FIRE MANAGEMENT FOR CONSERVATION : PLANS AND PRACTICE IN A FIRE-PRONE ENVIRONMENT

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SUMMARY

Fires are a regular feature of the landscape in the wet-dry tropics of northern Australia. The fire season lasts throughout the "dry" from March-April until November-December. During this period more than 50 per cent of the woodlands and open forests are burnt by fires. Fire behaviour changes during the fire seasons. Fires early in the dry are smaller, more patchy, less intense and burn for shorter periods than fires later in the dry season. The ecological consequences of these fires also vary through the season.

Aims and methods of fire management programs vary depending on land use and the goals of a program. Where fire management is used for conservation goals, the major constraints of fire management fall into the following categories:

(a) ecological information on fire effects and the dynamics of species' reponses to fire;

(b) logistic constraints affecting burning strategies and fire suppression;

(c) economic constraints; and

(d) willingness to implement active or passive fire management practices.

In Kakadu National Park an active fire management program has been developed and implemented since its declaration in 1979. The major constraints on implementing this program are discussed in this paper, and data from fire reports analysed.

INTRODUCTION

Fires are a regular feature of the landscape in the wet-dry tropics of northern Australia. In the western Arnhem Land and Darwin regions fires occur annually throughout the dry season (Braithwaite and Estbergs 1985, Day 1985, Press 1987, 1988). The length of fire season is determined by the cessation and onset of the wet season rainfalls which Taylor and Tulloch (1985) have shown to be extremely variable. Unseasonal dry season rains (Taylor and Tulloch 1985) may also influence the fire season by suppressing fires, promoting growth, increasing fuel loads and allowing unseasonable germination.

During the fire season more than 50 per cent of the region's lowland woodlands and open forests are burnt by fire (Braithwaite and Estbergs 1985, Day 1985, Press 1987, 1988). Fires are also common on the Arnhem Land plateau and in coastal and floodplain areas (Day 1985, Press, unpublished analyses of Landsat imagery). Fire behaviour changes during the dry season and consequently fire effects vary. Braithwaite and Estbergs (1985) have shown that early dry season fires are smaller, more patchy, less intense, and burn for shorter periods than fires later in the dry season. Individual fires show great variability regardless of time of year (Hoare 1985, Gill *et al* 1980, Bell 1981, Mott and Andrew 1985, Press 1987, Hoare 1985).

A number of studies of fire behaviour and fire effects have been undertaken in the region. Some of the existing information on fire behaviour and fire effects in Kakadu National Park has been incorporated into a micro-computer based expert system (Davis *et al* 1986, 1987, Hoare *et al* 1986, Walker *et al* 1985), and a project to model vegetation responses to fire is under way (Noble and Moore 1987).

In this paper I will use the example of Kakadu National Park to discuss the implementation of fire management plans in a fire-prone environment.

Kakadu National Park Plan of Management

The Kakadu National Park Plan of Management (ANPWS 1986) specifically addresses fire management and provides for the use of fire as a management prescription (ANPWS 1986 pp 37-9). The Plan of Management states that, "The general aim of fire management is to re-establish so far as possible the traditional Aboriginal patterns of burning. This strategy also aims to reduce the frequency, extent and intensity of wildfire within the park and to protect species and habitats ... Fire management must allow for traditional Aboriginal burning practices ... In general fire management will be adjusted according to vegetation type and the existing status of the vegetation" (ANPWS 1986 p 39). The Plan of Management states also in relation to vegetation, "The main object of vegetation management is to maintain in perpetuity the natural diversity of plant communities and habitats, and to protect threatened plant communities" (ANPWS 1986 p 22); and in relation to fauna, "... to maintain the natural abundance and distribution of native animals and to identify the factors influencing the status of rare or endangered animal species ... the maintenance of habitats vital to fauna will be given high priority in Park management" (ANPWS 1986, p 30).

Aims, Methods and Constraints to Fire Management Plans

In practice the aims of a fire management program can be viewed on two levels:

(a) the primary aims (strategy, methods and implementation); and

(b) the biological (biotic) aims (short and long term consequences of adopting a strategy and the strategy and methods used to achieve a particular goal).

