THE EFFECTS OF FIRE ON TASMANIA'S WEST COAST LOWLAND RAINFOREST

BY

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This thesis contains no material which has been accepted for the award of any other higher degree or graduate diploma in any tertiary institution and, to the best of my knowledge and belief, it contains no material previously published or written by any other person, except when due reference is made in the text of the thesis.

Mirranie Jane Barker

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ABSTRACT

This study examined the effects of extensive fires on lowland cool temperate rainforest burnt in 1982. Post-fire vegetation eight years after the fires was dominated by sclerophyll species. On burnt sites, there were more non-rainforest species than rainforest species, though there was regeneration of most rainforest vascular species. Rainforest species that did not appear to regenerate include species of *Hymenophyllum*, *Asplenium* and *Polyphlebium*. Many regenerating canopy species, especially *Atherosperma moschatum*, were recorded as small seedlings. Their rate of survival to maturity was unknown.

Floristic analyses using ordination and classification procedures indicated that rainforest type and burn intensity were the most important variables in determining post-burn vegetation. Regression analysis also showed the importance of rainforest type and fire intensity on individual species.

The dominant post-burn species were the non-rainforest species *Pteridium esculentum*, *Leptospermum scoparium* and the doubtful-rainforest species *Gahnia grandis*. The density of *P. esculentum* was greatest in callidendrous rainforest, while the other dominant species were denser in implicate rainforest (Jarman *et al.* 1984).

Recovery of rainforest species was predominantly by seedlings, though sprouting was important for some species. Eleven rainforest tree and shrub species were recorded sprouting, with the majority of sprouting occurring in implicate rainforest.

Recently burnt rainforest had a large component of sclerophyllous species and was considered to be more pyrogenic than mature rainforest. Rainforest regenerating after a recent fire would have burnt in milder conditions than those required for a large scale rainforest fire. Further fires appeared to be the major threat to the regeneration of rainforest as fires resulted in an increased sclerophyllous component and decreased rainforest elements. Additional fires also increased the time taken for rainforest to regenerate fully.

The time necessary for the regeneration of rainforest and its future composition in the study areas are not certain. To enable regeneration to mature rainforest a disturbance-free period of at least 100 years is required.

This study indicated that lowland rainforest can recover after a major disturbance, such as fire. It is essential that subsequent fires be excluded until the areas burnt are fully regenerated to rainforest, otherwise there will be an increase in the time required for rainforest to fully regenerate. The more fires the longer the period required for rainforest to regenerate fully with a decrease in the number of species regenerating. To ensure that subsequent fires do not occur responsible management by all land managers is required.

CHAPTER 1: GENERAL INTRODUCTION

Tasmania's rainforest is widely accepted as being very fire sensitive and with the advent of Europeans, fire is seen as its greatest threat (Jarman *et al.* 1984). There is mounting sub-fossil evidence that fire has caused widespread replacement of rainforest with other vegetation types (Podger *et al.* 1988). Over eight percent or 56 000 hectares of Tasmania's rainforest was burnt between 1950 and 1984 (Kirkpatrick and Dickinson 1984).

Generally rainforest will not burn under the weather conditions that prevail in western Tasmania. The low flammability of rainforest species (Dickinson and Kirkpatrick 1985) and the fuel-moisture differentials between rainforest and neighbouring vegetation is such that encroachment by fire into rainforest is generally limited to the margins. Edge attrition of rainforest can still have serious consequences, especially if it continues over time allowing a broad flammable ecotone to form. There appear to be two principal ways a rainforest burns. A less severe peat fire can burn for months in the peat of the forest floor, but flare during dry conditions, possibly causing a major conflagration. A major fire requires hot, dry conditions which only occurs occasionally, and an ignition source. Lightning appears as only a minor source of ignition. In a 12-year period Jackson and Bowman (1982) positively attributed only 0.01% of the total area burnt to lightening, whereas Ingles (1985) found that 0.1% was due to lightning strikes between 1979 and 1985. Podger et al. (1988) suggested that these figures may be considerably lower than the long-term average statewide.

The major ignition source is human. Weather conditions may have remained constant for the last approximately 1000 years (Macphail 1980) yet fire ignition has increased, especially since the onset of Europeans and their active use of fire for land management.

The role of fire in changing vegetation patterns prior to the arrival of Europeans is not well understood. There is evidence that climate is the primary determinant of long-term trends in Tasmanian forests and that fire and soil fertility are secondary (Macphail 1980, Colhoun and van der Geer 1986). Macphail (1980) states that "Since the middle Holocene, *Nothofagus cunninghamii* temperate rainforest has been in retreat, replaced by eucalyptus and other sclerophyll formations due to complementary effects of deteriorating climates, decreasing soil fertility, and probably increasing fire frequencies even in remote areas."

There have been major changes to Tasmania's vegetation since the arrival of Europeans, with 16% of the Tasmanian alpine vegetation and 10% of rainforest destroyed in the last two decades (Kirkpatrick and Dickinson, 1984a; Bowman and Brown 1986). These large changes, indicate that if there had been large scale burning by Aborigines, then it produced a fire pattern, that enabled fire sensitive vegetation to be retained.

Rainforest is the climax community in perhumid southwestern Tasmania in regions where rainfall is high and relatively uniform, corresponding to areas where summer rainfall is at least 25 mm per month. These regions are not dominated by rainforest but are a mosaic of rainforest and sclerophyll communities including grassland and sedgeland, scrub, shrubland and eucalypt or mixed forest (Jackson 1968).

There are two main hypothesis offering explainations why rainforest does not dominate these regions and both involve fire. The 'ecological drift model' proposed by Jackson (1968) argues that the mosaic of vegetation types is due to a complex relationship between fire, vegetation and soils. An increase in fire frequency will select for inflammable species which form open communities. These communities will then have characteristics which will enable them to burn more readily, further selecting and maintaining inflammable species. The increase in fire will promote nutrient loss, promoting more sclerophyllous species. If there is an increase in the fire frequency of a patch of rainforest then there will be an 'ecological drift' towards a more flammable, sclerophyllous vegetation. Sedgeland would be the end result of frequent fires (Jackson 1968). As fire frequency decreases, 'ecological drift' tends to less sclerophyllous communities.

An alternative explanation to account for the different vegetation communities is that vegetation boundaries are essentially stable (Mount 1979). Vegetation communities are determined mainly by an interaction of environmental factors including geology, topography and drainage. Each vegetation type has a different rate and quantity of fuel production and a different flammability, producing typical fire-free intervals for each community. This explanation is supported by Horton (1982), who argues that aboriginal burning only had a limited effect on vegetation and only reinforced the environmentally determined patterns.

The adoption of either hypothesis has important consequences for rainforest management. Jackson's hypothesis can be interpreted as indicating that recently burnt rainforest is highly susceptible to further fire and an increase in fire frequency leads to a sclerophyllous vegetation, which in turn makes it more fire prone. According to Mount (1979), a fire in rainforest produces an extended (i.e., > 60 years) period when fuel levels are low. This period enables rainforest to regenerate and recover its original pre-fire status.

Studies on the effect of fire on rainforest vegetation are limited. Quantitative research into the role of fire in determining rainforest boundaries (e.g., Brown and Podger 1982; Ellis 1985; Podger *et al.*, 1988) and observations on the effect of fire on individual species (e.g., Gilbert 1959; Howard 1973; Kirkpatrick 1977, 1984; Calais and Kirkpatrick 1983; Jarman *et al.* 1984; Neyland 1986; Hickey and Felton 1987; Brown *et al.*.1988) have been reported.

This study aims to examine the effects of fire on cool lowland temperate rainforest on the west coast of Tasmania. Jarman and Brown's (1983) definition of cool temperate rainforest is: "forest vegetation (trees greater than 8m) dominated by species of *Nothofagus, Eucryphia, Atherosperma, Athrotaxis, Lagarostrobos, Phyllocladus* or *Diselma*". The definition of rainforest species is "those able to regenerate below undisturbed canopies or in local recurring disturbances which are part of the normal rainforest ecosystem. Species depending on fire for their regeneration are not regarded as rainforest species." Lowland rainforest consists of the three major rainforest types: callidendrous, thamnic and implicate (Jarman et al. 1984). Implicate and thamnic rainforest are endemic to Tasmania and callidendrous rainforest also occurs in Victoria, although its best development is in Tasmania.

Callidendrous rainforest is tall park-like forest with open understoreys. This type is the most vascular species poor and is dominated by *N. cunninghamii* and *A. moschatum* with scattered shrubs and abundant epiphytic ferns. Implicate rainforest is of low stature with a broken, uneven canopy. The understorey is continous with the canopy and consists of a network of tangled branches. Implicate rainforest is relatively species rich with dominance of one species rare. Thamnic rainforest is in between callidendrous and implicate. It has greater diversity than callidendrous and the understorey is relatively open with a distinction between canopy and understorey (Jarman et al. 1984).

The specific aims of this project are:

- to examine the effect of fire on rainforest type and to determine whether rainforest maintains its integrity after fire;
- to observe the response of rainforest plant species to different fire intensities;

• to consider conservation options to protect unburnt and burnt rainforest from fire.

CHAPTER 2: THE SAVAGE RIVER AND WARATAH FIRES.

2.1 The Study Sites

The 1982 Savage River and Waratah fires, were chosen as they contained a range of temperate rainforest types and fire intensities (Figure 2.1). The Savage River fire was the largest rainforest fire since reliable records have been kept. The fire burnt approximately 45 000 ha of vegetation, 15 000 ha of which was rainforest (Figure 2.2). The Waratah fire burnt approximately 450 ha of rainforest (Figure 2.3). Access to all burnt areas was limited. However, the extent of these fires allowed a range of fire intensities to be surveyed in each of the three major lowland rainforest types.

2.2 The 1982 Savage River fire

The cause of the Savage River fire is not known. The fire was first noticed by some residents of Savage River as a pillar of smoke a few kilometres to the east of the township, early in February 1982 (Britton 1983). The cause was either a lightning strike from a storm recorded by the Savage River weather station on 8 February 1982, or a camp-fire lit by a mining survey party known to have been in the general area. The fire was first seen in a line between two mining survey markers. A police investigation following the fire failed to positively find a cause.

Fire officers from Savage River Mines investigated the fire on 13 February 1982. They described it as 'trickling around' five hectares of rainforest but concluded it was beyond their resources to contain.

On the afternoon of 14 February 1982, the fire flared and threatened the Savage River township. Overnight spotting caused fires throughout a strip of rainforest 25 km by 5 km. These spot-fires merged on the following day and overnight combined with another wildfire, the Trial Harbour-Granville Harbour fire. This fire then swung eastwards and burnt the Stringers Creek HEC camp. Weather conditions eased on 17 February 1982 and the fire stopped spreading. It was extinguished by rain in late February 1982.

2.2.1 *Weather conditions*

The weather conditions for the 1981/1982 fire season for all of Tasmania were

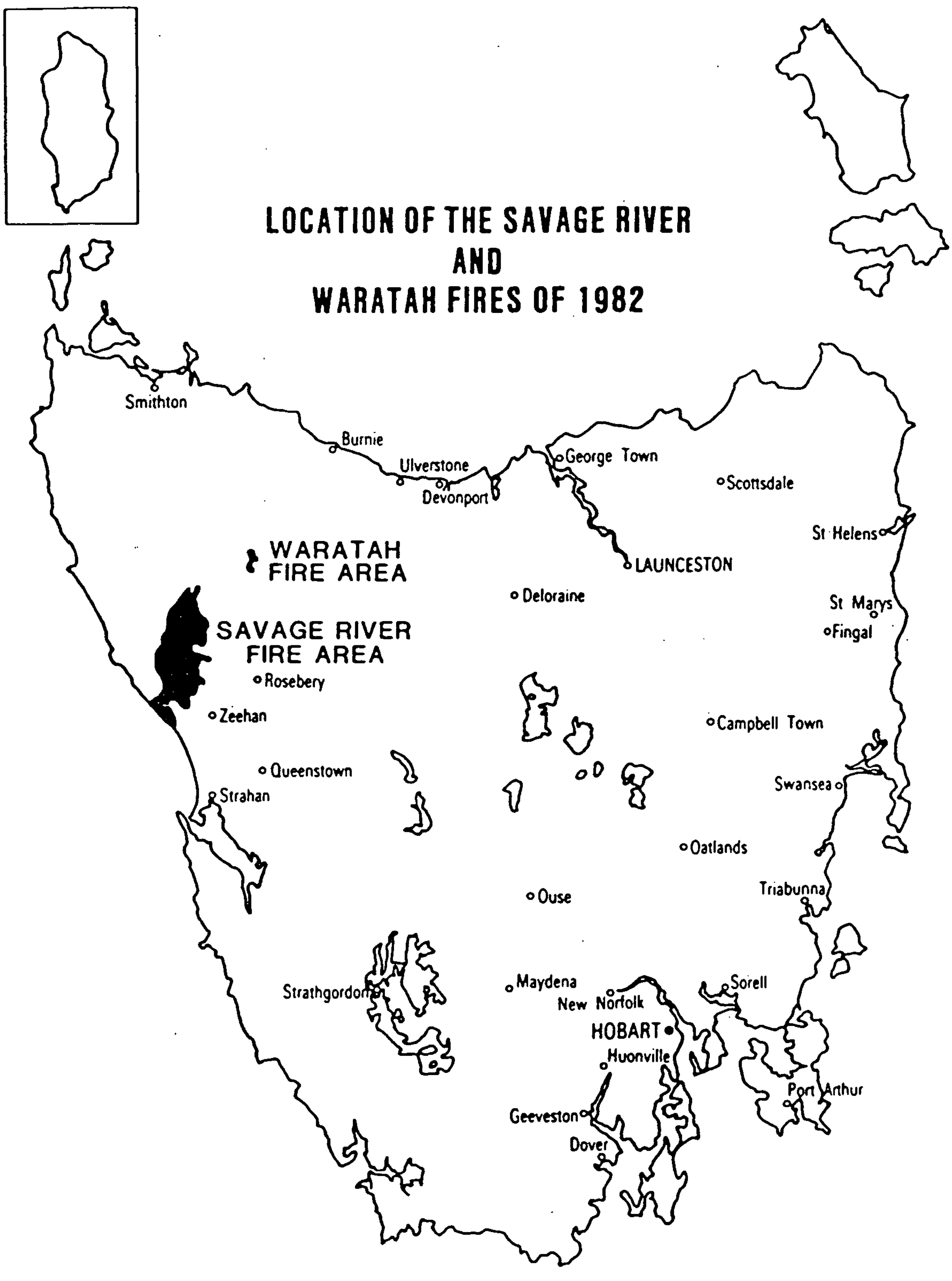


FIGURE 2.1: Location of the Savage River and Waratah fires of 1982.

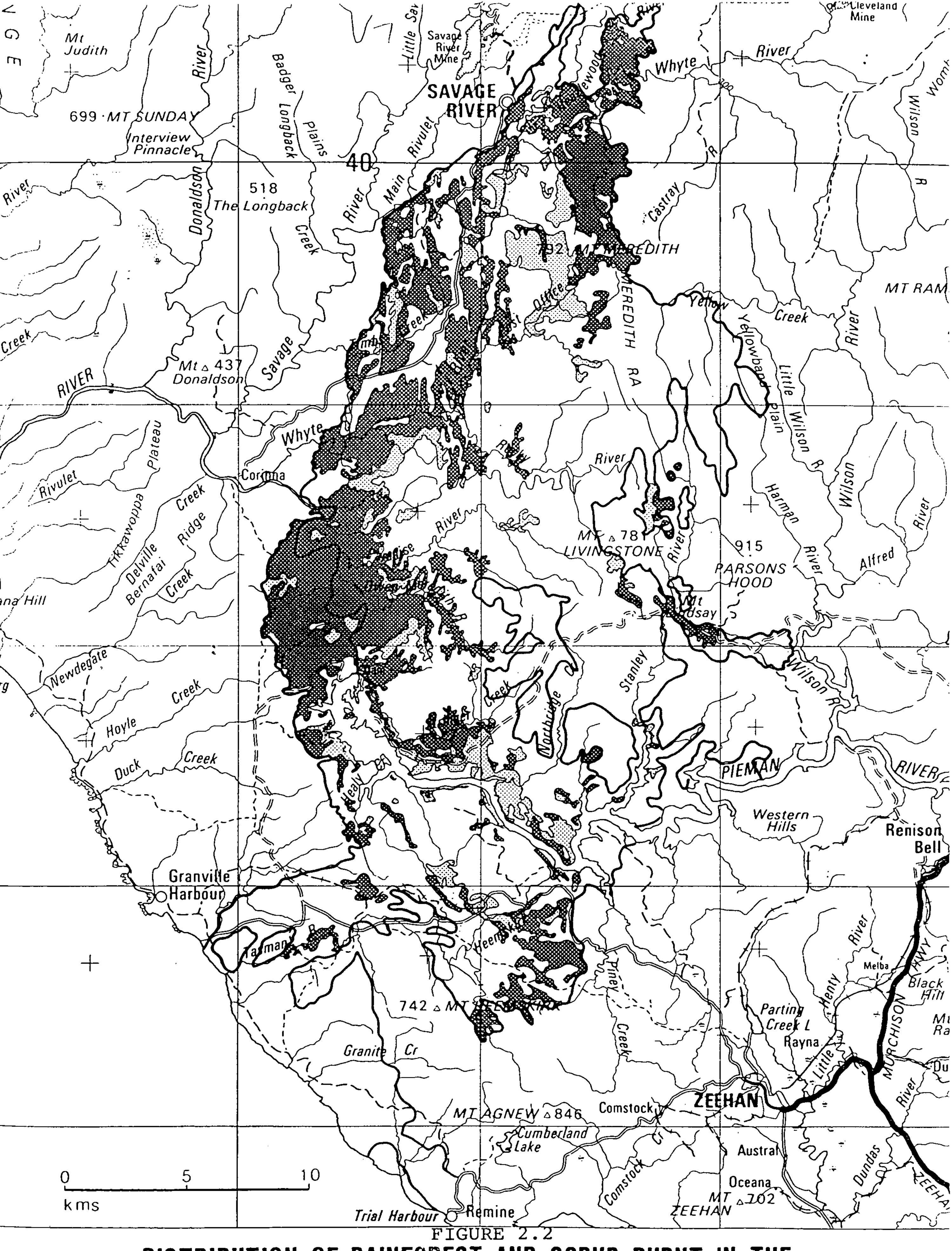


FIGURE 2.2

DISTRIBUTION OF RAINFOREST AND SCRUB BURNT IN THE 1982 SAVAGE RIVER FIRE

Fire area boundary

Rainforest with eucalypt density less than or equal to 5%

Scrub with eucalypt density less than or equal to 5%

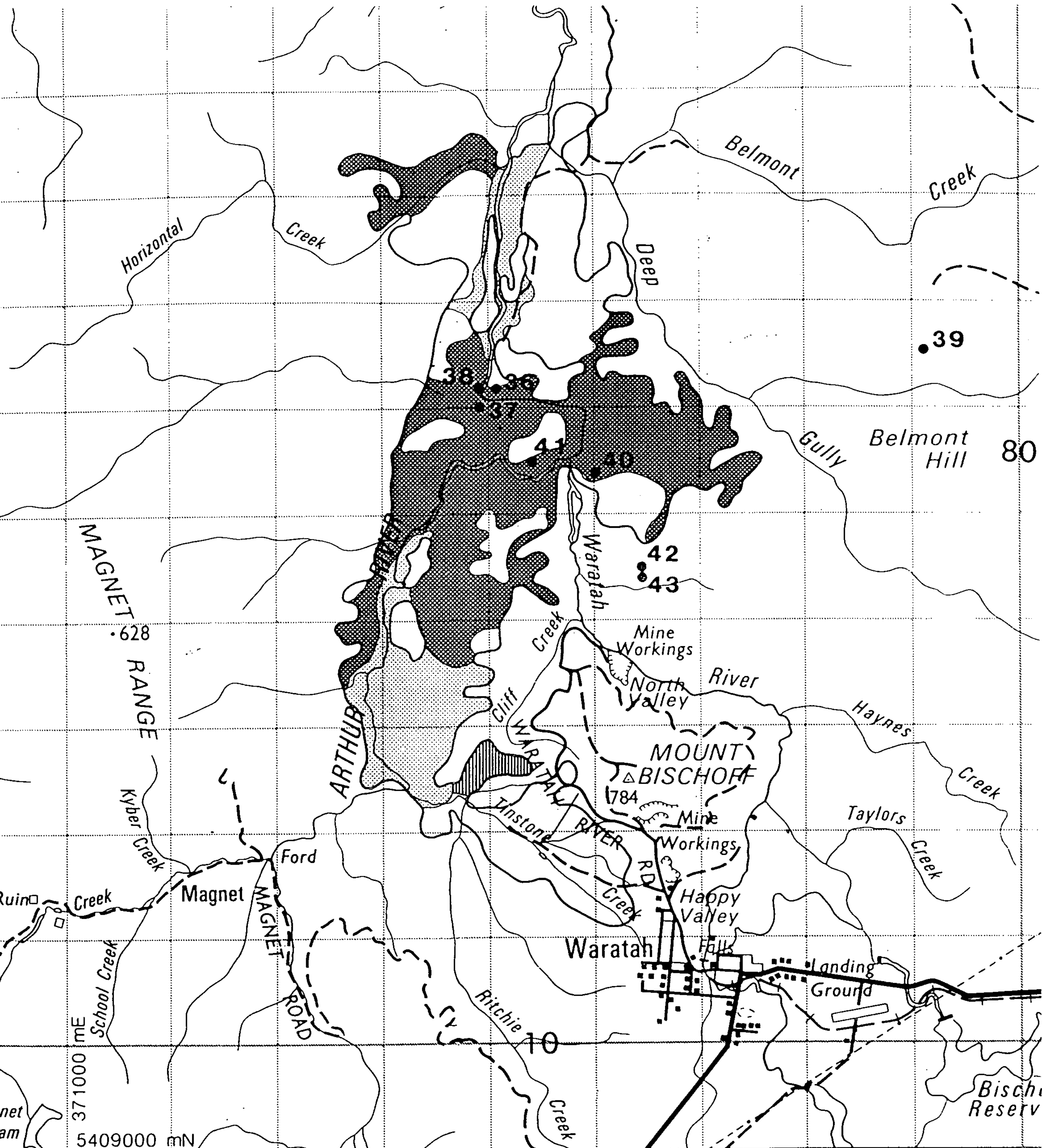


FIGURE 2.3

DISTRIBUTION OF RAINFOREST BURNT IN THE 1982 WARATAH FIRE AND SITE LOCATIONS

0 1 2 3 4
kms

- Fire area boundary
- M+ which corresponds to callidendrous rainforest
- M- which corresponds to thamnic
- Myrtle regrowth above 15 metres
- ● Site locations

described as 'extreme' in terms of bushfire threat (Britton 1983). Similar weather conditions were last experienced in 1960. Weather conditions during the 1981/1982 fire season on Tasmania's west coast were characterized by days of normal and below normal temperatures, interspersed with periods of very hot dry days (Table 2.1). The mean monthly weather conditions at Savage River for February 1982 were below the 1966-1989 February average (Table 2.2). The weekly soil dryness index (SDI: an estimate of long term dryness of soil in terms of millimeters of effective rainfall needed to bring it back to field capacity) for Savage River and Queenstown during February 1982 did not reach the west coast critical level of 50 (Mount 1972). An SDI value of 48 was reached in Savage River for the week ending 9 February 1982.

Severe drought had been recorded for the west coast in the previous fire season with a maximum SDI value of 150 computed. There were no major rainforest fires during this season and the following winter was very wet. The 1980/1981 drought may have increased fuel loads with many plants dying or dropping leaves.

The weather prior to an earlier fire, the Pine Cove fire, reported on 8 February 1982 was characterized by two very hot days with temperatures exceeding 30°C. February 14 1982 was the 'flare-up' day for many west coast fires, including the Savage River fire. Weather conditions reported at Queenstown sports oval for that day included a maximum temperature of 37°C, a humidity of 9% and a north easterly wind of 40+ knots (M. Peterson pers. comm.). These high temperatures continued until 16 February 1982, with substantial rainfall reported on 18 February 1982 in Queenstown and 21 February 1982 in Savage River.

2.2.2 *Area and vegetation burnt during the Savage River fire*

The total area of land within the Savage River fire boundary was 51 510 ha. The land systems within this boundary, (Appendix 1) where comprised of complex arrays of geology and topography. These land systems generally supported soils of poor to medium fertility (Richley, 1978).

An overlay of the Vegetation Map of Tasmania (Kirkpatrick and Dickinson 1984) on the fire boundary indicated that buttongrass and rainforest were the main vegetation types burnt (Table 2.3). The amount of rainforest burnt according to the Kirkpatrick and Dickinson (1984) map of 18 300 ha differed from estimates made from Forestry Commission forest type (PI) maps (11 500 ha: Table 2.4). This was due to different

TABLE 2.1: Weather conditions recorded in Savage River and Queenstown for February, 1982.

	SAVAGE RIVER WEATHER STATION				QUEENSTOWN WEATHER STATION			
Day	Maximum Temperature (°C)	Minimum Temperature (°C)	Rainfall (mm)	Evaporation (mm)	Maximum Temperature (°C)	Minimum Temperature (°C)	Rainfall (mm)	Evaporation (mm)
1	16.6				19.4	8.4	0.2	3
2	18.3	9		6.6	20.3	11.4		3
3	17	11	0.1	2.7	18.8	10.7		2.4
4	14.1	10.3	2.8	2.2	16.8	11.4	2.6	1.6
5		5.4		5.2	24.6	3.4		3.6
6					31.9	6.4		4
7	27.8				27.2	7.8	1.2	6.2
8	24.2	11		16.2	24.2	10.9	11.4	2.4
9	14.8	10	2.2	4.6	16.4	10.6	2	3.2
10	22.7	6.8	0.2	3.2	25.2	5		3.2
11	20.3	11.3		5.4	23.7	7.1		4
12		12.3		3.2	28.2	8		3.6
13					32.6	9.6		4.2
14	33.9				36.2	12		4.4
15	33.4	16.1		25.6	36.3	17		8
16	15.1	13.7		9.8	16.6	14.1		7.2
17	14.7	9.5	3.2	2.4	15.7	8.9	1	0
18	12.9	8.8	7.2	2	16.2	9.8	19.6	2.6
19		7.4	7.6	2	18.9	7.7	15.2	1.2
20	17.7				19.4	6.2		2.6
21	15.4	9.4	19.8	5	18.9	10.5	9.6	0.4
22	22.4	10.2	0.2	0.8	21.8	10.6		2.2
23	14	11.7	0.2	2.8	15.7	13.4	0.8	2.6
24	15.4	4.8	4.2	2.6	17.8	4.9	2.2	2.8
25	15.2	7.5	0.4	2.6	17.9	6		1.2
26	11.7	6.8	7.4	1.6	14	7.1	18.8	0.4
27		2.3	7		17.6	2.8	4.2	0.8
28			1	2.8	16.4	3.6		2.8

TABLE 2.2: **Weather conditions for February, (mean of Queenstown and Savage River)**

Mean of Queenstown and Savage River measurements	February **1982**	Average February **1966-1989**
mean daily maximum temperature	18.9°C	20.1°C
mean daily minimum temperature	9.3°C	9.9°C
mean daily sunshine duration	7.3 hours	7.6 hours
mean dewpoint 1500 hours	8.0°C	10.0°C
mean dewpoint 900 hours	9.0°C	10.0°C
mean daily pan evaporation	3.9mm	4.5mm
rainfall	64mm	78mm
number of raindays	16	20

TABLE 2.3: **Vegetation types burnt by the 1982 Savage River fire (Kirkpatrick and Dickinson 1984)**

VEGETATION TYPE	AREA (ha)
recently burnt rainforest	18 300
wet scrub	450
buttongrass moor	21 400
E. simmondsii wet forest	3 300
E. obliqua tall forest	4 450
Total area	47 900

definitions of rainforest between sources and mapping techniques. Kirkpatrick and Dickinson (1984) described rainforest as:
"...closed forest and open forest more than 8m tall and dominated singly or in combination by species of *Nothofagus, Athrotaxis, Atherosperma, Lagarostrobos, Phyllocladus, Eucryphia* and *Anodopetalum* with *Eucalyptus* species absent or present with less than 10% projective foliage cover."

This definition was much broader than that used by the Forestry Commission, in which rainforest comprised rainforest species and up to 5% eucalypt cover.

It was observed that some implicate rainforest was recorded as 'scrub' on the PI maps, which was the reason for including the 'scrub' category in Table 2.4 and Figure 2.2. Boundaries of the PI maps were more reliable than the Kirkpatrick and Dickinson (1984) vegetation map, as the PI maps were on a scale of 1:25 000 and the vegetation map was on a scale of 1:500 000. The main type of rainforest burnt was in the M-category, or thamnic and implicate rainforest (Jarman *et al.* 1984: Table 2.4).

2.2.3 *Burning patterns*

Rainforest was not uniformly burnt in the Savage River fire. There were a variety of fire intensities and burn types. The burn types included peat burns, ground fires, canopy fires and scorching. Unpublished data from J. Hickey (1982) indicated that, for certain forest areas (Figure 2.4), rainforest was burnt mainly by ground fires (Table 2.5). Implicate rainforest had a slightly higher percentage of area burnt by crown fires than thamnic rainforest. Eucalypt forest was mainly burnt by crown fires. The differences in burn types may have had a major effect on rainforest species regeneration and non-rainforest species composition.

2.3 The Waratah Fire

The Waratah fire started on 18 January 1982 during a logging operation in eucalypt forest. The fire started when a heavy chain pulling a large log over granite produced sparks. This fire burnt an extensive area but was under control until the day of the 'flare-up' conditions (14 February 1982) which turned the Savage River fire into a major wildfire. The Waratah fire again flared and threatened the town of Waratah and the Australian Forest Holdings (AFH) freehold. This fire was extinguished after the onset of autumn rain. No more accurate information was available.

2.3.1 *Weather conditions*

There were no weather stations located at Waratah. According to AFH workers, the temperature on the day the fire started was higher than 30°C, humidity was low and the wind was strengthening from the north north-east. Weather conditions which caused the fire to flare would be similar to those experienced on the flare-up day of the Savage River fire.

2.3.2 *Area and vegetation burnt during the Waratah Fire*

The total area of vegetation burnt in the Waratah fire was 1 061 ha. Rainforest, especially callidendrous rainforest (457 ha), was the main vegetation burnt, followed by eucalypt forest (Table 2.6). The land systems contained in the Waratah fire were 824241 and 882321 (Richley 1978). These land systems were associated with fertile soils and tall eucalypt and rainforest.

2.3.3 *Burning patterns*

The Waratah fire was mainly a ground fire, though some crowning was observed by AFH staff.

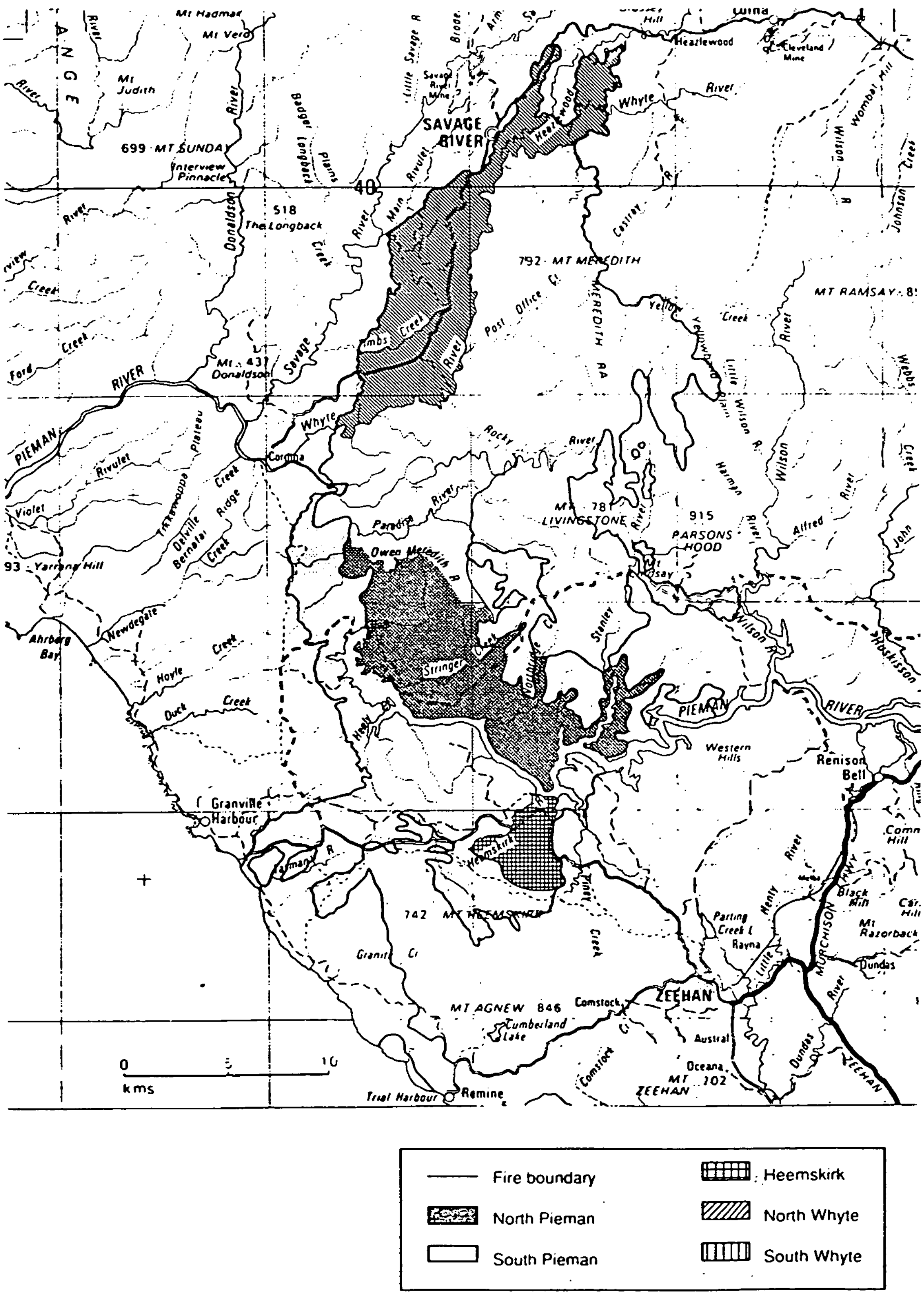


FIGURE 2.4: Zones used to determine the percentage of forest burnt by either a crown or ground fires, during the Savage River fire (J. Hickey unpub. data).

Table 2.4: Rainforest types burnt by the 1982 Savage River Fire, from Forestry Commission Photo Interpreted forest-type maps.

RAINFOREST TYPE	DESCRIPTION	AREA (ha)
M+ callidendrous type	Large crowned rainforest. Tall myrtle-dominant forest with predominantly sassafras and/or leatherwood, manfern understorey.	480
M- thamnic and implicate types	Small crown, generally shorter rainforest, with a dense scrubby understorey of species such as horizontal, native plum and laurel.	11 070
	total of M+ and M-	11 550
SCRUB	Short scrub with average height of less than 15m; allowed to contain up to 5% crown cover of myrtle or other species.	3 560
TOTAL		**15 110**

Table 2.5: The percentage of forest burnt by either a crown or ground fire for particular zones within the Savage River fire (Figure 4) (J. Hickey, unpub. data).

FOREST TYPE	ZONE	% CROWN FIRE	% GROUND FIRE	AREA (ha)
THAMNIC (M3S)	SOUTH PIEMAN	6	94	720
	NORTH PIEMAN	18	82	190
IMPLICATE (SM3)	SOUTH PIEMAN	35	65	1700
	NORTH PIEMAN	25	75	2170
THAMNIC & IMPLICATE	HEEMSKIRK	22	78	135
EUCALYPT	SOUTH PIEMAN	72	28	1165
	NORTH PIEMAN	68	32	1430
	HEEMSKIRK	76	24	440
TOTAL RAINFOREST		25	75	4910
TOTAL EUCALYPT		70	30	3035

TABLE 2.6: Vegetation types burnt by the 1982 Waratah fire

VEGETATION TYPE	AREA (ha)
RAINFOREST TYPE	
CALLIDENDROUS (M+)	457
THAMNIC (M-)	220
EUCALYPT FOREST	236
SCRUB	21
BUTTONGRASS	126
TOTAL	1064

CHAPTER 3: GENERAL METHODS

General

This study dealt with rainforest as defined by Jarman and Brown (1983) but included a small sample of mixed forest as defined by Gilbert (1959). Classification of rainforest types followed Jarman *et al.* (1984). Nomenclature of vascular species was after Buchanan *et al.* (1989); mosses after Scott and Stone (1976) and hepatics after Allison and Child (1975). A species list with authorities is given in Appendix 2.

Suitable site locations were determined initially from 1:25 000 Forest Type maps (Forestry Commission, Tasmania). Rainforest, as mapped by the Forestry Commission, was defined as consisting of rainforest species and up to 5% cover by *Eucalyptus* spp. This cover of 5% corresponded to the density of a community of senescing *Eucalyptus* spp. (Gilbert 1959).

Sites were chosen to reflect the broad rainforest categories (callidendrous, thamnic and implicate: *sensu* Jarman *et al.* 1984) and different fire intensities (mild, hot and unburnt controls). Initially equal numbers of sites for each rainforest type by burn intensity were planned. However, thamnic rainforest was greatest in area and only one pure callidendrous site could be located (Table 2.4). Consequently, this category was extended to include some communities intermediate between callidendrous and thamnic. Appropriate study areas in callidendrous and thamnic rainforest types could be readily identified from the Forest Type maps and verified using aerial photographs. Implicate areas were not as easily identifiable from the Forest Type maps and their locations were confirmed using aerial photographs. Some implicate sites were recorded as being in the scrub category of the Forest Type maps.

Burn intensities were determined for the Savage River sites from aerial photographs (1:40 000) taken within months of the fire and were verified by field observations, using green, brown and black areas to identify sites which were unburnt, subjected to mild fires (e.g., ground fire), and hot fires, respectively. No aerial photographs were taken after the Waratah fire so fire intensity was determined by field observations only.

Thirty-five sites were located in the area burnt by the Savage River fire and eight in the area burnt by the Waratah fire. The sites located in the Waratah fire area were all in the callidendrous rainforest group. The number of sites arranged by rainforest-type and burn-intensity are shown in Table 3.1.

Five mixed-forest sites an implicate site and thamnic site were later added to this study as a part of a monitoring program. All site locations in the Savage River fire area are shown in Figure 3.1. Locations for the Waratah fire area are shown in Figure 2.3.

Table 3.1: Number of sites in each rainforest type and burn intensity. Additional sites used for the temporal study in parenthesis.

Burn Intensity	Forest Type				
	Callidendrous	Thamnic	Implicate	Mixed	Total
Unburnt	4	3	3	0	10
Mild burn	5	7	3		15
Hot burn	5	7 (1)	6 (1)	(5)	25
Total	14	18	13	5	50

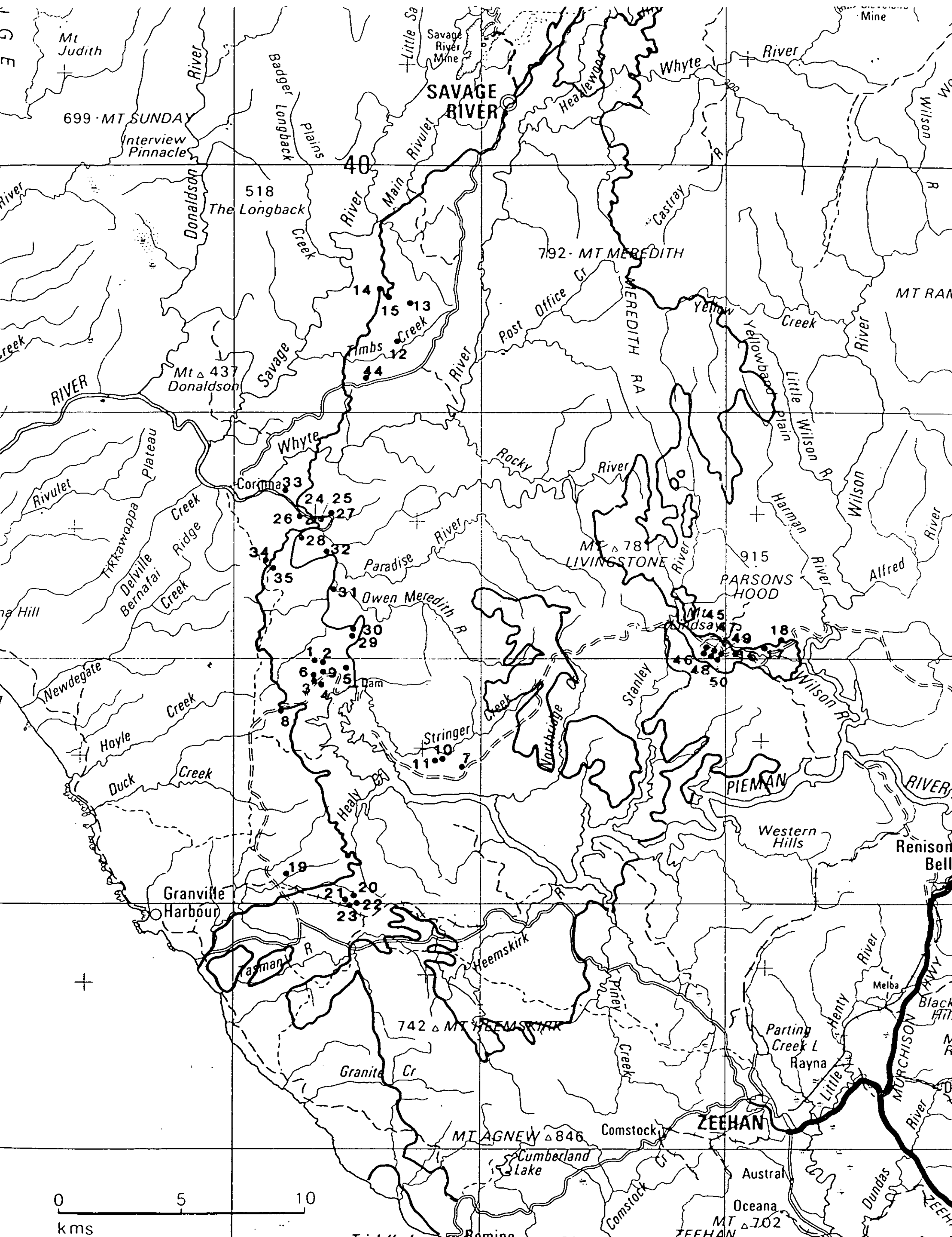


FIGURE 3.1

SITE LOCATIONS IN THE AREA BURNT BY THE 1982 SAVAGE RIVER FIRE

—— Fire area boundary

• Site locations

CHAPTER 4: THE EFFECT OF FIRE AND FIRE INTENSITY ON INDIVIDUAL PLANT SPECIES.

4.1 Introduction

Post fire rainforest floristics are determined by the intensity of the disturbance and the corresponding survivorship of pre-fire species by either vegetative and/or reproductive regeneration. Survivorship is affected by the presence of propagules soon after fire or the ability of a species to be dispersed and compete within gaps already greatly colonised by other species. The importance of the early presence of individuals soon after disturbance has been shown by Egler (1954) who stated that species tended to persist in a widely disturbed area if they established early through chance dispersal or differential survival of fire. Read and Hill (1988) have shown that initial floristic composition is an important determinant of the rainforest canopy in Tasmania, especially in view of the incidence of wildfire. This is due to the methods used by different species to maintain their presence in the forest.

Rainforest canopy species in Tasmania are normally self replacing, in the absence of a major disturbance, with no major changes in species composition or dominance occurring (Read and Hill 1985). This is a result of different reproductive characteristics and establishment preferences of the three dominant canopy species, *Nothofagus cunninghamii*, *Atherosperma moschatum* and *Eucryphia lucida*. *N. cunninghamii* and *E. lucida* require large canopy gaps, usually caused by the death of a single adult *N. cunninghamii*, whereas *A. moschatum* regenerates primarily through producing basal sprouts which utilise the canopy gap formed by the death of the original stem. It is also common for *E. lucida* to replace itself by vegetative reproduction.

The exception to the self replacement generalization could be rainforests containing canopy species which have a long stem life and a low capacity for self replacement (e.g., *Phyllocladus aspleniifolius*). Read and Hill (1985) have suggested that the recruitment requirements of *P. aspleniifolius*, which is frequent in forest types on poor soils (implicate rainforest), indicate that the forest types containing this species are disclimax and may be maintained by infrequent catastrophic disturbances such as fire or climatic perturbation. There has been little work done on the ecology of the rainforest understorey species.

Establishment of rainforest species after disturbance depends on a variety of factors, including mode of reproduction, light, substrate, competition from other species, soil type and nutrient status, water requirements and animal browsing. These factors are further compounded by the scale and type of disturbance. A study of the autecology of a Tasmanian canopy tree (*P. aspleniifolius*) and shrub (*Anodopetalum biglandulosum*) has found that both species are typical light demanding species with a great deal of plasticity in performance allowing them to grow under moderate but highly variable light levels. These light levels could be experienced in tree fall gaps, regrowth rainforest and subdominant rainforest canopies (Barker 1992). The canopy species, *N. cunninghamii* and *E. lucida* have higher growth rates in high, unfiltered light than *A. moschatum*, which has a greater shade tolerance. Early successional species which are generally light demanding have a greater capacity to acclimate to variability in the light regime, compared with later successional species. This enables these species to better utilize the light in which they grow and may be related to the increased variation in the habitats in which they occur (Bazzazz and Carlson 1982).

