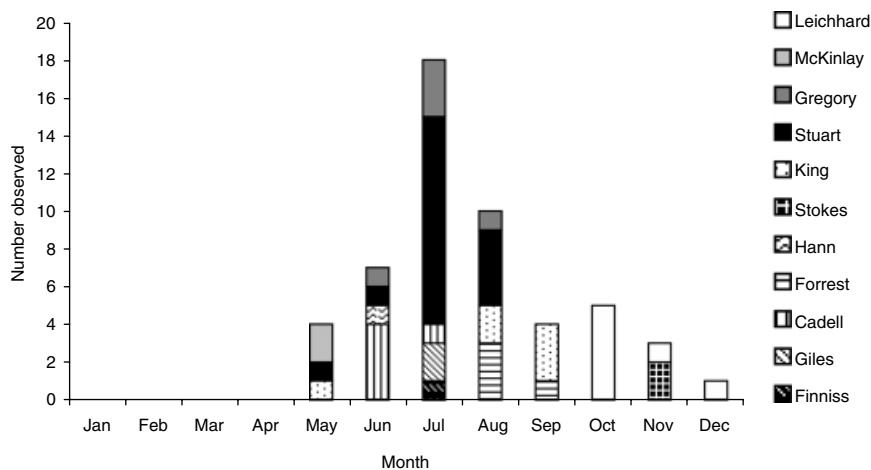
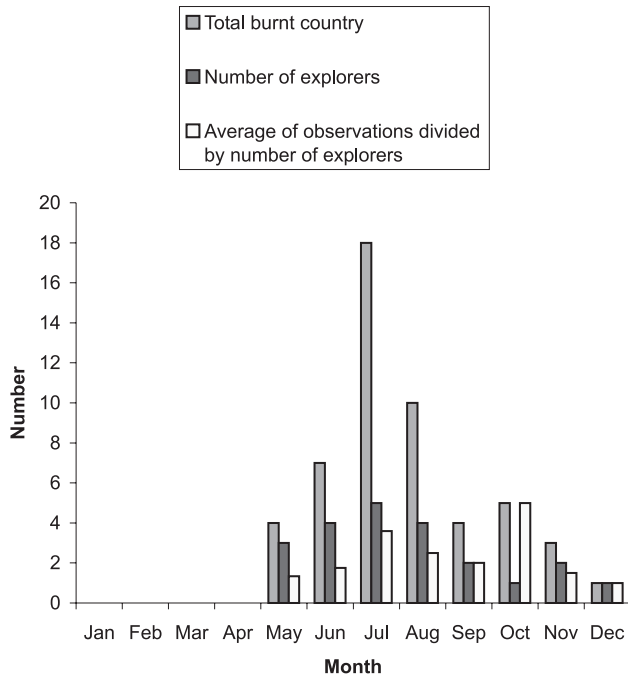
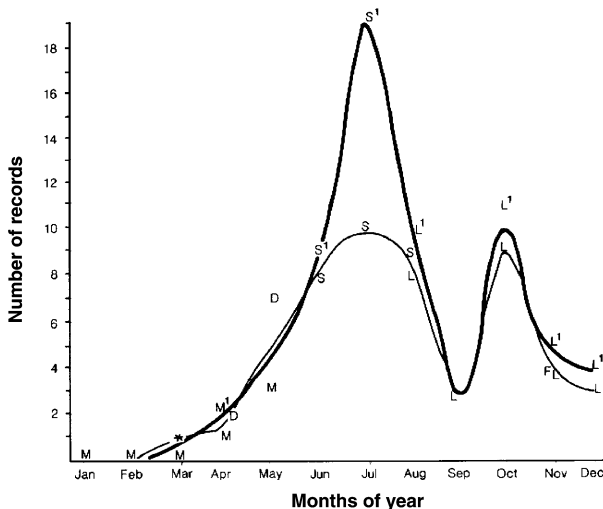


Figure 5 Observation of burnt vegetation by explorers.



**Figure 6** Comparison of explorers' presence against observations of burnt country.



**Figure 7** Seasonal trends of fire in the Northern Territory from Braithwaite (1991).

apparent trough cannot therefore be used to suggest that Aboriginal people stopped burning in October.

In the Kimberley study, using records of 25 explorers (and others) to record 90 observations of Aboriginal fire, fires were found to be spread throughout the dry season (Vigilante, 2001). In Queensland, 195 records of fire from seventeen explorers showed that fires were lit throughout the dry season, but even these records were insufficient to provide firm conclusions about seasonal patterns of Aboriginal fire in any vegetation types (Fensham, 1997). This was

also the case with the Northern Territory data. Regional variation has been masked, unfortunately, as a result of the need to summarize the data into higher categories (e.g. months instead of days) so that the data could be tested. This was recognized also by Fensham and Vigilante as an issue with the patchy historical record.

Fensham (1997) and Vigilante (2001) each grappled with the issue of previous fires. They concluded that the proportion of burnt country would naturally increase during a fire season, as a result of cumulative burns. They each separated previously burnt country from active fires to avoid this cumulative effect. The current study also recognized the limitations of using burnt country to interpret frequency of fires.

