INTERNAL REPORT RWP 42/87.

THE DESERT RESERVES ON FIRE:

A FIRE SURVEY OF QUEEN VICTORIA SPRING NATURE RESERVE

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Summary

There is mounting evidence (Burbidge, 1985) to suggest that losses of fauna from our desert reserves is as a result of a dramatically changed fire regime in the last sixty years or so. There is a recognised need to return to a patch burning strategy as practiced by Aborigines in the past, and to minimise the likelihood of large, intense wildfires.

Burning for protection (from wildfires) or for ecological reasons requires a firm knowledge of the fire environment of the reserves, fire behaviour and fire effects. Fire programme staff from Manjimup joined fire programme staff based at Kalgoorlie on a field trip to the Queen Victoria Spring Nature Reserve. Our role in a task force to study fire and to initiate trial aircraft burning in desert reserves, is mainly to improve an understanding of fire weather and fire behaviour in these fuel types. Here, we report on aspects of fire history, fire weather, fuels and fire behaviour as a result of our 6 day field trip into the QVSNR.

1. Preamble

A change in the fire regime has been the most likely cause for the decline in medium sized mammals from the hummock grasslands of the Western Australian arid zone (Burbidge, 1985). Desert reserves thus affected, total about 8.2 x 10^6 ha or about 50% of land administered by C.A.L.M. (Burbidge, 1985).

Currently, these reserves are not intensively managed. This is also true of fire management. Departmental records indicate that there has been little or no attempt at wildfire control or at deliberately using fire to achieve defined goals. The remoteness of the reserves, a lack of resources and a poor knowledge of fire behaviour and fire effects contribute to this current low level of management.

However, Burbidge (1985) maintains that C.A.L.M. must actively manage these reserves if habitat therein is to be suitable for the re-colonisation and re-establishment of mammals. Burbidge also suggests that the best form of management would be to mimic Aboriginal burning. Fire scientists based in Kalgoorlie (Dave Pearson and Dan Grace) are learning about Aboriginal burning practices. They are also studying aspects of fire effects on flora and fauna, and fire behaviour.

In keeping with the Programme approach to conducting research, C.A.L.M. scientists with relevant expertise have formed a task force to study fire effects, fire behaviour and fire management on hummock grasslands. The task force includes fire scientists based at both Kalgoorlie and Manjimup.

Fire scientists from Manjimup ventured out to the Queen Victoria Springs Nature Reserve for 6 days in June 1987 to achieve the following;

i. to become familiar with research being conducted by Dave Pearson and Dan Grace.

ii. to familiarise themselves with hummock grasslands as fuels.

iii. to study the recent fire history of the Reserve.

iv. to observe, measure and describe the physical properties of fuels.

v. to study weather patterns, fuel moisture diurnal regimes and fuel flammability.

vi. to study fire behaviour under winter conditions.

Obviously, in such a short time (6 days) we could not hope to achieve all objectives in full.

The following reports on our findings. We also make recommendations for management and for future research.

2. Brief description of study area

The Queen Victoria Spring Nature Reserve (QVSNR) lies some 270 km east of Kalgoorlie and is about 270 000 ha. The western boundary of the reserve lies just to the east of the mulga belt. The reserve extends some 70 km into what has been described as hummock grasslands (Beard, 1969). The landform units, soils and hence vegetation is varied but poorly described. The landscape is dominated by sand dunes which lie roughly east/west. The ground cover is mostly spinifex (*Triodia basedowii*) with a number of short (to 6m) trees, mallees and shrubs scattered throughout. For a more detailed description of the arid zone area, see Jessop, 1984.

The average annual rainfall for this area is around 200mm but rainfall is unreliable and may vary considerably from year to year. This region experiences cool to cold winters and hot dry summers. While there are no long term weather records for the QVSNR, its climate is unlikely to be greatly different to that experienced at Zanthus.

3. Fire history

There is little documentation of fire history. Records held at the Kalgoorlie Regional Office date back to 1975 when a number of "small" fires were reported to the south of the reserve. The ignition sources were not recorded. In 1976, a larger fire (~50 000 ha) burnt SE from near the Queen Victoria Spring . While not confirmed, it was reported that this fire was lit by Aborigines from the Warburton area who attempted to burn out the Aborigines at Cundeelee to avenge alledged murders committed by the "Cundeelee mob". Both sets of fires (1975/76) burnt around Christmas time and under the influence of a NW or W wind.

Other sources of information about fire history include the Aboriginal people themselves. As mentioned, Dave Pearson and Dan Grace are pursuing this.

While at the reserve, we conducted a fire history survey of parts of the reserve and surrounds as for as access would permit. We travelled many kilometres along mining exploration grid lines and at regular intervals, assessed fire history using on site indicators. These included ring counting coppice of several *Eucalyptus* species, back-dating by ring counts, to fire scars on larger eucalypts (such as marble gum), assessing the degree of charcoal weathering and noting the uniformity of age of spinifex and mallee coppice stems. The signs of recent (this century) fire were very obvious. Throughout the reserve, almost all marble gums showed bole fire scarring, dead tops and dead branches as a result of past fires. Most of the mallees were coppice stems. Often, the original stem could be seen lying on the ground or in some cases, still attached, in an upright position, to the rootstock.

From our survey, we conclude that a major conflagration swept through the entire reserve and some 80 km to the north of the reserve, about 33 years ago ($\pm$ 4 years). We estimate the area burnt at that time to be well in excess of half a million hectares. The fire (or fires - it may have been multiple ignition) was intense enough to kill the tops of large marble gums (40 - 50 cm dbhob). The burn was complete, we saw no signs of unburnt patches (although we could not have hoped to survey the entire area). Fire scars on marble gums were predominantly on the westerly or north westerly side of the bole suggesting that the fire was fanned by strong, hot, dry easterly winds. We tracked this fire print of some 33 years ago, as far south as Queen Victoria Spring (from where the 1976 fire started) and as far north as the PNC camp, some 80 km north of the northern boundary of the reserve. The fire continued in a westerly direction until it ran into the mulga belt where it appears to have stopped.

Since the great conflagration of about 1954, there have been a number of more recent but smaller wildfires throughout the reserve.

At several of our fire history sample points, we found evidence (by way of fire scars on marble gums and marble gum stags) of another large wildfire about 70 years ago (±6 years). We do not know the extent of this fire.

Table 1 below is a sketchy summary of recent wildfires in and around the reserve.

TABLE 1

Recent wildfires in QVSNR and surrounding country.

Date of wildfire	Cause	Area burnt
~1917	Lightning?	?
~1954	Lightning?	8000 km^2?
Dec. 1975	Lightning?	500 km^2?
20/11/76-5/12/76	??	950 km^2?
Dec. 1984	??	1200 km^2?

?? = suspected human caused.

Aside from the more recent, smaller fires, most of the reserve was burnt last in about 1954. Given the reported extent of past Aboriginal burning, it is highly unlikely that such a massive and intense conflagration would have occurred prior to European settlement. The impact on native fauna (and flora) must have been enormous, especially considering the extremely slow rate of regeneration following fire and the vast area burnt out. The recent fire history of this reserve supports Burbidge's theory of a dramatically changed fire regime in the 20th century.

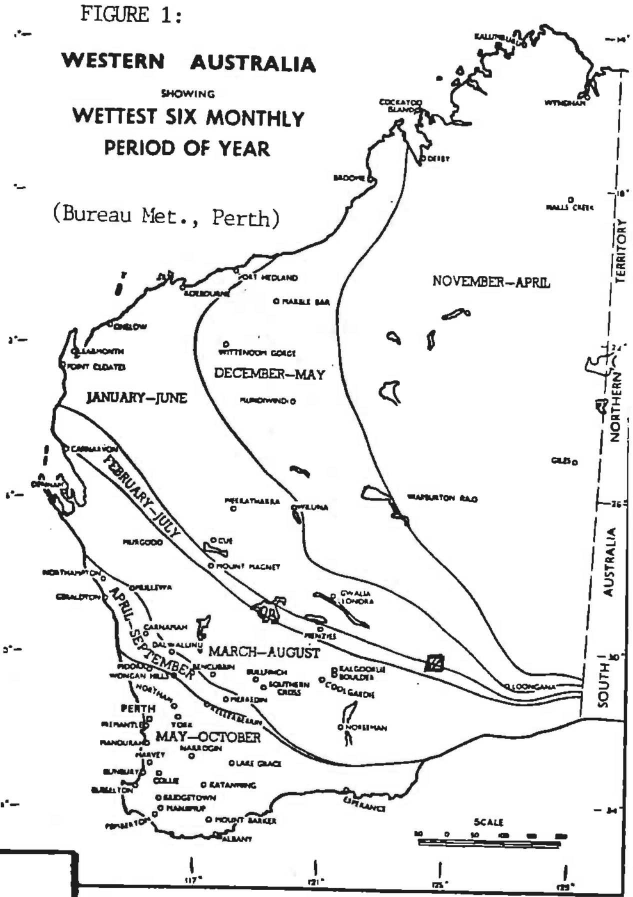
4. Fire weather

The QVSNR lies to the south of the winter position of the anti-cyclonic belt. Therefore the climate of the area is probably a mediterranean type with cool, moist winters and hot dry summers. There are no long term climatic data for the reserve. The nearest stations are at Kalgoorlie, Zanthus (rainfall only) and Rawlinna. Weather data from Giles (to the NE) is unsuitable as Giles lies in the summer rainfall climatic zone (see figure 1). With the northward movement of the anti-cyclone belt in winter, westerly winds are likely to be common. The westerly winds are maintained by a series of low pressure systems which move eastward, south of the W.A. coast. The development and movement of cold fronts is relatively easy to predict and meteorologists based in Perth are confident about forecasting for the reserve area (as confident as they are about forecasts anywhere else?). Spot forecasts are available for any location in the State. Much less predictable are north west cloud bands with associated strong NW winds and rain outbreaks. However, the weather associated with NW cloud bands is difficult to forecast anywhere. Strong cold fronts can bring strong north west winds to the area, even though the subtropical ridge is normally north of the reserve.