In rainforest, substrate is important for seedling establishment, with bare soil or rotting logs being frequent regeneration sites (Hickey 1982). Individual species (such as *N. cunninghamii* and *A. moschatum*) may have preferences for certain establishment sites. They can germinate anywhere that is moist, but more seedlings are found on stem downers, rotting wood fragments, exposed mineral soil and *Dicksonia antarctica* stems (Mesibov 1977). *Acacia melanoxylon* seedlings can be found on rotting wood and litter covered ground, the largest numbers are seen on exposed soil. *Phyllocladus aspleniifolius* germinants have a range of substrates but their preference appears to be litter covered soil (Mesibov 1977).

A large scale disturbance, such as fire, can readily change the conditions and preferences for germination and establishment of species. Hill and Read (1984) showed that after a fire some species exhibited a distinct preference for substrate. *N. cunninghamii* and *A. moschatum* were virtually restricted to burnt humus, mineral soil and fallen logs, whereas *Coprosoma quadrifida, Pittosporum bicolor* and to a lesser extent *Pimelea drupacea* occurred more commonly on unburnt humus. The burnt humus also had 100% cover of liverworts and mosses.

The intensity of a fire is particularly important to patterns of seedling establishment in northern North American conifer forests. Consumption of the organic layer, including the seed bank, by a hot fire and exposure of the mineral soil favours conifers. However, less intense fires, which do not consume the organic layer, favour the species which have seeds accumulated in the seed bank, with the subsequent vegetation being dominated by these species to the exclusion of the conifers (Sousa 1984).

Seedling establishment may be limited by competition between species for light or space. In disturbed areas dense patches of ferns, which virtually exclude germination or establishment of other species, form, possibly by intercepting the majority of available light (Cremer and Mount 1965). Together, *Hypolepis rugosula* and *Histiopterus incisa* generally form dense patches whereas *Pteridium esculentum* can produce a dense monoculture. These monocultures can be up to 2m in height, intercepting 95 - 99% of daylight, and persist for more than 30 years in open conditions (Cremer and Mount 1965). Another species that prevents rainforest tree establishment by forming dense clumps after large scale rainforest disturbance is *Gahnia grandis* (Calais and Kirkpatrick 1983). Mat forming bryophytes compete for space by 'growing over' seedlings thereby preventing their establishment. These bryophytes also colonise large areas preventing germination of other species from occurring (Duncan and Dalton 1982; Cremer and Mount 1965).

Preferences of different species for soil nutrient and pH levels may also be important for post-fire regeneration of rainforest species. Growth of *N. cunninghamii* is affected by soil nutrient status and pH, whilst *P. aspleniifolius* is less sensitive to changes in pH and nutrient status and *A. biglandulosum* is more affected by soil pH than nutrient status (Barker 1992). *N. cunninghamii* prefers more fertile soils but on infertile soils pH becomes more important, whereas *A. biglandulosum* prefers more acid conditions. Although a fire tends to increase soil pH, this can be lowered over time with a large reduction in pH occurring after 5 years on fertile soils derived from dolerite (Cremer and Mount 1965). There can also be an ash bed effect with an increase in soil nutrients. This effect generally only affects the top 3 cm of the soil and lasts between one and two years. It also depends on fire intensity (Cremer and Mount 1965).

Browsing by animals can have an important effect on the establishment of certain species in the rainforest. A study examining the effect of native browsing on seedling numbers in relict patches of callidendrous and thamnic rainforest found that the number of rainforest seedlings (550 seedlings) in plots excluding large browsers was greater than plots that did not exclude browsers (72 seedlings) (Neyland 1991). The main species being browsed was *A. moschatum*. This species was still susceptible to browsing after 21 months, only reaching a height of 10cm and was still being affected by other factors such as drought, damping off and insect attack. Hickey (1982) produced a browsing index for rainforest canopy trees, which had *N. cunninghamii*, *P. aspleniifolius* and *E. lucida* as least susceptible with *A. melanoxylon* and *A. moschatum* most susceptible. *A. moschatum* was 11 times more susceptible than *A. melanoxylon.* The effect of browsing was considered to be less important by Cremer and Mount (1965), after an extensive wild fire, because the population of browsing animals would be relatively low and unable to increase greatly before the woody plants were fully established.

Two previous studies on post-fire regeneration of west coast lowland rainforest and mixed forest, indicate that fire kills all rainforest species in the mixed forest, but many rainforest species survive after a surface fire in rainforest (Hill 1982; Hill and Read 1984). Hill (1982) showed that fire effect was extremely species specific and correlated to humus depth. Species such as *A. moschatum* and *A. melanoxlyon* survived fires, but *N. cunninghamii*, *Phyllocladus aspleniifolius*, *E. lucida* and *Cenarrhenes nitida* were more fire susceptible.

The mixed forest surveyed by Hill and Read (1984) was burnt in the Savage River fire. The larger sclerophyll element pre-fire led to a far greater sclerophyll element post-fire at the expense of rainforest species. There were no records of sprouting for any rainforest species in the mixed forest, although one canopy species and two shrub species resprouted after the Zeehan fire. The authors concluded:

- A small patchy fire in rainforest, with many trees surviving and able to provide a seed source, would regenerate toward pure rainforest after several seral stages, due to the absence of wet sclerophyll species within seed dispersal distance.

- A variety of germination and establishment substrates aided in maintaining rainforest species diversity, since some species were substrate-specific.

- The rainforest component in the burnt mixed forest was undergoing a similar regeneration to the rainforest at Zeehan, except for the large sclerophyll component.

- Rainforest species appeared not to be establish successfully outside their pre-fire ranges, whereas sclerophyll species had established in areas which were once rainforest.

- Mixed forest had undergone a major change in species composition to the detriment of the rainforest component, due to the proximity of sclerophyll seed sources. After a long fire-free interval, succession to climax rainforest could occur but this was unlikely due to the large amounts of fuel, drying effects of the forest edge, the forest's proximity to a road and to fires caused by humans.

- A fire in Tasmanian rainforest rarely resulted in the death of all trees, therefore fire behaviour should be considered in any model of fire ecology.

The aim of this chapter is to examine the effect of fire and fire intensity on individual rainforest species eight years after a fire.

4.2 Materials and Methods

Vegetation was surveyed at each site within a 25m x 10m quadrat. This quadrat was divided into ten 5m x 5m plots In each plot, occurrence, cover, abundance, height of seedlings and sprouts, and sexual maturity of vascular species were recorded. Sprouts were assumed to be as a result of the fire. This assumption was based on the work of Podger (pers. comm.) and taking ring counts from sprouts. The fire moss, *Polytrichum juniperinum* and liverwort, *Marchantia berteroana*, were also included as they were known to represent important early stages in post fire recolonisation (Duncan and Dalton 1982).

Cover was estimated visually according to a six point Braun-Blanquet scale (Mueller-Dombois and Ellenberg 1974). Abundance was measured on a three point scale ('occasional' - denoting one individual; 'frequent' - denoting two to five individuals; and' common' - denoting > five individuals). Mean dominant height and sexual maturity were recorded for seedlings and/or sprouts for all vascular species. The cover of logs, litter and mineral soil was also recorded, along with a broad group of unidentified mosses and lichens.

Analysis of important rainforest and non-rainforest species data was conducted using the Genstat 5 Statistical Package (Payne *et al.* 1988) (Appendices 5 and 6). Cover, seedling and sprout height, proportion of seedlings to sprouts, and importance values were analysed using regressions. Importance values (*sensu* Krebs 1978) were the sum of an individual species' cover, abundance and frequency at a site divided by the total cover, abundance and frequency for all species at that site. Frequency was calculated as the number of subplots in which a species was recorded as a proportion of the 10 subplots.

The total data set contained 50 sites: 43 rainforest sites (rainforest data) surveyed initially, an additional implicate site, thamnic site and a further 5 mixed forest sites (*sensu* Gilbert 1959) (all data).

To determine the minimum time since a possible previous fire, tree ring samples were taken at each site. Preference was given to species which generally required large scale disturbances to regenerate, were long lived and had prominent rings such as

Phyllocladus aspleniifolius and *Acacia melanoxylon.*

4.3 Results

4.3.1 *Species composition*

In this study, 146 vascular species were recorded including 15 species that could only be identified to either the genus or family level (Appendix 2). Seven species were found only in the mixed forest sites. All rainforest species found in unburnt sites were also present in burnt sites, with the exception of Native Olive, *Notelaea ligustrina,* and four fern species; *Asplenium flaccidum, A. terrestre, Hymenophyllum marginatum* and *H. peltatum.*

Of the positively identified species there were 60 rainforest species, 26 doubtful-rainforest species and 45 non-rainforest species (after Jarman and Brown 1983). The composition of rainforest species in burnt sites was different from unburnt sites (Appendix 4). This was probably due to sampling since a greater area of burnt rainforest was surveyed than unburnt rainforest.

Original 43 rainforest sites data.

The number of rainforest species in burnt and unburnt sites were similar (Table 4.1). There were more non-rainforest and doubtful-rainforest species in burnt rainforest than unburnt. Dicotyledons were the dominant plant form, with ferns an important component in the rainforest category. Monocotyledons were important in the doubtful- and non-rainforest categories.

The number of rainforest, doubtful-rainforest and non-rainforest species were similar between rainforest types (Table 4.2). Thamnic rainforest had the greatest number of species. The differences in the number of rainforest species between unburnt and burnt sites for all rainforest types were small. For all rainforest types the number of doubtful- and non-rainforest species were larger in burnt sites, especially in hot fire sites.

Table 4.2 also highlights the importance of fern species in different rainforest types. The highest number of fern species was found in thamnic rainforest. The number of fern species was lower in burnt sites, with small differences between mild and hot-fire sites.

Table 4.1: **Number of rainforest, doubtful- and non-rainforest species recorded in the original (43) rainforest burnt and unburnt sites.**

		DICOTS	MONOCOTS	FERNS	BRYOPHYTES	TOTAL
UNBURNT SITES	rainforest	22	2	20	1	45
	doubtful-rainforest	9	6	0	1	16
	non-rainforest	2	0	0	0	2
BURNT SITES	rainforest	24	2	18	2	46
	doubtful-rainforest	17	7	1	1	26
	non-rainforest	34	13	1	2	50

Table 4.2: **The number of rainforest, doubtful- and non-rainforest species in each rainforest class by burn intensity for the original rainforest sites.**

RAINFOREST TYPE	BURN INTENSITY	No. SITES	RAINFOREST SPECIES		DOUBTFUL-RAINFOREST		NON-RAINFOREST		
				ferns		ferns		ferns	weeds
IMPLICATE	unburnt sites	3	30	12	7	0	1		
	mild burn sites	3	27	7	7	0	11	1	
	hot burn sites	6	28	8	16	1	20	1	1
	TOTAL	**12**	**41**	**16**	**17**	**1**	**22**	**1**	**1**
THAMNIC	unburnt sites	3	34	16	7	0	1		
	mild burn sites	7	37	15	15	1	21	1	2
	hot burn sites	7	33	11	18	1	22	2	1
	TOTAL	**17**	**47**	**21**	**20**	**1**	**29**	**2**	**3**
CALLIDENDROUS	unburnt sites	4	33	17	4		5		
	mild burn sites	5	25	9	12		18	1	1
	hot burn sites	5	30	11	14		22	1	1
	TOTAL	**14**	**41**	**18**	**17**		**26**	**1**	**2**

Weed species

Weed species did not favour a particular rainforest type or fire intensity, and their frequency in the sites recorded was low. The weed species found are listed below;

Cerastium fontanum	Mouse-ear Chickweed;
Cirsium vulgare	Spear Thistle;
Hypochaeris radicata	Flat-weed, Cat's Ear;
Picris hieracoides	Hawkweed, Ox-Tongue.

4.3.2 *Post-fire vegetation*

After eight years, rainforest species were growing under a blanket of doubtful- and non-rainforest species. Many of the doubtful- and non-rainforest species were found over the range of forest types, although their contribution to each forest type was not equal (Table 4.3, Appendix 5). Fire intensity played a secondary role.

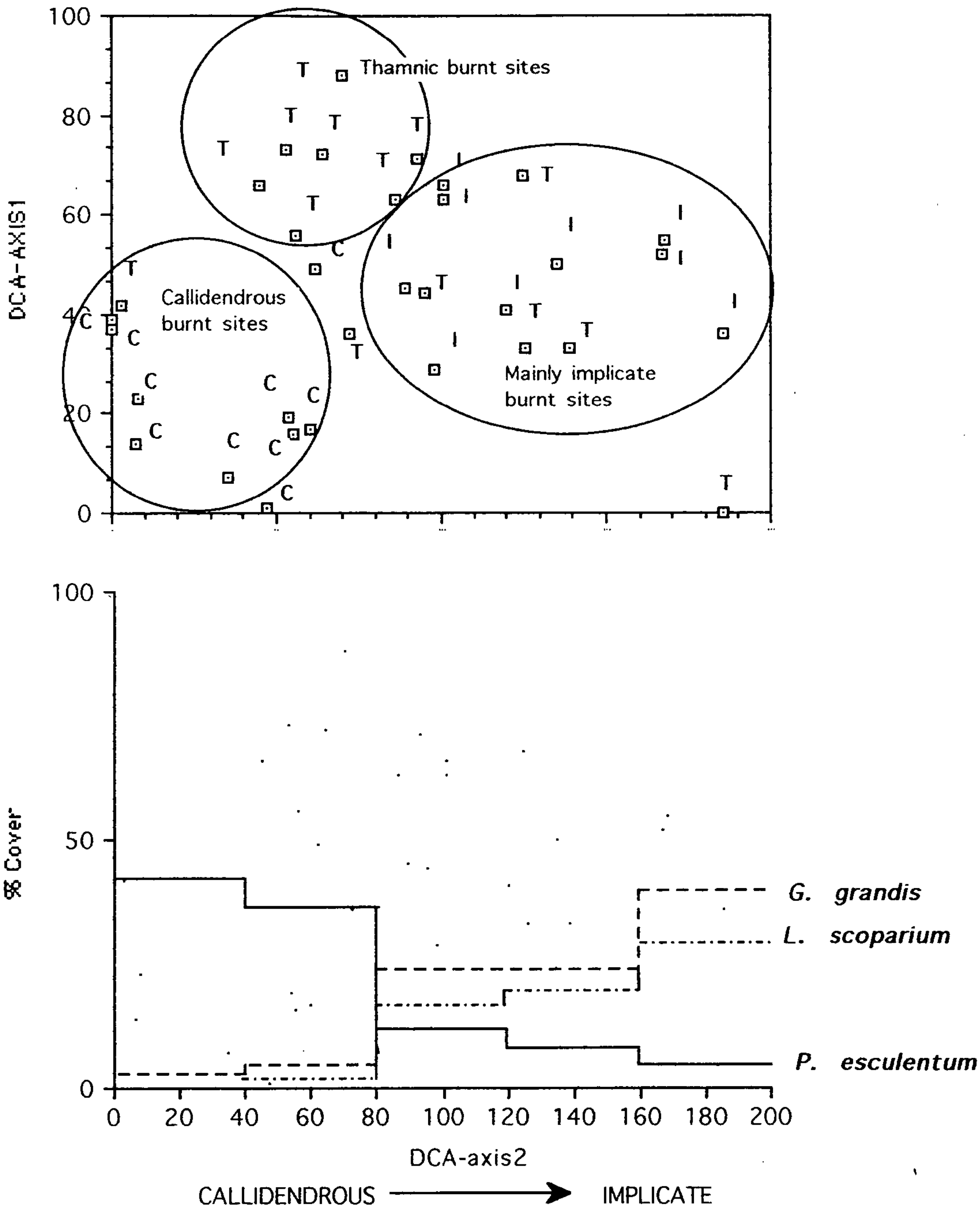
The three main post-fire colonizing vascular species were cutting grass, *Gahnia grandis,* bracken, *Pteridium esculentum,*and tea tree, *Leptospermum scoparium. P. esculentum* was found in all burnt sites except one implicate hot-fire site. Its density was greatest in callidendrous rainforest, especially after a mild-fire, where it was often the sole overstorey species. *G. grandis* and *L. scoparium* were more prominent in thamnic and implicate rainforest (Figure 4.1). The gradient from callidendrous through thamnic to implicate rainforest, produced by Detrended Correspondance Analysis (Chapter 5), was reflected by the composition of these 3 main invader species. *P. esculentum* dominated the callidendrous end of the gradient with a stepwise decline to implicate. However *G. grandis* and *L. scoparium* dominated the implicate side with nominal covers at the callidendrous end. The association between *P. esculentum* and burnt callidendrous rainforest and *G. grandis* and *L. scoparium* with implicate rainforest was reflected in the regression analysis (Table 4.3). The relationship between fire intensity and these three species was unclear, although the impression from field observations was of a higher component of invader species in the hot-fire sites.

The liverwort, *Marchantia berteroana* and the moss, *Polytrichum juniperinum* were major post fire ground colonizers. *M. berteroana* was found only on rainforest sites, mainly callidendrous and thamnic, with hot-fire sites generally having lower cover than mild-fire sites. *P. juniperinum* colonised all burnt forest types with

Table 4.3: Effects on individual doubtful-, non-rainforest species and ground attributes according to forest type and fire intensity.
A minimum sample size of 8 sites was required for each species for analysis. Abbreviations used: C - callidendrous, T - thamnic, I - implicate, MF - mixed forest, IV - importance value, Cov - cover value and (43) refers to rainforest data set and (50) refers to total data set, no brackets indicate significant in both data sets. Brackets in 'No. OF SITES' column refers to the total data set.
Key: † - ttest significant, * - ttest & Ftest significant, ° - no signficant differences, but obvious trend, # - interactions refer to Appendix 5.

STRATUM	No. OF SITES	SPECIES	OCCURRENCE forest	burnt/unburnt	EFFECT OF FOREST TYPE ON REGENERATION	EFFECT OF BURN INTENSITY ON REGENERATION	EFFECT OF FOREST TYPE ON SEEDLING HEIGHT	EFFECT OF BURN INTENSITY ON SEEDLING HEIGHT
CANOPY	26 (33)	Acacia melanoxylon	C, T, I & MF (All)	both	Cov#	Cov#	#	#
	(13)	Leptospermum glaucescens	All	burnt, mainly hot	lowest value C°			
	21 (27)	Leptospermum scoparium	All	burnt, 1 I unburnt	IV(50)†: I greater C	none	I & MF taller C & T*	mild lower unb (43)*
	(10)	Melaleuca squamea	T, I, MF, mainly I	burnt				
	9	Pomaderris apetala	C, T, mainly T	burnt, 1 T unburnt		hot values large°		hot values large°
UNDER STOREY	35 (41)	Gahnia grandis	All	both	IV†#: C lower I	#increase IV & Cov°	I taller C,T,MF*	
	8 (14)	Phebalium squameum	T, I, MF, mainly I & MF	burnt, 1 I unburnt		mainly hot burns, hot higher values°	I smaller MF (50)*	unb diff from burnt*
	14 (18)	Pimelea lindleyana	All	burnt	IV: I higher C & T*, Cov (50)#	Cov (50)#	(50)#	(50)#
	12	Pimelea bicolor	C, T, I	both	IV#	IV#, Cov: unb higher mild & hot†		unb taller mild & hot*
HERB LAYER	14 (15)	Acaena nova-zelandiae	C, T, I mainly C, T	burnt				
	15 (22)	Billardiera longifolia	All	both			C lower T & I (43)*, C lower T & MF (50)†#	hot taller unb (43&50)*, (50)#
	12	Clematis aristata	C, T, I, mainly C, T	both	IV: C lower T*	none		
	10	Galium australe	C, T					
	(9)	Gnaphalium collinum	All	burnt	IV#	IV#		
	(9)	Senecio biseratus	T, I, MF, mainly T	burnt				
	10	Senecio minimus	C, T, I, mainly C	burnt, 1 C unburnt	Cov: C lower T, higher I*	higher IV in burnt sites°, mainly in mild		
	14 (19)	Senecio spp.	All	burnt	none			
FERNS	32 (39)	Pteridium esculentum	All	burnt	C higher T, I & MF*		C taller T (43)*	
BRYOPHYTES	24 (27)	Marchantia berteroana	C, T, I, mainly C, T	burnt, 1 C unburnt		Cov: mild higher hot°		
	32 (38)	Polytrichum juniperinum	All	burnt	Cov*: I greater T (43,50) & C (43	higher values in hot, except C°		
GROUND LAYER	43 (50)	Litter	All	both	MF greater C, T, I (50)*	unb higher mild (43,50) & hot (50)		
	41 (48)	Logs	All	both	MF greater C, T, I*,(43)#	lowers Cov for C, T & MF*		
	25 (31)	Bare Ground	All	both	(43)†#	none		
	43 (50)	Other moss	All	both	(50)†#	unb higher hot (43)* & mild (43,50)*		
	38 (45)	Wood	All	both	none	fire increases Cov°, hot higher mild (43)†		

Figure 4.1: Burnt sites distributed using DCA on presence/absence data with the % cover of the three post-fire dominant species below.



greatest cover in implicate rainforest (Table 4.3).

There were small post-fire areas dominated by dogwood, *Pomaderris apetala*. These were in thamnic and callidendrous rainforest along the banks of the Pieman river and in a hot-fire site in a small rainforest patch at Heemskirk. Areas where *P. apetala* occurred were generally on fertile soils after a hot-fire. Seed sources along the Pieman River were probably from small pockets of *P. apetala* in adjacent unburnt rainforest. Areas dominated by *P. apetala* had dense canopies and very little regeneration of other species underneath. The sites appeared very dry.

Eucalypts (*E. nitidum* and eucalpt seedlings) were recorded in only two burnt rainforest sites (a thamnic mild fire site and hot fire site). Post-fire seedling regeneration occurred where there were eucalypts close by. Eucalypt seedlings were observed 200 m from a seed source in implicate rainforest on Brown's Plain and they were prevalent in the mixed forest sites. The Waratah sites were aerially seeded twice with eucalypt seed post fire. This was unsuccessful.

A site was located in rainforest burnt by a small fire which had spotted from the main Waratah fire. This site had a different density and composition of post-fire plants when compared with the other sites, which were located in the main fire area. This site comprised rainforest sprouts over the wet ferns *Histiopteris incisa* and *Hypolepis rugosula*, with only a small component of *P. esculentum*. This site appeared similar to Hill and Read's (1984) mild-fire site.

Survivors

Death depended on fire intensity. If the fire was a creeping ground fire, or plants were scorched, then some species survived the fire, intact. Generally there were small patches of survivors scattered throughout the burn usually consisting of *Anodopetalum biglandulosum, Anopterus glandulosus, Eucryphia lucida, Atherospermum moschatum* and *Nothofagus cunninghamii*. Hill (1982) showed that after a humus fire in temperate rainforest, survivorship was species specific with *A. moschatum, A. biglandulosum* and *Acacia melanoxylon* able to survive. Hill's (1982) species specificity was not as apparent in this study, though *A. moschatum* was common among survivors and large *N. cunninghamii* rare.

4.3.3 *Regeneration of rainforest species*

All of the canopy species, the majority of understorey species and half of the fern species had either lower importance values and/or covers in burnt sites (Table 4.4 & Appendix 6). Some rainforest species and many doubtful-rainforest species were recorded from a wider range of burnt rainforest types than unburnt rainforest types e.g. *Coprosma quadrifida* and *Dicksonia antarctica* (Appendix 6).

Canopy species

In this study rainforest canopy species were recruited post fire (Table 4.9). There were more individuals in burnt than unburnt sites although many of these were very small seedlings. This was especially apparent with *Atherosperma moschatum*, with the majority of seedlings being less than 3cm tall. The number of these seedlings surviving to maturity is unknown. The four canopy species were recorded in all forest types, with regeneration being higher in callidendrous rainforest than implicate rainforest for *A. moschatum* and *Nothofagus cunninghamii* and the opposite for *Phyllocladus aspleniifolius*. Fire reduced both the importance value and cover, with no obvious differences between fire intensities.

Understorey species

All rainforest understorey species were regenerating by seedlings and/or by sprouts (Table 4.4). Some species were recorded in burnt rainforest types but were absent in unburnt counterparts e.g., *C. quadrifida* was recorded in burnt sites for all forest types, although it is generally associated with callidendrous and thamnic rainforest. Other examples include *Monotoca glauca* and *Pimelea drupacea*. Cover and importance values were markedly lower in burnt sites than unburnt sites. This was especially evident in the endemic species, with the exceptions of *Aristotelia peduncularis*, and *Monotoca glauca*. Two species, *Agastachys odorata* and *Anopterus glandulosus*, showed a decline in either or both importance values and covers between mild and hot fire intensities. *Archeria eriocarpa* was not recorded in any hot fire sites. The only species which had higher cover and importance values in burnt sites than unburnt sites was *M. glauca*, with hot burns significantly higher than mild burns.

Table 4.4: Effects on individual rainforest species according to forest type and fire intensity.
Abbreviations used: C - callidendrous, T - thamnic, I - implicate, MF - mixed forest, IV - importance value, Cov - cover value and (43) refers to rainforest data set and (50) refers to total data set, no brackets indicate significant in both data sets. Brackets in 'No OF SITES' column refer to total data set.
Key: † - ttest significant, * - ttest & Ftest significant, ° - no signficant differences, but obvious trend, # - interactions refer to Appendix 5, (e) - endemic species

STRATUM	SPECIES	No. OF SITES	OCCURRENCE Forest	Burnt/Unburnt	EFFECT OF FOREST TYPE ON REGENERATION	EFFECT OF FIRE ON REGENERATION	DIFFERENCES BETWEEN INTENSITIES
CANOPY	A. moschatum	41 (48)	C,T,I & MF (All)		IV: C higher than I (43&50) & T (50) & I lower than T(50)*	lower IV and Cov*	
	E. lucida (e)	40 (47)	All		none	lower IV and Cov *	
	N. cunninghamii	43 (50)	All		IV, I lower C (50)†, Cov#	lower IV* (43&50), Cov#	
	P. aspleniifolius (e)	30 (37)	All		Cov#, I higher than C*	lower Cov* #	
UNDER STOREY	A. frankliniae (e)	6	T & I		none	lower IV and Cov†	
	A. odorata (e)	9	I & 1 site in T		none	lower IV*	hot values lower than mild*
	A. biglandulosum (e)	28 (31)	All, mainly T & I		none	lower IV and Cov#*	
	A. glandulosus (e)	30 (36)	All, mainly T & I		none	lower IV and Cov*	cov: hot values lower than mild* (50)
	A. eriocarpa (e)	3	I		none	lower IV and Cov°	not recorded in hot fire sites
	A. hirtella (e)	3	I		none	lower IV and Cov°	
	A. peduncularis (e)	10 (12)	C, T & MF		none	none	
	C. nitida (e)	20 (26)	All, mainly T, I & MF		IV#: I greater than C, Cov#: C lower than I & T* & I greater MF(50)*	lower IV and Cov*	
	C. quadrifida	24 (30)	All, mainly C & T		IV(50): MF lower than T & I*	lower IV (43)* & Cov (43°,50*)	
	C. juniperina	28 (33)	All	mainly burnt	IV(50): MF lower than T & I*	none	
	M. glauca (e)	26 (33)	All mainly T, I & MF	mainly burnt	IV, I higher T*	higher IV*	hot higher unb (43) & mild (43,50)
	P. straminea	8	I & mainly T		Cov#	Cov#	
	P. cinera	15	C, T, I, mainly T,I	burnt	IV: I different T*	IV: mild different hot*	
	P. drupacea	33	All		none	none	
	T. cunninghamii	13 (16)	All		IV*# & Cov† (43)#	IV* # & Cov †# (43)	IV & Cov: unb higher than hot
	T. gunnii (e)	4	only found in I			lower IV and Cov°	
HERB LAYER	C. appressa	8 (9)	All, mainly T	only burnt sites	IV*(43), C higher T & I	only recorded on burnt sites	
	D. tasmanica	(9)	All, mainly I	only burnt sites	none	none	
	D. cyanocarpa	8 (12)	All	burnt T, I & MF	none	none	
	H. javanica	32 (34)	All	mainly burnt	Cov(43)*: T lower than C	IV*	mild greater unb (43) & hot (43,50)*
	T. lanceolata	10	C, T, I	burnt & 2,I unburnt	IV(50)*: I higher than T	none	
	U. tenella	21	C, T, I, mainly C & T	mainly burnt	none	Cov (43)†	unb greater hot
FERNS	B. wattsii	31 (38)	All		none	IV(43)*	mild lower than unburnt
	D. antarctica	32 (36)	All		IV#	IV#, lower Cov*	
	G. billardieri	18 (19)	All	not in I burnt sites	none	lower IV *	
	H. incisa	35 (40)	All		IV*: C higher T, I & MF	fire increases IV*	
	H. australe	10	C, T, I	in 1 burnt site, T mild		lower IV°	
	H. flabellatum	8	C, T, I, mainly C	in 1 burnt site, C hot		lower IV° in C	
	H. rarum	11	C, T, I	both		lower IV* & Cov†	
	H. rugosula	33 (39)	All	mainly burnt	IV*: C higher T, I (43) & MF (43,50) Cov*: C greater T (43) & MF (43,50)	none	
	M. diversifolium	28 (32)	All		none	lower IV° (50) & Cov*(43)	
	P. proliferum	34 (38)	All		IV: C higher T & I (43)* & MF (43,50)#*	IV (50) #	
	R. adiantiformis	20 (26)	All		none	lower IV* & Cov (43)*	
	S. tener	(9)	T, I & MF	in 1 unburnt site	IV: I higher C, T & MF*		
	T. billardarium	9	C, T, I	in 1 burnt site, T mild	none	none	

Herb layer

Fire appeared to have had either a minimal effect or to have increased the density of rainforest herb species. However, only two species, *Hydrocotyle javanica* and *Carex appressa,* were associated with rainforest disturbance. The herb layer species were found in all forest types with the exception of *Uncinia tenella* which was not recorded in mixed forest. Many species were either recorded only in burnt sites (e.g., *C. appressa*) or were predominately in burnt sites (e.g., *U. tenella*) (Table 4.4). Two species, *C. appressa* and *H. javanica,* showed an effect of rainforest type on regeneration, with both having higher values in callidendrous than thamnic rainforest. *H. javanica* and *U. tenella* showed an effect of fire intensity with both having lower values in hot-fire sites.

Ferns

The smaller, more fragile ferns, such as species of *Hymenophyllum* and *Asplenium,* were generally absent from burnt sites, whereas larger fern species were frequent. Of the six *Hymenophyllum* spp. common in unburnt sites, two were not recorded in burnt sites, (*H. marginatum* and *H. peltatum*); three were recorded in one burnt site (*H. australe, H. cupressiforme* and *H. flabellatum*); and only *H. rarum* was recorded in three burnt sites. Two other small fern species, *Tmesipteris billardieri* and *Polyphlebium venosum,* found in unburnt sites were recorded in one burnt site. With the exception of *T. billardieri* all small ferns recorded in burnt sites had lower importance values than unburnt sites. They were also restricted to rainforest sites, with the exception of *Grammitis billardieri* (Table 4.4). Small fern species found in burnt sites appeared to be in favourable micro-sites, such as under or inside damp logs.

The majority of larger ferns were recorded in all forest types, (Table 4.4) with the exception of *Sticherus tener*, which was not recorded from callidendrous sites. Four species, (*Blechnum wattsii, Dicksonia antarctica, Microsorium diversifolium* and *Rumohra adiantiformis*), had burnt importance values lower than unburnt values, with the remaining four species, (*Histiopteris incisa, Hypolepis rugosula, Polystichum proliferum* and *Sticherus tener*), having higher or similar importance values. *Histiopteris incisa,* common in disturbed rainforest, was the only fern which had significantly larger importance values in burnt sites, although the other rainforest disturbance fern, *Hypolepis rugosula,* was recorded predominantly from burnt sites. Both had significantly higher importance values in burnt callidendrous sites than other rainforest types.

Ground Layer

Attributes measured for ground layer (Table 4.3), occurred in all forest types and in burnt and unburnt sites. All attributes showed differences between forest type, with the exception of 'wood' (material between litter and logs). The cover of 'litter and logs' in mixed forest was greater than in rainforest, whereas the relationships between the variables 'bare ground' and 'other moss' to rainforest type and burn intensity was more complex. Generally there were lower covers in burnt sites for 'litter', 'logs' (except in implicate rainforest) and 'other moss'. 'Wood' was the only attribute that had higher cover values in burnt than unburnt sites.

4.3.4 *Regeneration Strategy and Growth*

Rainforest

Regeneration after the fires appeared to be mainly by seed, though some rainforest species were observed to regenerate vegetatively. The eleven rainforest species observed sprouting during this study are listed in Table 4.5. All species had previously been documented as sprouting, except for *Acradenia frankliniae, Archeria eriocarpa* and *A. hirtella* (Table 4.6). Rainforest type and burn intensity had significant effects on the overall proportions of seedlings to sprouts (Table 4.7 & 4.8), with a lowering of the proportion of seedlings from callidendrous, through thamnic, to implicate rainforest. This indicated that the more implicate the rainforest, the greater the number of species and individuals of those species sprouting. Mixed forest had the lowest values.

There was a significantly higher number of sprouts in unburnt sites compared with hot-fire sites, with mild-fire sites values in between the two. Unburnt values may have been artificially high, due to difficultly in determining whether a mature individual was a sprout or a seedling.

The percentage of seedlings in hot-fire sites was marginally higher than in mild fire sites in thamnic and callidendrous rainforest. The percentage of sprouts in implicate rainforest was 24% in mild fires compared with 13% in hot fires. Even so, this implicate value of 13% was greater than those recorded for other forests hot-fire

Table 4.5: **Tree and shrub species sprouting after the Savage River and Waratah fires**

Archeria eriocarpa	
Archeria hirtella	
Acradenia frankliniae	Whitey Wood
Agastachys odorata	White Waratah
Anodopetalum biglandulosum	Horizontal
Anopterus glandulosus	Native Laurel
Atherosperma moschatum	Sassafras
Cenarrhenes nitida	Native Plum
Eucryphia lucida	Leatherwood
Nothofagus cunninghamii	Myrtle
Trochocarpa cunninghamii	

Table 4.6: **Records of rainforest species known to resprout after fire.**

SPECIES	COMMENTS	AUTHORS
*Acacia melanoxylon		Hill and Read (1984)
Agastachys odorata		Kirpatrick (1984)
		Jarman et al. (1984)
Anodopetalum biglandulosum		Kirpatrick (1977, 1984)
		Hill and Read (1984)
		Jarman et al. (1984)
		Podger et al. (1988)
Anopterus glandulosa	rare	Kirpatrick (1984)
		Hill and Read (1984)
		Jarman et al. (1984)
Atherosperma moschatum		Cadman (1984), Gilbert (1959)
		Hickey and Felton (1987)
		Jarman et al. (1984)
Baeckea gunniana		Kirpatrick (1984)
Cenarrhenes nitida		Kirpatrick (1984)
		Jarman et al. (1984)
Dicksonia antarctica		Gilbert (1959), Neyland (1986)
Eucryphia lucida		Jarman et al. (1984)
	rare	Kirpatrick (1984)
		Calais and Kirpatrick (1983)
		Cadman (1984)
		Hickey and Felton (1987)
Nothofagus cunninghamii		Howard (1972, 1973)
		Cadman (1984), Gilbert (1959)
		Hickey and Felton (1987)
		Jarman et al. (1984)
		Calais and Kirpatrick (1983)
	rare and at high elevations	Kirpatrick (1977, 1984)

* - doubtful rainforest species per Jarman et al. (1984).

Table 4.7: The percentage of regeneration by seedlings for each rainforest type using the original rainforest (43) sites and fire intensity.

FIRE INTENSITY	RAINFOREST TYPE: CALLIDENDROUS			THAMNIC			IMPLICATE		
	No. sites	% seedlings	variance	No. sites	% seedlings	variance	No. sites	% seedlings	variance
UNBURNT SITES	4	94.3	20.49	3	86.55	26.71	3	67.28	540.78
MILD-FIRE SITES	5	96.18	9.02	7	90.22	47.97	3	76.4	93.64
HOT-FIRE SITES	5	97.28	5.15	7	93.46	30.54	6	87.05	7.83

Burn Intensity significant (p<0.05): unburnt significant from hot (p<0.05).

Rainforest Type significant (p<0.005): implicate significant lower than callidendrous & thamnic (p<0.001); callidendrous significant from thamnic (p<0.05).

Table 4.8: The percentage of regeneration by seedlings for each forest type using the whole data set. and fire intensity.

FIRE INTENSITY	RAINFOREST TYPE: CALLIDENDROUS			THAMNIC			IMPLICATE			MIXED FOREST		
	No. sites	% seedlings	variance	No. sites	% seedlings	variance	No. sites	% seedlings	variance	No. sites	% seedlings	variance
UNBURNT SITES	4	94.3	20.49	3	86.55	26.71	3	67.28	540.78			
MILD-FIRE SITES	5	96.18	9.02	7	90.22	47.97	3	76.4	93.64	1	98.92	
HOT-FIRE SITES	5	97.28	5.15	8	93.64	26.44	7	86.5	8.57	4	98.11	3.33

Burn Intensity significant (p<0.01): unburnt significant from hot (p<0.01).

Rainforest Type significant (p<0.005): implicate significantly lower than callidendrous, thamnic & mixed forest (p<0.001); callidendrous significant from thamnic (p<0.0

sites.

Canopy

Regeneration of canopy species was mainly by seedlings with sprouting occurring in three of the four species: *Atherosperma moschatum, Eucryphia lucida* and *Nothofagus cunninghamii* (Table 4.9). The highest proportion of sprouts for all three species was in implicate rainforest, especially for *E. lucida*, where sprouting was the dominant method of regeneration. Sprouting was also dominant for *N. cunninghamii* in implicate rainforest subjected to a mild fire. *Eucryphia lucida* was different from the general trend in having more sprouts in hot-fire sites than mild-fire sites.

Eight years post fire, seedling and sprout heights were still a fraction of the heights of adults recorded in unburnt forest. Sprouts were taller than seedlings in implicate rainforest for all sprouting species with *E. lucida* also having taller sprouts in thamnic rainforest. All *A. moschatum* sprouts were taller than seedlings regardless of forest type or fire intensity.

Understorey

Sprouting occurred in all understorey species documented as sprouting in Table 4.6. Sprouting was the dominant method of regeneration for four species in all forest types, for three species in implicate rainforest and for one species (*Trochocarpa cunninghamii)* in thamnic mild fire sites (Table 4.9). The majority of species (7/8) which did sprout were endemic. The number of species, and individuals of these species sprouting increased from callidendrous through to implicate rainforest, with mild fires in implicate rainforest tending to have the highest sprout values. All understorey species which regenerated mainly from seed, had their seeds enclosed in either a drupe or a berry, indicating that dispersal by animals, and most probably by birds was important. The majority of these species appeared to have increased their range after fire. For example, *Cyathodes juniperina* was recorded in burnt but not unburnt callidendrous sites.

For all understorey species, heights in unburnt forest were taller than burnt forest with the exceptions of *Pimelea drupacea* and *P. cinerea*. Sprouts were taller than seedlings for six sprouting species (Table 4.9). All records of flowering or seeding in sprouting species were from sprouts (Table 4.10) generally from individuals in

Table 4.9: Effects on the proportion of seedlings to sprouts & seedling and sprout height of individual rainforest species to forest type and fire intensity.
Abbreviations used: (e) - endemic C - callidendrous, T - thamnic, I - implicate for rainforest types, se - seedling and sp - sprout, (43) refers to rainforest data set & (50) refers to total data set.
No brackets indicate significance in both data sets. Key: † - ttest significant, * - ttest & Ftest significant, ° - no signficant differences, but obvious trend, # - interactions refer to Appendix 5.

STRATUM	SPECIES	PROPAGATION	MAIN REGENERATION METHOD OBSERVED	EFFECT OF FOREST TYPE ON SE/SP	EFFECT OF BURN INTENSITY ON SE/SP	EFFECT OF FOREST TYPE ON SEEDLING AND SPROUT HEIGHT	EFFECT OF BURN INTENSITY ON SEEDLING AND SPROUT HEIGHT	DIFFERENCES BETWEEN SPROUTS & SEEDLINGS
CANOPY	A. moschatum	seed/sprout	se	I more sp *(43*,50†)			lower sp & se ht*	sp taller than se
	E. lucida (e)	seed/sprout	se in C, T & MF, sp in I.	I more sp*	More sp (43,50)* with hot more than mild (50)*	SE*#(50) I lower T, SP* I tallest	lower se ht*#	sp taller se in T & I
	N. cunninghamii	seed/sprout	se in All but sp in I. mild	I more sp*		SP tallest in I*	lower se & sp ht*	sp taller se in I, se taller sp in C, T, MF
	P. aspleniifolius (e)	seed	se				lower se ht*	
UNDER STOREY	A. frankliniae (e)	seed/sprout	sp	none			lower sp ht*	sp taller in mild burns = in hot burns
	A. odorata (e)	seed/sprout	se in T, sp in I	all sp in hot I				sp markedly taller than se
	A. biglandulosum (e)	seed/sprout	sp but prop variable				reduces se (50)* & sp* ht	sp markedly taller than se
	A. glandulosus (e)	seed/sprout	se in C, T & MF, sp in I	I has more sp*		SE#(50), SP*# C lower T, I, MF	#lower se ht*, sp#	sp taller than se, except in C
	A. eriocarpa (e)	seed/sprout	sp	only in I			lower heights°	sp taller than se
	A. hirtella (e)	seed/sprout	sp	only in I			lower heights°	
	A. peduncularis (e)	seed/sprout	se			#	#	
	C. nitida (e)	seed/sprout	se in C & T, sp in I	I predominantly sp*		I sp taller than C & MF*	# reduces se* & sp#* (50)	sp taller than se
	C. quadrifida	seed/sprout	se				none	
	C. juniperina	seed	se				lower heights*	
	M. glauca (e)	seed check	se			I taller T* & Mf taller C & T*	lower heights*	
	P. straminea	seed/sprout?	?			lower se*#		
	P. cinera	seed	se			#	#	
	P. drupacea	seed	se		MF lower C, T, I*	higher se (43)†		
	T. cunninghamii	seed/sprout	se, except in T mild & I unb				lower se ht†	
	T. gunnii (e)	seed	se			I taller se*	lower se ht†	
	T. lanceolata	seed	se					
HERB LAYER	C. appressa	seed	se				only in burnt sites	
	D. tasmanica	seed	se					
	D. cyanocarpa	seed	se					
	H. javanica	seed	se					
	T. lanceolata	seed						
	U. tenella	seed	se					
FERNS	B. wattsii	spore/sprout					unburnt heights slightly greater°	
	D. antarctica	spore/reshoot	spore	reshooting in MF*			#	
	G. billardieri	spore						
	H. incisa	spore/sprout	spore				mild heights greater*	
	H. australe	spore						
	H. flabellatum							
	H. rarum	spore				C higher than T†		
	H. rugosula	spore/sprout	spore			C higher than I & T (43)*	mild higher than unb (50)*	
	M. diversifolium	spore/sprout				#(50)	unb higher burnt (43*, 50*#)	
	P. proliferum	spore/sprout				#	#	
	R. adiantiformis	spore					lower se ht*	
	S. tener	spore						
	T. billardarium	spore						

implicate and thamnic rainforest. Four of the seven seeding species were recorded as flowering or seeding. Those which were not flowering or seeding were *Parsonsia straminea, Aristotelia peduncularis* and *Trochocarpa gunnii*, with their heights in the burnt sites a fraction of their heights recorded in the unburnt sites.

Hill and Read, in their 1984 study, had no records of species sprouting post fire, but a subsequent survey of their study area showed that a number of species had sprouted. All sprouts were of the rainforest species, *N. cunninghamii, A moschatum, E. lucida and Anopterus glandulosus.* Discs taken from some sprouts indicated that *E. lucida* and *N. cunninghamii* had sprouted immediately after the fire, though there was some delay for the other species. A visit to a recently burnt area of regenerating rainforest showed that there was sprouting, of all of the species mentioned above, four months after fire. These sprouts were being eaten and some *N. cunninghamii* sprouts had died. All leaves produced by these sprouts appeared to be deformed.

Ferns

Many of the large fern species regenerate vegetatively after disturbance, and all sprouting species had set spores during the study.

Doubtful and Non-Rainforest species

Colonization into burnt areas was by seed or spore, with the possible exception of scattered *Gahnia grandis.* Some species, e.g., *Pteridium esculentum, Gahnia grandis* and *Acacia melanoxylon,* have the ability to resprout following further disturbance which could aid their maintenance in the disturbed forest. Generally the doubtful and non-rainforest species had a faster growth rate than rainforest species and comprised the majority of the canopy. The three dominant invader species showed the same trend with heights as recounted for cover and importance values; for *G. grandis* and *Leptospermum scoparium* the tallest heights were in implicate rainforest, (although *L. scoparium* had tall heights in mixed forest) and *P. esculentum* had tallest heights in callidendrous rainforest. Generally the relationships between species height, rainforest type and burn intensity were unclear or not significant.