The apparent trough of burning in September suggested by Braithwaite as 'the time of most intense fires' (p. 248), is based on only Ludwig Leichhardt's observations. During September, he recorded fires only twice, his lowest recording rate, but made no record of burnt ground. In the previous months, he recorded burnt country frequently (five and eight times in July and August) and again recorded burnt ground in October ( $n = 5$ ), November ( $n = 1$ ) and December ( $n = 1$ ). It would be highly implausible that no burnt ground was encountered in September, late in the dry season. The lower frequency of fires recorded for September, November and December is more likely to be the result of neglected journal entries, rather than of the absence of fires. A gradual increase in the proportion of burnt country through a dry season, peaking in November and December, would be expected, but was not recorded.

Throughout the terrestrial explorers' journals, it is notable that there were few locations where grass was not available for the horses over extensive expanses of country. The daily traverses varied from some miles up to a maximum of about 40 miles on forced marches to the next water supply, and it was rare that a camp at night ended without edible grass. Each instance appears to have been noted by the explorers. It could be surmised that the country each of them traversed consisted of patchily burnt country of some miles extent wherever they explored.

It could also be surmised that if fires were lit throughout the year, consistently from the beginning of the dry season to the very end, even after rains, then the sizes of fires must have been relatively small. Otherwise, the available vegetation would have been consumed by fire early in the dry season. The alternative of large, hot fires at any time of the year cannot be argued with the same confidence. Aboriginal people used fire expertly for many reasons, including hunting and ceremony (see, for example, Russell-Smith *et al.*, 1998). They would not intentionally burn out all their resources to jeopardize their survival.

#### Northern Australian savanna fires

Burning by Aboriginal people across the northern Australian savannas during the nineteenth century was carried on throughout the dry seasons. In the Queensland savannas, fires were spread fairly evenly through the non-summer seasons (March–November) (Fensham, 1997). The data

suggested a slightly higher frequency of fires in the winter period (June–August), but this trend was not strong, and there were too few records to provide a robust statistical analysis.

Fensham also found a higher frequency of fires in the coastal and subcoastal areas and in the grasslands around the Gulf of Carpentaria, than in the drier inland regions. Fensham concluded that ‘Aboriginal burning was relatively infrequent in inland vegetation types’ (p. 20), but he did not quantify this in terms of rainfall or vegetation types. This trend could have been influenced by the strong rainfall gradient from north to south, as well as by the higher density of explorers in the coastal areas. No correction for this latter was made, so it is uncertain how strong the correlation was between numbers of fires and numbers of explorers. The Western Australian study (Vigilante, 2001) and this Northern Territory study found there was a correlation between the number of explorers and the reporting rate of fires, and it could be reasonably assumed that there would be a correlation in Queensland also. The north/south and north-east/south-west geographical range (mesic to arid) studied by Fensham was, however, much greater than in either the Northern Territory or the western Australian studies. If the tropical areas only are considered, there are too few data in Fensham’s study to make the same conclusion of a trend across climatic zones. The Northern Territory study did not detect any clear trend.

Another contrasting finding can be made between Fensham’s study and this one for the Northern Territory. There was actually little confusion (with some exceptions, such as that of Baines) in the journals of exploration in the Northern Territory about whether or not ‘fires were lit in reaction to the presence of the intruders’ as Fensham concluded for Queensland (Fensham, 1997, p. 20). From his own observations, Baines’ interpretation can be re-interpreted as probably landscape fires for cultural or economic reasons, and, in most other cases, aggressive fires can be identified and excluded from further analysis.

In the Cape York Peninsula (north Queensland) study, fires were found to be lit by Aboriginal people from early in the dry season to late dry season (April–November) (Crowley & Garnett, 2000). Early fires in April were noted in about 10% of explorer’s journal entries, and fires were noted in every month (except May) until November. Crowley and Garnett observed that this was in contrast to findings for the northern Northern Territory, where others (Leichhardt, 1847; Haynes, 1985; Braithwaite, 1991; Lucas & Lucas, 1993; Russell-Smith *et al.*, 1997) had reported avoidance and disdain for late fires. They proposed that late fires may have been necessary to maintain grasslands (Crowley & Garnett, 1998; Stanton, 1994). Late fires may have been used for signalling and perhaps aggressive acts towards explorers, but they were unlikely to have been lit if cultural or ecological reasons prohibited them from doing so. One of the Cape York explorers (Jack, 1922) reported so much burning in September that he was relieved to find areas which had not been burnt. Late October burning was

also observed by another Cape York explorer (Carron, 1849). The complete Northern Territory record, which shows fires in every month of the dry season, with approximately even frequency, is consistent with the findings on Cape York.

