CHAPTER 1

INTRODUCTION

1.1 Aims of the Study

The overall aim of this thesis is to devise a rapid and cost-effective methodology to assist in the development and implementation of fire management strategies for the Oxley Wild Rivers National Park (O.W.R.N.P.) and surrounding areas in the Apsley - Macleay Gorges of north-eastern New South Wales. Of particular concern for fire management in this area is the occurrence of many pockets of fire-sensitive, dry rainforest vegetation communities.

1.2 Background

During this current decade rainforest has become a significant focus for conservation in Australia, and indeed globally. Reflecting this focus, a coordinated policy for rainforest conservation in Australia was addressed by the Commonwealth Government in 1984 with the establishment of a rainforest working group. The recommendations of that group resulted in the provision of significant funds by the Commonwealth Government for a National Rainforest Conservation Programme. Accordingly, a need arose for the rapid development of specific and detailed management strategies for the increasing area of the National Parks and Wildlife Service Estate that contains this vegetation formation.

The O.W.R.N.P. currently covers some 93,000 ha. of the Apsley and Upper Macleay River Gorges in north-eastern New South Wales. Within the Park and areas that could potentially be added to the Park, a considerable area of non-contiguous patches of dry rainforest exist, principally it appears, in the more sheltered gully lines and other fire refugia. This rainforest type is both restricted in distribution and poorly conserved (Gillison, 1987). Little research has been undertaken on this community in Australia and thus the existence of documented information about dry rainforest is limited.

Dry rainforest communities are characterised by an ability to cope with extreme moisture and thermal fluxes (Gillison 1987), and this is reflected in their distribution patterns. Despite this characteristic, as with other rainforest community types, dry rainforests are extremely sensitive to the impact of fire (Gillison 1987). Thus, the extent and survival of individual dry rainforest patches is, to a large degree, dependent on the prevailing fire regime. Fire is thought to be a predominant factor responsible for severely reducing and fragmenting distribution of the community type in Australia (Gillison 1987, 319). There is also some evidence to suggest that dry rainforest can rapidly recolonise areas once the threat of fire has been removed.

The dry rainforest in the Apsley - Macleay Gorges occur in striking juxtaposition to the surrounding sclerophyllous communities, in what appears to be a finely balanced equilibrium. As the adjoining sclerophyllous communities have various adaptations to fire (see Gill 1975, 1981), any management strategy implemented in this area is complex. While an attempt must be made to protect both communities, the management strategy for one may affect the other.

Currently, the policy of the National Parks and Wildlife Service (N.P.W.S.) in north-eastern N.S.W. is one aimed at increasing potential long-term management options for rainforest areas. (Friederich 1984, 622). According to Friederich, this is achieved by endeavouring to exclude fire from rainforest communities and to reduce the frequency of fire in adjoining, open-canopy communities. In some areas such as, Dorrigo National Park and Illuka Nature Reserve, the Service undertakes strategic hazard reduction burning in adjoining communities to maximise protection of the rainforest from wildfire (Friederich 1984, 622).

1.3 Specific Objectives of the Study

The specific objectives of this study are as follows.

i) A rapid synthesis of knowledge of the resource and it's likely interaction with fire in the study area.

ii) The development of a fire history record for the study area and determination of current fire management practices.

iii) An assessment of the distributional patterns of dry rainforests in the gorges and determination of the major environmental factors influencing distribution.

iv) The determination of the characteristics of the dry rainforest patches which are likely to influence the significance of a fire to the patch and the likelihood of a patch actually being impacted by fire events.

v) The development of a provisional classification system by which the fire vulnerability of every dry rainforest patch can be assessed (that is, the combined significance and likelihood of fire to each patch).

At present there is little documented information on dry rainforest. In particular, its interaction with fire is poorly understood. This deficiency is redressed by convening a workshop that combines existing research and management expertise. The topics covered aim to establish research and management priorities for the study area.

The second stage addresses the need for a comprehensive record of the fire history and current fire management practices for the Gorges. This involves an extensive interview survey of land managers (graziers) in the study area.

The third stage of the study examines the configuration and distribution patterns of the dry rainforest patches. The relationship of fire to these patches is then determined. This is undertaken at a broadscale level through the examination of every rainforest patch from aerial photography and topographic maps.

The final stage generates a procedure which classifies rainforest patches in terms of their fire vulnerability. Every rainforest patch in the Gorges is classified according to this procedure and grouped into four fire vulnerability categories. These categories reflect the combined significance and likelihood of fire impact to each rainforest patch.

1.4 Thesis Structure

The opening chapter of this thesis presents the study's context and aim. It also develops specific objectives to achieve the study's aim. Chapter 2 presents a review of the literature of rainforest - fire interactions. Chapter 3 describes the actual study area. Chapter 4 presents the results of the 'experts' workshop. Chapter 5 reports the fire history survey and Chapter 6 the characteristics and fire vulnerability assessment of the dry rainforest resource. The final Chapter discusses the key findings of the studies and presents conclusions and recommendations for management and further research.

CHAPTER 2

A REVIEW OF RAINFOREST – FIRE INTERACTIONS IN AUSTRALIA

2.1 Rainforest: A General Description

Rainforest is structurally, floristically, and ecologically distinctive from most other Australian vegetation formations. This tree dominated community, although varying in species composition and structure over its geographic distribution, is by definition a characteristically closed-canopy mesophytic formation (Working Group on Rainforest Conservation 1985, 19).

The closed-canopy structure of the formation creates and maintains a distinctive, buffered microenvironment which exerts considerable influence over the community as a whole. Within the rainforest community temperature extremes are reduced, humidity levels are generally higher. Leaf litter accumulations are generally low and the reduced solar radiation penetrating to the forest floor largely precludes the germination and establishment of shade-intolerant species such as annual herbs, grasses and sclerophyllous taxa (such as *Eucalyptus*) (Richards 1979).

Any disturbance to the rainforest canopy will alter the microenvironment of the forest, and may predispose the community to change. The full recovery of the rainforest ecosystem relies on the reconstruction of the forest canopy and the re-establishment of the 'protective' rainforest microenvironment (Horne and Gwalter 1982, 41).

2.1.1 Rainforest Subforms or Types

Over the geographic range of rainforest distribution in Australia, there exists considerable variation in species composition and structure related to changes in climate, soils, topography and other environmental factors (WGRC 1985, 19). Broadly, a trend of decreasing species diversity and structural complexity with increasing latitude and altitude (i.e. decreasing temperatures) exists. In northern Australia this trend is a response to the increasing severity of the dry season (WGRC 1985, 22).

Consequently, within the broad definition of rainforest five quite distinct major rainforest types or subforms have been recognised on the basis of stand structure, botanical composition and environmental features (Forestry Commission of N.S.W. 1984, 3). These subforms are: tropical rainforest; subtropical rainforest; warm temperate rainforest; cool temperate rainforest; and dry rainforest.

2.2 The Dry Rainforest Subform

2.2.1 Description and Characteristics

Since its initial use in Australia by Baur (1957), the term dry rainforest has been used rather generally to cover various seasonal, closed canopy vegetation formations including monsoon forests, brigalow / softwood ('bottle-tree') scrubs, araucarian vine thicket ('hoop pine scrubs'), deciduous vine thickets and semi-evergreen vine thickets (Gillison 1987, 306).

Gillison (*pers. comm.*) has described dry rainforest as a loose and highly variable assemblage of plant taxa geared to seasonal extremes. Further, the community varies according to a wide range of environmental gradients, but are particularly associated with the drier end of the water availability spectrum. He has also stated that these environmental gradients are modified by primary variables such as soil fertility and drainage but are also influenced by aspects of landuse including fire.

The dry rainforest formation contains floristic and structural elements from more mesic rainforest formations (i.e. subtropical rainforest) and is characterised by deciduous or semi-deciduous woody taxa (Gillison 1987, 306). Structurally, the community consists of a low, dense layer of small trees and vines, usually with a scattered overstorey of larger trees which often possess foliage adapted to drier conditions (Forestry Commission of N.S.W. 1984, 3-4).

Floyd (1983, 2) has stated that the community is relatively slow growing and of generally small stature with small, thick leaves. These characteristics reduce plant water loss and are thought to reflect both the seasonal status of available soil moisture and the generally limited total precipitation in the areas of its occurrence (Gillison 1987, 306). The community, therefore, is able to withstand extended periods of relatively extreme soil moisture deficits and is considered to be amongst the more resilient of all rainforest communities in Australia (Gillison 1987, 305).

2.2.2 Distribution and Status

The widespread and fragmentary nature of dry rainforest distribution makes the determination of their location difficult. Indeed, in cases where the canopy is non-continuous, then, strictly speaking, by definition they cannot be classified as rainforest (Gillison 1987, 316). This significant classificatory problem prevents an accurate assessment of their distribution. However, with the exception of some littoral zones in the east, dry rainforests are located in areas defined by Nix (1982) as 'highly seasonal' (i.e. areas with a greater than 60% coefficient of variation of weekly mean moisture index) (Gillison 1987, 306). These areas predominantly occur in northern Australia, but in the east extend down into N.S.W.

In N.S.W., the dry rainforests are usually located on the eastern slopes of the tablelands with the main distribution occurring from the Upper Clarence River area south to Dungog and Maitland (N.P.W.S. 1985). Further southwards, the dry rainforests decrease in size and become more depauperate. Northwards, there exists a major floristic break between the dry rainforests of far northern N.S.W. and Southern Queensland (N.P.W.S. 1985). Despite a few individual species extending through to Queensland, these more northern dry rainforest communities tend to contain more monsoonal elements.

Due to the recent emphasis on the conservation of the better known more mesic rainforest formations, the conservation status of the less well known and less aesthetically pleasing (sic) dry rainforest is parlous by default (Gillison 1987, 320). Only an estimated 25% or 18,000 ha. of the total dry and depauperate rainforest resource existing in northern N.S.W. is suitably reserved (Floyd 1987, 97). The estimated remaining 53,000 ha. occurs in State Forests or on private land. Furthermore, some 67% of the dry rainforest suballiances in northern N.S.W. are inadequately conserved, while three suballiances are not conserved at all (Floyd 1987, 99).

In recent years, landuse pressures have dramatically reduced the area of dry rainforest available for conservation (Gillison 1987, 320). Currently, threats exist to remaining dry rainforest distribution as much of the remaining areas tend to be on leasehold and freehold land or in State forests and areas of interest for mineral exploration (Hitchcock 1984,7).

Thus, the conservation and management of the Apsley - Macleay Gorges dry rainforest would appear to be a priority, especially in view of the fact that they form a floristically distinct group of communities with some species restricted to the Gorges (King 1980; Floyd 1980, 1983). Collectively, the patches of dry rainforest scattered throughout the Apsley - Macleay Gorges probably represent the most extensive area of this vegetation community type in N.S.W.

2.3 Rainforest - Fire Interactions

2.3.1 Rainforest Segregation

The present thinking on the patterns of rainforest distribution, the subforms that occur and more specifically their boundary location in Australia, is that they are largely determined by the interactions between several factors. These factors include climate, topography, edaphic features, and also, particularly on a local scale, the product of the pattern of fire occurrence (Smith and Guyer 1983, 55; Unwin 1983; House 1986; Ash 1988, 628).

Geographic differentiation between rainforest and open forest was originally attributed to either soil parent material or soil nutrient status (Baur 1957; Moore 1959; Tracey 1969; Webb 1969). However, Webb and Tracey (1981) concluded that although rainforest vegetation favoured high fertility, basaltic soils, rainforests could be found on a wide range of soil types and fertility levels. Research has indicated that in general, nutrients are cycled comparatively rapidly in rainforests, enabling it to tolerate poor soils with limited nutrient fertility (Richards 1979, 220; Werren and Allworth 1982, 13). Stocker and Unwin (1986) proposed that soil fertility differences were more likely to influence vegetation dynamics on the rainforest edge by influencing fire behaviour.

The almost complete segregation of rainforest communities from the more ubiquitous open-canopied forest and woodland vegetation communities in Australia seems to be largely the result of two factors. The first is the higher light requirements of the open-canopied (largely *Eucalyptus* dominant) communities and the second is the differential adaptation to fire of the two broad community types.

In general, rainforest species are able to regenerate continuously within the shaded environment created by the community's dense canopy and do not rely on large scale disturbances, such as fire to maintain the vegetation type (Webb and Tracey 1981; Duff 1987). In contrast, the more open-canopied vegetation communities require high light conditions to germinate and grow (Webb and Tracey 1981, 70). In addition, most open-canopied communities have certain adaptations permitting their survival as a community within a specific fire regime, with many species favourably responding to fire, whilst rainforest is generally intolerant of recurrent or intense fire and can be significantly damaged by it (Ash 1988, 619). This contrasting response to fire represents a fundamental ecological difference between rainforest and the more open-canopied vegetation communities in Australia.

2.3.2 The Significance of Fire

Conditions allowing fire to penetrate Australian rainforests are relatively rare (Stocker 1981). Under 'normal' conditions rainforest formations usually avoid fire largely due to the nature of the community's structure and resulting buffered microenvironment (described in Section 2.1), and by the generally low combustibility of the foliage (Duff 1987, 180). However, under certain conditions (i.e., following disturbance modifying fuel conditions and availability or following extended dry periods), fire can and does periodically impinge on rainforest communities and can result in considerable damage to the fire-sensitive rainforest taxa and community structure.

Although coppicing has been observed to occur in almost all rainforest types after a single fire event (Cromer and Pryor 1942; Powrie 1981; Stocker 1981; Howard 1981; Erskine 1984; Unwin, Stocker and Sanderson 1985), repeated fire will destroy much of the regeneration and may lead to the establishment of a more fire tolerant vegetation formation (Stocker 1981).

Despite the inherent 'protective' characteristics of rainforest, evidence exists of fire occurrence in these communities world-wide (Schulz 1960; Mueller-Dombois and Lamoureux 1967; Mueller-Dombois 1981; Woods 1985). In Australia, contemporary fires have been witnessed in most rainforest types (Gardner 1961; Baur 1964; Hill 1982; Hill and Read 1984; Mills, cited in House 1986).

2.3.3 Fire Impacts on Rainforest Communities

The vegetation communities adjoining rainforest in Australia, with their more open canopies and hence denser substrata and greater accumulated fuel, dry out more rapidly than rainforest and carry fire much more effectively and frequently (Howard 1981, 105). The taxa comprising these adjoining communities possess adaptations and strategies which permit them to persist as a community within a fire regime. In many circumstances these communities actually depend on recurrent fire for their perpetuation. The intensity of fires in these communities is influenced by the nature and condition of available fuel (determined by the predominant vegetation and climatic factors), topography and wind strength and direction (Duff 1987, 166).

These fires can enter rainforest under certain conditions (e.g., during prolonged dry periods, after severe frosts and after damage to the forest canopy) but more often result in scorching of the rainforest margin leading to tree mortality and if recurrent and sufficiently intense, the retreat of the rainforest margin (Baur 1968, 54; Werren and Allworth 1982, 66). The situation may be exacerbated by the opening up of the rainforest margin, facilitating the influx of rapidly establishing flammable opportunist species such as grasses, herbs and shrubs (Stocker and Mott 1981, 433). Thus, if fire events recur sufficiently frequently or intensely enough, alteration to the rainforest margin structure or its geographic location will result (Unwin *in press*).

The likelihood of an area of rainforest being burnt and the impact that any single fire event will exert on the community will be influenced by the specific rainforest type or subform and physiological condition prior to a fire and the nature of the adjoining vegetation community (i.e. fuel levels and fuel condition). The severity and duration of dry seasons prior to and after a fire are other considerations. Also of importance is the nature and extent of any damage to the structure of the rainforest community as this may permit the accumulation of fuel and establishment of flammable species within the community itself.

Prolonged dry periods and severe droughts occur even in optimum rainforest habitats (Stocker and Unwin 1985; Winter, Atherton, Bell and Pahl 1987). Abnormally dry seasons predispose rainforest to fire damage by causing a breakdown in the community's buffering microenvironment and hence lowering the moisture content of humus and litter, particularly at the forest margins. (Hill 1982). Erskine (1984) has reported from studies of subtropical rainforest in N.S.W., that rainforest fuels dry out more rapidly than adjoining community fuels. Fuel levels may also build-up through increased leaf accession from the canopy and through the decreased litter decomposition resulting from the dry conditions (Ridley and Gardner 1961).

Rainforest disturbance, resulting from climatic factors (i.e., high winds) or human activities, alter the community structure and buffered microenvironment and causes an increase in the fuel loads through the addition of litter and debris from damaged and fallen trees (Stocker and Mott 1981, 433; Stocker and Unwin 1986). The normally moist, humid conditions of the rainforest floor are altered and the resulting increased insolation may facilitate the invasion and establishment of the disturbed area by more flammable vegetation types. The net effect of such disturbance is that the normally fire-proof rainforest community will burn if ignited during periods of warm, dry weather (Stocker and Unwin 1985).

Fires which actually penetrate beyond the rainforest margin, into the community proper, are usually confined to the litter layer and burn at low intensities (Hill 1982; Sanford, Saldarriaga, Clark, Uhl and Herrera 1985). However, Ridley and Gardner (1961, 227) have cited observations of both ground and crown fires occurring in subtropical rainforest of southeast Queensland. Such occurrences are rare and are only likely to arise in extreme weather conditions.

More common in Australia, is for fires in the adjoining open canopied (or phyrophytic) communities, to burn up to and extinguish itself on the rainforest edge, resulting in the scorching and damage or mortality of a band of rainforest taxa of varying width along the boundary (WGRC 1985). The canopy reduction on the rainforest edge facilitates the rapid establishment of flammable opportunist species such as grasses, encouraging recurrent fire in subsequent seasons. If the process is repeated frequently enough, the rainforest margin will gradually retreat. The influx of opportunist species and the resulting changes in the soils may restrict rainforest regeneration and this situation will be maintained for as long as fire is prevalent (Rundle 1981, 527).

In north Queensland, annual burning of rainforest margins has resulted in the replacement of rainforest by grassland, especially on relatively shallow and infertile soils (UNESCO 1978, 193). On the poorer soils, Howard (1981) has suggested that rainforests may have a shorter and more open structure and be less resilient to disturbance factors such as fire. Furthermore, Webb (1968) has noted that successional development after a fire, occurs more slowly on poorer soil sites thus increasing the chances of a further fire occurring before the more 'fire-proof' stage of rainforest development has been achieved.

2.3.4 Rainforest Boundary Dynamics

As rainforest communities often occur as relatively small, disjunct patches surrounded by open-canopied and hence generally more flammable vegetation, their margins assume considerable importance in terms of forest succession (Unwin *in press*). Furthermore, the smaller the rainforest patch, the more influential and critical are boundary dynamics to the maintenance of the community (Unwin *in press*).

The structure and composition of rainforest boundaries (or ecotones) separating open-canopied vegetation from rainforest provide a strong indication of the dynamic nature of the boundary (Unwin *in press*). Differences in the boundaries or ecotones of rainforests are thought to be related to different fire behaviour and regimes affecting the community under particular seasonal, climatic, topographic and edaphic conditions (Webb and Tracey 1981, 92).

From recent studies in north Queensland, Ash (1988, 626) has suggested that narrow transitional boundaries (i.e., ecotones *ca.* <20m wide) separating rainforest from open-canopied communities represent relatively stable boundary situations under existing conditions, while wider ecotones (i.e., *ca.* 20-200m) are successional, and very wide ecotones (i.e., *ca.* >200m) are unstable. Different fire regimes and fire behaviour, relating to differences in environmental conditions (i.e., climate, physiography, flammability and fuel loads of adjoining communities), were thought to be largely responsible for these boundary differences (Ash 1988, 626).

It appears that there is a general trend for ecotones to vary and change with latitude in response to differing fire regimes in communities adjoining rainforest. These differing regimes stem from variations in climate, vegetation and hence fuel-related factors occurring between the northern and southern distributional limits of Australian rainforests. However, Ash (*pers. comm.*) has suggested that patterns of topography and substrate etc. probably influence rainforest boundaries in all regions and hence wide and narrow boundaries occur at all latitudes under appropriate conditions.

Current evidence suggests that vegetation succession at the rainforest boundary largely favours rainforest in the absence of fire, but is against rainforest where fire is prevalent (Unwin 1983, Smith and Guyer 1983, House 1986). In essence, where fire is excluded from open-canopied communities in the vicinity of rainforest, successional processes may lead to the gradual replacement of the open-canopied community by rainforest, providing factors such as soils and climate are not limiting (House 1986). Conversely, destruction of rainforest by fire might, if fire is recurrent thereafter, allow its replacement by open-canopied community taxa.

Thus, it appears that the absence of fire disturbance is necessary for succession favouring rainforest, but in many circumstances the disturbance by fire is essential for succession favouring the more open-canopied community taxa. Therefore, it appears that manipulation of the fire regime will allow management of the position of the rainforest margin.

2.3.4.1 Arrested or Deflected Rainforest Succession

With single or infrequent, low intensity fire disturbance in rainforest, a constructive succession leading to the re-establishment of the rainforest structure and microenvironment usually occurs (Baur 1964, 53). Although high tree mortality rates may initially result from fire impact, the ability of many rainforest species to coppice enables them to favourably compete with invasive 'weeds' arising from seeds and thus to re-establish the protective rainforest canopy (Stocker 1981; Unwin, Stocker and Sanderson 1985).

However, fire impact does not necessarily initiate a constructive or progressive vegetation succession leading back to the pre-existing 'climax' rainforest community. Where conditions develop facilitating the recurrence of fire events, the rainforest taxa are unable to regenerate repeatedly, vegetatively or by seed (Stocker 1981). Hence, succession may be arrested at a stage prior to the establishment of the 'climax' rainforest, or the succession may actually be deflected and result in the establishment of a different, more fire tolerant vegetation community (Hopkins 1981). It is the inter-related effects of both changes in physical site factors and changes in biological site factors which cause successional processes to be arrested or deflected (Hopkins 1981).

2.3.4.2 Rainforest Expansion

In recent times in Australia, many reports have identified the active advance of rainforest margins, invading adjoining communities (Fraser and Vickery 1938; Dodson 1984 in the Barrington-Glouster Tops district of N.S.W.; Stocker 1981; Stocker and Unwin 1985 in northeastern Queensland; Ellis 1985 in northeastern Tasmania; and Clayton-Greene and Beard 1985 in northern Western Australia).

Much of the current advance has been attributed to reductions in fire frequency following the change from Aboriginal to European land-use practices (Ellis 1985; Stocker and Unwin 1985). In the Barrington Tops district of N.S.W., Fraser and Vickery (1938) stated that the rate with which rainforest advance occurs varied with the aspect and degree of the slope of the site. Cromer and Pryor (1942) reported from studies of subtropical rainforest in southern Queensland, that a slow rate of rainforest advance (as evidenced by a narrow ecotone) occurred on steep rocky slopes, while a rapid rainforest advance (i.e., a wide ecotone) occurred on areas of higher site quality. Similarly, Ellis (1985, 309) has stated that with cessation of burning, the establishment of cool temperate rainforest in Tasmania is most rapid on moist sites and southern aspects and slowest on convex topography with northern aspects.

