THE CONTRIBUTION OF PRESCRIBED BURNING TO FOREST FIRE CONTROL IN WESTERN AUSTRALIA: CASE STUDIES

BY

R.J. UNDERWOOD, R.J. SNEEUWJAGT,
AND H.G. STYLES *

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* Department of Conservation and Land Management, Perth, WA

SUMMARY

Current fire management policy for Western Australian State forests dictates periodic prescribed burning under mild weather conditions. The aim is to reduce levels of inflammable fuels on the forest floor, and thereby improve fire fighter effectiveness under severe weather conditions.

To evaluate the success of this policy, case histories of nine recent forest fires are examined. Data for each case study, including fire behaviour and size, control measures and damages sustained, are compared with projected values calculated from records of fuels and weather conditions made at the time of the fires.

For each case it is concluded that previous fuel reduction by prescribed burning facilitated control of the fire. Had the case fires developed as projected in a situation where fuels had not been reduced by prescribed burning, serious community damages and costs would have been incurred.

INTRODUCTION

The major eucalypt and pine forests of Western Australia occupy only two million hectares and are restricted to the southwest corner of the State. Two factors influence management in this area. Firstly, the forests are managed for a wide range of protective, productive, recreational and conservation values (Beggs 1982). Secondly, some 0.5 million people live near or within the forest region. Each year this region experiences a hot, dry summer, during which wildfires regularly start in the forest (Peet 1965, Luke and McArthur 1978).

For example, in the 30 year period 1954-1984, foresters dealt with 8533 fires burning in or threatening State forests (WAFD Annual Reports 1954-84). This represents an average of 284 fires each year.

Many of these fires occurred during severe or "blow-up" weather conditions (Burrows 1984). These conditions are characterised by high temperatures, dry fuels and hot, strong winds. Forest fires burning under such conditions can have catastrophic consequences: lives are lost and property is destroyed (Rodger 1961). They can also cause serious resource losses (Peet and Williamson 1968), erosion, siltation of streams, loss of wildlife and landscape values (Leitch et al 1983) and disruption to forest based industry, including bee-keeping. Furthermore, the suppression of high intensity forest fire is highly dangerous and very costly. Nineteen firefighters lost their lives fighting forest fires in South Australia, and Victoria in 1983. The direct fire fighting costs of suppressing one fire in the karri forest of W.A. in 1969 exceeded $100,000 (Peet 1969), equivalent to nearly half a million of today's dollars. This includes no allowance for loss and damage resulting from the fire, or for the value of volunteer fire fighters working on adjoining farmland.

Foresters in Western Australia have been concerned about the problem of wildfire since the beginnings of forest management in the 1920s (Kessell 1923). Since then there has been a steady evolution in fire policy as research and field experience led to improvements in technology and to a better understanding of fire behaviour and its role in forest ecosystems (Underwood and Christensen 1981).

The current approach is based on the premise that since fire occurence is inevitable, the aim must be to minimise undesirable consequences. Stemming from this philosophy two complimentary management systems have emerged.

The first involves maintenance of an efficient fire detection system, backed up by effective fire fighting forces stationed throughout the forest zone. This system has a proven capacity for rapid location and suppression of the fires which breakout under mild to average summer weather conditions.

The second system involves the systematic reduction of inflammable fuel on the forest floor by a programme of rotational prescribed burning. The aim of this programme is to help fire fighters cope with fires starting under severe weather conditions, or when many fires occur simultaneously. Under such circumstances the suppression task can rapidly exceed fire fighting resources, leading to large, intense forest fires, and consequent social and economic damage. Current estimates show that the organization required to suppress a large forest fire burning under severe conditions can cost up to $40,000 per day. Such a fire may take 5 or more days to be fully contained.

Experience over a wide range of weather conditions has shown that direct attack on forest headfires is not likely to succeed when flame heights are more than three metres or where fires are moving faster than 100 metres per hour. Fire behaviour is directly affected by the amount of fuel, and so long as inflammable fuel weights are maintained at less than about 8 tonnes per ha in the jarrah (E. marginata) forests or about 15 tonnes per ha in the karri (E. diversicolor) forests, there is a good chance that direct attack on the flanks of a fire will succeed with eventual control of the headfire by pincer action from the flanks.. This applies even under severe weather conditions. Furthermore, areas of light fuel throughout the forest provide anchor points for suppression lines, refuge areas for threatened fire crews or civilians, and improved access for men and equipment working on a fire edge or suppressing spot fires ahead of a main front.

There have been no major fires since 1961 in the jarrah forest, where a prescribed burning programme commenced in 1954, or since 1969 in the karri forest where the fuel reduction policy became effective in the late 1960s (Underwood and Christensen 1981). During this time no single firefighter has been burnt to death in a forest fire in W.A. - nor have there been any losses of life of civilians living in or near the forest zone. This contrasts with the "Ash Wednesday" fires in Victoria and South Australia in February 1983 which resulted in 70 deaths and hundreds of serious injuries.

Despite these results, both the effects and the effectiveness of prescribed burning are challenged. For example, Raison, Woods and Khanna (1984) suggest that a range of ecological problems may develop as a result of cyclic prescribed burning. They list alteration of ecosystem processes and components, accelerated soil erosion and depletion of nutrients. They also argue that since fuels re-accumulate after burning, the fire control advantages are shortlived and therefore dubious.

Whilst there is considerable literature on fire ecology, almost nothing has been published on forest fire control in Australia or the contribution to control made by prescribed burning for fuel reduction (Billings 1981). However, there is a wealth of unpublished information and personal knowledge within the WAFD (W.A. Forest Dept.). Dating back over 50 years, records are available of nearly every fire which has occurred within State forests, together with detailed reports of investigations into serious and large fires. Departmental officers have also developed a reliable prediction system on forest fire behaviour and fuel accumulation for Jarrah, Karri and Pine forests, (Sneeuwjagt and Peet 1979), which can be used to make projections on the behaviour of past fires.

In this paper we present a selection of case studies drawn from this information. We attempt to illustrate the contribution of prescribed burning to forest fire control in W.A., and discuss the advantages and disadvantages involved.

METHOD

Forests Department records of forest fires in W.A. over the period 1969-1984 were consulted. From the numerous fires in which the beneficial effects of fuel reduction burning was evident, 9 were selected for detailed analysis (Table 1). In making the selection we tried to ensure that a range of forest and fuel types were represented, and that examples of major fire runs as well as smaller fires with high damage potential were included. The study has concentrated on fires occurring over the past 15 years to ensure comparability with current suppression methods.

