JARRAH FOREST FIRE RESEARCH UPDATE

N. BURROWS 1984.

Project Narrik was a culmination of fire research to investigate;

- the potential maximum head fire rates of spread of massed forest fires
- the acceleration rates of massed forest fires burning under different weather conditions
- the interaction and coalescence of massed fires burning in close proximity and under dry fuel conditions
- the behaviour of fires burning in aerated scrub fuels
- fire shapes and spotting patterns over a range of weather conditions.

Jointly with C.S.I.R.O., we burnt 15 fires (each about 100 hectares) under dry conditions of summer, 1983 and in Nannup Division.

An infra-red line scanner mounted in C.S.I.R.O.'s F-27 aircraft, scanned the fires so that we could determine the above factors.

We have had problems in interpretting the infra-red imagery of the fires, which are crucial to the study. Main problems have been; distortion of images due to aircraft movement, especially when convection columns developed, and a phenomenon known as "flare", which make the actual fire line difficult to determine on some images.

Using computers at the Remote Sensing Applications Centre and our Intergraph Station at Como, we have been able to define the fires as best we can and hence produce isopleths, or fire maps with time (see figure 1 below).

From these fire "maps" we are able to extract fire behaviour information and fire shapes. We can then relate these to conditions of fuel and moisture at the time to determine relationships between fire behaviour, weather, fuels and topography.

We are still in the process of analysing data. Correcting the infra-red imagery is a slow process and we are only allowed 2 days per fortnight on the Intergraph Computer.

However, we do know that;

- At high wind speeds and when litter fuels are dry (<10%), fire can spread much faster than we have expected in the past.

In some cases, fires spread at 3 - 4 times faster than predicted. During coalescence, fires spread up to 10 times faster than predicted.

- Fires ignited from a point source, accelerate slowly at first and then rapidly. The rate of acceleration varied with wind speed and available litter fuel load. Generally, when winds were low (less than 10 - 15 kph tower) then fire burnt slowly for the first 60 - 90 minutes, with spread rates between 30 - 40 mph. When fires reached a size of about 1 hectare or so, then they accelerated rapidly and assumed an elliptical shape (see figure 2 below).

- When fires become large (> several hectares) and entered the acceleration phase, local changes in fuel type had little effect on fire spread rate. The fire integrates the fuels in front of itself and, we assume, burns at a rate equivalent to the average fuel loading along the headfire line.

- Fire shape critically effected fire behaviour. Fires with a "natural" shape (i.e. ignited from point source and become circular or elliptical) displayed much more stability because of their architecture than fires lit by a line of fire. "Natural" fires were more predictable and less responsive to wind and fuel changes than line fires, which often burnt several times faster than "natural" fires.

- Backburning, using line of fire, is a dangerous practise under dry, unstable conditions in summer. For the reasons described above, "backfires" can display often violent behaviour, even when the main headfire is 200 metres away. Backfires should not be lit in heavy, dry fuels or when the wildfire headfire is closer than 500 metres away.

- Under dry conditions in summer, scrub fuels in creeks, flats and swamps display violent behaviour because of the aerated nature of the fuels and because of airflow patterns. Existing fire prediction systems do not adequately predict the behaviour of fire in scrub fuels. We hope to remedy this at the end of this Project.

CONCLUSIONS

We will be creating a new fire behaviour modelling concept and using computers. The new model will include fire build-up, fire shapes and other descriptions of fire behaviour (such as intensity, heat release rate, etc) as well as maximum likely spread rate. The new model will not be static, but will actually "run" fires in time and space and using digital terrain models. We expect the model to be up and running in 2 - 4 years time.

The new version of the Red Book will include some fire behaviour updates gained from these studies.

PROJECT AQUARIUS UPDATE (from Notes By Phil Cheney)

PHASE II - THE VICTORIAN EXPERIMENTS 1983-84

The Victorian experiments were conducted on a 1600 hectare experimental site at Nowa Nowa in East Gippsland Victoria. Sixteen experimental blocks were prepared and the fuels and topography measured in detail. A fire suppression model which included data on fire movement and the pattern of retardant that would be delivered from different types of aircraft was prepared under contract from scientists in the Chisholm Institute of Technoloy. There is considerable information in North America about the types of pattern or footprint of retardant on the ground when dropped from the aircraft travelling at different speeds and at different heights above the ground. This information was made available to the project by the Fire Research scientists from the United States Forest Service and was included in the Chisholm model. The experiments in Victoria were to predict the intensity of the fire that would develop under the prevailing weather conditions and also predict the amount of retardant that was required to stop a fire of that intensity. Tests were carried out using the fire retardant chemical di-ammonium phosphate and they were also carried out with water.