Rainforest margin expansion is not limited to Australia. Gillison (1983) records expansion in areas of the south-west Pacific; Wade (1968); Gillison (1969, 1970, 1984); Paijmans (1976); Corlett (1979); Grubb and Stevens (1985) in montain New

Guinea; Hopkins (1965); Walker (1981) in Africa; Holmes (1951) in Sri Lanka; Kellman (1979) in Central America; and Mueller-Dombois and Lamoureux (1967) in Hawaii.

Ecotonal communities, particularly in southern Australia, separating rainforest from open-canopied forest generally represent a successional stage in the progression from pyrophytic open communities to relatively incombustible rainforest. The position of the ecotone, therefore, does not represent a stable community separating rainforest from the open-canopied communities (Smith and Guyer 1983; House 1986).

The dynamic state of transition forests is a reaction to the frequency and severity of wildfire and other disturbances (WGRC 1985). Successful wildfire control measures and minimal disturbance will favour continued rainforest expansion, whilst increased fire or disturbance to rainforests from other sources will reinforce the dominance of open forest in many areas (WGRC 1985).

2.4 The Situation in the Apsley - Macleay Gorges

Currently, grazing leases cover extensive areas of the Apsley - Macleay Gorges. The graziers controlling these leases use fire as a regular part of their property management programmes. In addition, wildfire is also a prevalent factor in the gorges.

Within the Gorges, the N.P.W.S. controls several disjunct areas totalling approximately 92,000 ha. at present. However, the Service intends to acquire further areas of the gorges as they become available and potentially the Oxley Wild Rivers National Park may extend to some 195,000 ha., encompassing most of the currently existing grazing leases.

Within the gorges, despite a long history of stock grazing, very little vegetation clearing has been undertaken. The area's vegetation predominantly consists of extensive eucalypt forest and woodland communities interspersed with numerous and widely distributed dry rainforest patches.

Despite the ability of dry rainforest to cope with high moisture and thermal fluxes, as with other rainforest types, dry rainforest is extremely sensitive to the impact of fire (Gillison 1987, 319). Thus, the extent and survival of individual dry rainforest patches is largely dependent on the fire regime. Indeed, fire is thought to be a predominant factor responsible for severely reducing and fragmenting distribution of the community type in Australia (Gillison 1987, 319). Furthermore, in the complete absence of fire, it has been reported that the dry rainforest subform that currently exists in many fire refugia would rapidly expand (Gillison 1987, 319).

Floyd (1983, 2) has stated that the characteristics of the dry rainforest in the Gorges suggest that edaphic factors are of reduced importance to the distribution of the community compared to that of the more mesic rainforest types in Australia. Within the Apsley - Macleay Gorges, Floyd (1983, 1) perceived that topography and freedom from wildfire were more important than edaphic factors in the location of rainforest patches. He considered that the patches of dry rainforest that have persisted in an otherwise hostile environment are largely the result of protection from fire and desiccating winter westerly winds in addition to the increased availability of ground water and prevalence of fogs and mists afforded by the steep topography (Floyd 1983, 18). According to Floyd (1983, 1), the currently existing pockets of dry rainforest in the Gorges provide an indication of the past distribution of the community under differing climatic and fire conditions.

The fragmented distribution of dry rainforest in the Apsley - Macleay Gorges is clearly evident. There are some 730 discreet rainforest patches distributed over the 290,000 ha. study area interspersing the dominating Eucalypt forest and woodland vegetation. Consequently, the management of the Oxley Wild Rivers National Park poses special problems for the Service in that substantial changes in the park's vegetation communities seem possible, depending on the fire regime that managers allow to develop. In particular, the very poorly conserved and researched dry rainforest vegetation type, with some 2,600 km. of boundary adjoining flammable vegetation communities, is at considerable risk of attrition from unmanaged fire.

CHAPTER 3

THE STUDY AREA

3.1 Introduction

This chapter describes the physical and managerial environment of the Apsley - Macleay Gorges study area. The distinctive landscape of the Gorges is reflected in the diverse and complex vegetation patterns that exist, and limits the potential management opportunities that are available for the area.

3.2 Location and Extent

In plan, the study area covers approximately 290,000 Ha. and encompasses the gorges and some of the surrounding tableland of the Apsley and Macleay rivers immediately east of Armidale in north-east New South Wales ($30^{0}30'$ - $31^{0}10'$S, $151^{0}40'$ - $152^{0}20'$E). The western boundary of the study area largely follows the escarpment edge, which separates the tableland from the 'coastal belt' (Ollier 1982). The eastern boundary is less topographically distinct, extending to the Carrai Tableland.

3.3 Existing Tenure and Landuse

Various land tenures exist within the study area including: Crown Land; State Forests; National Parks and Nature Reserves; and Freehold land. Within these tenures, six defined landuses are undertaken and include: rural; conservation; extractive industry; forestry; and infrastructure developments (i.e. hydro) (Crown Lands Office 1985, 7). The general trend for land tenure in the study area is one of various Crown leaseholds predominating in the gorges sections and freehold dominating on the tableland sections.

Rural activities currently predominate in the study area but are limited to beef cattle and sheep grazing. Whilst the majority of the tableland sections of the study area are cleared of native timber for pasture, the gorges are largely naturally timbered except for small areas adjoining the tablelands and scattered areas along the alluvial flats of the Macleay River and its tributaries.

Agricultural use of the gorges is limited to relief winter grazing of cattle only. Cattle range over much of the gorge country but are concentrated in the cleared river flats and lower slopes due to the steepness and instability of much of the area. These areas are relatively small and hence the overall carrying capacity of the gorges is very low, being estimated at approximately 1 beast per 40 ha. (Brickhill 1974). Indeed, the Department of Agriculture (1985, 1) and Soil Conservation Service (1985, 3) consider most of the Gorges to be unsuitable for any type of agricultural or pastoral use. The entire area is classified as being of class 5 agricultural suitability.

Nature conservation and recreation also represent significant actual and potential landuses in the study area. The area has been recognised as the third largest potential wilderness area in N.S.W., with an undisturbed core of some 71,500 ha. (Department of Environment and Planning 1985, 24). Further, three important wild and scenic river systems have outstanding aesthetic and recreational values within the study area (D.E.P. 1985, 24).

At present, the N.S.W. National Parks and Wildlife Service manages approximately 93,000 ha. representing some 32% of the Apsley - Macleay Gorges study area. This area forms the Oxley Wild Rivers National Park and is comprised of several disjunct parcels of land almost exclusively confined to the gorges. The Service is continuing with a policy of slowly acquiring areas of the Gorges as they become available and potentially, the

Oxley Wild Rivers National Park may extend to include some 195,000 ha., encompassing almost the entire gorge system.

State Forests and mining are largely restricted to the tableland around the periphery of the gorges with some mineral exploration conducted in favourable geological environments within the gorges themselves.

3.4 Physiography

The Apsley - Macleay Gorge system forms an entire and largely undisturbed biophysical province characterised by very steep hillslopes, interfluves and low gradient rivers (N.P.W.S. 1985).

The gorges are dominated by very steep slopes. Hillslope steepness is greatest towards the escarpment edge in the narrow upper gorges and adjoining tableland remnants. In these areas active erosion is common. These upper gorges are very narrow, their floors often only a few metres wide. Slopes vary from around 40^0 to 60^0, and local relief can be up to 600 metres (King 1980, 14). Downstream the gorges widen out with the gorge floor extending up to 500 metres wide permitting some development of alluvial flats.

Local relief in these middle and lower sections of the gorges is greater than in the upper sections while slopes are generally less steep. Local relief often may exceed 800 metres while slope angles are typically in the order of 15^0 to 30^0 (King 1980, 14).

Appendix 3.1 presents summary information on the range and extent of slope angles, aspects, and elevations in the study area from the N.P.W.S. Environmental Resource Mapping System (E-RMS) data base. Within the deeply dissected gorges, altitude ranges from less than 100 metres to in excess of 1,200 metres and slopes are predominantly 10^0 to 40^0.

3.5 Geology and Soils

The geology of the study area is fairly uniform, being dominated by Permian metamorphosed sediments, but also with areas of diorites, adamellite and small areas of basalt (see Figure 3.1) The major rock types are shales, greywackes and sandstones which have frequently been subjected to low grade metamorphism to form slates and phyllites (King 1980, 16). These rocks have generally been subjected to considerable deformation with a well developed cleavage often being present as well as numerous joint planes.

The patterns of soil distribution are related to parent material as well as topography and drainage. The major portion of the study area is covered by skeletal lithosolic soils particularly in the gullies and on the steeper slopes while podsols occur on the tableland and more gentle slopes (King 1980, 24). All rainforest sites sampled by King and in the present study occurred on the skeletal lithosolic soils, which were characterised by a high content of rock fragments and ranged from approximately 5 cm to 40 cm. in depth.

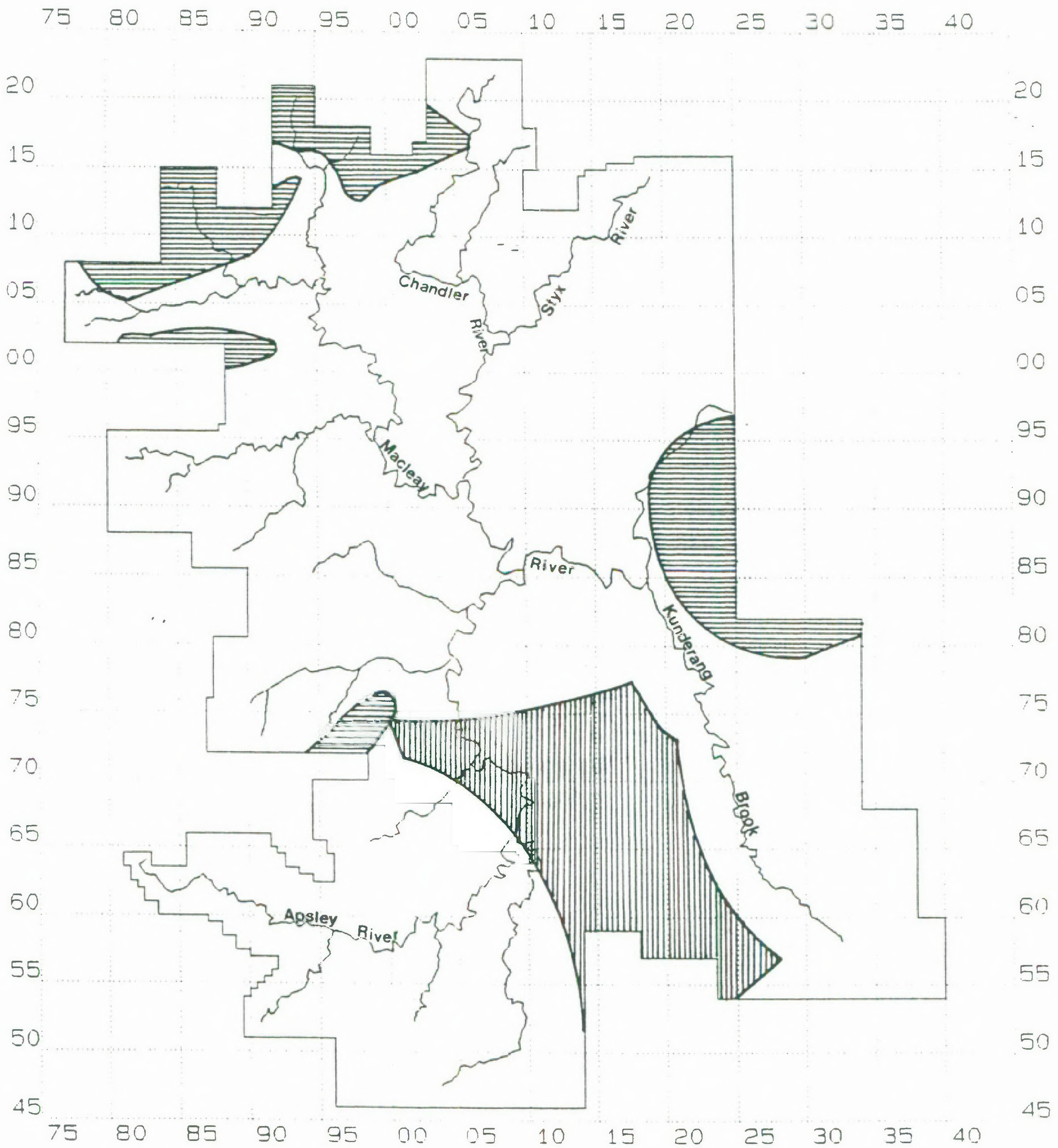
3.6 Climate

3.6.1 Precipitation

Average annual rainfall varies markedly over the study area. King (1980, 19) compiled an average annual rainfall isohyet map for the Apsley - Macleay Gorges from Bureau of Meteorology and private landholder records and this is presented in Figure 3.2. Although the rainfall pattern is highly variable, it tends to increase from less than 800 millimetres in the west to over 1,200mm in the east. However, the higher rainfall area in the east is divided by a drier area centred around the confluence of the Apsley and Macleay Rivers. This drier area is thought to result from the rainshadow effect of the Carrai Tableland (N.P.W.S. 1985).

Figure 3.1

Geology of the Apsley - Macleay Gorges



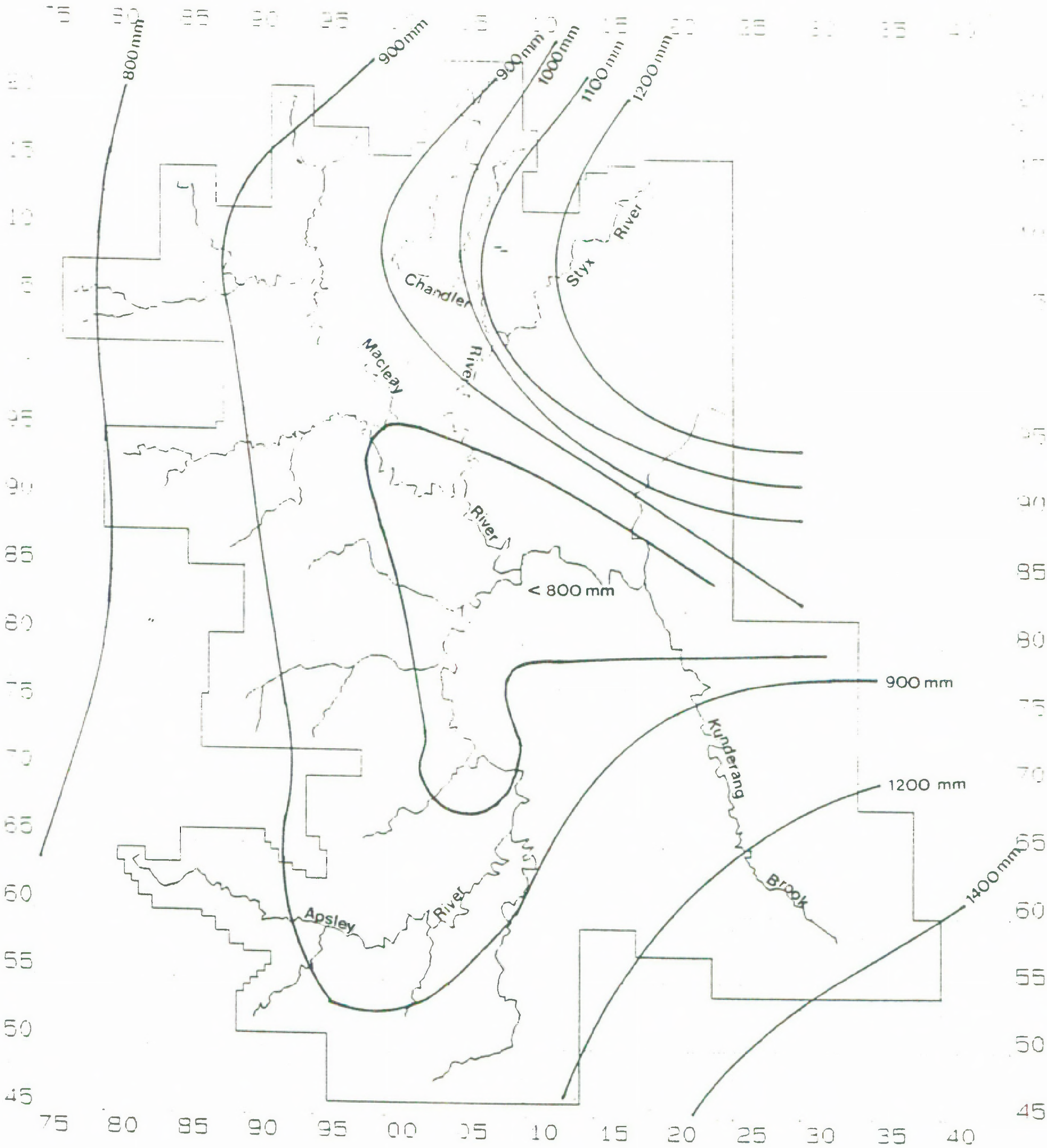
Granitic rocks

Chert, metabasalt, pebbly mudstone, greywacke

Greywacke, slate, phyllites and schists

Figure 3.2

Average Annual Rainfall Isohyet Map



The higher rainfall in the north-east and south east of the study area results from increased rainfall intensity rather than an increase in the number of days on which rain falls. Further, the seasonal distribution of rainfall suggests a summer dominance with a drier winter. However, while this is the norm it is not uncommon to have some years with very low rainfall in the summer months and heavy rain can occur at any time of the year.

Substantial local variations in rainfall can occur due to the high proportion of total rainfall coming from thunderstorms and the influence of the rugged topography. Appendix 3.2 summarises the approximate proportions of the study area positioned within each annual rainfall isohyet class delineated by King (1980). Whilst average annual rainfall does exceed 1,200mm in some areas, approximately 65% of the study area receives less than 900mm rainfall per annum.

3.6.2 Mist

King (1980, 113) found that in areas with greater relief, precipitation may be influenced by topography, being supplemented by fog drip and mist related drizzle at higher altitudes in the autumn and winter months (May-August). Where mist was not associated with rain, it was restricted to the upper slopes and top of the gorge.

3.6.3 Humidity

King (1980, 113) found that relative humidity maxima did not vary significantly with either altitude or forest type in the gorges. However, these factors did have a significant effect on minima readings. Data suggests that humidity minima are greater moving down the gorge slopes and were substantially greater in rainforest than woodland.

3.6.4 Temperature

Temperatures are warm in the summer and cool to cold during winter. The general trend within the area is towards increasing temperatures in the West (Hobbs and Jackson 1977). This is most pronounced with maximum temperatures, the differences in minima being relatively minor.

Within the actual study area, the main factors that are likely to affect the temperature are changes in altitude and topography. Based on the altitudinal thermal gradient of about 5^0C for every 1,000m height difference, temperatures on the gorge floors can be expected to be significantly greater than those on the tableland and gorge edge. The effect of altitude on temperature is further emphasised by the difference in frost-free days from only 200 on the tableland to over 300 on the Macleay below East Kunderang (N.P.W.S. 1985, Chapt. 2).

Within the Gorges themselves, temperature effects are likely to be further modified by the influence of local topography. For example, the shading effects of the gorge sides could be expected to influence day-time maxima whilst cold air drainage at night would influence the night-time minima.

King (1980, 113) found that both minimum and maximum temperatures increased with falling altitude in the gorges. However, due to the shading effects of the gorges, maximum temperatures are highest about midway down the slopes rather than at the gorge floor. Rainforest also has a modifying effect on temperatures with these communities being associated with generally warmer minima and cooler maxima.

3.6.5 Wind

The dominant wind directions (derived from Armidale data) vary with the season. In summer and autumn the major trend is for winds to be from the east and south-east. It is these warm, moisture laden winds, associated with the summer easterly airstream, that bring the summer rains to the north-eastern section of N.S.W. In winter and spring strong westerly winds are most frequent. These generally dry and desiccating winds are seldom associated with rain. Occurring as they do in the drier months, they are likely to add to any water-stress problems that may occur in the plant communities in the Gorges. Further, as with temperature, wind direction and speed are likely to be modified by topography and local relief.

3.7 Ground Water

King (1980, 113) has stated that the heavily jointed nature of the palaeozoic sedimentary-metamorphic rocks of the study area appear to facilitate the movement of ground water and thus provide an additional source of moisture for plant growth. King (1980, 113) suggested that ground water coming to or near the surface of the gullies in the gorges may be a major contributing factor to the virtual restriction of rainforest patches to such gullies.

3.8 Vegetation

3.8.1 Sclerophyll Communities

The vegetation of the study area can be divided into three broad vegetation types, sclerophyll forest, woodland and rainforest. Appendix 3.3 presents the relative areas and proportions of the study area covered by each main vegetation community.

It is evident from Appendix 3.3 that most of the study area contains sclerophyll communities and these are usually dominated by ***Eucalyptus*** species. The N.P.W.S. (1985) has recognised 25 sclerophyll plant communities in the study area.

Twelve of these communities are located on the tableland remnants existing in the area, forming a diverse mosaic of vegetation. The gorge rim also supports a distinctive vegetation which is thought to be related to the extreme conditions for plant growth in this area, such as the conditions arising from the continual loss of water, soil and nutrients downslope.

As stated earlier, steep slopes make up the majority of the study area. The dominant plant community on these slopes is the ***Eucalyptus tereticornis* - *E. laevopinea*** (or ***E. eugenioides***) - ***E. melliodora* - *Angophora floribunda*** association. In Kunderang Brook and other areas, the more coastal species ***E. eugenioides*** replaces ***E. laevopinea.*** On the lower gorge slopes ***E. moluccana*** grades into the association. Rainforest communities also occur on these steep slopes and will be discussed later.