4.3.5 *Flowering and Seeding*

Flowering plant species (monocotyledons and dicotyledons) recorded flowering or seeding during this study were listed in Table 4.10. The proportions of flowering

Table 4.10: Flowering plant species recorded flowering or seeding on burnt sites by rainforest type and fire intensity.

Species	method of regeneration	Callidendrous mild fire sites	height (m)	hot fire sites	height (m)	Thamnic mild fire sites	height (m)	hot fire sites	height (m)	Implicate mild fire sites	height (m)	hot fire sites	height (m)	Mixed forest mild (1 site) fire sites	height (m)	hot fire sites	height (m)
RAINFOREST SPECIES																	
Agastachys odorata	sprout									2	1.3						
Anodopetalum biglandulosum	sprout					2	?	2	1.0,3.0	1	1.5						
Anopterus glandulosus	sprout					1	2.0	2	1.0	3	1.5	2	1.0,1.5			2	1.0,2.0
Carex appressa	seed					1	1.5										
Cenarrhenes nitida	sprout									3	1.5-2.0	2	1.0-1.5				
Coprosoma quadrifida	seed			1	2.5												
Cyathodes juniperina	seed	1	1.0							1	0.4	2	0.5-1.0				
Eucryphia lucida	sprout					1	3.0			1	3.0	2	1.5-4.0				
Monotoca glauca	seed							1	1.5-2.0							1	3.5
Pimelea drupacea	seed	3	0.5-2.0	2	0.5-1.5	1	1.5-2.0	2	1.0-2.0			1	1.0-1.5			1	0.5
Pimelea cinerea	seed			1	1.5			1	1.5								
Trochocarpa cunninghamii	sprout					1	1.0										
Urtica incisa	seed			1	0.2												
DOUBTFUL RAINFOREST SPECIES																	
Acacia mucronata	seed													1	4.5	1	3.5
Dianella tasmanica	seed											1	0.5-1.0				
Gahnia grandis	?	1	1.0-1.5	2	1.0-2.0	6	1.0-2.0	6	1.0-2.0	2	1.5-3.0	5	1.0-3.0			1	2.0
Leptospermum nitidum	seed							1	1.0-3.0								
Leptospermum lanigerum	seed	1	3.0-5.0														
Leptospermum scoparium	seed							3	2.0-5.0	2	2.5-5.0	6	3.0-5.5	1	5.5	2	4.5-5.5
Melaleuca squarrosa	seed									1	2.0-3.0	1	5.0				
Phebalium squameum	seed															1	2.0-3.5
NON-RAINFOREST SPECIES																	
Billardiera longifolia	seed							2	3.0			4	1.0-3.0	1	2.0	1	2.0
Cirsium vulgare	seed	1	0.5														
Eriostemon virgatus	seed															1	2.0
Gnaphalium collinum	seed			1	0.2												
Hibbertia empetrifolia	seed															1	
Hydrocotyle hirta	seed			1	0.5												
Juncus affin. gregiflorus	seed							1	1.0	1	1.0						
Leptospermum glaucescens	seed											1	2.5-4.0	1	5.5	1	3.0
Lepyrodia tasmanica	seed											1	1.5				
Luzula densiflora	seed			1	0.2												
Luzula spp.	seed			1	0.5												
Muehlenbeckia gunnii	seed													1	2.0	3	1.0-3,5
Oxlobium arborescens	seed															1	4.0
Pimelea lindleyana	seed							1	0.5-1.0	1	0.7	2	1.5			1	1.0-2.0
Senecio linearifolius	seed	1	0.5-1.0														

species recorded flowering and/or seeding for rainforest (35%), doubtful- (33%) and non-rainforest (36%) species were similar. Removal of the mixed forest sites from the regression analysis produced no changes in the rainforest species proportion with the non-rainforest (31%) and especially the doubtful-rainforest (25%) species values falling.

Flowering and seeding of rainforest species were prevalent in implicate, followed closely by thamnic rainforest (Table 4.11). Doubtful-rainforest species showed a similar trend. Non-rainforest species had the greatest number flowering and/or seeding in mixed forest followed by implicate rainforest, with values greater in the hot-fire classes.

The number of species recorded flowering and/or seeding showed the same trend as described above (Table 4.12), although there was little difference between the thamnic and implicate values for rainforest species. Generally, more rainforest species flowered or seeded in rainforest; and non-rainforest species flowered or seeded in mixed forest.

Eucryphia lucida was the only rainforest canopy species recorded flowering. There were four sprouts with a range of 1.5 to 4m height, with the mode height of 3m (Table 4.10). The remainder of flowering rainforest species belonged in the shrub layer, except for the herb *Urtica incisa*. Six of the rainforest species recorded as flowering can regenerate by sprouting. The majority of individuals of these six species which were flowering had regenerated by sprouting. The height of the flowering rainforest species had reached or exceeded one metre, except for the seeders *Cyathodes juniperina*, *Pimelea drupacea* and *Urtica incisa*. There was no relationship found between fire intensity, rainforest type and height to flowering.

The species which were flowering in the doubtful rainforest category where all shrubs or small trees with the exception of *Dianella tasmanica* (Table 4.10). *Gahnia grandis* and *Leptospermum scoparium* were flowering and/or seeding in the majority of sites in which they were recorded. The only species which showed a trend in height was *L. scoparium* with the height for flowering and/or seeding increasing from thamnic (2.0 m) to mixed forest (4.5 m), probably reflecting site suitability.

The majority of non-rainforest species recorded flowering, were herbs. *Pteridium esculentum* was generally noted as sporing especially in the callidendrous

Table 4.11: Number of sites which recorded a species flowering and/or seeding.

	Callidendrous		Thamnic		Implicate		Mixed forest		Totals
	mild fire sites	hot fire sites	mild fire sites	hot fire sites	mild fire sites	hot fire sites	mild (1) sites	hot fire sites	
Rainforest species	4	5	7	8	11	9	0	4	**48**
Doubtful Rainforest species	2	2	6	10	5	13	2	5	**45**
Non-Rainforest species	2	4	0	4	2	8	3	9	**32**
Totals	**8**	**11**	**13**	**22**	**18**	**30**	**5**	**18**	

Table 4.12: Number of species flowering and/or seeding.

	Callidendrous		Thamnic		Implicate		Mixed forest		Totals
	mild fire sites	hot fire sites	mild fire sites	hot fire sites	mild fire sites	hot fire sites	mild (1) sites	hot fire sites	
Rainforest species	2	4	6	5	6	5	0	3	**31**
Doubtful Rainforest species	2	1	1	3	3	4	2	4	**20**
Non-Rainforest species	2	4	0	3	2	4	3	7	**25**
Totals	**6**	**9**	**7**	**11**	**11**	**13**	**5**	**14**	

and thamnic sites. Four of the six shrub species flowering occurred only in mixed forest sites (Table 4.10). All non-rainforest species were seeders.

4.3.6 *Time since previous fires*

The range of values for tree ring counts over the sites was large (Table 4.13), with thamnic and callidendrous rainforests having the greatest range, reflecting the larger number of species sampled. Generally the largest number of rings were found in *Phyllocladus aspleniifolius*. There were no major differences in ring numbers between rainforest types, especially when limiting results to *P. aspleniifolius* rings only.

4.4 DISCUSSION

4.4.1 Post-fire species composition

With the exception of *Notelaea ligustrina* and two ferns, *Hymenophyllum marginatum* and *H. peltatum*, all vascular rainforest species recorded in unburnt sites were recorded in burnt sites. *N. ligustrina* is a widespread species, not restricted to rainforest, and is found mainly on riverbanks. The absence of this species from burnt sites probably reflects its scattered distribution and not its fire susceptibility since it is known to regenerate freely in more fire prone vegetation elsewhere (M. Brown, pers. comm.). The absence of four moisture dependent fern species may reflect the fate of other highly fire susceptible ferns, mosses and liverworts. The time needed for such species to recolonize burnt rainforest is unknown and may require the rainforest to regenerate to its pre-fire form so that suitable substrates are available. There were lower cover values for logs in burnt sites. Logs are an important substrate for ferns and bryophyte species as are mature rainforest trees for the rich lichen flora of rainforest (Kantivilas and Minchin 1989).

Some rainforest species, e.g., *Richea pandanifolia*, were recorded only in burnt sites, reflecting the bias in sampling to burnt sites and the difficulty in finding comparable unburnt sites.

A large number of non-rainforest species was recorded in burnt rainforest, but only a few of these species were weeds. These weeds were scarce and not expected to survive in the absence of disturbance due to shading from existing non-weed species.

Table 4.13: **Minimum period, (years) since a previous fire, (derived from tree ring counts).**

	IMPLICATE RAINFOREST			THAMNIC RAINFOREST			CALLIDENDROUS RAINFOREST	
Site no.	Species	Disc age	Site no.	Species	Disc age	Site no.	Species	Disc age
3	P. aspleniifolius	380	1	E. lucida	196	16	E. lucida	226
4	N. cunninghamii	110	2	E. lucida	196	17	E. lucida	164
5	P. aspleniifolius	306	6	P. aspleniifolius	450	18	A. melanoxylon	84
7	P. aspleniifolius	279	8	P. aspleniifolius	217	19	N. cunninghamii	78
13	P. aspleniifolius	598	9	P. aspleniifolius	488	20	E. lucida	97
14	P. aspleniifolius	340	10	P. aspleniifolius	427	23	A. melanoxylon	200
15	P. aspleniifolius	445	11	P. aspleniifolius	427	36	P. aspleniifolius	327
29	P. aspleniifolius	179	12	P. aspleniifolius	105	37	P. aspleniifolius	327
30	P. aspleniifolius	253	21	E. lucida	97	38	P. aspleniifolius	327
31	P. aspleniifolius	388	22	E. lucida	144	39	P. aspleniifolius	330
34	not available		24	A. melanoxylon	115	40	P. aspleniifolius	170
35	not available		25	A. melanoxylon	115	41	P. aspleniifolius	470
			26	A. frankliniae	106	42	A. melanoxylon	242
			27	A. melanoxylon	105	43	E. lucida	233
			28	A. melanoxylon	156			
			32	A. melanoxylon	218			
			33	A. melanoxylon	186			
	P. aspleniifolius							
	mean age	352		mean age	352		mean age	325
	st. dev.	121.7		st. dev.	154		st. dev.	95
	All species							
	mean age	355		mean age	213		mean age	255
	st. dev.	138.8		st. dev.	133.2		st. dev.	116.0

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If the regenerating rainforest is disturbed, then the density of these species will probably increase, but their effect on other species is unknown. Though not recorded in this study, the declared secondary weed species, *Cortaderia richardii* (toetoe), *Ulex europaeus* (gorse), *Sarothamnus scoparius* (English broom) and *Genista monspessulana* (Canary broom) are scattered throughout the west coast. These species are a major threat to forest communities and if a seed source is present they will readily invade disturbed areas. *U. europaeus* exemplifies these weed species. It forms dense stands mainly along road sides where it acts as a 'fire wick'. These weeds are mainly located near or in disturbed areas, especially around and in settlements. The lack of these weeds in the study area is probably due to the limited amount of human settlement in and around the study area.

The dominant vascular species in the burnt sites were *Pteridium esculentum*, *Leptospermum scoparium* and *Gahnia grandis*. *Leptospermum scoparium* and *G. grandis* were also found in unburnt implicate rainforest. Propagules of these species were suited to wide spread colonisation of the burnt areas: *P. esculentum* is prolific and wind-born, so colonization of suitable areas by this species will occur even when no spore source is evident; *L. scoparium* seeds are small-winged, wind-dispersed and able to colonize large areas; *G. grandis* has small, dark seeds which are dispersed by birds.

The dominant ground covers in burnt sites were the liverwort, *Marchantia berteroana*, and the moss, *Polytrichum juniperinum*. *P. juniperinum* occurred throughout the burnt sites. The density of these two species may have an important effect on seedling germination and initial growth of rainforest species. Duncan and Dalton (1982) showed that *M. berteroana* germinated only on burnt soil and charred humus, whereas *P. juniperinum* readily germinated on forest soil, though germination was higher on burnt soil. *M. berteroana* colonized recently burnt areas, whereas populations of *P. juniperinum* appeared to peak approximately four years after fire and remained for many years (Cremer and Mount 1965). *M. berteroana* was not found in mixed forest sites and occurred mainly in callidendrous and thamnic rainforest whereas *P. juniperinum* occurred in all forest types. Although not substantiated with data, it was observed that dense 'mats' common in burnt sites had little or no seedlings growing on or in them. Where these bryophytes had a more scattered distribution, more vascular plant seedlings were found. This contradicted Hill and Read (1984), who found that bryophyte dominance had not prevented the establishment of rainforest species.

The importance of rainforest type and fire intensity was highlighted by their effects on the density and composition of post-fire 'invader' and rainforest species. The density of *Pteridium esculentum* was greatest in callidendrous rainforest. *G .grandis* and *L. scoparium* increased while the dominance of *P. esculentum* decreased along a gradient from callidendrous to implicate rainforest. Species such as *Acacia melanoxylon* and *Senecio minimus* were associated mainly with callidendrous burnt sites, while *Phebalium squameum* and *Polytrichum juniperinum* were common in implicate sites.

Differences in the heights and proportions of dominant species and other non- and doubtful-rainforest species may reflect soil fertility. *P. esculentum* appeared to dominate fertile sites. Its dominance diminished as the soil became less fertile. Other variables, affecting post-fire species composition included seed pool composition and density, differences in fire intensities and a combination of these, and other, factors.

4.4.2 Rainforest species

The importance values and covers for the majority of rainforest species were lower in burnt sites than in unburnt sites, with the fires drastically reducing both importance values and covers of rainforest canopy species regardless of fire intensity, with the possible exception of very mild ground fires.

The four rainforest canopy species in this study all showed adequate regeneration. Although many individuals in the burnt sites were small seedlings (especially *Atherosperma moschatum*), their rates of survival to maturity are unknown.

Rainforest understorey species were regenerating in burnt sites. The most fire susceptible understorey dicotyledonous species appeared to be *Archeria eriocarpa, A. hirtella* and *Trochocarpa gunnii.*

Small ferns and other moisture-dependent species appeared to be highly susceptible to fire. The fern species which were absent from burnt sites were *Hymenophyllum marginatum* and *H. peltatum.* Other *Hymenophyllum* species were scarce in burnt sites. When recorded, they were found only in damp micro-habitats, such as moist logs. This was also the case with *Tmesipterus billardieri* and *Polyphlebium venosum.* Although the larger fern species were regenerating, after the fire, the only species increasing in numbers were *Histiopteris incisa* and *Hypolepis rugosula.* They were recorded predominantly in burnt sites and both were associated with canopy gaps in undisturbed rainforest.

Rainforest and non-rainforest species mostly regenerated as seedlings though sprouting was also important for many rainforest species. Sprouting was mainly from subterranean buds, though earlier observations of fires have recorded *Eucryphia lucida*, *Atherosperma moschatum* and *Pittosporum bicolor* sprouting from aerial buds (J. Hickey, unpub. data). Non-rainforest species were not observed sprouting, but a second fire would cause sprouting of some of these species, especially *Pteridium esculentum*.

Eleven rainforest tree and shrub species were observed sprouting during this study. A number of fern species have been observed sprouting by other researchers (S.J. Jarman pers. comm), but it was not possible, due to the eight year time lapse between the fires and the study, to determine whether individual ferns arose from sprouts or spores. Similarly, it was not possible to determine the origins of *Gahnia grandis* individuals. Sprouting of rainforest species occurred mainly in implicate rainforest. Callidendrous rainforest had the lowest number of sprouts.

For rainforest species which sprout, sprouting was the main method of propagation in implicate rainforest, whereas seeding was predominant in callidendrous and thamnic rainforest. The exception was *A. moschatum*. *A. moschatum* is generally thought to sprout more readily than *Nothofagus cunninghamii* in Tasmania (Hill 1982; Hickey, unpub. data). *A. moschatum* is also susceptible to browsing which may have limited the number of sprouts and seedlings in the present study. Generally, sprouts were taller than seedlings, especially in implicate rainforest, though seedling height was as tall or taller in callidendrous rainforest for some species. These species included *Eucryphia lucida* and *N. cunninghamii*.

Howard (1973) perceived a difference in the ability of the Victorian and Tasmanian populations of *N. cunninghamii* to sprout. This author stated that epicormic burl development was poor in *N. cunninghamii* from the Surrey Hills area of north western Tasmania, whereas burl formation was well developed in *N. cunninghamii* from Victoria. Rainforest in the Surrey Hills area is of the callidendrous type which recorded low levels of *N. cunninghamii* sprouting in this study. Epicormic burl development of *N. cunninghamii* is greater in implicate rainforest, which explains the higher proportion of sprouting. Howard (1973) suggested that the more constant burning of forest in Victoria may have selected for epicormic burl development. Epicormic burl development enabled trees to sprout after fire and these trees were observed to have a higher growth rate and earlier seed production compared to non-sprouting plants. Sprouting enables a plant to reach sexual maturity earlier than if seeded. This can aid rainforest species in returning to their pre-fire density and to build up their seed banks (Howard 1973).

This study does not support Howard's (1973) suggestion. The ability of some rainforest species to sprout after fire does not indicate that sprouting by these species is a response to frequent fires. Instead, it probably reflects their method of vegetative regeneration occurring under a closed rainforest canopy (Read and Hill 1985, 1988) and to the nutrient status of the soil. Implicate rainforest is generally found on poor or waterlogged soils and is dense and species rich. This environment appears to favour regeneration by sprouting. Studies of the growth of Australian plants on poor soils indicate that nutrients in plants are generally stored below the ground and this may be a preadaptation for sprouting (Bowen 1981). An examination of tree rings to determine the minimum age since fire indicated that frequent fires, necessary to promote fire sprouts, did not occur in the study area (Table 4.13). Mean age of rings taken from the implicate sites were equivalent to callidendrous and thamnic values. The oldest tree, based on ring counts, was 598 years of age. This disc was collected from site 13, an implicate hot-fire site. These limited results do not support Jackson's (1968) view that the probability of fire in climax forest is related to soil fertility; that the greater floristic diversity, with limited stratification between layers and a broken canopy of rainforest associated with acid and infertile soils, corresponds to a greater fire risk than tall park like rainforest associated with fertile soils. The tree ring results, may indicate that fire may behave differently and have differing effects on vegetation from different soil fertilities. Forests on fertile soils generally are of taller stature, have a large above ground biomass and burn when conditions cause conflagrations, indicating that rainforest occurring near, or within surrounding vegetation on fertile soils, is more readily burnt. On poorer soils, the surrounding vegetation can burn under less 'conflagration' producing conditions, therefore, implicate rainforest has a higher probability of being singed at the edges, but not consumed.

Sprouting and coppicing of tropical rainforest species after hurricanes, logging and then burning have also been documented (Unwin et al. 1985; Stocker 1981; Uhl et al. 1981; Boucher 1990). A study on the effect of a fire in *Acmena smithii* dominated warm temperate rainforest in East Gippsland, Victoria, showed that post-fire vegetation was dominated by species found in mature rainforest (Chesterfield *et al.* 1990). Sprouting was also important in the regeneration of rainforest species. The dominant canopy tree, *A. smithii*, and all the understorey species regenerated primarily by sprouting. After fire, both warm temperate and tropical rainforest are dominated by rainforest species, especially lianes. This contrasts with the results of this study where post-fire dominance of cool temperate rainforest is by non- or doubtful-rainforest species.

CHAPTER 5: THE EFFECTS OF FIRE ON THE THREE LOWLAND RAINFOREST TYPES

5.1 Introduction

This chapter examines the capacity of each lowland rainforest type to maintain its identity after a major disturbance event caused by fire. Each rainforest type is characterized by its component species and structure, although intergrading is common. A major disturbance, such as fire, may shift one rainforest type along the continuum to another rainforest type or to a different vegetation type. This shift may occur in the rainforest types on soils of medium to poor fertility, because the structure of rainforest on poor soils carry fire more readily and fire leaches valuable soil nutrients (Jackson 1968). Rainforest on poor soils is generally of the implicate, implicate/thamnic type, which has no differentiation between the understorey and canopy layers and is relatively species rich. The leaching of nutrients, and the subsequent slow accumulation of nutrients from the parent material and rainwater, favour sclerophyllous species, increasing the fire risk.

Research on the distribution of the three major cool temperate rainforest types in Tasmania indicate that soil fertility, measured indirectly by geology and topography, may be the most important determinant of rainforest variability (Brown *et al.* 1990; and Jarman *et al.* 1991). Callidendrous rainforest is predominantly found on basic igneous rock types and implicate rainforest on quartzitic or conglomerate rocks with thamnic rainforest occupying sites of intermediate fertility. Other variables included in their analysis are altitude, slope, aspect, drainage, pH, and climate.

In Australia, published studies on the response to fire of different component identities within a vegetation type to fire are limited, with studies examining the role of fire on vegetation distribution within a defined area predominating (e.g., Brown and Podger, 1982, Bowman *et al.* 1988, Wilson and Bowman 1987). There appears to be only limited research on the effect of fire on rainforest, with research on tropical and subtropical rainforest predominating (see Goldammer 1990); even though fire is recognised as one of the most important factors initiating succession in most temperate forests throughout North America and Northern Europe (Mueller-Dombois and Goldammer, 1990). The role of fire in maintaining wet sclerophyll forest, including the removal of the rainforest understorey, in south-eastern Australia has been examined (e.g. Gilbert, 1959; Ashton, 1981). However only limited research has been conducted on the effect of burning practices, and associated logging practices on temperate rainforest species (Taplin *et al.* 1991; Jordan *et al.* 1992; Hickey 1992). The majority of research into this area is limited to rainforest tree species.

Rainforest types may respond differently to being burnt and to changes in fire intensity. This is due to the response of component species, the structure of each rainforest type and the proximity, composition and density of 'invader' species. For example, studies on the effects of a fire on wet beech forest, in the Tararua range, north of Wellington, New Zealand indicate that different rainforest types can regenerate differently after fire of an intensity required to kill the original vegetation (Wardle *et al.* 1983; Wardle 1984). These studies show that the majority of New Zealand forest species do not have the ability to resprout (Wardle *et al.* 1983) and succession of mid and low altitude rainforest on sheltered sites and good soils proceed faster than rainforest on exposed sites and poor soils.

The effects of a fire on individual species and whole communities may be mediated or exacerbated by factors effecting fire intensity, burning patterns, niche availability and seed sources. Such diverse factors include soil fertility, exposure, the proximity to undisturbed rainforest margins, the proximity of other vegetation types, soil type and solar radiation. In their study, Hill and Read (1984), on the effect of fire on Tasmanian rainforest and mixed forest show that the behaviour of fire is important in determining species composition. A small area of rainforest burnt by a patchy fire is regenerating to rainforest, whereas an area of mixed forest, burnt by a hot fire, has an increase in the sclerophyllous component at the expense of the pre-fire rainforest component. The effect of the patchy fire in rainforest is species-specific (Hill 1982). This specificity is correlated with humus depth. Vulnerable species, such as *Nothofagus cunninghamii* and *Eucryphia lucida*, are those growing on a humus layer of a depth required to sustain the fire.

The importance of fire intensity and the proximity to sclerophyll seed sources for warm temperate rainforest in Victoria is highlighteded by Cameron (1979) and Chesterfield *et al.* (1990). Rainforest burned by a ground fire retains its canopy with only a few opportunistic species invading. Regeneration is mainly by rainforest species. Rainforest subjected to a crown fire is invaded by many opportunistic species with subsequent regeneration patterns altered, possibly permanently by the composition of these invading species. Fire intensity also appears related to canopy closure with a closed canopy limiting the fire to a ground fire or a less intense crown fire (McMahon 1987). The composition of post-fire vegetation is variable within the same rainforest complex, and it is not known whether this is due to changes in fire same rainforest complex, and it is not known whether this is due to changes in fire intensity, seed bank dynamics or a combination of these and other factors (McMahon 1987). Crown burnt warm temperate rainforest, if invaded by eucalypts, may become more fire prone, with a resultant decrease in the probability of returning to rainforest; whereas rainforest not invaded by eucalypts may have a high probability of returning to a similar structure and composition as its pre-fire condition (Cameron 1979).

Fire intensity is also important in the lowland tropical rainforest of East Kalimantan (Indonesian part of Borneo) (Goldammer and Seibert 1990). Regeneration, after 4.5 years, of rainforest species in areas slightly damaged by fire appears to be rapid, whereas in areas where fire has removed the upper canopy, both the number and composition of species have changed drastically, with resultant recovery being slow.

This chapter aims to examine the effect of fire on the floristics of Tasmanian west-coast lowland callidendrous, thamnic and implicate rainforests. The specific aims being:

- to examine similarities and differences in floristics and composition between burnt rainforest and unburnt rainforest, 7 - 8 years post-fire, so as to determine whether rainforest has maintained its identity post-fire or has been replaced by another vegetation type;
- to assess the effect of pre-fire rainforest type, mixed-forest type and fire intensity on the post-fire floristics;
- to examine relationships between fire intensity, rainforest types and physiographic features.

5.2. Sampling and analytical techniques

Vegetation sampling is outlined in Chapter 4. Additional physiographic data were collected and are outlined below. All variables used are listed in Chapter 6, Appendices 3 and 7.

5.2.1 Physiographic Features

For each site the physiographic features measured were aspect, slope, rock type, soil type, soil pH, light radiation and fertility. The distance, direction and composition of the nearest seed source was also noted.

Light radiation indices were used to determine whether correlations between these indices and rainforest type and/or burn intensity could be found as high radiation indices maybe correlated with hotter fires due to lower moisture levels. In addition, different regeneration patterns attributable to light radiation maybe shown to occur in rainforest. Radiation indices for summer, winter and yearly were derived using two methods. The first was derived from a table of mean daily estimations of solar radiation received on slopes in Tasmania (Nunez 1983). Estimations for December, June and yearly were used (Nunez S, Nunez W, Nunez T). The second method utilized the computer program CLOUDY (Fleming 1971; Fleming and Austin 1983). CLOUDY derived site specific radiation indices using regional climatic data, latitude, horizon azimuths, aspect and slope to produce radiation indices for summer (ridec), winter (rijune) and total (ritotal)

Surface rock was determined from land systems and is an extremely broad classification (Richley 1978).

To examine further the role of soil fertility on rainforest type and the regeneration of these rainforest types, a number of different fertility ratings was used:

1. soil fertility ratings produced from the bioassay trial using oats, *Avena sp.*, and *Eucalyptus nitida* planted in burnt and unburnt soil collected under the three rainforest types. Two indices were produced using oats (ftoat1, ftoat2) and one index using *E. nitida* (fteuc) (refer to Chapter 6).

2. fertility ratings produced from a 'blind test' of site locations given to a geologist acquainted with the study area produced the indices NTfertility (Appendix 7).

3. fertility ratings produced from a 'blind test' of site locations given to a soil scientist produced the indices BNfertility (Appendix 7).

4. fertility ratings produced from an interpretation of land systems (Richley 1978) (fertilityu) included a rating for soils after being burnt (fertilityb) (refer to Appendix 7).

To examine whether there were any correlations between regenerating rainforest and potential seed sources, seed source indices were devised. These indices were based on the distance, direction and vegetation type of the nearest two potential seed sources to each site. Location, direction and vegetation of nearest seed sources were recorded on site if possible, or from photographs and maps.

A seed source was defined as:

1.- unburnt rainforest

2.- eucalypt forest/woodland

3.- other e.g.: tea tree scrub

4.- an unburnt control

Seed direction indices were based on position of the seed source in relation to the site together with the prevailing winds:

1. - 225° - 315°

2. - 315° - 360°; 180° - 225°

3. - 180° - 225°; 0° - 45°

4. - 45° - 135°

Distance indices were based on the following;

1. - ≤ 50m

2. - 51 - 200m

3. - >200 - 1000m

For each site two seed sources were identified, for each seed source the direction index and the distance index were multiplied to give the combination index. The seed source indices were named seed1 and seed2 and the combination indices were named comb1 and comb2.

5.2.2. Multivariate analyses

Floristic and cover data were analysed using the following multivariate methods: classification, ordination, canonical correlations and vector fitting. Classification and ordination techniques are complementary when relationships between plant composition and environmental differences are determined (Gauch and Whittaker 1981).

Classifications based on presence/ absence and cover data were used to:

- validate the rainforest type and fire intensity classifications used to stratify sample sites;

- determine the heterogeneity of plots within sites, to ensure that the data were suitable for other statistics;

- determine whether the burnt sites were floristically and compositionally different from the sites not burnt and the magnitude of these differences;

- examine whether the divisions were related to rainforest type and/ or presence or absence of fire and fire intensity;

- determine which species were important in explaining the divisions.

Ordinations were used to

- indicate how 'real' were the divisions as described by the classification technique, showing whether the sites along an axis formed succinct groups, or formed scattered gradients, or a combination of groups and gradients;

- determine whether the distribution of sites was related to rainforest type, presence of fire, fire intensity, and/ or any measured physiographic factors.

Canonical correlation and vector fitting were used to further examine the relationships between rainforest type, presence of fire, fire intensity, and the measured environmental variables, with the trends in vegetation composition as expressed by the ordination axis derived from the two methods. These methods assumed a linear relationship between species' success and environmental variables.

Classification

Data were classified using two-way indicator species analysis (TWINSPAN: Hill 1979a). TWINSPAN initially ordinated the data using reciprocal averaging, then determined the species which emphasized the polarity of the ordination. The ordination was then divided, the division refined by a reclassification in which species with maximum values were used to indicate the poles of the ordination axis. This process was repeated to produce each subsequent division. TWINSPAN utilized an hierarchical divisive polythetic technique which took all available information (polythetic), and successively divides (divisive), grouping together sites with similar attributes. Since a polythetic method partitions through the use of more than one (generally all) species, whereas a monothetic technique partitions on the basis of the presence or absence of a single character (species), the use of a polythetic method ensured that all the data was used. This procedure prevented the high rate of misclassifications associated with a monothetic technique (Gauch and Whittaker 1989). The ability to use all available information for the initial divisions gives divisive techniques theoretical advantages over agglomerative techniques (Lambert *et al.* 1973). Polythetic-agglomerative techniques differ from polythetic-divisive techniques in that they determined the dissimilarity between samples and then clustered similar samples together to compile an upwards hierarchy. A problem associated with TWINSPAN was that the division of the first axis may not have represented the 'natural' major discontinuity in the vegetation continuum. The point of division of the axis was determined on the basis of numerical distance, therefore when a subset of samples at one end of the axis had maximal numerical distance from samples at the opposing end, the point of division was arbitrary (Kuusipalo 1985).

Evaluations of classification methods using simulated data are limited and more research into this area is required. Discussion of the benefits of divisive-polythetic methods, especially TWINSPAN, over other classification procedures is offered by Kent and Ballard (1988) and Gauch and Whittaker (1989).

Ordination

Two ordination methods were used; Detrended Correspondence Analysis (DCA: Hill 1979b) and Hybrid Multidimensional Scaling (HMDS: Faith *et al.* 1987) which also utilized Non-Metric Multidimensional Scaling (NMDS: Kruskal 1964). Opinions differ over which procedure, DCA or HMDS with NMDS, is more robust and effective. DCA is apparently 'most satisfactory' (Hill and Gauch 1980) when compared with Reciprocal Averaging (RA) (Hill, 1973) and NMDS. Kent and Ballard (1988) have shown the increasing popularity of DCA over RA, a Bray & Curtis or Polar Ordination (Beals 1984), Principal Components Analysis (Hotelling 1933) and its variants. Minchin (1987) evaluated a range of ordination techniques which was verified by Kent and Ballard's (1988) findings. He also compared DCA with Local Non-Metric Multidimensional Scaling (LMNDS) and concluded that LMNDS was more robust. The problem with DCA is that in attempting to rectify curvilinear distortion of gradients (the arch effect) it distorts any non-linear environmental configurations.

Minchin's (1987) results differed from those of Hill and Gauch (1980), mainly because of the differences in assumptions used to derive simulated data. Minchin's simulated data were based on assumptions which encompassed most current concepts and hypotheses about the properties of community patterns, whereas Hill and Gauch's (1980) and Gauch *et al.*'s (1981) data were based on Gaussian response models.

Brown *et al.* (1990) used Tasmanian rainforest vegetation data to show that the axes generated by both DCA and HMDS methods were very similar. Discussion of the differences between these two methods were offered by Minchin (1987), Gauch *et al.* (1981) and Kenkel and Orloci (1986).

DCA has evolved from Reciprocal Averaging (Hill 1979b). However, there are two main problems associated with RA; the 'arch effect' or tendency for the second and sometimes higher axis to be strongly related to the first axis; and the problem that ecological distance is not preserved between samples along an axis. DCA has attempted to solve the arch effect by trying to remove any systematic relationships between each axis and all previously extracted axes. This process does not eliminate the possibility of a strong curvilinear relationship occurring between an axis and some combination of previous axes. DCA also has a re-scaling procedure to ensure that axis-scaling is uniform (Hill and Gauch 1980; Brown *et al.* 1984). DCA ordinations were conducted using the program DECORANA (Hill 1979b).

HMDS and NMDS differ from DCA in a number of important ways. Principally, they are non-metric scaling methods and only the rank order of dissimilarities is used, as opposed to a derived proportion. Further, HMDS attempts to relate linearly the distance between pairs (sites) to their dissimilarities if their dissimilarities are below a certain threshold. HMDS and NMDS ordinations were executed using KYST (Kruskal *et al.* 1973).

The data were ordinated initially using NMDS with 20 starting configurations. The Kulczynski coefficient was used to compute the dissimilarity index (Faith *et al.* 1987). The data were then ordinated using HMDS with the starting configuration comprising of the axes derived from the first ordination. This followed the procedure summarized by Kantvilas and Minchin (1989) and recommended in the DECODA manual (Minchin, 1990).

Canonical Correlations

Canonical correlations (e.g. Dunteman 1984) of ordination axes derived from the techniques described above and a range of physiographic and vegetation features were used to assess whether any combination of features were correlated. Canonical correlations identify relationships between two sets of variables, by investigating linear combinations of variables in one set that are most highly correlated with linear combinations of the second set (Gittens 1985). The value of this method for relating biological data to environmental data has been described as 'inappropriate' (Kuusipalo 1985; Green 1979 not seen) because it assumes a linear relationship between species' success and environmental variables.

Physiographic features included for Canonical Correlation analyses were aspect, slope, rock type, soil type, soil pH, light radiation (derived from Nunez) and fertility (derived from Land Systems). Rainforest type, fire intensity and stag height were also included. The sample sites were then plotted using the canonical coefficients of the first and second set.

Vector Fitting

Vector fitting is another method used to relate environmental variables and ordination patterns. This method allows for relationships between each variable and the ordination configuration to be readily interpreted and will also indicate trends which are oblique to the axes (Bowman & Minchin 1987; Kantvilas & Minchin, 1989). This technique finds the vector (or rotated axis) through an ordination so that there is maximal correlation (R_{max}) between this vector and the values of the chosen variable (Bowman & Minchin 1987; Kantvilas & Minchin, 1989). The correlation between the values of a variable in ordination space and the vector indicates goodness-of -fit. Direction of the vector corresponds to the direction of maximum slope of the hyperplane as fitted by multiple regression (Bowman & Minchin 1987). The direction of the vector is robust provided that trends are monotonic (Carroll & Chang 1964).

The procedure used is part of the DECODA package which also included the Monte-Carlo significance test for each vector (Minchin 1989). This test estimated the significance of R_{max} by running 999 random permutations of the data for each parameter and obtaining the probability of obtaining the actual R_{max} value by chance alone (Prober and Austin 1990).

Vector fitting was used for all the HMDS ordinations: presence/ absence and cover data for all sites, for all burnt sites, for rainforest sites, for burnt rainforest sites and for unburnt sites, thus making a total of 10 analyses.

5.3 RESULTS

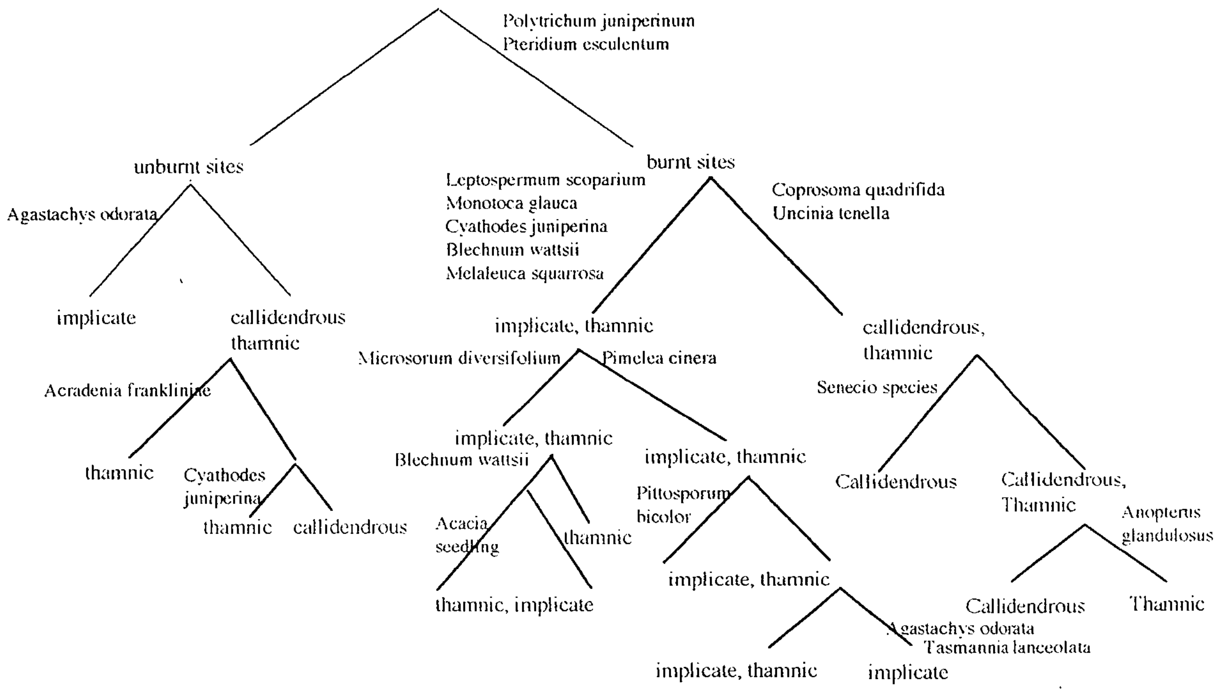
5.3.1 Classification

The TWINSPAN analyses indicate that early divisions were associated with separating sites into burnt, unburnt and rainforest type (Figures 5.1a&b, 5.2a&b). Analysis of presence/absence for the rainforest data showed the clearest divisions into burnt and unburnt sites and rainforest type while analysis of cover data indicated that fire intensity could also be an important factor. The TWINSPAN two-way table, consisting of sites and species presence/ absence data is shown in Table 5.1.

The first division resulting from the TWINSPAN analysis of presence/absence data on the original rainforest sites had *Pteridium esculentum*, and the moss *Polytrichum juniperinum* separating burnt from unburnt sites (Figure 5.1a); both these species being indicative of burnt forest. Further divisions of burnt sites indicated the importance of the sclerophyllous species, *Leptospermum scoparium* and *Monotoca glauca,* in dividing implicate sites from callidendrous sites. Final divisions appeared

Figure 5.1: TWINSPAN classification of sites by species for the 43 rainforest sites:

a) presence/absence data



b) cover

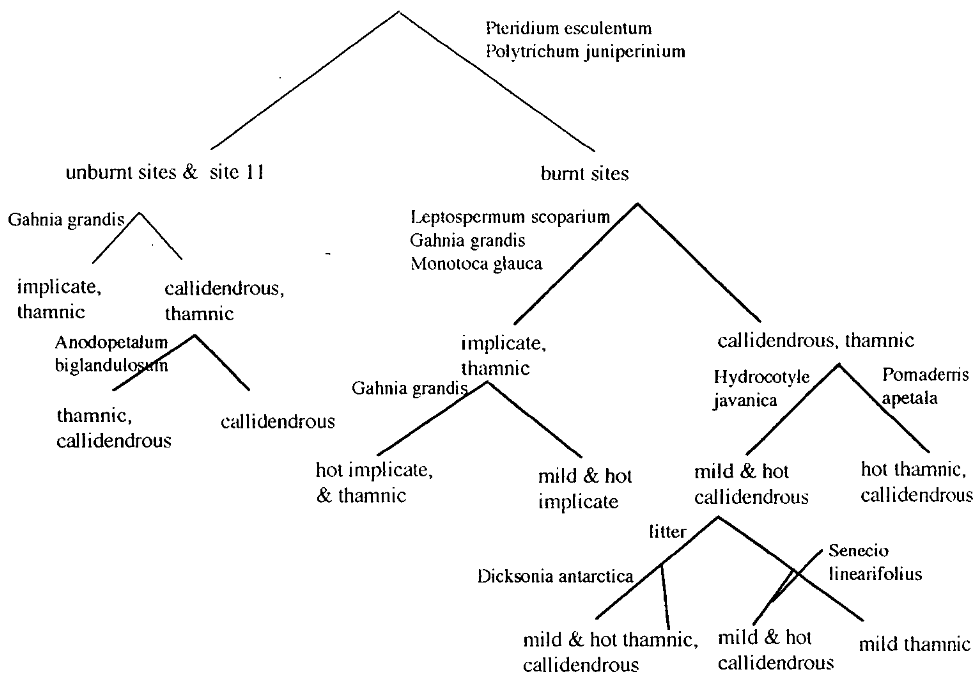
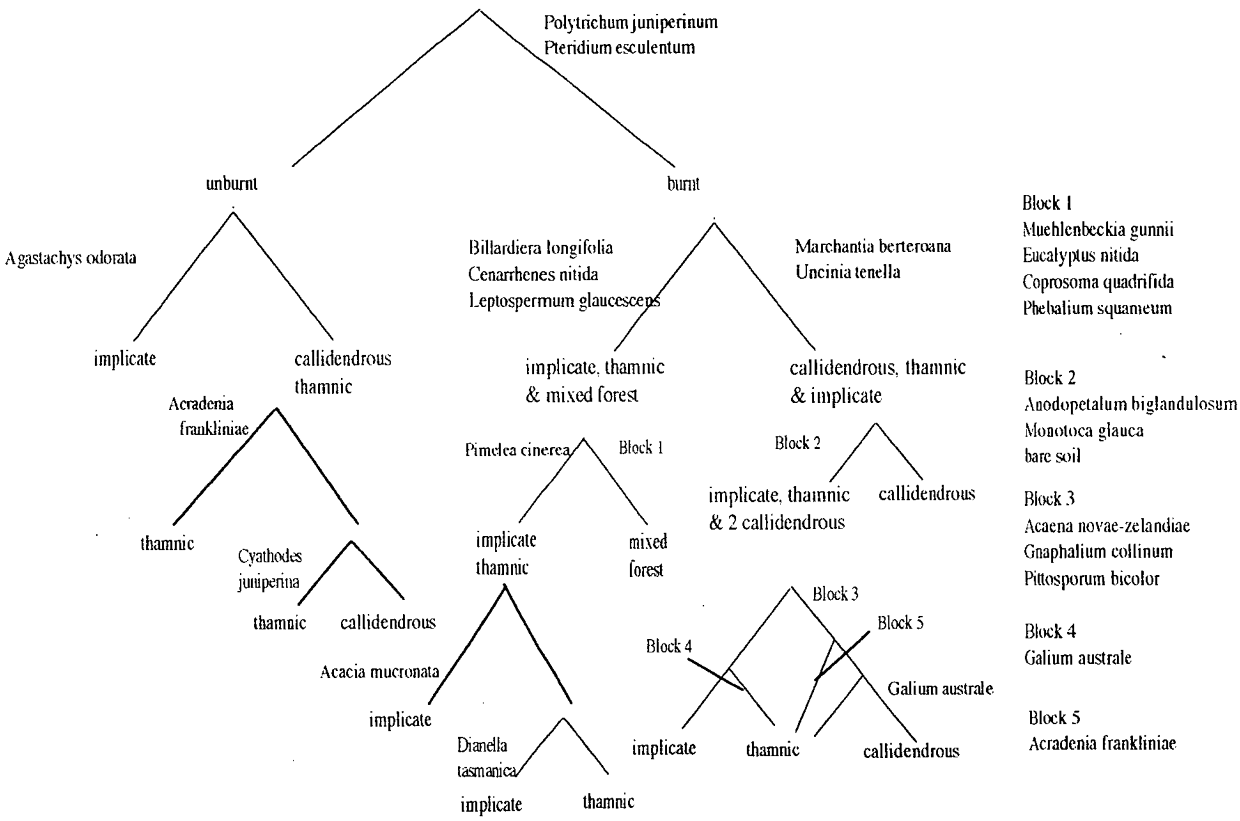


Figure 5.2: TWINSPAN classification of sites by species using all 50 sites.

a) presence/absence data



b) cover data

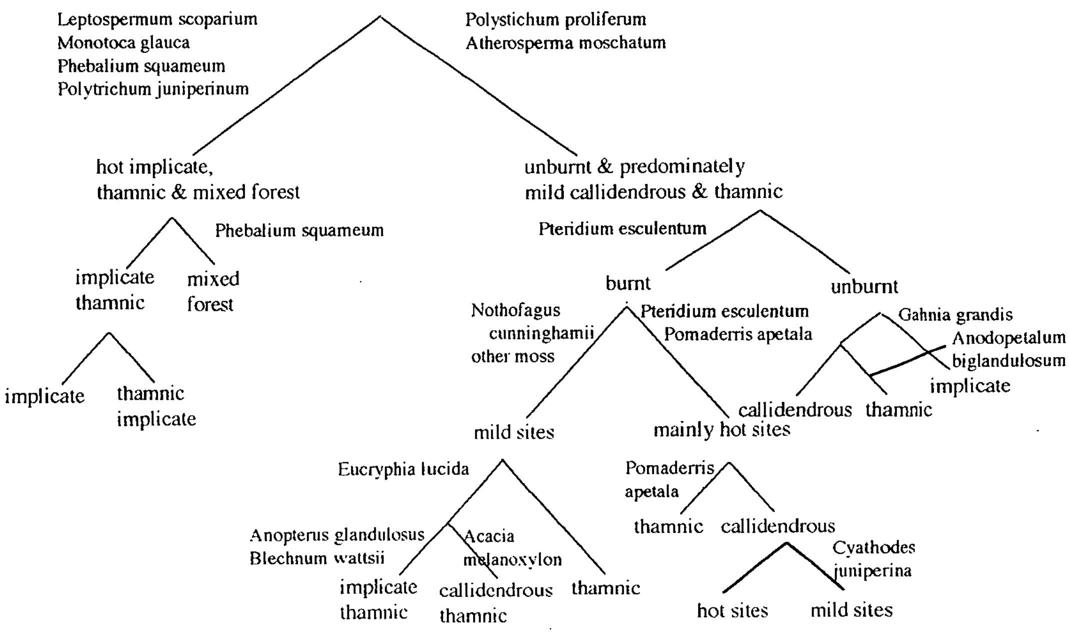


Table 5.1: TWINSPAN two-way table of species and rainforest sites.