The implementation of a strategy to re-establish the presumed patterns of Aboriginal burning has implicit in it the primary goal of reducing the extent and frequency of late dry season wildfires which have been shown to have the greatest impact on vegetation structure (Hoare *et al* 1980, Bell 1981, Hoare 1985, Lacey

1985, Press 1987). In order to carry out this strategy it is necessary to adopt methods that are not those of the traditional Aborigines. Two hundred years ago there were between 2 000 and 3 000 people living in 23 clan groups spread over the region of Kakadu and surrounding lands. In 1987 there are only two to three hundred Aboriginal people living inside Kakadu, 1 500 people in Jabiru, about 50 Park staff in five locations, and two hotel complexes (ANPWS 1986). Fires are lit by Park staff on foot, from vehicles and by the use of aerial ignition (Day 1985, ANPWS 1986, Press 1987). These management fires are lit between April and July. The exact timing of the start and finish of these fires is dependent on rainfall, curing of fuel, and weather factors influencing fire behaviour. Fires after the end of June begin to be more uniform spatially and burn for longer periods of time (Hoare 1985, Braithwaite and Estbergs 1985, Press 1987, 1988). The majority of management fires occur in May and June, and the most wildfires in August, September and October (Figure 1). The number of recorded days for each fire increases during the fire season to peak in September and then falls off from October to December (Figure 2). Late dry season fires are more likely to have greater canopy scorch and ground cover removal than early dry season fires (Figures 3 and 4). These findings are consistent with those of other authors (Hoare *et al* 1980, Hoare 1985, Bell 1981, Braithwaite and Estbergs 1985).

The source of non-management fires ("Other" in Figure 1) are many: commercial buffalo catchers and pet-meaters; Aboriginal and non-Aboriginal residents; and visitors. Fires originating outside Kakadu National Park also account for many of the non-management fires (Day 1985, and unpublished analyses of Landsat imagery). Only a few fires in October, November and December are attributable to lightning.

Analyses of data from Landsat imagery (Day 1985, Press 1988 and unpublished data from 1986 and 1987) show that the extent of late dry season wildfire can be limited by early dry season prescribed burning. Therefore one stated aim of the Plan of Management - reduction in late dry season wildfire - can be met using management fires.

The constraints to implementing such a strategy are mainly logistic and economic. The period in which management fires are lit (usually May and June) is also the period when Park staff are gearing up for the pressures of the visitor season (in 1987 Kakadu National Park had an estimated 38 000 visitors in May and June). Fire management priorities must be met along with opening of campgrounds, establishing ranger-guided tours and early dry season maintenance and development activities. Both ground and aerial ignition are time and labour intensive. In particular, "precision burning" to protect sensitive habitats such as monsoon forest, or aesthetic considerations around campgrounds and visitor destinations take time and labour. Money must be available also for the provision of specialist equipment, supplies, aircraft hire, wages and overtime. In a large national park such as Kakadu (almost 20 000 square kilometres), vast areas are remote from roads or otherwise inaccessible, and this increases logistic problems and costs. Another constraint on the effectiveness of implementing a regime of early dry season ignitions is change in the sources and incidents of late dry season fires. Visitor numbers to Kakadu are increasing at a rate of 40 per cent per year, new or improved roads have made access to remote areas easier, thus increasing visitor numbers to these areas, and visitors are remaining longer in the Park. The township of Jabiru is expanding as are facilities at Cooinda and the South Alligator. The declaration of Kakadu Stage III over the Gimbat and Goodparla pastoral leases may result in increased visitation to these areas. Changes in the

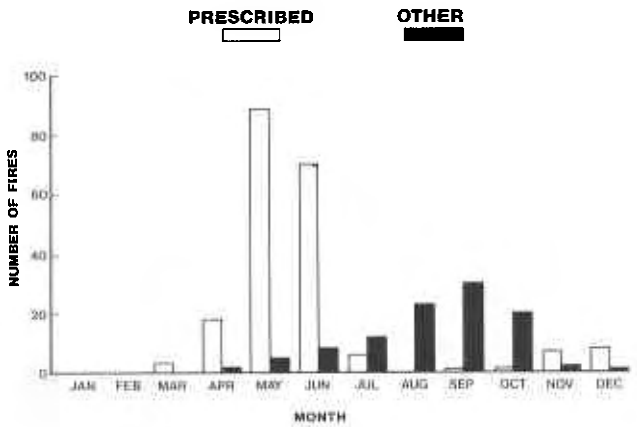

FIGURE 1
Sources of ignition. The number of fire report forms describing prescribed or other fires (wildfires, those lit by traditional owners, incursions from outside of Kakadu and others) for the years 1983-1986.