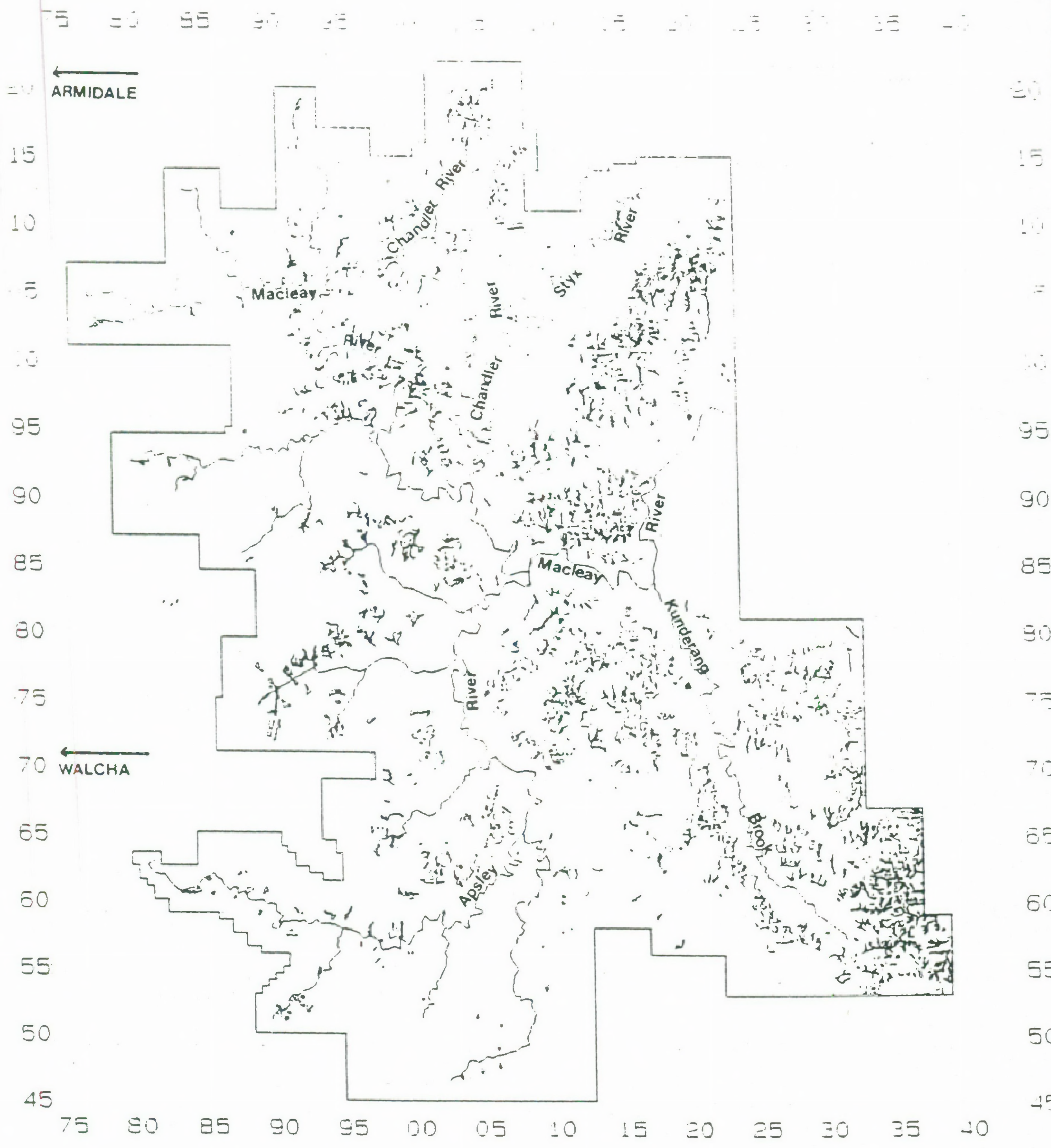
Four plant communities have been described for the valley floors in the study area. These include: ***E. conica and E. albens***, whilst ***E. dealbata*** occurs along rivers and lower slopes in the north-western part of the study area. A ***Casuarina cunninghamiana* - *Melaleuca bracteata*** community is widespread along all the major water courses.

3.8.2 Rainforest Communities

Subtropical, warm temperate, cool temperate and dry rainforest communities are all represented in the study area but the dry rainforest type is by far the most common. This latter rainforest type is widespread in the gorges (see Figure 3.3). Estimates of the area of dry rainforest in the gorges ranges from over 5,000 Ha. by King (1980, 24), to over 13,000 Ha. by the N.P.W.S. (according to their E-RMS data base) and around 18,000 Ha. from the present study. These latter two estimates may also include the small areas of the other rainforest types that occur in the gorges. These other subtropical, warm temperate and cool temperate rainforest types are restricted to

Figure 3.3

Rainforest Distribution in the Apsley - Macleay Gorges



the very south-eastern and north-eastern sections of the study area.

Although largely forming a continuum, the N.P.W.S. (1985, Chapt. 3) have divided the dry rainforests of the Apsley - Macleay Gorges into four structural physiognomic groups according to the definitions of Webb (1978). This work was predominantly based on research by King (1980) and Floyd (1983) and was supplemented by their own surveys. The four groups are:

i. open microphyll mossy thickets;

ii. microphyll mossy thickets;

iii. low microphyll mossy vine forest; and

iv. medium microphyll / notophyll mossy vine forests.

3.8.2.1 Open Microphyll Mossy Thickets

These communities occur on highly unstable slopes, particularly towards the heads of gorges where the gorges are narrow and slopes often exceed 40^0 and show evidence of frequent rock falls and / or scree movement. The vegetation on these slopes consists of scattered rainforest species which do not form a closed canopy, although localised patches within these thickets may be closed.

The dominant species in these communities are the hardier, more tolerant species such as ***Notelaea microcarpa*** var. ***velutina, Alectryon forsythii, Ficus rubiginosa, Alphitonia excelsa*** and ***Mallotus philippensis***. These species generally exhibit a mallee-like growth form and rarely exceed 3m in height.

Areas of these communities are most common in the gorge heads in the drier western parts of the study area. In particular, they occupy quite large areas in the Apsley and Tia Gorges, and the upper Chandler and Salsbury Waters.

3.8.2.2 Microphyll Mossy Thickets

This rainforest type is restricted to locally favourable pockets of soil in areas where there is minimal moisture for rainforest development and adequate protection from desiccating winds and sun. These thickets, which consist mainly of multi-stemmed individuals with a closed-canopy level of only 2.5 - 4m, are both structurally and floristically simple. They consist predominantly of an ***Alectryon forsythii* - *Notelaea microcarpa*** var. ***velutina*** association.

3.8.2.3 Low Microphyll Mossy Vine Forest

This dry rainforest group forms the bulk of the rainforest in the Gorges. The major associations within this group are the ***Olea paniculata* - *Geijera salicifolia* - *Diospyros australis*** association and the ***Backhousia sciadophora* - *Bauerella simplicifolia*** association.

This rainforest group is more diverse and is generally found where greater available moisture and / or protection from the harsher aspects of climate create more favourable sites. The canopy is generally up to 10-15m high and species diversity is considerably greater than that in the Microphyll Mossy Vine Thickets discussed above.

3.8.2.4 Medium Microphyll Mossy Vine Forest

This group occurs in moist sheltered gullies, particularly where the soils have been enriched by basalt. These forests are more diverse in terms of species and structural complexity, often with subtropical elements, and frequently with a canopy at 25 - 30m.

The major associations with this rainforest group are the ***Backhousia sciadophora* - *Dendrocnide excelsa* - *Daphnandra micranthra*** association and the ***B. sciadophora* - *D. excelsa*** association. Emergents are common and usually include ***Ficus*** *macrophylla, Ehretia acuminata, Olea paniculata and Dysoxylum fraseranum* and in the better developed forests, *Toona australis, F. macrophylla and Brachychiton discolor.*

3.9 Disturbance Factors and Rainforest Regeneration

Naturally high levels of sheet erosion are widespread on the steep slopes in the Gorges. Any factors which will reduce and disturb the existing ground cover on these slopes, such as grazing and fires (both wildfires and controlled burning), will greatly accelerate the erosion processes (Soil Conservation Service 1985, 3).

The general instability of the soils and scree on the steep slopes of the Apsley - Macleay Gorges appears to be a major factor causing disturbance to the dry rainforests that occur there. The movement of scree on the steep slopes can potentially uproot and clear considerable areas of rainforest. King (1980, 108) observed that tree species with wide ecological tolerances such as *Ficus rubiginosa* and *Alectryon forsythii* were the first colonisers of newly bare areas, whilst climbers formed an important regenerative feature on the edges of remaining rainforest.

Fire has been recognised as an active disturbance factor to the rainforests in the Gorges (King 1980, 111-112; Floyd 1983, 1-2; N.P.W.S. 1985). By its nature, the abundant, flammable sclerophyll vegetation that adjoins much of the rainforest would ensure that fire would be an important ecological variable in the study area. King (1980, 111) observed abundant evidence of the effects of past fires, such as the presence of burnt tree trunks and typical fire-related species such as the grass *Imperata cylindrica*.

King (1980, 111) observed only limited ecotones separating the rainforest from the surrounding sclerophyll vegetation, consisting largely of prickly shrubs in conjunction with scattered rainforest species such as *Mallotus philippensis,*

Rapanea howittiana and ***Diospyros australis*** as well as species of the genus Acacia (e.g., ***A. diphylla***). More frequent were sharp boundaries with the sclerophyll community with no ecotone present, and fire evidence, such as tree fire scars, suggesting that these abrupt boundaries were an artifact of fire (King 1980, 112).

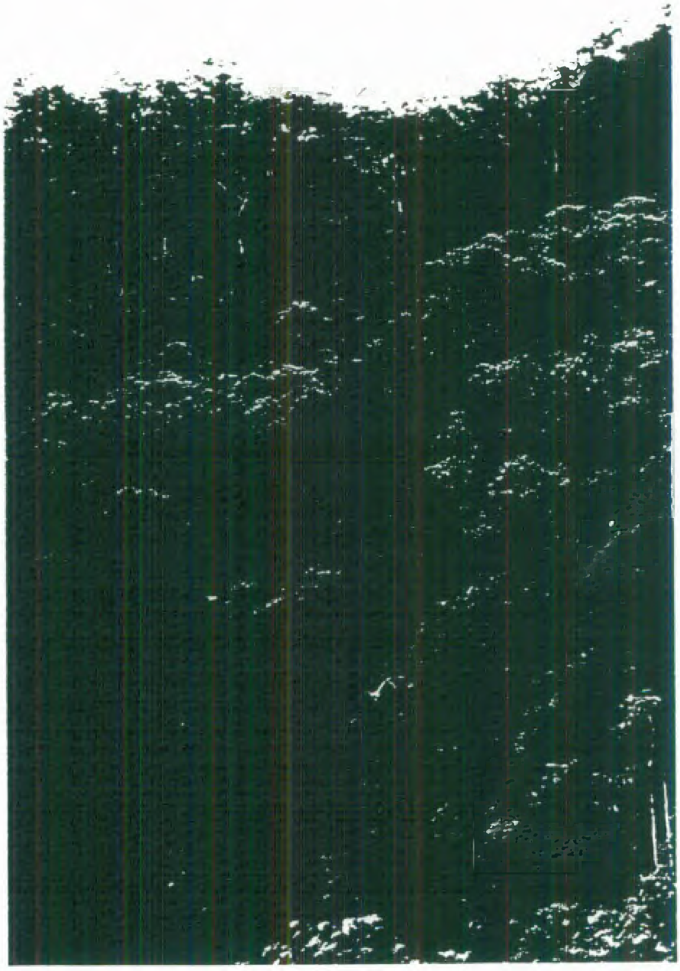


Plate 1

Dry Rainforest

Plate 2

The Ecotone

Plate 3

Grassy Ecotone

Plate 4

Fire scarred Rainforest Tree

Plate 5 and 6

High Grassy Fuel Load Adjoining Rainforest

CHAPTER 4

EXPERTS WORKSHOP

4.1 Introduction

The existing, available information on the ecological and biological characteristics of dry rainforests and particularly the community's likely interaction with fire in the Apsley - Macleay Gorges is very limited. Accordingly, a workshop was held to facilitate the rapid pooling of relevant research and management experience. This workshop brought together a group of research scientists and resource managers with significant experience or knowledge of dry rainforest and / or rainforest - fire interactions. This chapter presents a synthesis of the workshop discussions. It also identifies some management and research priorities for the Apsley - Macleay Gorges that evolved from the workshop discussions.

4.2 Aims and Objectives of the Workshop

The overall aims of the workshop were to combine research and management expertise to determine the current state of knowledge of dry rainforests and their likely interaction with fire. From this knowledge base research priorities could be ascertained for the development of fire management strategies for the dry rainforest patches in the Apsley - Macleay Gorges study area. Specifically, the objectives of the workshop were to address the following questions regarding the dry rainforest resource in the Apsley - Macleay Gorges study area:

i) What priority should the NPWS give to the protection of dry rainforests vis-a-vis other vegetation communities in the Apsley - Macleay Gorges?

ii) Is fire likely to be a major limiting factor on the current distribution of dry rainforest in the Apsley - Macleay Gorges?

iii) Are any of the existing dry rainforest patches likely to be vulnerable to further encroachment by fire and if so, under what circumstances?

iv) Could the dry rainforest resource be expanded by modifying the current fire regime and if so, what sort of fire regime would achieve this result?

v) What parameters could be used to describe the current condition of dry rainforest patches and what factors could be used to classify patches in terms of either their susceptibility to fire damage or their potential for expansion in the absence of fire?

vi) What priorities are needed in terms of monitoring the condition / changes in the vegetation in the future and what criteria should be used to select rainforest patches for more detailed investigations in both the short and long-term planning horizons?

The workshop proved to be a useful and cost-effective procedure for accelerating the synthesis of information on the dry rainforest resource and it's likely interaction with fire in the study area. Furthermore, it provided a rapid and sound basis for the identification of research needs for subsequent phases of this study.

4.3 Methodology

Scientists and resource managers, with a range of experience of dry rainforests and rainforest - fire interactions, were sought from a range of organisations within Australia. In addition, many local and regional N.P.W.S. managers, with experience in the local environment also attended. A full list of official participants is presented in Appendix 4.1.

The workshop was held over two days and involved two distinct sessions. Day one was devoted to briefing participants on the current state of knowledge. This involved a series of presentations by appropriate participants on the natural and management environments of the study area, the ecology, conservation and distribution of dry rainforest vegetation, and rainforest - fire interactions.

Day two of the workshop was devoted to addressing and discussing a list of relevant research and management questions pertaining to fire and the dry rainforest resource of the study area as outlined previously. This was facilitated through the grouping of the scientists and managers into three discussion groups such that the range of expertise was similar within each group. Each group addressed the common list of questions and concluded the day by with a delegate presenting a synthesis of responses at a plenary session.

Detailed descriptions of the results of the workshop have been reported elsewhere (Bennett and Cassells 1988a). The remainder of this chapter presents a synthesis of the workshop working group's responses to the previously specified subjects. This synthesis is presented as a series of summary statements under the relevant headings.

4.4 Results and Discussion

4.4.1 Conservation Priorities in the O.W.R.N.P.

The dry rainforest vegetation community type was recognised as being poorly conserved at both a State and National level in Australia. Accordingly, the workshop considered that dry rainforest should be considered a management priority for the O.W.R.N.P., but not the only or indeed the principal priority. Conservation of all vegetation types was considered important, and it was felt that protection measures for one community should not be developed without considering their impact on other vegetation communities. Indeed, most rare and endangered species recorded existing in the study area occur largely within the gorge rim and open forest communities.

The workshop felt that initially at least, management objectives should ensure the maintenance of at least the current distribution of dry rainforest and to aim at expansion of this community in the future. Priority should be given to the identification and management of areas of dry rainforest that are currently retreating in response to disturbances, such as fire and grazing.

4.4.2 Fire as a Limiting Factor to Dry Rainforest Distribution

In general, fire was considered to be a major factor controlling the current distribution of dry rainforest in the Apsley - Macleay Gorges. However, grazing was also identified as a likely key factor in rainforest distribution. Therefore it was felt that both fire and grazing need to and should be deliberately controlled.

More specifically, fire was considered to be more likely to be controlling dry rainforest distribution in the eastern section of the study area, largely as a result of a history of more frequent fire in that area. In the western section, fire was seen as less of a potential controlling factor. This is due to a reduced fire frequency being as a result of both limited pastoral activity and the existence of large areas of non-flammable rock faces and screes.

4.4.3 The Fire Susceptibility of Existing Dry Rainforest Patches

Fire susceptibility is highest for those patches that have not already retreated back to naturally fire protected refugial positions in the landscape. Thus, it was felt the larger patches, particularly in the higher fire frequency eastern sections of the study area, could be being impacted by fire and hence are likely to be retreating in response to current fire regimes. Dry Rainforest patches that are elongated in shape and hence have high area to perimeter ratios were also considered to be highly susceptible to fire impact where their boundaries were not protected by natural features.

In view of potential changes to the current fire and grazing regime resulting from changes in land tenure and hence management (i.e., resumption of land by the N.P.W.S.), it was felt that fuel loads may increase and accordingly that fires, when they do occur, may be more intense. The susceptibility of rainforest patches under these circumstances is likely to differ from the present situation.

Concern was expressed about the continuing invasion of the study area by flammable weed species, such as *Lantana*. It was felt that this may increase the fire vulnerability of the rainforest resource, as these species might act as fire 'wicks', facilitating the ingress of fire into rainforest areas.

4.4.4 Potential for Dry Rainforest Expansion

It was generally considered that the opportunity for dry rainforest expansion would be maximised with a reduction or total cessation of fire events in the vegetation communities immediately adjoining rainforest patches. However, despite a consensus that the community would be likely to expand in the absence of fire, it was recognised that there was no available research evidence of this for the study area.

With the general belief that rainforest expansion was possible in the absence or reduction of fire impacts, it was felt that fire management should aim at protecting vulnerable rainforest patches through planned fuel reduction burns that would prevent wildfire from impinging on these patches. Such strategies should consider controlled burns, at appropriate times in the year. These should occur down from ridgelines and on the grassy river flats. Initially, a single fire of reasonable intensity may be appropriate to stimulate coppice or growth of pioneer species along rainforest margins.

4.4.5 Parameters Assessing the Current Condition and Susceptibility to Fire Damage of Dry Rainforest Patches

The current condition of a rainforest patch was defined as whether the patch is dynamic (i.e., expanding or contracting in area) or static. The workshop participants felt that the current condition of the rainforest patches provided important clues as to their potential vulnerability to fire.

Parameters that were considered appropriate for describing both the current condition of a patch and the fire vulnerability of dry rainforest patches included:

i) the rainforest patch size and shape (or configuration);

ii) the rainforest patch physiographic position (i.e., topographic situation, slope angle, local relief, aspect);

iii) the nature of adjoining vegetation communities (i.e., fuel load and fuel condition);

iv) the rainforest patch boundary/edge condition (i.e., diffuse, abrupt, particular species patterns) and;

v) the fire history of the rainforest patch.

In particular, the condition of the edges or transition zones separating the rainforest patches from adjoining communities was considered to be very important. Edge condition was thought likely to indicate the direction, if any, of successional change on the rainforest margin. A proposed edge classification scheme delineated rainforest edges into four types viz, (i) abrupt; (ii) diffuse; (iii) distinctive transition community (e.g., *Acacia diphylla*); and (iv) retreating (i.e., a transition zone comprised of a band of grass and weeds).

Due to the extensive and fragmentary distribution of the rainforest in the study area it was considered that assessment of the resource was required at two levels. The first level would involve a broadscale, remote assessment of the entire study area. This would facilitate the grouping of rainforest patches into a manageable number of groups within which their characteristics are similar and definable. The second level of assessment would involve the validation and determination of the management significance of those rainforest groupings delineated at the initial broadscale level. This step would need to evaluate the groupings from ground assessment of representative samples.

4.4.6 Monitoring Priorities

The workshop felt that some priority should be given to the regular monitoring of the study area with respect to the identification and assessment of dynamic rainforest margins, invasion of weed species (especially *Lantana camara*) and the response of vegetation with changing fire regimes. Monitoring of these factors would best be facilitated through interpretation of regularly updated aerial photography at an appropriate scale.

4.5 Conclusion and Summary of Major Points

The following major points arose from the workshop.

Though dry rainforest was considered a conservation priority in the Gorges, it should not be managed in isolation from other vegetation communities existing in the study area.

Fire impacts and also stock grazing were identified as major factors controlling the distribution of the dry rainforest, particularly in the eastern half of the study area where fire frequencies are highest.

Those patches not already restricted to refugial positions naturally protected from fire, are likely to be most susceptible to current fire impact, as are patches with extensive boundaries. Accordingly, the larger rainforest patches and those elongated in shape are probably at risk from fire events. The current fire susceptibility of the rainforest resource may vary with changes to existing fire regimes and also due to the continuing invasion of flammable weeds into the study area.

With a reduction or total cessation of fire, consequent rainforest patch expansion is probable. Consequently, any management programme implemented should ensure the continued exclusion of fire from the immediate vicinity of rainforest patches.

An important parameter for the identification of individual rainforest patches current condition and hence management requirements, is the status of patch boundaries or margins. This parameter may assist in identifying which patches are dynamic (i.e., expanding or contracting in area) and which are static. As a priority, the dynamics of rainforest patch boundaries should be regularly monitored, particularly with regard to areas with changing fire regimes (i.e., land previously leased to graziers and coming under the control of the N.P.W.S.).

Thus, fire is indeed thought to be limiting or controlling the distribution of dry rainforest in the Apsley - Macleay Gorges. Consequently, manipulation of fire regimes, ensuring the protection of rainforest margins from fire impact, may encourage the expansion of this community in the Gorges. As a priority, the dry rainforest patches require assessment as to the importance of fire to each of them. Assessment would best be facilitated through the broadscale examination of each rainforest patch's configuration, physiographic position in the landscape, nature of adjoining vegetation communities, edge condition and fire history.

CHAPTER 5

FIRE HISTORY AND CURRENT FIRE MANAGEMENT SURVEY

5.1 Introduction

Whilst European use of the Apsley - Macleay Gorges began in the 1830's, an extensive Aboriginal presence existed prior to this (R. Leggatt *pers. comm.*). Up to the 1940's, pastoral use of the area expanded, ensuring a regime of frequent, small fires in the gorges (R. Leggatt *pers. comm.*). Pastoral interest in the area has declined since that time and it is thought that fires are now less frequent but larger and more intense.

The changing nature of the fire regime in the Gorges is thought to have had considerable influence on the current distribution and condition of the dry rainforest. Consequently, this Chapter aims to assess the fire history and current fire management practices in the Gorges and to determine the likely effect this has had and is having on the rainforest communities that occur there.

5.2 Objectives of the Survey

This chapter presents the results of an extensive, personally administered, questionnaire survey of land-managers in and adjacent to the Apsley-Macleay Gorges. Detailed descriptions of the results of the survey are reported elsewhere (Bennett and Cassells 1988b). The primary objective of this survey is to develop as comprehensive a picture as possible of the fire history and current fire management practices for the gorges and their surrounds. This involves eliciting information from the area's land-managers regarding their recollections of past unplanned bushfires (wildfires) and their past and current utilisation of fire for management purposes.

This information was sought to facilitate some assessment of the probable effects past fire events and current fire management practices have had, or are having, on the current distribution patterns and condition of the dry rainforest vegetation type in the Apsley - Macleay Gorges.

A comprehensive coverage of the area with regard to these factors was considered an essential component of this study. Without a reasonably accurate historical appreciation of the fire regimes that have prevailed in the gorge region, it is extremely difficult to make any informed judgements on the influence of these regimes on the current distribution and condition of the dry rainforest vegetation communities.

5.3 Methodology

5.3.1 Introduction

A personally administered questionnaire survey formed the basis for the collection of data. Despite the higher costs and more complex administrative arrangements associated with personal interview surveys, the advantages over alternative methodologies, such as mailed questionnaires and telephone administered surveys, were particularly relevant to this study.

Warwick and Lininger (1975, 129) have noted that average response rates are often much greater with interview surveys, and interviewers can ensure that the precision and clarity of respondent's answers are maximised by eliminating ambiguity, irrelevance, and incompleteness. In addition, the greater flexibility of the approach is ideal for the largely exploratory nature of this study and does not depend on the literacy or educational level of respondents. Further, Warwick and Lininger (1975, 129-130) also suggest that this approach is most appropriate where, as in this situation, the questionnaire is quite long, some items complex, and involves the use of several open-ended question types.

5.3.2 Sampling and Data Collection

5.3.2.1 The Target Population

Graziers with leased and / or freehold land in this area were targeted for this survey as they are responsible for the current fire management regimes operating and have the greatest knowledge of past bushfire events in their respective areas. Managers surveyed had either tableland country that adjoined the periphery of the gorges, or a combination of this and leased land within the gorges itself. Only one manager possessed gorge leases only.