SPECIES	SITES	
	`  1  11113 2233211  2222232344334 113423 13`	
	`7915602355329018671213457207028618899363444`	
Cyathodes juniperina	11111111111111111-11----1-11-11-11-------11	0000
Leptospermum scoparium	1111111-11111111-11------1---1------------1	0000
Phebalium squameum	11-1---11-----11--------------------------1	0000
Acacia verticillata	1------------1-----------------------------	000100
Isolepis inundata	------------11-----------------------------	000100
Melaleuca squarrosa	1------11-1-111----------------------------	000100
Richea pandanifolia	------------11--------1--------------------	000100
Dianella tasmanica	---1-1--111------1-------------------------	000101
Leptospermum glaucescens	-1-111-1--1----------1---------------------	000101
Pimelea ligustrina	------11-----------------------------------	000101
Leptospermum nitidum	1---1-1--------------1-----1---------------	000110
Pimelea cinerea	11111-1111--------1-1--111------1----------	000110
Pimelea lindleyana	1--11--11111------1-11----11--1------------	000110
Gleichenia microphylla	11--1------------------11------------------	000111
Senecio biserratus	111------------1------111------------------	000111
Senecio minimus	---1-------------1------1--111111---1------	001000
Galium australe	---------------111---1111---1-1-1----------	001001
Juncus procerus	----------------------1-1------11----------	001001
Leptospermum lanigerum	---------------------------1--1------------	001001
Luzula sp.	----------------------1---------1----------	001001
Olearia argophylla	-----------------------------1--1----------	001001
Urtica incisa	------------------------11--11-11----------	001001
Blechnum nudum	-------------------11-----1----------------	001010
Senecio minimus/bisseratus	----------1-----1-11111--------------------	001010
Acaena novae-zealandiae	-1-11-----1-----1111-1--11-1--1-1----------	001011
Carex appressa	-------------11--111---1-1------1----------	001011
Cirsium vulgare	----------1------1-------1-----1-----------	001011
Gaultheria hispida	----------1-1---1-11------------1----------	001011
Gnaphalium collinum	-1--------1-----1111-----------------------	001011
Juncus aff. gregiflorus	------------11--11-1-----1-----------------	001011
Pseudognaphalium luteo-album	-1--------------11-------------------------	001011
Uncinia tenella	1-1-1------1--1-111111111111---11-11-------	001011
Marchantia berteroana	-11-1-1--111111--1111111111111111--1-------	001100
Acacia mucronata	1--1------------------------1-1------------	001101
Cassinia aculeata	------1---------1--------------------------	001101
Epilobium sp.	--1-------------1--------------------------	001101
Picris hieracoides	---------------1-------1-------------------	001101
Polytrichum junipernum	11111111111111111111111111111-111----------	001101
Pteridium esculentum	-11111111111111111111111111111111----------	001101
Senecio sp.	----111-1---111-----------1111111----------	001101
Acacia melanoxylon	1--11111-111111111-11-11-11-11--1-1---1----	00111
Hypolepis rugosula	-1111111-111111111111111111111111---1----1-	00111
Anodopetalum biglandulosum	111111111-1-11111111--111--1-----11---11111	010000
Microsorium diversifolium	---------11111111-1111111111111--11111111--	010000
Logs	111111-1-1111111111111111111111111111111111	010000
Mineral soil	11111-11----111111----1111------111-1-1111-	010000
Anopterus glandulosum	1-11111111111111--11111111-------111--1-111	010001
Atherosperma moschatum	111111-11111111111111111111111111111111111-	010001
Dicksonia antarctica	11111-1--1-11-1-11111111111111111-111111---	010001
Eucryphia lucida	11111111111111111111111111-1-111111111-1111	010001
Gahnia grandis	11111111111111111111111111111-11-1------111	010001
Histiopteris incisa	111111--1111111-11111111111111111--1111--1-	010001
Hydrocotyle javanica	-1-11-1--11111111111111111111111111-11-----	010001
Nothofagus cunninghamii	1111111111111111111111111111111111111111111	010001
Pimelea drupacea	111111--1111111111111-1111111-1111--1-1-1--	010001
Polystichum proliferum	-11-11---111111111111111111111111-111111---	010001
Pomaderris apetala	-1---------1---1----1-11--1-----1------1---	010001
Trochocarpa cunninghamii	111--11-----------11-1------1-1--1------11-	010001
Litter	1111111111111111111111111111111111111111111	010001
Other moss	1111111111111111111111111111111111111111111	010001
Wood	1111111-111111111111111111111111111--1111--	010001
Cenarrhenes nitida	1--1111111-11-1--11-1-1---1------1--1----11	01001
Monotoca glauca	1111111111111111--11--1111----1--1------1-1	01001
Phyllocladus aspleniifolius	1111111-11111-11--11--11111---1-11-11-1-111	01001
Tasmannia lanceolata	------1111-1--------1---------1-1--------11	01001
Agastachys odorata	1---1--111--1---------------------------111	0101
Billardiera longifolia	1--11-11-111--------11-1----------1-11----1	0101
Blechnum wattsii	1111111111111111-1-11---11----11--1-1111111	0101
Chiloglottis sp.	-----------------1-11--1-------1-----1---1-	011
Clematis aristata	---1----------1-111----111----1--11-1------	011
Coprosoma quadrifida	----------11--1-11111111111111-1111111-----	011
Sticherus tener	1----------------------111------------1----	011
Coprosoma nitida	---------1-------------------------------1-	1000
Drymophila cyanocarpa	----111--1---------1----------1---11-------	1000
Acacia seedling	1111-----1--1111------1111-11----1-1--11--1	1001
Yabby holes	111-11--1-1-111-11-1-------------11-11-111-	1001
Acradenia frankliniae	------------11----------11------------11---	101
Trochocarpa gunnii	----------1-1-1---------------------1-----1	101
Rocks	---1----------11----------------1-----11-1-	101
Aristotelia peduncularis	-1-----------------1---------111111-11-----	1100
Chiloglottis cornuta	----------------------------1-1-----1------	1100
Lycopodium laterale	----------------------11--------------1----	11010
Parsonsia brownii	--------------11------111-------------11--1	11010
Pterostylis sp.	--1---------------1--1------------1--------	11010
Grammitis billardieri	--1----------------11-11-1-----111111111111	11011
Pittosporum bicolor	111-------------1--1-1--1-------1--11-1---1	11011
Rumohra adiantiformis	--1-1-1--111----1--111--11---1---1111111---	11011
Hymenophyllum rarum	-------------------1111----------111--11111	11100
Polyphlebium venosum	------------------------1--------1-1-1-----	111010
Asplenium flaccidum	--------------------------------------111--	111011
Asplenium terrestre	-------------------------------------11----	111011
Hymenophyllum australe	-----------1---------------------11-1111111	111011
Hymenophyllum cupressiforme	-----------------------1----------1---111--	111011
Hymenophyllum flabellatum	----------------------------1----111111---1	111011
Hymenophyllum marginatum	--------------------------------------1--11	111011
Hymenophyllum peltatum	---------------------------------11-1-11---	111011
Notelaea ligustrina	------------------------------------1-----1	111011
Tmesipteriss billardieri	--------------------1-------------11111-111	111011
Archeria eriocarpa	------------1---------------------------1-1	1111
Archeria hirtella	--------1--------------------------------11	1111
	0000000000000000000000000000000001111111111	
	0000000000000000111111111111111110000000111	
	0000000000111111000000000011111110000011	
	00011111110000010000001111000001101111	
	`   000011100111 001111     00001`	

to reflect individual site factors.

The addition of the mixed-forest sites to the rainforest sites produced different site separations. This was especially evident with cover data; the first division separating predominantly hot fire sites from unburnt and predominately mild-fire sites. The mixed forest sites were initially grouped with the hot-fire implicate and some thamnic sites. They separated into their own group after the third level of divisions. The grouping of implicate and thamnic sites, burnt by a hot fire, with the mixed-forest sites indicated an increase in sclerophyllous species which was not evident in the callidendrous sites. There appeared to be an increase in sclerophylly along a continuum from callidendrous to implicate and finally to mixed forest, evident only in sites burnt by a hot fire. The grouping of the mild-fire sites with the unburnt sites indicated that rainforest (independent of type) retained a large component of its prefire rainforest element after a mild fire.

Classification of the 430 plots from the original rainforest sites showed relative homogeneity. Each site had at least five plots grouped together (Table 5.2). Implicate sites were more homogeneous than the callidendrous and thamnic sites. There was no difference in the homogeneity between unburnt and burnt sites.

The placement of all the unburnt and the majority of burnt sites into the same rainforest types by TWINSPAN as initially determined, validated the field classification of rainforest sites. The division of fire intensity classes did not appear successful. The TWINSPAN analysis of rainforest plots also showed that the data were homogeneous and therefore could be subjected to further analysis.

5.3.2 Ordinations

The overall trends were exemplified by the HMDS on presence/absence data shown in Figure 5.3. Burnt sites were separated along one axis and rainforest types along the other. Rainforest type was a continuum with callidendrous sites concentrated at one end, implicate sites at the opposite end and thamnic sites scattered. Mixed forest burnt sites were either grouped with the implicate, thamnic burnt sites patch or were centrally placed between the patches dominated by callidendrous sites and the implicate sites (Figure 5.4). The mixed forest sites were separated into their own cluster when HMDS axes 3 & 4 were examined.

When ordinations were conducted on cover data, there was evidence of separation of burnt sites into the groupings described above with further differentiation occurring between mild-fire and hot-fire groups. This was particularly evident using HMDS.

Analysis of the first two axes of DCA's using all 50 sites data and a subset of 43 rainforest sites data separated burnt sites from unburnt sites (Figures 5.3 to 5.7). Delineation of unburnt sites into the particular rainforest types occurred when using presence/ absence data for the 43 rainforest sites (Figure 5.3). DCA's on cover for both the 43 and 50 sites data sets and on the 50 sites presence/ absence data produced an unburnt implicate group and a callidendrous group with the thamnic sites scattered in between (Figures 5.5 & 5.6). Burnt sites were divided into two groups, callidendrous/ thamnic and implicate/ thamnic. Cover data best delineated mild-fire sites from hot-fire sites. Mixed forest sites were placed into the callidendrous, thamnic group when using species presence/ absence data and into the implicate, thamnic group when using cover data.

Analysis of the first two axes of HMDS showed that cover data separated burnt and unburnt sites along the first axis and rainforest type along the second axis (Figure 5.7). HMDS of cover data showed a gradation from unburnt through mild fires to hot fires along Axis 1. A gradation from implicate to callidendrous rainforest occurred along Axis 2. Presence/ absence data on all 50 sites produced two main divisions along each axes. Burnt and unburnt sites were separated along the second axis (Figure 5.4). Axis 1 had callidendrous and thamnic sites separated from implicate and thamnic sites, while axis 2 had burnt sites separated from unburnt sites. Unburnt sites using species presence/ absence data were separated into the three rainforest types. Cover data separated unburnt sites along a gradient from implicate to callidendrous. HMDS, using cover data, produced more recognizable patterns related to fire intensity and rainforest type, than patterns related to species presence/ absence data.

Ordinations using HMDS on cover data of burnt sites showed Axis 1 delineating rainforest types and Axis 2 delineating mild and hot fires. This was true for ordinations using both the original rainforest sites and the total number of sites. Interpreting axes from ordinations using species presence/ absence data for burnt sites was more difficult. Each axis appeared to be a combination of fire intensity and rainforest type.

The association between sites, rainforest type and fire intensity was more obvious when using HMDS on cover data. Cover data ordinated using DCA showed some groupings which could be associated with mild and hot fires. Figures 5.6 and

Table 5.2: Homogeneity of plots in rainforest sites; the number of plots in each site grouped together by TWINSPAN analysis. The sites are then grouped by the number of their plots which are classified together, and by rainforest type and fire intensity.

Burn Intensity	Callidendrous sites		Thamnic sites		Implicate sites	
	8-10 plots	5-7 plots	8-10 plots	5-7 plots	8-10 plots	5-7 plots
unburnt sites	2	2	3	0	3	0
mild burn sites	3	2	2	5	2	1
hot burn sites	4	1	4	3	5	1
total sites	9	5	9	8	10	2

Table 5.3: Canonical correlations on environmental and vegetation variables against the DCA scores obtained from rainforest site cover data.

Number	Eigenvalue	Canonical Correlation	Wilks Lambda	Chi-Square	D.F.	Sign. Level
1.0000	0.8273	0.9095	0.0213	128.89	48	0.0000
2.0000	0.6773	0.8230	0.1235	70.06	33	0.0002
3.0000	0.3909	0.6252	0.3828	32.17	20	0.0042
4.0000	0.3716	0.6096	0.6284	15.56	9	0.0766

Coefficients for Canonical Variables of the First Set

rainforest type	-0.3358	-0.4070	0.1539	-0.1850
burn intensity	0.9462	0.1940	0.2095	0.0160
soil type	-0.0907	-0.2171	-0.0136	0.1860
soil pH	-0.0783	-0.1768	-0.6349	0.1740
stag height	-0.0903	0.6091	-0.1029	-0.2310
fertility	0.0416	-0.2089	-0.4672	0.4890
aspect	0.1227	-0.0762	0.1697	0.4910
rock type	0.0739	0.1636	0.2681	0.7140
slope	-0.1211	-0.2140	-0.1623	-0.7030
summer radiatic	-0.0112	-0.2031	0.9081	-0.6770
winter radiation	0.1084	0.1137	0.4833	-0.4250
yearly radiation	0.1705	-0.076	-1.156	0.6120

Coefficients for Canonical Variables of the Second Set

DCA-axis 1	0.6568	-0.3751	0.7130	0.0720
DCA-axis2	0.6322	0.4947	-0.6171	0.3020
DCA-axis 3	-0.2410	0.5918	0.8408	0.1260
DCA-axis 4	-0.1562	-0.3527	0.1080	0.9310

Figure 5.3: A plot of the first two axes produced by HMDS on presence/absence data for the rainforest sites.

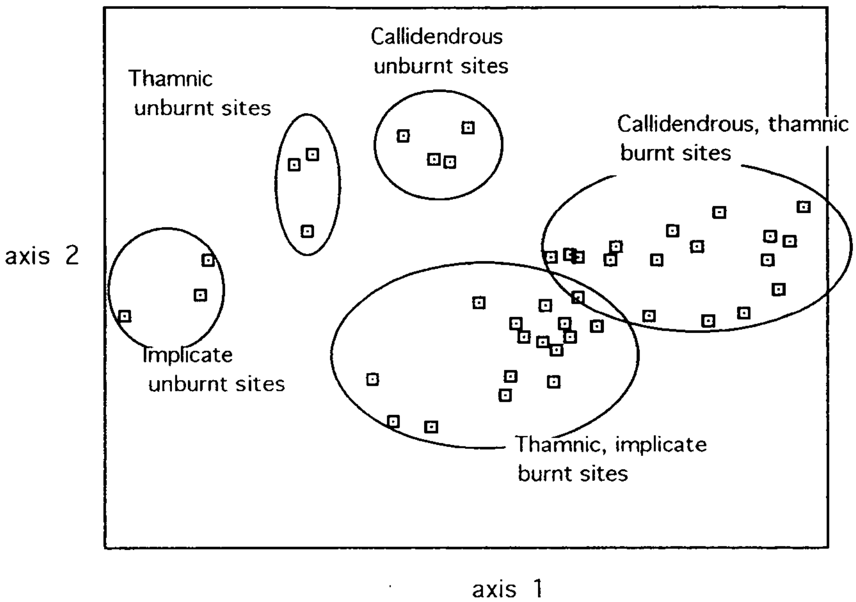


Figure 5.4: A plot of the first two axes produced by HMDS on presence/absence data for all 50 sites.

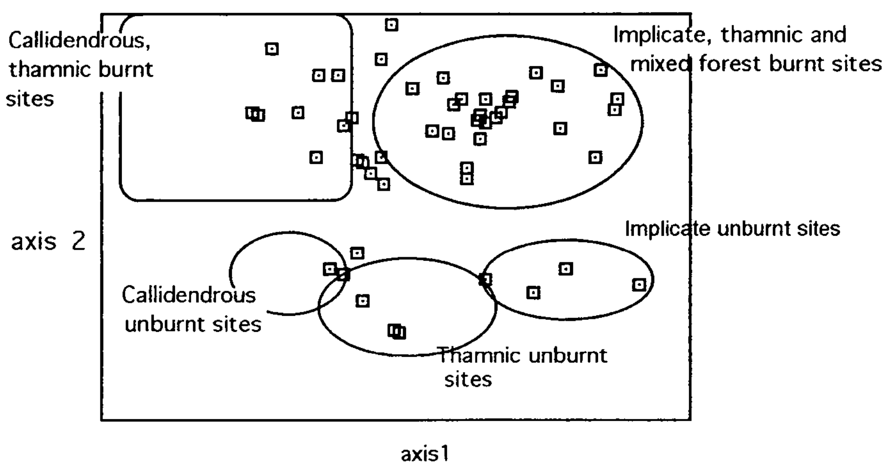


Figure 5.5: A plot of the first two axes produced by DCA analysis on presence/absence data for all 50 sites.

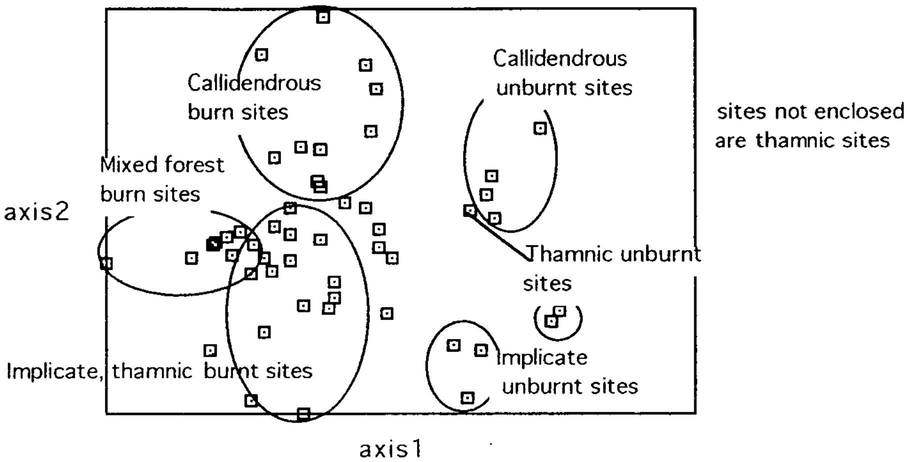


Figure 5.6: The first two axes from ordinations on cover data using DCA analysis for all, 50 sites.

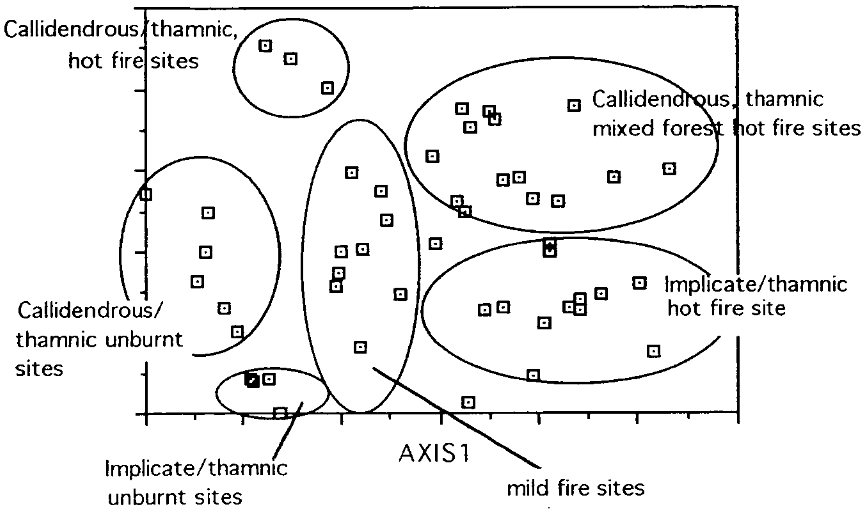
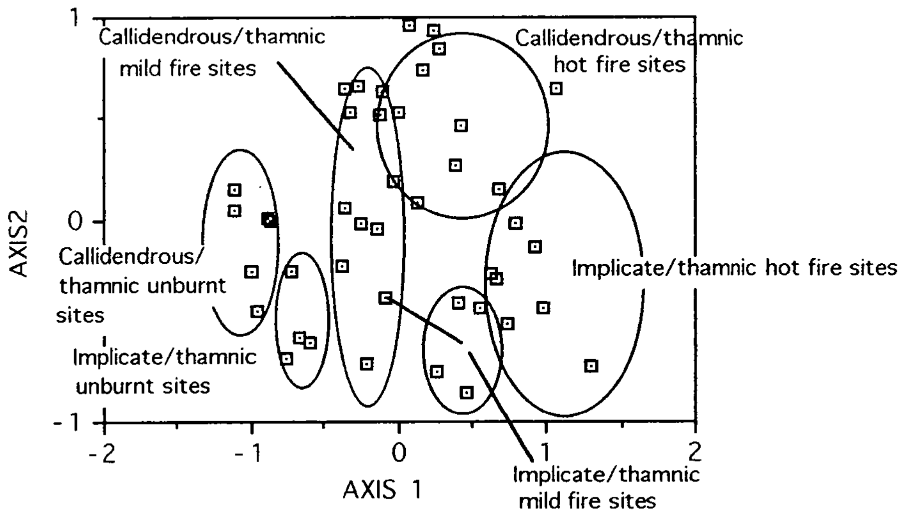


Figure 5.7: The first two axes from ordinations on cover data using HMDS analysis for the rainforests sites.



5.7 show the separation of cover data by DCA and HMDS. Separations of sites into mild and hot fire sites were not obvious from ordinations on presence/ absence data. Species presence or absence on a site was associated with rainforest type, though other factors may also be important. There was a strong association between species cover, fire intensity and rainforest type.

5.3.3 Canonical correlations

Canonical correlation analysis of the seven site variables and the DCA scores were obtained from the rainforest sites' cover data (Table 5.3). The first three canonical correlations were significant. The first set of variables was most heavily weighted by fire intensity and the other variables had only a minor effect. The second set was most heavily weighted by a combination of DCA Axis 1 and DCA Axis 2. This indicated that the trends in floristics relating to fire intensity were oblique to the DCA axes. Rainforest type, though not the highest weighted variable, was prominent in the first two sets of variables. Similar results were obtained from the analysis of the same first set variables against other ordination indices.

Ordinations of cover values plotted against the range of physiographic and vegetation features generally grouped sites by fire intensity or rainforest type (Figure 5.8). Plots of axes from species presence/ absence data generally produced three gradients. Each gradient comprised sites belonging to a particular rainforest type which had unburnt sites and hot fire sites at either end of the gradient (Figure 5.9). These results indicated that rainforest type and fire intensity were probably the most important factors in determining the post-fire vegetation.

5.3.4 Vector Fitting

The vectors with significant correlations were plotted (Table 5.4). The variables which were significant for many of the analyses included rainforest type, fire intensity, radiation index derived from Nunez (1983) for summer, soil fertility on burnt sites, stag height, a combination of BN and NT fertilities and fertility indices based on the bioassay. Rainforest type and stag height were significant for all analyses, although some r values were low especially for stag height (Monte-Carlo significance test: Minchin 1990). Fire intensity was significant for all analyses except for rainforest presence/ absence data for burnt sites.

Similar variables, e.g., the fertility ratings, radiation ratings and seed source/

direction ratings generally had similar directions (Figures 5.10a-d, 5.11a-d). Rainforest type was generally found in a similar position to a fertility rating but was not related to any individual fertility rating. Stag height tended to be associated with BN fertility but not to rainforest type. This may indicate that the components of 'fertility' related to rainforest type were different from those related to stag height. Individual variables relating to soil fertility such as soil type, pH and geology were not significant, indicating the complexity inherent in the broad term 'soil fertility'. The most significant fertility ratings were from the bioassay trial using oats, indicating the usefulness of the bioassay. Fire intensity was not associated with any variables. Although it had a tendency to be close to the seed source ratings and the radiation ratings, this was not constant. The variables used explained some direction of the sites within the ordination cloud.

Rainforest type had the highest r values for the analyses on unburnt presence/ absence data (0.948) and cover data (0.960) and was significant in the other analyses, indicating the importance of this factor. Fire intensity did not have such a good correlation in the analyses of burnt sites only, but still appeared to be an important measure. The variable NunezS was significant for many analyses. The radiation index ridec derived from CLOUDY (Fleming 1971; Fleming and Austin 1983) was also significant for some analyses, indicating that solar radiation during summer had some effect on rainforest composition and possibly fire intensity. Another variable differentiating burnt and unburnt sites was seed source 1, although it was not related to fire intensity.

5.4 DISCUSSION

All of the multivariate techniques used produced similar results. The analyses using HMDS and vector fitting had slightly clearer delineations in trends. The results showed that burnt rainforest was markedly different from unburnt rainforest, both in the presence or absence of species and in the cover of component species. The basis of the majority of divisions produced by the classification procedure was on the presence or absence of sclerophyllous species. The fern *Pteridium esculentum* and the moss *Polytrichum juniperinum* were the major indicators differentiating burnt from unburnt rainforest. This agreed with field observations that burnt rainforest consisted of regenerating rainforest species under a blanket of sclerophyllous species and that the composition of the sclerophyll 'blanket' was different for callidendrous and implicate rainforest.

Figure 5.8: Distribution of sites using the first variable set (environment and vegetation) and second variable set (floristics) produced from canonical correlations as stated in Table 5.3.

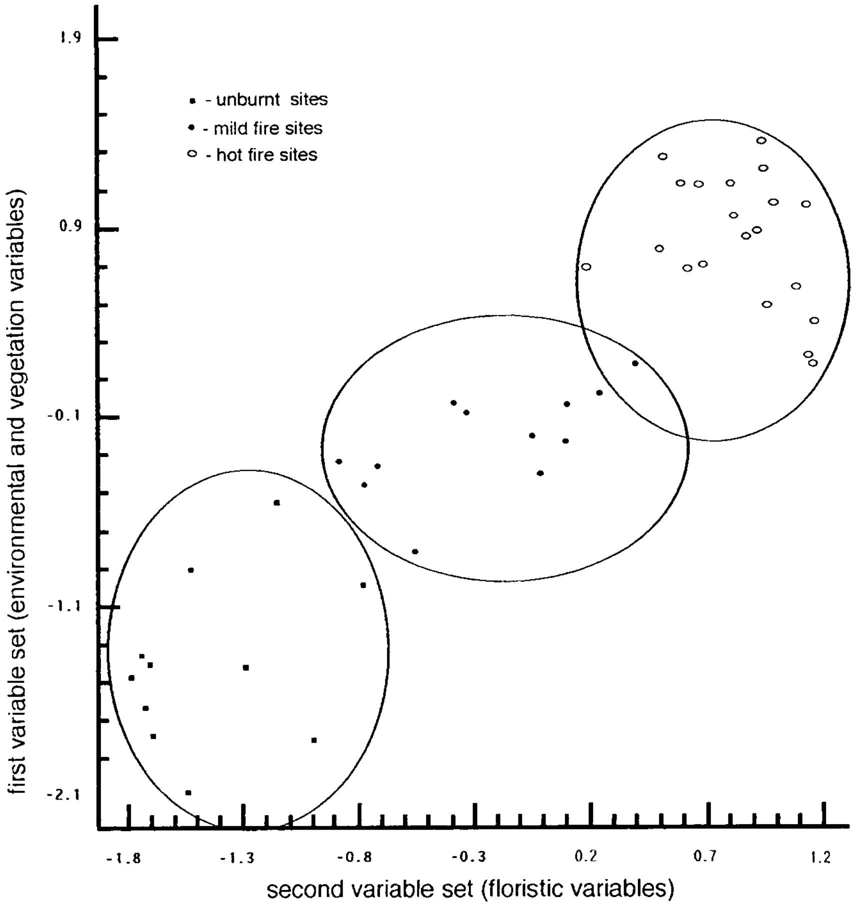


Figure 5.9: Distribution of sites using the first variable sets as described in Table 5.3 against floristic indices obtained by DCA analysis on all sites presence/absence data.

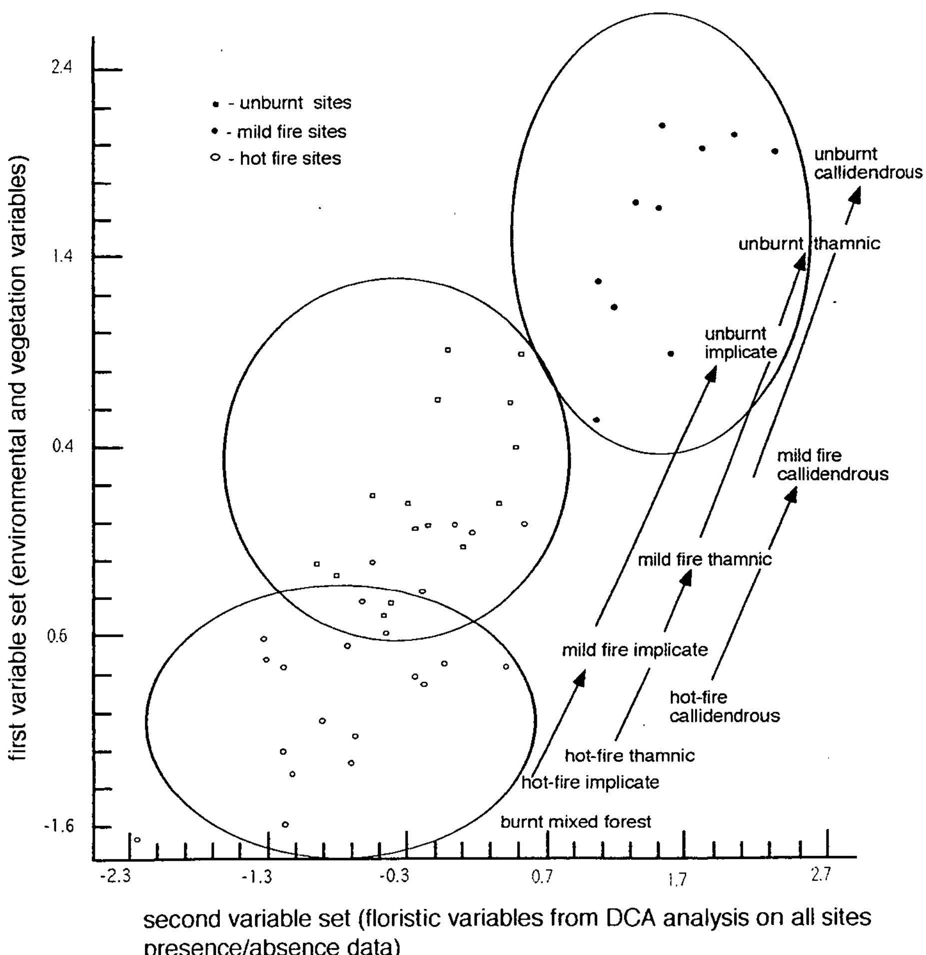


Table 5.4: Results of fitting vectors into the HMDS ordinations. For each HMDS ordination the maximum correlation and its direction cosine for significant vectors, according to the Monte-Carlo significance test, is given.
Stars refer to the significance level assigned by the Monte-Carlo significance test (Minchin 1989).

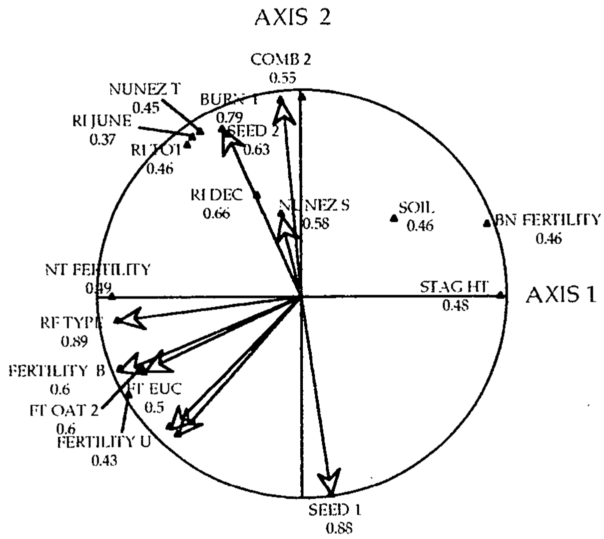
VARIABLE	All sites +/- data	All sites cover data	Rf sites +/- data	Rf sites cover data	burnt sites from All +/- data	burnt sites from Rf +/- data	burnt sites All cover data	burnt sites Rf cover data	unburnt sites +/- data	unburnt sites cover data
RFTYPE	0.84 ***	0.66***	0.82***	0.74***	0.81***	0.67**	0.79***	0.72***	0.99***	0.95**
FIRE INTENSITY	0.79***	0.82***	0.80***	0.83***	0.52**	0.64***		0.62***	UNDEFINED	UNDEFINED
NUNEZ S	0.58***		0.62***	0.54***	0.63***		0.62***			
NUNEZ W									0.64	0.52
NUNEZ T		0.45***							0.55	
SOIL			0.52***						0.57	0.67
PH									0.72	0.53
FERTILITY BURNT#	0.60***		0.71***	0.55**	0.72***		0.75***	0.54*	0.88*	0.96**
FERTILITY UNBURNT#			0.54***		0.52***		0.56***		0.59	0.69
ROCK TYPE#								0.53*	UNDEFINED	UNDEFINED
STAG HT	0.48***	0.59***	0.74***	0.68***	0.66***	0.63***	0.80***	0.70***	0.72	0.69
SEED SOURCE1	0.88***	0.78***	0.92***	0.80***					UNDEFINED	UNDEFINED
COMB1	0.54***		0.57***						UNDEFINED	UNDEFINED
SEEDS SOURCE2	0.63***	0.60***	0.56***	0.60***					UNDEFINED	UNDEFINED
COMB2	0.55***	0.55***	0.52***	0.58***		0.46***			UNDEFINED	UNDEFINED
NT FERTILITY	0.49***		0.57***		0.59***	0.50**	0.64***		0.58	0.81
BN FERTILITY	0.66***	0.53***	0.57***	0.49***	0.69***	0.60**	0.67***	0.58**		
RI JUNE									0.61	0.61
RI DECEMBER			0.69***	0.58***	0.67***		0.68***			
RI TOTAL		0.49***	0.48***	0.49***				0.50*	0.61	0.55
FI EUC	0.50**		0.52***		0.57**	0.53*	0.53*	0.53*	UNDEFINED	UNDEFINED
FI OAT1	0.69***	0.66***	0.69***	0.65***	0.74***	0.65***	0.75***	0.67***	UNDEFINED	UNDEFINED
FI OAT2	0.60***	0.58***	0.60***	0.56***	0.71***	0.61**	0.73***	0.66***	UNDEFINED	UNDEFINED
	KY59B	KY50C	KY43B	KY43C	KY50BB	KY50BC	KY43BB	KY43BC	KYUNBB	KYUNBC

- from land systems (Richley, 1978)

FIGURE 5.10: Vectors of maximum correlation, which are significant according to the Monte-Carlo test within the 3 dimensional HMDS ordination using all 50 sites. Arrors indicate maximum r values greater than 0.5.

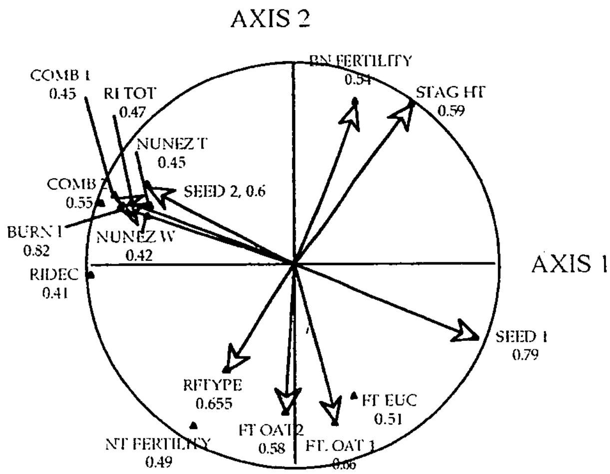
a). axes 1 v 2 of presence/absence data

minimum stress = 0.1734

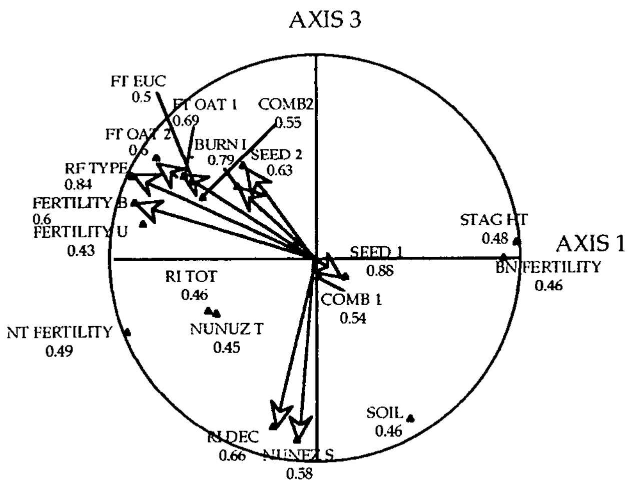


c). axes 1 v 2 of cover data

minimum stress = 0.1449



b). axes 1 v 3 of presence/absence data



d). axes 1 v 3 of cover data

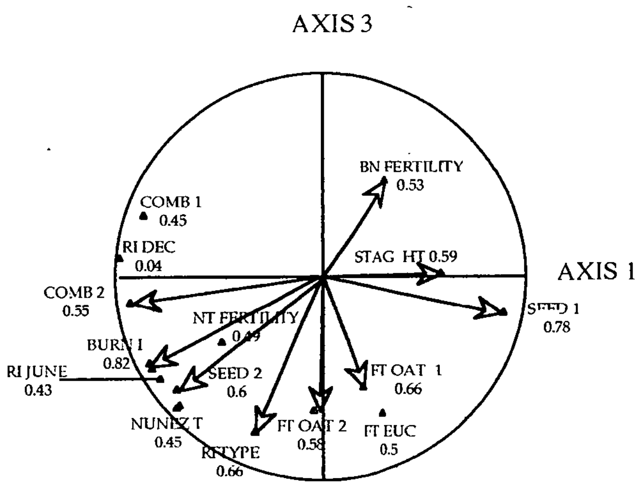
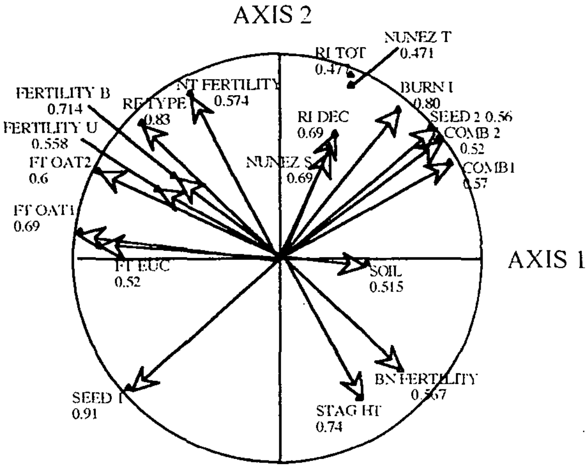
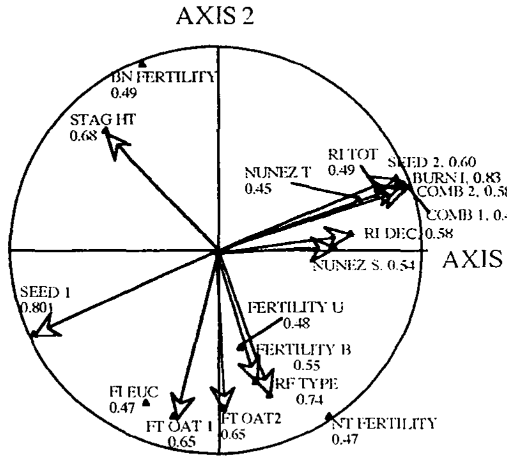


FIGURE 5.11: Vectors of maximum correlation, which are significant according to the Monte-Carlo test within the 3 dimensional HMDS ordination using the 43 rainforest sites. Arrors indicate maximum r values greater than 0.5.

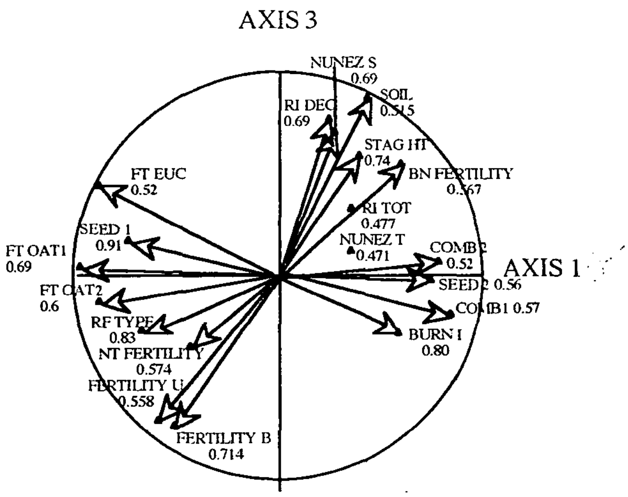
a) axes 1 v 2 of presence/absence data
minimum stress = 0.1577



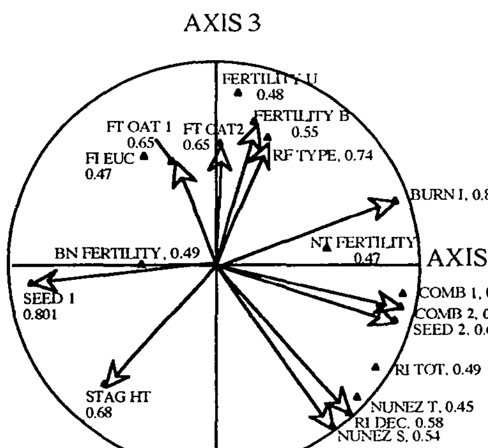
c). axes 1 v 2 of cover data
minimum stress = 0.1535



b) axes 1 v 3 of presence/absence data



d). axes 1 v 3 of cover data



The multivariate techniques indicated the importance of rainforest type in the composition of burnt and unburnt rainforest. Even after fire each rainforest type retained its identity, although how floristically similar this post-fire identity will be to its pre-fire type is not known. The rainforest continuum, as defined by Brown *et al.* (1991), was still evident post-fire, with callidendrous and implicate sites separating at either end of a continuum and thamnic sites scattered between and within them. Generally, the divisions of implicate/ thamnic sites were based on the increase in the species richness of the sclerophyll component in these rainforest types compared with callidendrous/ thamnic sites. Wardle (1984) found similar differences for the rainforest types in the wet beech forest of Tararua, with the more sclerophyllous invader species recorded from burnt forest on poor soils.

Fire intensity appeared to play a role when using cover data, indicating that although it may not affect greatly the composition of species at burnt sites, it did have a large effect on the relative proportions (importance) of species. Other studies, (e.g. Hill, (1982), Hill and Read (1984), Cameron (1979) and Chesterfield *et al.* (1990)), on temperate rainforest within Australia, indicated that fire intensity had a far greater effect, but these studies were comparing small, mild ground creeping fires to major canopy fires. The same large differences were observed in the present study between sites representing these two major extremes. Only one site was comparable to Hill's (1982) mild burn site in fire intensity and proximity to seed source; a small mild spot fire, surrounded by unburnt rainforest. This site was markedly different from other burnt sites in that it lacked *Pteridium esculentum* and other invader species.