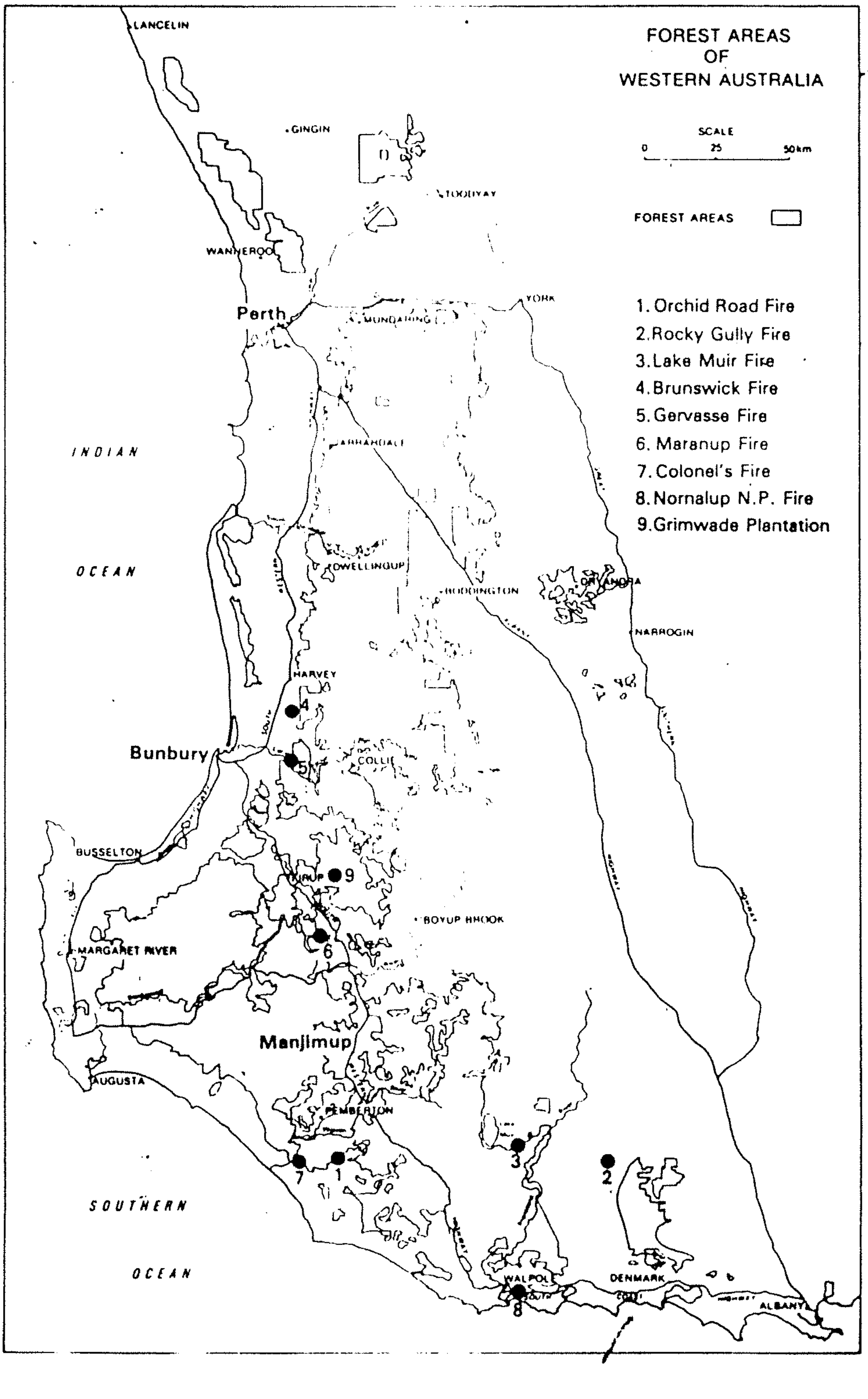
TABLE 1: THE STUDY FIRES

Case Study No.	Fire Name	Date Of Fire	Major Fuel Type	Eventual Size
1.	Orchid Road Fire	31.12.69	Jarrah/titree/ pasture	40 ha
2.	Rocky Gully Fire	20.12.74	Jarrah/pasture	8000 ha
3.	Lake Muir Fire	28. 2.77	Jarrah/swamp	7100 ha
4.	Brunswich Fire	4. 4.78	Jarrah/pine/pasture	3760 ha
5.	Gervasse Fire	4. 4.78	Jarrah/pine/pasture	2730 ha
6.	Maranup Ford Fire	4. 4.78	Jarrah/pasture/ pines	5280 ha
7.	Colonel's Fire	31. 1.84	Jarrah/marri	60 ha
8.	Nornalup Fire	24. 2.84	Swamps/karri/tingle	170 ha
9.	Grimwade Fire	2. 3.84	Pine Plantation/ jarrah	171 ha

The location of the study fires is shown in Figure 1.

For each study fire we examined the fire report, and record of subsequent investigation; meteorological data from the nearest station; archive fuel type and fuel age maps; and topographic and tenure plans. Fire behaviour projections were calculated using the WAFD Forest Fire Behaviour Tables (Sneeuwjagt and Peet 1979).

Locations of study fires



These studies provided data on:

- Date and time of fire start.
- Cause of fire.
- Meteorological conditions leading up to, during and after the fire.
- Fuel types and ages.
- Actual and projected fire behaviour.
- Actual and projected fire size.
- Suppression measures.
- Values threatened.

Figure 1. near here

RESULTS: THE CASE STUDIES

1. THE ORCHID ROAD FIRE OF DECEMBER 1969

The fire commenced in a farm paddock adjoining State forest at approximately 0930 hrs on 31.12.69. It originated from smouldering logs within dry grass, fanned by strong easterly winds.

Weather conditions in the southwest had been severe for the three previous days, and a number of fires were already running in the region. The conditions at Pemberton Headquarters (15 kms from the fire) were 31^{o}C temperature, 25% relative humidity and 45 kph winds with gusts to 60 kph. Under these conditions predicted rate of spread in heavy karri fuels ahead of the fire was approximately 600 metres per hour. In this situation, flame heights would have exceeded 20 metres, and direct attack would not have been possible.

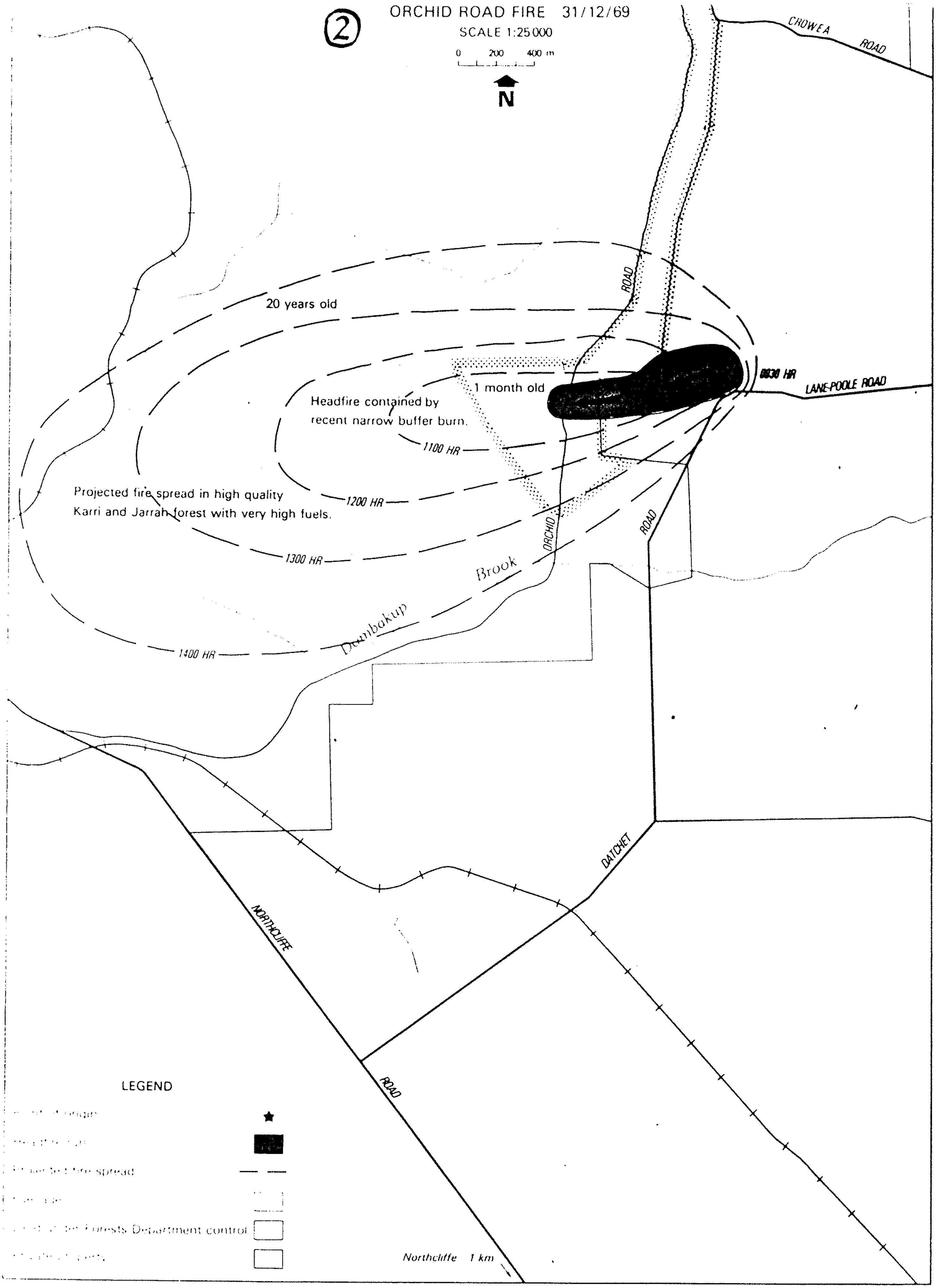
The fire expanded rapidly in the pasture and quickly entered State forest. It ran immediately into a narrow strip of forest which had been prescribed burnt in the previous month. Fire behaviour was mild and the edges were attacked directly by forestry crews when they arrived at about 1000 hrs. Including the area of pasture burnt in the farmer's paddock, final fire size was 40 hectares.

Suppression and mop-up was completed by 1430 hrs. The crews and machines then transferred to another fire elsewhere in the region.

The Projection

Beyond the narrow buffer within which the fire was contained, the forest carried 20 year old fuel loads. This area had previously been burnt by wildfire in 1950. The three major forest blocks in the path of the fire (Crowea, Dombakup and Warren) all comprised virgin karri, marri and jarrah forest. These blocks are surrounded by private property and National Park.

②


ORCHID ROAD FIRE 31/12/69
SCALE 1:25 000
0 200 400 m
N
CHOWEA ROAD
ROAD
20 years old
1 month old
LANE-POOLE ROAD
Headfire contained by
recent narrow buffer burn.
1100 HR
1200 HR
1300 HR
1400 HR
Projected fire spread in high quality
Karri and Jarrah forest with very high fuels.
ORCHID
ROAD
Brook
Dombakup
DATCHET
NORTHCLIFFE
ROAD
LEGEND
Northcliffe 1 km

Easterly winds and high temperatures persisted for approximately 24 hours following suppression of the fire. This was followed by a southwesterly change. (Headfire rates of spread of up to 1000 m/hr were measured on another fire in similar fuels on the same day).