The desired objective was to obtain as near a full census of the managers in the study area as possible within the studies temporal, financial and labour constraints. To facilitate this a list of appropriate land-managers was constructed from N.P.W.S. records, the Crown Lands Department and consultations with identified key land-managers.

Some 77 property managers were interviewed during the survey period. Almost complete coverage was attained in the northern, western, and southern sections of the study area, with somewhat less complete coverage of the more distant eastern section.

5.3.2.2 Devices Encouraging Participation

Several strategies were employed to maximise survey participation and co-operation. Initially, to prepare the target population, the study and its aims were publicised in the local newspaper media.

The second strategy to prepare respondents and encourage participation was the mailing of a personalised letter to each land-manager prior to the interview period detailing the aims and objectives of the study and the need for their participation to ensure its success.

Finally, telephone contact was attempted throughout the survey period (18th January - 3rd February, 1988), with available land-managers.

Early morning and evenings were used to make phone contact as most managers were unavailable during business hours due to the outdoor nature of their work. With the failure of initial contact (i.e. phone unanswered or manager not home), recalls were made until contact was initiated or four calls had been attempted. All but a few landholders with whom telephone contact was made participated, with the exceptions being due to ill health or work commitments rather than any expressed antagonism to the study or its objectives.

5.3.2.3 Response Rate

A total of 77 survey interviews were completed however, three of these could only be conducted over the telephone and so were excluded from analysis. Of the remaining 74 valid cases, 55 were with managers with tableland country only, on the periphery of the gorges, and 19 with managers with gorge country only (1 case) or properties comprised of both gorge and tableland country. Of this latter category, the gorge component of total property size ranged from 5% to 100% and averaged approximately 61%.

The valid 74 properties surveyed constituted some 190,000 hectares (110,500 ha (58.1%) of gorge and 79,500 ha (41.9%) of adjacent tableland country). Actual gorge country covers some 126,000 hectares of the study area. Therefore, the interview survey successfully covered approximately 88% of this important land component of the study area.

Records from the Crown Lands Department compiled by the N.P.W.S., indicate that there are a total of 152 properties (leasehold and freehold) in the study area. Of these 114 are tableland-only properties, on the periphery of the gorges, of which many are very small, and 38 are gorge only or gorge and tableland properties. This latter group are particularly relevant to this study, having greatest impact on the past and present fire regimes in the gorges.

These figures would indicate that the survey successfully covered only some 51% of the potential target population. However, this was considered to be an acceptable result in view of the large property area covered, particularly in the actual gorges (some 88% of this area), and that many of the 114 tableland-only properties are very small and probably would have less direct impact or knowledge of the fire regimes prevailing in the gorges. Thus, it is felt that the results of this interview survey can be taken as being representative of most of the property managers in the study area.

5.3.3 The Questionnaire Interview Schedule

5.3.3.1 Design and Pretesting

The final interview schedule format is presented in Appendix 5.1. Its design involved translating the broad objectives of the study into specific questions that would obtain the desired information. To achieve this, several drafts of the questionnaire were produced and subjected to review. The review was performed by University of New England academic staff, experienced in this form of data collection, and field and research personnel from the N.P.W.S. This draft and review process was repeated several times until a satisfactory questionnaire was produced. This final draft was then pretested on several key landholders in the study area prior to the survey. In light of their comments final modifications were made.

These modifications included some changes in question sequence, emphasis placed on the confidentiality of responses, and minor alterations of terminology used, such as "top-country" instead of tablelands and "rainforest scrub" for rainforest vegetation.

5.3.3.2 The Questions

The questionnaire used words which were simple, direct and familiar to all respondents and was comprised of both closed and open answer questions. The former are preferable for comparative analysis and are usually easier for respondents to answer but suffer the drawback that answers are restricted, permitting less spontaneity and accuracy (Warwick and Lininger 1975). The latter largely avoids these drawbacks by encouraging freedom of expression, but similarly has problems, particularly with coding and analysing data. Such problems are due to the enormous variety of responses that can develop.

In those questions where preferences were to be expressed, it was recognised that the order of presentation of alternatives in the response could in itself introduce some bias in respondents answers (Gardner 1976, 48). To overcome this problem, the order of response appearance on the questionnaire was determined by random ballot.

To achieve the studies objectives the format of the questionnaire followed a logical sequence. The title page briefly outlined the aims of the survey, which were broadly interpreted as research into better fire management in the area. The first section (Q.1 to Q.6) dealt with details of the respondent's property. The second section (Q.7 to Q.15) examined their current fire management practices, while section three (Q.16 to Q.29) dealt with bushfire history and control. The final section (Q.30 to Q.34) explored respondents interactions with public authorities and other bodies and management problems associated with the Apsley-Macleay Gorges.

5.3.3.3 Interview Structure

As a first step in each interview, managers were briefed on the study and any queries were addressed. Property managers, who in all cases but two were men, were then provided with a blank interview schedule for use as a check-list while the interviewer presented the schedule verbally and recorded the responses to each question.

5.3.4 Data Analysis

Each completed questionnaire was edited and coded onto Fortran coding sheets before being entered onto the University of New England's DEC20 System Mainframe computer. Editing data is a normal procedure in questionnaire analysis, particularly where open-answer questions are used (Warwick and Lininger 1975, 234). In this study, editing was required for two reasons: firstly, to convert the large number of responses generated from the open-answer questions into a smaller number of related and meaningful categories which could be analysed; and secondly, where respondents had failed to provide complete rankings in questions that required respondents to rank their answers (i.e., from 1-5). Unranked categories were considered to be least or not important and were given the lowest ranking to facilitate analysis. Coding involved constructing and assigning a numeric code system to responses in order to facilitate computer analysis.

In order to prevent bias arising and difficulties in analysing and interpreting other data, missing data was coded as missing, and analysed as such. Further, prior to data analysis, machine consistency checks were undertaken on the data to identify and allow removal of inconsistencies and improbable data generated from data-entry.

Basic descriptive statistics (frequencies and crosstabulations) were undertaken on the data, utilizing the Statistical Package for the Social Sciences ($SPSS^x$) (Nie 1983). More detailed statistical analysis was inappropriate due to the largely descriptive nature and objectives of the study. However, in instances where trends from descriptive summaries of data suggested important differences, the statistical significance of these differences were tested using Chi-Square (X^2) analysis.

To facilitate differentiation in responses due to the different types of country owned or leased in the sampled population, the overall data file was structured to include three subfiles. These subfiles were developed using the 'Select if' $SPSS^x$

command, separating the survey data file into (i) total survey sample (74 cases); (ii) respondents with tableland country only (55 cases); and (iii) respondents with gorge country only, or both gorge and tableland country (19 cases).

5.4 Results and Discussion

5.4.1 Introduction

As detailed above, the property managers interviewed have been divided into two groups based on the type of land they own or control: the tableland-only managers (T'l); and the gorge and tableland managers (G&T'l). The former group is represented by 55 cases and covers 60,243 ha or almost 32% of the total area surveyed. The latter group is represented by 19 cases covering 129,502 ha. or 68% of the survey area, giving a total of 74 cases in all. The G&T'l manager group controlled some 110,237 ha. of gorge country, representing approximately 88% of this group's entire area, and 19,265 ha. of tableland country making up the balance.

Results of the questionnaire analysis are presented in terms of valid percent (percent of respondent's answering question only) of the total sample of 74 cases, and the two component manager groups making up the total. In many instances, total percentages for manager groups may exceed 100% and reflects the fact that managers may undertake several categories of answer to any one question.

Recollections of the boundaries of fire events, as depicted by the managers surveyed on 1:25,000 scale topographic map sheets, are held by the Armidale District Office of the National Parks and Wildlife Service.

5.4.2 Property Details

The aim of the first six questions was to compile a baseline of information on the properties surveyed in the study area.

5.4.2.1 Property Size

Property sizes varied considerably, particularly the G&T'l group which ranged from some 360 ha. to almost 40,000 ha. The overall average property size was approximately 2,560 $\pm$564 ha. The mean size of T'l properties were significantly lower than for the G&T'l properties ($t(18)=3.05, p<0.01$). The former averaging approximately 1,070 $\pm$131 ha. and the latter some 6,820 $\pm$1,880 ha.

Figure 5.1 depicts the frequencies of properties in seven size categories. The frequency of T'l properties declines markedly over 2,000 ha., while a large proportion of the G&T'l properties exceed 5,000 ha.

5.4.2.2 Retention of Native Vegetation

Although also varying widely, properties were on average, about 70 $\pm$4% cleared of native vegetation. Again, the average proportion of land cleared is significantly higher ($t(60)=3.91$, $p<0.001$) on tableland properties (80 $\pm$4% cleared) than on the gorge and tableland properties (38 $\pm$7% cleared). Indeed, almost all of the gorge country is under native vegetation, with only six cases recording clearing some gorge country, ranging from 76 ha. to 1,800 ha., and averaging some 220 ha.

Figure 5.2 presents the proportions of the respondents properties falling into 5 categories of area of vegetation cleared. It is clearly evident that the majority of the G&T'l group fall into the lower percent-cleared categories while most of the T'l group are in the higher categories.

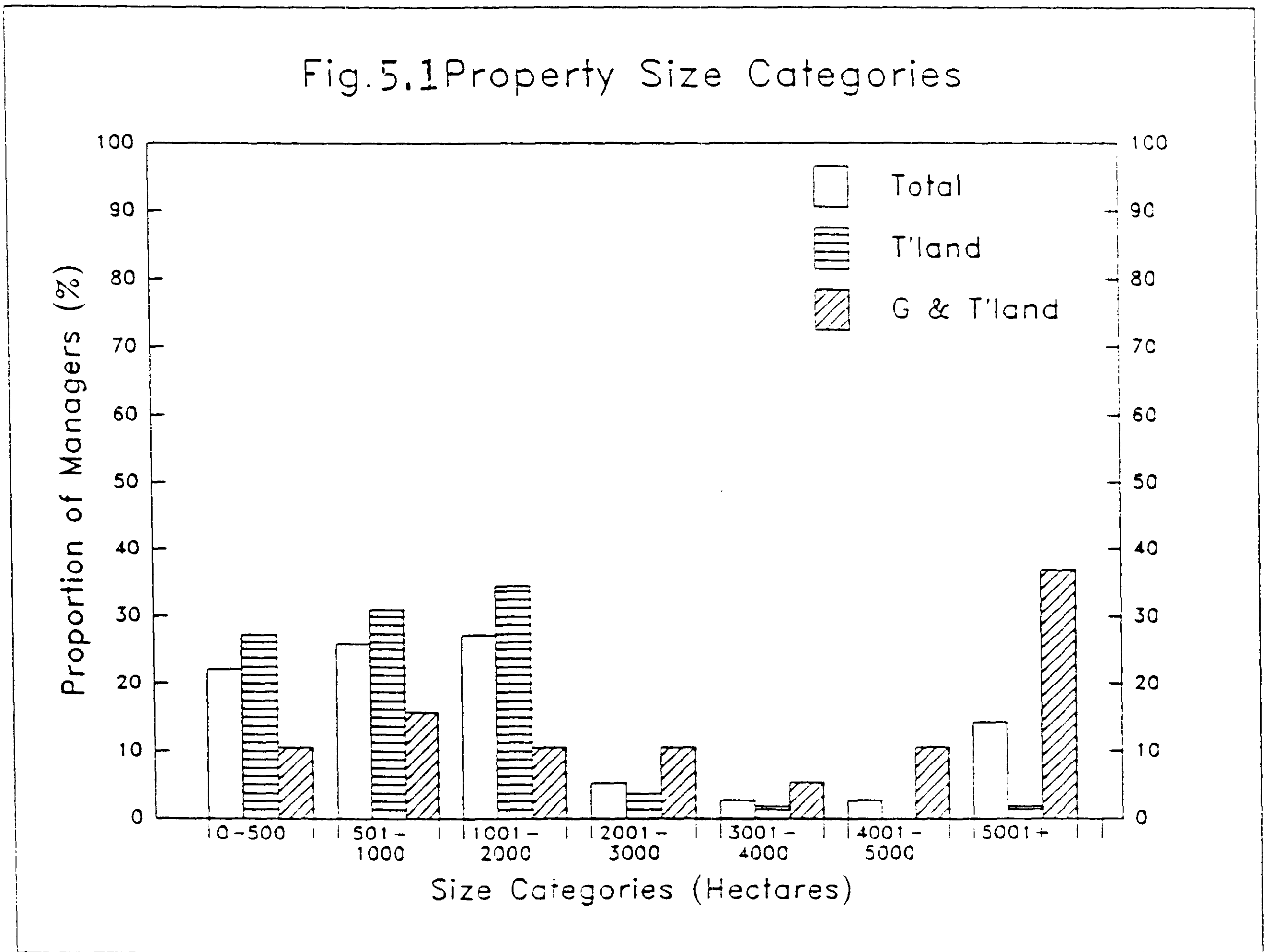
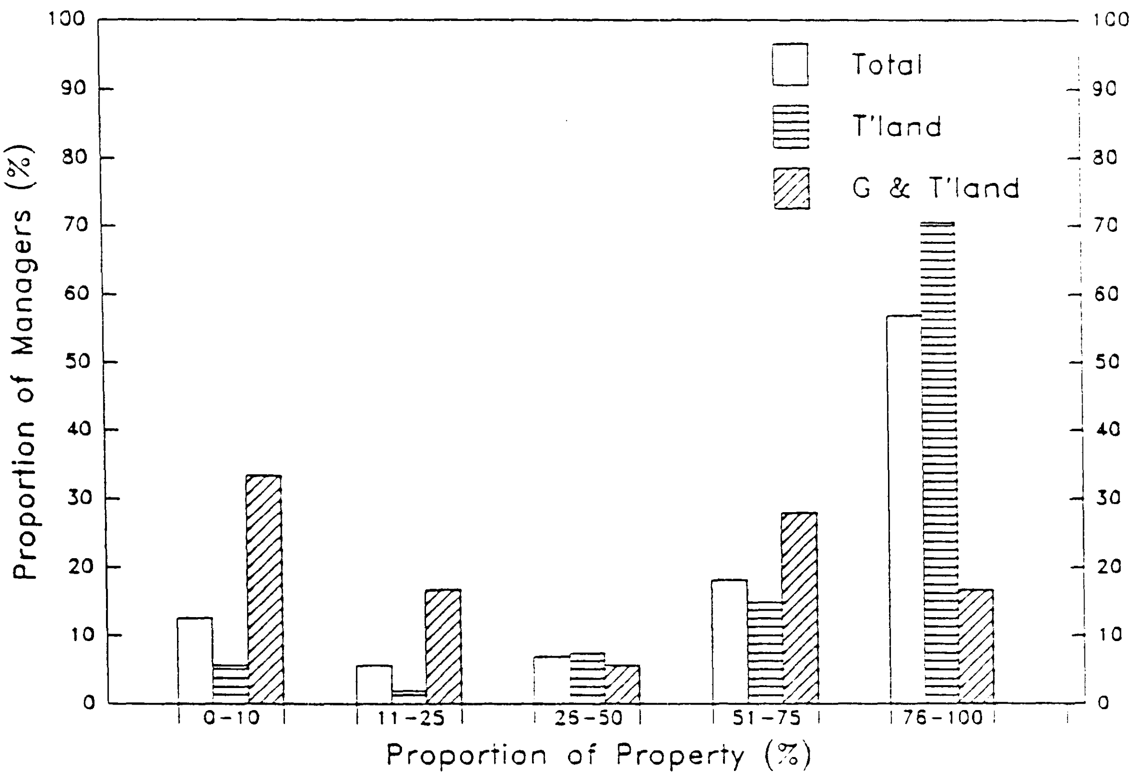


Fig.5.1Property Size Categories
Proportion of Managers (%)
100
90
80
70
60
50
40
30
20
10
0
Total
T'land
G & T'land
0-500
501-
1000
1001-
2000
2001-
3000
3001-
4000
4001-
5000
5001+
Size Categories (Hectares)

Fig.5.2 Mean Proportion of Property Cleared



5.4.2.3 Rainfall

Some 76% of the managers interviewed maintain rainfall records and have been doing so on average for some 24 years. Estimated average annual rainfall ranged from approximately 690 mm through to 1220 mm with a mean of some 900 mm. This variation probably reflects to a large degree the variation in local relief and topography over the study area. A full list of property rainfall records is presented in Appendix 5.2. Although not able to be determined precisely, these rainfall records suggest the commonly perceived (see King 1980, 18) east to west trend of declining rainfall.

5.4.3 Fire Management

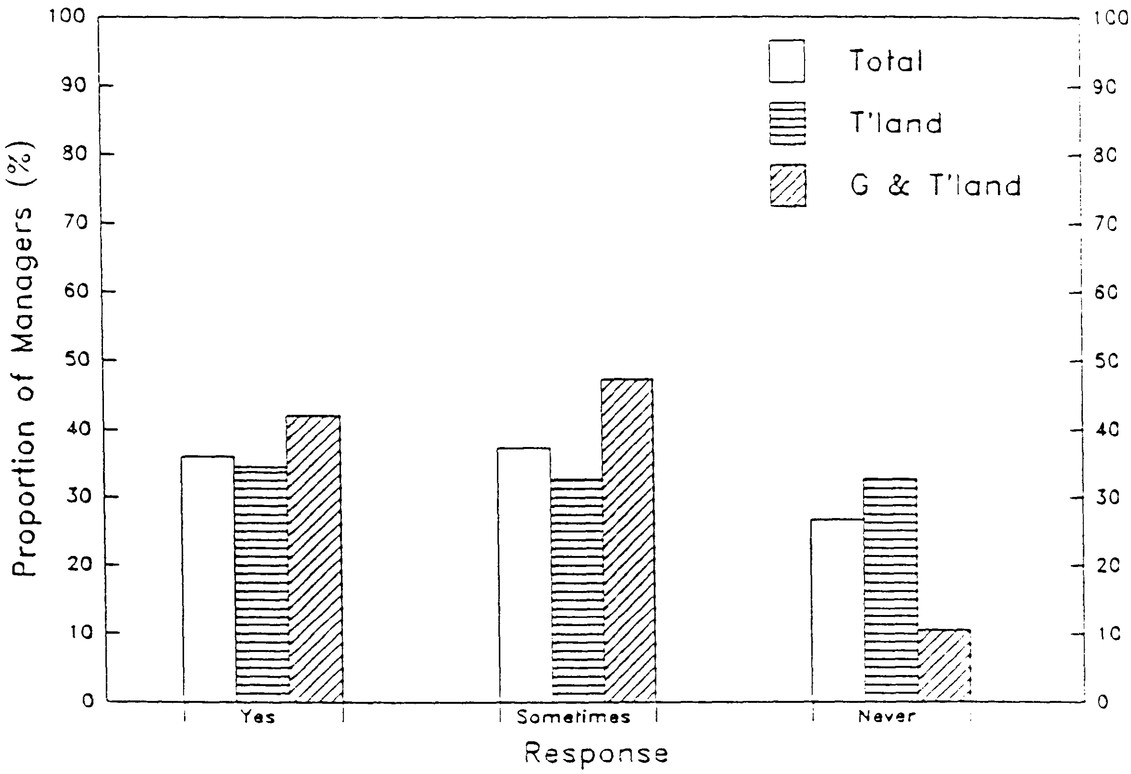
The aim of questions 7 to 15 was to obtain information regarding property managers past and current fire management regimes. The questions covered included the following. Was fire being used for management purposes? What were the specific purposes for which fire was used and what was its importance? What was the frequency of burning operations and the average area burned? Which areas of the property was fire excluded from? What was the timing of burning operations? What were the usual type of fires that occurred? What were the changes in the property manager's use of fire management over time, and the reasons for these changes?

5.4.3.1 Fire Management Use

Question 7: "Do you use fire in the management of your property?"

The aim of this question was to gauge the extent to which fire is utilised as a management tool in the study area. The response is summarised in Figure 5.3. No significant difference existed between the two manager groups with regard to fire management use. On average the majority of managers use fire for management purposes on a frequent basis (36%) or

Fig.5.3 Utilisation of Fire For Management



only sometimes (37.3%), with the balance (26.7%) stating that they never use fire at all.

The overall response indicates that fire is a widely utilized management tool by both manager groups in the study area, with some 90% of the G&T'l managers and some 67% of the T'l managers utilizing it on either a frequent or infrequent basis.

5.4.3.2 Reasons For Using Fire For Management

Question 8: "If fire is used in the management of your property, list the specific purpose(s) for which it is used and its importance".

This question aimed to determine the specific purposes for which fire is used in landholder management programmes. Both T'l and G&T'l managers utilize fire for a variety of reasons in their property's management programmes. The managers responses are depicted in Figure 5.4. Overall, the responses in order of average decreasing importance to managers, were as follows: (i) to regenerate pasture for grazing purposes by removing rank grass growth (Regen.); (ii) for fuel reduction to reduce bushfire risk (Fuel); (iii) to burn dead timber, stumps, and 'rubbish' (Timber); (iv) to form fire breaks (Break); (v) to burn regrowth after clearing and to assist in clearing operations (Control); and (vi) for miscellaneous purposes, such as to prepare land for cultivation, for control of blackberries and rabbits, and to regenerate native forest (Misc.).

The largest response category for both groups was the use of fire to regenerate pastures, being listed by almost 54% of T'l and almost 65% of G&T'l managers. The use of fire for fuel reduction burning was indicated by a significantly greater number of the G&T'l group (59% versus 31% for the T'l group) (x^2=3.91, 1df, p=<0.05), whilst, the use of fire for burning dead timber etc. was indicated by a significantly greater proportion of the T'l group (49% versus 18% for the G&T'l group) (x^2=4.79, 1df, p=<0.05). Burning fire breaks was equally important to both manager groups.