Towards the end of winter, the anticyclonic belt moves southward and hot, dry easterly winds prevail. winds may be from NE around to the SE. Thunderstorms are most frequent over the summer months. The area north and east of Kalgoorlie experiences an annual average of 20 thunderstorms which makes the area one of the highest incidences of thunderstorm activity in the southern part of the state.

It is interesting to note that the reserve lies near the climatic boundary between predominantly summer rainfall and predominantly winter rainfall (figure 1). There are no long term climatic data for the reserve, but rainfall measured at Zanthus, to the south, is probably similar to that experienced on the reserve. Figures 1, 2 and 3 show wettest 6 months, annual rainfall isohytes and annual thunderstorm activity respectively. Summers are most often hot and dry. Together with strong and persistent easterly winds, there are many days when the Fire Danger Rating would exceed extreme on existing fire danger meters. It is not surprising that most of the severe fires occur over the summer months. Many are likely to be started by lightning strikes.

FIGURE 1:



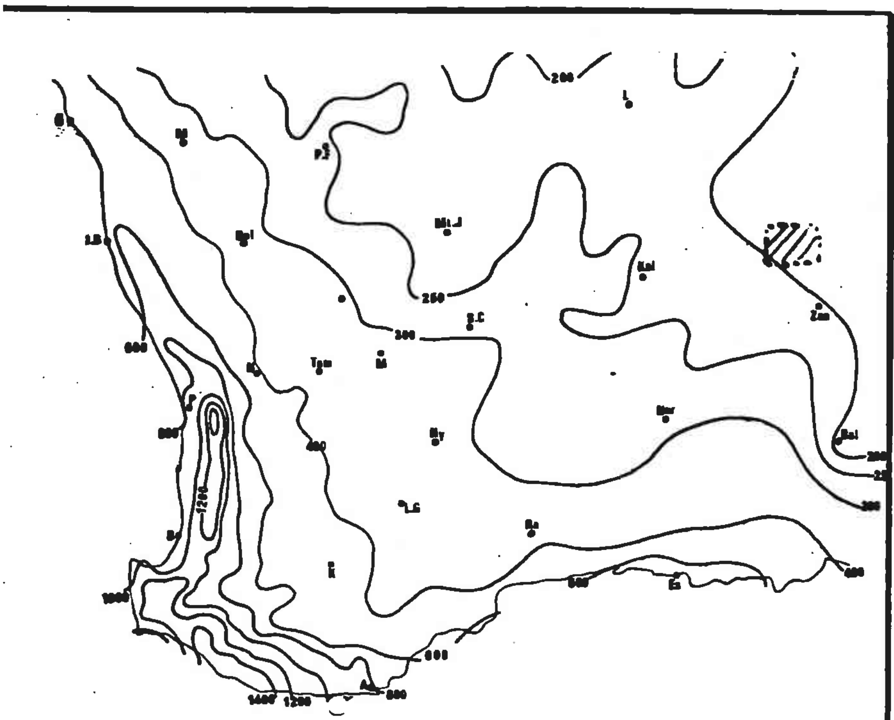


FIGURE 2: Isohytes for the southern area of W.A. and including QVSNR (Source Bureau Met., Perth).

FIGURE 3: Thunderstorm incidence for the southern area of W.A. QVSNR is shown hatched (Source Bureau Met., Perth).

5. Vegetation as fuel

It is not surprising that the fuel (or vegetation) within a 270 000 ha reserve is diverse. Landform and soil properties result in vegetation associations which, for the purposes of describing vegetation as fuel, form discrete units. A detailed study and mapping of landform, soils and vegetation patterning has not been done for the reserve so it is difficult to know just what part of the biogeographic spectrum we are dealing with. However, from what we have seen, we are dealing with a simplex fuel dominated by spinifex (*T. basedowii*). From the survey of fire history, it appears that the spinifex is degenerate and even aged throughout most of the reserve with the exception of a few smaller pockets burnt in the last 10 - 12 years.

Our aim was to describe the distribution and quantity of fuel in and adjacent to fire effects study plots established by Dave Pearson on the northern boundary of the reserve. This was achieved by assessing ground cover and height of vegetation from 1000 point transects made along 5 x 100m lines. Ten (10) biomass samples, each of $1m^2$, were clipped from each line. Following Griffins (1984) method, we attempted to develop a relationship between oven dry weight of spinifex (t/ha), and % cover and height of spinifex. We used Griffins (1984) method of describing the patchiness of spinifex and bare ground, which was determined from point transects at 0.5m intervals. Spinifex pathciness is the ratio of the variance of spinifex clump size and the mean clump size (Griffin, 1984). Bare ground patchiness was calculated the same way.

Results - Fuels

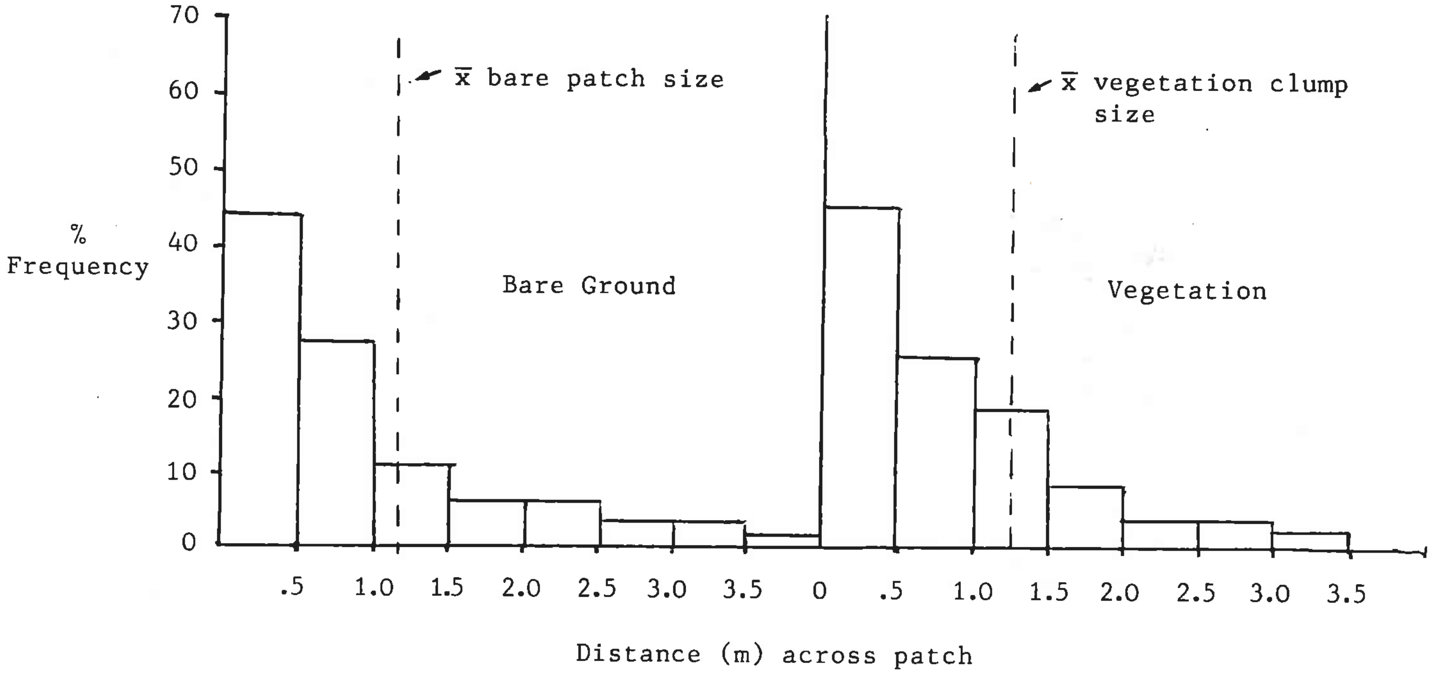
TABLE 2

Summary of fuel characteristics near fire research plots, QVSNR.

	Range	Mean
Spinifex cover (%)	29.1 - 39.4	34.4
Cover of other plants (%)	2.4 - 20.2	11.6
Bare ground (%)	44.4 - 61.3	54.0
Spinifex patchiness ratio (var/mean)	0.27 - 1.02	0.54
Bare ground patchiness (var/mean)	0.55 - 0.81	0.63
Height of spinifex clumps (cm)	10 - 30	18
Height of other plants (cm)	10 - 160	60
Fuel quantity (t/ha)	4.0 - 6.6	5.2

The frequency distribution of the sizes of spinifex clumps and of bare ground patches for the 500m of sample line is shown in figure 4. All sample sites were of uniform age since last burnt (about 1954).