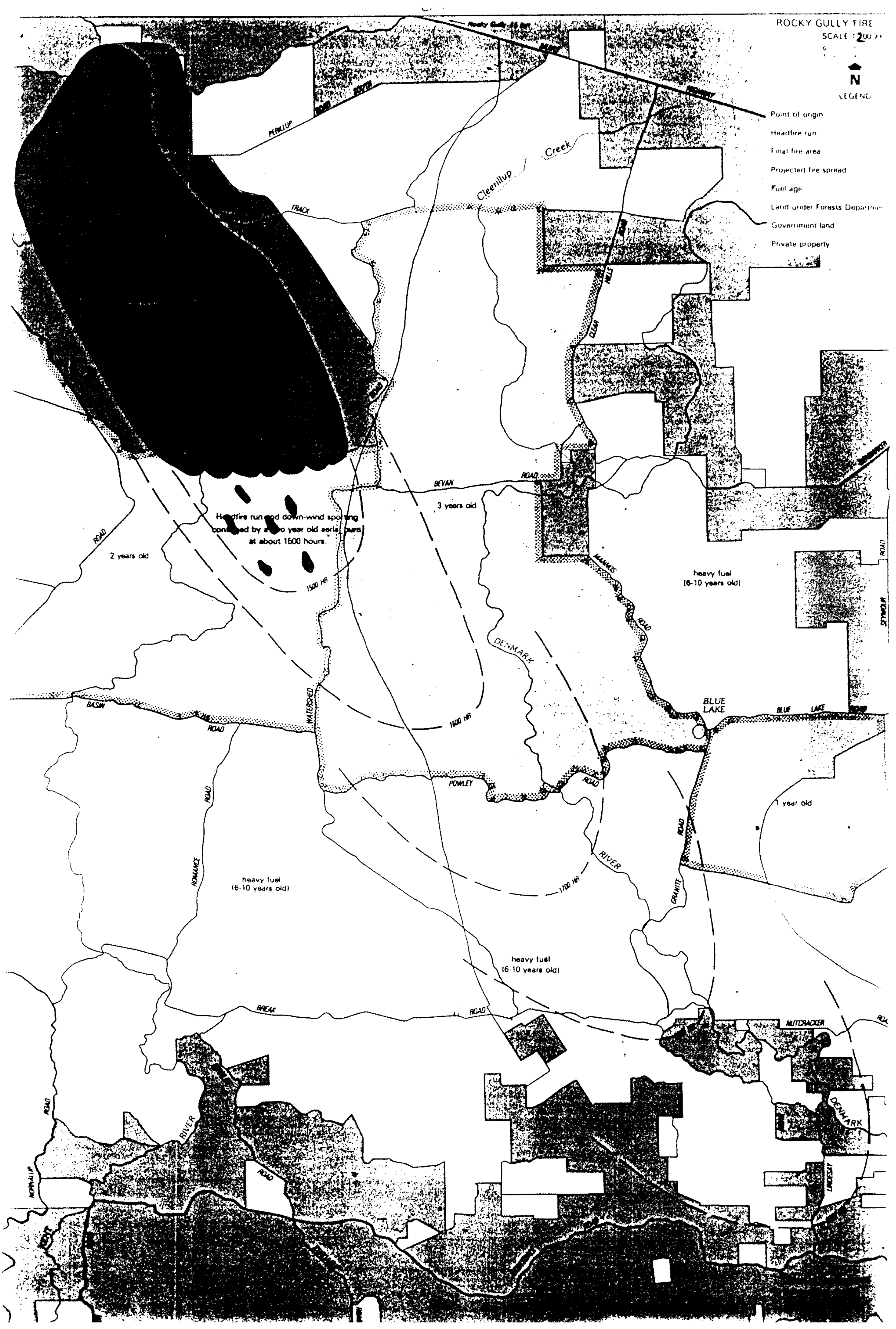
A projection of likely fire development over the first 5 hours of 31 December 1969 is shown in Figure 2. This projection assumes success in controlling the tail of the fire in private property, and that no long distance spotting occurred. It is calculated that the fire would have attained a size of 12000 ha by mid-day of the following day (January 1st) and caused severe damage to forest and community values.

[Figure 2 near here]

2. THE ROCKY GULLY FIRE OF DECEMBER 1974

The fire commenced from burning waste at a sawmill located 7 kms southeast of Rocky Gully. The time was 1230 hrs on December 20th 1974. December 20th 1974 was a blow-up day. Temperatures throughout the southwest of the State exceeded 40°C and relative humidities were below 10%. Gale force northwesterly winds (60-70 kph, gusting to 90 kph) blew for most of the day until a southwesterly change came through that evening. Departmental fire fighters were simultaneously dealing with 44 separate wildfires in State forest that day.

The fire escaped into Vacant Crown Lands and was attacked immediately by sawmill workers, but they could not contain it. The fuels were jarrah forest and open titree flats, unburnt for at least 10 years (actual fuel age not known).


ROCKY GULLY FIRE
N
LEGEND
Point of origin
Headfire run
Final fire area
Projected fire spread
Fuel age
Government land
Private property
PERILLUP
TRACK
Cleerillup
Creek
CLEAR
HILLS
BEVAN
ROAD
3 years old
Headfire run and down-wind spotting
at about 1500 hours.
2 years old
1500 HR
1600 HR
1700 HR
DENMARK
MANNS
heavy fuel
(6-10 years old)
SEYMOUR
BLUE
LAKE
BASIN
WATERSHED
POWLEY
GRANITE
RIVER
1 year old
ROMANCE
BREAK
NUTCRACKER
LINDESAY
NORNALUP

Fire behaviour was intense. At a rate of spread of approximately 6400 metres/hour, the fire ran 15 kms in 2.5 hours. Spotfires were numerous and developed up to 2000m ahead of the front.

No Departmental firefighters forces were available to move to this fire due to commitments on other fires. In any case, fire intensity greatly exceeded that at which suppression could be attempted.

At 1500 hrs, the headfire and northeastern flank ran into forest prescribed burnt two and three years previously. The head fire stopped at this point. Control and mop-up was completed by a small team of volunteer bushfire brigade forces the following days.

Actual fire size was 8000 ha. See Figure 3.

The Projection

Assuming the headfire continued to spread at 6400 m/h in the forest it is calculated that the fire would have run for a further 26 kms and reached a size of approximately 30000 ha over the period 1500 hrs to 1900 hrs on December 20th. See Figure 3.

Such a fire would have posed a direct threat to the town of Denmark (population 1000) and surrounding farming communities.

3. THE LAKE MUIR FIRE OF JANUARY 1977

Two fires were lit by an arsonist, in a Flora and Fauna Reserve adjoining State forest, at 1710 hours on January 16th 1977. Although fuels were estimated to be over 15 years old, conditions were cool and mild and fire fighters successfully extinguished both fires the same evening.

Eight days later at 1315 hours on 24th January 1977, a new fire commenced in the same area, either an escape from one of the original fires or a third attempt by the incendiarist.

Conditions at the time were now hot and dry (weather at Manjimup 60 kms from the fire was 34 C, RH 24%) with Northeast winds (20 kph) followed by northwesterlies in the afternoon. The fuels in the area were jarrah, paperback and swamp, unburnt for at least 15 years.