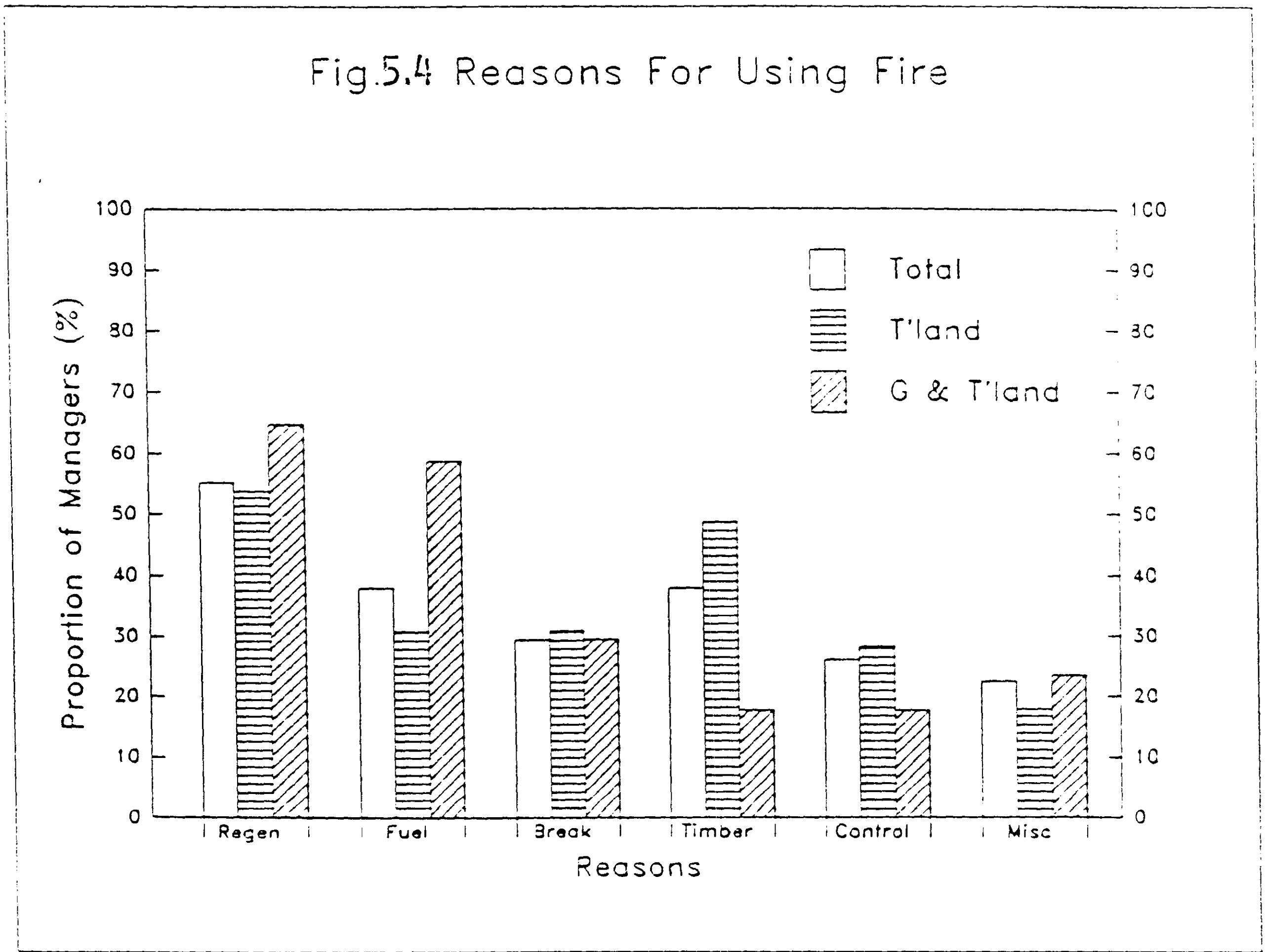


Fig.5.4 Reasons For Using Fire
Proportion of Managers (%)
0
10
20
30
40
50
60
70
80
90
100
Total
T'land
G & T'land
Regen
Fuel
Break
Timber
Control
Misc
Reasons

The second part of this question, the importance of each purpose for using fire, was poorly answered and was excluded from analysis.

The large proportion of managers utilizing fire to regenerate native pastures was expected in the G&T'l group but not in the T'l group. It is apparent therefore that a considerable portion of this latter group must have areas of unimproved pasture requiring burning-off. Obviously with the largely unimproved nature of the majority of the G&T'l country and the extensive areas of native vegetation, fuel reduction burning is to be expected to be considerably more important to G&T'l managers than the T'l group. Similarly, the reverse is to be expected with regard to fire use for burning dead timber, stumps and rubbish. Further, it appears that a larger proportion of the G&T'l group's use of management fire is related to bushfire control purposes than the T'l group.

5.4.3.3 Management Fire Frequency

Question 9: "For any particular area of your property, how frequently would you use fire as part of your management programme?"

An important factor in any fire regime is the frequency with which fire occurs (Christensen, Recher and Hoare 1981, 376). Accordingly, this question sought to determine the frequency with which management fire is used by managers in their management programmes.

The response to burning frequency is presented in Figure 5.5. Both groups had largely similar responses with the majority of management burning undertaken on average on a yearly (29%), two to three year (27%), or four to five year (23%) rotation.

Thus, management burning is carried out relatively frequently, ranging predominantly between yearly burning to burning every four to five years. Crosstabulations of management fire frequency and reasons for which fire is used suggest that the manager groups differ in their practices. Notably, G&T'l

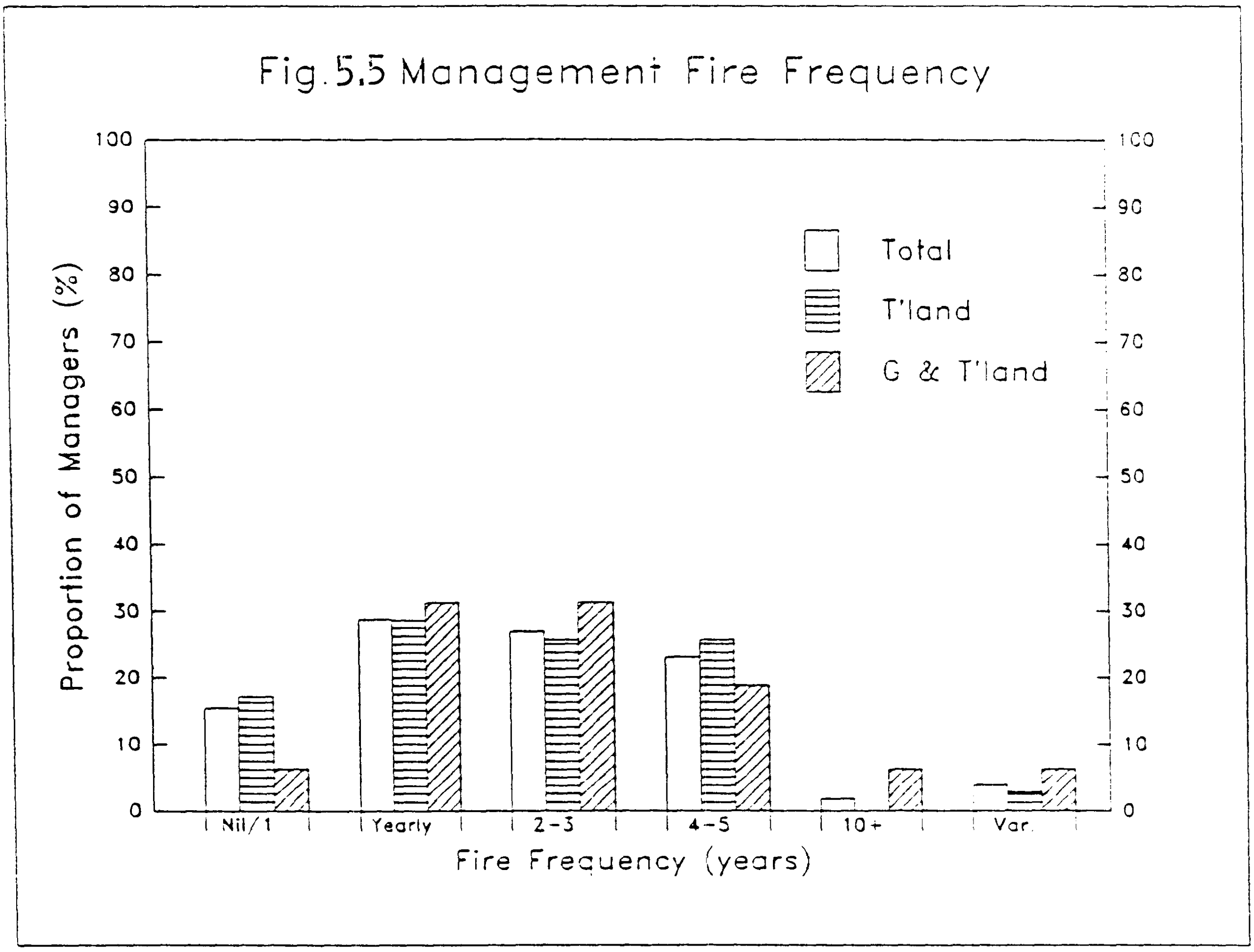


Fig. 5.5 Management Fire Frequency
Proportion of Managers (%)
0
10
20
30
40
50
60
70
80
90
100
Total
T'land
G & T'land
Nil/1
Yearly
2-3
4-5
10+
Var.
Fire Frequency (years)

managers undertake burning operations on a yearly or 2-3 year rotation, predominantly for fuel reduction purposes and to a lesser extent for regenerating pasture. Yet the same group burns nil/once only or on a 4-5 year rotation primarily for regenerating pastures. In contrast the T'l managers burn yearly or on a 2-3 or 4-5 year rotation principally for regenerating pastures followed by burning dead timber, stumps and rubbish. Yet nil/once only burning is utilized for burning dead timber, stumps and rubbish.

5.4.3.4 Area of Properties Subjected to Management Burning

Question 10: "What area of your property do you burn as part of your management programme?"

This question sought to determine the spatial extent of management burning operations undertaken by managers. The response is listed in Table 5.1. Considerable variation in both area and proportion of property size management burnt occurs between the two groups. However, the majority of cases are clustered towards the lower levels, with almost 80% of all managers that use fire for management burning 100 ha. or less of their property.

Importantly, the G&T'l group burn a significantly greater ($t(18)=2.09$, $p<0.051$) proportion of the area of their properties (some 21 ±8%) than respondents with tableland-only property (some 7 ±2%). Furthermore, this former group not only burn a larger proportion of their properties in their management programmes but also a greater total area.

Table 5.1

Area of Property Management Burnt

	Mean Area (ha.)	Mean Proportion of Property (%)
Total	489 ±215	10.5 ±3
T'l	72 ±32	7.3 ±2
G&T'l	1775 ±813	21.3 ±8

5.4.3.5 Areas Where Management Burning Excluded

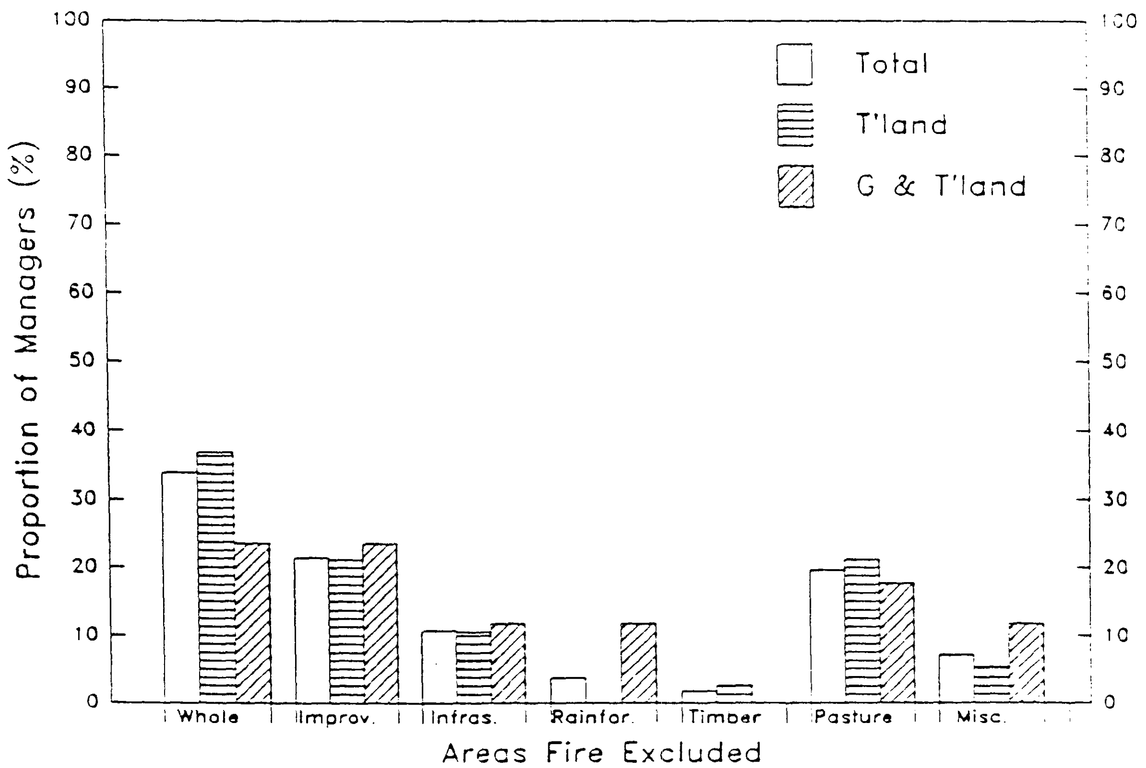
Question 11: "Are there any particular areas of your property where you try to keep fire out?"

This question aimed to determine whether managers perceived any need not to use management fire and from which areas of their properties they attempted to exclude it.

On average almost 86% of the managers interviewed, that utilize fire for management purposes, ensure that fire is excluded from certain areas of their properties. Areas listed as being excluded from management burning are presented in Figure 5.6 and in overall order of decreasing average importance, were as follows: (i) the whole property (Whole); (ii) areas of improved pasture (Improv.); (iii) pasture, grassland, or cleared country (Pasture); (iv) property infrastructure (Infras.); (v) miscellaneous areas, such as gorge river flats, ridge country and the park boundary (Misc.); (vi) rainforest (Rainfor.); and (vii) timber areas, shelter belts, pine plantations (Timber).

Excluding management fire from the whole property was the highest response category for both manager groups. In general, except for the 'whole property' and 'rainforest' categories,

Fig. 5.6 Areas Where Management Burning Excluded



both groups appear to behave similarly with respect to areas where they attempt to exclude management burning, and even between these two categories no significant differences were evident. Taken together, the somewhat related 'improved pasture' and 'pasture, grassland or cleared' area categories account for a considerable portion of management fire exclusion areas. Indeed, on average some 40% of managers excluded management fire from these areas.

5.4.3.6 Timing of Management Burning Operations

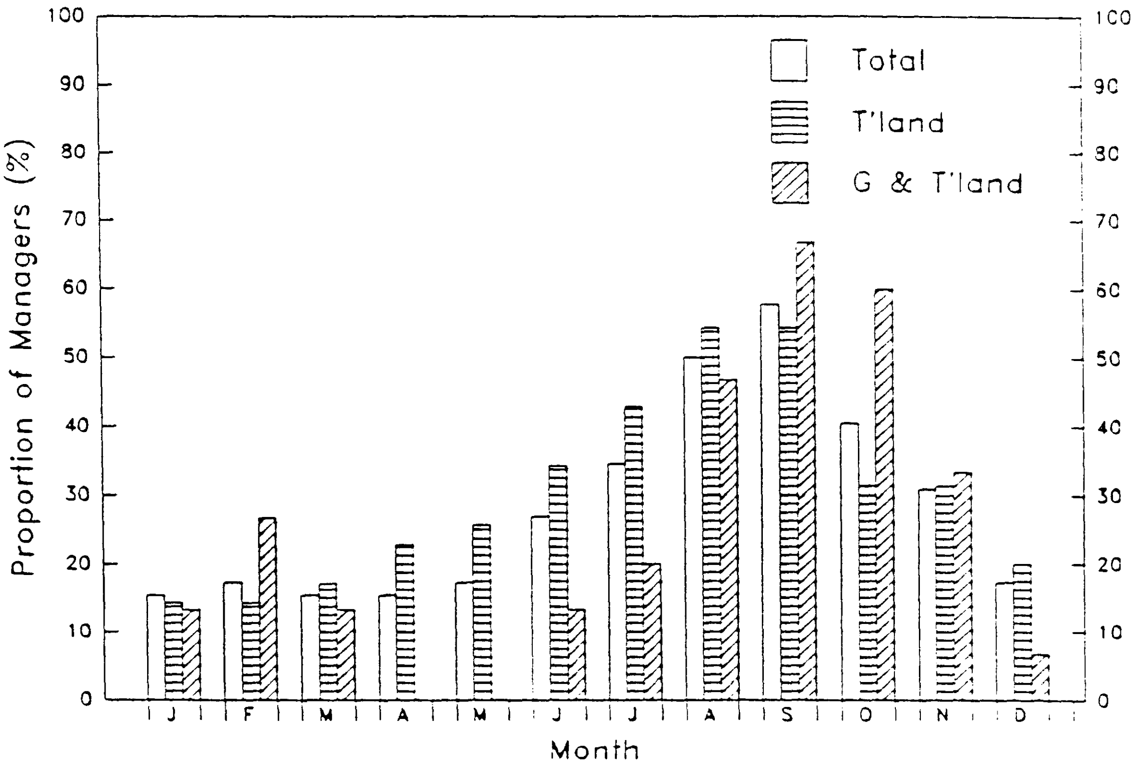
Question 12: "In what month(s) do you usually carry out burning operations for your property?"

Similarly as with Q.9, the time of the year (season) fire occurs is another important factor of a fire regime (Christensen, Recher and Hoare 1981, 374). Thus, the aim of Q.12 was to elicit the specific time of year managers use fire for management.

The response to Q.12 is presented in Figure 5.7. Burning operations are undertaken throughout the entire year. The greatest activity occurred between August and October and peaked in September with almost 58% of all managers undertaking burning operations during this month.

Whilst the proportion of the T'l group using fire gradually increases year, peaking in August - September and abruptly declining in October, the proportion of the G&T'l group's use of fire rapidly rises in August through to October, and is low or nil for the rest of the year. Thus, the G&T'l group appear to have a more confined period of fire use between late Winter and mid Spring, whilst the T'l group utilize fire more evenly throughout most of the year, with maximum activity in late Winter to early Spring. Statistically significant differences between the groups regarding the timing of burning operations were apparent in the responses for April ($x^2=4.08$, 1df, $p=<0.05$) and May ($x^2=4.7$, 1df, $p=<0.05$) when no burning is undertaken by the G&T'l managers.

Fig. 5.7 Timing of Management Burning Operations



Crosstabulations of the timing of management burning operations and the reasons for which fire is used indicate that those G&T'l managers undertaking fuel reduction burning do so predominantly between September and October, whilst T'l managers primarily begin a month earlier, from August through to September. Similarly, G&T'l managers burning fire breaks do so largely between August and September, with T'l managers predominantly restricting it to September only. Both manager groups burning to regenerate pastures undertake this burning predominantly during September. Further, the majority of G&T'l managers burning dead timber and stumps undertake this activity mainly during October, whilst T'l managers undertake this operation largely during August.

5.4.3.7 Management Burning Fire Type

Question 13: "Predominantly, what type of fires occur during your burning programme?"

This question sought to determine the type of fire that occurred during management programmes and hence to provide some assessment of the likely intensity of management fires.

The response to Q.13 is presented in Figure 5.8. Grass only and grass and undergrowth fires were the predominant fire types experienced during management burning programmes. Although the data suggests some difference between the two manager group's responses, statistical analysis found there to be no actual significant difference. Furthermore, crown fires were very rare, occurring on 6.3% of the G&T'l group only.

5.4.3.8 Changes in Management Burning Regimes

Question 14: "How has your use of fire to assist in the management of your property changed over time?"

The aim of this question was to identify whether fire management regimes had changed over recent time in the study area.

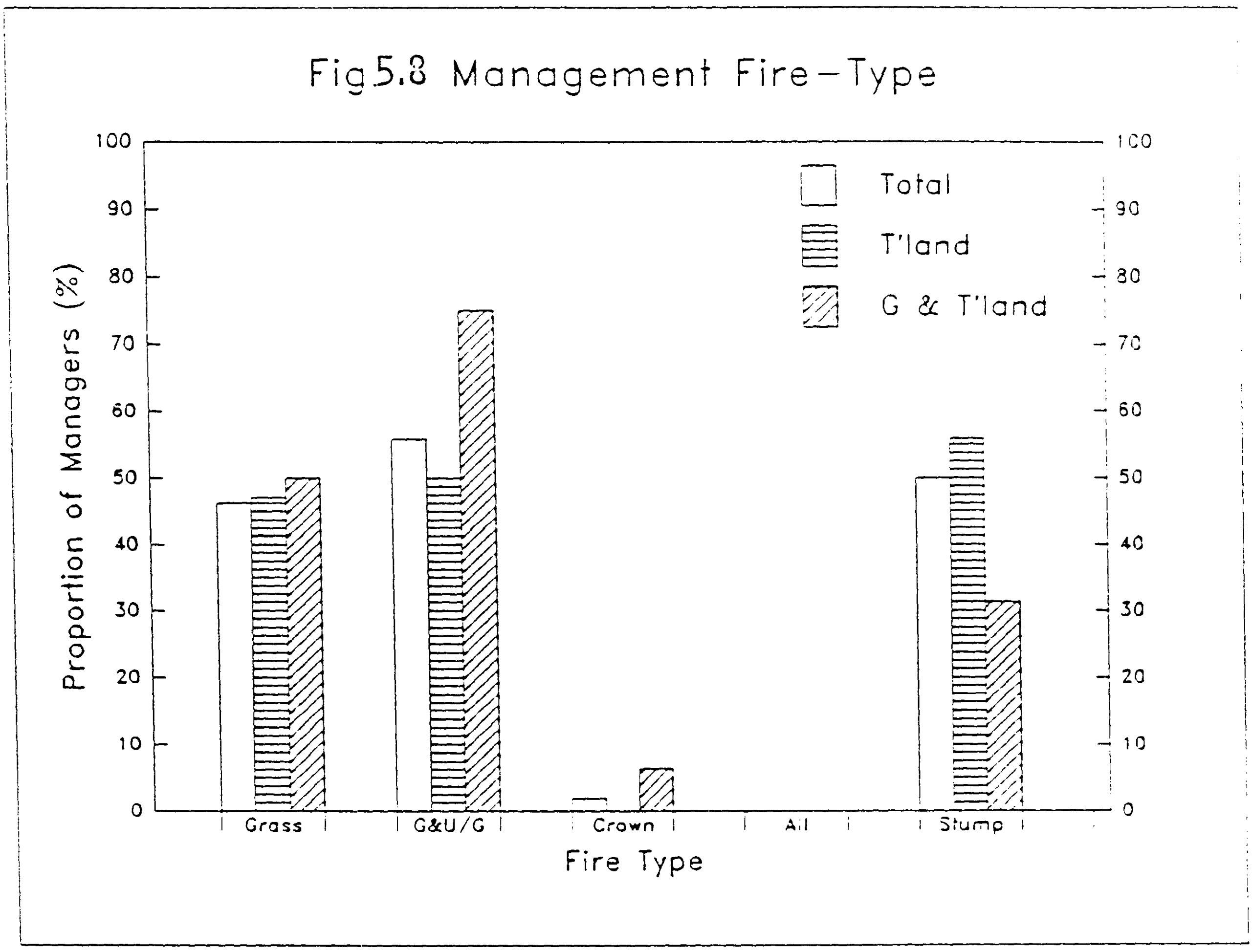
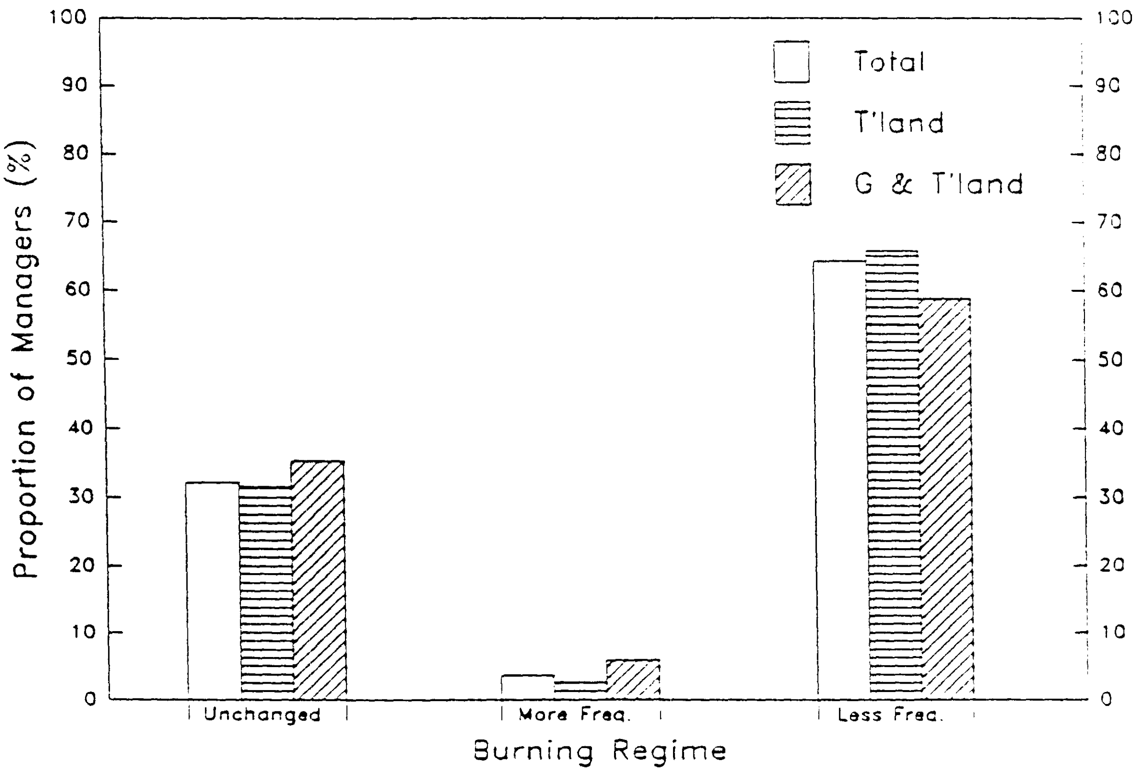


Fig5.8 Management Fire-Type
Total
T'land
G & T'land
Proportion of Managers (%)
100
90
80
70
60
50
40
30
20
10
0
Grass
G&U/G
Crown
All
Stump
Fire Type

Fig.5.9 Changes to Management Burning Regime



The response to Q.14 is presented in Figure 5.9. Trends are similar between the two manager groups with the majority of managers, some 64%, using fire less frequently in management programmes. In contrast, more frequent burning was undertaken by only some 4% of respondents, whilst the balance (32%) remained unchanged.