FIGURE 4: Frequency distribution of vegetation clump size classes and bare ground patches for study site, QVSNR.



6. Discussion of fuels

The most significant features are that spinifex is the dominant component of a simplex fuel and that fuel quantity is low even after 33 years.

Griffin (1984) working in the Uluru National Park, found that the dimensions of fuel and bare patch sizes varied according to the successional state of the vegetation and short term climate. While we could not demonstrate this due to the short study period and due to lack of variability in fuel age (or times since last fire) the same probably applies here. At this study site (as is the case for most of the reserve) the spinifex appeared to be in a uniformly degenerate state, as indicated by the formation of spinifex rings. Most rings were senescent and fragmented. Occasionally, plants had coalesced to form continuous fuel patches. The mean spinifex patch size was 1.12m. Griffin discusses the development of spinifex from early succesional states through to senescence and concludes that, as a fuel, it reaches a peak on terms of continuity (and probably quantity) and then breaks down. Obviously, this has important implications for fire behaviour. This is in contrast with most south west forests, where fuel quantity increases with time since fire and finally plateaus.

To calculate fuel load, Griffin provides the following equation;

Fuel load (kg/ha) = -2938.5 + 212.2 * spinifex cover (%) + 131.8 * cover of other plants (%) (r = 0.85).

Using this equation and the mean vegetation covers in Table 2, we arrive at 5889 kg/ha or 5.9 t/ha. This is very close to our measured average loading of 5.2 t/ha. We had insufficient data to determine a reliable relationship between fuel load and other fuel descriptors, but is seems that Griffin's equation is quite adequate.

7. Fuel moisture content diurnal regimes

The importance of fuel moisture content in determining fire behaviour is well accepted. We monitored the moisture content (MC) of spinifex every 2 hours or so and for 2 consecutive days to gain a better feel for the range of moisture contents and to determine the relationship between MC and weather variables. We identified 4 fuel types in terms of their potential moisture content fluctuations, these being;

i. The green spines on the top of clumps.

ii. Stem material on the bottom of clumps.

iii. Entire clump (profile).

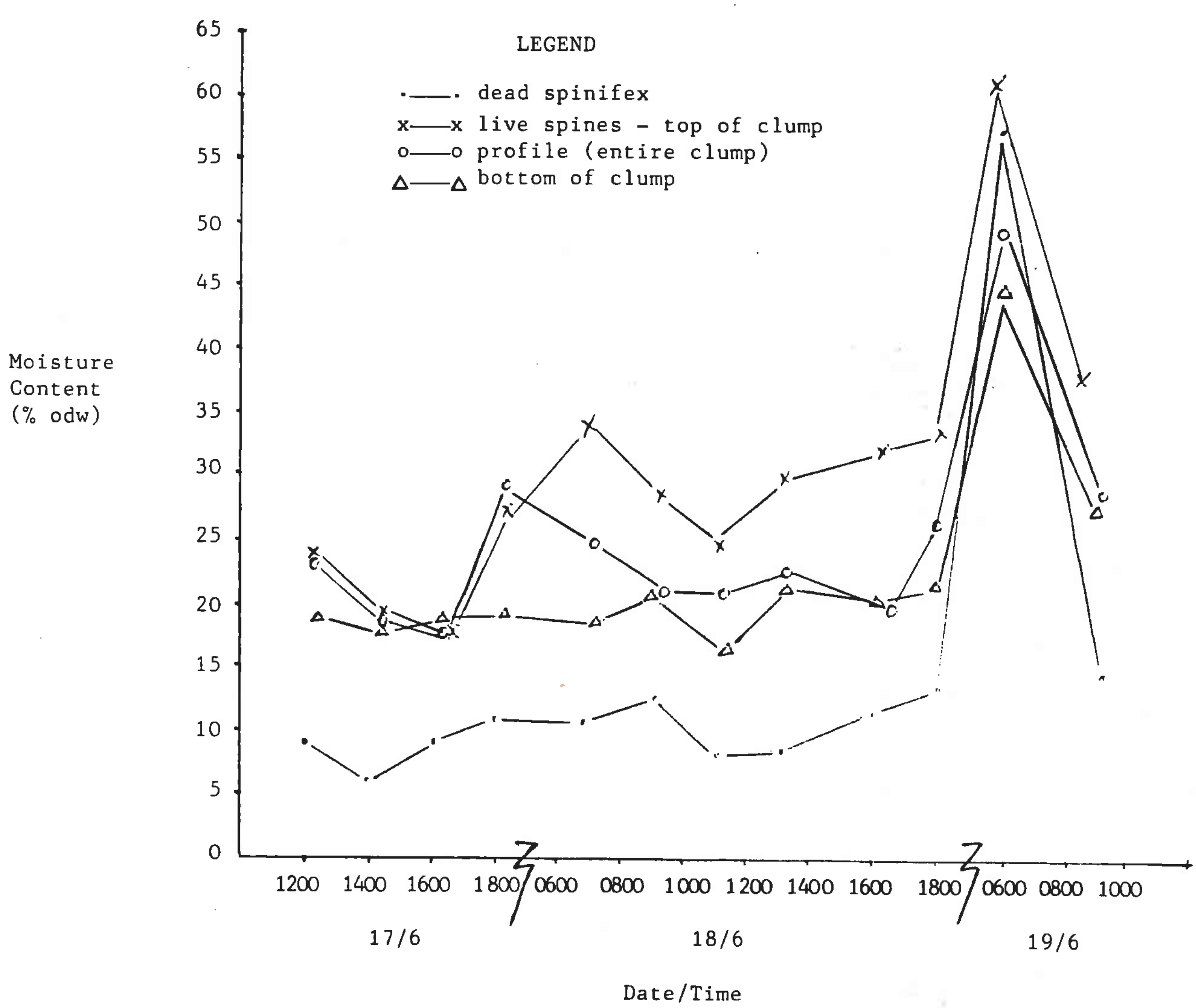
iv. Dead material in the clump.

The above were clipped out and placed in air tight containers for oven dry moisture content determination.

8. Results - Fuel moisture content

Throughout the conditions of this limited study, fuel moisture contents fluctuated diurnally. Generally, fuels were wettest just prior to sunrise, and driest at about 1200 - 1400 hrs. The moisture content of "green" spines varied 18 - 63% o.d.w., the latter being as a result of rain and free water on the spines. The very high moisture contents graphed in figure 5 are due to overnight rain.

FIGURE 5: Moisture content fluctuations of different components of spinifex clumps.



Over the two days of this study, a reasonably good relationship between profile (whole clump) moisture content and relative humidity (RH) was determined. This is described by the equation;

$$\text{clump moisture content (\% o.d.w.)} = 9.57 + 0.29\ (\text{RH\%})$$

$$R^2 = 0.6111$$

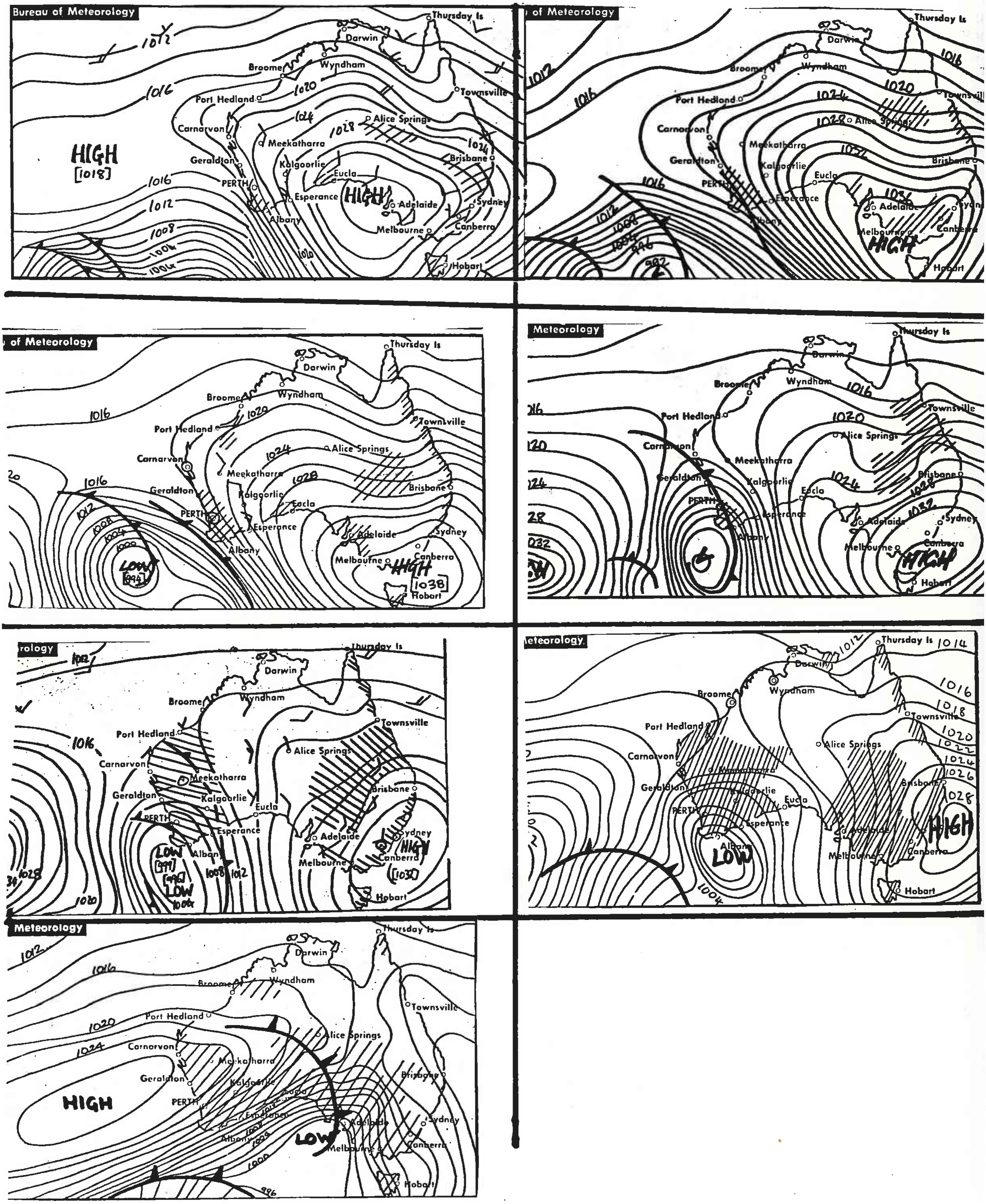
The above relationship was developed from a narrow range of conditions, but may be a useful guide to winter burning until further work is done. Diurnal fuel moisture content fluctuations will have important implications for fire behaviour and planning prescribed fires. It is worth noting that spinifex could be ignited with a single fusee match over the entire range of fuel moistures shown in figure 5.