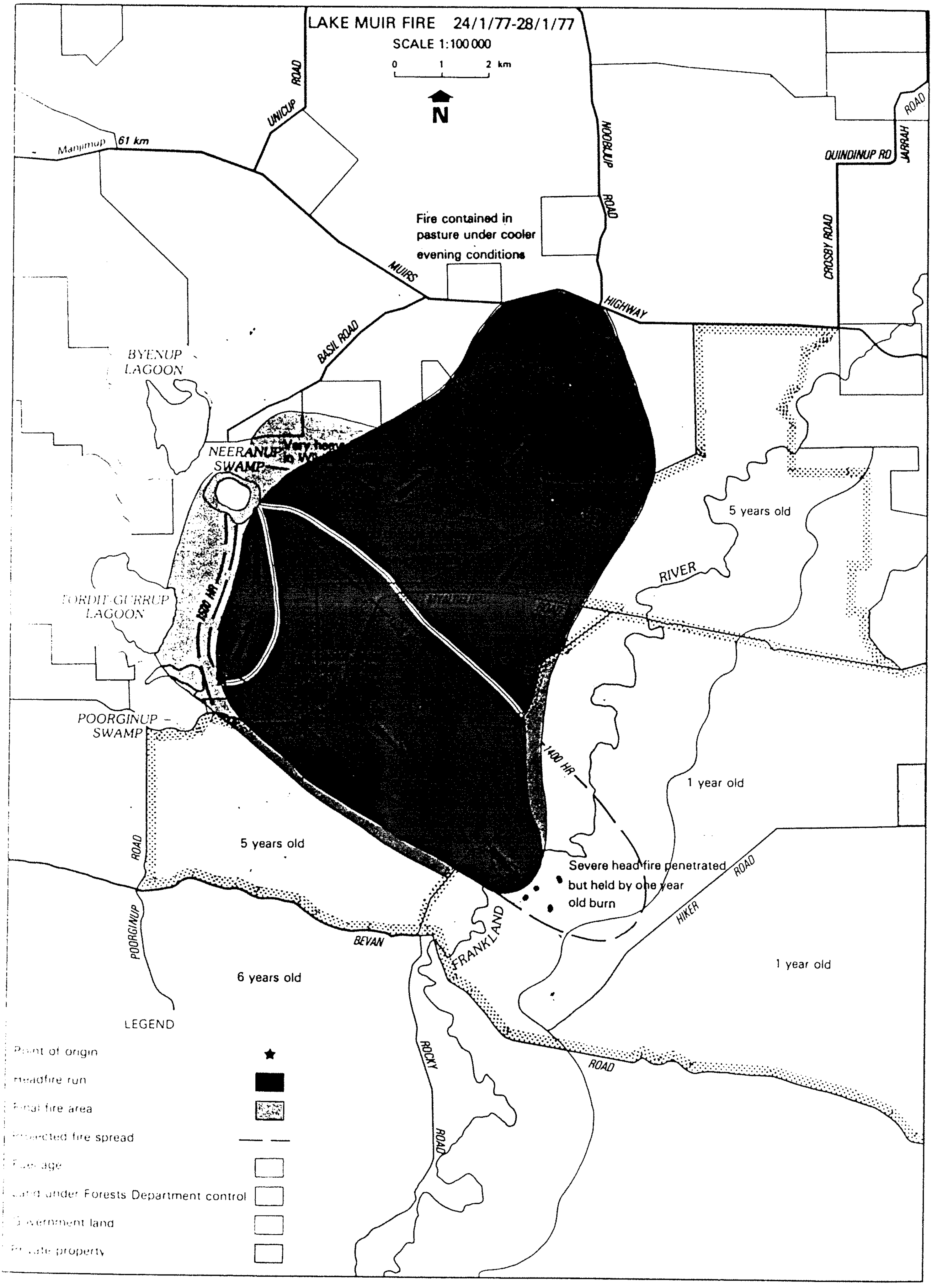
Under these conditions, suppression attempts failed. Flame heights were recorded up to 8 metres and the average head fire rate of spread was 1000 m/hour. Spotting was estimated at 200 metres. Suppression efforts were deferred until evening under cooler conditions. Early the following morning, bulldozers succeeded in surrounding the fire with earth breaks.

The following day (25.1.79) was also hot and dry, (temperature 37 C and RH 29%). Strong northwesterly winds up to 30 kph blew all morning, followed by a southwesterly change in the early afternoon. Numerous spot fires occurred across the eastern edge of the fire; these eventually overcame the efforts of suppression crews. A major fire developed driven by the northwesterly wind. Head fire rate of spread reached 3000 m/hr. At 1400 hours the fire front ran into a one year old prescribed burn area. The head fire stopped at this point. However, before this situation could be capitalized, the wind swung from northwest to southwest and the whole northern flank of the fire broke away. A new fire developed with a 7 km front. Flame heights reached 35 metres and the head fire rate of spread exceeded 6000 m/hr.

Late on the afternoon of the 25th the fire reached private property, comprising paddocks eaten bare by stock over previous months and a network of firelines prepared that day. A heavy concentration of Departmental and volunteer forces was able to contain the fire at this point. All edges were contained on the following day.

Final fire size was 7100 ha. See Figure 5.

10A


LAKE MUIR FIRE 24/1/77-28/1/77
SCALE 1:100 000
0 1 2 km
N
Manjimup 61 km
UNICUP ROAD
NOOBIJUP ROAD
MUIRS HIGHWAY
QUINDINUP RD
JARRAH ROAD
CROSBY ROAD
BASIL ROAD
Fire contained in pasture under cooler evening conditions
BYENUP LAGOON
NEERANUP SWAMP
TORDIT-GURRUP LAGOON
POORGINUP SWAMP
1400 HR
5 years old
RIVER
1 year old
Severe head fire penetrated but held by one year old burn
HIKER ROAD
ROAD
POORGINUP
BEVAN
FRANKLAND
6 years old
ROCKY ROAD
ROAD
LEGEND
Point of origin
Headfire run
Final fire area
Projected fire spread
Fuel age
Land under Forests Department control
Government land
Private property

The Projection

Had not the head fire run into a one year old burn it is calculated that the southeasterly head fire run upto 1400 hours on the 25th would have proceeded for a further 3.5 km before the southwesterly change came through. The subsequent breakout of the northern edge would have generated a fire size of approximately 10,000 ha, and caused a more difficult suppression problem on private property and on State forest and Wildlife Reserves.

CYCLONE ALBY FIRES - 4TH APRIL 1978

On April 4th 1978, Cyclone Alby passed through the southwest corner of Western Australia. High temperatures, dry north-west winds of upto 140 kph, combined with a high drought factor at the end of summer to produce one of the most serious fire emergencies experienced in the forest zone of W.A. since records have been kept.

92 separate wildfires developed within the region. These burnt out 54000 ha of private forest, State forest and Crown lands, but the area of State forest burnt was confined to less the 7000 ha. In all situations where fires entered State forest from neighbouring properties, they were contained or retarded by light fuels. The following 3 wildfire case studies provide examples of this.

4. THE BRUNSWICK FIRE

This fire occurred during the passage of Cyclone Alby on the 4th April 1978. It started at 1440 hours in pasture on private property as a spark from a rotary slasher.

The fire ran 12 kms in 1.5 hours indicating a headfire rate of spread of 8000 metres/hour. Fuels were mainly flats, jarrah forest and privately owned pine plantations. No suppression could be attempted on head or flank fires at any stage of the main fire run.

The fire burned through private property and skirted along light (4 month-old) fuels in the adjoining State forest on the eastern flank before burning through some 50 ha of the Forests Department Brunswick pine plantation. The head fire was then halted by light fuels within a large private forest block that had been burnt 5 months and 1 year earlier by the Forest Department in a mutual aid agreement with the owner.

The fire was fully under control by evening and mopped-up on the following day. Total fire area was 3700 ha, of which only 320 ha was within State forest.