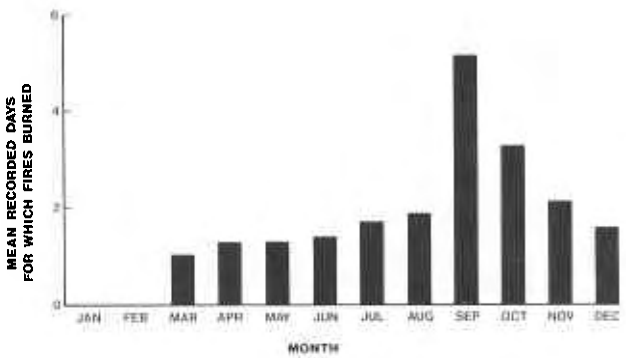

FIGURE 2
Length of fires. The means of the reported number of days for which each fire burned for the years 1979-1986. The variance of these means are as follows: Mar (s^2 = 1); Apr (1.59); May (1.57); Jun (1.91); Jul (2.89); Aug (3.6); Sep (27.80); Oct (15.6); Nov (7.11); Dec (5.6).

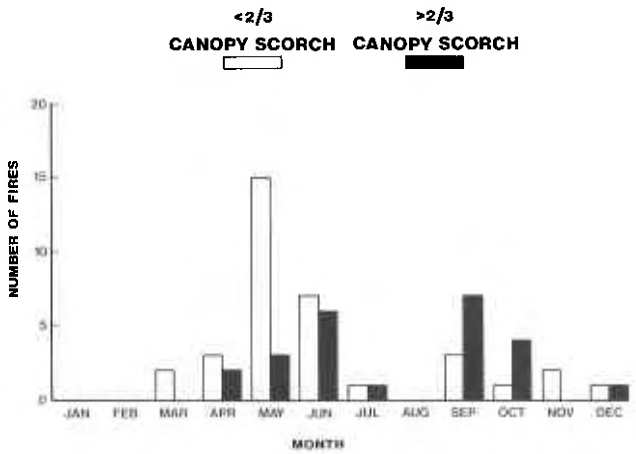

FIGURE 3
Canopy scorch. The number of reports estimating less than or greater than 2/3 of the canopy of foliage being scorched by fires during 1983-1986

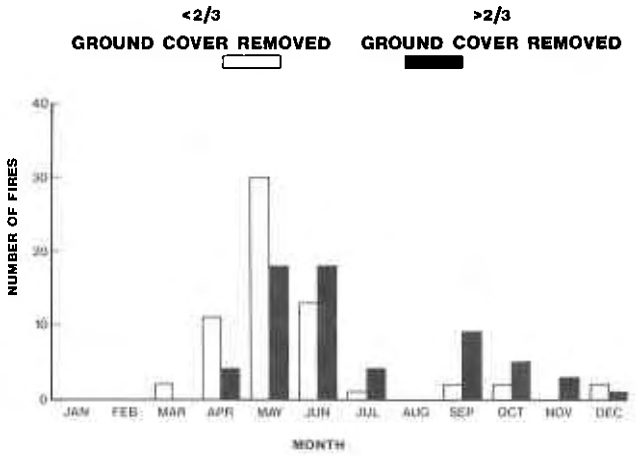

FIGURE 4
Ground cover removed. The number of reports estimating that less or greater than 2/3 of the ground cover had been removed by fire during 1983-1986.

demography and mobility of Aboriginal residents are also occurring. All of these changes may influence the success of the fire management strategy adopted for the region. Implementation of fire management programs is dependent also on the willingness of land managers to carry them out. This is especially so in relation to programs requiring the lighting of fires. Many European land managers in the "Top End" have a natural reticence, born of experiences in southern Australia, to go out and light fires. On the other hand laissez-faire attitudes to fire are also counterproductive to proper fire management.

