DENSE SPOTTING AND ERRATIC FIRE BEHAVIOUR ON THE MAJURA PINES FIRE, AUSTRALIAN CAPITAL TERRITORY, 2ND MARCH 1985

(revised 8/10/2020)

by Jeff Cutting ARPS

An ACT Forests fire tanker working near the Majura pines is coming under severe radiation stress: © Jeff Cutting

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Introduction: As a professional museum and fine arts photographer with active membership of the ACT Rural Fire Service, I had long standing arrangements with local fire authorities to attend bushfire incidents to undertake photography on a freelance basis in order to create a visual resource on Australian bushfires. With fifty-five years experience with wildfires, I have considerable knowledge of fire behaviour, suppression strategies and tactics gained from close encounters with hundreds of grass and forest fires. Some of these fires were disastrous and I often assisted with firefighting and property protection. Major incidents were: the giant Chatsbury fire 1965, the 1968 Blue Mountains disaster, the 1979 Hall fire, all of the significant ACT and regional fires in the 1984/85 season, the 1987 Mount Dowling fire and the 2003 Canberra disaster.

In the summers of 1982, 1983 & 1984, I worked as a Technical Assistant in the field and Photographer with Project Aquarius - a CSIRO Division of Forest Research undertaking - in the ACT, Western Australia and Victoria, investigating high-intensity forest fires, the cost-benefit of aerial suppression by large tanker aircraft, the productivity and health of firefighters using hand tools along with an evaluation of protective clothing and of personal survival shelters. [1]

My work for many years has been, and still is, used extensively for fire exhibitions, firefighter training, fire research and publications, in museums and for legal purposes.

I have been awarded: with firefighters *The Canberran of the Year 1985*, the *ACT Emergency Medal 2003*, a *30 Year Service Medal* with the ACT Rural Fire Service and the *National Medal & clasp*.

Foreword: The rare opportunity to document active wildfires close up and produce case studies, permits detailed analysis and insights into these natural, often baffling and damaging phenomena, and thereby providing valuable information on fire behaviour vital to foresters, land managers and firefighters.

Currently, there is a pressing need for more understanding of the nature of troubling wildfires in Australian softwood plantations that have acquired an awesome reputation for intractability and savagery, particularly after the tragic Wandilo fire in 1958, in South Australia where eight firefighters lost their lives,[2] and later, in the same region, the hopeless situations faced by firefighters as vast conflagrations raged in the south-east pine plantations on Ash Wednesday in 1983.[3] More recently, a scientific report on the 2006 Billo Road pine fire in southern New South Wales [4] revealed unexpectedly severe fire behaviour under moderate weather conditions and highlighted the inadequacy of existing fire prediction models in Australia for exotic pine plantations. Softwood plantations in Australia are widespread high value fire sensitive commercial assets needing to be managed economically and safely for some 30 to 50 years of growth.

On Saturday the 2nd March 1985, a day of extreme fire danger in the Australian Capital Territory, whilst observing a large out-of-control fire in a pine plantation to the north of Canberra, I was in a position to photograph a sequence of events leading up to a sudden eruption of fire in nearby grassland and the development of a massive crown fire surge sweeping out of the pines that jeopardized the safety of a bushfire tanker operating nearby.[5] After careful consideration I determined that it was necessary to warn rural firefighters who might otherwise be transiting or working in the vicinity of fires in pine plantations on days of elevated fire danger, to be aware that sudden changes in wind direction moving across an active flank or head fire, may produce dense short distance spotfire swarms resulting in sudden eruptive fire behaviour both within the plantations and in the surrounding vegetation that may entrap unwary crews.

It is the characteristics of the fire in the Majura Plantation that are the principal subjects of this report.

An unusual fire season: In December 1984, after two years of above average rainfalls with prolific growth in grass and shrublands, the Australian Capital Territory entered the hottest and driest summer on record, and this resulted in a most unusual fire season in that a high potential for both grass and forest fires existed throughout the summer months. Particularly troubling was the continuity of the abundant and very dry fuels that would carry fires into all landscapes. Previously, it was more usual for a fire season to be biased either towards grass or forest fires with long drought periods being characterised by extensive forest fires, with a lack of grass reducing the threat from that quarter. Conversely, extended wet periods leading into cooler summers usually resulted in lush growth in grasses that cured annually to provide extensive dry fuels whilst forested areas remained too damp to burn.