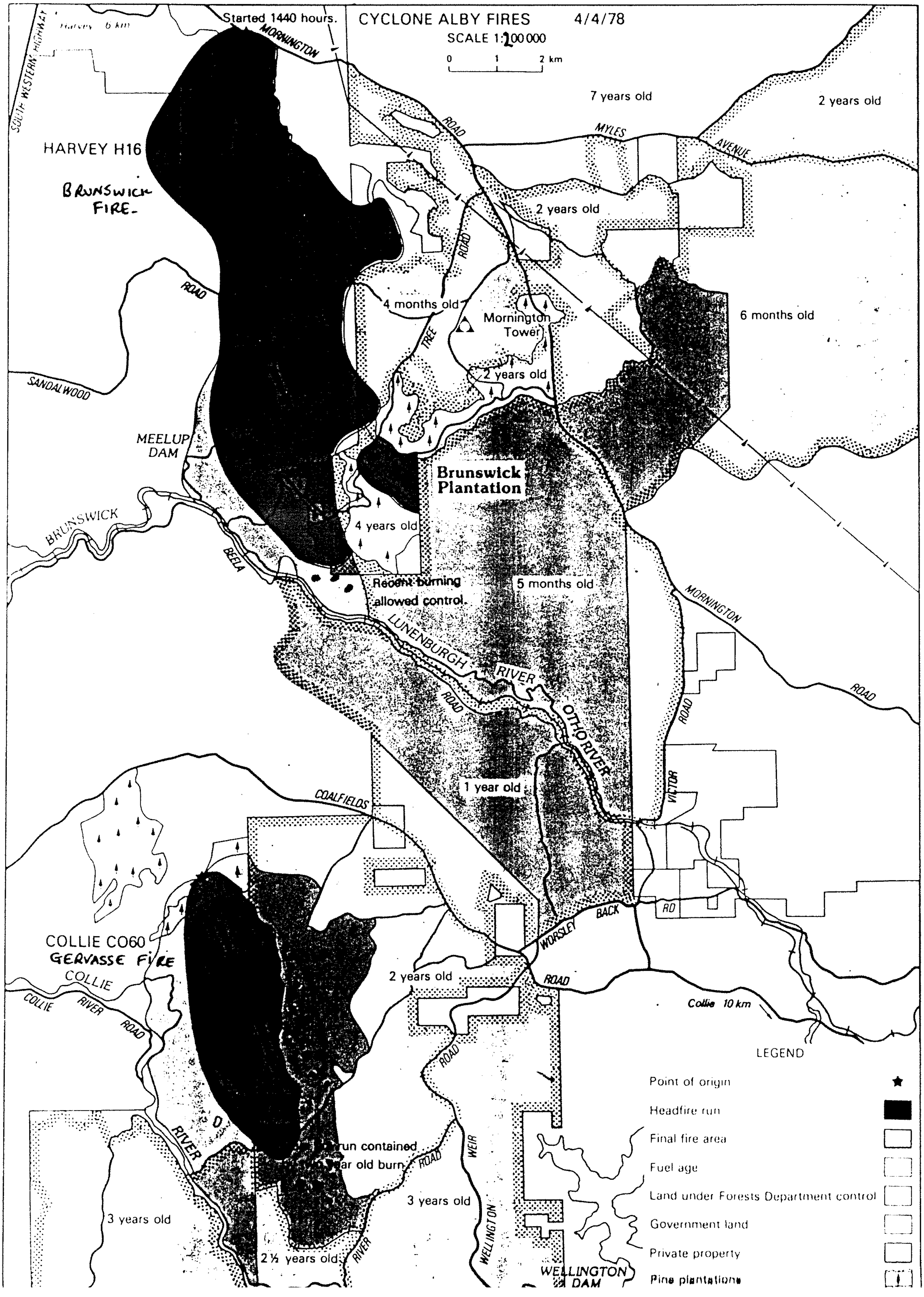
5. THE GERVASSE FIRE

The fire commenced at about 1600 hours on April 4th 1978. The cause is not known. Smoke and dust throughout the southwest obscured the fire detection system. It is probable that the fire commenced in grassland on private property as a spot fire thrown from the Brunswick fire burning directly to the north at that time.

No suppression activity could be attempted. Fire behaviour was not closely observed, but it appears that head fire rates of spread varied between 5000 and 10,000 metres per hour through privately owned bush and pine plantation. The fire entered State forest at approximately 1700 hours driven before winds of over 100 kms per hour. Fuels in the forest were only 1, 2 and 3 years old as a result of prescribed burning burning operations. The fire front was halted and contained in these areas. Numerous small spot fires occurred up to 3 kilometers ahead into these low fuel zones but failed to develop.

The tail of the fire was suppressed by farmers on the night of the 4th. No action was taken on the fire in State forest for another 3 days until fire fighters could be freed from more pressing tasks elsewhere. During those days the fire trickled about in the light fuels, but burnt only 500 ha of State forest in total. It was eventually made safe by burning out to existing roads and fire breaks on April 7th. (See Figure 6)

12A


Started 1440 hours.
CYCLONE ALBY FIRES 4/4/78
SCALE 1:200 000
0 1 2 km
HARVEY H16
BRUNSWICK FIRE.
7 years old
2 years old
MYLES AVENUE
2 years old
4 months old
Mornington Tower
6 months old
2 years old
MEELUP DAM
Brunswick Plantation
4 years old
BRUNSWICK
Recent burning allowed control.
5 months old
LUNENBURGH RIVER
OTHO RIVER
MORNINGTON ROAD
1 year old
COALFIELDS
VICTOR ROAD
WORSLEY BACK RD
COLLIE CO60
GERVASSE FIRE
COLLIE RIVER ROAD
2 years old
Collie 10 km
LEGEND
Point of origin
Headfire run
Final fire area
Fuel age
Land under Forests Department control
Government land
Private property
Pine plantations
run contained
ar old burn
3 years old
3 years old
2½ years old
WELLINGTON WEIR ROAD
WELLINGTON DAM
SANDALWOOD
TREE ROAD
SOUTH WESTERN HIGHWAY

The Projection Of Both The Brunswick and Gervasse Fires

Northwesterly cyclonic winds continued unabated in the area until 2300 hours. At this time, a southwesterly change came through.

The projection of these fires upto 2300 hours if forest fuels in the area had been 10 years old, would show that both fires would have joined up and burnt out a total of 33,000 ha. This would have involved total destruction of the Brunswick pine plantation, worth over a million dollars. More seriously, the spotting from a high intensity forest fire burning under cyclonic winds, would have generated impossible conditions for fire fighters and occupants on farms and townships downwind of the fire.

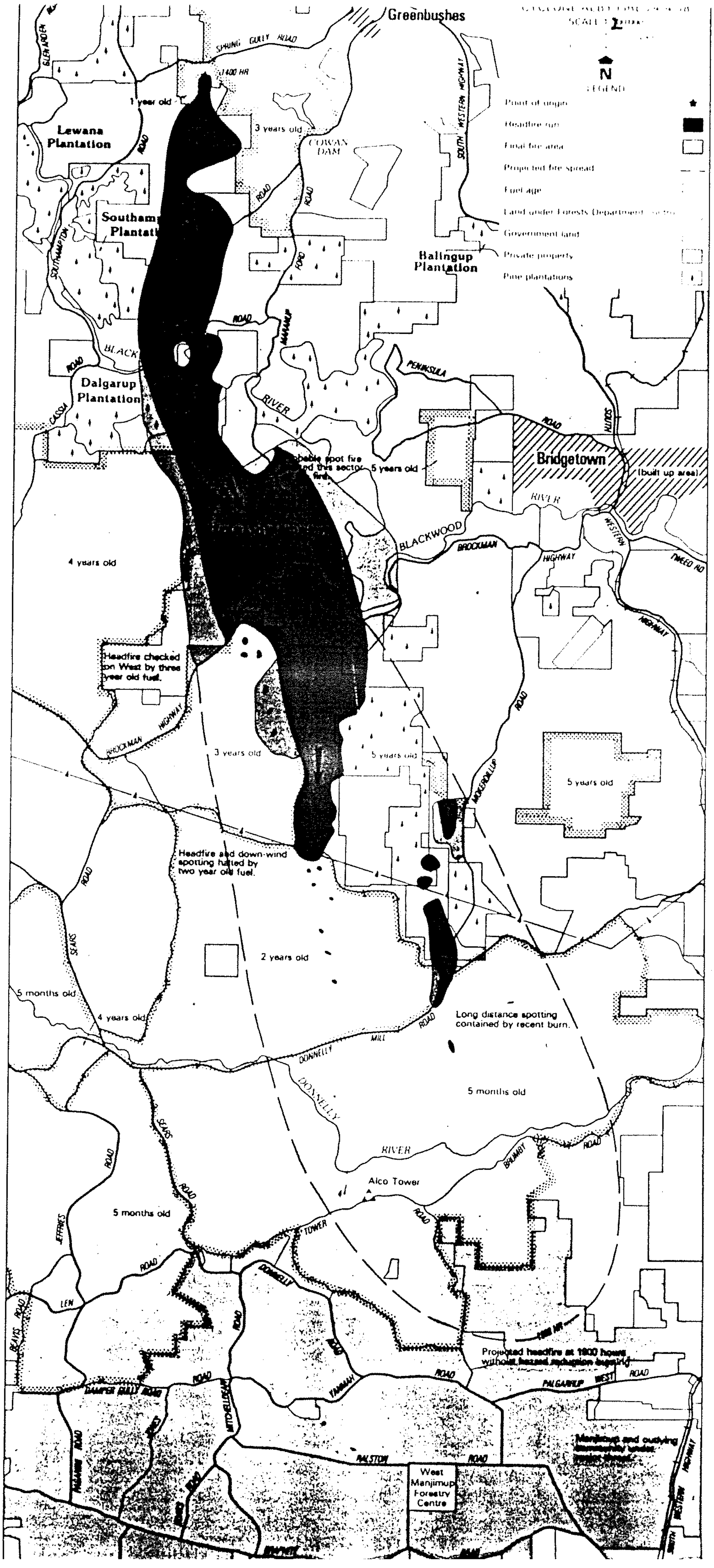
6. THE MARANUP FORD FIRE

The Maranup Ford fire escaped from a clearing burn on private property 16 km northeast of Bridgetown. The fire started at 1100 hours and rapidly burnt through pasture and bracken fuels on steep slopes. The wind was Northeast to North upto 40 kph. At about mid-day the fire was contained by bushfire brigade units at Huitson Road, within private property. However, at about 1500 hours the arrival of Cyclone Alby winds of 80 to 120 kph caused the fire to break away to the south. The headfire reached rates of 5000 to 10000 metres per hour. Spotting upto 10 km in front of the head fire occurred when the fire crossed the Blackwood River and accelerated up the southern slopes of the valley. Many of these spots eventually became part of the main head fire, whilst others showed up as individual fires in State forest north of Manjimup townsite. The main fire eventually stretched 21 km, although 4 spotfires developed 3 to 6 km further downwind. During its run, the shape of the main fire was narrowed by the presence of 3 and 4 year old burns on the western flank. The head fire was effectively stopped on State forest when it reached a 2 year old burn. The spotfires which would have threatened the Manjimup community also failed to develop because of light fuels within a 5 month old burn located 15 km north of Manjimup.