The invasion of eucalypts, as described by Cameron (1979) for warm temperate rainforest, was only seen on the margins of burnt rainforest and vegetation containing eucalypts. For eucalypts to establish throughout the area of rainforest that was burnt, a number of fires at suitable intervals would have to occur. Eucalypt establishment in rainforest burnt by the Waratah fire was marginal, even after Australian Forest Holdings, within a year of the fire, had broadcast eucalypt seeds. Species such as *Gahnia grandis*, *Pteridium esculentum* and *Leptospermum* spp. were more obvious.

Mixed forest sites were generally placed into the implicate, thamnic group by both the classification and ordination techniques. The exceptions were ordinations using DCA on presence/absence data. The general placement of the mixed forest sites with the implicate thamnic burnt sites agreed with Hill & Read's (1982) reconstruction of the pre fire vegetation of these sites.

The results from both the ordinations and classifications showed the importance of site specific factors in the division of sites. When trying to determine other factors apart from rainforest type and fire intensity which may have accounted for the distribution of sites using canonical correlations, no one factor became evident, but some became evident using vector fitting. This indicated that many of the factors chosen either had no or only a small effect on site distribution within ordinations, and/ or that the methods used to determine and/or measure these factors were inadequate.

It was evident from the results that soil fertility and solar radiation had a role in determining site distribution, within ordinations, but these roles were hard to define. The importance of soil fertility as indicated by the research of Brown *et al.* (1990) and Jarman *et al.* (1991) was not as apparent in this study. The magnitude of the fire effect may have masked the importance of other variables. Other important factors included soil type (composition), altitude and rainfall. The height of stags was also important but was not related to rainforest type. Structure as well as composition played an important role in determining rainforest type, with callidendrous rainforest being described as tall and park-like and implicate rainforest being described as low in stature (Jarman *et al.* 1984). This indicated that rainforest type was probably more related to differences in composition and stag height to site suitability of the rainforest canopy species.

Fire did have a major effect on rainforest with sclerophyll species dominating burnt areas post fire. Each rainforest type maintained its identity post fire and contained the majority of rainforest species recorded in unburnt areas. The maintenance of rainforest type was due to the component species of vascular plants regenerating after fire and to different groups of invader species favouring certain rainforest types. Thamnic rainforest may have been an exception, with an increase in the number of opportunistic rainforest species (see Chapter 4) and a decrease in soil fertility, making sites, which tended to the implicate end of the gradient, more implicate.

Chapter 6: The Bioassay Trial

6.1 Introduction

The distribution of different rainforest types within Tasmania appears closely related to soil fertility (Jackson 1968). Recent research on the relationship of soils to to rainforest type indicate that soil fertility measured indirectly by geology and topography, may be the most important determinant of rainforest variability (Brown *et al.* 1990; Jarman *et al.* 1991). Callidendrous rainforest occurs on fertile soils, such as those derived from basalt; implicate rainforest occurs on non-fertile soils, such as those derived from siliceous parent materials; and thamnic rainforest occurs on soils with fertilities between the other rainforest types (Richley 1978; Brown et al. 1991). Other factors, such as drainage, also affect rainforest distribution.

The complexity of the interactions between soils and vegetation is enhanced when the effects of fire are also included. Fire, as a result of the degree and duration of soil heating, affects the chemical, physical and biological nature of soils (Rundel 1981). Fire immediately increases the availability of nutrients to plants although more nutrients are lost through volatilization and the leaching of released nutrients out of the root zone (Humphreys & Gray 1981). Formation of a hydrophobic layer, changes in soil pH and soil structure and an increase in soil erosion are all results of fire.

The aims of this trial were:

1. to examine the relationship between rainforest type and soil fertility;
2. to examine the effects of fire on soil fertility;
3. to develop a fertility rating based on the results of the bioassay for all 43 rainforest sites used in the floristic section of this thesis, so that the role of soil fertility, in relation to the ability of each rainforest type to regenerate, could be examined.

6.2 Methods and Analytical Techniques

A subset of the three rainforest types with a burnt or unburnt component was chosen from the existing sites used in the floristic section of this thesis (Table 6.1).

Soil was collected at each site in the centre of the ten 5x5m contiguous plots. Soil was bulked, dried, sieved (0.5cm) and then thoroughly mixed, watered and aerated using a mechanical soil vibrator.

Soil samples were analysed for pH, total organic matter content and particle size at the Forestry Commission, Tasmania. Total P, K, Ca, Mg and Fe were assayed using hot nitric acid extract (Zarcinas & Cartwright 1983); mineralizable N using a hot KCl extract (Gianello & Bremner 1986).; exchangeable Ca, Mg, Na and K using an ammonium chloride extract (Tucker 1974); exchangeable Cu, Fe, Mn and Zn (Hannam & Reuter 1977); exchangeable Al using a calcium chloride extract (Hoyt & Webber 1974); P in sodium hydrogen carbonate extracts of soil (Calwell 1965) and bulk density on ground dry soil (Mikhail & Briner 1978). Analyses were done at the Department of Primary Industry Mt. Pleasant Laboratories, Launceston Tasmania.

For each soil sample, 30 pots (112 x 225mm) were prepared. These were divided into ten pot sub-samples. One sub-sample was potted with one plant per pot of seedlings of the Tasmanian west coast endemic, *Eucalyptus nitida*. Seedlings were grown from seeds collected from Holder's Spur, NW Tasmania. The seeds were sown on 3 November 1989 and transplanted on 9 January 1990. Deaths occurring in the first fortnight were attributed to transplanting and seedlings were replaced. Two sub-samples were planted with oat seeds (*Avena sativa var quamby*), one sub-sample was fertilized with N as oats have a high N requirement (Reuter and Robinson 1986). The fertiliser, Nitram®, which contains 34% Ammonium Nitrate; was added at the manufacturer's recommended rate of 3.6 g per pot when the oat seedlings were five days old. Each pot was then watered thoroughly. This dose was excessive and led to high mortality, especially in soils collected under implicate rainforest. The results of this sub-sample were not analysed.

Seedling height, leaf number and leaf length were measured fortnightly. After 12 weeks seedlings were harvested, dried and weighed.

6.2.1 Statistical Analyses

The dry weight data showed no skewness but had kurtosis and the variances were not equal when data was structured into rainforest type with and without fire, therefore, the results were analysed using the generalized linear model (GLM) technique. GLM allows the relationships between dependent variables and independent variables to be non linear so non-linear independent variables, such as rainforest type, can be used. GLM also allows the use of data that does not conform strictly to the criteria necessary for ANOVA and regression analysis (McPherson 1990).

To determine if means of individual treatments were significantly different from each other the Scheffe test was undertaken. Although the Scheffe test is conservative, it was suitable for the type of data used.

The relationships between soil variables and oat and eucalypt dry weights were analysed using forward and stepwise model multiple regression procedures. Both the forward and stepwise model procedures add independent variables which significantly explain the dependent variable. These model procedures are similar and start with the same number of variables, those which meet the 0.5 significance level, but the stepwise model removes any independent variable which in combination with the other variables does not explain a significant amount of variance. The forward model contains all initial significant independent variables.

6.3 Results and Discussion

A summary of the sites used, soil type and geology is presented in Table 6.1, with the results of the soil analysis in Table 6.2. The dry weight data for *E. nitida* and *Avena sativa.* is shown in Table 6.3.

GLM's for both the eucalypt and oat dry weight data showed that rainforest type, the presence and intensity of fire and the interaction of these two factors were highly significant (Tables 6.4 & 6.5). Examination of the interactions showed that the callidendrous mild-fire treatment was the major cause of the significance of rainforest type, the presence and intensity of fire for both the eucalypt data (Tables 6.6 & 6.7) and oat data (Tables 6.8 & 6.9). This treatment had plant weights up to 10 times greater than other treatments (Table 6.3). The callidendrous hot-fire treatment, for the oat data only, was also significantly higher than all other treatments except for the callidendrous mild-fire. The other significant differences for both the oat and eucalypt data were between individual treatments: for the oat data the implicate mild-fire treatment was significantly higher than the implicate hot-fire treatment (Table 6.9); and for the eucalypt data, thamnic unburnt and implicate unburnt treatments were significantly lower than the thamnic hot-burn treatment (Table 6.7).

The results from the multiple regressions on soil variables against the dry weights indicated that the major influence on both eucalypt and oat biomass was cation balance. There were no deficiencies in any of the macro nutrients.

Soil variables which had a positive effect on the oat biomass forward model were

Table 6.1: Sites used in the Bioassay with their soil and geology type.

Site Number	Rainforest Type	Unburnt/Burnt Fire Intensity	Soil Type	Geology
19	Callidendrous	unburnt	clay loam	Tertiary sand, silt and clay
23	Callidendrous	hot fire	clay loam	Tertiary sand, silt and clay
43	Callidendrous	unburnt	clay	Cambrian greywacke (chert or basalt)
42	Callidendrous	mild fire	clay	Cambrian greywacke (chert or basalt)
8	Thamnic	unburnt	sand/loamy sand	chlorite muscovite quartz shitz
6	Thamnic	mild fire	organic sandy loam	chlorite muscovite quartz shitz
26	Thamnic	unburnt	sandy clay	chlorite muscovite quartz shitz
25	Thamnic	hot fire	sandy clay	chlorite muscovite quartz shitz
4	Implicate	unburnt	loamy sand	chlorite muscovite quartz shitz
3	Implicate	hot fire	clay	chlorite muscovite quartz shitz
14	Implicate	unburnt	sandy clay	chlorite muscovite shitz
15	Implicate	mild fire	loamy sand	leached area within an amphibolite band

Table 6.2: Results from the soil analysis.

Site Number	loss on ignition %	pH	Sand %	Silt %	Clay %	Mineralizable N (ppm)	Hot nitric acid extract P %	K %	Ca %	Mg %	Fe ppm
19	31	4.2	89	5	6	67	0.048	0.014	0.011	0.049	1342
23	31	5.7	89	6	5	59	0.043	0.019	0.117	0.046	1287
43	22	4.6	71	16	13	73	0.053	0.038	0.068	0.117	1257
42	25	5	75	9	16	59	0.086	0.04	0.087	0.119	1314
8	17	5.2	95	3	2	64	0.103	0.006	0.22	0.092	1327
6	41	4.4	89	9	2	34	0.008	0.027	0.056	0.032	556
26	16	4.8	80	5	15	89	0.039	0.039	0.079	0.091	1234
25	14	6.3	70	16	15	38	0.014	0.078	0.06	0.357	1228
4	13	4.6	93	5	2	31	0.006	0.012	0.027	0.023	358
3	14	4.8	87	11	3	22	0.007	0.012	0.048	0.025	459
14	12	4.5	87	8	5	21	0.005	0.007	0	0.014	641
15	33	3.9	94	4	2	71	0.008	0.004	0.095	0.047	296

Site	Ammonium chloride extract				DTPA analysis (ppm)			CaCl extract	Bulk Density
Number	Ca ppm	Mg ppm	Na ppm	K ppm	Cu	Mn	Zn	Al ppm	g/cc
19	198	225	143	167	1.03	3.02	2.13	7.77	0.82
23	1212	322	98	251	1.74	5.19	3.49	1.03	0.67
43	868	462	107	283	3.35	41.3	3.68	1.38	0.67
42	767	184	92	331	0.75	15.9	1.13	3.74	0.7
8	1646	782	127	203	0.56	166	4.73	0.04	0.69
6	542	272	99	170	1.36	4.4	6.9	1.88	0.65
26	802	328	111	201	3.7	7.3	3.28	6.71	0.44
25	578	189	76	363	4.15	33.2	5.94	1.55	0.66
4	530	282	91	181	0.84	631	4.16	1.34	0.66
3	827	246	68	104	0.87	16	4.61	0.96	0.66
14	89	101	56	134	0.95	2.58	2.94	6.62	0.78
15	1512	716	139	170	1.93	7.99	10.2	1.05	0.46

Table 6.3: **Mean whole plant dry weights (gm) and standard errors for oat and e**

		OAT DATA			EUCALYPT DATA	
Site Number	Sample Size Oats	Mean Oat Dry Weight	Standard Error Oats	Sample size Eucalypts	Mean Eucalypt Dry Weight	Standard Error Eucalypt
19	10	0.291	0.1232	10	0.852	0.0137
23	10	0.922	0.0766	10	0.155	0.0283
43	10	0.643	0.1113	10	0.146	0.0205
42	10	1.681	0.0924	10	1.311	0.0911
8	10	0.615	0.0497	10	0.107	0.0111
6	10	0.329	0.0161	10	0.061	0.0051
26	10	0.417	0.0775	10	0.108	0.0176
25	10	0.586	0.1581	10	0.263	0.0522
4	10	0.338	0.0201	3	0.071	0.0119
3	10	0.62	0.0358	10	0.174	0.0254
14	10	0.281	0.0289	7	0.099	0.0061
15	10	0.201	0.0221	10	0.091	0.0128

Table 6.4: **Summary of results from the Generalized Linear Model on eucalypt dry weights by rainforest type and fire intensity.**

Source	DF	Sum of Squares	Mean Square	F value	Pr>F
Model	8	13.46	1683	146.34	0.0001
Error	111	1.28	0.0115		
Corrected total	119	14.74			

Mean Total weight = 0.2118 r 2= 0.9134 C.V.= 50.624 mse=0.107

Source	DF	Type 1 SS	Mean square	F value	Pr>F	Type 111 SS	DF	Mean Square	F value	Pr>F
rainforest type	2	2.655	1.327	115.4	0.0001	3.488	2	1.744	151.6	0.0001
unburnt/burnt	1	1.944	1.944	169.1	0.0001		0			
fire intensity	1	1.764	1.764	153.4	0.0001	1.764	1	1.764	153.4	0.0001
rftypeXburnt	2	1.932	0.966	84	0.0001		0			
rftypeXfire intensity	2	5.17	2.585	224.8	0.001	5.17	2	2.585	224.8	0.0001

Table 6.5: **Summary of results from the Generalized Linear Model on oat dry weights by rainforest type and fire intensity.**

Source	DF	Sum of Squares	Mean Square	F value	Pr>F
Model	8	16.6	2.075	48.35	0.0001
Error	100	4.2	0.042		
Corrected total	108	20.8			

Mean Total weight = 0.591 r 2= 0.798 C.V. = 34.672 mse=0.205

Source	DF	Type 1 SS	Mean square	F value	Pr>F	Type 111 SS	DF	Mean Square	F value	Pr>F
rainforest type	2	5.821	2.91	69.23	0.0001	7.319	2	3.66	87.05	0.0001
unburnt/burnt	1	2.534	2.534	60.29	0.0001	0	0	0		
fire intensity	1	1.292	1.292	30.73	0.0001	1.251	1	1.251	29.75	0.0001
rftypeXburnt	2	4.571	2.286	54.37	0.0001	0	0			
rftypeXfire intensity	2	2.38	1.19	28.3	0.0001	2.38	2	1.19	28.3	0.0001

Table 6.6: **Scheffe's test on eucalypt mean weights for treatments; rainforest type and unburnt/burnt.**
significance levels: *=0.05, **=0.005, ***=0.0005

Treatments	CU	CB	TU	TB	IU	IB
Calli x Tham unburnt (CU)	-	***	NS	NS	NS	NS
Calli x Tham burnt (CB)		-	***	***	***	***
Thamnic unburnt (TU)			-	NS	NS	NS
Thamnic burnt (TB)				-	NS	NS
Implicate unburnt (IU)					-	NS
Implicate burnt (IB)						-

Table 6.7: **Scheffe tests on eucalypt mean weights between treatments; rainforest type, burnt/unburnt and fire intensity.**
significance levels: *=0.05, **=0.005, ***=0.0005

Treatments	CU	CM	CH	TU	TM	TH	IU	IM	IH
Calli x Tham unburnt (CU)	-	***	NS	NS	NS	NS	NS	NS	NS
Calli x Tham mild-fire (CM)		-	***	***	***	***	***	***	***
Calli x Tham hot-fire (CH)			-	NS	NS	NS	NS	NS	NS
Thamnic unburnt (TU)				-	NS	NS	NS	NS	NS
Thamnic mild-fire (TM)					-	*	NS	NS	NS
Thamnic hot-fire (TH)						-	*	NS	NS
Implicate unburnt (IU)							-	NS	NS
Implicate mild-fire (IM)								-	NS
Implicate hot-fire (IH)									-

Table 6.8: **Scheffe's test on oat mean weights for treatments; rainforest type and unburnt/burnt.**
significance levels: *=0.05, **=0.005, ***=0.0005

Treatments	CU	CB	TU	TB	IU	IB
Calli x Tham unburnt (CU)	-	***	NS	NS	NS	NS
Calli x Tham burnt (CB)		-	***	***	***	***
Thamnic unburnt (TU)			-	NS	NS	NS
Thamnic burnt (TB)				-	NS	NS
Implicate unburnt (IU)					-	NS
Implicate burnt (IB)						-

Table 6.9: **Scheffe tests on oat mean weights between treatments; rainforest type, burnt/unburnt and fire intensity**
significance levels: *=0.05, **=0.005, ***=0.0005

Treatments	CU	CM	CH	TU	TM	TH	IU	IM	IH
Calli x Tham unburnt (CU)	-	***	**	NS	NS	NS	NS	NS	NS
Calli x Tham mild-fire (CM)		-	*	***	***	***	***	***	***
Calli x Tham hot-fire (CH)			-	***	***	NS	***	NS	***
Thamnic unburnt (TU)				-	NS	NS	NS	NS	NS
Thamnic mild-fire (TM)					-	NS	NS	NS	NS
Thamnic hot-fire (TH)						-	NS	NS	NS
Implicate unburnt (IU)							-	NS	NS
Implicate mild-fire (IM)								-	*
Implicate hot-fire (IH)									-

clay, Mg, Ca, bulk density and sand: K, Cu, Al, Fe and Mn had a negative effect (Tables 6.10 & 6.11). The important variables, in order, were K, Cu, clay and Al. Only these variables were used in the final stepwise model. These results supported the importance of cation exchange. The negative K value indicated that there was excess K which is known to reduce considerably the amount of other cations a plant is able to absorb. This explained in part the inclusion of Mg, Ca and clay in the model (Russel 1973; Ulrich & Ohki 1966). The other negative soil variables were the ions Cu, Al and Mn. The solubility of these ions increased with an increase in soil acidity (Pratt 1966; Reuther & Labanauskas 1966; Labanauskas 1966). An increase in acidity can be produced by the replacement of Ca and Mg ions with H^+ ions (Chapman 1966a; Embleton 1966; Russel 1973). Although, an increase in acidity is known to reduce the solubility of Ca and Mg, it does increase the relative availability of Fe (Wallihan 1966). The inclusion of clay in the model could be related to water stress, but this was unlikely as the pots were watered every second day to field capacity. A likely explanation of the positive clay value was that an increase in clay content led to an increase in colloidal soil particles for cation exchange (Russel 1973). The inclusion of bulk density in the model was likely to be a function of clay content.

The forward multiple regression model for the eucalypt data was similar to the oat data. Positive soil variables were Ca, Zn, Na, bulk density and clay with Cu, Mn, Al and pH being negative soil variables (Tables 6.12 & 6.13). The final stepwise model included all the above soil variables, except pH and Na. A lowering of soil pH decreased the solubility of some elements such as Mg, Ca, Zn and Na, whereas the solubilities of other elements such as Al, Mn and Cu were increased (Pratt 1966; Chapman 1966a&b; Reuther 1966; Walliham 1966; Embleton 1966; Labanauskas 1966; Russell 1973). This meant that plants may have become deficient in the less soluble ions in acidic soils, whereas the soluble ions may have reached toxic levels.

Soil structure, composition and microflora would have been altered while collecting and processing the soil samples. The removal of soil from the field removed all surrounding influences which would have affected plant growth. Drying of the soil prior to mixing would have produced a flush of humus decomposition, thereby increasing the amount of available nutrients (Russel 1973). Mixing and potting the soil would have altered soil structure. Since all soils collected underwent the same processing it is assumed that the underlying soil fertility would still be apparent.

Biomass of oats and eucalypts grown on unburnt soil from the three rainforest types were not significantly different, thereby indicating that there were no differences

Table 6.10: Results of the Multiple Regression on soil variables against the dependant variable, oat dry weight. Only the soil variables which met the 0.5 significance level were used for the model.

VARIABLE	PARAMETER ESTIMATE	STANDARD ERROR	TYPE 11 SUM OF SQUARES	F	PROB>F
Intercept	-3.355	1.0053	0.00631	11.41	0.1854
Ca %	8.049	0.8581	0.04989	87.98	0.0676
Mg %	0.059	0.2052	0.00005	0.08	0.8221
Cu (PPM)	-0.142	0.0349	0.00935	16.5	0.1537
Mn (PPM)	-0.0079	0.0005	0.11504	202.89	0.0446
K (PPM)	-0.003	0.0005	0.0197	34.79	0.1069
Bulk Density g/cc	3.082	0.5394	0.0185	32.65	0.1103
Al (PPM)	-0.1139	0.01177	0.0532	93.77	0.0655
Fe (PPM)	-0.0002	0.0001	0.00264	4.66	0.2762
Sand %	0.0223	0.0078	0.0046	8.13	0.2147
Clay %	0.1468	0.017	0.0423	75.57	0.0734

Table 6.11: Model produced from the Multiple Regression on soil variables against the dependant variable, oat dry weight.

STEP	VARIABLE ENTERED	PARTIAL R SQUARED	MODEL R SQUARED	F	PROB>F
1	K (PPM)	0.3846	0.3846	6.2491	0.0315
2	Cu (PPM)	0.2824	0.667	7.6322	0.022
3	Clay %	0.1133	0.7803	4.1271	0.0767
4	Al (PPM)	0.0992	0.8796	5.7687	0.0473
5	Mg (PPM)	0.0287	0.9083	1.8779	0.2196
6	Fe (PPM)	0.0125	0.9208	0.7915	0.4144
7	Mn (PPM)	0.0369	0.9577	3.4919	0.135
8	Ca (PPM)	0.0271	0.9848	5.3502	0.1037
9	Bulk Density g/cc	0.0123	0.9971	8.5602	0.0997
10	Sand %	0.0026	0.9997	8.1335	0.2147

Table 6.12: Results of the Multiple Regression on soil variables against the dependant variable, eucalypt dry weight. Only the soil variables which met the 0.5 significance level were used for the model.

VARIABLE	PARAMETER ESTIMATE	STANDARD ERROR	TYPE 11 SUM OF SQUARES	F	PROB>F
Intercept	0.7057	0.026047	0.000273	734	0.0235
Ca %	1.3604	0.126872	0.00427	11497	0.0059
Cu (PPM)	-0.2832	0.001473	0.013715	36931	0.0033
Mn (PPM)	-0.0021	0.000018	0.004764	12829	0.0056
Zn (PPM)	0.0251	0.000877	0.000304	818	0.0222
Ca (PPM)	0.0003	0.000004	0.00149	4011	0.0101
Na (PPM)	0.0004	0.000021	0.000148	399	0.0319
Bulk Density g/cc	1.5966	0.025582	0.001446	3895	0.0102
Al (PPM)	-0.0476	0.000496	0.003404	9166	0.0066
Clay %	0.09	0.000158	0.121806	327986	0.002
pH	-0.3982	0.009076	0.000715	1925	0.0145

Table 6.13: Model produced from the Multiple Regression on soil variables against the dependant variable, eucalypt dry weight.

STEP	VARIABLE ENTERED	PARTIAL R SQUARED	MODEL R SQUARED	F	PROB>F
1	Clay %	0.3163	0.3163	4.626	0.057
2	Cu (PPM)	0.4633	0.7797	18.92	0.0018
3	Zn (PPM)	0.1389	0.9186	13.65	0.0061
4	Al (PPM)	0.0422	0.9608	7.52	0.0288
5	Mn (PPM)	0.02	0.9808	6.27	0.0463
6	Ca %	0.0129	0.9937	10.23	0.024
7	Bulk Density g/cc	0.0045	0.9982	10.32	0.0325
8	Ca (PPM)	0.0007	0.999	2.17	0.2374
9	pH	0.0009	0.9999	16.27	0.0563
10	Na (PPM)	0.0001	1	398.63	0.0319

in soil fertility between rainforest types, or that some other factor was playing an important role in the plant growth of the two trial species. Other factors which may have had an affect included composition and density of beneficial and antagonistic soil microflora and the specific nutrient requirements of *A. sativa* and *E. nitida*. Many Tasmanian *Eucalypt* species have died prematurely when a rainforest understorey grew beneath them. This was due to the increasing rainforest component changing the composition of the soil microflora (Ellis 1985). Fire altered the composition of soil microflora by heating and drying the soil, and could be the reason for the large growth of these two species in the mild fire callidendrous treatment. The increase in soil heating in the hot-fire callidendrous treatment would have further changed both soil nutrient levels and microflora, favouring the growth of *A. sativa* but not *E. nitida*.

These data indicated that rainforest type coupled with the presence of fire and fire intensity influenced soil fertility, but that was limited to callidendrous rainforest: a mild fire on Cambrian greywacke soil, produced much larger growth rates than the other soil types and heat regimes. The implicate and thamnic sites soils, which were mainly derived from chlorite muscovite quartz shitz, showed no major significant changes for any treatment. Although these results may give some credence to the idea that soil fertility is related to rainforest type, the small sample size could have biased the results.

Changes in the soil due directly to fire may be beneficial to the growth of rainforest species and especially non-rainforest species. However the increase in light and heat reaching ground level due to canopy loss after fire is probably more beneficial to non-rainforest and some rainforest species' germination and growth.

The production of soil fertility indices from these data was possible, although they will be extremely simplistic. These indices were likely to represent the growth of non-rainforest species as the majority of rainforest species appear to grow readily in soil under rainforest if there is enough light reaching the ground as in canopy gaps.

6.3.1 Fertility Indices

Indices derived from the *E. nitida* results were:

FTEUC:

1. callidendrous mild burn
2. the other treatments.

Two indices based on the oat data were produced:

The first set of indices

FTOAT1

1. callidendrous mild burn
2. callidendrous hot burn
3. the other treatments.

The second set of indices

FTOAT2

1. callidendrous x mild burn
2. callidendrous hot burn
3. thamnic hot burn and implicate mild burn
4. the other treatments

This trial gave limited support to the idea that rainforest type was related to soil fertility, although other factors such as soil micro flora and fauna were also important. The soil analysis results indicated that with the exception of K, which appeared in excess for the oat data, no other macronutrient was important. The important factor related to plant growth was cation exchange, with some cations, such as Cu, Al, Mn and K negatively related and some, Ca, Mg and Zn, positively related. Other factors relating to colloidal activity, such as clay and bulk density, were also important. Some rainforest species were known to be Al accumulators, *Anodopetalum biglandulosum* and *Phyllocladus aspleniifolius* (Webb 1954), but the Al amounts showed no distinct trend and could not be easily related to rainforest type or the presence and intensity of fire.

Fertility indices could be defined, but their usefulness is unknown mainly due to their simplicity.

CHAPTER 7: DISCUSSION

7.1 The Savage River and Waratah Fires

The Savage River fire burnt an extensive area of rainforest. Only a few days of extremely hot temperatures and low humidities enabled the rainforest in Savage River and Waratah to burn. The overall weather conditions during February 1982 were not extreme and the temperature, evaporation and rainfall measurements were average to below average (Table 2.2). Although the soil dryness index (SDI) value for the week of the Savage River fire was high, it had not reached the west coast critical level of 50 (Mount pers. comm.). High temperatures coupled with low humidities are not common on the west coast and only occur a few times in any year (Table 2.2).

The Savage River fire did not burn uniformly. There were a variety of fire intensities and burn types, including peat and understorey burns, canopy fires and scorching. The fires under review generally appeared to burn at ground level, though some crowning did occur. Different rainforest types may have had different burning patterns: callidendrous rainforest is tall and 'park-like' having fuel at ground and crown level; implicate rainforest has no delineation between canopy and understorey layers and so fire may burn throughout the vegetation; thamnic rainforest is intermediate and will burn according to vegetation density.

The variety of burning patterns produced a mosaic of seed beds as well as patches of surviving rainforest species. The survival of rainforest species, either intact or as sprouts, would decrease the time needed to produce a rainforest seed pool and may have had a major effect on rainforest regeneration.

This study dealt mainly with a large-scale rainforest fire: spot fires in extensive rainforest appeared to produce a different pattern of regeneration.

7.2 Post-fire species composition

With the exception of *Notalaea ligustrina* and two ferns, *Hymenophyllum marginatum* and *H. peltatum*, all vascular rainforest species recorded in unburnt sites were also recorded in burnt sites. Some rainforest species, e.g., *Richea pandanifolia*, were recorded only in burnt sites. A large number of non-rainforest species was recorded in burnt rainforest and there was an increase in the number of species which occur in, but are not restricted to rainforest. Some weed species were recorded in burnt sites, but they were scarce.

The dominant vascular species in the burnt sites were *Pteridium esculentum, Leptospermum scoparium* and *Gahnia grandis*. *L. scoparium* and *G. grandis* were also found in unburnt implicate rainforest. Spore production by *P. esculentum* was prolific and wind-born, so colonization of suitable areas by this species will occur even when no spore source was evident. *L. scoparium* seeds, being small-winged, wind-dispersed and able to colonize large areas. *G. grandis*'s small dark seeds were dispersed by birds.

The dominant ground covers in burnt sites were the liverwort, *Marchantia berteroana*, and moss, *Polytrichum juniperinum*. Density of these two species may have had an important effect on seedling germination and initial growth of rainforest species. Dense 'mats' of either species may have prevented germination as they grew over seedlings (personal observation).

Floristic analyses using ordination and classification indicated that rainforest type and burn intensity were the most important factors in determining the composition of post-fire vegetation. However other factors such as light radiation and soil type played a role.

The importance of both rainforest type and fire intensity was highlighted by their effects on the density and composition of the post-fire 'invader' species and the rainforest species recorded.

Non-rainforest species composition differed between rainforest types post-fire. The density of *Pteridium esculentum* was greatest in callidendrous rainforest. *G .grandis* and *L. scoparium* reduced the dominance of *P. esculentum* along a gradient from callidendrous to implicate rainforest. Species such as *Acacia melanoxylon* and *Senecio minimus* were associated mainly with callidendrous burnt sites, while *Phebalium squameum* and *Polytrichum juniperinum* were common in implicate sites.

Differences in the proportions of dominant species and other non- and doubtful-rainforest species may have reflected soil fertility. *P. esculentum* appeared to dominate fertile sites. Its dominance diminished as the soil became less fertile. Other factors affecting post-fire species composition included seed pool composition and density, differences in fire intensities, or a combination of these and other factors.

7.2.2 *Rainforest species*

The importance values and covers for the majority of rainforest species were significantly lower in burnt sites than in unburnt sites. The four rainforest canopy species in this study all showed adequate regeneration, though many individuals in the burnt sites were small seedlings (especially *Atherosperma moschatum*) and their survival to maturity is unknown.

Rainforest understorey species, with the exception of some fern species, were regenerating in burnt sites. The most fire susceptible understorey dicotyledonous species appeared to be *Archeria eriocarpa, A. hirtella* and *Trochocarpa gunnii.* Small ferns and other moisture-dependent species appeared to be highly susceptible to fire.

The fern species which were absent from burnt sites were *Hymenophyllum marginatum* and *H. peltatum*. Other members of *Hymenophyllum* were scarce in burnt sites. When recorded, they were found only in damp micro-habitats, such as moist logs. This was also the case with *Tmesipteris billardieri* and *Polyphlebium venosum*. The larger fern species, with the exception of *Grammitis billardieri,* had increased, or had similar numbers of individuals in burnt and unburnt sites. *Histiopteris incisa* and *Hypolepis rugosula*, species associated with rainforest canopy gaps, had increased their density post-fire.

Seeding was the main regeneration method for both rainforest and non-rainforest species, though sprouting was an important regeneration method for many rainforest species. Eleven rainforest tree and shrub species were observed sprouting during this study and a number of fern species have been observed sprouting by other researchers (S.J. Jarman pers. comm). Sprouting of rainforest species occurred mainly in implicate rainforest, with callidendrous rainforest having the lowest recordings. An exception was *A. moschatum*. Sprouting was more prevalent in mild fire sites than hot fire sites.

Sprouting is advantageous when competing with other plants for nutrients, water and light, as the sprout already has a well developed root system. Sprouting enables a plant to reach sexual maturity earlier than if seeded. This can aid rainforest species in returning to their pre-fire density and building up their seed banks.

The ability of some rainforest species to sprout after fire does not indicate that sprouting by these species is a response to frequent fires. Instead, it probably reflects their method of vegetative regeneration occurring under a closed rainforest canopy (Read and Hill 1985, 1988). Minimum time since previous fires, for all rainforest types in the study area, indicated that frequent fires, necessary to promote sprouting as a fire response as per Howard (1973), did not occur.

The only canopy species which flowered during the study, and was not an intact survivor, was a sprout of *Eucryphia lucida*. Some rainforest understorey species such as sprouts of *Anopterus glandulosus*, *Cenarrhenes nitida* and seedlings of *Cyathodes glauca* were flowering during the study.

7.3 Threats to Regenerating Rainforest

7.3.1 *Flammability of post-fire vegetation*

In general, rainforest species in burnt sites were under a blanket of non- and doubtful- rainforest species. The outward appearance of the burnt rainforest was a dense scrub or bracken field. The post-fire scrub eight years after the fires was highly flammable. Many of the 'invaders', such as *P. esculentum*, were fire weeds able to colonize burnt areas and also able to survive further fires. These species, unlike rainforest species, reach maturity, produce seeds/spores quickly and generally have a relatively short life span. Species such as *P. esculentum* will also sprout after fire.

Recently burnt rainforest contains a large component of sclerophyllous species and therefore is more pyrogenic than mature rainforest. This sclerophyllous element will also burn in milder conditions than those that allow a large scale rainforest fire. It is commonly accepted that rainforests will not burn until the SDI approaches 50, whereas ecotonal scrub can burn when SDI levels are as low as 25.

A second fire will lower the existing number of regenerating rainforest species and remove species which have not seeded, thereby limiting the establishment of a rainforest seed bank. Additional research examining rainforest seed banks both in unburnt and burnt rainforest, yielded only one rainforest vascular germinant, *Phebalium squameum* (Appendix 8). The main germinants were bryophytes, liverworts, ferns and some doubtful rainforest species. This was similar to Melick & Ashton's (1991) results in warm temperate rainforest in Victoria.

Seeds of temperate rainforest species do not appear to be long lived. Existing survivors and sprouts have a high probability of being killed if a second fire occured in the regenerating forest. Burnt regenerating rainforest must rely almost solely on large patches of unburnt rainforest as a seed source. Increased fire frequency in regenerating rainforest would result in a more flammable vegetation, with the rainforest component being lowered after each subsequent fire, and an increase in the time taken for regeneration to mature rainforest. Therefore, the greatest threat to regenerating rainforest is further fire, this is in line with Jackson's (1968) 'ecological drift model'.

7.3.2 *Phytopthora cinnamomi*

Recently burnt rainforest offers suitable conditions for the soil-borne pathogen *Phytopthora cinnamomi*. This fungus has been isolated from 39 indigenous rainforest species (Podger and Brown 1989). *P. cinnamomi* requires soil temperatures above 15°C to establish and removal of forest canopy by fire allows the soil to reach this temperature. Canopy closure will lower the soil temperature and prevent the spread of the fungus. Canopy closure may take two to three years in regenerating callidendrous lowland forest and up to 20 years in implicate rainforest at elevations above 500 m (Podger and Brown 1989). Further fires will permit the spread of *P. cinnamomi*.

7.3.3 *Exotic species*

Weed species in this study were few and individuals scarce, though further fires may allow the widespread introduction of more weed species. *Cortaderia richardii* (toetoe), *Ulex europaeus* (gorse), *Sarothamnus scoparius* (English broom) and *Genista monspessulana* (Canary broom) are found on the west coast and may actively invade burnt rainforest and be serious competitors for nutrients and water.

7.4 Time required for Cool Lowland Temperate Rainforest to regenerate.

The time necessary for complete regeneration of rainforest burnt in the 1982 Savage River and Waratah fires is uncertain. It is dependent on rainforest seedlings and sprouts already present, reaching maturity, and the death of non-rainforest species. Large areas of burnt cool temperate rainforest have a successional pathway with several seral stages. These stages include initial colonization by bryophytes, liverworts, invader species and seedlings and sprouts of rainforest species. The herb layer diminishes under the canopy of invader species, which also inhibits further germination of invader and doubtful rainforest species. Rainforest germinants may still be recorded under this canopy, but their survival to maturity in unknown. The invader species then die, especially under a canopy of rainforest species, leaving the rainforest component. The time taken for this to occur will depend on the ability of invader species to continually regenerate until the rainforest species have formed a closed canopy. This may take longer in sites dominated by *Gahnia grandis* as this species can survive under low light levels in implicate rainforest, although they appear etiolated.

Conversion of mixed forest to pure rainforest requires a fire free period of 400 years and once the removal of eucalypts has occurred then a subsequent fire will yield only rainforest regeneration (Jackson 1968). This study substantiates Jackson (1968) findings in regard to the removal of eucalypts, with eucalypts observed only when there was a seed source within 100m, but refutes the finding that only rainforest will regenerate. Burnt sites that consist primarily of rainforest regeneration were only observed in small areas burnt by a mild ground fire. The large areas of burnt rainforest witnessed in this study were dominated by non-rainforest species. The regenerating rainforest will probably require 100 years to remove the non-rainforest species as these non-rainforest species generally have short life spans than rainforest species. For the burnt rainforest to reach its characteristic structure will require a longer time period as undisturbed rainforest is composed of a number of different generations. It will also require many years for suitable substrates to become available for the bryophyte and lichen rainforest components. Large logs are an important substrate for many bryophytes, lichens and seedlings. The reduction of large logs in burnt sites could limit the diversity and abundance of these species. The lack of mature trees will also limit the recolonisation of burnt sites by many lichen species (Kantvilas and Minchin 1984).

7.5 Conclusion

Each lowland rainforest type maintained its identity post fire and contained the majority of vascular species recorded in unburnt rainforest. Many rainforest species associated with implicate and thamnic rainforest increased their distribution into callidendrous and thamnic rainforest. This is probably due to the merging of thamnic sites, which are at the callidendrous end of the continuum, with the sites classified as callidendrous rainforest for data analysis, due to the inadequate number of pure callidendrous sites. The density of these rainforest species was not large so it should not have a major effect on the floristics of the regenerated rainforest.

The composition of regenerated rainforest may differ from the pre-fire composition. The density and composition of the more fire susceptible species also may be lower in the regenerated rainforest. The effect of fire on the moss and lichen component of rainforest is unknown.

Cool temperate rainforest burnt during the extensive 1982 fires, has a different regeneration pattern compared to other rainforest types in Australia, due to the domination of non-rainforest species. The abundance of these colonizing species generally produced a low dense canopy cover inhibiting the regeneration of other non-rainforest species. Seedlings of rainforest species were found under this canopy, but they were generally small and their survival rate, unknown.

To enhance this study, similar research on the effects of fire on other rainforest types is required. Further studies on the long term effects of frequent fires in rainforest would also be beneficial. Research on the ecology of individual rainforest species, especially understorey species, would also help to explain the distribution patterns observed during this study.

This study indicates that lowland temperate rainforests can exist even after a major fire disturbance. It is essential however that subsequent fires be excluded until the areas burnt are fully regenerated to rainforest. This will require responsible management from all agencies.

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Appendix 1: Landsystems within the Savage River fire boundary.

LANDSYSTEM	AREA (ha)	No. SITES
704141	11 738	12
714121	1 096	0
714131	4 797	14 + 1*
741131	3 913	0
772131	3 360	1
782131	10	0
784121	1 110	5
793121	112	0
793161	3	0
813131	9 780	0
813251	5 091	0
822241	5	0
824141	1 364	3 + 6*
824241	41	0
841231	32	0
841351	9 058	0
TOTAL AREA	51 510	

* = sites in the temporal study

Appendix 2: List of species recorded during the study.

DICOTYLEDONS

APIACEAE
Hydrocotyle hirta R.Br. ex A.Rich.

APOCYNACEAE
Parsonsia brownii (Britten) Pichon

ASTERACEAE
Asteraceae species
Cassinia aculeata (Labill.) R.Br.
Cirsium vulgare (Savi) Ten
Gnaphalium collinum Labill.
Gnaphalium species
Helichrysum rosmarinifolium (Labill.) Benth.
Hypochaeris radicata L.
Olearia argophylla (Labill.) Benth.
Olearia persoonioides (DC.) Benth.
Olearia ramulosa (Labill.) Benth.
Olearia stellulata (Labill.) DC.
Picris hieracoides L.
Pseudognaphalium luteo-album (L.) Hillard & B.L.Burtt
Senecio biserratus Belcher
Senecio glomeratus Desf. ex Poiret
Senecio gunnii (Hook.f.) Belcher
Senecio linearifolius A.Rich.
Senecio minimus Poiret
Senecio quadridentatus Labill.
Senecio species

CARYOPHYLLACEAE
Cerastium fontanum Baumg.

CUNONIACEAE
Anodopetalum biglandulosum A.Cunn. ex Hook.f.
Bauera rubioides Andrews mf

DILLENIACEAE
Hibbertia empetrifolia (D.C.) Hoogl. mf

DROSERACEAE
Drosera binata Labill.

ELAEOCARPACEAE
Aristotelia peduncularis (Labill.) Hook.f.

EPACRIDACEAE
Archeria eriocarpa Hook.f.
Archeria hirtella (Hook.f.) Hook.f.
Cyathodes juniperina (Forst.) Druce
Monotoca glauca (Labill.) Druce
Monotoca submutica (Benth.) Jarman
Richea pandanifolia Hook.f.
Sprengelia incarnata Smith
Trochocarpa cunninghamii (DC.) W.M.Curtis
Trochocarpa gunnii (Hook.f.) Benth.

ERICACEAE
Gaultheria hispida R.Br.

ESCALLONIACEAE
Anopterus glandulosus Labill.

EUCRYPHIACEAE
Eucryphia lucida (Labill.) Baill.

FABACEAE
Acacia melanoxylon R.Br.
Acacia mucronata Willd. ex Wendl.f.
Acacia verticillata (L'Herit.) Willd.
Oxylobium arborescens R.Br. mf

FAGACEAE
Nothofagus cunninghamii (Hook.) Oersted

HALORAGACEAE
Gonocarpus teucrioides DC.

LAMIACEAE
Prostanthera lasianthos Labill.

MONIMIACEAE
Atherosperma moschatum Labill.

MYRTACEAE
Eucalyptus nitida Hook.f.
Leptospermum glaucescens S.Schauer
Leptospermum lanigerum (Aiton) Smith
Leptospermum nitidum Hook.f.
Leptospermum rupestre Hook.f.
Leptospermum scoparium Forst. & Forst.f.
Melaleuca squarrosa Donn ex Smith

OLEACEAE
Notelaea ligustrina Vent.

ONAGRACEAE
Epilobium billardierianum Ser. ex DC.
Epilobium ciliatum Raf. mf

OXALIDACEAE
Oxalis species

PITTOSPORACEAE
Billardiera longifolia Labill.
Billardiera scandens Smith
Pittosporum bicolor Hook.

POLYGONACEAE
Muehlenbeckia gunnii (Hook.f.) Walp. mf

Appendix 2 (cont'd)

PROTEACEAE
Agastachys odorata R.Br.
Banksia marginata Cav.
Cenarrhenes nitida Labill.
Telopea truncata (Labill.) R.Br.

RANUNCULACEAE
Clematis aristata R.Br. ex DC.

RHAMNACEAE
Pomaderris apetala Labill.

ROSACEAE
Acaena novae-zealandiae Kirk

RUBIACEAE
Coprosoma nitida Hook.f.
Coprosma quadrifida (Labill.) Robinson
Galium australe DC.

RUTACEAE
Acradenia frankliniae Milligan ex Kippist
Eriostemon virgatus Hook.f. mf
Phebalium squameum (Labill.) Engl.
Zieria arborescens Sims

THYMELAEACEAE
Pimelea cinerea R.Br.
Pimelea drupacea Labill.
Pimelea ligustrina Labill.
Pimelea lindleyana Meissner

URTICACEAE
Urtica incisa Poiret

WINTERACEAE
Tasmannia lanceolata (Poiret) A.C.Smith

MONOCOTYLEDONS

CYPERACEAE
Carex appressa R.Br.
Gahnia grandis (Labill.) S.T.Blake
Isolepis inundata R.Br.
Lepidosperma elatius Labill.
Lepidosperma species
Schoenus fluitans Hook.f.
Scirpus species
Uncinia tenella R.Br.

IRIDACEAE
Libertia pulchella Sprengel

JUNCACEAE
Juncus amabilis Edgar
Juncus aff. gregiflorus L.Johnson
Juncus procerus E.Meyer
Juncus species
Luzula densiflora (Nordensk.) Edgar
Luzula species

LILIACEAE
Dianella tasmanica Hook.f.
Drymophila cyanocarpa R.Br.