Underlying the primary aims of any fire management program are the biotic goals. These are not usually explicitly expressed or if they are, expressed imprecisely. This is necessarily the case as in even a well studied national park the interactions between the biota and disturbances such as fire are poorly understood. Certain processes are obvious, for example repeated burning of entire monsoon forest thickets by wildfires will lead to their degradation and eventual elimination. The biotic goal of "preservation of monsoon forest thickets" can be met by elimination or reduction of the frequency of fires in monsoon forests. Other processes are not so obvious. The role of fire in *Eucalyptus* woodlands and open forests in the wet-dry tropics is disputed among ecologists (see Press 1987), and more empirical and experimental data need to be obtained before these processes are fully elucidated. Nonetheless, fire does have an appreciable impact on the structure of vegetation (Hoare *et al* 1980, Hoare 1985, Lacey 1985, Bell 1981, Press 1987). Hoare *et al* (1980) predicted degradation of forests if late dry season wildfires continued to dominate the landscape.

The Kakadu National Park Plan of Management requires protection of species and habitats and maintenance of the natural diversity of plant communities and habitats. This protection requires that this process of "degradation" be halted. The precise way to do this is unclear. First, it is obvious that a necessary condition is a reduction in the extent and frequency of late dry season fires (Hoare et al 1980, Hoare 1985, Bell 1981, Press 1987). What to do from this point onward poses many questions. Empirical evidence suggests two things:

(a) the absence of fire is not sufficient for recruitment to all strata; and

(b) the presence of fire *per se* is not sufficient to inhibit recruitment. Early dry season fires have less impact on recruitment than late dry season fires, and early dry season fires at intervals greater than one year have less impact than annual fires. The imposition of a static regime (eg early dry season fires) in all places may not be sufficient to reverse this process of "degradation". Historical changes in fire regimes (Hoare *et al* 1980, Hoare 1985, Braithwaite and Estbergs 1985, Press 1987) may have set in motion a series of processes which require more than just a simple reduction in the frequency of late dry season fires to ameliorate. Hoare *et al* 1980 and Braithwaite and Estbergs (1985) have described the absence of a mid-storey component in Top End forests. The management processes required to promote the establishment of this "missing stratum" could be quite complex.

Studies of the population dynamics of *Eucalyptus* forests in Kakadu National Park (Werner 1986), and simulations based on an extension of the Vital Attributes models of Noble and Slatyer (1980) have revealed fundamental gaps in the knowledge of "Top End" forests (Noble and Moore 1987). These gaps relate to propagule viability, time of seedling establishment, competitive interactions,

environmental tolerances, growth rates between development stages, rates of senescence and the impact of different kinds of fires on the various life stages of individuals and species. Some of these data can be obtained by observation and others require manipulation and experimentation. Long-term experiments are necessary to elucidate the interactions between fire and fauna (Press 1987). While such large gaps exist in our knowledge, approaches to management must necessarily be conservative; ie to reduce the impact of disturbances (see Press 1987). The "fine tuning" of management plans necessarily is dependent on filling in these gaps in our knowledge.

In summary, the major constraints on the development and implementation of fire management plans are:

(a) ecological information on fire effects and the dynamics of species' (or communities) response to fire;

(b) logistic constraints affecting burning strategies (and fire suppression);

(c) economic constraints; and

(d) willingness to implement active or passive fire management practices.

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APPENDIX 1
SOURCE OF DATA FOR FIGURES

Data used in Figures 1-4 are derived from fire report forms completed by staff of Kakadu National Park. These data have inherent biases which should be considered:

(a) the first report form has changed a number of times since 1980 and some data were not included on some of these forms;

(b) observations are biased by accessibility to the source of ignition or to fires themselves;

(c) fires may have burned for a number of days without being observed (see Figure 2);

(d) the estimates of scorch height and patchiness are purely subjective and not quantitative. The >2/3, <2/3 categories are arbitrary;

(e) some data have been excluded because they were incomplete;

(f) it is likely that a greater proportion of management-lit fires were reported than wildfires.