[redacted]

7

13A



No suppression was possible during the main run of the fire because of the intense fire behaviour, falling trees and flying debris.

Because of community problems elsewhere in the wake of the cyclone, suppression of the fire within State forest was given a low priority, and delayed for 2 days. During these days, the fire trickled about harmlessly in light fuels. Final containment of the fire on State forest was not completed until 4 days later and involved the locating and mopping up of many spotfires that had not developed in the light fuel areas.

The total fire area was 5280 ha. This included 270 ha of Forest Department pine plantation and 1000 ha of native forest. See Figure 7.

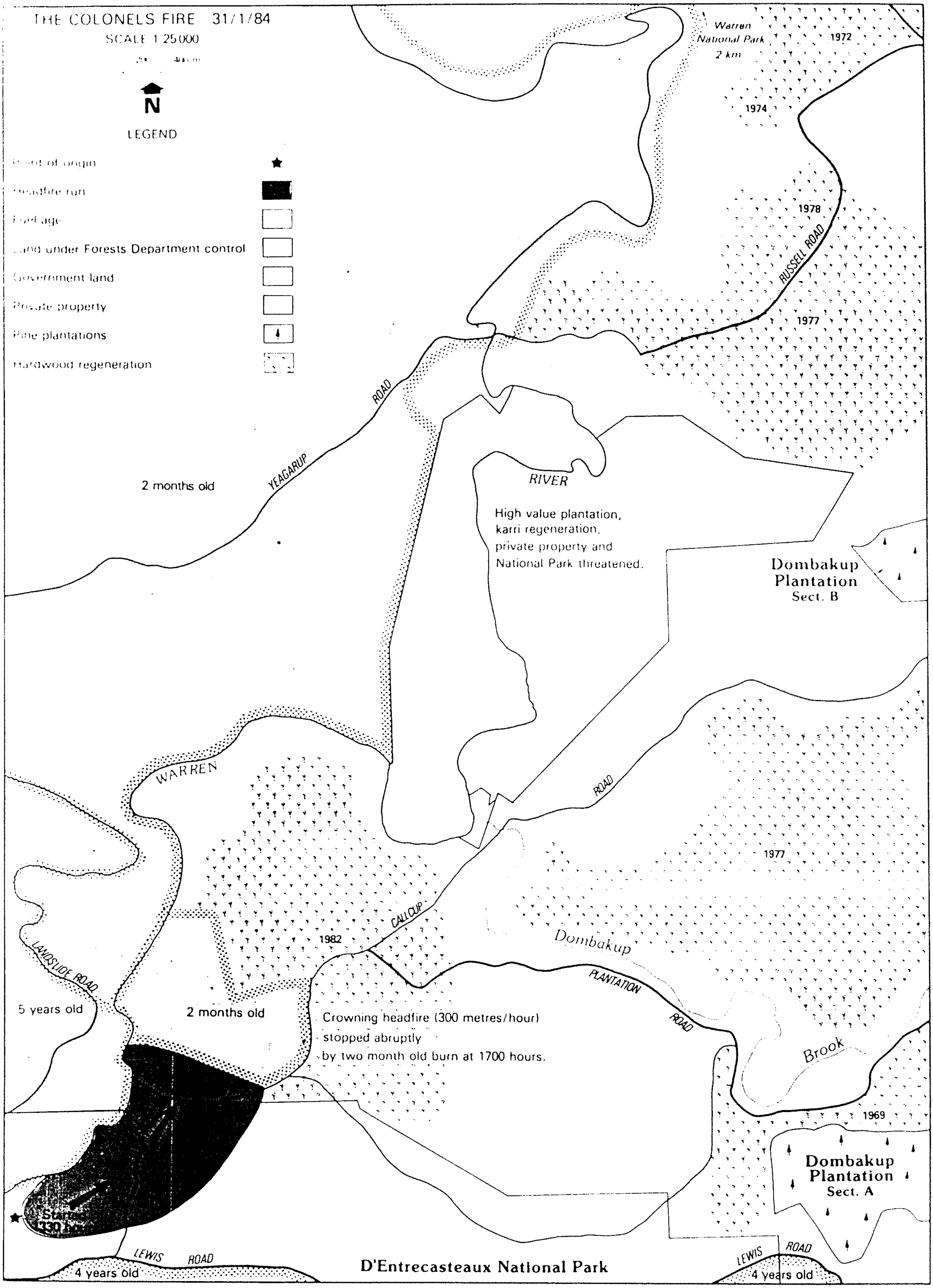
The Projection

If the forest fuels ahead of the fire had been 10 years old, it is predicted that the fire would have reached the outskirts of Manjimup town by 1930 hours. The cyclonic winds continued at Manjimup until midnight. In the absense of prescribed burnt fuel reduced zones in State forest, this fire could well have spread for another 30 km by 2400 hours on the 4th April covering an area of 40,000 ha of farmland and State forest. The town of Manjimup (population 3500) and settlements of Palgarup (130), Deanmill (200) and Jardee (100) may have been engulfed by this fire. See figure 7.

7. THE COLONEL'S FIRE OF JANUARY 1984

The fire commenced at 1330 hours on January 31st 1984 when a smouldering log from a clearing burn on private property flared up and ignited dry pasture.

The conditions at the time were severe, with a temperature of 40°C and relative humidity of 16% recorded at Pemberton (20 kms away). At the time of the escape winds were northwest at 25 kph. A strong (35 kph) southwesterly wind followed at about 1400 hours.


THE COLONELS FIRE 31/1/84
SCALE 1:25000
N
LEGEND
Point of origin
Headfire run
Fuel age
Land under Forests Department control
Government land
Private property
Pine plantations
Hardwood regeneration
Warren National Park 2 km
1972
1974
1978
RUSSELL ROAD
1977
ROAD
YEAGARUP
2 months old
RIVER
High value plantation, karri regeneration, private property and National Park threatened.
Dombakup Plantation Sect. B
WARREN
ROAD
1977
CALLCUP
1982
Dombakup
LANDSLIDE ROAD
PLANTATION
ROAD
5 years old
2 months old
Crowning headfire (300 metres/hour) stopped abruptly by two month old burn at 1700 hours.
Brook
1969
Dombakup Plantation Sect. A
LEWIS ROAD
4 years old
D'Entrecasteaux National Park
LEWIS ROAD
4 years old

There was no one on the farm on the day, and the fire was not immediately attacked. It entered thick scrub and burnt out into the neighbouring D'Entrecasteaux National Park. The forest type was mixed jarrah and marri and fuels were 10 year old (i.e., approximately 18 tonnes per hectare). Two Departmental firefighting crews were unsuccessful in attempts to control the head fire at this stage, and were withdrawn to work on the south eastern flank where fire intensity was less intense.

At approximately 1700 hours the head fire ran into a one month old burn on State forest. The burn protected an extensive area of young karri regrowth, pine plantation, State forest and National Park. The head fire was halted in the burn and suppression crews were able to contain the flanks by direct attack.

Fire area was 60 hectares.
See Figure 8.