ORCHIDACEAE
Chiloglottis cornuta Hook.f.
Chiloglottis species
Glossodia major R.Br.
Orchidaceae species
Pterostylis species

POACEAE
Agrostis species
Poa species

RESTIONACEAE
Calorophus elongatus Labill.
Lepyrodia tasmanica Hook.f.
Restio tetraphyllus Labill.

XANTHORRHOEACEAE
Lomandra longifolia Labill.

GYMNOSPERMS

PHYLLOCLADACEAE
Phyllocladus aspleniifolius (Labill.) Hook.f.

PTERIDOPHYTES

ASPIDIACEAE
Polystichum proliferum (R.Br.) C.Presl

ASPLENIACEAE
Asplenium flaccidum Forst.f.
Asplenium terrestre Brownsey

BLECHNACEAE
Blechnum fluviatile (R.Br.) E.J.Lowe ex Salom
Blechnum nudum (Labill.) Mett. ex Luerss
Blechnum wattsii Tind.

DAVALLIACEAE
Rumohra adiantiformis (Forst.f.) Ching

DENNSTAEDTIACEAE
Histiopteris incisa (Thunb.) J.Smith.
Hypolepis rugosula (Labill.) J.Smith
Pteridium esculentum (Forst.f.) Cockayne

DICKSONIACEAE
Dicksonia antarctica Labill.

GLEICHENIACEAE
Gleichenia microphylla R.Br.
Sticherus tener (R.Br.) Ching

GRAMMITIDACEAE
Grammitis billardieri Willd.
Grammitis magellanica Desv.

Appendix 2 (cont'd)

HYMENOPHYLLACEAE
Hymenophyllum australe Willd.
Hymenophyllum cupressiforme Labill.
Hymenophyllum flabellatum Labill.
Hymenophyllum marginatum Hook.f. & Grev.
Hymenophyllum peltatum (Poir.) Desv.
Hymenophyllum rarum R.Br.
Polyphlebium venosum (R.Br.) Copel.

LYCOPODIACEAE
Lycopodium fastigiatum R.Br.
Lycopodium laterale R.Br.
Lycopodium species
Lycopodium varium R.Br.

POLYPODIACEAE
Microsorium diversifolium (Willd.) Copel.

PTERIDACEAE
Pteris comans Forst.f
Pteris tremula R.Br. [mf]
Fern species

TMESIPTERIDACEAE
Tmesipteris billardieri Endl.

BRYOPHYTES

MARCHANTIACEAE
Marchantia berteroana Lehm. Lindenb.

POLYTRICHACEAE
Polytrichum juniperinum Hedw.

[mf] - found only in mixed forest sites.

Appendix 3: Site Descriptions

Site No.	Site Title	Rainforest Type	Burn Intensity	Grid Reference E.	N.	Altitude (m)	Aspect	Slope	Soil	Geology	Land Systems
1	Reece Dam1	thamnic	hot	343400	5379600	160	140°	14°	sandy clay	underlining chlorite muscovite quartz shitz, with amphibolite body nearby	714131
2	Reece Dam2	thamnic	mild	343500	5379600	140	150°	9°	light clay	as in Reece Dam1	714131
3	Reece Dam3	implicate	hot	343400	5379100	180	120°	11°	clay	chlorite muscovite quartz shitz possibly influenced by: 1. position in leached area near 'gravel top' 2. interbanded with quartzite	714131
4	Reece Dam4	implicate	unburnt	343400	5378900	170	180°	21°	loamy sand	as in Reece Dam 3	
5	Reece Dam5	implicate	hot	344400	5379250	150	345°	18°	sandy loam	underlining chlorite muscovite quartz shitz, strongly influenced by	714131 714131
6	Reece Dam6	thamnic	mild	343400	5379200	165	280°	8.5°	organic sandy loam	amphibolite as in Reece Dam3	714131
7	Reece Dam7	implicate	hot	349250	5375400	190	60°	3°	sandy loam	Permian Zeehan glacial formation but close to Quaternary raised beaches	772131
8	Reece Dam8	thamnic	unburnt	341750	5377925	180	130°	11°	sand/loamy sand	as in Reece Dam3	714131
9	Reece Dam9	thamnic	hot	343680	5379320	165	280°	8°	silty clay loam /sandy loam	as in Reece Dam1	714131
10	Stringers Creek1	thamnic	hot	348250	5375870	170	240°	5°	clay	boundary of Permian glacial formation and Precambrian Oonah quartzite and slate	704141
11	Stringers Creek2	thamnic	mild	348120	5375850	150	280°	25°	clay loam	as in Stringers Creek1	704141
12	Savage River1	thamnic	hot	346700	5392800	230	325°	10°	clay loam/ sandy loam	amphibolite	
13	Savage River2	implicate	hot	347200	5394500	260	90°	15°	sandy clay	chlorite and muscovite quartz shitz	
14	Savage River3	implicate	unburnt	346100	5395100	270	202°	2°	sandy clay	as in Savage River2	
15	Savage River4	implicate	mild	346400	5394700	270	60°	12°	loamy sand	leached area of an amphibolite band	714131
16	Tullah1	callidendrous	hot	360600	5380200	175	30°	22°	clay loam	volcaniclastic lithiwacke siltstone and mudstone with minor carbonate and theoliitic basalt	824141
17	Tullah2	callidendrous	mild	361500	5380400	180	70°	25°	clay	as in Tullah1	824141
18	Tullah3	callidendrous	unburnt	362200	5380750	170	235°	16°	clay	as in Tullah1	824141
19	Heemskirk1	callidendrous	unburnt	342150	5371100	160	150°	9°	clay loam	Tertiary sand, silt and clay	784121
20	Heemskirk2	callidendrous	hot	344900	5370200	180	flat	flat	clay/ clay loam	Tertiary basalt	784121
21	Heemskirk3	thamnic	mild	344750	5370100	190	flat	flat	clay loam	Tertiary basalt	784121
22	Heemskirk4	thamnic	mild	344880	5370000	190	flat	flat	sandy loam	boundary of Tertiary basalt and Tertiary sand, silt and clay	784121

Appendix 3 (cont'd)

Site No.	Site Title	Rainforest Type	Burn Intensity	Grid Reference E.	Grid Reference N.	Altitude (m)	Aspect	Slope	Soil	Geology	Land Systems
23	Heemskirk5	callidendrous	hot	344800	5369950	190	flat	flat	clay loam	as in Heemskirk4	784121
24	Pieman River1	thamnic	hot	342950	5385650	20	340°	15°	sandy clay	chlorite and muscovite quartz shitz	704141
25	Pieman River2	thamnic	hot	343020	5385600	50	0°	33°	sandy clay	as in Pieman River1	704141
26	Pieman River3	thamnic	unburnt	342720	5385800	30	20°	41°	sandy clay	as in Pieman River1	704141
27	Pieman River4	thamnic	mild	343800	5385900	40	155°	17°	sandy clay	amphibolite	704141
28	Pieman River5	thamnic	hot	342550	5384820	50	265°	31°	sandy clay	chlorite and muscovite quartz shitz with patches of amphibolite	704141
29	Pieman River6	implicate	mild	344880	5381150	30	flat	flat	loamy sand	chlorite and muscovite quartz shitz could be influenced by river alluvium	704141
30	Pieman River7	implicate	hot	344900	5381200	30	flat	flat	sandy loam	chlorite muscovite quartz shitz possibly influenced by: 1. position in leached area near 'gravel top' 2. interbanded with quartzite	704141
31	Pieman River8	implicate	hot	344100	5382920	20	15°	5.5°	clay loam	predominantly chlorite and muscovite quartz shitz with some amphibolite	704141
32	Pieman River9	thamnic	mild	343500	5384220	50	160°	29°	sandy clay	chlorite and muscovite quartz shitz	704141
33	Pieman River10	thamnic	unburnt	342000	5386750	80	209°	21°	sandy clay	metamorphosed basaltic rocks	704141
34	Corinna Track1	implicate	unburnt	341300	5384020	160	90°	22°	loamy sand	chlorite and muscovite quartz shitz in very leached area just below Tertiary basalt	714131
35	Corinna Track2	implicate	mild	341550	5384100	150	112°	3°	peat	as in Corinna Track1	714131
36	Waratah1	callidendrous	mild	375050	5416200	300	flat	flat	sandy loam	Cambrian greywacke (chert or basalt) with probable alluvial influences	824241
37	Waratah2	callidendrous	mild	374900	5416020	305	30°	10°	clay loam	Cambrian greywacke (chert or basalt)	824241
38	Waratah3	callidendrous	mild	374900	5416200	300	180°	2°	clay loam	Cambrian greywacke (chert or basalt)	824241
39	Waratah4	callidendrous	unburnt	379100	5416550	570	190°	27°	loam	Tertiary basalt	824241
40	Waratah5	callidendrous	hot	376000	5415400	340	20°	10°	clay loam	Cambrian greywacke (chert or basalt) but closer to basalt	824241
41	Waratah6	callidendrous	hot	375400	5415500	330	130°	28°	clay loam	Cambrian pillowed basalt	824241
42	Waratah7	callidendrous	mild	376450	5414500	530	280°	7°	clay	Cambrian greywacke (chert or basalt) possibly influenced colluvially by Tertiary basalt which occurs only a short way upslope	824241
43	Waratah8	callidendrous	unburnt	376450	5414400	525	180°	24°	clay loam	Cambrian greywacke (chert or basalt)	824241

Appendix 3. (cont'd)

Site No.	Site Title	Rainforest Type	Burn Intensity	Grid Reference E.	Grid Reference N.	Altitude (m)	Aspect	Slope	Soil	Geology	Land Systems
Additional monitoring sites											
44	Savage River5	implicate	hot	344325	5391325	250	280°	10°	sandy loam/ sandy clay loam	thin Tertiary gravel underlining mica quartz shitz	714131
45	H & R 1A	thamnic	hot	359350	5380370	210	70°	27°	sandy loam	siltstone, mudstone and small amount of carbonate	824141
46	H & R 1B	mixed forest	hot	359325	5380390	215	30°	18°	loamy sand/ sandy loam	as in H & R 1A	824141
47	H & R 2A	mixed forest	hot	359550	5380337	220	90°	12°	sandy loam/ sandy clay loam	as in H & R 1A	824141
48	H & R 2B	mixed forest	hot	359500	5380325	220	260°	20°	sandy loam	as in H & R 1A	824141
49	H & R 3A	mixed forest	hot	359700	5380300	220	270°	35°	sandy loam/ sandy clay loam	as in H & R 1A	824141
50	H & R 3B	mixed forest	hot	359725	5380300	240	90°	35°	fine sandy loam /loamy sand	as in H & R 1A	824141

Appendix 4: Rainforest and doubtful-rainforest species recorded only in burnt sites, or in more burnt sites than unburnt sites.

RECORDED ONLY IN BURNT SITES

Rainforest Species	Growth Form
Acacia mucronata	shrub
Blechnum fluviatile	fern
Carex appressa	sedge
Chiloglottis cornuta	orchid
Galium australe	herb
Libertia pulchella	iris
Lycopodium fastigiatum	clubmoss
Pimelea cinerea	shrub
Pteris comans	fern
Richea pandanifolia	shrub
Telopea truncata	shrub

Doubtful-Rainforest Species	Growth Form
Acacia verticillata	shrub
Dianella tasmanica	lily
Gaultheria hispida	shrub
Gleichenia microphylla	fern
Leptospermum glaucescens	tree
Leptospermum lanigerum	tree
Leptospermum nitidum	tree
Leptospermum rupestre	shrub
Prostanthera lasianthos	shrub
Restio tetraphyllus	sedge

RECORDED IN MORE BURNT SITES THAN UNBURNT SITES

Rainforest Species	Growth Form
Acacia melanoxylon	tree
Cenarrhenes nitida	shrub
Coprosma quadrifida	shrub
Cyathodes juniperina	shrub
Dicksonia antarctica	fern
Histiopteris incisa	fern
Hydrocotyle hirta	herb
Hypolepis rugosula	fern
Monotoca glauca	shrub
Pimelea drupacea	shrub
Polystichum proliferum	fern
Uncinia tenella	sedge

Doubtful-Rainforest Species	Growth Form
Gahnia grandis	sedge
Leptospermum scoparium	tree
Phebalium squameum	tree
Pomaderris apetala	tree

Appendix 5: Summary of regression analysis for individual non-rainforest and doubtful-rainforest species.

Acacia melanoxylon
ss.=26 (33)

Importance Values

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n	Implicate mean	Implicate variance	Mixed Forest n	Mixed Forest mean	Mixed Forest variance
unburnt	1	1.8		1	9.5		0					
mild	2	11.5	216.40	5	2.3	2.01	2	2.3	4.95	1	1.3	
hot	4	9.0	97.47	5 (6)	5.0 (6.0)	12.76 (16.33)	6 (7)	8.0 (7.0)	34.10 (34.33)	4	14.7	2.49

Rf & All data: no significant values.

Cover

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n	Implicate mean	Implicate variance	Mixed Forest n	Mixed Forest mean	Mixed Forest variance
unburnt	1	0.0		1	18.5		0					
mild	2	3.8	28.50	5	3.2	43.26	2	0.1	0.01	1	0.3	
hot	4	2.1	6.84	5 (6)	1.2 (1.4)	3.34 (2.93)	6 (7)	1.2 (1.0)	1.69 (1.53)	4	4.0	2.96

Rf data: burn intensity significant ($p<0.05$); unburnt significant from hot ($p<0.05$); interactions significant ($p<0.025$); callidendrous/unburnt ($p<0.01$) significant from thamnic, thamnic/mild, thamnic/hot. Mild/thamnic ($p<0.01$) significant from unburnt & callidendrous/unburnt

All data: burn intensity significant ($p<0.025$); unburnt significant from mild ($p<0.05$) and hot ($p<0.02$). Interactions significant ($p<0.05$); callidendrous/unburnt significant ($p<0.001$) from thamnic, mild/thamnic & hot/thamnic. Thamnic/mild significant from unburnt ($p<0.001$), unburnt/callidendrous ($p<0.01$). Hot/mixedforest significant unburnt ($p<0.001$) & unburnt/callidendrous ($p<0.01$).

Seedling Height

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n	Implicate mean	Implicate variance	Mixed Forest n	Mixed Forest mean	Mixed Forest variance
unburnt	1	0.1		1	7.8		0					
mild	2	0.8	0.91	5	2.1	6.23	2	1.3	0.13	1	2.5	
hot	4	3.1	6.36	5 (6)	1.8 (2.1)	0.85 (1.30)	6 (7)	2.4 (2.3)	1.61 (1.41)	4	4.7	0.71

Rf data: interactions significant ($p<0.05$): callidendrous/unburnt signficant from thamnic ($p<0.01$), mild/thamnic ($p<0.05$) & hot/thamnic ($p<0.005$). Thamnic/mild significant from unburnt ($p<0.01$), callidendrous/unburnt ($p<0.05$). Regression may have been skewed by one large thamnic/unburnt value.

All data: interactions significant ($p<0.05$); callidendrous/unburnt significant from thamnic & hot/thamnic ($p<0.005$) & mild/thamnic ($p<0.05$). Thamnic/mild significant from unburnt ($p<0.005$). Mixforest/hot significant from unburnt ($p<0.005$), thamnic & implicate ($p<0.05$) & unburnt/callidendrous ($p<0.005$). Ttests indicate callidendrous significant from mixforest ($p<0.05$).

Acaena nova-zelandiae
ss.=14 (15)

Importance Values

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n	Implicate mean	Implicate variance	Mixed Forest n	Mixed Forest mean	Mixed Forest variance
unburnt	0			0			0			0		
mild	3	2.5	7.23	4	1.7	0.98	0			0		
hot	3	2.5	9.40	2 (3)	4.0 (3.1)	6.9 (6.01)	2	1.7	1.93	0		

Rf & All data: no significant differences, found only in burnt sites, predominately callidendrous and thamnic.

Cover

Rainforest/forest Type

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance	Mixed Forest n	mean	variance
unburnt	0			0			0					
mild	3	0.1	0.01	4	0.0	0.00	0					
hot	3	0.0	0.00	2 (3)	0 (0.2)	0 (0.08)	2	0.0	0.00			

Rf & All data: no significant differences

Seedling Height

Rainforest/forest Type

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance	Mixed Forest n	mean	variance
unburnt	0			0			0					
mild	3	0.0	0.00	4	0.0	0.00	0					
hot	3	0.0	0.00	2 (3)	0.05 (0.04)	0.00 (0.00)	2	0.0	0.00			

Rf & All data: no significant differences.

Billardieri longifolia
ss.=15 (22)

Importance Values

Rainforest/forest Type

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance	Mixed Forest n	mean	variance
unburnt	3	1.1	0.04	0			1	0.9				
mild	0			3	1.8	0.27	1	2.9		1	4.1	
hot	1	0.8		2 (3)	1.8 (2.3)	0.22 (0.93)	4 (5)	2.7 (2.4)	3.54 (2.94)	4	6.4	37.19

Rf & All data: no significant differences.

Cover

Rainforest/forest Type

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n.	mean	variance	Mixed Forest n.	mean	variance
unburnt	3	0.0	0.00	0			1	0.0	0.00			
mild	0			3	0.1	0.02	1	0.0	0.00	1	0.3	
hot	1	0.0	0.00	2 (3)	0.1 (0.5)	0.03 (0.50)	4 (5)	0.1 (0.05)	0.02 (0.01)	4	0.3	0.29

Rf & All data: no significant differences.

Height

Rainforest/forest Type

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance	Mixed Forest n.	mean	variance
unburnt	3	0.1	0.00	0			1	0.4	0.00			
mild	0			3	0.1	0.06	1	0.5	0.00	1	2.3	
hot	1	0.0	0.00	2 (3)	2.0 (2.0)	0.47 (0.24)	4 (5)	1.5 (1.5)	0.36 (0.27)	4	1.6	0.60

Rf data: burn intensity significant ($p<0.01$); unburnt significant from hot ($p<0.01$). Rainforest type significant ($p<0.05$); callidendrous significantly lower than thamnic ($p<0.02$) & implicate ($p<0.05$).

All data: burn intensity significant ($p<0.005$); unburnt significant from hot ($p<0.005$). Ttests indicate callidendrous significant from thamnic ($p<0.05$) & mixforest ($p<0.02$).

Ttests indicate interactions significant; callidendrous/unburnt significant from thamnic ($p<0.01$), mild/thamnic & mild/implicate ($p<0.02$). Mild/thamnic significant from hot & callidendrous ($p<0.01$), mixforest ($p<0.05$) & hot/mixforest ($p<0.02$).

Clematis aristata
ss=12

Importance Values

Burn Intensity	Rainforest/forest Type								
	Callidendrous			Thamnic			Implicate		
	n.	mean	variance	n.	mean	variance	n	mean	variance
unburnt	2	2.1	2.63	1	6.6		0		
mild	2	0.9	0.01	2	7.9	11.08	0		
hot	1	1.7		2	2.3	0.62	2	0.9	0.04

Rf data: rainforest type significant ($p<0.025$); callidendrous significantly lower than thamnic ($p<0.02$).

Cover
Values too small for analysis

Seedling Height

Burn Intensity	Rainforest/forest Type								
	Callidendrous			Thamnic			Implicate		
	n.	mean	variance	n.	mean	variance	n	mean	variance
unburnt	2	0.0	0.00	1	0.4		0		
mild	2	1.0	1.96	2	0.3	0.05	0		
hot	1	1.2		2	0.2	0.01	2	0.8	1.08

Rf data: no significant differences.

Gahnia grandis
ss. = 35 (41)

Importance Value

Burn Intensity	Rainforest/forest Type											
	Callidendrous			Thamnic			Implicate			Mixed Forest		
	n.	mean	variance	n.	mean	variance	n	mean	variance	n	mean	variance
unburnt	0			1	7.1		3	7.5	54.20			
mild	4	4.9	26.30	7	16.9	195.70	3	15.2	30.80	1	12.9	
hot	4	9.1	48.20	7 (8)	25.0 (23.2)	703.7 (628.9)	6 (7)	33.7 (32.3)	343 (300.1)	3	9.6	27.10

Rf data: F test indicates no significant differences. Ttests have callidendrous significant from implicate ($p<0.05$); callidendrous/unburnt ($p<0.05$) from hot & implicate.
All data: F test indicates no significant differences. Ttests have callidendrous significant from implicate ($p<0.02$; callidendrous/unburnt ($p<0.05$) from hot & implicate; mixforest/hot significant from unburnt ($p<0.05$).

Cover

Burn Intensity	Rainforest/forest Type											
	Callidendrous			Thamnic			Implicate			Mixed Forest		
	n.	mean	variance	n.	mean	variance	n.	mean	variance	n.	mean	variance
unburnt	0			1	2.1		3	3.5	8.70			
mild	4	1.1	0.40	7	7.0	74.10	3	2.6	3.20	1	2.4	
hot	4	1.1	2.50	7 (8)	13.1 (11.7)	265.4 (244.25)	6 (7)	18.4 (18.0)	381.4 (318.87)	3	1.5	0.48

Rf & All data: no significant differences

Height

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance	Mixed Forest n	mean	variance
						Rainforest/forest Type						
unburnt	0			1	1.6		3	2.5	0.22			
mild	4	1.1	0.17	7	1.3	0.11	3	1.3	0.03	1	1.6	
hot	4	0.9	0.12	7 (8)	1.1 (1.1)	0.29 (0.25)	6 (7)	1.8 (1.8)	0.22 (0.19)	3	1.4	0.04

Rf data: burn intensity significant (p<0.005), rainforest type significant (p<0.005); unburnt significant from mild (p<0.002) & hot (p<0.005). Implicate significantly higher than callidendrous (p<0.005) & thamnic (p<0.02).

All data: burn intensity significant (p<0.005), rainforest type significant (p<0.005); unburnt significant from mild (p<0.001) & hot (p<0.002). Implicate significantly higher than callidendrous (p<0.001) & thamnic (p<0.005).

Galium australe
ss. = 10

Importance Value

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance
						Rainforest/forest Type			
unburnt	0			0			0		
mild	2	1.6	1.64	1	3.5		0		
hot	4	4.6	24.67	3	3.1	13.78	0		

Rf data: no variable significant, only found in burnt callidendrous & thamnic rainforest.

Cover
values too small, nothing significant

Height

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance
						Rainforest/forest Type			
unburnt	0			0			0		
mild	2	0.1	0.01	1	0.2		0		
hot	4	0.1	0.01	3	0.1	0.01	0		

Rf data: no significant differences.

Gnaphalium collinum. Only used the total data set of 50 sites
ss. = 9

Importance Value

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance	Mixed Forest n	mean	variance
						Rainforest/forest Type						
unburnt	0			0			0					
mild	1	3.2		1	0.9		0			0		
hot	1	1.0		2	4.4	0.44	1	1.3		3	1.9	0.49

All data: interactions significant (p<0.02); mild/thamnic significant (p<0.05) from hot, implicate, mixforest,callidendrous/unburnt & hot/callidendrous. Mixforest/hot significant (p<0.005) from mild, thamnic & callidendrous/mild. Only found on burnt sites.

Cover values too small for analysis - no significant differences

Seedling Height

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance	Mixed Forest n	mean	variance
	Rainforest/forest Type											
unburnt	0			0			0					
mild	1	0.0		1	0.0		0			0		
hot	1	0.2		2	0.0	0.00	1	0.2		3	0.1	0.00

All data: no significant differences.

Leptospermum glaucescens - analysis for total (50 sites) data set
ss. = 13

Importance Values

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n.	mean	variance	Mixed Forest n.	mean	variance
	Rainforest/forest Type											
unburnt	0			0			0					
mild	0			1	2.4		0			1	14.3	
hot	1	0.8		3	5.5	64.13	4	8.4	78.89	3	8.4	38.11

All data: no significant differences. Found only on burnt sites especially hot burn sites.

Cover

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n.	mean	variance	Mixed Forest n.	mean	variance
	Rainforest/forest Type											
unburnt	0			0			0					
mild	0			1	0.2		0			1	2.8	
hot	1	0.0		3	0.9	2.52	4	1.4	2.56	3	0.7	0.13

All data: no significant differences.

Height

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance	Mixed Forest n	mean	variance
	Rainforest/forest Type											
unburnt	0			0			0			0		
mild	0			1	0.8		0			1	2.9	
hot	1	1.0		3	1.8	3.27	4	2.7	0.67	3	2.5	0.07

All data: no significant differences.

Leptospermum scoparium
ss. = 21 (27)

Importance Values

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance	Mixed Forest n	mean	variance
	Rainforest/forest Type											
unburnt	0			0			1	9.7				
mild	1	0.9		4	4.0	18.40	2	23.7	202.00	1	20.8	
hot	2	2.3	5.00	5 (6)	22.2 (20.5)	332.6 (283.6)	6 (7)	23.7 (22.4)	236.6 (208.9)	4	8.9	32.70

Rf data: no significant differences.
All data: F values not significant. T tests have implicate significant from callidendrous (p<0.05).

Cover ss. = 21 (28)

Burn Intensity	Rainforest/forest Type: Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n.	mean	variance	Mixed Forest n.	mean	variance
unburnt	0			0			1	38.1				
mild	1	0.5		4	0.2	0.11	2	9.2	90.53	1	10.2	
hot	2	0.0	0.00	5 (6)	7.8 (6.9)	68.52 (59.79)	6 (7)	10.3 (9.2)	176.68 (154.76)	4	1.4	1.88

Rf data: burn intensity significant (p<0.05); unburnt (p<0.01) significant from mild and hot.
All data: burn intensity significant (p<0.005); unburnt (p<0.001) significant from mild and hot.

Height

Burn Intensity	Rainforest/forest Type: Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance	Mixed Forest n	mean	variance
unburnt	0			0			1	5.0		0		
mild	1	3.0		4	1.4	0.71	2	3.1	0.01	1	4.1	
hot	2	0.8	0.01	5 (6)	2.2 (2.6)	2.01 (2.29)	6 (7)	3.3 (3.4)	0.74 (0.81)	4	3.3	0.72

Rf data: burn intensity significant (p<0.05); mild significant from unburnt (p<0.05). Rainforest type signficant (p<0.025); implicate (p<0.05) significant from callidendrous & thamnic.
All data: rainforest type significant (p<0.01); implicate (p<0.05) significant from callidendrous, thamnic. Mixforest (p<0.05) significant from callidendrous & thamnic

Marchantia berterona
ss. = 24 (27)

Importance Values

Burn Intensity	Rainforest/forest Type: Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance
unburnt	1	1.1		0			0		
mild	5	9.1	14.78	7	7.0	23.20	1	5.0	
hot	4	12.7	21.67	4	7.4	16.41	2	3.3	0.03

Rf & All data: no significant differences. found on burnt sites.

Cover

Burn Intensity	Rainforest/forest Type: Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n.	mean	variance
unburnt	1	0.0		0			0		
mild	5	1.9	16.78	7	0.7	0.42	2	1.1	2.35
hot	4	0.4	0.36	4	0.1	0.05	3 (4)	0.2 (0.2)	0.07 (0.05)

Rf & All data: no significant differences.

Melaleuca squamea. Analysis for total (50 sites) data set.
ss. = 10

Importance Values

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n	Implicate mean	Implicate variance	Mixed Forest n	Mixed Forest mean	Mixed Forest variance
unburnt	0			0			0					
mild	0			0			2	12.9	141.86	1	11.6	
hot	0			1	4.6		6	6.7	27.60	0		

Rainforest/forest Type

All data: no significant differences, only found on burnt sites predominately hot burn sites and in implicate rainforest.

Cover

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance	Mixed Forest n.	Mixed Forest mean	Mixed Forest variance
unburnt	0			0			0					
mild	0			0			2	3.2	4.21	1	2.4	
hot	0			1	0.3		6	0.6	0.32	0		

Rainforest/forest Type

All data: burn intensity significant (p<0.025); mild (p<0.01) significant from unburnt & hot.

Height

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n	Implicate mean	Implicate variance			
unburnt	0			0			0					
mild	0			0			2	2.8	0.13	1	2.8	
hot	0			1	2.3		6	1.9	0.93	0		

Rainforest/forest Type

All data: no values signicant.

Phebalium squameum
ss. = 8 (14)

Importance Values

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance	Mixed Forest n.	Mixed Forest mean	Mixed Forest variance
unburnt	0			0			1	0.9				
mild	0			0			1	3.8		1	14.8	
hot	0			2 (3)	5.4 (9.0)	10.87(43.24)	4	10.8	46.16	4	21.8	116.20

Rainforest/forest Type

Rf & All data: no significant differences.

Cover

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance	Mixed Forest n.	Mixed Forest mean	Mixed Forest variance
unburnt	0			0			1	0.0	*			
mild	0			0			1	0.3		1	3.0	
hot	0			2 (3)	0.1 (1.5)	0.014 (5.66)	4	0.3	0.06	4	12.4	144.46

Rainforest/forest Type

Rf & All data: no significant differences.

Height

Burn Intensity	Callidendrous			Thamnic			Implicate			Mixed Forest		
	Rainforest/forest Type											
	n.	mean	variance	n.	mean	variance	n	mean	variance	n	mean	variance
unburnt	0			0			1	2.0				
mild	0			0			1	1.3		1	3.1	
hot	0			2 (3)	1.3 (2.1)	0.003 (1.90)	4	1.2	0.66	4	3.2	0.38

Rf data: no significant differences

All data: rainforest type significant (p<0.05), implicate significant from callidendrous (p<0.005) & mixforest (p<0.01).

Pimelea lindleyana

ss. = 14 (18)

Importance Values

Burn Intensity	Callidendrous			Thamnic			Implicate			Mixed Forest		
	Rainforest/forest Type											
	n.	mean	variance	n.	mean	variance	n.	mean	variance	n.	mean	variance
unburnt	0			0			0					
mild	2	1.4	0.15	3	2.7	5.91	2	14.0	4.12	1	12.6	
hot	2	3.1	1.06	1 (2)	0.6 (2.3)	6.09	4 (5)	10.0 (9.7)	66.24 (50.26)	1	6.6	

Rf data: rainforest type significant (p<0.05), implicate significantly higher than callidendrous & thamnic (p<0.02).

All data: rainforest type significant (p<0.05), implicate significantly higher than callidendrous & thamnic (p<0.01).

Cover

Burn Intensity	Callidendrous			Thamnic			Implicate			Mixed Forest		
	Rainforest/forest Type											
	n.	mean	variance	n.	mean	variance	n.	mean	variance	n.	mean	variance
unburnt	0	0.0	0.00	0			0					
mild	2	0.0	0.00	3	0.0	0.00	2	0.9	0.68	1	1.2	
hot	2	0.0	0.00	1 (2)	0 (0.2)	0 (0.07)	4 (5)	0.1 (0.1)	0.016 (0.00)	1	0.2	

Rf data: no significant differences.

All data: rainforest type & interactions signficant (p<0.05); mixforest significant from unburnt (p<0.05). Callidendrous/unburnt signficant from mild/implicate (p<0.05). Mild/thamnic significant from implicate & mixforest (p<0.01). hot/implicate (p<0.02) hot/mixforest (p<0.05). Mixforest/hot significant from mild (p<0.05).

Height

Burn Intensity	Callidendrous			Thamnic			Implicate			Mixed Forest		
	Rainforest/forest Type											
	n.	mean	variance	n.	mean	variance	n.	mean	variance	n.	mean	variance
unburnt	0			0			0					
mild	2	0.7	0.15	3	0.2	0.02	2	0.8	0.06	1	1.6	
hot	2	0.4	0.10	1 (2)	1.0 (1.2)	0 (0.07)	4 (5)	0.8 (0.8)	0.07 (0.05)	1	0.8	

Rf data: no signicant differences.

All data: interactions significant (p<0.005); callidendrous/unburnt significant from thamnic (p<0.02). mild/thamnic (p<0.005). All values signicantly higher than mild/thamnic. Mixforest/hot significant from mild (p<0.05).

Pittosporum bicolour
ss. = 12

Importance Values

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance
				Rainforest/forest Type					
unburnt	2	1.9	0.09	1	2.0		1	9.7	
mild	0			3	2.3	1.24	0		
hot	3	1.0	0.36	1	1.8		1	1.2	

Rf data: interactions significant (p<0.01): callidendrous/unburnt significant from implicate (p<0.001) & implicate hot (p<0.01). Thamnic/mild from implicate/unburnt (p<0.01).

Cover

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance
				Rainforest/forest Type					
unburnt	2	4.8	18.00	1	0.3		1	5.6	
mild	0			3	0.0	0.00	0		
hot	3	0.0	0.00	1	0.0		1	0.0	

Rf data: F tests show no significant differences. T tests have unburnt significant from mild (p<0.05) & hot (p<0.02).

Height

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance
				Rainforest/forest Type					
unburnt	2	5.5	4.50	1	2.8		1	1.8	
mild	0			3	0.1	0.01	0		
hot	3	0.1	0.00	1	0.4		1	0.6	

Rf data: burn intensity significant (p<0.005); unburnt significantly higher than mild & hot (p<0.005).

Pomaderris apetala
n. = 9

Importance Values

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n	Implicate mean	Implicate variance
				Rainforest/forest Type					
unburnt	0			1	9.4		0		
mild	0			2	2.5	0.10	0		
hot	2	29.5	1554.00	4	32.1	1311.50	0		

Rf data: no signicant differences.

Cover

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance
				Rainforest/forest Type					
unburnt	0			1	14.1		0		
mild	0			2	0.1	0.00	0		
hot	2	22.8	905.30	4	23.6	588.80	0		

Rf data: no significant differences.

Height

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n	Implicate mean	Implicate variance
unburnt	0			1	2.5		0		
mild	0			2	0.6	0.02	0		
hot	2	4.0	16.53	4	4.3	0.06	0		

Rainforest/forest Type

Rf data: no significant differences.

Pteridium escalentum

n. = 32 (39)

Importance Values

Rainforest/forest Type

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance	Mixed Forest n.	Mixed Forest mean	Mixed Forest variance
unburnt	0			0			0					
mild	5	52.1	823.90	7	18.8	222.00	3	14.2	14.13	1	9.9	
hot	5	42.5	442.90	7 (8)	24.31 (23.42)	265.4 (233.8)	5 (6)	21.15 (18.99)	24.5 (47.7)	4	18.6	6.30

Rf data: rainforest type significant ($p<0.005$); callidendrous significantly higher than thamnic & implicate ($p<0.01$).

All data: rainforest type significant ($p<0.005$); callidendrous significantly higher than thamnic & implicate ($p<0.001$) & mixforest ($p<0.01$).

Cover

Rainforest/forest Type

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance	Mixed Forest n.	Mixed Forest mean	Mixed Forest variance
unburnt	0			0			0					
mild	5	33.1	614.50	7	9.3	159.50	3	1.9	1.30	1	1.1	
hot	5	24.8	414.50	7 (8)	8.12 (7.78)	205.3 (176.9)	5 (6)	5.36 (4.78)	19.2 (17.4)	4	5.4	5.40

Rf data: rainforest type significant ($p<0.005$); callidendrous higher than thamnic & implicate ($p<0.01$).

All data: rainforest type significant ($p<0.005$); callidendrous higher than thamnic & mixforest ($p<0.01$) & implicate ($p<0.001$).

Height

Rainforest/forest Type

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance	Mixed Forest n.	Mixed Forest mean	Mixed Forest variance
unburnt	0			0			0					
mild	5	2.0		7	1.5	0.18	3	1.7	0.03	1	1.4	
hot	5	1.8		7 (8)	1.5 (1.5)	0.05 (0.07)	5 (6)	1.8 (1.7)	0.09 (0.09)	4	1.7	0.04

Rf data: rainforest type significant ($p<0.05$), thamnic lower than callidendrous ($p<0.05$).

All data: no sgnificant differences.

Senecio biseratus - analysis only on the 50 site data.
ss. = 9

Importance Values

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance	Mixed Forest n.	Mixed Forest mean	Mixed Forest variance
unburnt	0			0			0					
mild	0			2	4.1	11.56	0			0		
hot	0			4	5.5	18.55	1	1.2		2	8.3	20.72

(Rainforest/forest Type)

All data: no significant differences.

Cover
Values too small to compare.

Seedling height

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance	Mixed Forest n.	Mixed Forest mean	Mixed Forest variance
unburnt	0			0			0					
mild	0			2	0.2	0.00	0			0		
hot	0			4	0.1	0.00	1	0.0		2	0.2	0.03

(Rainforest/forest Type)

All data: no significant differences.

Senecio minimus
ss. = 10

Importance Values

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n	Implicate mean	Implicate variance
unburnt	1	1.8		0					
mild	5	8.6	34.72	1	11.3				
hot	2	11.2	1.62	0			1	0.7	

(Rainforest/forest Type)

Rf data: no significant differences. mainly found in callidendrous and recorded in all callidendrous/mild burn sites.

Cover

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance
unburnt	1	0.0		0			0		
mild	5	0.0	0.00	1	0.2		0		
hot	2	0.0	0.00	0			1	0.0	

(Rainforest/forest Type)

Rf data: rainforest type significant ($p<0.005$): thamnic significant from callidendrous ($p<0.001$) & implicate ($p<0.01$).

Seedling height

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n	Implicate mean	Implicate variance
unburnt	1	0.1		0			0		
mild	5	0.1	0.01	1	0.3		0		
hot	2	0.1	0.01	0			1	0.1	

Rf data: no significant differences.

Senecio species
ss.=14 (19)

Importance Value

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance	Mixed Forest n.	Mixed Forest mean	Mixed Forest variance
unburnt	0			0			0					
mild	4	5.8	41.66	1	0.6		2	1.1	0.29	0		
hot	3	3.7	0.93	2 (3)	0.9 (1.6)	0.01 (1.37)	2 (3)	4.4 (3.6)	25.02 (14.35)	3	6.1	21.77

Rf & All data: no significant differences.

Cover
Values too small for analysis.

Seedling Height

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n	Implicate mean	Implicate variance	Mixed Forest n	Mixed Forest mean	Mixed Forest variance
unburnt	0			0			0					
mild	4	0.1	0.02	1	0.0		2	0.0	0.00	0		
hot	3	0.0	0.00	2 (3)	0.04 (0.07)	0.00 (0.00)	2 (3)	0.05 (0.06)	0.00 (0.00)	3	0.1	0.00

Rf & All data: no significant differences.

Litter
ss. = 43 (50)

Cover

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance	Mixed Forest n.	Mixed Forest mean	Mixed Forest variance
unburnt	4	33.4	189.40	3	37.0	264.00	3	38.8	107.80			
mild	5	24.7	191.70	7	19.4	150.80	3	8.3	20.50	1	55.0	
hot	5	28.1	327.50	7 (8)	28.7 (28.2)	204.8 (327.5)	6 (7)	19.3 (20.9)	195.2 (181.4)	4	48.5	87.80

Rf data: burn intensity significant (p<0.025); mild significant from unburnt (p<0.01).
All data: burn intensity (p<0.025) & rainforest type (p<0.005) significant; unburnt significant from mild (p<0.01) (2nd analysis), hot (p<0.05); mixforest significant from callidendrous (p<0.01) & thamnic & implicate (p<0.001).

Logs
ss. = 41 (48)

Cover

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance	Mixed Forest n.	Mixed Forest mean	Mixed Forest variance
	Rainforest/forest Type											
unburnt	4	6.8	1.56	3	5.5	1.49	3	1.9	0.33			
mild	5	2.0	10.14	7	2.2	3.04	2	2.0	0.45	1	3.9	
hot	5	1.8	1.39	6 (7)	1.012 (1.639)	0.102 (2.835)	6 (7)	1.888 (1.904)	1.481 (1.236)	4	5.9	11.23

Rf data: burn intensity (p<0.05) & interactions (p<0.025) significant; unburnt significant from mild & hot (p<0.001). Callidendrous/unburnt from mild, hot & implicate (p<0.001) & mild/implicate & hot/implicate (p<0.01).
All data: burn intensity & rainforest type significant (p<0.005); unburnt significant from mild & hot (p<0.01); mixforest significant from callidendrous, thamnic & implicate (p<0.01).

Bare Ground
ss. = 25 (31)

Cover

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance	Mixed Forest n.	Mixed Forest mean	Mixed Forest variance
	Rainforest/forest Type											
unburnt	2	11.4	209.61	3	0.8	0.16	2	0.8	0.22			
mild	1	1.2		4	0.7	0.52	1	1.1		1	1.5	
hot	2	5.0	15.87	5 (6)	2.2 (2.4)	13.31 (11.02)	5 (6)	3.0 (2.6)	9.19 (8.39)	3	1.7	0.01

Rf data: F tests have no significant differences. T tests have callidendrous/unburnt significant from thamnic (p<0.02) and implicate (p<0.05) & thamnic significant from callidendrous (p<0.05)
All data: no significant differences.

Other Moss
ss. = 43 (50)

Cover

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance	Mixed Forest n.	Mixed Forest mean	Mixed Forest variance
	Rainforest/forest Type											
unburnt	4	26.5	20.60	3	24.0	110.90	3	32.4	129.00			
mild	5	8.1	89.90	7	27.0	245.40	3	19.2	235.90	1	1.3	
hot	5	8.8	22.90	7 (8)	6.8 (8.2)	44.2 (54.8)	6 (7)	5.3 (7.3)	25.1 (50)	4	19.4	159.70

Rf data: burn intensity significant (p<0.005); hot significant from unburnt (p<0.001).
All data: burn intensity significant (p<0.005); unburnt significant from mild (p<0.05) & hot (p<0.001), mild significant from hot (p<0.05). Ttests have callidendrous/unburnt significant from mild & hot (p<0.02) & mild/thamnic (p<0.05). Mild/thamnic significant from hot & callidendrous (p<0.01) & mixforest, callidendrous/hot & mixforest/hot (p<0.05). Mixforest/hot significant from unburnt (p<0.01) & mild/implicate (p<0.05).

Wood
ss. = 38 (45)

Cover

Burn Intensity	Rainforest/forest Type: Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance	Mixed Forest n.	Mixed Forest mean	Mixed Forest variance
unburnt	2	1.5	4.50	3	0.2	0.07	1	2.7				
mild	5	2.7	0.78	7	4.5	6.02	2	6.5	2.31	1	14.4	
hot	5	2.7	0.41	7 (8)	5.9 (8.0)	39.90 (71.03)	6 (7)	4.7 (8.1)	9.09 (88.50)	4	10.8	48.74

Rf data: F values not significant. T tests have hot significantly from mild (p0.05).
All data: no significant differences.

Appendix 6: Summary of Regression Analysis for Individual Rainforest Species

Acradenia franklinae
ss. = 6

Importance Values

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n	Implicate mean	Implicate variance
unburnt	0			2	48.8	116.96	0		
mild	0			2	7.4	43.48	1	8.2	
hot	0			0			1	2.2	

Rf data: Ftest not significant. Ttests have unburnt category significant from mild (p<0.01) and hot (p<0.02).

Cover

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance
unburnt	0			2	43.8	209.10	0		
mild	0			2	2.0	1.30	1	0.5	
hot	0			0			1	0.0	

Rf data: F tests not significant. Ttests indicate mild fire significant from unburnt (p<0.05).

Seed and Sprout Proportions

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance
unburnt	0			2	32.5	113.00	0		
mild	0			2	33.3	2222.00	1	44.4	
hot	0			0			1	50.0	

Rf data: F tests & ttests not significant, variances large. Majority of regeneration are sprouts in thamnic and at least half in implicate.

Sprout Height

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance
unburnt	0			2	6.2	0.50	0		
mild	0			2	0.7	0.46	1	0.3	
hot	0			0			1	0.1	

Rf data: Burn intensity significant (p<0.025). Unburnt significant from mild burn (p<0.01) & hot burn (p<0.01).
Due mainly to large thamnic unburnt value.

Seedling Height

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance
unburnt	0			2	0.8	0.48	0		
mild	0			2	0.2	0.11	1	0.1	0.00
hot	0			0			1	0.2	0.00

Rf data: F tests not significant. values lowest in burnt sites.

Agastachys odorata
ss. = 9

Importance Values

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n	Implicate mean	Implicate variance
				Rainforest/Forest Type					
unburnt	0			0			3	9.6	1.50
mild	0			1	4.0		3	3.3	0.51
hot	0			0			2	0.8	0.08

Rf data: Burn intensity significant ($p<0.005$); unburnt significant from mild & hot ($p<0.001$) & mild from hot ($p<0.02$).

Cover

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance
				Rainforest/Forest Type					
unburnt	0			0			3	2.3	1.36
mild	0			1	0.3		3	1.3	0.69
hot	0			0			2	0.5	0.00

No significant differences

Proportion of seedlings

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance
				Rainforest/Forest Type					
unburnt	0			0			3	50.0	2500.00
mild	0			1	66.7		3	36.1	1412.00
hot	0			0			2	0.0	0.00

Rf data: no significant differences, variances large. Sprouting is important for recruitment especially in implicate
With a hot fire in implicate severely reducing the number of seedlings.

Sprout Height

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance
				Rainforest/Forest Type					
unburnt	0			0			3	1.7	2.41
mild	0			1	0.5		3	0.8	0.09
hot	0			0			2	1.4	0.85

Rf data: No significant differences

Seedling Height

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance
				Rainforest/Forest Type					
unburnt	0			0			3	2.5	4.58
mild	0			1	0.5		3	0.3	0.08
hot	0			0			2	0.0	0.00

No significant differences, unburnt variance value large. Burnt values very small.

