Effects of fire on the biota of the Western Australian wheatbelt. I. Background to the study.

A.J.M. Hopkins[1], G.R. Friend[12], M.A. Langley[1], J.M. Harvey[1], D Mitchell[13] and B. Johnson[1]

[1] CALMScience Division, Department of Conservation and Land Management, WA Wildlife Research Centre, PO Box 51, Wanneroo, WA 6065

[2] Present Address Parks, Flora & Fauna Division
Department of Natural Resources & Environment, PO Box 500, East Melbourne, Vic 3002

[3] Present Address Department of Conservation and Land Management, Swan Region, 3044 Albany Highway, Kelmscott WA 6111

Abstract

Introduction

Fire is an important factor to be taken into account in the management of areas of natural vegetation in the semi-arid region of south-western Australia. There are at least three reasons for this. Firstly, wildifre is a contingency to be planned for: the combination of long, hot, dry summers and dense, highly flammable vegetation creates a situation where extensive and intense unplanned fires can occur readily. Control measures will often involve fuel reduction burning. Secondly, consideration must also be given to the maintenance of ecological process in natural areas, and the design and implementation of an appropriate fire regime is central to this, since fire has been a feature of the evolutionary environment for millenia and is an important trigger of biological processes. And thirdly, the plant and animal communities in the semi-arid region are generally sensitive to disturbance, including fire, and recover slowly. Inappropraite disturbance regimes, particularly those involving too-frequent fire, or combinations of fire and some other type of disturbance, can cause isolated populations to decline, sometimes to extinction.

In the Western Australian Agricultural Region, the problems of fire management in natural areas are exacerbated by the fact that the conservation reserve system now comprises a small proportion of the landscape, the individual reserves are generally small and they are not well connected. The individual reserves are susceptible to deteoration because of their high perimeter-to-area ratio (edge effects) and their isolation and, therefore, they require very careful management - management based on an understanding of processes. An additional complication is that they are particularly prone to weed invasion: this may cause changes to fire fuel loadings and may also intefere with post-fire regeneration and recolonisation.

This paper is the first in a series in which we describe the results of a 10 year study of the effects of fire on some of the plant and animal communities of the Agricultural Region. Here we provide the seting for the study: in subsequent papers we describe the effects on the individual components of the biota that were studies, and we go on to produce a synthesis in the final paper.

(need some references in the Introduction)

The Study Area

Location and setting

Tutanning Nature Reserve is located at $32^{\circ}31'$S, $117^{\circ}23'$E, approximately 150 km south east of Perth and just east of the town of Pingelly in the central part of the Agricultural Region of Western Australia (Figure 1). The Reserve has an area of 2310 ha. The Reserve was created in 1960 for the conservation of flora and fauna and includes areas that had previously been set aside for timber, some uncleared road reserves and some repurchased farm land.

The Agricultural Region, part of which is commonly referred to as the wheatbelt (but see Gentilli 19xx) is a major cereal-growing area of approximately ?14 million hectares lying between the 280 and 580 mm rainfall isohyets. The area was rich in plant and animal species, including many endemics, prior to the extensive clearing of the native vegetation for agriculture. The richness of the biota has been attributed in part to the mosaic of habitats found there, the evolutionary and selective pressures imposed by the major changes in climate at least since the Tertiary, and to the long history of patchy disturbance (Hopper 1979; Kitchener *et al.* 1980; Hopkins 1985).

The Shire of Pingelly that includes Tutanning Reserve was intensively settled over 100 years ago at a time when little priority was given to conservation. Consequently, by 1983, 86.2% of the Shire had been cleared of native vegetation (Coates 1987). Only *c.* 6% had been set aside in secure reserves for the purpose of nature conservation and much of that was small, poorly-shaped, degraded remnants of vegetation associated with non-arable soils. A similar situation applies throughout the Agricultural Region (Beecham et al 1998, Shepherd 1998). In the light of these statistics, it is clear that long-term conservation of the biota of the region will depend on effective management of the reserves (and the privately-owned remnants): thus the need to understand the role of fire in these environments, the effects on the biota and the post-fire recovery of that biota.

Climate

The area experiences a mediterranean-type climate (Thermo-mediterranean attenuated, UNESCO-FAO 1963) with an annual rainfall of around 420 mm and annual evaporation of 1500mm (52 years of records for Landscape Hill, Bureau of Meteorology 1965, see also Table 1). Rainfall exceeds evaporation for the months April to August. Mean summer temperature is 22°C while that for winter is 10°C. The plants exhibit markedly seasonal growth and flowering rhythms with maximum activity in the period October-December (Specht *et al.* 1981).