9. Weather during study period

An instrument cluster consisting of an anemometer, wind direction vane, temperature and RH probes was mounted on a 10m pump up mast at the study site. Weather readings were logged at 10 minute intervals from average readings taken every 5 seconds. The weather station ran for the duration of the study. As a back up to the electronic station, we also set up mechanical equipment including a thermohydrograph, aspirated phsychrometer and anemometer. Two rain gauges were set out and read 8:00 a.m. daily.

Figure 6 shows the 3 p.m. synoptic situation (courtesy W.A. newspaper) for each day of the study. From this figure, weather was influenced by a high pressure system centred in the Bight and ridging out to the Pilbara/Gascoyne. This strong high blocked the movement of cold fronts from the south west and the tightening of the isobars was felt as strong north westerly

FIGURE 6: Synoptic situation during the study period (Courtesy "The West Australian Newspaper").



winds at the QVSNR. On the 15th and 16th weather was fine, but windy, with gusts up to 35 k.p.h. On the 17th, the high moved further east and a strong cold front brought cloud and later, rain to the area on the 18th (0.6mm). As the cold front moved east-ward, weather continued to be overcast with some rain (2.2mm on 20th). Winds from the NW strengthened with the passage of the cold front and gusts of up to 50 k.p.h. were recorded. As the cold front moved into eastern Australia, a high pressure system in the Indian Ocean ridged out over the southern half of the State bringing south westerly winds and further rain. The ability to forecast synoptic situations hence surface conditions has important implications for fire management in the desert areas. Meteorologists based in Perth feel reasonably confident about forecasting, as discussed earlier.

Figures 7 - 10 show weather conditions as recorded by the electronic data logger. A very noticeable and important feature is the strength of the NW winds associated with the strong cold fronts which are not uncommon at this time of year. The strength of these winds followed a strong diurnal pattern during this study (figure 7). Wind strength peaked between 1100 hrs - 1300 hrs at 8 - 12 m/s (28 - 40 km/hr) each day, then reduced to 1 - 2 m/s (4 - 8 km/hr) overnight. Again, this pattern and ability to predict it, has very important implications for prescribed burning in winter. This is discussed later. Temperature and relative humidity data also show strong diurnal patterns, as to be expected. Again, this is important for

FIGURE 7: Wind speeds recorded at 10m above ground and at 10 minute intervals from 1000hrs 17|6|87-1600hrs 22|6

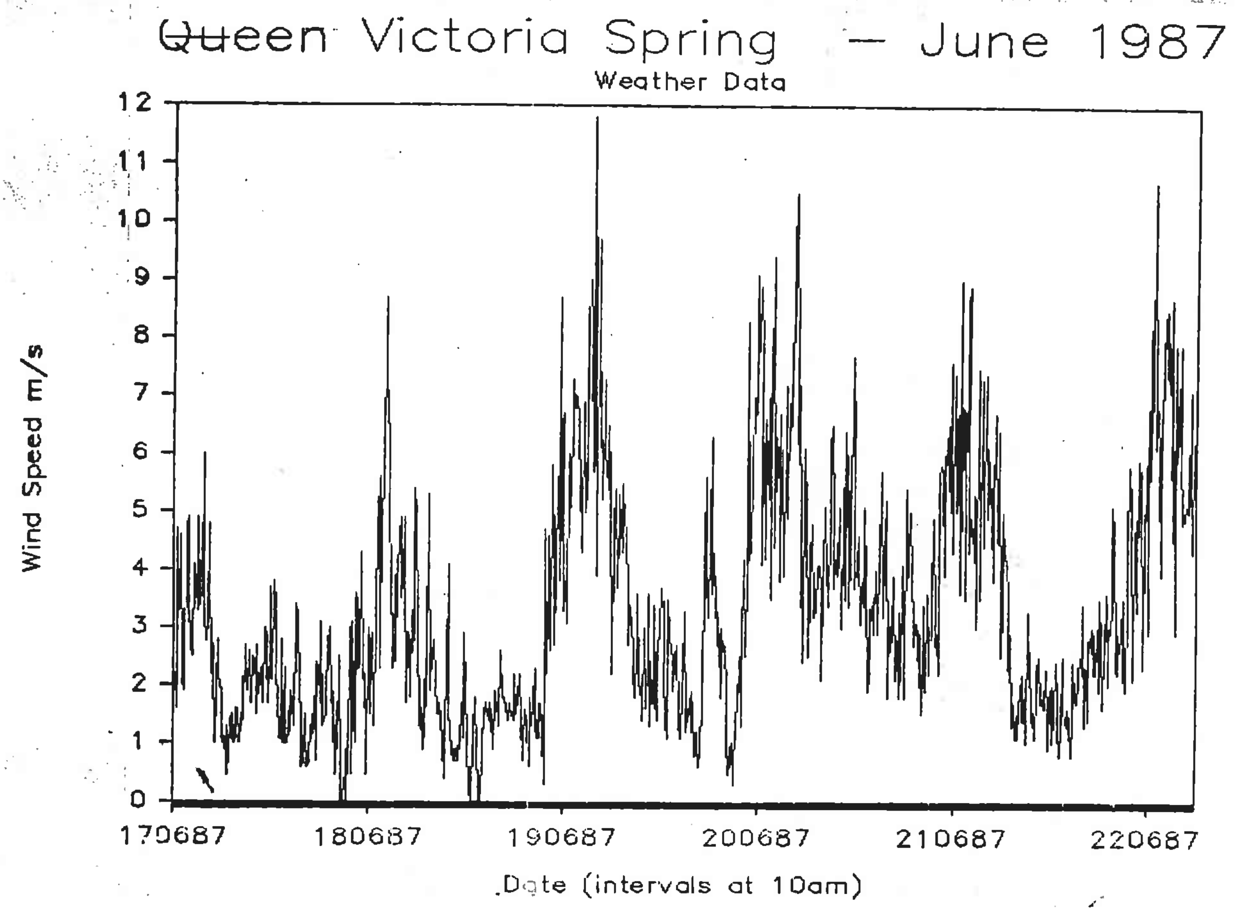


FIGURE 8: Wind directions during the study period.