Anodopetalum biglandulosum
ss=28 (31)

Importance Values

Burn Intensity	n.	Callidendrous mean	variance	n.	Thamnic mean	variance	n	Implicate mean	variance	n	Mixed Forest mean	variance
unburnt	1	28.2		3	14.9	0.25	3	22.4	30.96			
mild	2	10.2	21.08	4	12.9	53.36	2	10.8	142.87			
hot	1	6.0		6 (7)	9.4 (8.6)	74.07 (65.93)	6 (7)	6.5 (7.6)	16.34 (22.30)	1	1.6	

Rainforest/Forest Type

RF data: burn intensity significant (p<0.005); unburnt significantly different from mild (p<0.02) & hot (p<0.005).
All data: burn intensity significant (p<0.005); unburnt significantly different from mild (p<0.02) & hot (p<0.001).

Cover

Burn Intensity	n.	Callidendrous mean	variance	n.	Thamnic mean	variance	n.	Implicate mean	variance	n.	Mixed Forest mean	variance
unburnt	1	18.2		3	5.8	11.85	3	10.4	13.84	0.0		
mild	2	3.5	6.00	4	3.4	5.03	2	3.2	14.22	0.0		
hot	1	0.2		6 (7)	2.6 (2.3)	17.35 (14.97)	6 (7)	0.5 (0.9)	0.06 (1.30)	1.0	0.3	

Rainforest/Forest Type

RF data: Burn intensity (p<0.005) & interactions (p<0.05) significant; unburnt significant from mild & hot (p<0.001). Callidendrous/unburnt significant from mild & hot (p<0.001), thamnic (p<0.01), implicate (p<0.05), mild/thamnic (p<0.02) & hot/thamnic (p<0.01).
All data: burn intensity (p<0.005) & interactions (p<0.05) significant; unburnt significant from mild & hot (p<0.001). Callidendrous/unburnt significant from mild & hot (p<0.001), thamnic (p<0.01), implicate (p<0.05), mild/thamnic & hot/thamnic (p<0.01).

Seedling/Sprout Proportions

Burn Intensity	n.	Callidendrous mean	variance	n.	Thamnic mean	variance		Implicate		n	Mixed Forest mean	variance
unburnt	1	9.1		3	21.7	408.30	3	23.7	781.30			
mild	2	7.1	102.00	4	34.9	494.60	2	5.0	50.00	0		
hot	1	60.0		6 (7)	38.0 (42.1)	1128.60 (1058.2)	6 (7)	12.9 (14.3)	383.60 (334.50)	1	50.0	

Rainforest/Forest Type

RF data: Nothing significant, large variances. Trend: more sprouts than seedlings except callidendrous hot burn sites
All data: F tests not significant but ttests indicate implicate significant from thamnic (p<0.05).

Sprout Height

Burn Intensity	n.	Callidendrous mean	variance	n.	Thamnic mean	variance	n	Implicate mean	variance	n	Mixed Forest mean	variance
unburnt	1	6.5		3	3.8	1.60	3	5.3	4.53			
mild	2	2.1	4.06	4	2.2	1.90	2	2.0	1.09	0		
hot	1	0.7		6 (7)	1.1 (1.0)	0.95 (0.84)	6 (7)	1.2 (1.2)	0.21 (0.18)	1	1.3	

Rainforest/Forest Type

RF data: Burn intensity significant (p<0.005); unburnt significant from mild & hot (p<0.001).
All data: Burn intensity significant (p<0.005); unburnt significant from mild & hot (p<0.001).

Seedling Height

Burn Intensity	n.	Callidendrous mean	variance	n.	Thamnic mean	variance	n	Implicate mean	variance	n	Mixed Forest mean	variance
unburnt	1	0.1		3	1.1	0.97	3	1.2	4.07	0.0		
mild	2	0.0	0.00	4	0.1	0.03	2	0.0	0.00	0.0		
hot	1	0.4		6 (7)	0.3 (0.3)	0.07 (0.06)	6 (7)	0.05 (0.06)	0.01 (0.009)	1.0	0.2	

Rainforest/Forest Type

RF data: no significant differences.
All data: Burn intensity significant ($p<0.005$); unburnt significant from mild ($p<0.02$) & hot ($p<0.02$).

Anopterus glandulosus
ss. = 30 (36)

Importance Values

Burn Intensity	Callidendrous			Thamnic			Implicate			Mixed Forest		
	n.	mean	variance	n.	mean	variance	n	mean	variance	n	mean	variance
unburnt	2	11.2	0.52	2	11.0	15.68	3	15.7	19.63			
mild	0			7	10.8	30.79	3	10.7	0.64			
hot	1	9.5		6 (7)	5.382 (5.066)	12.77 (11.34)	6 (7)	4.975 (5.185)	15.39 (13.13)	4.0	1.0	0.26

Rainforest/Forest Type

RF data: Burn intensity significant ($p<0.005$); hot fire significant from unburnt ($p<0.001$) & mild ($p<0.01$).
All data: Burn intensity significant ($p<0.005$) hot fire significant from unburnt ($p<0.001$) & mild ($p<0.001$).

Cover

Burn Intensity	Callidendrous			Thamnic			Implicate			Mixed Forest		
	n.	mean	variance	n.	mean	variance	n.	mean	variance	n.	mean	variance
unburnt	2	3.0	17.57	2	3.2	5.78	3	4.9	9.06			
mild	0			7	2.1	2.22	3	2.1	0.12	0.0		
hot	1	0.8		6 (7)	1.3 (1.15)	1.5 (1.33)	6 (7)	0.7 (0.78)	0.4 (0.43)	4.0	0.1	0.02

Rainforest/Forest Type

RF data: Burn intensity significant ($p<0.01$); unburnt significant from mild ($p<0.05$) and hot ($p<0.001$).
All data: Burn intensity significant ($p<0.005$); unburnt significant from mild ($p<0.05$) & hot ($p<0.001$) and mild significant from hot ($p<0.05$).

Seedling/Sprout Prop — Rainforest/Forest Type

Burn Intensity	Callidendrous			Thamnic			Implicate			Mixed Forest		
	n.	mean	variance	n.	mean	variance	n	mean	variance	n	mean	variance
unburnt	2	80.6	15.40	2	80.9	1.70	3	33.7	825.70	0.0		
mild	0			7	71.7	458.30	3	11.1	123.50	0.0		
hot	1	100.0		6 (7)	50.3 (50.2)	1200.5 (1000.4)	6 (7)	33.78 (30.74)	720.8 (665.4)	4.0	75.0	2500.00

RF data: Rainforest significant ($p<0.005$); implicate sites significantly lower than thamnic & callidendrous ($p<0.01$).
All data: Rainforest significant ($p<0.005$); implicate sites significantly lower ($p<0.01$) than thamnic, callidendrous & mixforest.

Seedling Height

Burn Intensity	Callidendrous			Thamnic			Implicate			Mixed Forest		
	n.	mean	variance	n.	mean	variance	n	mean	variance	n	mean	variance
unburnt	2	1.4	2.92	2	3.7	0.01	3	1.8	3.43	0.0		
mild	0			7	0.5	0.13	3	0.1	0.01	0.0		
hot	1	0.9		6 (7)	0.3 (0.3)	0.05 (0.04)	6 (7)	0.2 (0.2)	0.03 (0.03)	4.0	0.3	0.22

Rainforest/Forest Type

RF data: burn intensity significant ($p<0.005$); unburnt significant ($p<0.001$) from mild & hot.
All data: burn intensity ($p<0.005$) and interactions ($p<0.025$) significant; unburnt significant ($p<0.001$) from mild & hot. Callidendrous/unburnt signficant from mild, thamnic & hot/thamnic ($p<0.01$). Thamnic/mild significant from unburnt ($p<0.001$). Mixforest/hot significant from unburnt ($p<0.01$) & unburnt/thamnic ($p<0.02$).

Sprout Height

Burn Intensity	Callidendrous			Thamnic			Implicate			Mixed Forest		
	n.	mean	variance	n.	mean	variance	n	mean	variance	n	mean	variance
unburnt	2	0.5	0.03	2	1.1	0.00	3	3.2	1.26			
mild	0			7	1.2	0.86	3	1.2	0.01			
hot	1	0.0		6 (7)	0.5 (0.56)	1.3 (0.12)	6 (7)	0.8 (0.9)	0.2 (0.19)	4.0	0.4	0.56

Rainforest/Forest Type

RF data: rainforest type & burn intensity ($p<0.005$), & interactions significant ($p<0.05$); hot significant from unburnt ($p<0.01$), callidendrous significant from implicate ($p<0.01$). Interactions; callidendrous/unburnt significant from mild & implicate ($p<0.001$) & mild/implicate ($p<0.01$).
Thamnic/mild significant from unburnt/implicate ($p<0.001$).
All data: rainforest type & burn intensity ($p<0.005$), & interactions significant ($p<0.05$); hot significant from unburnt ($p<0.005$), callidendrous significant from thamnic ($p<0.05$) & implicate ($p<0.002$). Interactions; callidendrous/unburnt significant from mild & implicate ($p<0.001$) & mild/thamnic ($p<0.01$).
Thamnic/mild significant from unburnt/implicate ($p<0.01$). Mixedforest significant from unburnt ($p<0.001$) & unburnt/thamnic ($p<0.02$).

Archeria enocopa
ss. = 3

Importance Values

Burn Intensity	Callidendrous			Thamnic			Implicate		
	n.	mean	variance	n.	mean	variance	n	mean	variance
unburnt	0			0			2	21.7	101.20
mild	0			0			1	2.3	
hot	0			0			0		

Rainforest/Forest Type

Rf data: no significant differences.

Cover

Burn Intensity	Callidendrous			Thamnic			Implicate		
	n.	mean	variance	n.	mean	variance	n	mean	variance
unburnt	0			0			2	11.8	0.59
mild	0			0			1	1.8	
hot	0			0			0		

Rainforest/Forest Type

Rf data: Ftests indicates no significant differences. Ttests have mild significant from unburnt ($p<0.01$)

Seedling/sprout proportions.

Burn Intensity	Callidendrous			Thamnic			Implicate		
	n.	mean	variance	n.	mean	variance	n	mean	variance
unburnt	0			0			2	54.3	1322.00
mild	0			0			1	33.3	
hot	0			0			0		

Rainforest/Forest Type

Rf data: no significant differences. Main method of regeneration is by sprouting.

Seedling Height

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance
unburnt	0			0			2	2.1	4.75
mild	0			0			1	0.0	
hot	0			0			0		

Rf data: no significant differences

Sprout Height

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance
unburnt	0			0			2	2.4	5.12
mild	0			0			1	0.8	
hot	0			0			0		

Rf data: no values significant. Sprouts are taller than seedlings

Archeria hirtella
ss. = 3

Importance Values

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance
unburnt	0			0			2	12.7	1.35
mild	0			0			1	9.8	
hot	0			0			0		

Rf data: no significant differences. Sample size too small

Cover

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance
unburnt	0			0			2	7.3	55.52
mild	0			0			1	0.3	
hot	0			0			0		

Rf data: no significant differences.

Seedling/Sprout Proportions

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance
unburnt	0			0			2	16.7	555.60
mild	0			0			1	25.0	
hot	0			0			0		

Rf data: no significant differences. Main method of regeneration is by sprouts.

Seedling height

Burn Intensity	Callidendrous			Thamnic			Implicate		
	n.	mean	variance	n.	mean	variance	n	mean	variance
unburnt	0			0			2	0.5	0.52
mild	0			0			1	0.1	
hot	0			0			0		

Rainforest/Forest Type

Rf data: no significant differences.

Sprout height

Burn Intensity	Callidendrous			Thamnic			Implicate		
	n.	mean	variance	n.	mean	variance	n	mean	variance
unburnt	0			0			2	4.1	0.14
mild	0			0			1	0.2	
hot	0			0			0		

Rainforest/Forest Type

Rf data: no significant differences. Sprouts taller than seedlings.

Aristotelia peduncularis
ss. = 10 (12)

Importance Values

Burn Intensity	Callidendrous			Thamnic			Implicate			Mixed Forest		
	n.	mean	variance	n.	mean	variance	n	mean	variance	n	mean	variance
unburnt	3	2.1	2.88	1	3.5		0					
mild	3	1.6	0.27	1	0.9		0					
hot	1	1.5		1	1.3		0			2.0	0.7	0.00

Rainforest/Forest Type

Rf & All data: no significant differences.

Cover
Values too small for analysis

Height

Burn Intensity	Callidendrous			Thamnic			Implicate			Mixed Forest		
	n.	mean	variance	n.	mean	variance	n	mean	variance	n	mean	variance
unburnt	3	0.1	0.00	1	1.3		0					
mild	2	0.1	0.00	1	0.1		0					
hot	1	0.4	0.00	1	0.3		0			2.0	0.1	0.00

Rainforest/Forest Type

Rf data: Ftests have burn intensity, rainforest type & interactions significant ($p<0.005$). Callidendrous/unburnt significant from ($p<0.001$) hot, thamnic , hot/thamnic, mild/thamnic

All data: burn intensity, rainforest type and interactions significant ($p<0.005$). Interactions: callidendrous/unburnt significant from hot ($p<0.01$), thamnic ($p<0.001$), mixedforest ($p<0.01$), mild/thamnic & hot/thamnic ($p<0.001$). Thamnic/mild significant from unburnt ($p<0.001$), hot ($p<0.01$) & unburnt/implicate ($p<0.001$). Mixedforest/hot signficant from unburnt ($p<0.001$), mild ($p<0.05$), callidendrous ($p<0.01$) & thamnic ($p<0.05$)

Atherosperma moschatum
ss. = 41 (48)

Importance Values

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance	Mixed Forest n	mean	variance
					Rainforest/Forest Type							
unburnt	4	29.5	209.59	3	14.7	140.67	2	15.6	40.21			
mild	5	16.3	13.23	7	13.6	9.47	3	3.6	5.03	1.0	3.7	
hot	5	10.7	9.29	6 (7)	9.3 (9.6)	25.53 (21.78)	6 (7)	5.0 (4.7)	21.40 (18.89)	4.0	9.8	21.86

Rf data: burn intensity & rainforest type significant ($p<0.005$); unburnt from mild ($p<0.01$) & hot ($p<0.001$), implicate significant from callidendrous ($p<0.001$).
All data: burn intensity ($p<0.005$) & rainforest type ($p<0.01$) significant; unburnt significant from mild ($p<0.01$) & hot ($p<0.001$). Implicate significantly lower than callidendrous ($p<0.001$) & thamnic ($p<0.05$); callidendrous significant from thamnic ($p<0.05$) and implicate ($p<0.001$).

Cover

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n.	mean	variance	Mixed Forest n.	mean	variance
					Rainforest/Forest Type							
unburnt	4	20.7	186.36	3	13.3	88.69	2	9.0	48.62			
mild	5	0.9	2.41	7	1.3	1.40	3	0.2	0.08	1.0	0.0	
hot	5	0.1	0.01	6 (7)	0 (0.01)	0.00	6 (7)	0.1 (0.1)	0.04	4.0	0.1	0.01

Rf data: burn intensity significant ($p<0.05$); unburnt significant from hot ($p<0.001$) and mild ($p<0.001$).
All data: burn intensity significant ($p<0.05$); unburnt significant from hot ($p<0.001$) and mild ($p<0.001$).

Seedling/Sprout proportions

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance	Mixed Forest n	mean	variance
					Rainforest/Forest Type							
unburnt	4	84.7	319.90	3	92.3	177.50	2	50.0	555.60	0.0		
mild	5	93.0	91.40	7	83.6	50.00	3	94.4	92.60	1.0	100.0	
hot	5	89.3	138.70	6 (7)	100 (98.7)	0 (11.8)	6 (7)	61.7 (67.14)	2416.7 (2223.8)	4.0	90.6	181.50

Rf data: rainforest type ($p<0.05$); implicate significantly lower than callidendrous ($p<0.05$) & thamnic ($p<0.02$).
All data: F tests not significant, ttests implicate significant from callidendrous ($p<0.05$) & thamnic ($p<0.05$).

Seedling height

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance	Mixed Forest n	mean	variance
					Rainforest/Forest Type							
unburnt	4	3.7	4.67	3	4.3	3.86	2	2.6	0.44	0.0		
mild	5	0.1	0.03	7	0.6	0.58	3	0.0	0.00	1.0	0.0	
hot	5	0.0	0.00	6 (7)	0.04 (0.05)	0.001 (0.001)	6 (7)	0.06 (0.06)	0.008 (0.007)	4.0	0.1	0.00

Rf data: burn intensity significant ($p<0.005$); unburnt significant ($p<0.001$) from mild & hot.
All data: burn intensity significant ($p<0.005$); unburnt significant ($p<0.001$) from mild & hot.

Sprout height

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance	Mixed Forest n	mean	variance
					Rainforest/Forest Type							
unburnt	4	2.9	15.81	3	1.1	3.85	2	3.4	22.35			
mild	5	0.2	0.11	7	1.7	2.91	3	0.1	0.06	1.0	0.0	
hot	5	0.3	0.25	6 (7)	0 (0)	0 (0)	6 (7)	0.6 (0.5)	0.43 (0.40)	4.0	0.1	0.03

Rf data: burn intensity significant (p<0.025); unburnt signficant from mild (p<0.05) & hot (p<0.005).
All data: burn intensity significant (p<0.01); unburnt significant from mild (p<0.05) & hot (p<0.002).

Blechnum wattsii
ss.=31 (38)

Importance Values

Burn Intensity	Callidendrous			Rainforest/Forest Type Thamnic			Implicate			Mixed Forest		
	n.	mean	variance	n.	mean	variance	n	mean	variance	n	mean	variance
unburnt	3	14.6	18.47	3	12.8	88.52	3	18.8	36.58			
mild	2	3.5	3.94	5	9.2	57.70	3	9.0	1.33	1.0	14.1	
hot	1	7.6		5 (6)	12.5 (12.63)	13.15 (10.66)	6 (7)	10.4 (11.9)	27.50 (38.29)	4.0	11.9	66.32

Rf data: burn intensity significant (p<0.05); mild significantly lower than unburnt (p<0.01).
All data: no significant differences, the extra sites had some large variances, expecially the mixed forest sites

Cover

Burn Intensity	Callidendrous			Rainforest/Forest Type Thamnic			Implicate			Mixed Forest		
	n.	mean	variance	n.	mean	variance	n.	mean	variance	n.	mean	variance
unburnt	3	0.2	0.12	3	2.5	16.14	3	1.4	1.52			
mild	2	0.0	0.00	5	0.7	2.24	3	0.1	0.01	1.0	2.5	
hot	1	0.1		5 (6)	0.21 (0.65)	0.083 (1.266)	6 (7)	0.51 (2.49)	0.753 (28.146)	4.0	3.5	34.22

Rf data: no significant differences, variances are variable.
All data: no significant differences.

Height

Burn Intensity	Callidendrous			Rainforest/Forest Type Thamnic			Implicate			Mixed Forest		
	n.	mean	variance	n.	mean	variance	n	mean	variance	n		variance
unburnt	3	0.2	0.03	3	0.4	0.14	3	0.4	0.11			
mild	2	0.1	0.00	5	0.2	0.05	3	0.2	0.01	1.0	0.4	
hot	1	0.3		5 (6)	0.2 (0.2)	0.03 (0.03)	6 (7)	0.4 (0.4)	0.1 (0.11)	4.0	0.4	0.05

Rf data: no significant differences.
All data: no significant differences.

Carex appressa
ss.=8 (9)

Importance Values

Burn Intensity	Callidendrous			Rainforest/Forest Type Thamnic			Implicate			Mixed Forest		
	n.	mean	variance	n.	mean	variance	n	mean	variance	n	mean	variance
unburnt	0			0			0					
mild	1	5.8		2	1.2	0.60	0			0.0		
hot	1	1.0		2	0.7	0.01	2	3.4	1.60	1.0	1.4	

Rf data: F values show rainforest type significant (p<0.05); Ttests have callidendrous significant (p<0.05) only at regression determining interactions.
All data: no significant differences.

Cover

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n.	mean	variance	Mixed Forest n.	mean	variance
unburnt	0			0			0			0.0		
mild	1	1.5		2	0.8	1.13	0			0.0		
hot	1	0.5		2	0.0	0.00	2	1.3	1.39	1.0	0.3	

Rf data & All data: no significant differences.

Height

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance	Mixed Forest n.	mean	variance
unburnt	0			0			0			0.0		
mild	1	0.9		2	0.4	0.23	0			0.0		
hot	1	0.4		2	0.1	0.00	2	0.9	0.01	1.0	1.0	

Rf data & All data: no significant differences.

Cenarrhenes nitida
ss. = 20 (26)

Importance Values

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance	Mixed Forest n.	mean	variance
unburnt	1	2.2		1	13.8		2	11.7	1.35			
mild	1	0.7		3	2.0	5.12	3	8.7	25.13	1.0	2.2	
hot	1	3.0		4	2.1	2.93	4 (5)	1.9 (2.8)	0.02 (4.89)	4.0	4.4	7.70

Rf data: burn intensity ($p<0.005$), rainforest type & interactions ($p<0.05$) significant; unburnt from mild ($p<0.05$) & hot ($p<0.01$); callidendrous significant from implicate ($p<0.05$). Interactions: unburnt/callidendrous signficant from thamnic ($p<0.01$), implicate($p<0.02$), mild/thamnic & hot/implicate ($p<0.05$). Mild/thamnic significant from implicate ($p<0.01$), unburnt/implicate ($p<0.05$) & hot/implicate ($p<0.05$).
All data: burn intensity ($p<0.005$) & rainforest type ($p<0.05$) significant; unburnt from mild ($p<0.02$) & hot ($p<0.01$); implicate from callidendrous ($p<0.05$).

Cover

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n.	mean	variance	Mixed Forest n.	mean	variance
unburnt	1	0.0		1	4.7		2	3.9	0.40			
mild	1	0.0		3	0.5	0.88	3	1.8	0.73	1.0	0.0	
hot	1	0.3		4	0.6	0.64	4 (5)	1.1 (1.2)	0.43 (0.47)	4.0	0.1	0.01

Rf data: burn intensity ($p<0.005$) & rainforest type ($p<0.01$) significant; unburnt from mild ($p<0.02$) & hot ($p<0.01$); callidendrous from thamnic ($p<0.05$) & implicate ($p<0.01$).
All data: burn intensity ($p<0.005$) & rainforest type & interactions ($p<0.05$) significant; unburnt significant from mild ($p<0.01$) & hot ($p<0.001$); implicate significant from mixforest ($p<0.01$). Callidendrous significant from thamnic ($p<0.05$) and implicate ($p<0.01$). Interactions: callidendrous/unburnt significant from thamnic & implicate ($p<0.001$), mild/thamnic & hot/thamnic ($p<0.01$) & hot/implicate ($p<0.05$). Thamnic/mild significant from unburnt ($p<0.001$) & implicate ($p<0.05$). Mixforest/hot significant from unburnt ($p<0.001$) & implicate ($p<0.05$).

Seed/Sprout Proportions

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n	Implicate mean	Implicate variance	Mixed Forest n	Mixed Forest mean	Mixed Forest variance
unburnt	1	100.0		1	90.0		2	29.9	116.70	0.0		
mild	1	100.0		3	88.9	370.40	3	30.0	300.00	1.0	100.0	
hot	1	100.0		4	64.3	2244.90	4 (5)	12.5 (14.4)	625 (487.7)	4.0	100.0	0.00

Rf data: rainforest type significant (p<0.005); implicate significant from callidendrous & thamnic (p<0.001).
All data: rainforest type significant (p<0.005); implicate significant from callidendrous (p<0.001), thamnic (p< 0.001) and mixedforest (p<0.001).

Seedling Height

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n	Implicate mean	Implicate variance	Mixed Forest n	Mixed Forest mean	Mixed Forest variance
unburnt	1	0.1		1	2.6		2	1.2	0.63			
mild	1	0.3		3	0.2	0.09	3	0.2	0.06	1.0	0.2	
hot	1	1.7		4	0.2	0.15	4 (5)	0.002 (0.009)	0 (0.0002)	4.0	0.2	0.01

Rf type: burn intensity (p<0.005) & interactions (p<0.005) significant; unburnt signficant from mild & hot (p<0.02). Interactions: callidendrous/unburnt significant from hot (p<0.01), thamnic (p<0.001), implicate (p<0.05), mild/thamnic (p<0.01), hot/thamnic & hot/implicate (p<0.001) (all except mild & mild/implicate). Thamnic/mild significant from unburnt (p<0.001), implicate/unburnt & callidendrous/hot (p<0.05). implicate/unburnt (p<0.05), callidendrous/hot (p<0.05).
All data: burn intensity (p<0.005) & interactions (p<0.005) significant; unburnt significant from mild (p<0.005) & hot (p<0.005). Interaction: callidendrous/ /unburnt signficant from all values except mild. Mild/thamnic significant from unburnt (p<0.001), mixedforest (p<0.005), unburnt/callidendrous (p<0.01) & callidendrous/hot (p<0.02). Mixedforest/hot significant from unburnt (p<0.001), callidendrous (p<0.001), unburnt/callidendrous (p<0.0001), unburnt/thamnic (p<0.02) & mild/callidendrous (p<0.05).

Sprout height

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n	Implicate mean	Implicate variance	Mixed Forest n	Mixed Forest mean	Mixed Forest variance
unburnt	1	0.0		1	0.3		2	3.7	1.05			
mild	1	0.0		3	1.1	3.52	3	1.1	0.02	1.0	0.0	
hot	1	0.0		4	0.5	0.32	4 (5)	1.1 (1.1)	0.14 (0.12)	4.0	0.0	0.00

Rf data: rainforest type significant (p<0.025); implicate significantly higher than callidendrous (p<0.02).
All data: burn intensity (p<0.025) & rainforest type (p<0.01) significant; unburnt significant from hot (p<0.05), implicate significant from callidendrous (p<0.01) & mixforest (p<0.02).

Coprosoma quadrifida
ss. = 24 (30)

Importance Values

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n	Implicate mean	Implicate variance	Mixed Forest n	Mixed Forest mean	Mixed Forest variance
unburnt	4	11.7	7.95	1	15.4		0					
mild	4	6.9	30.36	5	5.6	12.72	0			1.0	2.8	
hot	5	6.5	14.88	3 (4)	4.0 (4.1)	6.14 (4.09)	2 (3)	1.3 (1.1)	0.32 (0.33)	3.0	4.5	13.70

Rf data: burn intensity significant (p<0.005); unburnt significant from mild (p<0.01) & hot (p<0.01).
All data; rainforest type significant (p<0.05); mixedforest significantly lower than thamnic (p<0.05) and implicate (p<0.01).

Cover

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n.	mean	variance	Mixed Forest n.	mean	variance
Unburnt	4	0.5	1.00	1	1.3		0					
mild	4	0.1	0.01	5	0.1	0.01	0			1.0	0.2	
hot	5	0.1	0.01	3 (4)	0.04 (0.06)	0.005 (0.004)	2 (3)	0.2 (0.2)	0.12 (0.08)	3.0	0.1	0.01

Rf data: No signficant F tests; ttests indicate than unburnt significant from mild (p<0.05) and hot (p<0.05).
All data: burn intensity significant (p<0.05); unburnt significant from mild (p<0.01) & hot (p<0.01).

Height

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance	Mixed Forest n	mean	variance
unburnt	4	0.7	1.49	1	2.0		0					
mild	4	0.3	0.05	5	0.4	0.05	0			1.0	0.1	
hot	5	0.3	0.03	3 (4)	0.1 (0.1)	0.01 (0.01)	2 (3)	1.1 (0.9)	0.91 (0.57)	3.0	0.3	0.07

Rf data & All data: no significant differences

Cyathodes juniperana
ss. = 28 (33)

Importance Values

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance	Mixed Forest n	mean	variance
unburnt	0			1	2.8		2	3.3	0.34			
mild	3	7.5	36.04	5	4.7	11.10	3	12.4	56.74	1.0	2.2	
hot	3	3.9	5.53	5	9.4	20.85	6 (7)	8.8 (9.2)	31.96 (27.97)	3.0	1.0	0.14

Rf data: no significant differences. Found in proportionally more burnt than unburnt sites.
All data: rainforest type significant (p<0.05); mixedforest significantly lower than thamnic (p<0.05) & implicate (p<0.01).

Cover

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n.	mean	variance	Mixed Forest n.	mean	variance
unburnt	0			1	0.2		2	1.1	0.91			
mild	3	0.3	0.16	5	0.0	0.00	3	1.2	1.27	1.0	0.2	
hot	3	0.2	0.15	5	0.3	0.06	6 (7)	0.2 (0.4)	0.07 (0.31)	3.0	0.0	0.00

Rf data & All data: no significant differences.

Seedling Height

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n.	mean	variance	Mixed Forest n.	mean	variance
unburnt	0			1	1.8		2	2.2	0.85			
mild	3	0.4	0.11	5	0.3	0.02	3	0.5	0.02	1.0	0.5	
hot	3	0.4	0.01	5	0.6	0.01	6 (7)	0.5 (0.6)	0.004 (0.01)	3.0	0.2	0.02

Rf & All data: burn intensity significant (p<0.001); unburnt significant from mild (p<0.001) & hot (p<0.001).

Dianella tasmanica - regressions from 'All data' only
ss. = 9

Importance Values

Burn Intensity	n.	Callidendrous mean	variance	n.	Thamnic mean	variance	n	Implicate mean	variance	n	Mixed Forest mean	variance
unburnt	0			0			0					
mild	1	1.5		0			2	3.2	1.28	0.0		
hot	0			1	2.6		3	4.3	25.98	2.0	9.4	7.37

All data: no significant differences. Only recorded from burnt sites.

Cover

Burn Intensity	n.	Callidendrous mean	variance	n.	Thamnic mean	variance	n.	Implicate mean	variance	n.	Mixed Forest mean	variance
unburnt	0			0			0					
mild	1	0.5		0			2	1.1	0.95	0.0		
hot	0			1	0.0		3	0.9	0.38	2.0	0.8	0.13

All data: no significant differences.

Seedling Height

Burn Intensity	n.	Callidendrous mean	variance	n.	Thamnic mean	variance	n.	Implicate mean	variance	n.	Mixed Forest mean	variance
unburnt	0			0			0					
mild	1	0.6		0			2	0.6	0.05	0.0		
hot	0			1	0.7		3	0.7	0.06	2.0	0.7	0.00

All data: no significant differences.

Dicksonia antarctica
ss. = 32 (36)

Importance Values

Burn Intensity	n.	Callidendrous mean	variance	n.	Thamnic mean	variance	n	Implicate mean	variance	n	Mixed Forest mean	variance
unburnt	4	15.3	116.72	2	1.1	0.04	0					
mild	5	3.5	8.41	7	7.8	19.24	2	3.5	16.01	0.0		
hot	5	8.9	9.96	4 (5)	3.2 (3.0)	2.20 (2.91)	3	3.0	3.20	3.0	4.4	3.02

Rf data: interactions significant ($p<0.01$); callidendrous/unburnt significant ($p<0.01$) from mild, thamnic, mild/thamnic.
Mild/thamnic significant from unburnt/callidendrous ($p<0.01$) & hot/callidendrous ($p<0.05$)
All data: interactions significant ($p<0.025$); callidendrous/unburnt significant ($p<0.001$) from mild/thamnic.
Mild/thamnic significant from unburnt/callidendrous ($p<0.001$) & hot/callidendrous ($p<0.02$)

Cover Values

Burn Intensity	n.	Callidendrous mean	variance	n.	Thamnic mean	variance	n	Implicate mean	variance	n	Mixed Forest mean	variance
unburnt	4	5.9	30.27	2	0.0	0.00	0					
mild	5	0.4	0.27	7	1.0	3.72	2	0.0	0.00	0.0		
hot	5	2.7	8.46	4 (5)	0 (0.1)	0 (0.05)	3	0.0	0.00	3.0	0.0	0.00

Rf data: Burn intensity significant (p<0.05); unburnt significant from mild (p<0.02) & hot (p<0.05).
All data: Burn intensity significant (p<0.025); unburnt significant from mild (p<0.02) & hot (p<0.02).

Seedling/Sprout relationships

Burn Intensity	Rainforest/Forest Type											
	Callidendrous			Thamnic			Implicate			Mixed Forest		
	n.	mean	variance	n.	mean	variance	n	mean	variance	n	mean	variance
unburnt	4	100.0	0.00	2	100.0	0.00	0					
mild	5	100.0	0.00	7	100.0	0.00	2	100.0	0.00	0.0		
hot	5	100.0	0.00	4 (5)	100.0	0.00	3	100.0	0.00	3.0	95.2	68.03

Rf data: no significant differences
All data: rainforest type significant (p<0.025); mixforest significant from callidendrous (p<0.01), thamnic (p<0.01) & mixedforest (p<0.01).

Height

Burn Intensity	Rainforest/Forest Type											
	Callidendrous			Thamnic			Implicate			Mixed Forest		
	n.	mean	variance	n.	mean	variance	n	mean	variance	n	mean	variance
unburnt	4	1.8	1.39	2	0.0	0.00	0					
mild	5	0.3	0.20	7	0.7	0.92	2	0.1	0.00	0.0		
hot	5	1.3	0.36	4 (5)	0.08 (0.10)	0.001 (0.004)	3	0.1	0.00	3.0	0.1	0.00

Rf data: F tests have rainforest type (p<0.05) and interactions (p<0.05) significant. Interactions; callidendrous/unburnt signficant from mild (p<0.01), thamnic (p<0.01), implicate (p<0.05), mild/thamnic (p<0.01); thamnic/mild significant from unburnt/callidendrous (p<0.01), hot/callidendrous (p<0.02).
All data: interactions significant (p<0.025); callidendrous/unburnt signficant from mild (p<0.005), thamnic (p<0.01), implicate (p<0.02), mixedforest (p<0.02) & mild/thamnic (p<0.01). Thamnic/mild significant from cath (p<0.01), callidendrous/hot (p<0.01). Mixedforest/hot significant from callidendrous (p<0.02).

Drymophilia cyanocarpa
ss. = 8 (12)

Importance Values

Burn Intensity	Rainforest/Forest Type											
	Callidendrous			Thamnic			Implicate			Mixed Forest		
	n.	mean	variance	n.	mean	variance	n	mean	variance	n	mean	variance
unburnt	2	2.2	0.36	0			0					
mild	1	2.5		2	0.6	0.00	1	0.6		1.0	0.9	
hot	0			2 (3)	3.3 (3.0)	10.28 (5.32)	1	0.6		1.0	0.7	

Rf data: no significant differences. Sample size too small, results inconclusive.
All data: no significant differences.

Cover
Values too small nothing is significant.

Height

Burn Intensity	Rainforest/Forest Type											
	Callidendrous			Thamnic			Implicate			Mixed Forest		
	n.	mean	variance	n.	mean	variance	n	mean	variance	n	mean	variance
unburnt	2	0.1	0.01	0			0					
mild	1	0.1		2	0.0	0.00	1	0.4		1.0	0.3	
hot	0			2 (3)	0.2 (0.2)	0.05 (0.04)	0 (1)	0.2		1.0	0.2	

Rf & All data: no significant differences.

Eucryphia lucida
ss. = 40 (47)

Importance Values

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance	Mixed Forest n	mean	variance
unburnt	4	13.7	94.17	2	11.1	116.48	3	15.7	17.74			
mild	5	7.3	21.41	7	9.9	41.57	3	9.9	13.73	1	1.3	
hot	3	6.4	19.48	7 (8)	9.3 (9.9)	18.07 (17.73)	6 (7)	6.4 (6.5)	13.3 (11.14)	4	9.6	19.72

Rf data: burn intensity significant ($p<0.05$); unburnt significant from mild ($p<0.05$) & hot ($p<0.02$).
All data: burn intensity significant ($p<0.05$); unburnt significant from mild ($p<0.05$) & hot ($p<0.02$).

Cover

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n.	mean	variance	Mixed Forest n.	mean	variance
unburnt	4	9.5	31.16	2	8.5	1.81	3	6.9	3.41			
mild	5	0.8	1.03	7	1.4	2.16	3	2.0	1.88	1	0.0	
hot	3	0.2	0.07	7 (8)	0.4 (0.5)	0.38 (0.48)	6 (7)	0.8 (1.1)	0.20 (0.65)	4	0.4	0.16

Rf data: burn intensity significant ($p<0.005$); unburnt significant from mild ($p<0.001$) & hot ($p<0.001$).
All data: burn intensity significant ($p<0.005$); unburnt significant from mild ($p<0.001$) & hot ($p<0.001$).

Seedling/Sprout proportions

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance	Mixed Forest n	mean	variance
unburnt	4	91.7	277.80	2	95.5	41.30	3	77.6	93.30	0		
mild	5	77.5	1906.20	7	76.2	391.10	3	10.2	86.50	1	100.0	
hot	3	95.8	52.10	7 (8)	68.2 (69.3)	1426.5 (1232.2	6 (7)	19.1 (19.54)	657 (548.9)	4	91.5	139.00

Rf data: burn intensity ($p<0.05$) & rainforest type ($p<0.005$) significant; unburnt significant from hot ($p<0.05$) and mild ($p<0.02$) (2nd analysis).
Implicate significant from callidendrous ($p<0.001$) & thamnic ($p<0.001$).
All data: burn intensity ($p<0.05$) & rftype($p<0.005$) significant; unburnt significant from hot ($p<0.02$) and mild ($p<0.02$), mild significant from hot ($p<0.02$), (burn intensity only significant at the 2nd level). Rainforest type has same significance as Rf data with mixedforest significant from implicate ($p<0.001$).

Height of Seedlings

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance	Mixed Forest n	mean	variance
unburnt	4	6.6	2.25	2	12.3	0.42	3	6.5	8.54			
mild	5	0.3	0.08	7	0.4	0.13	3	0.0	0.00	1	0.2	
hot	3	0.8	0.64	7 (8)	0.2 (0.3)	0.07 (0.09)	6 (7)	0.1 (0.2)	0.06 (0.05)	4	0.4	0.12

Rf data: burn intensity ($p<0.005$), rftype ($p<0.01$) & interactions ($p<0.005$) signficant; unburnt significant from mild & hot ($p<0.001$), no significant Ttests for rainforest type. Interactions: callidendrous/unburnt significant ($p<0.001$) from mild, hot, thamnic, mild/thamnic & hot/thamnic.
Thamnic/mild significant ($p<0.001$) from unburnt, unburnt/callidendrous, unburnt/implicate.
All data: Burn intensity & interactions ($p<0.005$) & rainforest type ($p<0.025$) significant; unburnt significant from mild & hot ($p<0.001$), implicate significant from thamnic ($p<0.05$). Interactions same as Rf data with mixedforest/hot significant from unburnt ($p< 0.001$) & unburnt/thamnic ($p<0.001$).

Height of Sprouts

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance	Mixed Forest n	mean	variance
unburnt	4	0.7	1.84	2	0.1	0.03	3	1.6	6.77			
mild	5	0.3	0.29	7	1.3	1.45	3	2.5	0.45	1	0.0	
hot	3	0.2	0.11	7 (8)	0.4 (0.4)	0.33 (0.29)	6 (7)	1.3 (1.5)	0.13 (0.34)	4	0.1	

Rf data: rainforest type significant (p<0.01); implicate significant from callidendrous (p<0.01) and thamnic (p<0.02).
All data: rainforest type significant (p<0.005); implicate significant from callidendrous (p<0.001), thamnic (p<0.005) & mixedforest (p<0.005).

Grammitis billardieri
ss. = 18 (19)

Importance Value

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n	Implicate mean	Implicate variance	Mixed Forest n	Mixed Forest mean	Mixed Forest variance
unburnt	4	19.5	8.24	3	16.7	40.80	3	15.4	28.15	0		
mild	1	1.1		4	2.4	2.27	0			0		
hot	1	0.9		2	4.3	7.49	0			1	0.7	

Rf data & All data: burn intensity significant (p<0.005); unburnt significant from mild (p<0.001) and hot (p<0.001).

Cover values too small for analysis - nothing significant

Height

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n	Implicate mean	Implicate variance	Mixed Forest n	Mixed Forest mean	Mixed Forest variance
unburnt	4	0.1	0.00	3	0.1	0.00	3	0.0	0.00	0		
mild	0			4	0.0	0.00	0			0		
hot	1	0.0		2	0.0	0.00	0			1	0.0	

Rf type: no significant differences

Histiopterus incisa
ss. = 35 (40)

Importance Value

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n	Implicate mean	Implicate variance	Mixed Forest n	Mixed Forest mean	Mixed Forest variance
unburnt	3	3.7	11.76	1	1.4		1	0.9				
mild	5	23.3	290.81	7	12.5	4.26	3	13.7	109.29	0		
hot	5	18.7	19.30	5 (6)	7.8 (7.1)	7.97 (9.29)	5 (6)	10.8 (10.8)	23.86 (19.09)	3	7.6	2.80

Rf type: burn intensity (p<0.01) & rainforest type (p<0.025) significant; unburnt significant from mild (p<0.01) & hot (p<0.05), callidendrous significant from thamnic (p=0.01) & implicate (p=0.05).
All data: burn intensity (p<0.005) & rainforest type (p<0.025) significant; unburnt significantly lower than mild (p<0.01) & hot (p<0.05),
callidendrous significantly higher than thamnic (p<0.01), implicate (p<0.02) & mixedforest (p<0.05).

Cover Values

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance	Mixed Forest n.	Mixed Forest mean	Mixed Forest variance
unburnt	3	0.7	0.69	1	0.0		1	0.0				
mild	5	8.7	256.90	7	1.2	1.21	3	2.7	17.82	0		
hot	5	3.3	16.01	5 (6)	0.1 (0.3)	0.05 (0.23)	5 (6)	0.8 (0.8)	1.17 (0.94)	3	0.5	0.50

Rf data & All data: no significant differences.

Seedling Height

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n	Implicate mean	Implicate variance	Mixed Forest n	Mixed Forest mean	Mixed Forest variance
unburnt	3	0.8	0.07	1	0.2		1	0.1				
mild	5	0.9	0.11	7	1.0	0.05	3	1.0	0.12	0		
hot	5	0.9	0.02	5 (6)	0.6 (0.6)	0.10 (0.09)	5 (6)	0.8 (0.8)	0.15 (0.13)	3	0.6	0.14

(Rainforest/Forest Type)

Rf data & All data: burn intensity significant ($p<0.01$); mild significant from unburnt ($p<0.005$) & hot ($p<0.05$).

Hydrocotyle javanica
ss. = 32 (34)

Importance Value

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n	Implicate mean	Implicate variance	Mixed Forest n	Mixed Forest mean	Mixed Forest variance
unburnt	3	5.9	13.80	1	2.5		0					
mild	5	16.2	26.12	6	12.0	5.79	2	7.0	53.87	0		
hot	5	10.4	32.78	6	7.6	32.70	4 (5)	10.3 (9.3)	21.73 (20.80)	1	3.9	

(Rainforest/Forest Type)

Rf data: burn intensity significant ($p<0.025$); unburnt significant from mild ($p<0.02$). Is more prevalent in burnt sites
All data: burn intensity significant ($p<0.025$); mild significant from unburnt ($p<0.02$) & hot ($p<0.05$).

Cover

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n	Implicate mean	Implicate variance	Mixed Forest n	Mixed Forest mean	Mixed Forest variance
unburnt	3	0.0	0.00	1	0.0		0					
mild	5	0.2	0.05	6	0.0	0.00	2	0.1	0.03	0		
hot	5	0.1	0.03	6	0.0	0.00	4 (5)	0.01 (0.03)	0.0006 (0.002)	1	0.0	

(Rainforest/Forest Type)

Rf data: rainforest type significant ($p<0.05$); thamnic significant from callidendrous ($p<0.02$).
All data: no significant differences

Seedling Heights
Heights were too small to be analysed.

Hymenophyllum australe
ss. = 10

Importance Value

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n	Implicate mean	Implicate variance
unburnt	3	9.3	43.21	3	9.8	6.08	3	12.9	2.10
mild	0			1	0.7		0		
hot	0			0			0		

(Rainforest/Forest Type)

Rf data: no significant differences. Recorded in only one burnt site, a thamnic mild fire site.

Cover

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance
				Rainforest/Forest Type					
unburnt	3	0.0	0.00	3	0.0	0.00	3	0.3	0.24
mild	0			1	0.0		0		
hot	0			0			0		

Rf data: no significant differences, too many zeros.

Seedling Height

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance
				Rainforest/Forest Type					
unburnt	2	0.0	0.00	3	0.0	0.00	3	0.0	0.00
mild	0			1	0.0		0		
hot	0			0			0		

Rf data: No significant differences.

Hymenophyllum flabellatum
ss. = 8

Importance Values

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance
				Rainforest/Forest Type					
unburnt	4	7.5	20.25	2	2.1	0.88	1	1.9	
mild	0			0			0		
hot	1	1.8		0			0		

Rf data: no significant differences. Recolonisation after fire appears limited.

Cover
Values too small all zeros.

Height

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance
				Rainforest/Forest Type					
unburnt	3	0.1	0.00	2	0.1	0.00	1	0.1	
mild	0			0			0		
hot	1	0.0		0			0		

Rf type: no significant differences, values too small.