Weather records for the town of Pingelly, some 25 km to the west of Tutanning Reserve, indicate that the area experienced average rainfall in 1988, 1991 and 1995, below-average winter rainfall in 1989, 1993, 1994, below-average summer rainfall in 1993/94, 1994/95 and above-average summer rainfall in 1989/90 and 1991/92

Physiography, landforms and soils

In the setting of the relatively subdued topography of southwestern Australia (e.g. Nix 1981; Pilgrim 1979), Tutanning Nature Reserve encompasses a diverse cross-section of the landscape. It includes the Dutarning Range and some nearby lateritic plateau remnants to 440 m in elevation and a variety of lower members of the landform sequence to 340 m in elevation. The lateritic uplands form part of the watershed between two major westward flowing river systems, the Avon and the Murray/Hotham.

Landforms and soils of the Murray catchment have been mapped by McArthur *et al.* (1977) while the whole of the Tutanning Reserve has been studied in detail by Nyagba (1976). Three landform units have been described. At the top of the sequence is the Norrine Landform consisting of a complex of residuals of the Tertiary lateritic plateau together with deep, yellow and grey siliceous sands, lateritic gravels, sandy gravels and duricrusts (indurated laterite). In the middle of the sequence is the Noombling Landform, a unit stripped of lateritic materials to produce gentle slopes with sandy loams, duplex soils and exposures of doleritic or granitic country rock. The slopes of the Noombling Unit run into a valley-floor unit (Bibberkine Landform) which, at Tutanning, is composed mainly of coarse-textured soils, many of which are waterlogged and salt affected. A generalized figure which shows the relationships between the landforms and soils at Tutanning Reserve is given in Brown and Hopkins (1983).

Vegetation and floristics

Tutanning Nature Reserve lies within the Avon District of the South West Botanical Province in an area with predominantly *Eucalyptus* and *Banksia* woodland vegetation (Beard 1980)(now the Avon Wheatbelt IBRA Bioregion, Thackway and Cresswell1995). Kwongan (vegetation where the ecologically dominant component comprises leptophyllous or nanophyllous sclerophyll shrubs with a high proportion of species from the families Proteaceae, Myrtaceae and Leguminosae, usually mapped as a type of shrubland, Beard and Pate 1984) is also an important feature of the area; however, it tends to occur in small patches (Beard 1984; Hopper 1979; Hopkins 1985). We have mapped the vegetation at Tutanning Reserve at the scale 1:25,000: at this level of detail there are 12 major vegetation units including *Eucalyptus* forests and woodlands, *Acacia* low open woodlands and mixed scrub and heath (Hopkins 1985 Fig. 2). The units tend to occur as a complex mosaic of small patches. For example, of the 385 polygons mapped, only 46 are larger than 10 hectares and, of those, only six exceed 50 hectares in size.

There is some relationship between the Landform Units and our vegetation units, although the boundaries as mapped are seldom coincident (see comments on this by Nyagba 1976, Little and Friend 1993). The lateritic soils together with the pockets of overlying sand at the top of the landform sequence generally support low woodlands (*Eucalyptus accedens*, *Banksia attenuata*) and mallee shrublands (*Eucalyptus drummondii*, *E. pachyloma*) together with shrublands dominated by *Dryandra armata*, *D.nobilis*, *D ferruginea*, *D senecifolia* (on laterite) and *Leptospermum erubescens*, *Eremaea pauciflora*, *Banksia sphaerocarpa*, *Conospermum stoechadis*, *Davesia* spp., and *Hakea* spp. (on sand). Pediment slopes immediately below the lateritic breakaways support woodlands (*Eucalyptus astringens, E. accedens* with some *E. wandoo*, *Allocasuarina huegeliana*) and shrublands (*Dryandra proteoides*). The gravelly duplex soils of the spurs and ridges support mixed low heath (kwongan), often with emergent *Xanthorrhoea* and *Allocasuarina huegeliana,* while vegetation on the deep duplex soils is mainly *Eucalyptus accedens* in upper-slope positions and *Allocasuarina huegeliana, Eucalyptus wandoo* and *Acacia acuminata* with an understory of legumes (mainly *Gastrolobium parviflorum)* in lower lying areas. The sands and sandy loams of the mid to lower slope areas support low forests and woodlands of *Eucalyptus wandoo, E. loxophloeba*, *Allocasuarina huegeliana*, *Acacia acuminata* and *A. lasiocalyx*, all of which have shrubby understoreys with *Gastrolobium parviflorum*. The scattered rock exposures are generally surrounded with dense low woodlands of *Allocasuarina huegeliana*. The sandy loams on the lower slopes and the valley floor soils support woodlands of *Eucalyptus wandoo*, *Allocasuarina huegeliana*, *Acacia lasiocalyx* and *A. saligna.*