By the close of the 1984/85 fire season, the ACT Bushfire Council had attended a record 185 fires, and most were quickly contained without serious damage to property. However, on the 2nd & 4th March 1985, two days of strong, very dry and gusty winds producing Very High to Extreme fire dangers in both grassland and timbered environments, several fires burnt out of control resulting in record property losses in the ACT and surrounding areas of New South Wales.[6]

At 1326 hours, on Saturday 2nd March, ACT lookouts reported smoke from a fire on the steep and largely inaccessible southern slopes of Mount Majura. (Fig. 1) Strong westerly winds soon drove the fire down the eastern side of the mountain through eucalypt woodland into the Majura Pine Plantation where it intensified and spotted across Majura Road into the Field Firing Range before burning eastwards through open woodland and eucalypt forests towards Sutton Road and eventually into New South Wales.

The run of the M**ajura fire:** The origin of the Mount Majura fire was in *low closed forest* of *Casuarina stricta,* on a west facing slope at 790 masl (metres above sea level), when the McArthur Forest Fire Danger Index was at 64 (Extreme). (Fig. 1) The cause of the fire was unknown, but suspicious. Driven by very strong winds, it crossed a ridge line onto the eastern side, then burnt downslope through eucalypt woodland and the Majura Pine Plantation onto level grassy woodland at 620 masl, (Fig. 2) and spotted across Majura Road where it burnt through a pine windbreak. Strong west-nor-westerly winds (285°), then drove the fire eastwards over undulating terrain through grass and open woodlands. At 1415 hours, the head fire flanked by two spotfires (lofted 1.5 ~ 2.0 kilometres) was 1.75 kilometres into the Firing Range (East of Majura Rd) with two distant spotfires (lofted 3.5 kilometres) burning some 4.6 kilometres into the Range. (Fig. 3)

At about 1445 hours, the distant spotfires merged to form the main head fire and burnt into a 206 Hectare block of recently hazard reduced forest abutting Sutton Road where it stalled. This fuel reduced block of eucalypt forest materially prevented the Majura fire from entering the extensive Kowen pine plantations.

Soon after 1500 hours, the westerly winds backed to south-westerly enabling the fire to work its way around and past the hazard reduced forest on the northern side, (Fig. 19) and make a strong run eastwards through heavily timbered land and open grazing country towards Sutton Road. (Fig. 20)

At approximately 1640 hours, as the fire approached properties on Sutton Road, a sharp and very strong south-westerly wind change (~245°) blew-out the entire northern flank of the fire from Mount Majura all the way to Sutton Road, resulting in several head fire runs up into heavily timbered hill country, and crossed Sutton Road in a number of places to eventually burn into Wamboin estate in New South Wales. (Fig. 21)

The Mount Majura fire burnt a total of 6,000 Hectares of grassy woodland and native forest in the ACT and New South Wales, with significant damage to rural assets including 120 Hectares of the Majura pines.

Photography: Photographs were taken looking northwards up Majura Road of the right-hand (southern) flank of the Mount Majura fire at 1410~1415 hours, coming down off the mountain and across Majura Road (Fig. 2) with the head fire and two flanking spotfires 1.75 kilometres into the Firing Range, and of distant spotfires approaching the hazard reduced forest at 4.6 kilometres into the Firing Range. (Fig. 3)

The next set of images were taken from 1425~1435 hours, are of two firefighting units suppressing fires in the grassland as they emerge from the pine plantation, (Fig. 4) and of the flank fire surges flashing out of the plantation. (Figs. 5 ~ 7)