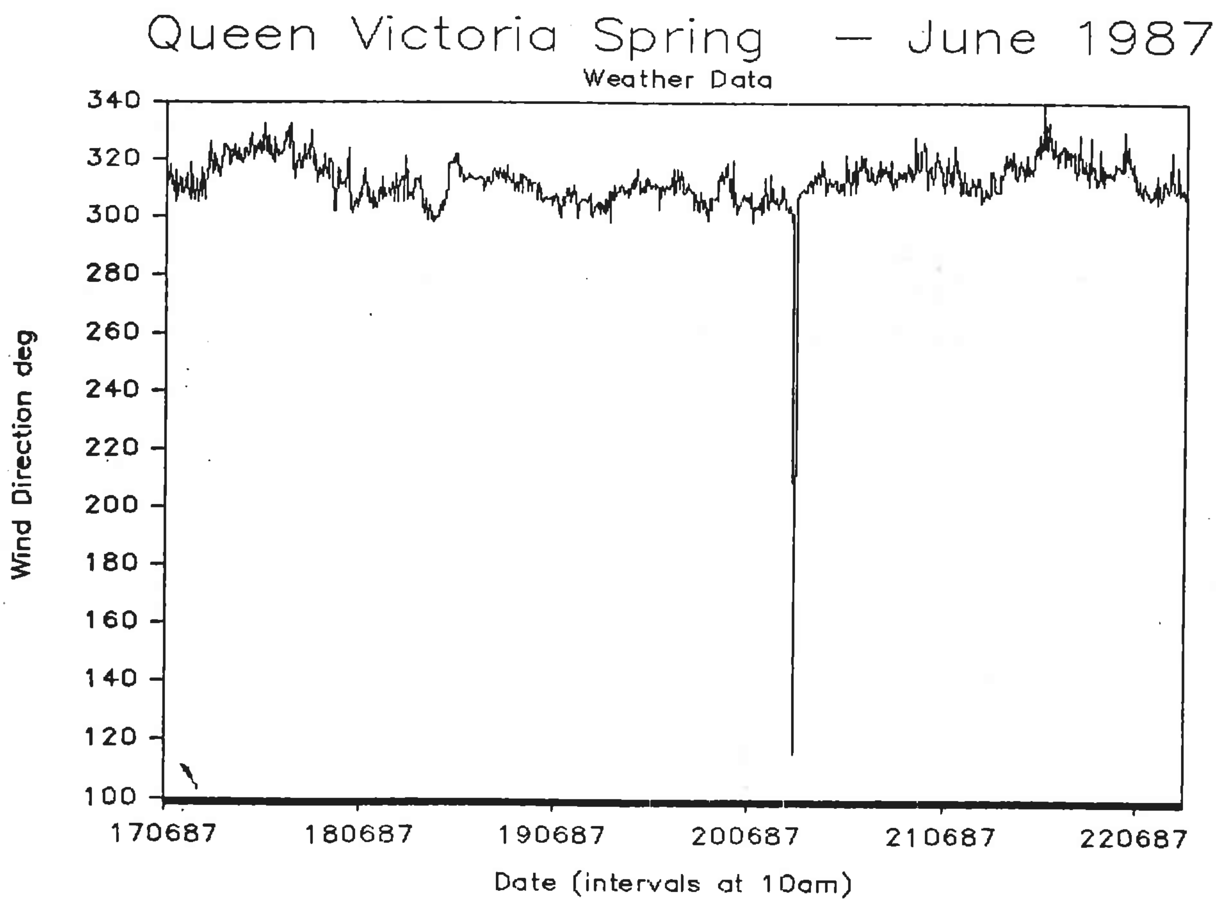


FIGURE 9: Temperatures at 10m above ground and at 10 min intervals.

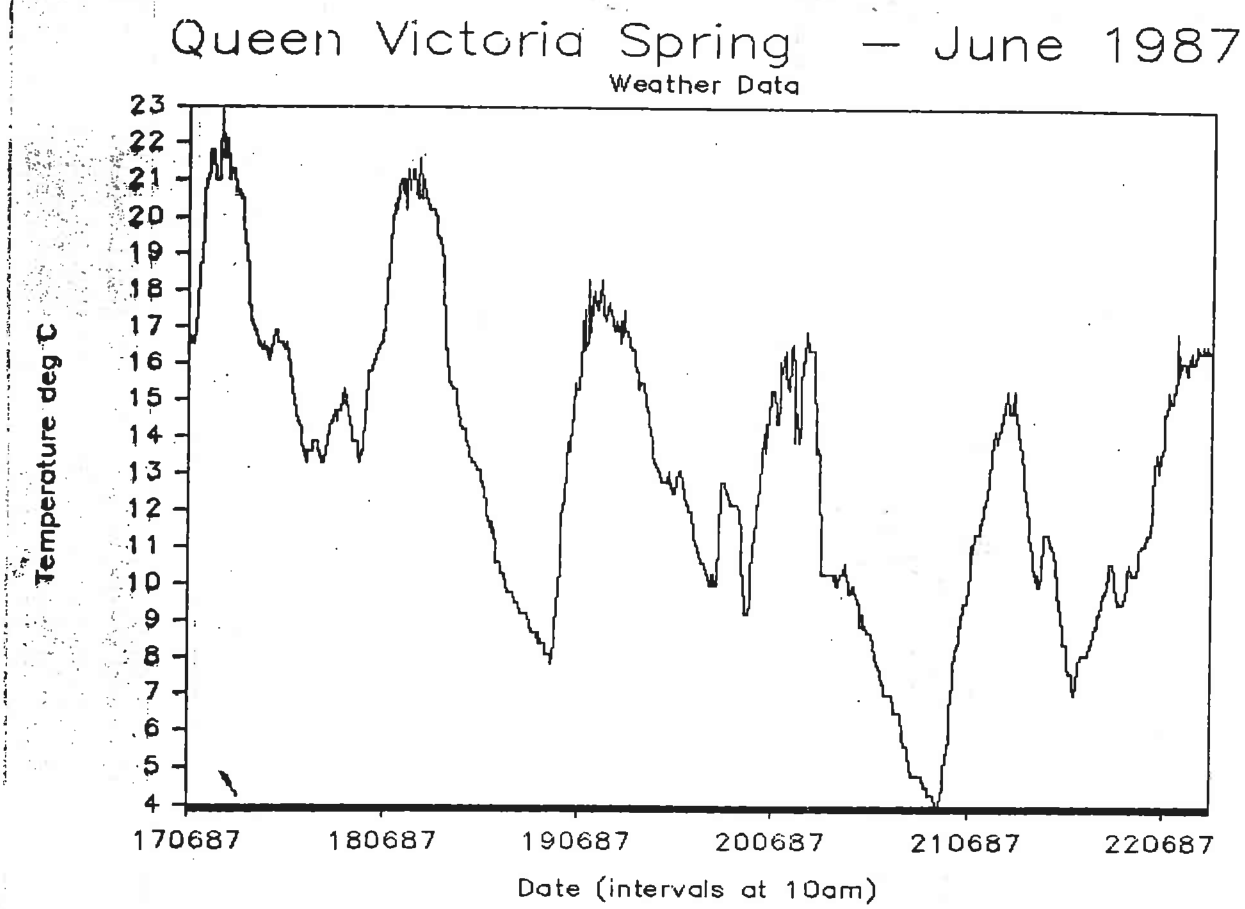
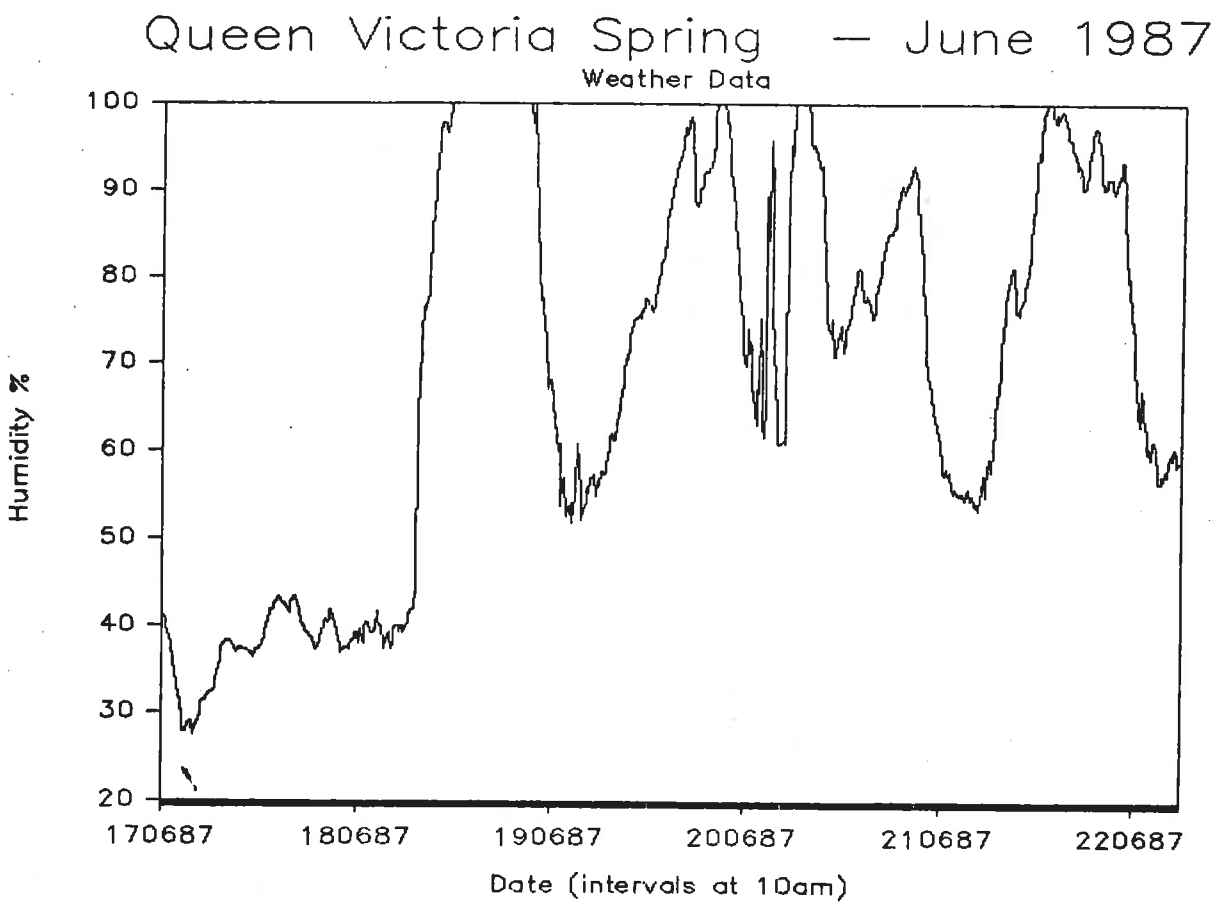


FIGURE 10: Relative humidity at 10m above ground and at 10 min intervals.



planning prescribed burning. The gradual descending daily maximum temperatures shown in figure 9 reflects the passage of the cold front. The time of rainfall (RH = 100%) is clear from figure 10.