A total of 660 species of vascular plants have been recorded for the Reserve so far (Hopkins, Harvey and Langley, unpublished data). Ten families account for over 70% of these species: Proteaceae (xx spp.), Leguminosae (xx), Myrtaceae (xx), Orchidaceae (xx), Cyperaceae (xx), Stylidaceae (xx), Asteraceae (xx), Poaceae (xx), Liliaceae (xx) and Epacridaceae (xx). **(MAL to complete)** On a species per unit area at the landscape scale the 660 figure is high even for the south west of Western Australia where larger reserves at nodes of species richness have floras of 820 to 1750 species (Griffin *et al.* 1990, Lamont *et al.* 1984). About half of the total species found at Tutanning were reported as occuring in 11 patches of kwongan on different soil types (total area *c.*64 ha), with individual 0.1 ha quadrats in this vegetation type containing up to 103 species (Brown and Hopkins 1983). The figures serve to highlight the importance of kwongan as a vegetation type in the south west and the mosaic of kwongan and other vegetation types at Tutanning in contributtng to the high floristic richness at the local and landscape scale (alpha and gamma diversity respectively*sensu* Whittaker 1972).

Vertebrate fauna

GRF to provide a summary

Invertebrate fauna

GRF to provide a summary or just a reference to Little and Friend 1993 tacked on to the vertebrate fauna section

Fire history

The fire history of the Reserve has been acertained from a combination of aerial photgraphs, historical maps, Departmental files and interviews with Reserve neighbours (A Hopkins, unpublished data, see also Kessell *et al.* 1985). As far as could be ascertained, the oldest vegetation in the Reserve dates from a fire in 1932, and fires from a varierty of sources were recorded as occuring on the Reserve up to the time of commencement of this study.

The study sites

Tutanning Nature Reserve is divided up into a series of compartments or irregularly-shaped blocks for the purposes of management, particularly for fire mamagement. For this study, two blocks containing similar combinations of landforms, soils and vegetation units and with similar fire histories were chosen, with one block to be used as the treatment (burnt in March 1990) and the other to be the control (to remain unburnt) (?refer back to Figure 1 or new Figure?). Matching pairs of study sites were established in the two blocks. Each study site consists of a belt transect 120 m long and 100 m wide containing 30 quadrats 20 m x 20 m in size. The transects at each of the study sites are shown in Figure ?3. Details of the sampling strategy based on these transects, for each component of the biota studied, will be given in the relevant paper in this series.

The study sites are all situated within the Noombling Landform. Nyagba (1976) described 15 soil types within this unit and, on the advice of H M Churchward (personal communication 1977) we simplified this to nine major soil types. Of these, four are important in this study as they have been mapped as occuring within the quadrats (Figure 2).

Gravelly duplex soils (**Dp**) are associated with gently sloping spurs and ridges in a mid-landscape position. Shallow grey gravelly sands (pH 5-6) and with up to 15% clay pass sharply to subindurated, mottled clay (pH 4.5-5.5) at a depth of about 15cm. Soils have poor internal drainage, and a perched watertable usually develops in winter at the sand/clay interface. Local variations within this unit may include deeper sandy A horizons or complete mantle of loose sands.

Deep dulpex soils (**dD**) are also associated with spurs and ridges in the mid-landscape position. This soil type consists of greyish brown sandy ironstone gravels changing fairly sharply at about 30-40 cm to fragmented, (sub-indurated,) mottled sandy clay. Where the soil has developed over basic rock it is brownish to dark reddish in colour and the matrix in the gravels is heavier textured.

Two types of soils associated with the lower pediment slopes occur within our study areas. The first includes brown loamy sands and sandy loams (**SL**) 40-50 cm deep over pale reddish or reddish-yellow compact massive clay. These soils have a deeper, less gritty and much darker surface horizon than the soils higher up the pediment slopes. Also mapped as **SL** but occuring lower down in the landform sequence and often flanking the drainage lines, are greyish brown, tough, massive light clays. These give way at depth to mottled (yellowish brown and reddish brown) light clay. Partially weathered acid country rock is usually present about 1m below the surface. Occasionally, ironstone gravels of various shapes and sizes occur scattered on the soil surface.