Wet weather during the summer of 1983 meant that only 9 experimental fires could be conducted over an area of about 300 hectares. We found that the US Forest Service Model used to simulate retardant drop patterns (PATSIM) required modification and additional data was collected to enable US scientists to continue with this work. Unfortunately, experimental fires were of low intensity and there was little difficulty suppressing fires by any technique.

VICTORIA 1984-85

Continuation of the program during the 1984-85 fire season was made possible by the very generous assistance of the National Safety Council of Australia, Victorian Division, and the Department of Conservations Forests and Lands. The original planned project could not be completed and the efforts were concentrated on:

- physiological stresses on firefighters and rates of fireline construction with handtools

- measurement of the effectiveness of air delivered retardant concentrations on high intensity fires

- characterisation of high intensity fires for evaluation of personal protective shelters

- examination of the windflow around a high intensity fire front.

Work could not be completed on studies measuring the suppression capability of bulldozers although we were able to gain some additional information when fires burnt across prepared breaks.

Over 20 experiments were conducted with fires ranging from a few hectares to over 100 hectares. The total area burnt was 900 hectares in 9 blocks.

Any aircraft capable of delivering 1.5 - 2 mm depth of fire retardant chemical would sufficiently coat most Australian forest fuels to prevent them from burning. Whether or not that barrier was effective in stopping a fire depended on other factors such as the width of the barrier, intensity of the fire, flame heights and spotting distance. In very general terms, the fire intensity at which fires could be suppressed by different techniques is given in Addendum 'D'.

The fire danger index at which this suppression is effective at a given fire intensity depends strongly on the fuel load. Large airtankers were no more effective than bulldozers. A combination of airtankers and bulldozers would be effective at only a slightly higher fire intensity than for any one alone - say 2500-300 kW/m.

Fire behaviour measurements confirmed observations in W.A. and now needs to be carefully analysed with fuel, slope and weather data.

ECONOMICS OF FIRE SUPPRESSION

An economic model based on the Canadian model AIRPRO has been developed to examine the economics of fire retardant droppping aircraft compared with conventional suppression techniques in Australia. To date, the historical data for the last 10 years from Victoria has been fed into the model and a number of test runs carried out. Currently we are adding historical information for fires over the last 10 years in N.S.W. and the SE of South Australia and will compare the economics of airtankers with the historical cost of fire suppression in those areas.

The results to date suggest that aircraft are not cost effective on small fires during a mild fire season when compared with conventional techniques. In moderate fire danger seasons some substantial savings may be made depending on the location of the fire and the location of the retardant base or water bodies suitable for water scooping. On days of construction rates compared with conventional firefighting techniques. The model relies on average spread conditions and it cannot take into account possible savings which might be made if an aircraft arrives at a fire soon after its start and takes advantage of slower rates of spread while the fire is small. Often, large aircraft can be shown to be cost effective on operating costs alone but large initial costs and standby payments which must be made to have aircraft available when needed (fixed costs) make the operation uneconomic in most circumstances.

OTHER PROJECTS

A. Physiological stresses on firefighters (CIH)

The field program over two years enabled a complete set of data to be collected to compare the stresses experienced by firefighters constructing fireline with handtools, with and without fires, and in two different sets of clothing. The limits of fire intensity that could be effectively fought were defined and several times firefighters worked close to the point of exhaustion.

B. Personal protective shelters (NSW BFC)

Three tests were conducted on the multi-person protective shelter. Tests showed that some previous information is misleading for summer fire conditions.

i. air temperature is highest close to ground

ii. protection from radiant heat is required for around 20 minutes and not for only the passage of the flame front

iii. air temperature inside the tent closely follows the external air temperature

Some additional work is required to complete this program - probably in conjunction with CIH.

ANALYSIS AND PUBLICATION SCHEDULE

The following program is subject to retaining some staff employed on Project Aquarius in the NBRU and not suffering disruption through re-location.

A. Definition of fire intensity at which suppression by various methods fail - September 1985.

B. Production of a computer model to evaluate airtanker effectiveness at defined locations - May 1985.

C. Revision of McArthur Forest Fire Danger Tables to account for acceleration periods - June 1986.

D. Publication of economic analysis of airtankers for Victoria - August 1985.

E. Publication of economic analysis of airtankers for NSW forest area and plantations in SE of South Australia - October 1985.