10. Fire behaviour

During this short trip, we managed to conduct 6 experimental fires in order to measure fire behaviour and relate this to weather and fuel factors. From such a small number of fires over a narrow range of conditions, it is impossible to develop a firm fire behaviour model.

We employed 2 techniques for measuring fire behaviour, both techniques were used simultaneously. Firstly, we tagged the perimeter of each fire with metal tags and at 5 minute intervals. The second technique was the use of very oblique photograhy. This was achieved by mounting a 70mm camera on a 8m portable tower. Sequential photographs were taken at 4 minute intervals. A number of control points placed in the field enabled us to map fire development from the photographs. Weather conditions were recorded at regular intervals from a station nearby. Realising the sensitivity of fire behaviour to wind strength, a fire runner used a hand held anemometer to take spot readings near the headfire.

11. Results

Fuel and weather conditions for each fire are summarised in table 3. Fire spread rates with time after ignition are shown in figure . All fires self extinguished.

Fire 1 (18/6/87)

1521 hrs - Ignition using fusee match. Spinifex ignited readily. Headfire travelled for 10m. No flank or backfire. Fire stopped by 0.5m bare patch at 1531 hrs. Average rate of spread over 10m was 60 m/h. Flames from 0.5 - 2.0m. Flaring in mallees. Average fire intensity ~123 kW/m. Fire width was 3.0m.

1532 hrs - Fire 1 re-lit using fusee ahead of first lighting attempt. Again, fire travelled for 10m before being stopped by 1m bare ground patch. Fire width ~2.5m, flames 0.5 - 2.0m. Wind strength (9 k/h at 1.5m) was insufficient to carry fire aross bare patches. No further lighting attempted.

ABLE 3

onditions of fuel, weather and fire behaviour during experimental winter fires in QVSNR. Predicted ROS is from Griffin and Allan (1984).

ire No.	Temp (°C)	R.H. (%)	$\bar{x}$ wind speed 2.0m	$\bar{x}$ wind speed 10m	Vegetation Cover (%)	Bare Ground (%)	Patchiness Spinifex	Profile M.C.(%)	Predicted ROS (m/s)	Actual ROS (m/s)	Comments
1	20	39	2.5	3.4	37	61	0.27	20	0.25	0.03	Fire stopped by 0.4m bare patch after 10 minutes.
2	17	53	4.4	7.2	39	56	0.32	26	0.45	0.05	Fire spread when wind >3.4 m/s then went out when wind dropped.
3	14	67	4.1	6.9	29	58	0.41	25	0.37	0.06	Fire went out when wind dropped <2.0 m/s.
4	15	64	4.7	7.4	39	46	1.02	25	0.69	0.19	Fire spread rapidly when wind gusting to 10 m/s. Stopped when wind <2.5 m/s.
5	16	57	4.0	5.8	36	44	0.37	24	0.44	0.03	Fire stopped by 0.4m bare patch after 15 minutes.
6	16	57	4.0	5.9	38	44	0.81	23	0.58	0.10	Fire stopped by 1.0m bare patch after 12 minutes.

<u>Fire 2 (19/6/87)</u>

1353 - Ignition by fusee.

1403 - Headfire stopped by 1m bare patch after having travelled ~5m. No flank or backfires. Fire width ~1.8m.

1404 - Fire re-lit with a 10m line of fire using drip torch.

1407 - No flank or backfire. Headfire fragmented - flames hopping from clump to clump. Survival of fire dependent on wind gust at right moment to bend flames over and ignite adjacent clump. Flames up to 1.0m, mostly 0.5m. Fire length 10m, fire width 3m, rate of spread 200 m/h.

1412 - Headfire persisting, but fragmented. Fire almost stopped on several occasions by 0.4m bare patches. Fire length 15m, width 3.4m, rate of spread 60 m/h.

1417 - headfire persisting, but fragmented. Only maintained by occasional wind gusts to 25 k/h (at 2.0m), fire length 20m, width 4.0m, rate of spread 60 m/h.

1422 - Wind strength more consistently 15 - 20 k.p.h. Headfire more active. Flames to 1.5m, fire length 35m, width 5.0m, rate of spread 175 m/h.

1427 - Fire stopped by 1m bare ground patch. Re-lit using 10m line of fire.

1432 - Wind speed gusting to 30 k/h. Solid headfire, but no flank or backfire. Two fire tongues developed from 10m line. Fire length (from new lighting) 20m, fire width 4m, flames 1.5 - 2.0m, rate of spread 240 m/h.

1437 - Fire stopped by 1m bare patch.

Fires 3, 4, 5 and 6 were mapped and are shown in figures 11 and 12. These fires were lit using a continuous 50m line of fire perpendicular to wind direction. In all cases, only 2 segments along each line, sustained combustion. All fires eventually burnt out, although fire 4 burnt for a total distance of about 150m before self extinguishing.

For the conditions experienced during this study, all experimental fires were reluctant to spread when the wind speed at 2.0m above ground was less than 15 k.p.h. or about 4 m/s. Ideally, winds of 20 - 25 k.p.h. (5.5 - 7.0 m/s) are needed to maintain fire spread. This is discussed later.

FIGURE 11(a): Fire shape and ROS in spinifex fuels.

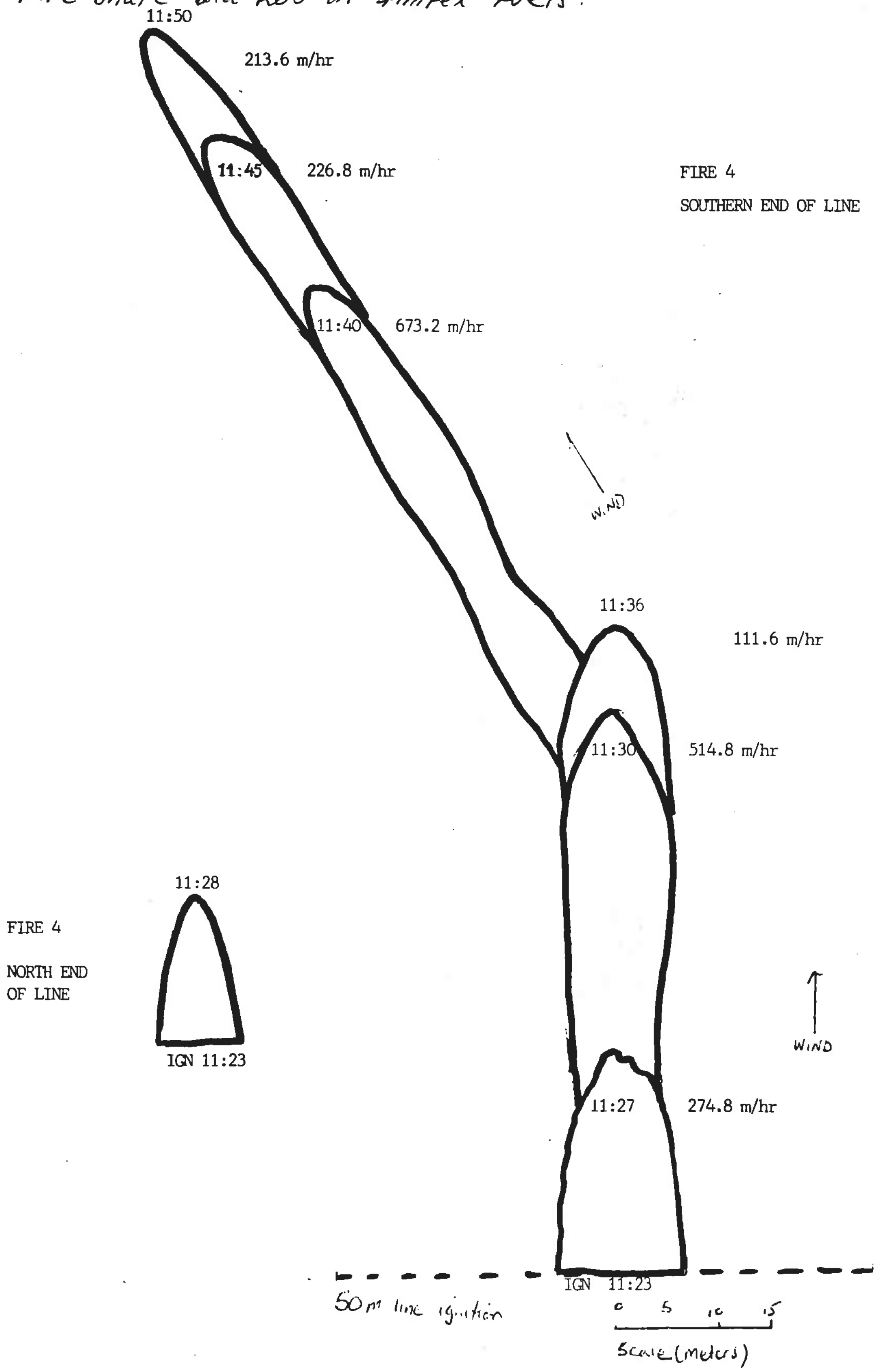


FIGURE 11(b):