Occuring on the gently sloping surfaces around granite outcrops is the soil type termed scattered rock exposure (**sR**). These soils comprise deep, gritty, greyish brown sands with rock fragments over partially weathered rock.

All four study sites incorporate kwongan vegetation (open heath 0.25 - 2m in height) which is comprised of a mixture of sclerophyllous and semi-sclerophyllous shrubs of species in the families Proteaceae,Myrtaceae, Leguminosae and Epacridaceae and a variety of geophytes. They also incorporate woodlands: *Eucalyptus wandoo, E. accedens* and *Allocasuarina huegeliana* low woodland (trees 5 - 10m in height) over low scrub of Ha, Gp some Mu and so on **more here, including a more precise description of the vegetation and see Appendix 1**

The two patches of kwongan which form part of this present study were documented in detail by Brown and Hopkins (1983): site 8 from that study is within the block we now refer to as the unburnt control and site 9 is within the block burnt in 1990. Brown and Hopkins (1983) found the two patches to be floristically similar, but the similarity value (ISj) was still only about 65%. Species richness for $100m^2$ (square quadrat) at kwongan site 8 was 64 spp and for Site 9, 70 spp. Although kwongan has been recognised a species rich vegetation type, some woodland sites nearby showed similar high richness. Five *Eucalyptus wandoo, Allocasuarina huegeliana* open woodland sites located just to the west of kwongan site 9 were sampled on September 1981 (Hopkins, Brown & Griffin unpublished data). These contained between 60 and 70 spp in circular $100m^2$ plots (60,69,60,61,65, x=63). Over 90% of the species were herbs, sedges and grasses.

The fire history records for the Reserve show that the block now described as the unburnt control was last burnt by a hot fire in 1940. The block burnt experimentally in 1990 had been last burnt by a cool fire in 1965.

The experimental fire

On 20 March 1990, the western block was burnt using a prescription intended to ensure that the fire was of moderate intensity yet manageable. Conditions were cloudless with a south-south westerly wind of 8 to 9 km/hour (at 2 m height in the open). The wind tended to south east during the afternoon. Air temperature ranged from 24° to 26° C and relative humidity was 45 to 50% during the burn. After backburning the northern and eastern edges of the compartment, the fire was established from the south eastern edge, at 14.15 hours. A continuous flame front developed beneath the *Allocasuarina* with average flame lengths of 1 to 2 m in litter fuel and localized torching in the denser areas of *Allocasuarina*, estimated rate of spread 200 metres per hour. The southern side of the block was ignited by 14.45 hours and a distinct headfire developed as the flame front moved into the kwongan with an estimated rate of spread 1100 metres per hour. The *Eucalyptus* woodland was burnt by the western front of the fire which was reduced in intensity by the very light ground cover/litter fuels and cooling conditions, estimated rate of spread of 100 metres per hour (L. McCaw, personal. communication,1994).

Following the fire, each of the 20 m square quadrats was inspected for fire effects. Records were made of the removal of the ground litter layer, consumption of the shrub layer, and height of scorch where trees were present.

In the *Eucalyptus* woodland/ kwongan transect containing plots 1 to 6, the fire was patchy. Only one plot was completely burnt. The canopy of the *Eucalyptus* and *Allocasuarina* remained unburnt in 9 of 15 plots but the shrub and herb storeys were mostly or all burnt. The fire had been more intense in area of the *Allocasuarina* woodland - kwongan transect containing plots 7 to 12: all but one of the treed plots showed crown scorch and small amounts of unburnt material from the shrub and herb storeys remained in only 5 of 15 plots.

(?Do we need a table showing the fire effects at each of the plots ? eg see Appendix 1 over)

Other factors

In early December 1990, subsequent to the immediate post-fire sampling, plague locusts moved through the Tutanning area from the breeding areas around Wongan Hills, Northam and Kellerberrin (120 - 170 km NNW to N of the Reserve)(K. Walden, Entomologist, Agriculture Western Australia, Geraldton, personal communication 1994). Observations at Tutanning Nature Reserve on 17 December 1990 indicate the presence of significant numbers of locusts with a concentration in the burnt compartment (approximately 10 - 20 locusts per m^2 in *Allocasuarina huegelliana* woodland) and in the adjacent block of repurchased farmland (D. S. Mitchell, personal communication 1994). At this time, *A. huegelliana* trees along the nearby roadside had been denuded by locusts and approximately 10% of *Gastrolobium parviflorum* seedlings in the eastern area of burnt *A. huegelliana* were dead as a result of stem damage from locusts. No seedlings of *A. huegelliana* were seen alive either intact or damaged. (D. S. Mitchell personal observation, 1994). Similar observations were reported to the Department of Agriculture for *Allocasuarina* spp. trees, and young plants of other species in locust-affected areas, typically when green crop plants were not available as a food source for locusts. Trees up to 5 years old were reported to be highly susceptible to locust attack (K.Walden personal communication 1994).