F. Completion of fire survival criteria for personal survival shelters - September 1985.

G. Publication of a preliminary model for predicting windspeeds around intense fire fronts - December 1985.

H. Completion of analysis of Aquarius fire spread data - December 1986.

I. Publication of paper on the physiological stresses on firefighters - CIH - September 1986.

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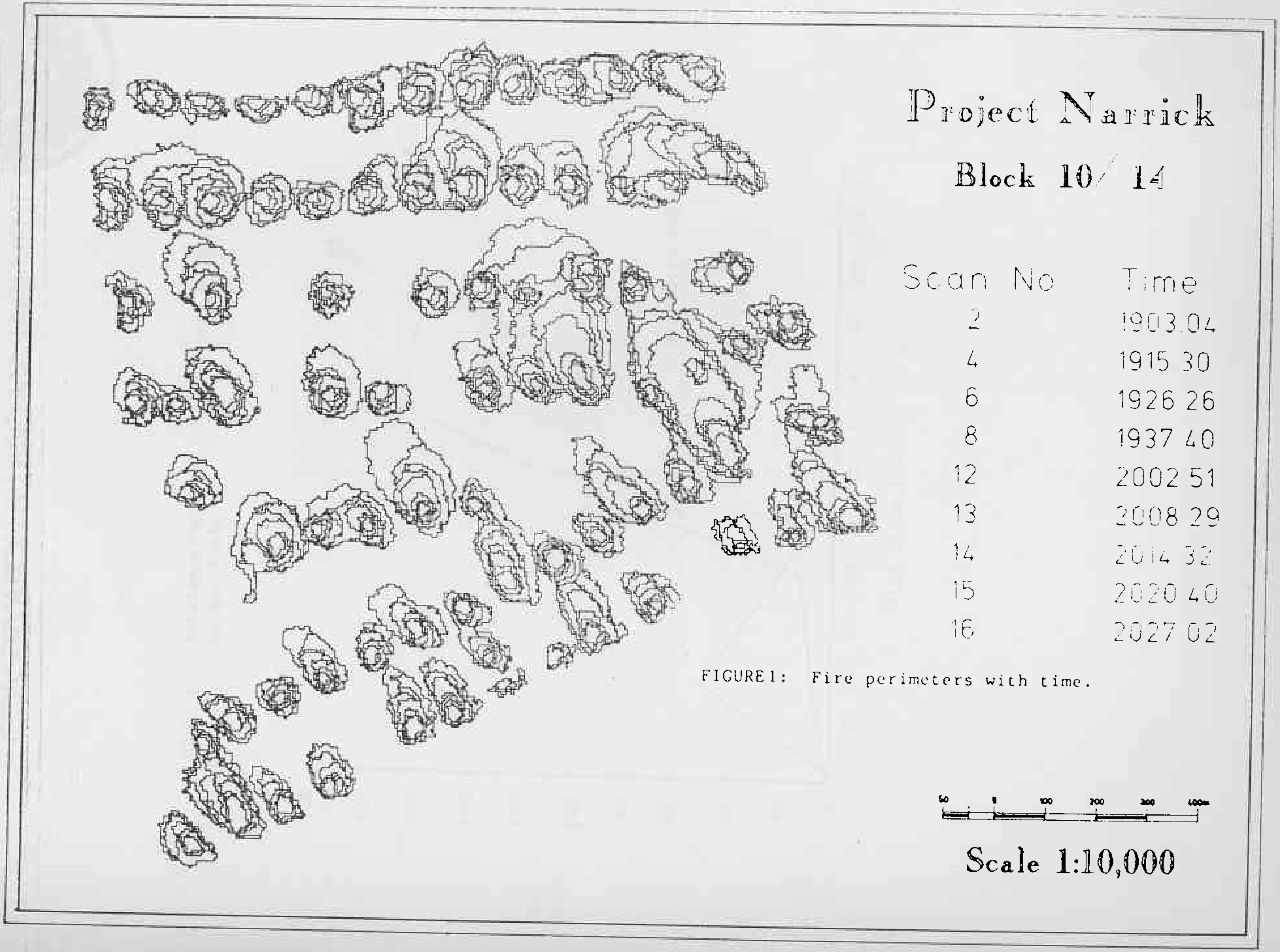

FIGURE 1: Fire perimeters with time.

Department of
CONSERVATION & LAND MANAGEMENT

FIGURE 2: Acceleration rates of some fires burning in dry fuels.