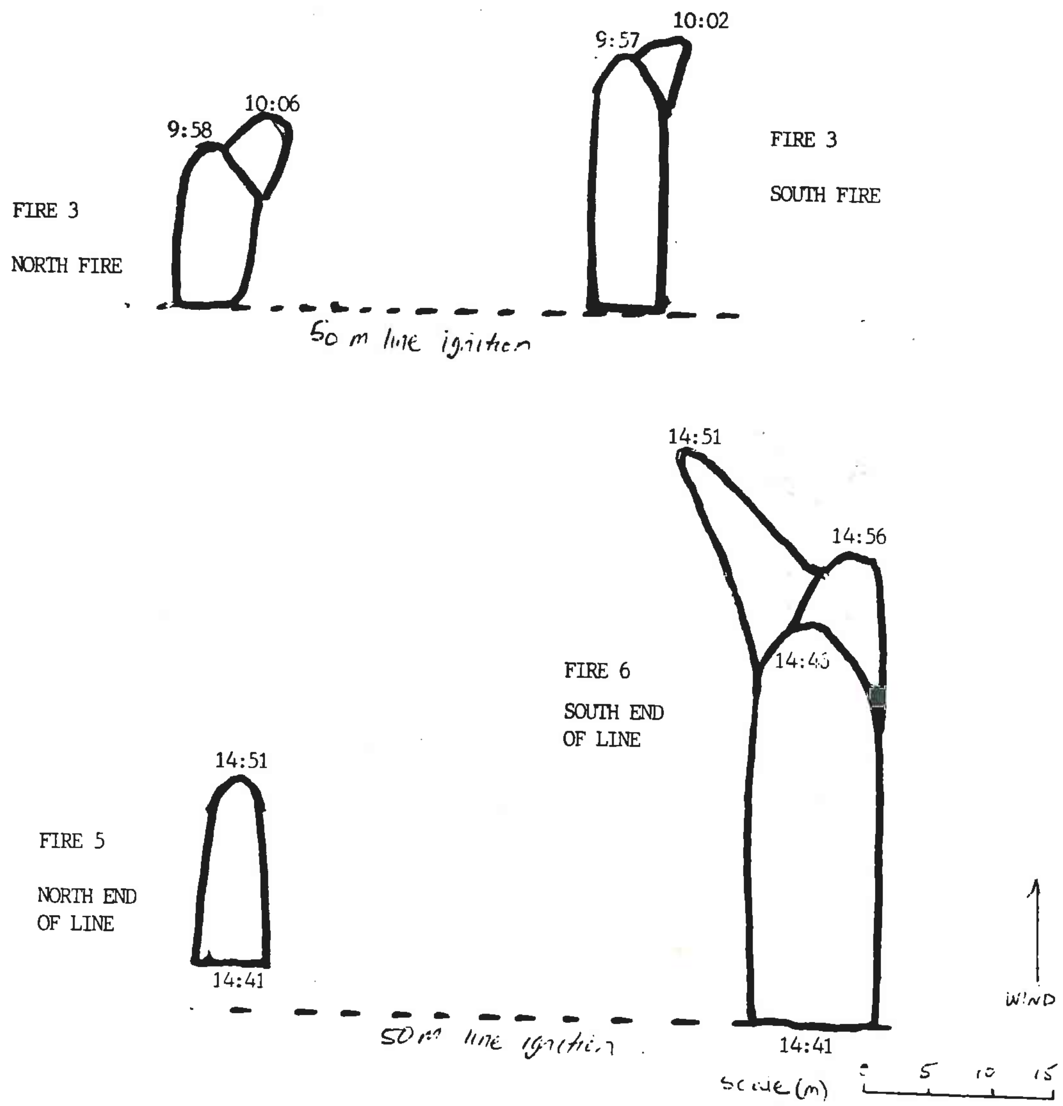
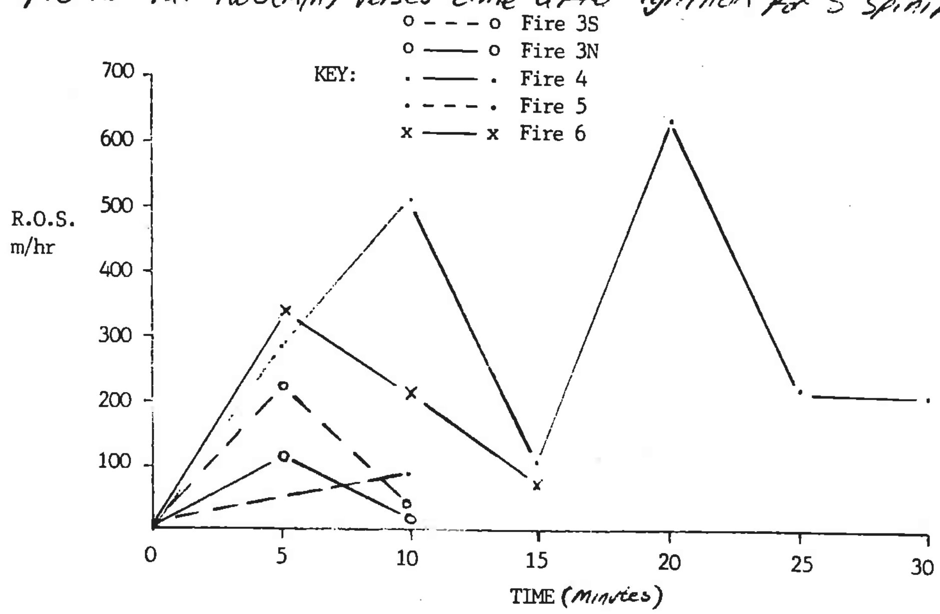


FIGURE 12: ROS(m/h) verses time after ignition for 5 spinifex fires.



12. Discussion

Under these winter conditions, all experimental fires in spinifex displayed the following features;

i. readily ignited by fusee, but did not transfer from clump to clump. Fusee or point ignition was not appropriate for sustained fire in these patchy fuels.

ii. Spinifex ignited over the entire range of moisture contents, even while it was raining (up to 60% M.C.).

iii. Line ignition was far more successful in starting fires. By using a continuous line of fire, the chances of setting alight to a continuous fuel bed and hence, fires being sustained, are increased. Also, there is considerably more initial heat energy from line ignition which assists in the initial stages of fire build-up.

iv. Fires are headfire only, no flank or backfires. Hence, fires burn in long narrow tongues. Fire tongue width from 50m of line ignition was consistently between 10 - 12m.

v. With the patchiness of fuels, wind is the critical factor affecting fire behaviour. Under these conditions (see Table 3) the threshold wind speed was about 15 k.p.h. at 1.5m above ground (4.1 m/s).

vi. All fires eventually self extinguished. The fragmentation of fuels caused headfires to be gradually squeezed to a point and to be finally stopped by a bare ground patch as little as 0.3m.

Under hot, dry and windy conditions in summer, there is ample evidence that extreme fire behaviour is possible. Spinifex is highly flammable, even at high moisture contents. Under hot, dry conditions, the threshold wind speed (to carry fire from clump to clump) is likely to be considerably less than for winter conditions, Griffin (1984) reports spread rates in excess of 3000 m/h under moderate fuel and weather conditions. However, even under extreme conditions, we believe spinifex fires can be relatively easily stopped (see discussion later).

We compared our measured rates of spread with those predicted using Griffins (1984) model (Table 3) and were disturbed to find very large differences (in order of magnitude 10). We can only attribute this to variations in the fuel complexes between those at QVSNR and those near Alic Springs. These variations are not readily apparent on comparing fuel measures although the % of bare ground at QVSNR is higher (by about 12%) than near Alice Springs. Also, most of our experimental fires were lit under cool, mild and moist conditions.

Griffin found that the wind speed threshold was 1 m/s (~4 k.p.h.). However, from our limited number of fires and under these conditions, we found it to be closer to 4.2 m/s (15 k.p.h.) at 2.0m above ground. An explanation for this large difference may be that Griffin was working in structurally different vegetation especially in the vertical profile. *Triodia basedowii* clumps in QVSNR are very low (~15 - 20cm). Taller vegetation would mean a higher fuel load (for a given horizontal structure) and higher and longer flames on combustion. Hence, the windspeed threshold would be considerably lower.

The uncertainty with using Griffin's model necessitates further testing and validation.