It is readily apparent, therefore, that most managers of both landholder groups are changing their management burning regimes, predominantly to one utilizing fire on a less frequent basis. Crosstabulations between changes in management burning regimes and the reasons for burning displayed largely similar trends between manager groups. The frequency of management burning regimes have been reduced for all burning practices (identified in Q.8, Fig. 5.4) except for the G&T'l managers who utilize fire for fuel reduction purposes. The frequency with which fire is used by this group for this purpose has remained unchanged over time.

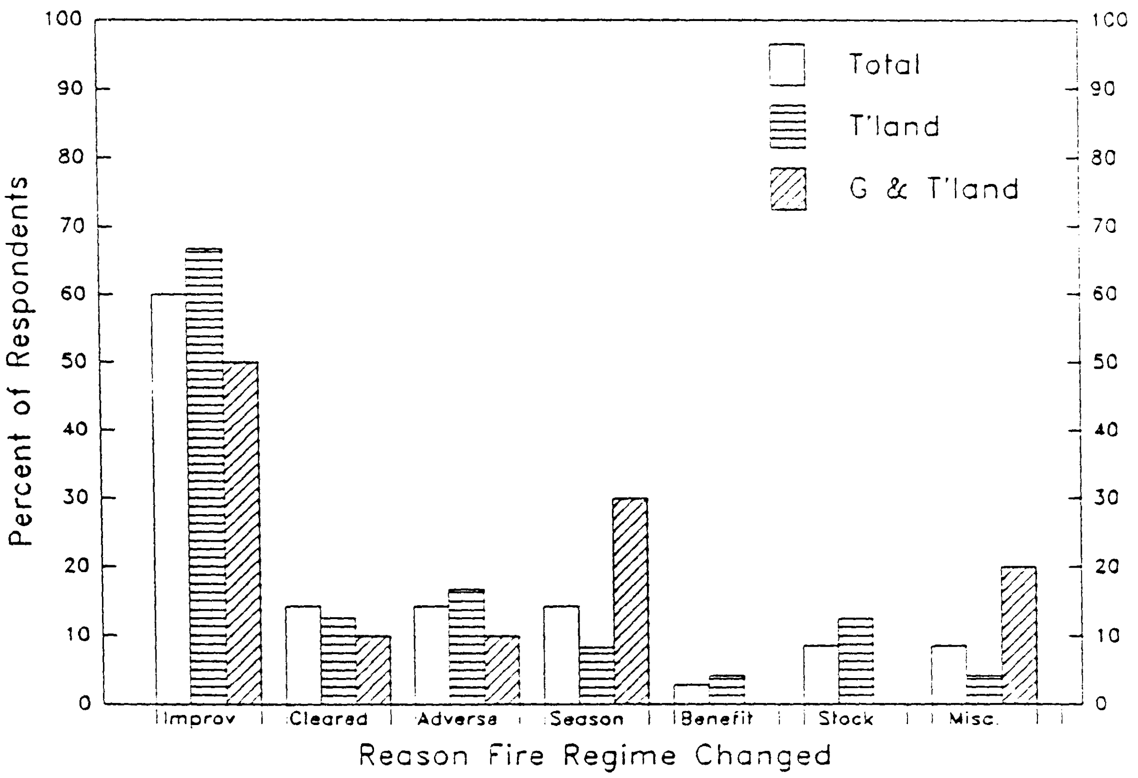
5.4.3.9 Reasons for Changes in Management Burning Regimes

Question 15: "If your use of fire has changed, why has it changed?"

This question is linked with the one above, and aimed to assess the reasons for any change in fire management regimes.

Changes in management fire frequency are depicted in Figure 5.10. The reasons for the changes listed by managers, in order of decreasing overall importance, were as follows: (i) pasture improvement (Improv.); (ii) property cleared / more developed (Cleared); (iii) realisation of the adverse effects of fire e.g. destroys soil-seed store, does not generate new grass growth, and reduces soil nutrients and predisposes areas to soil erosion (Adverse); (iv) seasonal conditions i.e. recent dry seasons have kept fuel levels low (Season); (v) intensive stocking i.e. keeps fuel levels low (Stock); (vi) miscellaneous reasons, such as reduced stock numbers, reduced fire risk due to changes in neighbours, greater access for fire ignition by vehicle (Misc.); and (vii) beneficial effects of fire e.g.

Fig. 5.10 Reasons For Changes to Mgt. Fire Regime



increases stock feed (Benefit). These last two reasons (vi and vii), account for the 4% of managers who burnt more frequently as well as some of those burning less frequently, whilst the first five categories accounted for those majority of managers who indicated a reduced frequency of fire use.

Changing fire frequency due to improved pasture was the highest response category for both manager groups, listed by 67% of the T'l group and 50% of the G&T'l managers. A large proportion (30%) of the G&T'l group also identified reason (iv), 'seasonal conditions' (i.e. recent dry years have kept fuel levels low) as a major factor contributing to reduced fire-use, which was not considered highly by the T'l group, however the difference was not statistically significant. These differences were to be expected considering the importance of fire for fuel reduction burning to the G&T'l managers, as identified in Figure 5.4 above. Largely similar responses were recorded by both groups for all other reasons for changes to fire management regimes.

Thus, in general it appears that the frequency of fire use is declining due to the increasing area of improved pasture and clearing in the study area. Furthermore, G&T'l managers do not need to undertake fuel reduction burning as frequently as in the recent past, as recent dry seasons have kept fuel levels naturally low. Interestingly, some property managers have perceived certain adverse effects of frequent fire and in response have reduced their use of fire.

5.4.4 Bushfire History and Control

Questions 16 to 28 sought information on unplanned bushfires and their control in the study area. The questions examined addressed the following issues. What are the local people's concerns about bushfire activity? What are the perceived bushfire ignition areas and causes of ignition? What is the bushfire frequency on the tablelands and in the gorges? What types of bushfire occur in this area? What are the bushfire impacts on rainforest vegetation? What are the current bushfire control methods and what are the perceived additional control needs.

5.4.4.1 Bushfire Concern

Question 16: "Are unplanned bushfires of concern to you and your property?"

The aim of this question was to assess the degree of concern and importance placed on bushfire events in the area by managers.

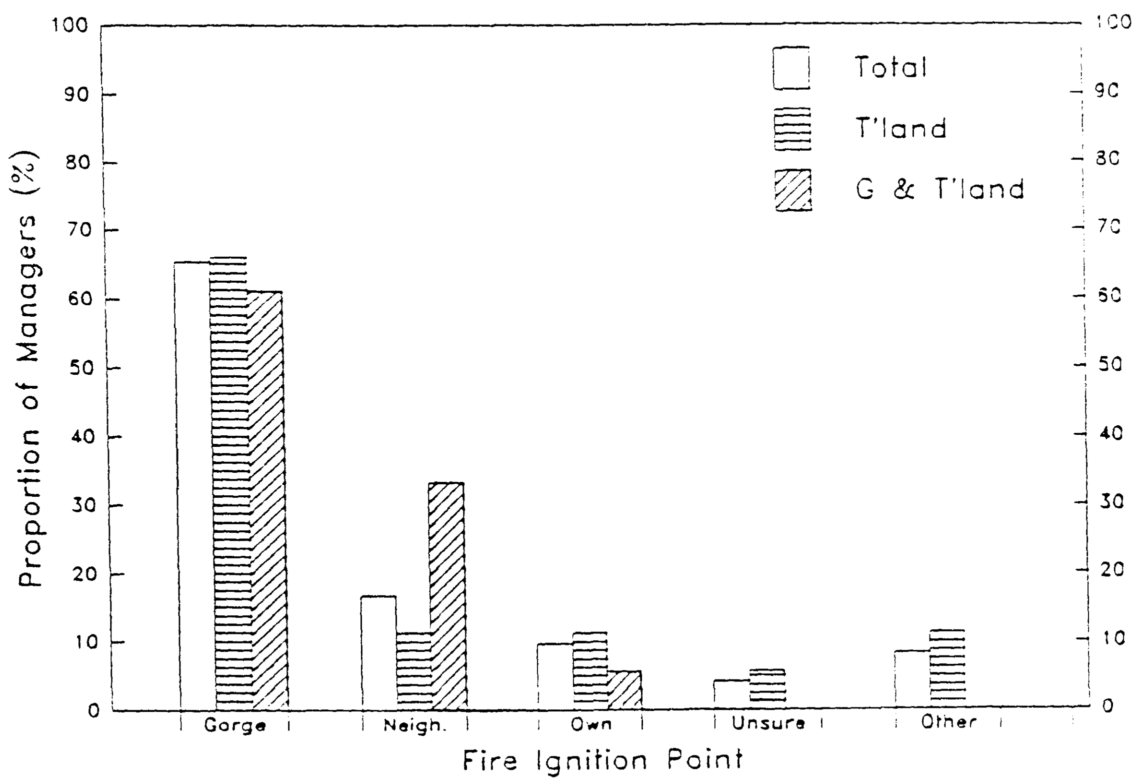
Bushfires were of concern to the majority of managers, with a slightly higher proportion of the T'l managers (85%) indicating concern than G&T'l managers (79%).

5.4.4.2 Bushfire Ignition Points

Question 17: "In order of importance (1 = most important) where do most unplanned bushfires that effect your property start?"

This question aimed to identify property managers knowledge and perception of the places where most bushfires start. Figure 5.11 lists the response of first preferences only to this question. A full listing of all preferences is presented in Appendix 5.3. The gorges were indicated as the prime point of bushfire ignition by both manager groups, being listed by some 65% of all managers. Further, neighbouring properties were also seen as important bushfire sources by the G&T'l managers (33%), being listed as a major bushfire ignition point by a significantly greater proportion of this group (x^2=4.64, 1df, p=<0.05). In these cases neighbouring properties are probably predominantly gorge country further emphasising the importance of the gorges as the study area's major bushfire ignition point.

Fig.5.11 Bushfire Ignition Points



5.4.4.3 Causes of Bushfire Ignition

Question 18: "From your knowledge, what are the causes of these unplanned bushfires?"

This question aimed to ascertain the predominant cause of bushfire ignition. The response of first preferences to Q.18 is presented in Figure 5.12, with full preference listings presented in Appendix 5.4. Overall, lightning was indicated as the most prevalent bushfire ignition source (indicated by some 57% of all managers) followed by fires escaping from landholder and public authority management burnoffs (some 35% of all managers). The data in Figure 5.12 suggests that escaping burnoffs are a more important bushfire ignition source for the G&T'l managers. However, the level of response of this group to both 'escaping neighbouring property burnoffs' and 'lightning' as bushfire ignition sources was similar and statistical analysis did not reveal any significant differences between the responses of the two groups for these ignition sources. Carelessness by tourists and bushwalkers was only considered to be a minor source of bushfire ignition, while arson was an extremely rare causal agent.

Crosstabulations of bushfire ignition point and the cause of bushfire ignition indicated similar trends for both manager groups. Managers indicating the gorges as the prime ignition point of bushfires perceived the cause of these fires to be in order of importance: lightning strike; escaping burnoffs; and carelessness. Further, of those managers indicating neighbouring properties to be the prime bushfire ignition point, escaping burnoffs followed by carelessness were thought to be the major causes.

Actual specific causes of bushfire ignition are probably largely a matter for conjecture. However, perceptions of managers have indicated that the prime sources of bushfire ignition are lightning strikes and escaping landholder and public authority management burnoffs.

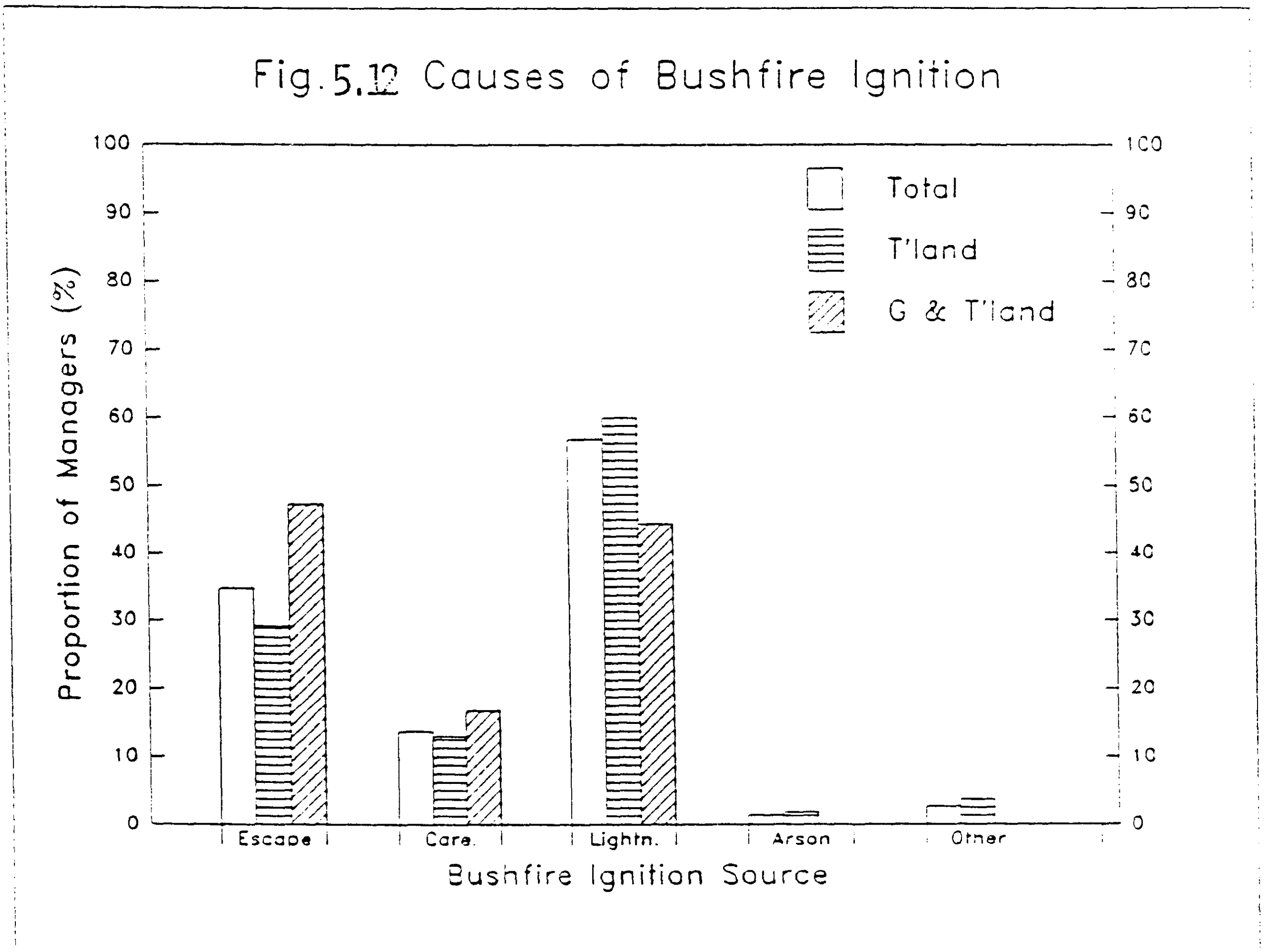


Fig. 5.12 Causes of Bushfire Ignition
Total
T'land
G & T'land
Proportion of Managers (%)
100
90
80
70
60
50
40
30
20
10
0
Escape
Care.
Lightn.
Arson
Other
Bushfire Ignition Source

5.4.4.4 Gorges Bushfire Frequency

Question 19: "How often does the gorge-lands country portion of your property burn as a result of unplanned bushfires?"

The six fire-frequency categories provided on the questionnaire, were condensed to four categories for more meaningful analysis. These are presented in Figure 5.13. Fire frequency in the gorges is quite variable ranging from very infrequent i.e nil or once only burning (38% of managers) through to frequent burning i.e. every 1 - 3 years (29% of managers). The responses for both groups was largely similar for all fire frequencies, with no statistically significant differences evident between manager groups.

Thus, it appears that bushfire frequency in the gorges is quite variable from area to area ranging from frequent to very infrequent. This largely reflects past and current seasonal conditions and the differing environments and landuse intensities within the gorges.

5.4.4.5 Tableland Bushfire Frequency

Question 20: "How often does the top-country portion of your property burn as a result of unplanned bushfires?"

Figure 5.14 lists the response to this question. As for the previous question, responses from Q.20 were grouped into four main categories. These also ranged from very infrequent through to frequent burning. Again responses are largely similar between both manager groups, however, in contrast to gorge bushfire frequency (Q.19, Fig. 5.13) the response to Q.20 displays a marked peak for very infrequent i.e. nil or once only bushfire frequency for the tablelands. Almost 73% of managers listed this category for the tablelands as opposed to only some 38% for the gorges area discussed in the previous question. This response is significantly greater than was indicated for the gorges in Q.19 (x^2=6.27, 1df, p<0.02). In addition, the response to frequent burning was also significantly different between the gorges and the tableland.

Fig. 5.13 Gorge Bushfire Frequency

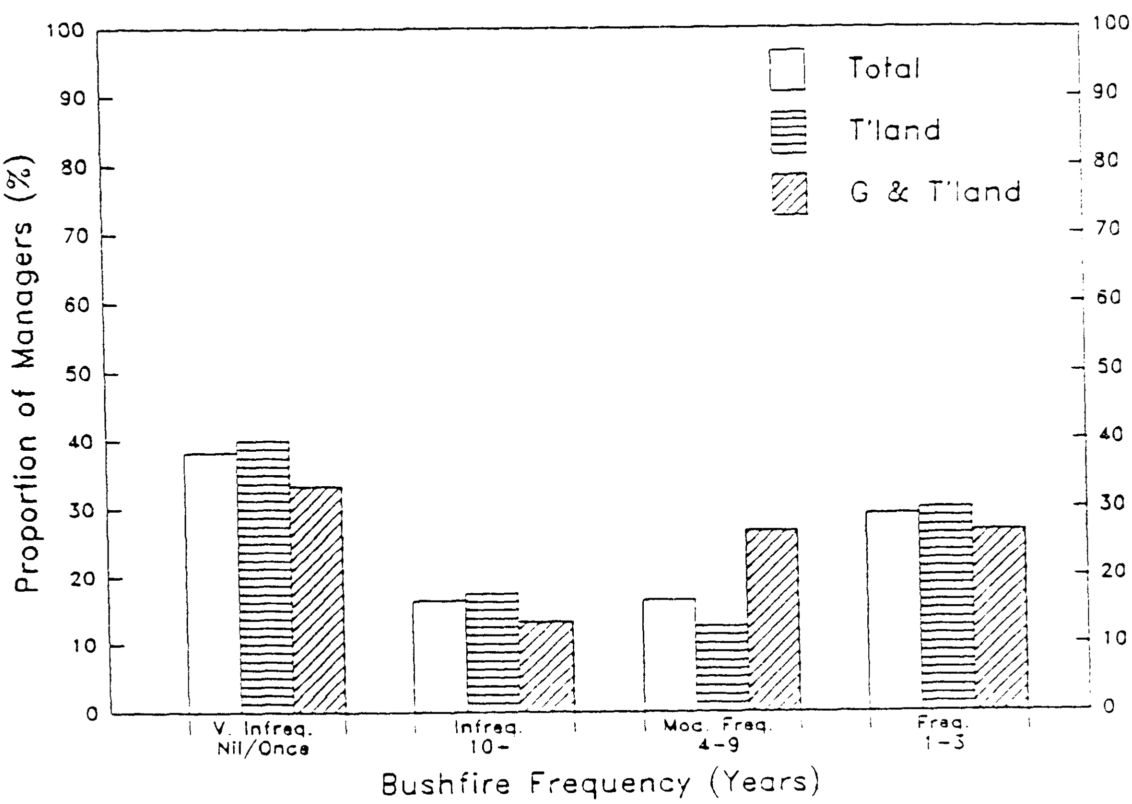
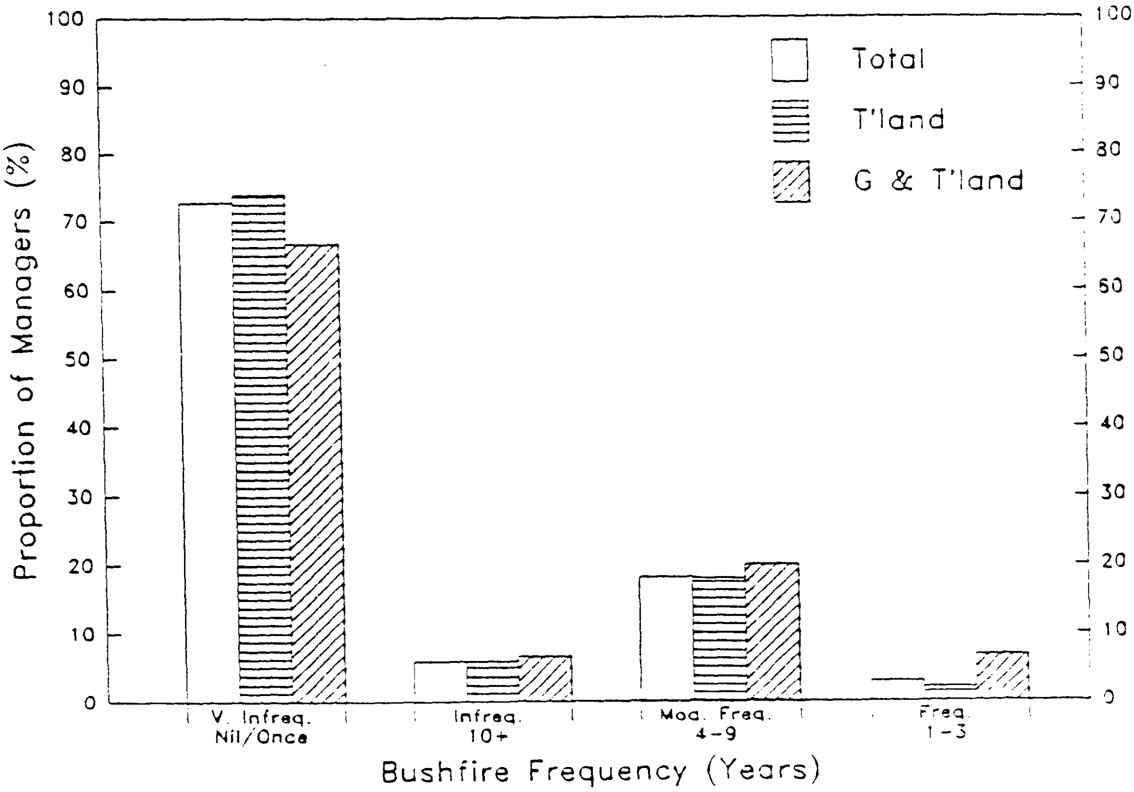


Fig.5.14 Tableland Bushfire Frequency



Only some 3% of managers indicated frequent bushfires on the tableland as opposed to some 29% for the gorges (x^2=13.7, 1df, $p<0.01$).