Hymenophyllum rarum
ss. = 11

Importance Value

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance
				Rainforest/Forest Type					
unburnt	2	19.0	1.83	3	15.3	67.36	3	16.4	4.46
mild	0			2	1.2	0.33	0		
hot	1	1.2		0			0		

Rf type: burn intensity significant ($p<0.025$); unburnt significant from mild ($p<0.01$) & hot ($p<0.02$).

Cover

Burn Intensity	Rainforest Type Callidendrous n.	mean	variance	Rainforest/Forest Type Thamnic n.	mean	variance	Implicate n	mean	variance
unburnt	2	0.3	0.00	3	0.1	0.01	3	0.1	0.03
mild	0			2	0.0	0.00	0		
hot	1	0.0		0			0		

Rf data: No F tests significant, ttests indicate that callidedrous significant from thamnic ($p<0.05$).

Height
Values too small, all zeros.

Hypolepis rugosula
ss. = 33 (39)
Importance Value

Burn Intensity	Callidendrous n.	mean	variance	Rainforest/Forest Type Thamnic n.	mean	variance	Implicate n	mean	variance
unburnt	1	4.7		0			1	1.2	
mild	5	15.6	33.38	7	7.4	1.57	2	8.1	111.03
hot	5	11.8	35.08	7 (8)	5.8 (5.6)	18.42 (16.04)	5 (6)	7.2 (6.8)	26.11 (21.61)

Rf data: rainforest type significant ($p<0.005$); callidendrous significant from thamnic ($p<0.01$) & implicate ($p<0.02$).
All data: rainforest type significant ($p<0.005$); callidendrous significantly higher than thamnic ($p<0.001$), implicate ($p<0.01$) & mixedforest ($p<0.001$).

Cover

Burn Intensity	Callidendrous n.	mean	variance	Rainforest/Forest Type Thamnic n.	mean	variance	Implicate n.	mean	variance	Mixed Forest n.	mean	variance
unburnt	1	0.5		0			1	0.0				
mild	5	0.9	1.41	7	0.1	0.05	2	0.6	0.82	1	0.0	
hot	5	0.5	0.38	7 (8)	0.03 (0.03)	0.004 (0.004)	5 (6)	0.1	0.011 (0.009)	3	0.0	0.00

Rf data: rainforest type significant ($p<0.05$); thamnic significant from callidendrous ($p<0.02$).
All data: rainforest type significant ($p<0.05$); callidendrous significant from thamnic ($p<0.01$) & mixed forest ($p<0.05$).

Height

Burn Intensity	Callidendrous n.	mean	variance	Rainforest/Forest Type Thamnic n.	mean	variance	Implicate n	mean	variance	Mixed Forest n.		
unburnt	1	0.7		0			1	0.0				
mild	5	0.8	0.03	7	0.7	0.07	2	0.7	0.18	1	0.7	
hot	5	0.8	0.03	7 (8)	0.4 (0.5)	0.04 (0.00)	5 (6)	0.5 (0.5)	0.09 (0.01)	3	0.4	0.04

Rf data: rainforest type ($p<0.05$), callidendrous significant from thamnic ($p<0.05$) & implicate ($p<0.05$).
All data: burn intensity significant ($p<0.05$); mild significant from unburnt ($p<0.05$).

Microsorium diversifolium
ss. = 28 (32)

Importance Values

Burn Intensity	Callidendrous			Thamnic			Implicate			Mixed Forest		
	n.	mean	variance	n.	mean	variance	n	mean	variance	n	mean	variance
unburnt	4	4.8	1.80	3	6.3	20.04	1	4.6				
mild	3	2.4	6.38	5	3.2	0.72	2	1.9	0.00	0		
hot	4	4.5	6.08	3 (4)	3.8 (3.1)	24.33 (18.37)	3	1.1	0.16	3	3.2	2.34

(Rainforest/Forest Type)

Rf data: No significant differences.
All data: F tests not significant, but ttests indicate that unburnt significant from mild ($p<0.05$) and hot ($p<0.05$).

Cover

Burn Intensity	Callidendrous			Thamnic			Implicate			Mixed Forest		
	n.	mean	variance	n.	mean	variance	n.	mean	variance	n.	mean	variance
unburnt	4	0.1	0.01	3	0.3	0.15	1	0.5				
mild	3	0.0	0.00	5	0.0	0.01	2	0.0	0.00	0		
hot	4	0.0	0.00	3 (4)	0.0	0.00	3	0.0	0.00	3	0.0	0.00

(Rainforest/Forest Type)

Rf data: burn intensity significant ($p<0.01$); unburnt significant ($p<0.01$) from mild & hot.

Height

Burn Intensity	Callidendrous			Thamnic			Implicate			Mixed Forest		
	n.	mean	variance	n.	mean	variance	n	mean	variance	n	mean	variance
unburnt	4	0.2	0.01	3	0.2	0.01	1	0.4				
mild	3	0.1	0.01	5	0.1	0.00	2	0.0	0.00	0		
hot	4	0.1	0.01	3 (4)	0.06 (0.07)	0.001 (0.001)	3	0.0	0.00	3	0.1	0.00

(Rainforest/Forest Type)

Rf data: burn intensity significant ($p<0.005$), unburnt significant ($p<0.001$) from mild & hot.
All data: burn intensity ($p<0.005$) & interactions ($p<0.05$) significant; unburnt significant from mild ($p<0.001$) & hot (p0.005).
Interactions: callidendrous/unburnt significant from hot ($p<0.05$), implicate ($p<0.01$), mild/implicate ($p<0.001$) & hot/implicate ($p<0.01$).

Monotoca glauca
ss. = 26 (33)

Importance Value

Burn Intensity	Callidendrous			Thamnic			Implicate			Mixed Forest		
	n.	mean	variance	n.	mean	variance	n	mean	variance	n	mean	variance
unburnt	0			1	0.7		2	2.5	3.67			
mild	1	4.6		6	3.7	17.50	3	12.8	3.22	1	13.6	
hot	0			7 (8)	8.4 (8.6)	58.66 (50.66)	6 (7)	17.2 (16.2)	86.22 (78.96)	4	14.2	10.17

(Rainforest/Forest Type)

Rf data: burn intensity & rainforest type significant ($p<0.05$); hot significantly higher than unburnt ($p<0.05$). Implicate significantly higher than thamnic ($p<0.01$).
All data: burn intensity ($p<0.025$) & rainforest type ($p<0.05$) significant; hot significant from unburnt ($p<0.02$) and mild ($p<0.05$). Implicate significant from thamnic ($p<0.01$).

Cover

Burn Intensity	Callidendrous			Thamnic			Implicate			Mixed Forest		
	n.	mean	variance	n.	mean	variance	n.	mean	variance	n.	mean	variance
unburnt	0			1	0.0		2	1.0	0.50			
mild	1	0.0	0.00	6	0.1	0.03	3	0.7	0.51	1	1.5	
hot	0			7 (8)	0.8 (0.9)	3.74 (3.24)	6 (7)	3.5 (3.1)	18.58 (16.71)	4	1.8	0.35

(Rainforest/Forest Type)

Rf data & All data: no significant differences.

Height

Burn Intensity	Rainforest/Forest Type: Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance	Mixed Forest n	mean	variance
unburnt	0			1	3.0		2	3.9	2.22			
mild	1	0.2		6	0.5	0.17	3	1.0	0.69	1	1.6	
hot	0			7 (8)	0.6 (0.7)	0.27 (0.28)	6 (7)	1.6 (1.5)	0.42 (0.38)	4	2.0	0.13

Rf data: burn intensity (p<0.005) & rainforest type (p<0.02) significant; unburnt (p<0.001) significantly higher than mild & hot, implicate from thamnic (p<0.01).
All data: burn intensity (p<0.005) & rainforest type (p<0.005) significant; unburnt significant (p<0.001) from mild & hot,
mixedforest significant from callidendrous (p<0.05) & thamnic (p<0.005), implicate significant from thamnic (p<0.005).

Nothofagus cunninghamii
ss. = 43 (50)

Importance Values

Burn Intensity	Rainforest/Forest Type: Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n.	mean	variance	Mixed Forest n.	mean	variance
unburnt	4	33.1	59.33	3	27.0	28.95	3	26.5	67.52			
mild	5	14.3	6.17	7	16.3	13.63	3	10.0	26.76	1	1.9	
hot	5	14.8	6.85	7 (8)	12.3 (12.4)	24.31 (20.88)	6 (7)	10.2 (10.5)	24.69 (21.16)	4	14.2	0.15

Rf data: burn intensity significant (p<0.005); unburnt (p<0.001) significantly higher than mild & hot.
All data: burn intensity significant (p<0.005); unburnt (p<0.001) significantly higher than mild & hot. Ttests have implicate significant from callidendrous (p<0.02).

Cover

Burn Intensity	Rainforest Type: Callidendrous n.	mean	variance	Rainforest/Forest Type: Thamnic n.	mean	variance	Implicate n.	mean	variance	Mixed Forest n.	mean	variance
unburnt	4	28.8	93.06	3	11.4	61.13	3	14.9	30.36			
mild	5	0.9	2.09	7	2.9	10.88	3	1.7	0.04	1	0.0	
hot	5	0.7	0.80	7 (8)	0.3 (0.4)	0.28 (0.26)	6 (7)	1.1 (1.1)	1.26 (1.05)	4	0.7	0.27

Rf data: burn intensity (p<0.05), rainforest type significant (p<0.05) & interactions significant (p<0.005); unburnt (p<0.001) significant from mild & hot.
Interactions: callidendrous/unburnt (p<0.001) significant from mild, hot, thamnic, implicate, mild/thamnic, hot/thamnic, hot/implicate & from mild/implicate (p<0.01).
All data: Interactions significant (p<0.005); callidendrous/unburnt (p<0.001) significant from mild, hot, thamnic, implicate, mild/thamnic, mild/implicate
hot/thamnic & hot/implicate.

Seedling/Sprout Proportions

Burn Intensity	Rainforest/Forest Type: Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance	Mixed Forest n.	mean	variance
unburnt	4	96.9	39.10	3	93.9	27.50	3	81.6	597.70			
mild	5	93.3	37.00	7	84.5	196.50	3	33.4	432.90	1	100.0	
hot	5	85.3	189.70	7	88.7	348.20	6	56.8	1102.90	4	93.3	66.70

Rf data: rainforest type significant (p<0.005); implicate (p<0.001) significant from callidendrous & thamnic.
All data: rainforest type significant (p<0.005); implicate (p<0.001) significant from callidendrous, thamnic & mixedforest.
Ttests indicate mild significant from unburnt (p<0.001).

Seedling Height

Burn Intensity	Rainforest/Forest Type Callidendrous			Thamnic			Implicate			Mixed Forest		
	n.	mean	variance	n.	mean	variance	n	mean	variance	n	mean	variance
unburnt	4	9.3	15.15	3	6.1	15.40	3	7.6	4.76			
mild	5	0.6	0.57	7	1.7	1.78	3	0.2	0.04	1	0.1	
hot	5	1.0	1.00	7 (8)	0.4 (0.4)	0.07 (0.07)	6 (7)	0.8 (0.8)	0.5 (0.4)	4	0.8	0.09

Rf & All data: burn intensity significant ($p<0.005$); unburnt significantly higher ($p<0.001$) than mild & hot.

Sprout Height

Burn Intensity	Rainforest/Forest Type Callidendrous			Thamnic			Implicate			Mixed Forest		
	n.	mean	variance	n.	mean	variance	n	mean	variance	n	mean	variance
unburnt	4	0.1	0.02	3	0.3	0.14	3	2.0	11.32			
mild	5	0.2	0.03	7	0.9	0.80	3	2.6	0.20	1	0.0	
hot	5	0.3	0.10	7 (8)	0.3 (0.3)	0.30 (0.29)	6 (7)	1.6 (1.5)	1.94 (1.66)	4	0.1	0.03

Rf data: rainforest type significant ($p<0.005$); implicate significant from callidendrous ($p<0.001$) & thamnic ($p<0.001$).

All data: rainforest type significant ($p<0.005$); implicate significant from callidendrous ($p<0.001$), thamnic ($p<0.001$) & mixedforest ($p<0.005$).

Parsonsia straminea

ss. = 8

Importance Value

Burn Intensity	Rainforest/Forest Type Callidendrous			Thamnic			Implicate		
	n.	mean	variance	n.	mean	variance	n	mean	variance
unburnt	0			2	16.7	93.03	1	1.1	
mild	0			1	0.6		0		
hot	0			3	6.3	52.12	1	0.8	

Rf data: no significant differences.

Cover

Burn Intensity	Rainforest/Forest Type Callidendrous			Thamnic			Implicate		
	n.	mean	variance	n.	mean	variance	n.	mean	variance
unburnt	0			2	0.1	0.00	1	3.0	
mild	0			1	0.0		0		
hot	0			3	0.0	0.00	1	0.0	

Rf data: burn intensity, rainforest type & interactions significant ($p<0.005$); only significant Ttests for interactions. Interactions: callidendrous/unburnt significant from mild, hot, thamnic, hot/thamnic ($p<0.001$). Thamnic/mild significant from implicate ($p<0.05$) & unburnt/implicate ($p<0.005$).

Height

Burn Intensity	Rainforest/Forest Type Callidendrous			Thamnic			Implicate		
	n.	mean	variance	n.	mean	variance	n	mean	variance
unburnt	0			2	0.6	0.00	1	6.0	
mild	0			1	0.0		0		
hot	0			3	0.1	0.00	1	0.0	

Rf data: burn intensity, rainforest type & interactions significant ($p<0.005$); Ttests significant for interactions only.

Interactions: callidendrous/unburnt ($p<0.001$) significant from mild, hot, thamnic, thamnic/hot.

Phyllocladus aspleniifolius
ss. = 30 (37)

Importance Values

Burn Intensity	Rainforest/Forest Type											
	Callidendrous			Thamnic			Implicate			Mixed Forest		
	n.	mean	variance	n.	mean	variance	n.	mean	variance	n.	mean	variance
unburnt	2	3.0	7.40	2	4.4	23.65	3	5.2	0.38			
mild	1	2.1		6	2.0	1.42	3	10.5	56.58	1	1.5	
hot	2	3.4	11.84	7 (8)	3.1 (2.8)	10.85 (9.72)	4 (5)	2.5 (2.8)	7.15 (5.87)	4	7.1	42.34

Rf & All data: no significant differences.

Cover

Burn Intensity	Rainforest/Forest Type											
	Callidendrous			Thamnic			Implicate			Mixed Forest		
	n.	mean	variance	n.	mean	variance	n.	mean	variance	n.	mean	variance
unburnt	2	0.5	0.41	2	2.7	13.10	3	9.2	26.51			
mild	1	0.0		6	0.0	0.00	3	0.4	0.02	1	0.0	
hot	2	0.0	0.00	7 (8)	0.0	0.00	4 (5)	0 (0.02)	0 (0.002)	4	0.1	0.01

Rf data: burn intensity ($p<0.005$), rainforest type ($p<0.01$) & interactions ($p<0.0025$) significant; unburnt significant ($p<0.001$) from mild and hot, implicate significant from callidendrous ($p<0.02$). Interactions: callidendrous/unburnt significant from implicate ($p<0.001$), mild/implicate ($p<0.01$) & hot/implicate ($p<0.001$). Mild/thamnic significant from unburnt/implicate ($p<0.01$).
All data: burn intensity ($p<0.005$), rainforest type ($p<0.025$) & interactions ($p<0.005$) significant; unburnt significant ($p<0.001$) from mild and hot, implicate significant from callidendrous ($p<0.02$). Interactions: callidendrous/unburnt significant ($p<0.001$) from implicate, mild/implicate & hot/implicate. Mild/thamnic significant from unburnt ($p<0.05$), unburnt/implicate ($p<0.01$). Mixedforest/hot significant ($p<0.001$) from unburnt, callidendrous/unburnt & thamnic/unburnt.

Height

Burn Intensity	Rainforest/Forest Type											
	Callidendrous			Thamnic			Implicate			Mixed Forest		
	n.	mean	variance	n.	mean	variance	n	mean	variance	n	mean	variance
unburnt	2	2.5	8.49	2	4.0	31.93	3	5.9	3.51			
mild	1	0.3		6	0.1	0.01	3	0.3	0.01	1	0.1	
hot	2	0.1	0.00	7 (8)	0.15 (0.14)	0.017 (0.016)	4 (5)	0.08 (0.11)	0.001 (0.005)	4	0.1	0.00

Rf & All data: burn intensity significant ($p<0.005$); unburnt significant ($p<0.001$) from mild & hot.

Pimelea cinera
ss. =15

Importance Values

Burn Intensity	Rainforest/forest Type								
	Callidendrous			Thamnic			Implicate		
	n.	mean	variance	n.	mean	variance	n	mean	variance
unburnt	0			0			0		
mild	0			5	2.5	2.63	2	1.1	0.35
hot	1	6.0		4	9.7	24.88	3	1.4	0.34

Rf data: burn intensity ($p<0.025$) & rainforest type ($p<0.05$) significant; mild ($p<0.05$) from unburnt & hot; implicate different than thamnic ($p<0.02$).

Cover

Burn Intensity	Rainforest/forest Type								
	Callidendrous			Thamnic			Implicate		
	n.	mean	variance	n.	mean	variance	n.	mean	variance
unburnt	0			0			0		
mild	0			5	0.4	0.15	2	0.1	0.03
hot	1	0.6		4	0.3	0.02	3	0.2	0.06

Rf data: no significant differences.

Seedling Height

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance
				Rainforest/forest Type					
unburnt	0			0			0		
mild	0			5	1.1	0.04	2	0.4	0.02
hot	1	0.8		4	1.1	0.07	3	1.1	0.04

Rf data: rainforest type (p<0.05) & interactions significant (p<0.025);

Interactions: callidendrous/unburnt signficant from mild (p<0.01) & mild/thamnic (p<0.05); thamnic/mild from implicate (p<0.01) & hot/implicate (p<0.02)

Pimelea drupaceae

ss. = 33 (37)

Importance Values

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance	Mixed Forest n.	Mixed Forest mean	Mixed Forest variance
				Rainforest/forest Type								
unburnt	1	11.5		2	4.8	23.12	1	2.7				
mild	4	5.9	32.78	7	6.5	16.03	3	4.8	12.89			
hot	4	8.3	2.73	6	9.0	33.75	5 (6)	5.0 (5.0)	26.96 (21.58)	3	1.2	0.20

Rf data: no significant differences.

All data: F tests show no differences. Ttests have mixforest significant (p<0.02) from callidendrous & thamnic.

Cover

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance	Mixed Forest n.	Mixed Forest mean	Mixed Forest variance
				Rainforest/forest Type								
unburnt	1	0.1		2	0.0	0.00	1	0.0				
mild	4	0.9	2.32	7	0.5	0.47	3	0.3	0.14	0		
hot	4	0.2	0.10	6	0.5	0.37	5 (6)	0.6 (0.6)	0.84 (0.69)	3	0.0	0.00

Rf & All data: no signficant differences

Height

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n	Implicate mean	Implicate variance	Mixed Forest n	Mixed Forest mean	Mixed Forest variance
				Rainforest/forest Type								
unburnt	1	0.7		2	0.3	0.08	1	0.2				
mild	4	1.1	0.56	7	1.0	0.23	3	1.1	0.09			
hot	4	0.9	0.25	6	1.0	0.21	5 (6)	1.4 (1.3)	0.47 (0.39)	3	0.2	0.02

Rf data: F tests are not significant. Ttests have unburnt significant from mild (p<0.05) & hot (p<0.02).

All data: rainforest type significant (p<0.05); mixforest significant from callidendrous & thamnic (p<0.02) & implicate (p<0.005).

Polystichium proliferum
ss. = 34 (38)

Importance Values

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n.	mean	variance	Mixed Forest n.	mean	variance
	Rainforest/Forest Type											
unburnt	4	18.1	14.64	2	5.9	0.95	0					
mild	5	10.0	36.50	7	11.5	30.74	2	3.0	4.03			
hot	5	13.8	90.70	6 (7)	5.0 (4.4)	9.25 (10.16)	3 (4)	3.6 (3.0)	14.26 (10.6)	2	1.1	0.03

Rf data: rainforest type significant (p<0.01); callidendrous significantly higher than thamnic (p<0.05) & implicate (p<0.01).
All data: burn intensity (p<0.025), rainforest type (p<0.005) & interactions (p<0.05) significant; hot significant from unburnt (p<0.02); callidendrous significant from thamnic (p<0.02), implicate (p<0.01) & mixforest (p<0.05). Interactions: callidendrous/unburnt significant from mild (p<0.05), thamnic (p<0.02), implicate (p<0.01), mixforest (p<0.01), thamnic/mild (p<0.05). Thamnic/mild significant from hot & hot/callidendrous (p<0.05). Mixforest/hot signficant from callidendrous (p<0.01).

Cover

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n.	mean	variance	Mixed Forest n.	mean	variance
	Rainforest/Forest Type											
unburnt	4	2.6	3.60	2	0.2	0.00	0					
mild	5	0.4	0.25	7	1.3	4.96	2	0.0	0.00			
hot	5	2.2	12.54	6 (7)	0.5 (0.4)	1.47 (1.27)	3 (4)	0.0	0.00	2	0.0	0.00

Rf & All data: no significant differences.

Height

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n.	mean	variance	Mixed Forest n.	mean	variance
	Rainforest/Forest Type											
unburnt	4	0.7	0.08	2	0.3	0.01	0					
mild	5	0.2	0.03	7	0.4	0.10	2	0.1	0.00			
hot	5	0.5	0.10	5 (6)	0.1 (0.1)	0.002 (0.002)	3 (4)	0.1 (0.1)	0.001 (0.001)	2	0.1	0.01

Rf data: burn intensity (p<0.05) & interactions signficant (p<0.05), unburnt significant (p<0.05) from mild & hot. Interactions: callidendrous/unburnt significant from mild (p<0.005), implicate & mild/thamnic (p<0.05). Thamnic/mild significant from callidendrous/hot (p<0.02).
All data: burn intensity (p<0.01) & interactions (p<0.05) significant; unburnt significant (p<0.05) from mild & hot. Interactions: callidendrous/unburnt significant from mild (p<0.005), implicate (p<0.005), mild/thamnic (p<0.05). Thamnic/mild significant from callidendrous/hot (p<0.01).

Polytrichium juniperinum
ss. = 32 (38)

Importance Values

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n.	mean	variance	Mixed Forest n.	mean	variance
	Rainforest/Forest Type											
unburnt	0			0			0					
mild	4	18.0	425.90	7	5.4	32.50	1	20.4				
hot	5	9.8	132.10	5	15.7	150.50	5 (6)	27.5 (23.8)	187.6 (231.5)	4	0.0	0.00

Rf & All data: no significant differences, variances are very large, found only on burnt sites.

Cover

Burn Intensity	Callidendrous			Thamnic			Implicate			Mixed Forest		
	n.	mean	variance	n.	mean	variance	n.	mean	variance	n.	mean	variance
unburnt	0			0			0					
mild	4	11.1	316.60	7	1.1	5.60	3	9.8	72.10	0		
hot	5	5.0	89.20	7 (8)	7.9 (7.1)	44.4 (43.4)	6 (7)	20.9 (20.0)	154 (135.2)	4	11.4	106.20

(Rainforest/Forest Type)

Rf data: rainforest type significant ($p<0.03$): implicate significant from thamnic ($p<0.02$), & callidendrous ($p<0.02$).
All data: rainforest type significant ($p<0.05$), implicate significant from thamnic ($p<0.01$).

Rumohra adiantiformis
ss. = 20 (26)

Importance Values

Burn Intensity	Callidendrous			Thamnic			Implicate			Mixed Forest		
	n.	mean	variance	n.	mean	variance	n.	mean	variance	n.	mean	variance
unburnt	4	7.8	13.22	3	4.9	2.42	0					
mild	1	1.1		7	2.4	2.54	1	0.6		0		
hot	2	1.5	1.37	1 (2)	1.0 (0.97)	0.01	1 (2)	2.5 (3.6)	2.36	4	0.7	0.01

(Rainforest/Forest Type)

Rf data: burn intensity significant ($p<0.005$): unburnt significant from mild ($p<0.001$) and hot ($p<0.01$).
All data: burn intensity significant ($p<0.005$): unburnt significant from mild ($p<0.001$) and hot ($p<0.001$).

Cover

Burn Intensity	Callidendrous			Thamnic			Implicate			Mixed Forest		
	n.	mean	variance	n.	mean	variance	n.	mean	variance	n.	mean	variance
unburnt	4	0.1	0.02	3	0.2	0.06	0					
mild	1	0.0		7	0.0	0.00	1	0.0	0.00	0		
hot	2	0.0	0.00	1 (2)	0.0	0.00	1 (2)	0.0	0.00	4	0.0	0.00

(Rainforest/Forest Type)

Rf data: burn intensity significant ($p<0.05$): unburnt significant higher than mild ($p<0.01$) and hot ($p<0.02$).
All data: no significant differences

Seedling Height

Burn Intensity	Callidendrous			Thamnic			Implicate			Mixed Forest		
	n.	mean	variance	n.	mean	variance	n	mean	variance	n	mean	variance
unburnt	4	0.3	0.01	3	0.3	0.03	0					
mild	1	0.1		7	0.1	0.00	1	0.2				
hot	2	0.0	0.00	1 (2)	0.2 (0.3)	(0.02).	1 (2)	0.2 (0.2)	0.00	4	0.2	0.00

(Rainforest/Forest Type)

Rf data: burn intensity significant ($p<0.01$): unburnt significant from mild ($p<0.001$) and hot ($p<0.01$).
All data: burn intensity significant ($p<0.005$): unburnt significant from mild ($p<0.001$) and hot ($p<0.05$).

Sticherus tener - only analysed in the regressions using the total sample size (50 sites)
ss. = 9

Importance Values

Burn Intensity	Callidendrous			Thamnic			Implicate			Mixed Forest		
	n.	mean	variance	n.	mean	variance	n.	mean	variance	n.	mean	variance
unburnt	0			1	1.0		0					
mild	0			2	2.4	0.22	0			0		
hot	0			2	3.0	5.09	1	10.4		3	1.7	0.89

(Rainforest/Forest Type)

Rf data: rainforest type significant (p<0.005); implicate significant from callidendrous (p<0.01), thamnic (p<0.02) and mixed forest (p<0.01).

Cover

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance	Mixed Forest n.	Mixed Forest mean	Mixed Forest variance
unburnt	0			1	0.0		0					
mild	0			2	0.0	0.00	0			0		
hot	0			2	0.1	0.03	1	0.0		3	0.0	0.00

All data: no significant differences, frequency higher in thamnic.

Height

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance	Mixed Forest n.	Mixed Forest mean	Mixed Forest variance
unburnt	0			1	0.1		0					
mild	0			2	0.1	0.00	0			0		
hot	0			2	0.1	0.01	1	0.3		3	0.2	0.01

All data: no significant differences

Tasmannia lanceolata
ss. = 10

Importance Values

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance
unburnt	0			0			2	2.1	3.34
mild	1	2.9		2	1.4	0.72	2	16.1	31.63
hot	1	2.3		1	2.1		1 (2)	2.9 (5.8)	16.60

Rf data: no significant differences; more prevalent in implicate rainforest.
All data: rainforest type significant (p<0.05): thamnic signicant from implicate (p<0.05).

Cover

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance
unburnt	0			0			2	0.8	1.32
mild	1	0.2		2	0.0	0.00	2	1.7	4.50
hot	1	0.3		1	0.3		1 (2)	0 (0)	0.56

Rf & All data: no significant differences. Values greater and frequency higher in implicate.

Height

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n	Implicate mean	Implicate variance
unburnt	0			0			2	1.4	3.92
mild	1	0.6		2	1.0	0.49	2	0.8	0.51
hot	1	1.0		1	0.5		1 (2)	0.6 (0.8)	0.11

Rf & All data: no values significant

Tmispterus billardarium
ss. = 9

Importance Values

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance
unburnt	4	5.0	43.07	1	5.4		3	1.6	0.47
mild	0			1	2.9		0		
hot	0			0			0		

(Rainforest/Forest Type)

Rf data: no significant differences

Cover values are too small for comparison (they are all 0)

Height

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance
unburnt	4	0.2	0.00	1	0.1		3	0.1	0.00
mild	0			1	0.0		0		
hot	0			0			0		

(Rainforest/Forest Type)

Rf data: no significant values.

Trochocarpa cunninghamii
ss. = 13 (16)

Importance Values

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n.	mean	variance	Mixed Forest n.	mean	variance
unburnt	0			1	15.6		2	3.9	0.00			
mild	1	2.5		2	3.4	0.31	0			1	0.6	
hot	2	1.7	1.55	4	2.4	2.27	1 (2)	4.3 (5.8)	4.54	1	0.7	

(Rainforest/Forest Type)

Rf data: burn intensity (p<0.001), rainforest type (p<0.025) & interactions (p<0.001) significant; unburnt significant from hot (p<0.05). Interactions: callidendrous/unburnt signficant from thamnic & hot/thamnic (p<0.001) & mild/thamnic (p<0.01). Mild/thamnic significant (p<0.001) from unburnt & implicate/unburnt.
All data: burn intensity (p<0.05) & interactions (p<0.05) significant; unburnt (p<0.05) significant from mild & hot. Interactions: callidendrous/unburnt significant from thamnic (p<0.001), implicate (p<0.05), mild/thamnic (p<0.01) & hot/thamnic (p<0.001). Mild/thamnic signficant from unburnt & implicate/unburnt (p<0.001) & implicate (p<0.05). Hot/mixforest significant from implicate (p<0.02) & unburnt/thamnic (p<0.001).

Cover

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n.	mean	variance	Mixed Forest n.	mean	variance
unburnt	0			1	2.5		2	0.5	0.00			
mild	1	0.0		2	0.9	1.32	0			1	0.0	
hot	2	0.0	0.00	4	0.0	0.00	1 (2)	0 (0)	0.00	1	0.0	

(Rainforest/Forest Type)

Rf data: no F values significant. Ttests have hot significant from unburnt (p<0.05), callidendrous/unburnt (p<0.05) from hot/thamnic & mild/thamnic from unburnt (p<0.05) & unburnt/implicate (p<0.05).
All data: burn intensity significant (p<0.025); unburnt signicant from hot (p<0.02).

Proportion of Seedlings to Sprouts

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance	Mixed Forest n	mean	variance
unburnt	0			1	80.0		2	50.0	5000.00	0		
mild	1	100.0		2	25.0	1250.00	0			1	100.0	
hot	2	100.0	0.00	4	81.3	1406.00	1	100.0		1	100.0	

(Rainforest/Forest Type)

Rf & All data: no significant differences. vaariances large.

Seedling Height

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance	Mixed Forest n	mean	variance
unburnt	0			1	1.8		2	1.1	2.53	0		
mild	1	0.1		2	0.1	0.03	0			1	0.1	
hot	2	0.0	0.00	4	0.2	0.03	1 (2)	0.2 (0.2)	0.00	1	0.2	

(Rainforest/Forest Type)

Rf data: F test not significant, Ttests have unburnt significant from mild ($p<0.02$) & hot ($p<0.01$)

All data: F test not significant, Ttests have unburnt significant from mild ($p<0.01$) & hot ($p<0.005$)

Sprout Height

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance	Mixed Forest n	mean	variance
unburnt	0			1	0.4		2	0.9	1.68			
mild	1	0.0	0.00	2	0.5	0.15	0			1	0.0	
hot	2	0.0		4	0.1	0.03	1 (2)	0.0		1	0.0	

(Rainforest/Forest Type)

Rf & All data: No significant differences.

Trochocarpa gunnii

ss. = 4

Importance Values

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n.	mean	variance
unburnt	0			0			1	9.2	
mild	0			0			1	2.9	
hot	0			0			2	3.3	9.56

(Rainforest/Forest Type)

Rf data: only found on implicate sites. No values significant.

Cover (ss.=5)

Burn Intensity	Callidendrous n.	mean	variance	Thamnic n.	mean	variance	Implicate n	mean	variance
unburnt	1	0.3		0			1	3.6	
mild	0			0			1	0.0	
hot	0			0			2	0.0	0.00

(Rainforest/Forest Type)

Rf data: no significant differences.

Seedling Height

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Thamnic n.	Thamnic mean	Thamnic variance	Implicate n	Implicate mean	Implicate variance
				Rainforest/Forest Type					
unburnt	1	0.0		0			1	3.3	
mild	0			0			1	0.1	
hot	0			0			2	0.1	0.01

Rf data: rainforest type significant ($p<0.05$); implicate ($p<0.05$) significant from callidendrous & thamnic. T tests have unburnt ($p<0.05$) significant from mild & hot

Uncinia tenella
ss. = 21

Importance Values

Burn Intensity	Rainforest Type: Callidendrous n.	Callidendrous mean	Callidendrous variance	Rainforest/Forest Type: Thamnic n.	Thamnic mean	Thamnic variance	Implicate n	Implicate mean	Implicate variance
unburnt	2	2.5	3.15	0			0		
mild	3	5.4	27.72	7	8.9	24.43	0		
hot	4	4.3	8.33	3	6.9	14.04	2	6.4	54.06

Rf data: no significant differences. Fire appears to have increased its range and possibly its importance.

Cover

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Rainforest/Forest Type: Thamnic n.	Thamnic mean	Thamnic variance	Implicate n.	Implicate mean	Implicate variance
unburnt	2	0.1	0.03	0			0		
mild	3	0.2	0.03	7	0.4	0.21	0		
hot	4	0.1	0.01	3	0.1	0.02	2	0.0	0.00

Rf data: no F tests significant, Ttests have hot significant from unburnt ($p<0.05$).

Seedling Height

Burn Intensity	Callidendrous n.	Callidendrous mean	Callidendrous variance	Rainforest/Forest Type: Thamnic n.	Thamnic mean	Thamnic variance	Implicate n	Implicate mean	Implicate variance
unburnt	2	0.1	0.00	0			0		
mild	2	0.1	0.00	6	0.1	0.00	0		
hot	4	0.1	0.00	3	0.1	0.00	2	0.0	0.00

Rf data: no significant differences.

Appendix 7: Physiographic Variables used in Chapter 5

Site No.	Nunez Summer	RADIATION INDICES (Jm-2) Nunez Winter	Nunez Total	Cloudy Decembe	Cloudy June	Cloudy Total	pH	Fertility BN^	Fertility NT*	FTEUC*	FTOAT1'	FTOAT2*	Stag Canopy Height (m)	Number of Rings (Minimum age)
1	22	4.0	4.5	20.4	3.3	138.5	6.8	4	2	2	3	4	25-30	196
2	22	4.0	4.5	20.7	3.6	142.7	4.7	4	2	2	3	3	25	196
3	22	4.5	4.5	20.7	3.8	144.6	4.8	3	2	2	3	3	25	380
4	21	3.0	4.0	19.7	2.5	125.0	4.6	3	1	2	3	3	20-25	110
5	22	7.0	5.0	20.8	5.5	163.7	6.3	4	2	2	3	3	15	306
6	22	5.5	5.0	20.9	4.3	152.1	4.4	3	2	2	3	3	20-25	450
7	22	6.0	5.0	21.1	4.3	152.8	4.9	4	3	2	3	3	15-20	279
8	21	4.0	4.5	20.7	3.6	143.0	5.2	3	2	2	3	3	15-25	217
9	22	5.1	4.8	21.0	4.3	152.1	6.0	4	2	2	3	4	15-20	488
10	22	5.0	4.5	20.9	4.0	148.7	5.0	3	3	2	3	4	20-25	427
11	21	5.0	4.5	20.1	4.4	148.9	5.0	3	3	2	3	3	25-30	427
12	22	6.0	5.0	21.2	4.9	159.5	5.3	5	1	2	3	4	25-30	105
13	21	5.0	4.5	20.8	4.2	150.3	5.1	4	3	2	3	3	15-20	598
14	22	5.0	4.8	21.1	4.1	151.0	4.5	4	3	2	3	3	30	340
15	22	5.5	4.8	21.0	4.7	157.0	3.9	4	3	2	3	4	12-15 (20)	445
16	22	7.0	5.0	20.6	5.6	163.2	4.7	6	1	2	2	2	25-30	226
17	21	6.0	5.0	20.2	4.7	152.8	5.3	6	1	2	1	1	35-40	164
18	22	4.5	4.5	20.3	3.4	139.1	5.2	6	1	1	3	3	30-35	84
19	22	5.1	4.8	20.7	3.6	142.5	4.3	3	2	2	3	3	35	78
20	22	5.1	4.8	21.0	4.2	151.3	5.9	10	1	2	2	2	45	97
21	22	5.1	4.8	21.0	4.2	151.4	4.8	10	1	2	3	3	30	97
22	22	5.1	4.8	21.0	4.2	151.4	4.7	9	1	2	3	3	25-30	144
23	22	5.1	4.8	21.0	4.2	151.3	5.7	7	2	2	2	2	30	200
24	22	6.0	5.0	21.0	5.3	163.0	4.6	4	2	2	3	4	20-25	115
25	21	8.0	5.0	19.7	6.4	167.4	6.3	4	2	2	3	4	20-25	115
26	20	8.0	5.0	18.8	6.6	164.0	4.8	10	2	2	3	3	15	106
27	21	3.5	4.0	20.2	3.0	133.4	5.4	5	2	2	3	3	20-25	105
28	20	4.0	4.5	19.5	3.9	140.7	4.9	5	2	2	3	4	20-25	156
29	22	5.1	4.8	21.1	4.2	152.4	4.4	5	3	2	3	4	15-20	179
30	22	5.1	4.8	21.1	4.2	152.4	4.5	3	3	2	3	3	15-20	253
31	22	5.1	4.8	21.2	4.7	157.6	4.8	6	2	2	3	3	15-20	388
32	20	3.0	3.5	18.8	2.3	115.9	5.1	4	2	2	3	3	25-30	218
33	21	3.0	4.0	19.8	2.8	128.9	5.5	7	1	2	3	3	25-30	186
34	21	5.0	4.5	20.3	4.2	147.4	4.6	6	2	2	3	3	15-20	@150
35	22	5.1	4.8	21.1	4.1	151.3	3.8	6	2	2	3	4	15	@150

Appendix 7 cont'd: Physiographic Variables used in Chapter 5

Site	Seed Source 1.			Seed Source 2		
No.	Vegetation	Direction	Distance	Vegetation	Direction C	Distance
1	Rainforest	190	150	Rainforest	65-98	150
2	Rainforest	Living trees on site				
3	Rainforest	190-55	20	Rainforest	315-330	200
4	unburnt					
5	Rainforest	220	400	Eucalypt	140	150
6	Rainforest	320-360	100			
7	Rainforest	340	400	Eucalypt	360-90	20
8	unburnt					
9	Rainforest	70-80	200	Rainforest	160-170	250
10	Rainforest	270	150	Rainforest	345	250
11	Rainforest	135	20			
12	Rainforest	40	200	Eucalypt	65	60
13	Rainforest	305	125	Eucalypt	90	50
14	unburnt					
15	Rainforest	Living trees on site		Rainforest	45	50
16	Rainforest	30	300			
17	Rainforest	Living trees on site		Rainforest	90	100
18	unburnt					
19	unburnt					
20	Rainforest	220	250			
21	Rainforest	220	100			
22	unburnt	20-50	20	Eucalypt	90	5
23	Rainforest	290	50	Rainforest	70	50
24	Rainforest	300	50			
25	Rainforest	270	150			
26	Rainforest					
27	Rainforest	70-270	100			
28	Rainforest	260	170			
29	unburnt	270	20			
30	unburnt	255	50			
31	Rainforest	160	60			
32	Rainforest	60	60	Rainforest	120	30
33	Rainforest					
34	Rainforest					
35	Rainforest	270	75			

Appendix 7 cont'd: Physiographic Variables used in Chapter 5

	RADIATION INDICES (Jm-2)													
Site No.	Nunez Summer	Nunez Winter	Nunez Total	Cloudy Decembe	Cloudy June	Cloudy Total	pH	Fertility BN	Fertility NT	FTEUC	FTOAT1	FTOAT2	Stag Canopy Height (m)	Number of Rings (Minimum age)
36	22	5.1	4.8	21.3	4.4	154.1	5.5	6	2	1	1	1	36	327
37	22	6.0	5.0	21.3	5.1	161.3	4.4	6	2	1	1	1	32	327
38	22	5.0	4.8	21.2	4.0	149.9	5.0	6	2	1	1	1	28	327
39	20	3.0	3.5	19.2	2.4	118.8	5.0	10	1	2	3	3	35	330
40	22	6.0	5.0	21.3	5.1	162.0	5.0	7	2	2	2	2	34	170
41	20	4.0	4.0	19.3	3.0	128.2	5.1	9	1	1	1	1	30	470
42	22	5.5	4.8	21.3	4.4	154.9	5.1	7	1	2	2	2	34	242
43	20	3.0	4.0	19.6	2.4	122.8	4.6	6	2	2	3	3	20-35	233
Additional monitoring sites											3	3		
44	21	5.0	4.5	21.0	4.4	153.3	4.1	3	4	2	3	3	25	555
45	21	6.0	5.0	20.1	4.8	152.4	3.7	5	2	2	3	3	15-20	@200
46	21	7.0	5.0	20.8	5.4	162.2	4.2	5	2	2	3	3	25E	@200
47	22	5.0	4.5	20.8	4.2	150.0	4.5	5	2	2	3	3	35E, 15R	@200
48	21	5.0	5.0	20.3	3.9	144.0	4.6	5	2	2	3	3	30E, 25R	@200
49	20	5.0	4.5	19.2	4.0	140.0	4.5	5	2	2	3	3	30E, 20R	@200
50	20	5.0	4.5	19.2	4.0	140.1	5.2	5	2	2	3	3	30E, 20R	@200

^ - Numbering goes from 1, least fertile to 10, most fertile

* - the higher the number the less fertile

@ - the same sample was used for these sites.

Appendix 7 cont'd: Physiographic Variables used in Chapter 5

Site	Seed Source 1.			Seed Source 2		
No.	Vegetation	Direction	Distance	Vegetation	Direction	Distance
36	Rainforest	135	650	Eucalypt	0-90	100
37	Rainforest	305	600	Eucalypt	30	450
38	Rainforest	280	550	Eucalypt	310	220
39	unburnt					
40	Rainforest	270	300	Eucalypt	120	100
41	Rainforest	10-20	50	Eucalypt	180	300
42	Rainforest	Living trees on site				
43	unburnt					
Additional monitoring sites						
44	Rainforest	225-315	175	Rainforest	195-225	175
45	Rainforest	90-180	50	Eucalypt	270	50
46	Rainforest	90-180	51-200	Eucalypts living trees on site		
47	Eucalypt	230-280	51-200	Eucalypts		
48	Rainforest	230-280	51-200	Eucalypts		
49	Rainforest	180-360	51-200	Eucalypts		
50	Rainforest	180-360	51-200	Eucalypts		

Appendix 8: Preliminary seed bank trial

This thesis examined the vegetation that had regenerated eight years after fires in different types of cool temperate rainforest. To examine the initial effect of fire on the soil seed bank and determine if the soil seed bank played a role in rainforest regeneration a preliminary trial was initiated. This preliminary trial was to examine the feasibility of a major trial on the effect of fire on rainforest soil seed bank. Implicate rainforest was chosen as it is more vascular species rich than the other rainforest types.

Methods

Four implicate sites were chosen from the sites already examined; one not burnt control (site 34), 2 mild fire sites (sites 35 and 29) and 1 hot fire site (site 30).

At each site the soil from an area 20 x 20 cm x 10 cm deep was collected from the centre of the 10 sub-plots (refer to Chapter 4) and pooled. Soil from each site was divided into 6 samples and subjected to 3 treatments; heated to 55°C, heated to 75°C and not heated. The soil was heated by encasing a sample in aluminium foil and placing it into an oven until the soil had reached the desired temperature for 15 minutes. Soil was then placed on a bed of vermiculite in a 34 x 28 x 5 cm germination tray. Trays were placed into a glass house.

Results and Discussion

Germinants were recorded after 26 days, with the non-heated samples having more species than the heated samples. The main germinants were bryophytes, liverworts, ferns and some doubtful rainforest species such as *Scenecio* sp.. The fire bryophytes, *Polytrichum juniperinum* and *Marchantia berteroana* were an important component of the non-heated samples. The heated samples had no germinants until a month after and many of these were glass house weeds such as *Leptobryum pyriforme.* The only rainforest vascular species recorded was one germinant of *Phebalium squameum* in the non-heated unburnt sample.

The results showed that the heated samples had been sterilised by the treatment. The time taken to reach the required temperature and then to cool would indicate that the soil was subjected to high temperatures a lot longer than 15 minutes, compounding the effect of the heating. The sample size was only large enough to include one rainforest vascular species. A trial examining the appropriate sample size is required.

The samples when placed into the glasshouse appeared to have a low capacity to retain moisture with the normal glasshouse watering regime, formulated for watering pots, being inadequate. The water regime was changed but many samples had dried with the death of some germinants.

This trial was limited but the results were similar to Melick & Ashton's (1991) results in warm temperate rainforest in Victoria. The seed bank of rainforest species is limited and seeds of temperate rainforest species do not appear to be long lived.