Observations at Tutanning Nature Reserve on 12 February 1991 indicate that locust numbers were well down but still higher in the burnt compartment (<1 per m^2 in the burnt compartment) than elsewhere. Results of our subsequent sampling in the *Allocasuarina* area for those plots that were completely burnt, ie. post-fire cover for seedlings only, do not indicate a total loss of seedling cover; however actual numbers of seedlings were not recorded.

Concluding remarks

Acknowledgements

We thank Max Churchward for his help in sorting out some of the apparent anomalies in the soils and landform mapping at our sites, Ted Griffin and Lachie McCaw for assistance in monitoring the experimental fire, staff from the NarroginPingelly office of CALM for conducting the fire .... ?list of volunteers here of in the relevant papers

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Appendix 1 Descriptions of the individual quadrats at each of the study sites.

Site 1. Site burnt in the experimental fire, March 1990			
Plot Number	Soil Type	Vegetation Type	Effect of Fire
1a			fire patchy, plot incompletely burnt
1b			
1m			
1c			
1d			
2a			
2b			
2m			
2c			
2d			
3a			
3b			
3m			
3c			
3d			
4a			
4b			
4m			
4c			

4d			
5a			
5b			
5m			
5c			
5d			
6a			
6b			
6m			
6c			
6d			

Thackway, R and Cresswell, I.D. (eds) (1995), *An Interim Biogeographic Regionalisation for Australia: A Framework for Setting Priorities in the National Reserves System Cooperative Program.* Version 4. Australian Nature Conservation Agency, Canberra.

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Dwarf scrub C	DSC	Dwarf scrub C	DSC
Heath A	HA	Heath A	HA
Low forest A	LFA	Low forest A	LFA
Low forest B	LFB	Low forest B	LFB
Low Scrub A	LSA	Low Scrub A	LSA
Low scrub B	LSB	Low scrub B	LSB
Low woodland A	LWA	Low woodland A	LWA
Low woodland B	LWB	Low woodland B	LWB
Open dwarf scrub C	ODSC	Open dwarf scrub C	ODSC
Open dwarf scrub D	ODSD	Open dwarf scrub D	ODSD
Open low scrub A	OLSA	Open low scrub A	OLSA
Open low scrub B	OLSB	Open low scrub B	OLSB
Open low woodland A	OLWA	Open low woodland A	OLWA
Open low woodland B	OLWB	Open low woodland B	OLWB
Open shrub mallee	OSM	Open shrub mallee	OSM
Very open herbs	VOH	Very open herbs	VOH
Very open low grass	VOLG	Very open low grass	VOLG
Very open low sedges	VOLS	Very open low sedges	VOLS
Very open mat plants	VOMP	Very open mat plants	VOMP
Very open shrub mallee	VOSM	Very open shrub mallee	VOSM

Site 1. Site burnt in the experimental fire, March 1990

Plot	Soil type	Vegetation structure	Post fire observations
01A		Ew LWA / OLSB	
01D		Ew OLWA / LSB	
01M		Ew LFA / OLWB / LSB	
02B		Ew OLWA / VOSM / OLSB	
02C		Ew OLWA / OLWB / VOSM / LSB	
03A		Ew LWA / OLSA / OLSB	
03D		Ew LWA / OLWB / LSB / ODSD / VOH	
03M		OSM / OLSA / ODSB	
04B		Ew OLWA / LSB	
04C		Ew OLWA / OLSA / OLSB	
05A		OLWB / VOSM / HA / OLSB / ODSC	
05D		Ew LWA / OLWB / LSB / ODSC	
05M		Ew OLWA / VOSM / OLSA / OLSB / ODSC	
06B		OLWB / OLSA / OLSB / ODSC / ODSD	
06C		Ew OLWA / OLSA / OLSB / ODSC	