A further set of photographs taken from 1435~1445 hours, near the south-eastern corner of the Majura plantation, show dark ember laden smoke billowing out of the southern perimeter of the pines and seeding spotfires for 150 metres out into the grassland, and covering an area of 3.5 Hectares, (Figs. 8 ~ 9) whilst at the same time sowing spotfires within the pines. With extreme fire danger in both grassland and forest environments,[7 & 8] some 18 to 20 spotfires erupted in the grassland and coalesced violently in swirling winds and were drawn back into the pines where they rapidly built up in the dry pine needle fuels. (Figs. 10 ~ 11) The subsequent coalescence of the grassland fires with spotfires within the plantation led to an eruptive mass fire effect, that reached high into the canopy of the pines and spilled out of the plantation as a wall of flame and subjected a bushfire tanker working nearby to an intense radiation flux, forcing it to shear away to safety. (Figs. 12 ~ 17)

The resulting crown fire surge (Fig. 18) was by way of ladder fuels - an abundance of dead needles hung up on drought stressed vegetation on the lower branches of the perimeter trees - and aided by the free inflow of clean air from outside the plantation.

Conclusion: The spectacular eruptions of fire in the Majura Pine Plantation were not part of the initial head fire run through the pines but subsequent discrete flank fire surging and a separate blow-up crown fire.

The crown fire surges on the southern / left-hand flank of the fire in the pines, were aligned with the main fire axis, (Figs. 4 ~ 7) and resulted from turbulent wind currents entering the plantation through breaks in the canopy, most probably the result of previous crown fires clearing out the foliage, allowing the relatively quieter burning flanks to flare up. Another possibility was that the flank fires suddenly overcame fuel free zones (i.e. bare rock outcrops or road clearings) and engaged new deposits of flashy fuels, such as slash from windfall or thinnings. The strong centring effect of the main convection column tended to restrain some of the lateral movements of the fire in the pines.

The eruptive blow-up crown fire breaking out from the canopy of the plantation (Figs. 14 ~ 18) resulted from the explosive coalescence of spotfires following an off-axis ember shower blown out of the plantation by a strong gust of wind crossing over the fire. Numerous spotfires were seeded in the critically dry fuels in the grassland and in the plantation's deep and very dry needle beds. The grasslands were weathered and 100% cured and desiccated by the extremely low relative humidity of 4%. Similarly, the plantation fuels were extremely dry with the surrogate BKDI soil moisture depletion count of 144 mm, and subjected to the same diurnal low humidity. The fire danger indices for both environments were in the Extreme range. [7 & 8]

The off-axis wind shear responsible for scattering embers out from the plantation was most likely the product of strong gusty winds in an unstable atmosphere, much in evidence that day, (Appendix 1) or lee-slope turbulence in the wind field over the eastern fall of Mount Majura, or a combination of both.[9]

Whatever the cause, it illustrates the propensity for dense short distance spotting and erratic fire behaviour to occur both within and in close proximity to radiata plantations on days of elevated fire danger and the very dangerous conditions faced by firefighters who might be tempted to enter pine plantations for reconnaissance or close-in fire suppression. This caution, although specific to fires in pine plantations during periods of drought, considers that similar dangerous situations may well arise in the vicinity of native eucalypt forests and plantations, acknowledged as prolific generators of firebrands, and the need for firefighters to be aware of sudden changes in wind direction whatever the cause.[10]

Sudden wind speed and direction changes may arise from thunderstorm downdraughts, rolling gusts in an unstable atmosphere, sea breeze fronts, approaching cold fronts, channelling of wind in deep gullies and the influence of other large fires nearby. Firefighters must always be on the alert for abrupt changes in fire activity and for smoke suddenly passing overhead.