In the Kimberley region of Western Australia, a similar pattern of burning was observed by nineteenth century explorers (Vigilante, 2001). There appeared to be a latitudinal difference in the start and end of the fire season. In the northern parts of the Kimberley in the high rainfall zone (>700 mm) the fire season ran from February to December, and suggested peaks of burning in June and September. In southern parts, south of the 400 mm isohyet and down to about 20° S, the fire season appeared to run from February to August. Vigilante noted, however, that this ending to the season was inconsistent with ethnographer’s observations, in which fires were observed late in the year.

Observations of burnt ground and standing fuel in the Kimberley were also consistent with the Northern Territory observations. Some explorers, including Stuart and Forrest commented on unburnt grass, noting that it was unusual to encounter tall rank grass, because they had observed that Aboriginal people usually burnt the country. Vigilante found that burnt ground was observed by the explorers from May to December. He found the same problems of interpretation found in this study, in that burnt vegetation tends to accumulate through a dry season, and so should be more prominent in the late dry season. There was, however, a higher reporting rate by the explorers of active fires than of burnt ground.

The several references to peak months of burning (Fensham in Queensland: June–August; Vigilante in Western Australia: June and September) were not reflected in the Northern Territory data. Braithwaite’s interpretation of July and October peaks was clearly not reflected in the expanded historical record. Vigilante’s observation and the observation in this study that the number of fires was strongly linked to the number of observers may account for the apparent peaks. It is also clear that there are so few data that it is nigh impossible to quantify and verify such interpretations.

The more complete record also clears some of the confusion reflected upon by some researchers of fire in northern Australia. In western Arnhem Land, for instance, during *gurrung*, the hot time of the year in the *Gundjeihmi* seasonal calendar (August–October in the Gregorian calendar), most burning ceased, except, importantly:

on floodplains and in situations where fires could be well controlled, including kangaroo hunting fires. Older Aboriginal people are quite clear on this point; it is a season when extreme care must be taken given that fires will burn all day, often through areas burnt previously in that year, and all night, fanned by the warm sea breeze, *mabbilil*. Uncontrolled, intense fires result in *gabulayongan* (literally, ash), the canopy scorched and leafless, the ground blackened and covered in fine ash. (Russell-Smith *et al.*, 1997, p. 175)

This shows that fires were lit through the hot dry season *gurrung*, on the floodplains, but that more care was taken. Peaks and troughs of burning suggested by Braithwaite (Russell-Smith, 2000) cannot be confidently asserted on the complete historical record. The evenness of observations throughout the year (but in different environments) is, in fact, more consistent with Russell-Smith's own observations.

In another study, Bowman & Panton (1993) and Price & Bowman (1994) assumed from the literature that Aboriginal people traditionally lit 'cool' fires in the early dry season only. While their conclusions about the negative effects of changed fire regimes on stands of *Callitris intratropica* R.T. Baker & H.G. Smith (a fire-sensitive cypress pine) still hold, their suggestion that 'cool' early dry season fires are preferred needs to be re-considered because fires were evidently lit throughout the dry season traditionally.

## CONCLUSION

The data from the historical record show that Aboriginal burning in the northern savannas occurred throughout the dry seasons, from March or April, depending on the timing of the end of the wet season, right up until the first rains of the wet season prevented further burning. Fires were burnt in most, if not all, landscapes observed by the explorers. There was no gradual increase in frequency, but rather an immediate response to drying out of the grass fuels, and a consistent frequency of burning throughout the dry season.

These practices were current at the time of European occupation and continued at least until the end of the nineteenth century, and in places until the last 20–30 years. Reasons for burning cited in the journals were mostly speculative, although some of them were quite insightful. Further interpretation is difficult to make, and it would be stretching the available information to suggest any more than these few insights into Aboriginal fires in the nineteenth century.

Applying fire in ways which do not reflect long-term fire regimes is likely to de-stabilize ecosystems to their detriment. The consequences of introducing unknown and untested practices, as has been carried out, include the loss of species, habitats, and vegetation formations, and shifts of ecosystems to new thresholds. A reinstatement of burning throughout the dry season should be considered to reflect the traditional long-term fire regimes.

The historic record can provide some insight into general Aboriginal practices of the time. But it can provide only superficial understanding of reasons, patterns and trends. In order to understand the detail of the practices, it is necessary to resort to more thorough and more recent studies of the ethnographic and scientific literature, and contemporary field studies with Aboriginal custodians of the knowledge. Custodians of the knowledge of the traditional practices can provide both the knowledge of these practices where it is extant, and in many cases the skills to apply these practices and reinstate traditional practices where they have ceased. It is incumbent on the scientific and land management community to recognize that traditional knowledge and practices

are important to the sustainability and best management of the savannas.

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#### BIOSKETCH

Noel Preece has worked on land and fire management issues since 1974, starting with fighting fires in the Australian alps, lighting fires in central Australia, and now studying and consulting on land management issues in northern and central Australia. He (with four others) wrote the first fire management manual for central Australia, has since gained a Master of Science, and is Director of the environmental consultancy firm EcOz. Noel is writing his Doctor of Philosophy on traditional ecological knowledge, land management and science. Thanks to Alaric Fisher for preparing the map of the northern savannas.