The Projection

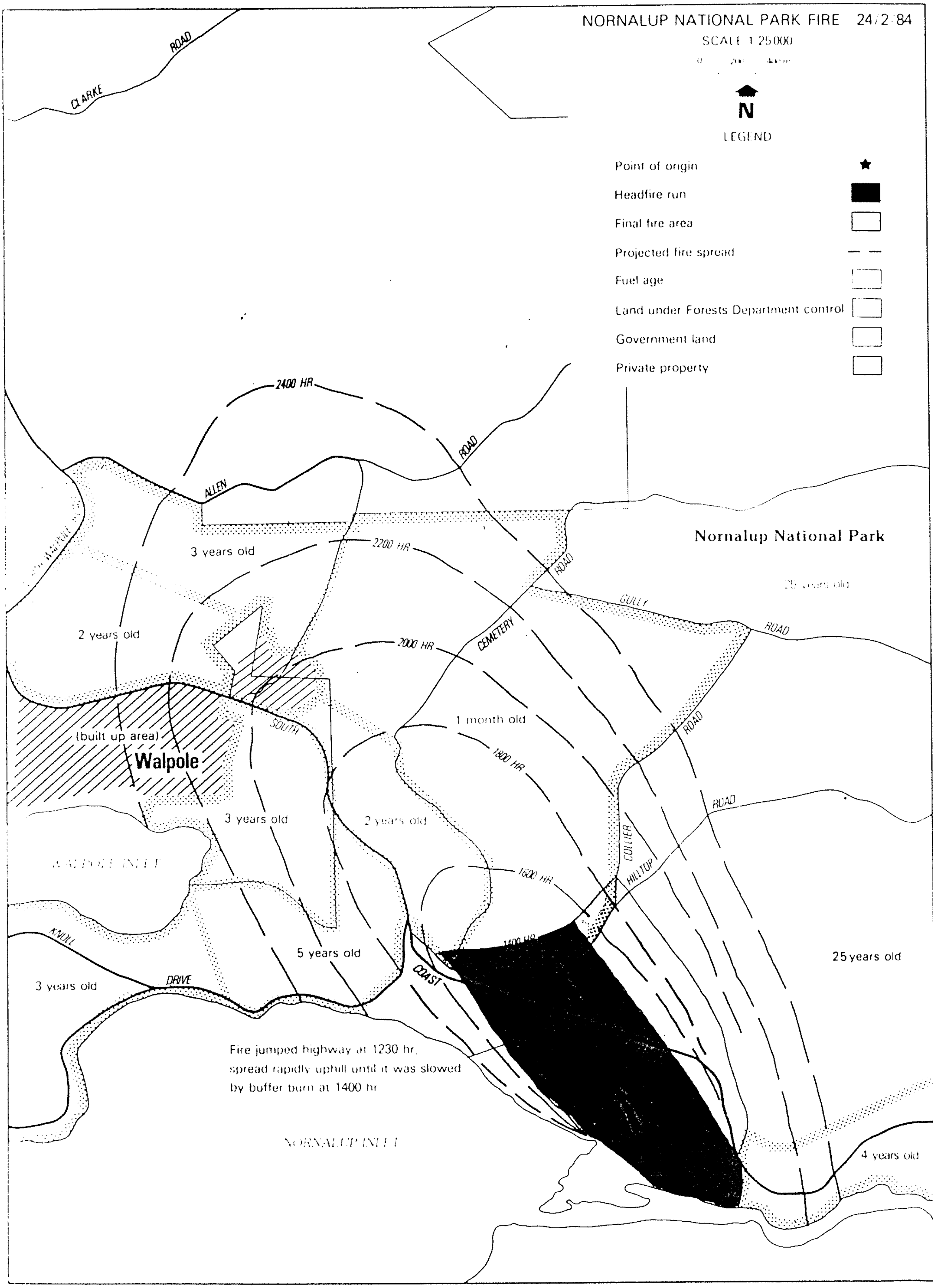
Southwesterly winds, high temperatures and low humidity persisted for approximately 7 hours after the start of this fire.

Given no protective fuel reduction burning in the area this fire would have continued to spread at 400 metres per hour fanned by the strong southwesterly wind. It is estimated that by midnight the fire area would have been about 500 ha. Such a fire had the potential to destroy large areas of highly valuable and fire sensitive karri regrowth forest, pine plantation, National Park and private property.

8. THE NORNALUP NATIONAL PARK FIRE OF JANUARY 1984

The fire commenced in National Park, presumably from a fisherman's campfire at 0800 hours on 24.2.84. It immediately burned into an area of dense, impenetrable swamp where direct fire attack could not be mounted.

15A


NORNALUP NATIONAL PARK FIRE 24/2/84
SCALE 1:25000
N
LEGEND
Point of origin
Headfire run
Final fire area
Projected fire spread
Fuel age
Land under Forests Department control
Government land
Private property
Nornalup National Park
CLARKE ROAD
ALLEN ROAD
2400 HR
2200 HR
2000 HR
1800 HR
1600 HR
1400 HR
3 years old
2 years old
1 month old
3 years old
2 years old
5 years old
3 years old
25 years old
4 years old
(built up area)
Walpole
SOUTH
COAST
KNOLL DRIVE
CEMETERY ROAD
GULLY ROAD
COLLIER ROAD
HILLTOP ROAD
WALPOLE INLET
NORNALUP INLET
Fire jumped highway at 1230 hr,
spread rapidly uphill until it was slowed
by buffer burn at 1400 hr

Conditions were mild, with the weather readings at Walpole (4 kms away) at the time being temperature 24 C, relative humidity 54% and winds northeast at 5-10 kph.

The fire was attended by a small fire fighting force, who allowed it to burn slowly through the swampy country with the aim of tying it in later when it backburned out to access tracks.

At mid-day the wind veered to southeast and freshened to 25-30 kph. The flank fire became a head fire, reaching a rate of spread of 500 m/hr within the dense ti-tree flats. At 1230 hours the fire crossed the Southwest Highway and entered the dense mixed Karri and Red Tingle (E. jacksonii) forest in this area of the National Park. These stands had not been burnt for 25 years.

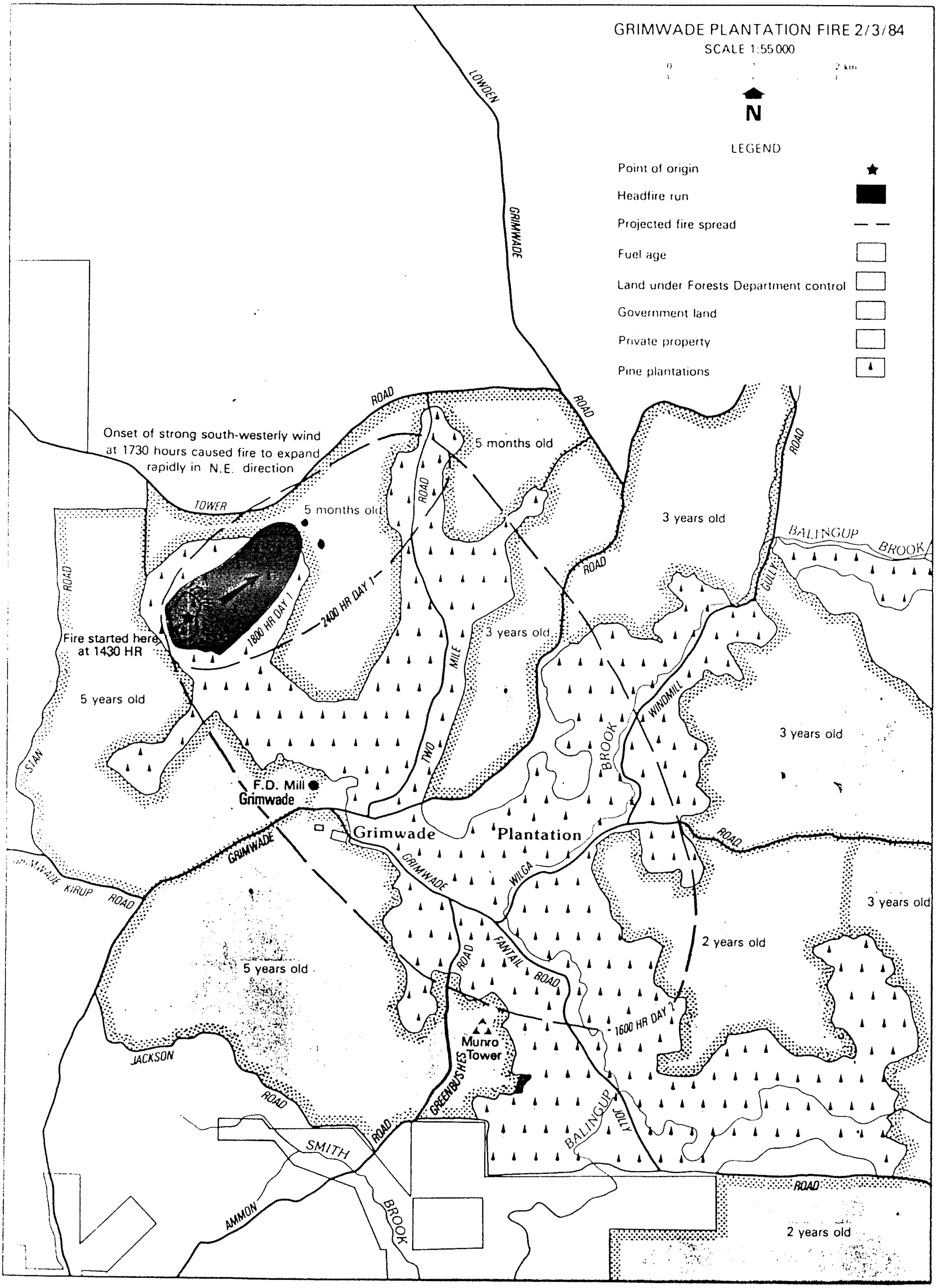
At this stage the head fire rate of spread exceeded 300 m/hr and direct attack failed.

The head fire was abruptly halted when it reached a one-month old prescribed burn at 1400 hours. This burn had been carried out to protect the Walpole townsite and adjoining farms. The flanks of the fire were contained by direct attack leaving a final fire size of 170 ha.

The Projection

Assuming a head fire rate of spread of 300 m/hr in the forest over a ten hour period from 1400 to 2400 hours, eventual fire size could have amounted to 900 ha from this fire. Apart from National Park, this area is likely to have included the eastern part of the Walpole township (population 800) and the surrounding farming community. Strong northeasterly winds occurred on the following day which would have driven any running fire into Walpole township, emphasising the value of containing this fire to a small size. See Figure 9.