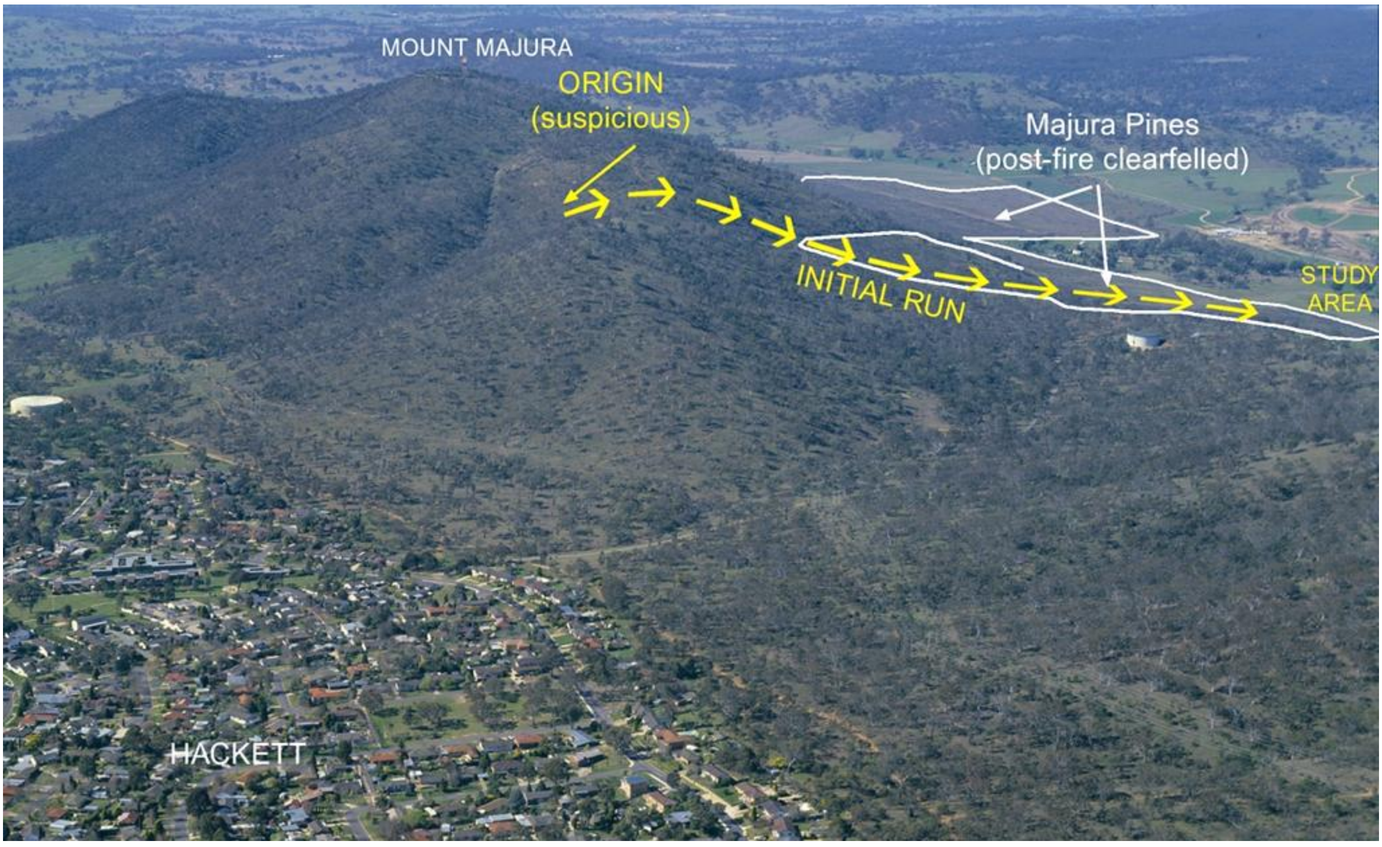

Figure 1. The origin and establishing run of the Mount Majura fire, Saturday 2 March 1985, showing the study area.

Figure 2. View looking northwards up Majura Road at 1410/15 hours, 2 March 1985, at the Mount Majura fire which has burnt through the Majura plantation (far left) and spotted across the road into the Majura Field Firing Range.

Figure 3. View looking north-east from Majura Road at 1410/15 hours, 2 March 1985, at the Mount Majura fire which has burnt 1.75 kilometres into the Field Firing Range (left centre) with spotfires (far right) at 4.6 kilometres, burning towards the recently hazard reduced block of eucalypt forest.

Figure 4. ACT fire crews on light tanker units are suppressing the Majura fire as it moves out from the plantation into grasslands and are careful to maintain a safe working distance from the pines.