Again, bushfire frequency on the tablelands is as variable as it is in the gorges. Yet here a distinct trend is evident suggesting that on many tableland properties, bushfire frequency is considerably less frequent than in the gorges. This situation probably relates to the higher level of management input and prevalence of improved pasture on the tableland country in comparison to the gorge leases.

5.4.4.6 Bushfire Fire Type

Question 23: In order of frequency (1 = most common) what type(s) of unplanned bushfire(s) occur in the gorge-lands?"

The first preference response to Q.23 is presented in Figure 5.15 and full preference listings are displayed in Appendix 5.5. Similarly, as for the management fire type, the predominant fire-type associated with bushfires in the gorges was also grass and undergrowth fires, being listed by some 70% of managers. Importantly, compared with responses to management burning fire-types (Q.13, Fig. 5.8), more than twice as many managers (some 13%), indicated that tree-crowns burnt ('Crown' and 'All' response categories) in association with the other fuels during some bushfire events. Also the incidence of grass-only fire-types during bushfires is much less prevalent than during management burning.

5.4.4.7 Bushfire Impact on Rainforest

Question 24: "From your knowledge, have any of the patches of rainforest scrub in the gorge-lands burnt during any fire event(s)?"

Both this question and Q.25 following, sought to ascertain property managers knowledge of the existence of the dry rainforest community type in the gorges, and their perceptions

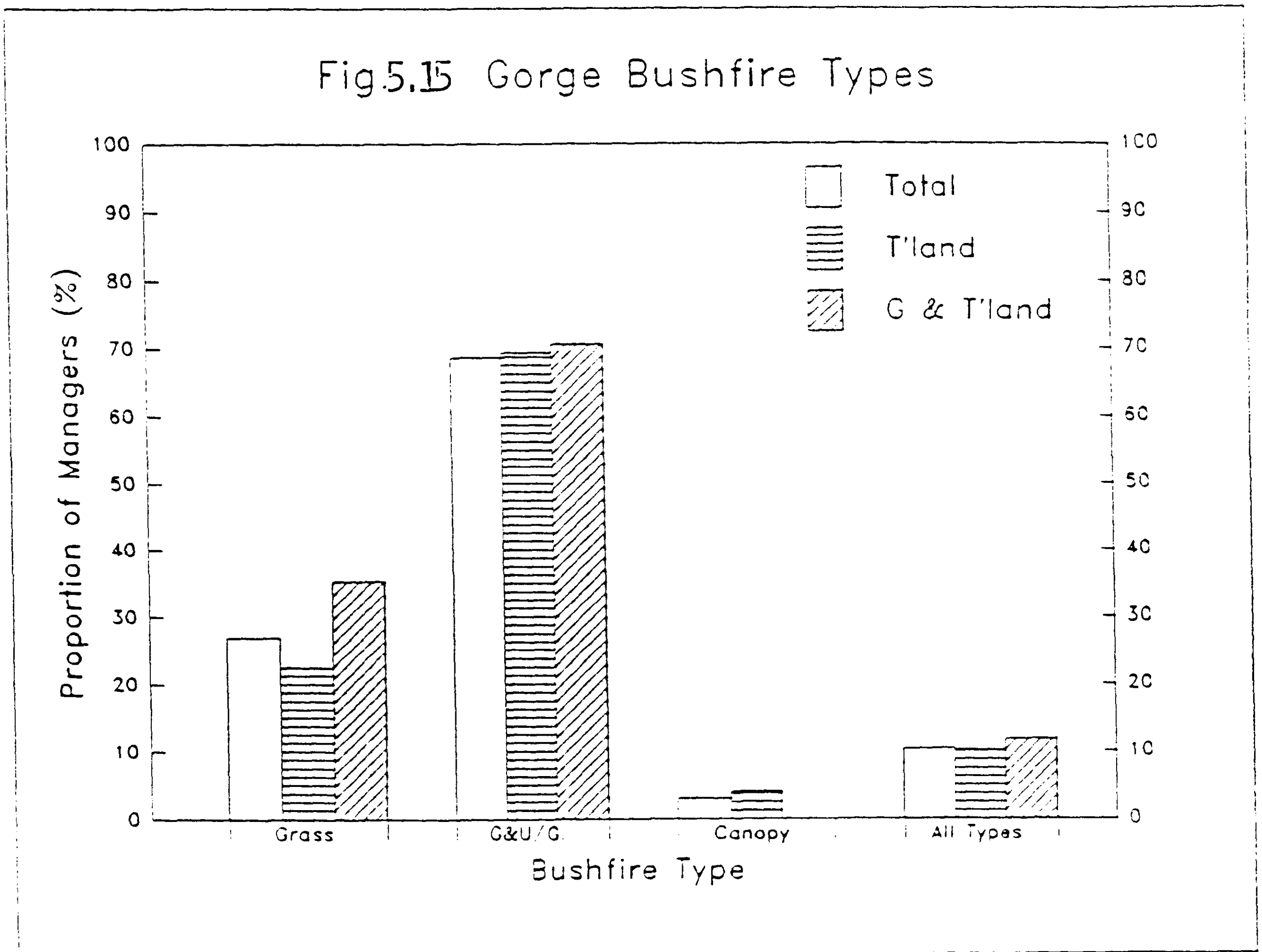


Fig.5.15 Gorge Bushfire Types
Total
T'land
G & T'land
Proportion of Managers (%)
0
10
20
30
40
50
60
70
80
90
100
Grass
G&U/G.
Canopy
All Types
Bushfire Type

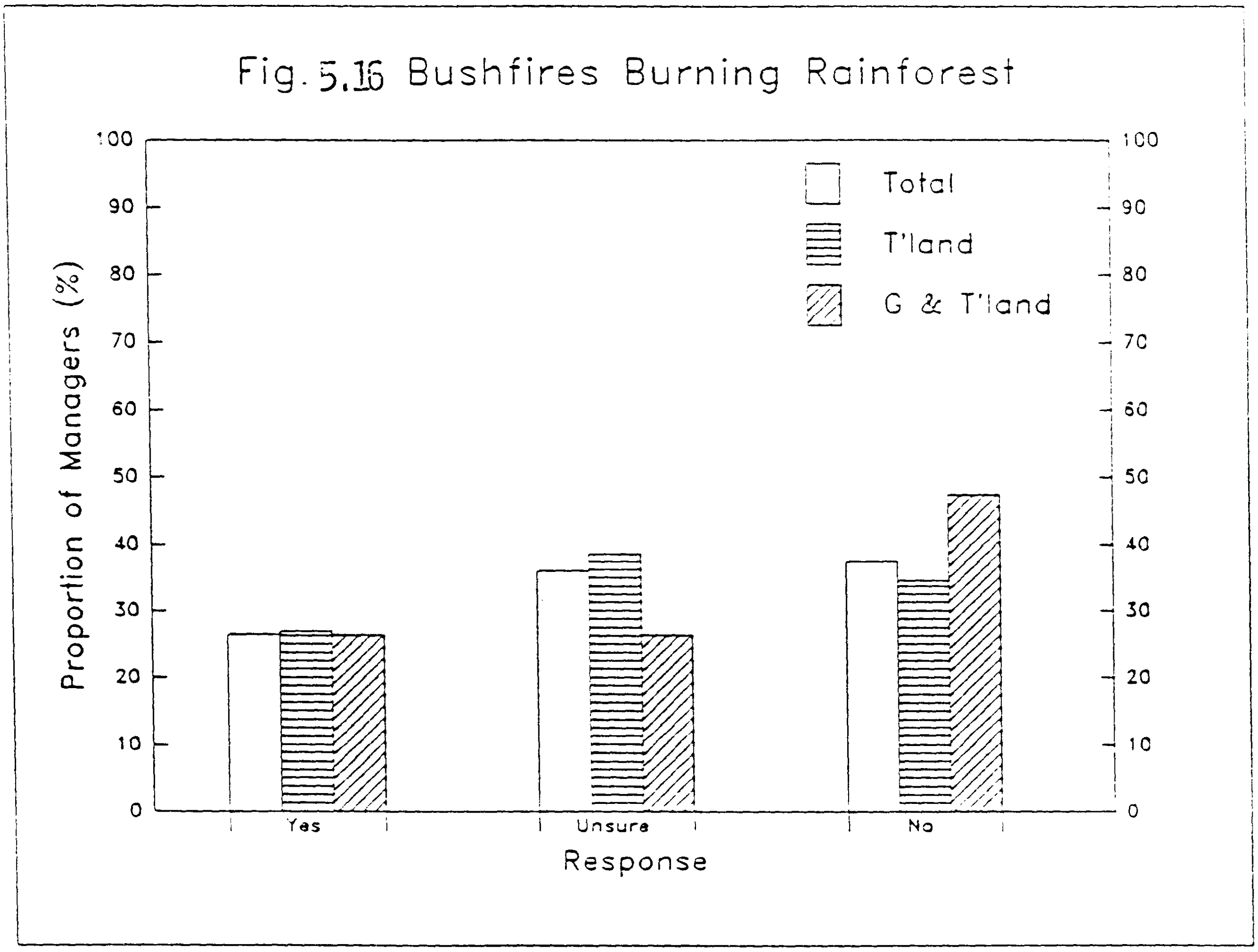


Fig. 5.16 Bushfires Burning Rainforest
Proportion of Managers (%)
100
90
80
70
60
50
40
30
20
10
0
Total
T'land
G & T'land
Yes
Unsure
No
Response

of whether it has been impacted by bushfire events and whether its distribution had changed over time.

Figure 5.16 presents the response to Q.24. Although a large proportion of managers (some 38% of T'l and 26% of G&T'l managers) were unsure as to whether rainforest had ever been burnt during bushfires, a considerable number (some 26% of both manager groups) indicated that the community had in fact been impacted by bushfire events in recent times. Furthermore, there was no statistically significant difference between the total number of managers indicating that rainforest had, or had not been impacted by bushfire events.

Thus, over one quarter of all managers interviewed indicated that patches of dry rainforest in the gorges had actually burnt during some bushfire events, whilst the balance were either unsure or indicated that rainforest vegetation had not been burnt during bushfires.

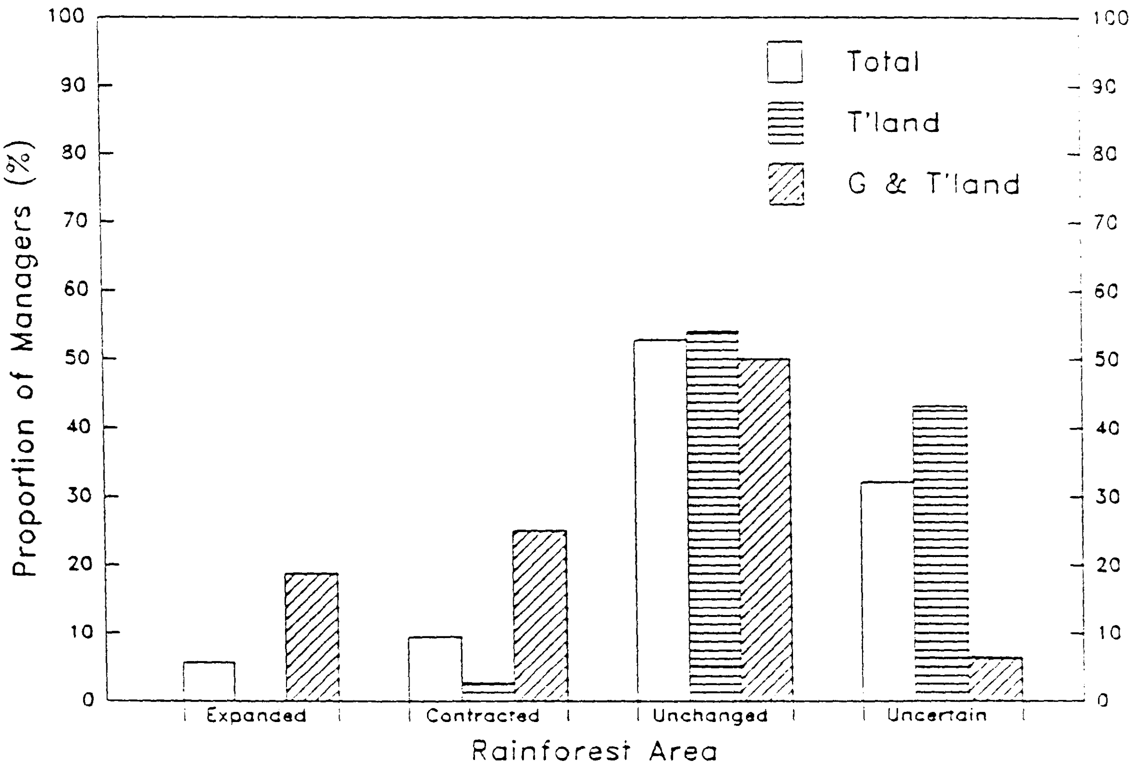
5.4.4.8 Changes in Rainforest Area

Question 25: "Has the area of Rainforest Scrub on your property changed over time?"

Although this question was phrased with regard to rainforest specifically occurring on the managers property, interviewers expanded this to managers perceptions of rainforest changes in their local region, as many properties did not actually encompass this vegetation type.

Figure 5.17 presents the responses to Q.25. The largest response category for both manager groups (some 54% of T'l and 50% of G&T'l managers) indicated that the area of rainforest has remained unchanged over time, from their knowledge. The remaining T'l managers (some 43%) were largely uncertain of changes, while most of the remaining G&T'l managers (some 44%) thought it had either expanded or contracted. Some 19% of this latter and most relevant response group indicated that the area of rainforest had actually increased over time, while approximately 25% thought it had contracted.

Fig. 5.17 Changes in Rainforest Area



Despite a large proportion of managers indicating that the area of rainforest had remained largely unchanged over recent time (or, particularly with the T'l group, were uncertain), a considerable number of G&T'l managers actually perceived that the area of the community had indeed either expanded or contracted.

5.4.4.9 Bushfire Exclusion Areas

Question 26: "Are there any particular areas of your property that you feel need protection from fire?"

The response to Q.26 is listed in Figure 5.18. Some 78% of managers attempt to exclude bushfire from areas of their properties. Seven categories of fire-exclusion areas were compiled from responses. In order of decreasing overall importance these were: (i) the whole property (Whole); (ii) property infrastructure (Infras.); (iii) improved pasture (Improv.); (iv) property boundary (Boundary); (v) timber areas and shelter belts (Timber); (vi) pasture/cleared areas (Cleared); and (vii) miscellaneous areas, such as the falls area, adjacent to roadway and gorge boundary (Misc).

Similarly, as with management burning exclusion areas (Q.11, Fig. 5.6), large numbers of managers attempt to exclude bushfire from the whole property, particularly managers of the G&T'l group (42%). Almost twice the number of managers from this group attempt to exclude bushfires from the whole property than the same group of managers with regard for management burning. Thus, it appears that unplanned bushfires (which largely occur during December and January) are a potential problem to G&T'l managers, and may explain the managers high usage of fire for management purposes during specific periods of the year. The response to bushfire exclusion of property infrastructure was considerably higher for the T'l than the G&T'l group, though the sample size precluded statistical analysis of these differences. However, this result seems somewhat consistent with the differential investment in property infrastructure between these groups.

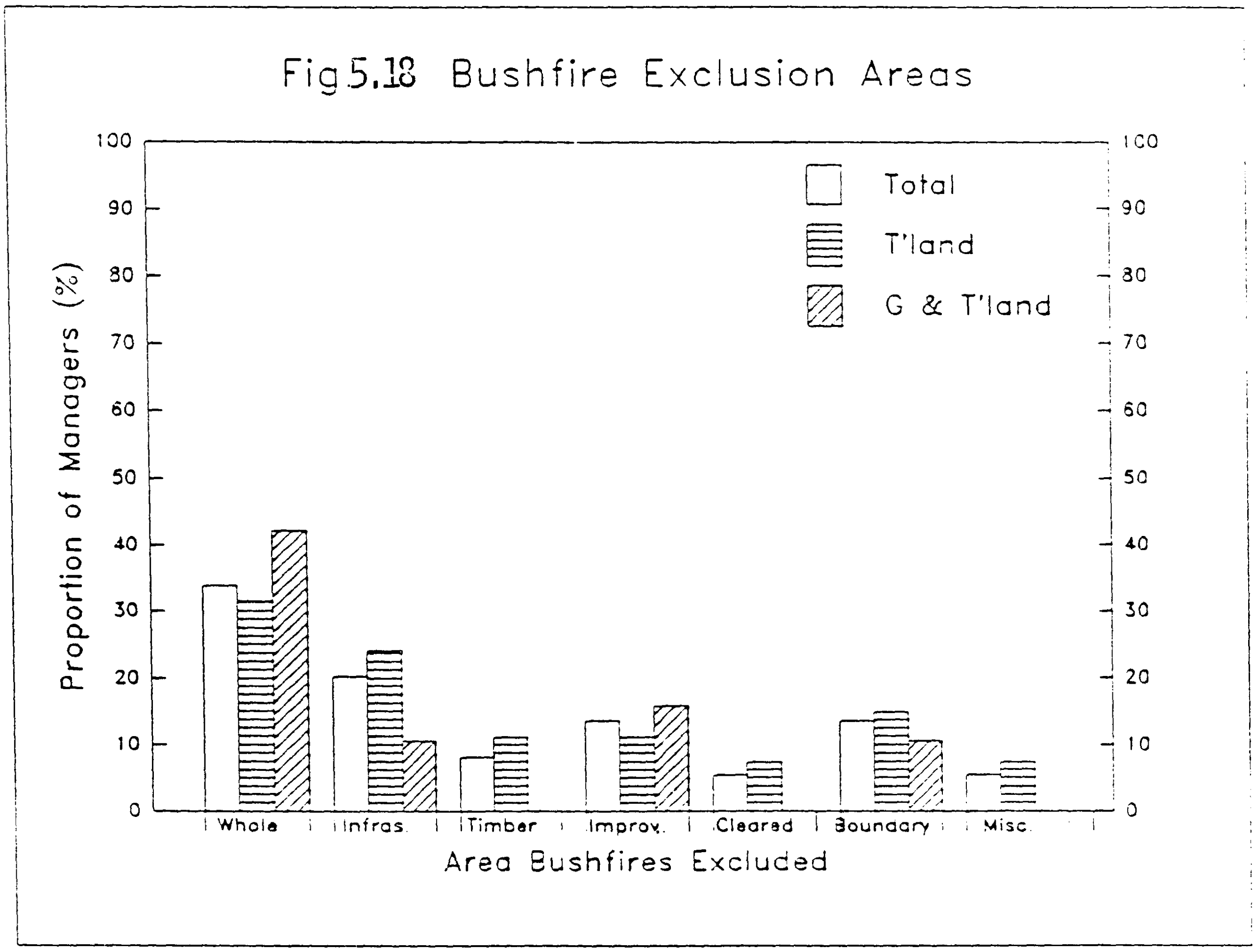


Fig 5.18 Bushfire Exclusion Areas
Total
T'land
G & T'land
Proportion of Managers (%)
0
10
20
30
40
50
60
70
80
90
100
Whole
Infras.
Timber
Improv.
Cleared
Boundary
Misc.
Area Bushfires Excluded

5.4.4.10 Bushfire Control Methods

Question 27: "What fire control methods do you use on your property?"

Six categories of fire control methods were listed by managers. These were, in order of decreasing overall importance: (i) fire breaks i.e burn, doze or ploughed (Break); (ii) fire fighting equipment (Equip.); (iii) fuel reduction burning (Fuel); (iv) miscellaneous methods, such as pasture improvement, spot-spraying fence lines with herbicide, fire trails/boundary roads, natural breaks (Misc.); (v) nil control methods (Nil); and (vi) strategic grazing (Grazing).

These responses are shown in Figure 5.19. This figure suggests major differences in the fire control methods used by the two manager groups. A significantly greater proportion of the G&T'l managers use fuel reduction burning for bushfire control (being listed by some 16% of T'l managers compared to 53% of G&T'l managers; (x^2=9.73, 1df, p<0.01). However, statistical analysis did not reveal any significant differences between the manager groups with regard to the use of other fire control techniques.