16A


GRIMWADE PLANTATION FIRE 2/3/84
SCALE 1:55 000
N
LEGEND
Point of origin
Headfire run
Projected fire spread
Fuel age
Land under Forests Department control
Government land
Private property
Pine plantations
Onset of strong south-westerly wind at 1730 hours caused fire to expand rapidly in N.E. direction
Fire started here at 1430 HR
1800 HR DAY 1
2400 HR DAY 1
1600 HR DAY 2
5 months old
5 months old
3 years old
3 years old
3 years old
3 years old
5 years old
5 years old
2 years old
2 years old
F.D. Mill Grimwade
Grimwade Plantation
Munro Tower
LOWDEN
GRIMWADE
ROAD
TOWER
TWO MILE ROAD
BALINGUP BROOK
GULLY ROAD
WINDMILL
BROOK
WILGA
FANTAIL ROAD
GRIMWADE
GRIMWADE KIRUP ROAD
STAN
JACKSON ROAD
GREENBUSHES ROAD
SMITH BROOK
AMMON
BALINGUP
JOLLY
ROAD

9. THE GRIMWADE PLANTATION FIRE OF MARCH 1984

The fire commenced at 1420 hours on 2nd March 1984 in 50 year old Pinus radiata plantation at Grimwade. The cause of the fire is not established.

Conditions were hot (35%) and dry (relative humidity 20%). When the first forces arrived, the fire was influenced by light northeasterly winds. Suppression was difficult due to the intense fire behaviour and access difficulties caused by logging debris. Before the fire could be contained a strong (35 kph) southwest wind change at 1730 hours caused the fire to break away and expand rapidly. The rate of spread of the fire varied from 700 to 1000 metres per hour, augmented by continuous spot fire development 200 to 500 metres in advance of the head fire. Flame heights exceeded 30 metres, and a crown fire developed.

At 1930 hours the head fire burnt out of the pine plantation and entered a strip of jarrah forest separating the burning pine from another pine plantation 1.5 kms away.

The jarrah stand had been prescribed burnt 5 months previously. This burnt area is part of a system of buffers around the Grimwade pine plantation which are systematically burnt every 4 to 5 years as protection against wildfires. Once it entered this buffer the head fire dropped in intensity in this area and was successfully suppressed. This was followed by direct and successful attack on the flank fires still burning within the plantation.

The final fire size was 171 ha, including 18 ha of jarrah forest. Approximately $400,000 worth of pine trees were killed in the fire.

The Projection

High temperatures and strong southwesterly winds persisted upto 2100 hrs. Allowing for a head fire rate of spread of 700 m/hr/ in the pine forest, and of 400 m/hr in the adjoining jarrah forest (assuming 10 year old fuel), a fire of 500 ha is projected upto 2100 hours.

By this time, the fire would have burnt an additional 80 ha of mature pine plantation and about 250 ha of high quality jarrah pole forest.

As strong northwesterly winds were experienced on the following day, the rest of the Grimwade plantation (2300 ha) and the Grimwade settlement (population 100) and sawmill could have been under major threat as indicated in Figure 10.

DISCUSSION

The presence of zones in the forest where fuels had been reduced by prescribed burning was an important factor in reducing fire size and improving the ease of control in the cases studied. The projections made indicate that in every case a larger fire would have led to serious social and economic costs to the community.

Any theoretical projection of a fire can be debated. This is because the development of a forest fire is influenced by two sets of factors. The first are physical and environmental, i.e., weather, fuel and topography. These factors can be measured and their effects on fire rate of spread calculated with reasonable accuracy. The second set of factors are the suppression forces brought to bear on the fire perimeter by the firefighting agency. Firefighter effectiveness is highly variable: it is influenced by fire size and intensity, access, terrain and forest type, the equipment used and numbers of men and machines available. All of these factors can be roughly predicted, but not so the intangibles such as leadership, morale, fitness and organization.

In the fires studied in this exercise we tried to project a "most likely" result, based on known physical factors, knowledge of events prevailing at the time and our own firefighting experience. *

The small sample of case studies does not, of course, represent a statistical or scientific support "for" the contribution of prescribed burning, in the sense that plot or laboratory studies on soil nutrients before and after fire are sometimes cited as proofs "against" (Raison, Woods and Khanna, 1984).

Footnote * The combined fire fighting experience of the authors in the jarrah and karri forest exceeds 70 years.

Nevertheless, in the context of a record of no serious forest fires over more than two decades and the accumulated summer experiences of hundreds of Western Australian forest fire fighters, it is difficult not to acknowledge the positive contribution to forest fire control which the prescribed burning policy has made.

This view is further supported by comparative data on fire size between W.A. and other areas with similar climate, terrain and forest type but where no prescribed burning programme is in place. For example, Mount (1984) has presented data which indicate that the average fire size in comparable forests in Tasmania is 18 times larger than in W.A. The figure for Victoria is approximately 12 times and N.S.W. 13 times. (W.A.F.D., 1980)

The case against prescribed burning is usually based on two factors: ecological damage and dubious fire control benefit (Ecos, 1984). The first question is contentious (Attiwill, 1985); certainly not enough research has been done yet to fully elucidate the effects of the range of possible regimes (including fire exclusion) on the range of forest ecosystems in South Western Australia.

In our opinion, the question of fire control value is not contentious. Light fuels resulting from prescribed burning do reduce fire intensities and improve the ease of wildfire control. Of course, fuels do re-accumulate. Therefore there is a need for a cyclic programme of fuel reduction, where burns are repeated once a critical level of re-accumulation has been reached. In W.A. this critical level takes about 5-8 years in the jarrah and karri forests and 8-10 years in forests further east adjoining the main agricultural zone. In an 8-year rotational programme, approximately 50% of the forest fuels will be 4 years "old" or younger, providing excellent opportunities for wildfire control under difficult conditions .

Finally, five important points must be made.

1. A prescribed burning programme should not be embarked upon without solid data on fuel accumulation rates and fire behaviour. This is needed to allow rotation lengths to be tailored to site and vegetation factors, and to enable confident prediction of fire intensity on the day.

Without these data, fires may be lit too frequently or too rarely, or may be difficult to control and lead to the sort of suppression costs and damages the burning programme is designed to minimise.

Research into fuel accumulation and fire behaviour in W.A. forests is probably further advanced than for any other W.A. vegetation type, but is still incomplete and continuing.

2. A prescribed burning programme is not a fire control system by itself. It must be welded to an effective fire detection and suppression organization.

Fuel reduction does not prevent forest fires. In fact, numerically most forest fires start under relatively mild conditions and are easily suppressed by a quick moving and well trained firefighting force.

3. Managers asked to implement a prescribed burning programme must be thoroughly trained, possess a high level of technical expertise in fire behaviour and control and be provided with men, equipment and finance to implement the policy. The more complicated and diverse the prescriptions, the more costly they will be. This demands a high level of agency commitment, and Treasury support.

4. To be successful and effective, a prescribed burning programme must be thoroughly planned at three separate levels of implementation. Firstly there needs to be a regional burning plan which indicates the most suitable burn boundary location, burn frequency (rotation), season of burning for each forest area and highlights areas which are not to be burnt, both regionally and within daily "jobs". Such a plan should be reviewed and updated each year for the following 5 year period.

At the next level of planning, burning prescriptions must be prepared months in advance. These involve detailed inspection and fuel sampling, and indicate the most suitable weather conditions and ignition procedures required to meet burn objectives. In preparation for the burn such tasks as perimeter track maintenance and notifications to neighbours and forest users must be planned for.

Finally, on the day of the burn, the various complex tasks involved with the ignition and containment of the fire within the burning block must be planned in detail, and well co-ordinated. To be effective, burns should cover at least 60% of the area; patchy, light burns will not provide useful fuel reduction. All burns must be thoroughly mopped up and subsequently patrolled to ensure the edges are safe.

These three levels of planning and control are crucial to the success of a prescribed burning policy.

5. Finally, a prescribed burning policy, like any system of forest ecosystem management must be accompanied by an active research programme. This should be focused on fire regime effects (including the study of unburnt controls) and on the development of improved fire detection and suppression systems, so that any change in one part of the fire management approach can allow a calculated adjustment to be made somewhere else. Research into social factors and community attitudes is also needed (Underwood, 1985).

The current fire management policy in W.A. forests is not regarded as an end-point. Adjustments are continually being made in the light of changing community attitudes and improved science and technology stemming from research and management experience. In the meantime, the current policy, which includes the regular, cyclic prescribed burning of about 70% of the southwestern forests (excluding areas set aside for scientific study or specific species conservation programmes), provides a high level of community security from the ravages of intense fire, improved safety for firefighters and an opportunity to develop and test a range of alternative fire management systems.

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