Figure 5. A flank fire surge with crowning on the perimeter trees.

Figure 6. Strong turbulent winds entering the pines are causing erratic fire behaviour with crown fire surges running along the flanks of the fire. Strong convective activity is drawing large flames out from the plantation. Such fire behaviour would serve as a warning to firefighters to keep well clear of the plantation.

Figure7. The late ignition of envelopes of volatile gasses distilled from the canopy of drought stressed pines by searing radiation fluxes from surface fires, were common on this day and resulted in fireballs ascending in the convection column before combustion was completed.

Figure 8. Strong gusting winds moving across the fire in the Majura pines is spilling out dense smoke laced with embers from the southern perimeter of the plantation and seeding spotfires in the surrounding grassland.

Figure 9. A swarm of spotfires is rapidly developing in the grasslands beside the plantation, whilst spotfires sown within the pines are much slower to develop.

Figure10. In less than five minutes, strong in-draught from the main fire in the plantation is drawing the grass fires back into the plantation where spotfires in the pine litter are beginning to erupt.

Figure 11. The main plantation fire is drawing the grassland fires back into the plantation where they coalesce violently with spotfires in the pine litter fuels and begin to climb up the bark on tree trunks.

Figure 12. An ACT Forest brigade heavy tanker is working to suppress the spotfires in grassland whilst coalescing spotfires in the plantation are rapidly gaining in intensity.

Figure 13. An ACT Forest brigade heavy tanker is working to suppress spotfires in the grassland whilst fires in the plantation are drawing towards the main fire and rapidly gaining in intensity.

Figure 14. Violently coalescing fires in the plantation are rapidly gaining in intensity with flames reaching up into the crowns through ladder fuels (low branches on unpruned perimeter trees laden with dead needles).

Figure 15. A full crown fire surge emerging from the perimeter of the plantation is the result of the coalescence of numerous spotfires set in critically dry pine litter fuels and drought stressed canopy foliage. The fire tanker is working too close to the pines and will soon have to withdraw.

Figure 16. The resultant crown fire surge out of the plantation is placing the nearby fire tanker under severe radiation stress and is about to retire.

Figure 17. The crown fire surge out of the plantation has subjected the fire tanker to severe radiation stress which is drawing away to safer ground. The tanker suffered scorched paintwork and melted light fittings.

Figure 18. This massive crown fire surge out of the plantation is fuelled by the abundance of suspended needle fuels and drought stressed foliage on the unpruned trees and by the inflow of clean air from outside the plantation.

Figure 19. The initial run of the Majura fire under a west-nor-westerly wind faltered as it entered a hazard reduced forest near Sutton Road. At about 1500 hours, the wind backed to south-westerly and allowed the fire to skirt around the fuel reduced area (above) and resume burning through dry sclerophyll forest towards Sutton Road.

Figure 20. After the Majura fire burnt around the hazard reduced forest, it resumed burning eastwards through a large block of dry sclerophyll forest, then made a strong run through open grazing lands towards Sutton Road.

Figure 21. At 1640 hours, a sharp and very strong south-westerly wind change blew-out the entire northern flank of the Majura fire which ran up into timbered hill country in a number of tongues and crossed Sutton Road.

Figure 22. Clear felling of the fire killed Majura pines revealed a pattern of alternate crown firing and scorch on the downhill run from Mount Majura. Slender trees and high crop density indicates a sub-mature crop before thinning.

APPENDIX 1

Evidence of an unstable atmosphere on 2 March 1985: There were clear signs of an unstable atmosphere on the Mugga Lane fire as it burnt through Smiths Mill, Hume in the ACT between 1225 hours and 1325 hours on 2nd March 1985. The Mugga Lane fire was the first serious fire in the ACT that day and was ignited at roadside approximately 850 m west of the divided four lane Monaro Highway. Driven by a strong west-nor-westerly wind from (288°), it spotted freely over the highway into grassy shrubland at the Mugga Lane junction where it intensified and scattered further spotfires right throughout the sawmill area. As the spotfires burnt progressively through the sawmill complex, the wind swung sharply from west-nor-west to west-sou-west (300° to 280° to 250°) and back as evident in the following photographs. (Figs. 28 ~ 33) Data from the Fairbairn weather station located 10.5 kilometres due north indicate a mean wind direction of (310°) at 1230 hours and backing to (280°) at 1330 hours before steadying at (290°) by 1400 hours. Average wind speed was variable about 40 km/h then steadied at 45 km/h. Wind gusts varied from 59 km/h to a maximum of 72 km/h at 1400 hours coinciding with a steep drop in the dew point to -19°C and relative humidity to 4%, which took the Grassland Fire Danger Index to 106, a Catastrophic rating.[10.]