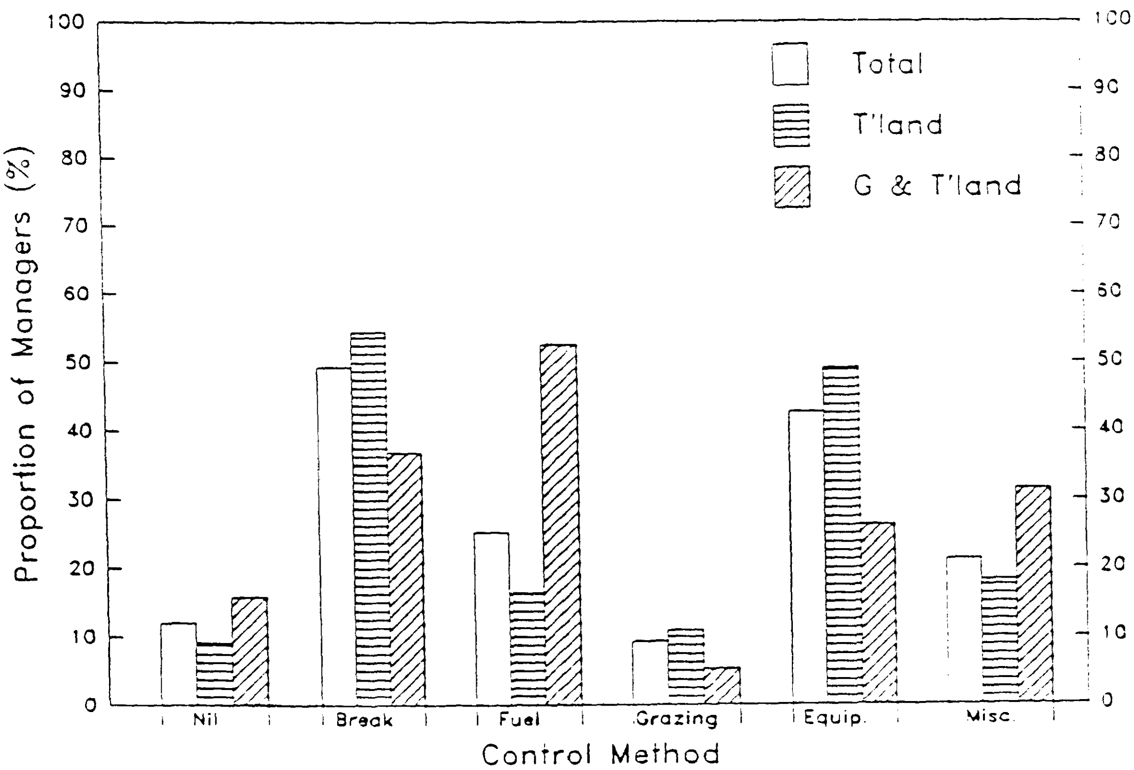
Fire breaks (55%) and fire-fighting equipment (49%) are the main bushfire control methods used by the T'l group, whilst fuel reduction burning (53%) followed by fire breaks (37%) are the primary methods used by the G&T'l managers.

Thus, while fire breaks, fire-fighting equipment and fuel reduction burning are important bushfire control methods for both manager groups, fuel reduction burning is significantly more important to G&T'l managers than to the T'l managers.

5.4.4.11 Additional Bushfire Control Needs

Question 28: "In your opinion, what additional help or techniques are needed for fire control in your area?"

Fig.5.19 Fire Control Methods



The aim of this question was largely to elicit landholders perceptions of the responsibilities of public authorities in the area with regard to fire management and control. This was in addition to identifying specific areas where bushfire control could be improved or expanded.

Responses to Q.28 are presented in Figure 5.20. The most common response, listed by almost 40% of managers, was that no additional ('Nil') fire control methods were needed. In order of decreasing overall importance, the additional fire control needs that were emphasised included: (i) miscellaneous additions, such as fire trails, fire management research and increased N.P.W.S. field personnel (Misc.); (ii) additional organised fuel reduction burning programmes incorporating landholders, the Forestry Commission and the N.P.W.S. (Fuel); (iii) fire breaks on N.P.W.S and Forestry Commission boundaries (Breaks); (iv) improved co-ordination and training of local bushfire brigades and better communications between authorities and brigades and between brigades themselves (Comm.); (v) strategic stocking of gorges (Grazing); and (vi) additional equipment and finance (Equip.).

The response of the two manager groups to question 28 was largely the same, with no statistically significant differences evident between the groups for any of the response categories. However, there is some suggestion in the data that 'additional fuel reduction burning programmes' may have been more important for the G&T'l managers (33%) than the T'l group (14%). Likewise, 'miscellaneous additions, such as fire trails, fire management research and increased N.P.W.S. personnel' seemed to have been more important to the T'l group (34%) than the G&T'l group (17%). In addition, no G&T'l managers recognised 'strategic stocking of the gorges' or 'additional equipment and finance' as an additional fire control need.

Thus, despite the large proportion of managers who did not perceive the need for additional fire control methods, many managers did recognise such a need. Areas of particular concern to G&T'l managers seemed to be a perceived need for

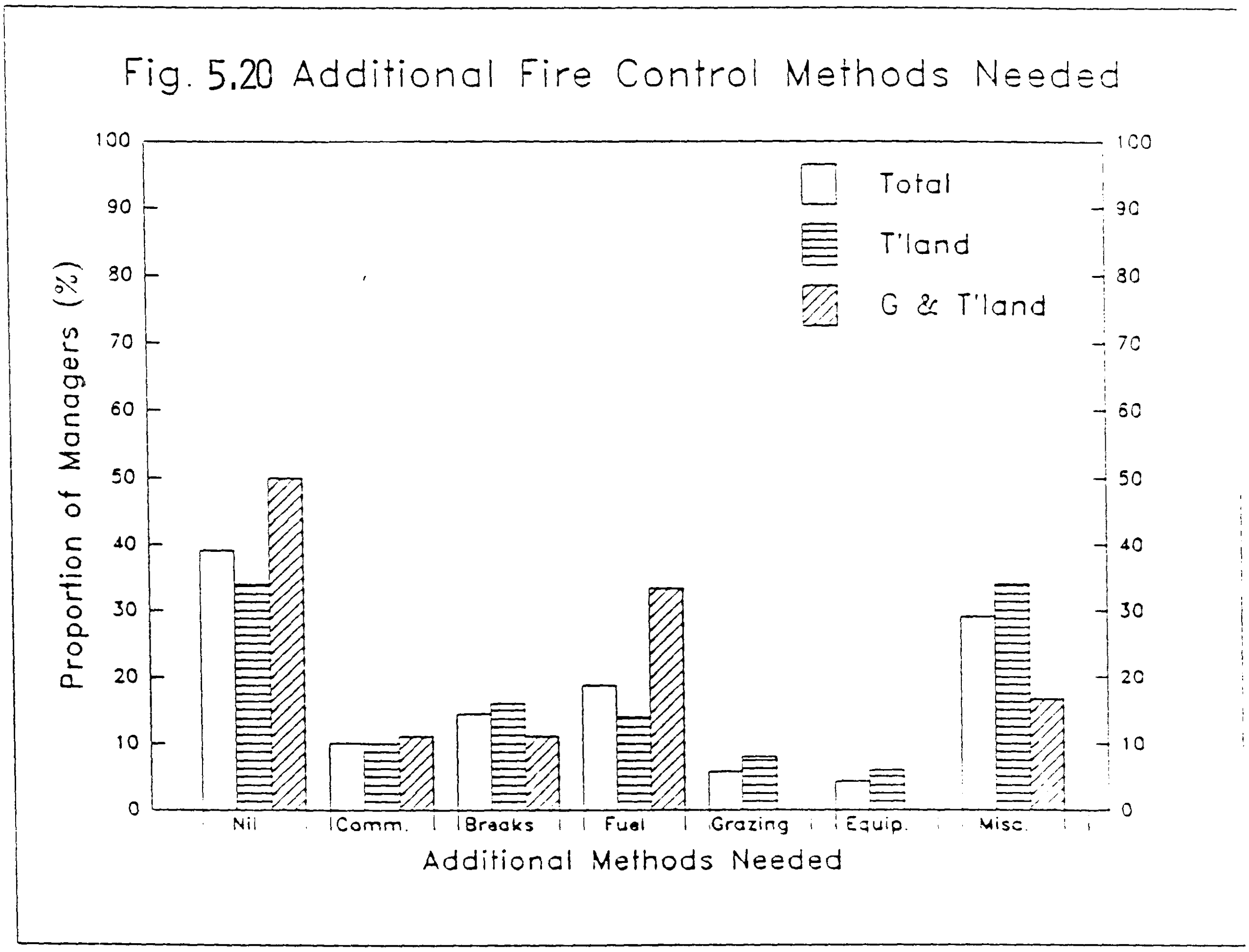


Fig. 5.20 Additional Fire Control Methods Needed
Total
T'land
G & T'land
Proportion of Managers (%)
0
10
20
30
40
50
60
70
80
90
100
Nil
Comm.
Breaks
Fuel
Grazing
Equip.
Misc.
Additional Methods Needed

more organised fuel reduction burning programmes. The T'l managers saw greater utility in a series of miscellaneous steps such as the construction of fire trails, fire management research and increased N.P.W.S. field personnel.

5.4.5 Public Authority Interactions and Gorge Management Problems

Questions 30 to 34 aimed to assess the degree of awareness and the interactions of property managers with public and other authorities, and to detail management problems associated with the gorge country. Questions included: the awareness of property managers of public authorities and the Armidale District N.P.W.S. Advisory Committee; landholder contact with these authorities; and management problems associated with the gorges.

5.4.5.1 Awareness of Public Authorities

Question 30: "Are there any public authorities with land management and / or fire-control responsibilities in the gorge-lands in your area?"

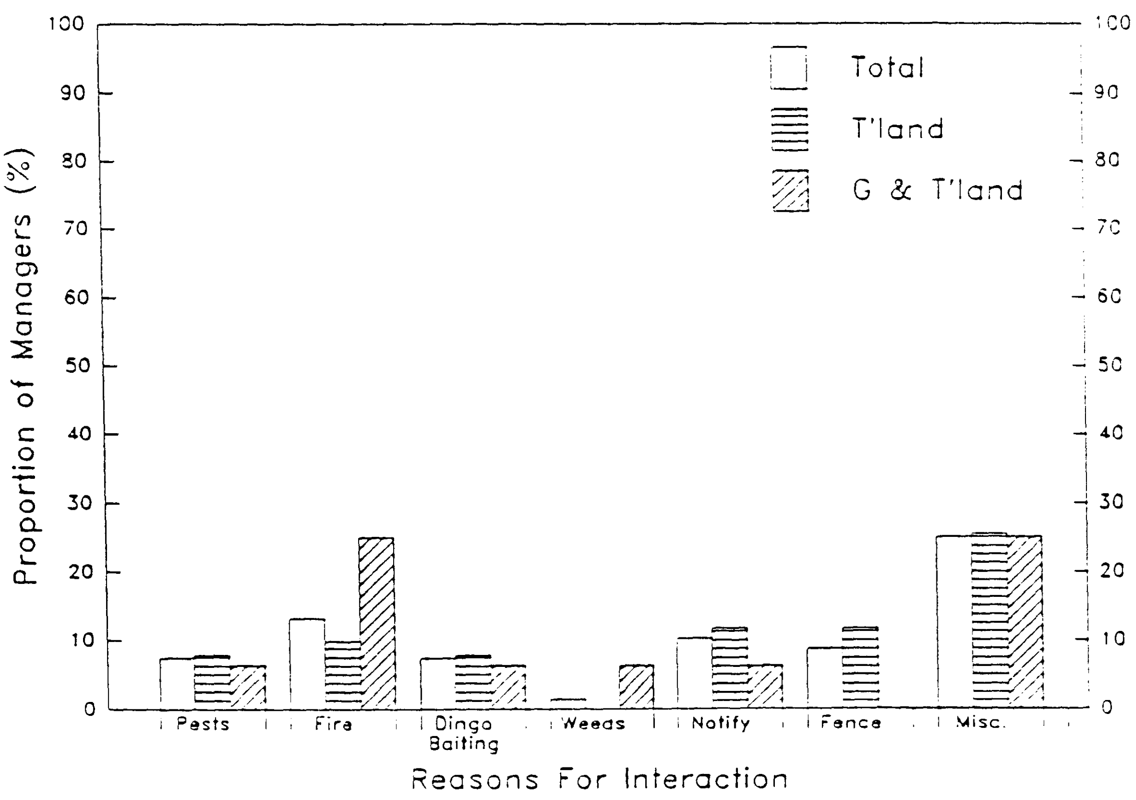
Some 83% of T'l managers and almost 74% of G&T'l managers listed one or several public authorities or other bodies with responsibilities in their area. Authorities recognised included; the N.P.W.S. (57%), local bushfire brigades, Pastures Protection Board, or ELCOM (31%), and the Forestry Commission (16%).

5.4.5.2 Contact With Public Authorities

Question 31: "Have you had any contact or involvement with any of these government authorities?"

On average, some 58% of property managers had contacted a public authority regarding the authority's responsibilities in the local area. The reasons contact was made are presented in Figure 5.21, and include in order of decreasing overall

Fig. 5.21 Reasons For Interactions With Public Authorities



importance: (i) miscellaneous factors, such as enquiries regarding burning permits, land tenure and land purchase (Misc.); (ii) enquiries regarding fire use, management and responsibilities (Fire); (iii) notification of fire (Notify); (iv) enquiries regarding responsibility for fence lines i.e., maintenance / damage (Fence); (v) dingo baiting (Dingo Baiting); (vi) pests (Pests); and (vii) weeds, such as blackberries (Weeds). While the low level of response precluded statistical analysis of differences between manager groups for many of these response categories, responses appeared to be largely similar between both manager groups. A possible exception was for interactions regarding 'fire use, management and responsibilities'. A considerably larger proportion of G&T'l managers (25%) than T'l managers (10%) indicated this as a predominant reason for interaction with public authorities. Furthermore, G&T'l managers had no interactions regarding 'fences' and similarly for T'l managers regarding 'weeds'.

5.4.5.3 Gorge Management Problems

Question 32: "Do the gorge-lands cause you any problems in the management of your property?"

Almost 78% of T'l managers and some 63% of G&T'l managers indicated property management problems associated with the gorges. Management problems specified by respondents are presented in Figure 5.22, and in order of decreasing overall importance include: (i) native pests e.g., dingos, kangaroos and eagles (Native Pests); (ii) bushfire (Fire); (iii) weeds e.g. lantana, blackberries and prickly pear (Weeds); (iv) exotic pests e.g. feral cats, goats, wild-bulls, pigs, and foxes (Exotic Pests); (v) miscellaneous problems regarding fencing, the N.P.W.S. and the Forestry Commission's management (Misc.); and (vi) tourists and bushwalkers (Tourists).

Native pests were by far the major management problem associated with the gorges accounting for some 70% of T'l and 58% of G&T'l manager responses. Bushfire represents the next main problem, being listed by almost 30% of T'l and almost 16%

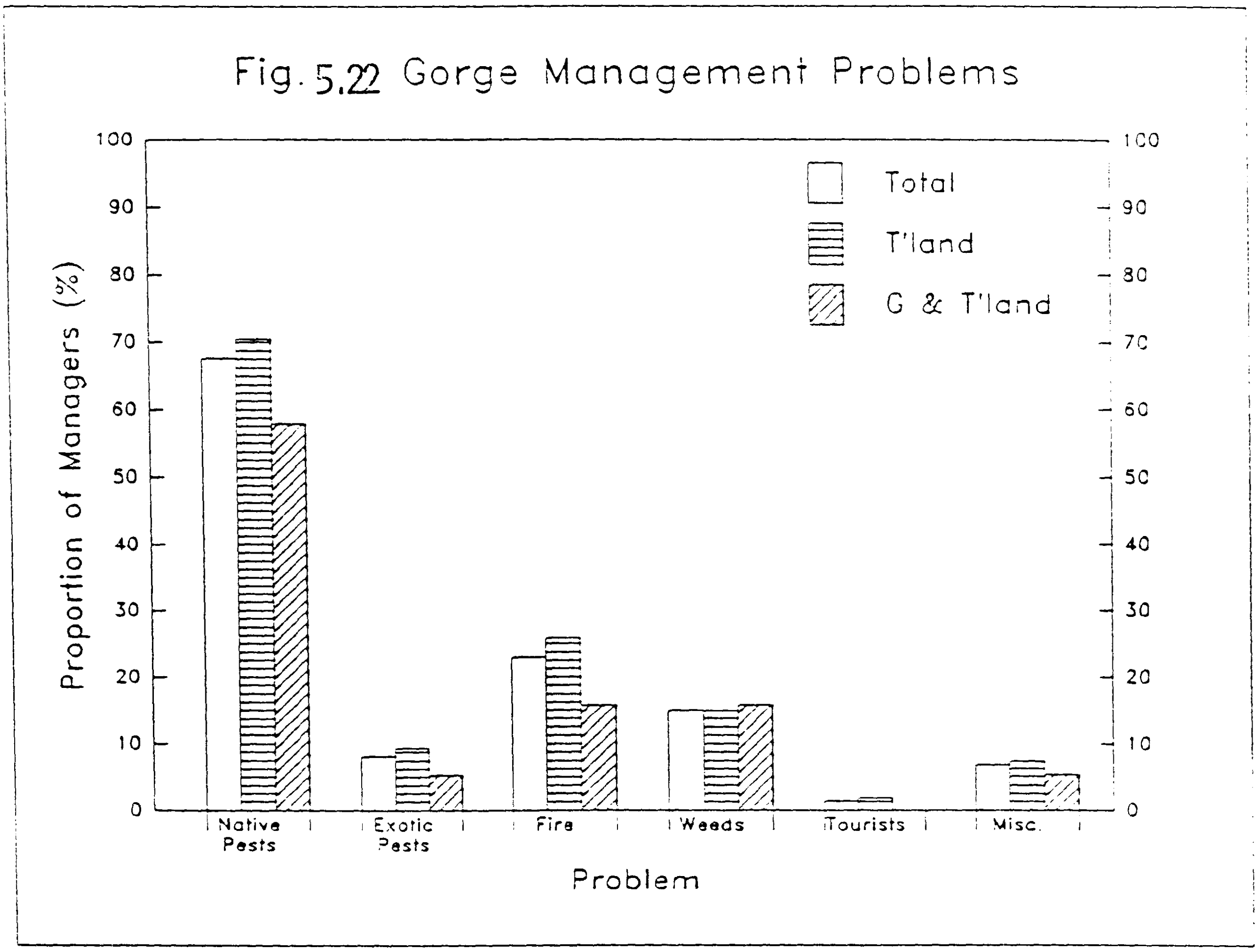


Fig. 5.22 Gorge Management Problems
Proportion of Managers (%)
Total
T'land
G & T'land
Native Pests
Exotic Pests
Fire
Weeds
Tourists
Misc.
Problem
0
10
20
30
40
50
60
70
80
90
100

of G&T'l managers. Similar and relatively low responses were indicated for all other categories.

5.4.5.4 N.P.W.S Advisory Committee

Question 33: "The New South Wales Government has recently appointed a community based advisory committee to bring local concerns about the management of the districts national parks to the attention of the National Parks and Wildlife Service. One of the Major parks of concern to the Committee is the Oxley Wild Rivers National Park, which covers part of the gorge-lands country. Are you aware of the existence of this committee?"

Question 34: "If you are aware of this committee, do you know how to contact its members to discuss matters that concern you with regard to the management of the gorge-lands country?"

The aim of Q.33 and Q.34 was to assess the level of awareness of the existence of the N.P.W.S Advisory Committee, and thus whether there was any need for the committee to emphasise its existence and role in the district. Responses indicated that only some 63% of the managers interviewed were aware of the existence of the community-based advisory committee. Furthermore, only 48% were aware of who or how to contact it.

5.5 Conclusion and Summary of Major Findings

5.5.1 Property Details

Property sizes are extremely variable throughout the study area. In general, T'l properties are significantly smaller than G&T'l properties. Similarly, the retention of native vegetation on properties also varies between the two groups, with significantly higher levels of vegetation retention associated with the G&T'l group.

The differential property areas and level of property development in the form of clearing, characteristic of the two groups may be partially explained by the basic differential capability of the lands to support agriculture. In general, the tableland country offers better grazing conditions whilst the majority of the gorge leases are rugged, steep and highly erodible lands, often with clearing restrictions imposed.

Rainfall records are widely maintained. Throughout the study area rainfall averages some 900 mm per annum, but with marked variation occurring over the study area reflecting both an east - west declining trend and the variation in local relief and topography of the area.

5.5.2 Current Fire Management Practices

Fire is used by a large proportion of the managers in the study area as part of their property management programmes. It is used for a number of reasons the most predominant being regenerating pastures. It is also particularly important to the G&T'l managers for fuel reduction purposes and to the T'l managers for burning dead timber and stumps.

The burning operations on properties are undertaken on a relatively frequent basis usually every one to five years. Almost 56% of managers burning every 1 - 3 years. However, recent times have seen a trend for fire frequency to be reduced, largely it appears in response to expanding areas of improved pasture. For the G&T'l managers, recent dry seasons have also contributed to the reduced burning frequencies because of reduced grass and other "fuel" growth in the gorges.

The highest use of management fire usually occurs in late Winter - mid Spring (Aug. - Oct.). This incorporates both manager groups though the activities of the G&T'l managers are more tightly clustered within this period.

The G&T'l group burn both a larger area of land and proportion of their property during their management programmes. Most management fires appear to be of relatively low intensity, being predominantly grass only or grass and undergrowth fire-types.

5.5.3 Bushfire History and Control

Bushfires are of considerable concern to the majority of managers in the study area. These managers perceived that the majority of bushfire events originate in the gorges, or (as emphasised by many G&T'l managers), from neighbouring properties. The cause of most bushfires was largely attributed to lightning strike and to escaping management burnoffs undertaken by landholders and public authorities. Lightning strikes were of greater importance to the T'l managers while escaping burnoffs were more important to the G&T'l group. The frequency with which bushfires occur ranged from very infrequent through to frequent and varied between the gorges and the tablelands. Bushfires are very infrequent on the tablelands whilst they occur with greater frequency in the gorges.

The majority of managers had either no recollections, or were unsure, if patches of dry rainforest were burnt during bushfire events. However, more than a quarter of all managers did recollect fire impacts on dry rainforest communities in the gorges. Importantly, some 44% of the G&T'l managers indicated that the community had either expanded or contracted over relatively recent time.

Managers attempt to exclude bushfires from the whole property. Specifically they sought to protect property infrastructure, areas of timber, cleared and improved land, and property boundaries. Bushfire control methods primarily include fire breaks, fuel reduction burning and fire-fighting equipment in addition to strategic grazing and other minor methods. Fuel reduction burning is a particularly important fire control method for the G&T'l group, whilst the majority of T'l managers utilise fire breaks and fire-fighting equipment for control. Nearly 40% of managers did not perceive any need for additional fire control methods, being satisfied with current practices. However, organised fuel reduction burning programmes incorporating all land managers (including public authorities) were suggested as an additional need, particularly by the G&T'l managers. In addition, the T'l managers emphasised the need for fire trails, fire-management research and increased N.P.W.S. field personnel.

5.5.4 Public Authority Interactions and Gorge Management Problems

Most managers in the study area were aware of the relevant public and other authorities or bodies with responsibilities in their respective areas. Authorities recognised included the N.P.W.S., local bushfire brigade units, the Pastures Protection Board, ELCOM, the Soil Conservation Service, and the Forestry Commission.

Interaction between managers and such authorities occurred for a variety of reasons and predominantly concerned obtaining burning permits, enquiries of land tenure and land purchase, dingo baiting, pests and fire. The G&T'l managers in particular made considerable contact with regard to fire use, management and responsibilities.

Six categories of management problems were recognised as being associated with the gorges. In particular, native pests, such as: dingos, kangaroos, and eagles followed by bushfires were of paramount concern to managers.

In general the Armidale District Advisory Committee has a relatively low profile amongst the managers in the study area, with less than half the managers surveyed aware of how or who to contact for information.