STIRLING RANGE TEST FIRE ANALYSIS FEB. 1974

The four main criteria that affect headfire rate of spread are:

(a) Wind velocity
(b) Fuel Moisture Content
(c) Fuel
(d) Slope

Of these FOUR fires in the heath type vegetation wind velocity measured at 1.5 metres appeared to be the most crucial, thence to test this the data was classified into

1.	roughly normal fires	18
2.	fires obviously affected by Moisture content	9
3.	fires obviously affected by fuel content	2

WIND VELOCITY

The roughly normal fires numbered eighteen and these were divided into slope and non slope fires and separately plotted against wind velocity.

The results of this justified the belief that wind was a dominant part in fire behaviour as excellent linear relationships were found.

Slopes $HFROS = \frac{(\text{Wind Vel.} - 2.1)}{0.038}$ $r = 0.93$, $n = 8$, $MC\% \simeq 6$

Flats $HFROS = \frac{(\text{Wind Vel.} - 1.76)}{.032}$ $r = 0.94$, $n = 10$, $MC\% \simeq 14$

Hence for slopes 86% and flats 88% of variation in headfire rate of spread can be accounted for by wind velocity at 1.5 metres.

This leaves only 14% and 12% of the variation to be explained for in terms of moisture content and fuel quantity.

It must be remembered however that the fires had previously been classified rejecting those that were obviously affected by moisture content, and as fuel quantity was fairly uniform in the plot this variable was also minimised.

Therefore the 14 and 12% unaccounted variation allowed for moisture content and fuel quantity does not reflect the true field position, merely that of the selected data.

FUEL MOISTURE CONTENT

The next step was to isolate the effect of fuel Moisture Content.

It would be of no avail to plot fuel MC% against HFROS because the large effect wind velocity has on headfire rate of spread has already been shown and therefore any variation due to moisture content would almost certainly be masked by wind velocity.

The aim then is to put the fires into classes of wind speed then plot HFROS vs MC% for the fires in each class. A complication to this is that in this case there were few fires (28) with a large range in windspeed 1 - 15 km/hr plus site variations (e.g. slope) which must be eliminated. The result of this is that there are only one or two classes with enough data on them to draw useful conclusions.

The classes selected were: for flats and slopes

0 - 6.5 km/hr

6.6 - 10 km/hr

10+ km/hr

Of these, the only two found to be useful were the slopes for the 0 - 6.5 km/hr class and the 6.6 - 10 km/hr.

These were plotted and as is usual with moisture content vs HFROS curves a exponential relationship suggested itself. This was confirmed by plotting again on semi log graph paper which gave a straight line.

The equation for these lines are:

$$0 - 6.5 \text{ km/hr} \quad (a) \quad HFROS = (.8874)^{x} \times 160$$

$$6.5 - 10 \text{ km/hr} \quad (b) \quad HFROS = 492 \times (0.8521)^{x}$$

x = Aerial moisture content

The extrapolation of these curves suggests that the cutoff point for this type of fuel is between 25% and 32% of oven dry weight.

Looking at the graphs for the 6.5 km/hr - 10 km/hr class the three fires in the data have wind speeds of 8.7 km/hr, 9.4 km/hr and 9.8 km/hr. As seen from our wind speed graphs, under these conditions with moisture contents being equal, a range of approximately 30 metres/hr could be expected. However the actual range is 170 metres/hr which can only be attributed to moisture content.

From the curve we get readings of:

20% - 20 m/hr

15% - 45 m/hr

10% - 100 m/hr

5% - 215 m/hr

This suggests that for every drop of 5% moisture content below 20% the headfire rate of spread is doubled.

This observation is confirmed in the 0 - 6.5 km/hr class of the slope fires. At 5% moisture content and 6.2 km/hr winds a headfire rate of spread of 110 m/hr could be expected. However, at 10% moisture content only 13 m/hr was recorded. Therefore assuming a halving of the rate of spread with every 5% rise in moisture content

5% - 110 m/hr

10% - 55 m/hr

15% - 27 m/hr

20% - 14 m/hr

which closely agrees with the recorded value. This of course only applies to slope fires below 10 km/hr winds as no conclusive information can be gained from the higher wind category on the flat fires.

Slope effect

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is hard to believe.

From this report
draw up a chart for
wind velocity and
assuming ≈ 12 ton

HEAD FIRE

Aerial M.C % / WIND VELOCITY km/hr	0-5	7	1[illegible]
0-2	20	15	1[illegible]
3	25	17	12
4	50	37	2[illegible]
5	75	55	3[illegible]
6	100	75	5[illegible]
7	125	95	6[illegible]
8	150	110	75
9	180	135	90
10	200	175	10[illegible]

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Slope effect

It is well known that slope influences headfire rate of spread and a common value is that HFROS doubles for every 10° rise in slope for forest fuels (McArthur). This of course need not apply to the heath type vegetation found in the Park.

On looking at the data it is impossible to see any effect on HFROS by slope. In fact it would appear that when reduced to an equal basis, the fires burning on the flat plots were faster than those on the slopes.

However entering into this is the problem of fuel quantity. The average fuel quantity on the slope fires was 12 tonnes/ha whilst that on the flats was 18 tonnes/ha. Under normal circumstances one would expect an increased fuel quantity to aid rate of spread up to a certain limit, provided its bulk density was not limiting.

Hence in this case the increased fuel availability may be more than compensating for a slope effect.

If it is accepted that HFROS doubles for every 10° rise in slope, the slope fires should theoretically have been 4 times as fast as the flat fires. As they were not, going on the same assumption, this suggests a 50% increase in fuel quantity leads to a quadrupling in the rate of spread, which is hard to believe.

— From this report data it was possible to draw up a chart for calculating HFROS from wind velocity and aerial moisture content assuming ≈ 12 tonnes/hectare of fuel.

HEAD FIRE RATE OF SPREAD Metres/hour [NORTH ASPECT SLOPES]

WIND VELOCITY km/hr \ Aerial M.C %	0-5	7	10	12	15	17	20	25
0 - 2	20	15	10	7	5	3	2	–
3	25	17	12	9	6	4	3	–
4	50	37	25	18	12	9	6	3
5	75	55	35	25	17	12	8	4
6	100	75	50	37	25	18	12	6
7	125	95	65	50	33	25	17	8
8	150	110	75	57	38	29	19	10
9	180	135	90	67	45	35	22	11
10	200	175	100	75	50	40	25	12