13. General discussion & conclusion.

There are two aspects of fire management in our desert reserves such as QVSNR. Firstly, we must afford some wildfire control. Burbidge (1985) and Burbidge *et al.* (1987) firmly believe that changes in fire regime have contributed to the diminishment of desert fauna. Our survey revealed that since the turn of this century, vast tracks of the reserve and surrounding areas have been burnt by large and intense wildfires. These large wildfires have reduced the floristic and structural composition of the reserve. The second aspect of fire management is prescribed burning to introduce variability; patch burning or tight mosaic burning is favoured in the literiture.

14. Wildfire control

It is an axiom of land management that before we can manage lands, we must be able to protect them (from wildfire or other disturbance). The desert reserves are remote, large and poorly serviced by way of management resources. However, given this, we believe action can be taken. With respect to QVSNR, we recommend the following;

1. The reserve be broken up using wind driven fires to reduce the likelihood of further large and devastating wildfires.
2. That this be achieved over a period of 5 years and using existing resources available in the Goldfields Region.
3. Using prescribed fire to make fire breaks in spinifex fuels and under the following conditions is achieveable, practical and inexpensive.
4. The overall objective would be to break the reserve in half using the grid line which runs north - south (see figure 13). Then, to further fragment the reserve using other existing grid lines running east - west.
5. A burnt strip, approximately 100m wide on each side of the grid lines (200m total width) would probably stop most wildfires in these fuels.
6. Aboriginal employment money could be used to employ Aborigines over the winter period to burn edges off grid lines. Under the supervision of a C.A.L.M. Officer, and armed with a drip torch, it would be a simple matter to simply walk along the grid lines 4 abreast and about 20 - 30m apart (see figure 13).

The prescription below should ensure that;

i. fires do not escape or burn large tracts.

ii. fire will carry sufficiently to provide a suitable break.

iii. the edge will be irregular in depth, up to 200m and should break up major wildfire runs.

Burn prescription

Season of Burn: Winter, when days are cool, overnight temperatures are low and after some rainfall.

Conditions of Spinfex: Yellow/green in colour and 18 - 24% MC.

Soil Moisture: Top 10cm is moist.

Temperature: 16 - 25°C.

Relative humidity: 30 - 55%.

Wind strength: 25 - 35 k.p.h. at 2.0m above ground, or when the tops of the seed stalks of spinifex are bent parallel to the ground by wind. This is critical.

Wind direction:	In winter, the above winds are likely to be NE to NW to W, and accompanied by cloud or rain. This is ideal. Such conditions are generated by strong, cold fronts which can be forecast.
Time of light-up:	Normally, winds are too weak before about 1000 - 1100 hrs. Plan light-up for about 1130 or when winds are as per prescription. Wind strength will probably hold until about 1500 - 1600 hrs, then fade.
Lighting pattern:	Drip torches and a continuous line of fire, with the wind. Lighters to walk in staggered formation, 4 abreast as shown in figure 13 below.
Expected fire behaviour	Using a line of fire, expect an initial rush of flames (for about 10 - 20m). Then most of the edge will fragment. A few tongues will continue to burn for up to 200m, but will eventually stop. Fading wind in the late afternoons and early evening will ensure fires will stop. The tongues will probably burn to a distance of about 200m in about 20 - 30 minutes. Expect tongues to be about 10 - 15m wide (see figure 14).

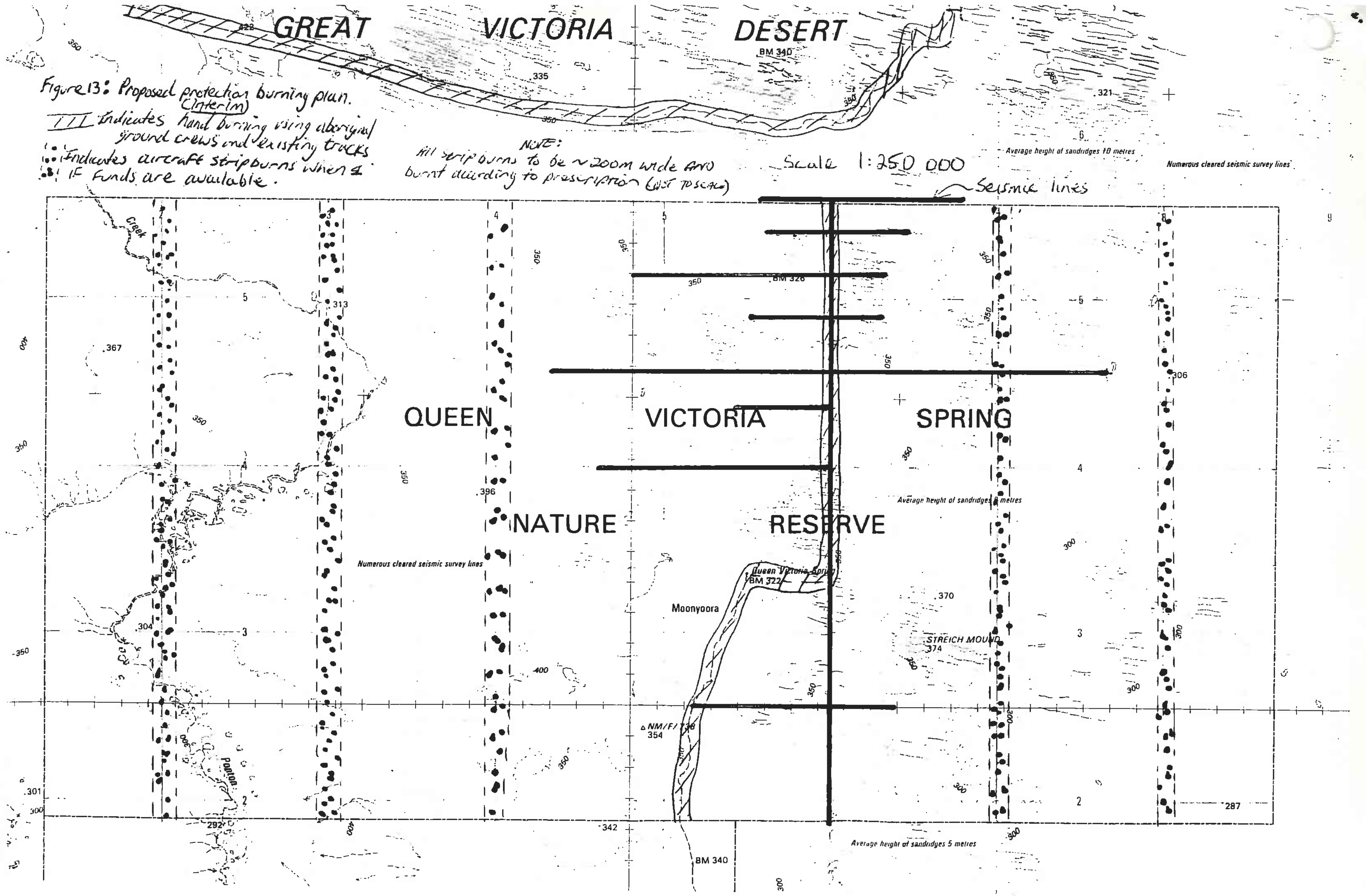


Figure 13: Proposed protection burning plan. (Interim)
/// Indicates hand burning using aboriginal ground crews and existing tracks
⁞⁞ Indicates aircraft stripburns when & if funds are available.

15. Further research

1. Biogeography

There is a need to understand, describe and map landform units, soils and associated vegetation. The size of the Reserve prohibits detailed ground surveys but there is a need to understand patterning of landforms, soils and vegetations and to understand how this is perceived by desert fauna. That is, patterning can then be interpretted as habitat. It is important to understand the various site types or niches if we are to conduct fire effects studies, and later, to undertake manipulative patch burning. The following is a suggested simple procedure for developing a classification system.

1.1 Compile broad scale landform and soil maps from colour air photographs and for the entire reserve at 1:250 000 scale. This can be done relatively quickly and cheaply given that we have access to air photos.

1.2 From the above map, select a portion of the reserve which contains representations of the broad landform units and map these, from air photographs, at a higher resolution (1:100 000) and a finer breakdown of landform and soil units.

1.3 Ground survey each of the landform and soil classifications by standard biological survey techniques including trapping and vegetation surveys.

1.4 Select specific types for experimental fire research based on importance as habitat, uniqueness, abundance, etc.

The procedure for producing maps and site typing the reserve as described would cost in the vicinity of $2000 to $4000. We have normally contracted Max Churchward (CSIRO) or Bill McArthur to do this work. Follow-up biological surveys are an additional cost. My belief is that this procedure and this information is critical before we contemplate experimental research and before we contemplate manipulative management.

2. Fire research

2.1 On a site basis (as described above) continue long term fire effects studies along the lines of Dave Pearson's programme. Before treating experimental sites with fire, it is important to conduct pre-treatment trapping on a seasonal basis and for a minimum of 2 years.

2.2 Fire behaviour research in hummock grasslands is relatively straight forward. Some 20 - 30 experimental fires over a range of conditions would be adequate to validate existing models or adjust existing models. This could be achieved by 1 - 2 field trips, each of about 2 weeks duration. Further work is needed on forecasting weather conditions. This should be done in conjunction with the Bureau of Meteorology or Ocean Routes.

17. References

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