Site 2. Site burnt in the experimental fire, March 1990			
Plot	Soil type	Vegetation structure	Post fire observations
07A		OLWB / OLSA / OLSB / ODSC / ODSD / VOH	
07D		OLWB / OLSA / OLSB / Open DSC / ODSD / VOLS	
07M		OLSA / DSC / ODSD / VOH	
08B		OLWB / OLSA / ODSC / ODSD / VOLS	
08C		OLSA / OLSB / DSC / ODSD / VOH	
09A		OLSA / ODSD	
09D		Ew OLWA / OLSA / OLSB / DSC / ODSD / VOH	
09M		OLWB / OLSA / DSC / ODSD / VOH	
10B		LFB / OLSB / ODSD / VOLS	
10C		Ew OLWA / OLWB / OLSA / OLSB / ODSC / VOLS	
11A		LFB	
11D		Ew OLWA / LWB / OLSA / ODSC	
11M		Ew OLWA / LWB / OLSA / VOLS	
12B		Ew OLWA / LFB / OLSB	
12C		Ew OLWA	

3		
Plot	Soil type	Vegetation structure
13A		Ew OLWA / LWB / OLSA / OLSB
13D		Ew LWA / OLWB / OLSA / OLSB / ODSC
13M		Ew OLWA / OLWB / OLSB / ODSC / ODSD
14B		OLWB
14C		Ew OLWA / LSB
15A		Ew OLWA / OLSA / OLSB / ODSC / VOH
15D		Eac LWA / LSB
15M		Ew LWA
16B		Ew LWA / OLSA / LSB
16C		Ew OLWA / OLSAover LSB / ODSC
17A		OLSA / ODSC / VOH
17D		OLSA / ODSC / ODSD
17M		Ew OLWA / OLSA / DSC / ODSD / VOH
18B		OLSA / OLSB / DSC / ODSD
18C		OLSA / OLSB / DSC / ODSD / VOH

4		
Plot	Soil type	Vegetation structure
19A		OLSA / LSB / DSC
19D		Eac OLWA / OLWB / OLSA
19M		OLSA / OLSB / DSC / ODSD
20B		OLSA / LSB / ODSC
20C		OLSA / DSC / VOMP
21A		OLWB / OLSA / OLSB / ODSC
21D		OLWB / OLSA / ODSC
21M		LWB / OLSA / OLSB / DSC
22B		LWB / OLSA / OLSB
22C		LWB / OLSB / ODSC
23A		LFB / VOSM / OLSA
23D		Ew OLWA / LFB / Open low scrub
23M		LWB

Site 5			
Plot	Soil type	Vegetation structure	Post fire observations
25A		Eac LWA / LSB	
25D		Ew OLWA / OLSA / OLSB	
25M		Eac Ew LWA / OLSA / LSB	
26B		Eac LWA	
26C		Eac LWA / OLSB	
27A		Eac OLWA / LSB / VOLG	
27D		Ew LWA / OLSB	

27M		Eac Ew OLWA / OLWB / OLSB	
28B		Eac OLWA / OLSB	
28C		Ew OLWA / OLSB	
29A		Eac OLWA / LSB	
29D		Ew OLWA / OLSB / ODSC	
29M		Eac LWA / LSB	
30B		Ew OLWA / OLSB	
30C		Ew Eac OLWA / OLSB	

6		
Plot	Soil type	Vegetation structure
31A		Eac LWA / OLSA
31D		Eac Ew OLWA / OLWB / OLSA
31M		Eac LWA / OLSA / LSB
32B		Eac OLWA / LSB
32C		Eac OLWA / OLSA
33A		Eac OLWA / OLSA / ODSC / VOLS
33D		Eac OLWA / OLWB / OLSA / OLSB
33M		Eac OLWA / OLSB
34B		Eac OLWA / OLSA / ODSC
34C		Eac OLWA / OLSA / LSB / ODSC
35A		Eas LWA / OLWB
35D		Eac OLWA / OLSA / OLSB
35M		Eac LWA / OLSA / VOLS
36B		Eac Ew OLWA / VOH
36C		Eac LWA / OLSA

Site 1. Site burnt in the experimental fire, March 1990			
Plot Number	Soil Type	Vegetation Type	Effect of Fire
1a			fire patchy, plot incompletely burnt
1b			
1m			
1c			
1d			
2a			
2b			
2m			
2c			
2d			
3a			
3b			
3m			
3c			
3d			
4a			

4b			
4m			
4c			
4d			
5a			
5b			
5m			
5c			
5d			
6a			
6b			
6m			
6c			
6d			