For more information on erratic fire behaviour in grassland due to atmospheric turbulence see the CSIRO publication GRASSFIRES... [9]

FAIRBAIRN METEOROLOGICAL LOG: 2 MARCH 1985 [11]

Fire Starts	EDS Time	Wind Direction	Average Wind Speed km/h	Max Wind Gust km/h	Dry Bulb Temp °C	Dew Point Temp °C	Relative Humidity %	Grassland Fire Danger Index	Forest Fire Danger Index
Googong 11.25 hr	11.30	300°	39	57	25°	1°	21%	44	35
Mugga Lane 12.05 hr	12.00	300°	46	72	25°	5°	28%	53	32
	12.30	310°	41	59	25°	-3°	16%	56	43
Red Hill 13.06 hr	13.00	300°	37	59	26°	-6°	12%	53	47
Mt Majura 13.26 hr	13.30	280°	46	65	25°	-12°	8%	92	64
	14.00	290°	45	72	25°	-19°	4%	106	72
	14.30	290°	45	70	24°	-4°	15%	67	48
Sundown Drive In 14.57	15.00	290°	46	67	23°	-1°	20%	60	40
	15.30	290°	45	63	23°	-1°	20%	57	39
Seasonal factors: Grassland curing 100%; KBDI Lowland Forests 144 mm, Drought factor 10									

Figure 23.
The first significant fire on 2nd March 1985 was detected at 1125 hours, burning in grassland near Googong Dam south of Queanbeyan. The fire danger was Very High to Extreme. Strong burning with a billowing smoke plume and clear sky indicated an unstable atmosphere.

Figure 24.
The Mugga Lane fire was detected at 12.05 hours. By 1220 hours, it arrived at the Monaro Highway driven by west-north-westerly wind from (288°) The Grassland Fire Danger Index was 56, Extreme. Initially the fire burnt in the lee of an air gap (aligned pass) in the Isaacs / Wanniassa Ridge, whereas the Fairbairn met station is on a wide open plain, indicated a 12°~22° difference in wind direction.

Figure 25.
With strong gusty winds, mass spotting occurred for 100 to 200 metres into grassy shrubland on the eastern side of the Monaro Highway.

Figure 26.
Numerous spotfires immediately erupted in grassy shrubland on the eastern side of Monaro Highway with strong winds sending masses of firebrands right throughout the Hume Industrial estate. The wind direction changed to west-north-west (295°)

Figure 27.
Spotfires lofted for 200 to 300 metres from the shrublands ignited throughout the sawmill complex and in the adjacent transport facilities in Alderson Place Hume.

Figure 28.
At 1235 hours, firebrands lofted some 500 metres from their source in shrubland, ignited spotfires at the eastern end of Alderson Place (beyond the sawmill) and crossed into New South Wales, driven by a strong west-nor-westerly wind from (300°). This new head fire run soon overtook the earlier Googong fire and resulted in the death of a firefighter.

Figure 29.
Ember storms from the severe burning in the grassy shrubland ignited sawn timber stacks and buildings right throughout Smiths Sawmill. Strong gusty winds backing to (280°/283°) drove fires right through the sawmill complex.

Figure 30.
A strong gusting wind backing to a south-westerly direction (250°)

Figure 31.
A temporary lull in the gusty south-westerly wind.

Figure 32.
The resumption of the very strong and gusty south-westerly wind from (250°/255°)

Figure 33.
A return to a more westerly wind from (280°) at approx 1325 hours.

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