Jim Gould

57

HIGH INTENSITY FIRES IN PLANTATIONS OF *PINUS RADIATA*

Report to the Fire Research Working Group

October 1982

by Mark Dawson

Background

At the last meeting of RWG 6, members recommended that available data on major conifer fires be collated. Fred Hoschke circulated a letter (appended) requesting information on all fires in *Pinus radiata* in excess of 5 ha which had occurred since 1960, or other fires which exhibited some significant behavioural pattern. This paper summarises the extent and fire behaviour data supplied, and suggests additional data that would improve management and research.

Introduction

Most Australian States and New Zealand have extensive plantings of *P. radiata*. Australia has about 505 300 ha[1], while New Zealand has about 800 000 ha (Cooper 1980). Although only about one per cent of the Australian forest area, the plantation resource will be the mainstay of the Australian wood products industry by 2010 (Australian Forestry Council 1974).

P. radiata has been successfully established in a range of environments with an annual rainfall exceeding 600 mm. Many of these are fire prone, having fire regimes unrelated to *P. radiata's* natural habitat. The species is very fire sensitive. Hence policies of total protection have predominated, and protection systems are based on hazard reduction in adjacent native vegetation, together with fast detection and initial attack (Cheney & Richmond 1980, Gill 1963). Attempts at fuel reduction burning in plantations have had limited success (Billing 1979, Fearnside 1970, Gilmour & Cheney 1968). Forest managers need better fire behaviour knowledge to permit strategic burning to reduce hazard and create crown fire free areas. Broad scale burning such as in plantations of *Pinus caribaea* and *P. elliottii* may not be feasible. These species are more resistant to fire than *P. radiata*, and hazard reduction burning according to fire behaviour guides has operated in Queensland since 1973. Strategic breaks are maintained in high risk and high hazard areas. The successful program has reduced the protection component of the total plantation cost from 33 per cent to 10 per cent (Byrne 1980).

Most wildfires in *P. radiata* have been quickly controlled, and the estate destroyed small. However, recent large, uncontrollable fires in some regions have highlighted deficiencies in fire behaviour knowledge. The Caroline fire in 1979 destroyed 3 500 ha of plantation on the SA/Vic. border (Geddes & Pfeiffer 1981). The estimated loss was $2 million (Geddes 1981) and yield regulation will be disrupted for many years. Concern for such problems was expressed at recent meetings under the auspices of the Australian Forestry Council, by the Fire Research Working Group and the Fire Control Officer's Group.

---

1. At 31 March 1980. Forests Branch, Department of Primary Industry.

Fire behaviour guides are available for several eucalypt and conifer forest types, but not for exotic *Pinus radiata* D. Don plantations. Fire behaviour research in such plantations would improve:

- the design of plantation protection systems;
- suppression tactics and strategies;
- fire regime planning to meet integrated resource management objectives;
- the use of fire to eliminate unwanted pine regeneration.

Data limitations

Most of the information supplied concentrates on fire size and suppression action details needed for costing. The few data on fire behaviour are very general, and there is no explanation of the bases of 'estimates' supplied. However, more detailed data are available for several large fires, but even here, the critical conditions for behaviour phenomena are only estimated, usually through postmortem. Not all agencies with *P. radiata* holdings responded, and there is no record of fires in private holdings.

Area burnt

Table one gives a breakdown of area burnt by State. Australia has lost at least 9 639 ha, which is 0.020% of the radiata plantation resource. New Zealand has lost at least 10 650 ha, about 0.013% of its radiata resource.

Insufficient data were supplied to comment on trends such as number, occurrence time, or fire size. Most agencies rely on early detection, and fast initial attack. If control is not effective within the first hour, a large fire is probable, with control restricted to flank attack.

Fire behaviour

Table two summarises the data in Table one, providing information on the behaviour of high intensity fires. Douglas (1964) provided more detailed information on characteristic fire behaviour, and further detail is provided by Prior (1958), McArthur (1965), McArthur, Douglas and Mitchell (1966), and Geddes and Pfeiffer (1981). However, the critical thresholds for changes in fire behaviour are not well defined. For example, what are the critical conditions for crowning and spotting? Van Wagner (1977) indicated a need to better understand spread rate, flame length, and energy transfer associated with such phenomena. This would require more detailed observations and measurements of fire behaviour than are presently available for *P. radiata*.

The general data available provide a basis for plantation design, coupe layout, and silvicultural regimes for fire management purposes, and managers may find this satisfactory. However, plantations are still being destroyed by wildfire. One might ask:

- is existing fire behaviour data adequate?
- is existing data being used effectively?
- what research should be conducted to refine fire behaviour estimation?
- should research priority be geared to the cost of plantation losses?

Bibliography

Australian Forestry Council. (1974) - FORWOOD. Report of Panel 2, Forest Resources. Forestry and Wood Based Industries Development Conference, AGPS, Canberra.

Billing, P.R. (1979) - Using fire to reduce fuel accumulations after first thinning in radiata pine plantations. For. Comm. Vic. Fire Res. Branch Report No. 4, Unpublished.

Byrne, P.J. (1980) - Prescribed burning in Queensland coastal *Pinus* spp. plantations. Qld. Dept For., Paper to 11th Comm. For. Conf., 32pp.

Cheney, N.P. and Richmond, R.R. (1980) - The impact of intensive forest management on fire protection with special regard to plantations of eucalypts. Paper to 11th Comm. For. Conf., 22pp.

Douglas, D.R. (1964) - Some characteristics of major fires in coniferous plantations. *Aust. For.* **28(2)** : 119-124.

Fearnside, A. (1970) - Burning ground fuels under *P. radiata.* *Aust. Timb. J.* **36(3)** : 99-101.

Geddes, D.J. (1981) - Plantation re-establishment following the Caroline forest fire: an interim review. Woods and Forests Department. South Australia, Misc. Pub. No. 2.

Geddes, D.J. and Pfeiffer, E.R. (1981) - The Caroline forest fire 2nd February, 1979. Woods and Forests Department, South Australia, *Bull.* **26**, 52pp.

Gill, E.D. (1963) - General prescriptions for the fire protection of new plantations. *For. Comm. Vic. Tech. Pap.* **10** : 25-34.

Gilmour, D.A. and Cheney, N.P. (1968) - Experimental prescribed burn in radiata pine. *Aust. For.* **32** : 171-177.

McArthur, A.G. (1965) - Fire behaviour characteristics of the Longford fire, 17 November 1962. *Forestry and Timber Bureau, Leaflet No.91.*

McArthur, A.G., Douglas, D.R. and Mitchell, L.R. (1966) - The Wandilo fire, 5 April 1958 - fire behaviour and associated meteorological and fuel conditions. *Forestry and Timber Bureau, Leaflet No.98.*

Van Wagner, C.E. (1977) - Conditions for the start and spread of crown fire. *Canad. J. For. Res.* **7(1)** : 23-34.

TABLE 1 HIGH INTENSITY FIRES IN *PINUS RADIATA*

	Date	Age (yr)	Area (ha)	Stocking (stems/ha)	HT (m)	T (°C)	RH (%)	FMC	ROS (m/h)	FLAME HT (m)	CROWNING	SPOTTING (m)	WIND SPEED (km/h)	OTHER
1. VICTORIA														
Creswick	25/ 1/66	sapling mature	200			35	21						30	
Creswick	12/ 2/77	mature	258			34	25						30	+nigra
Myrtleford	10/ 3/78	45	22						4600					
Caroline	2/ 2/79	13	163											
Longford	17/11/62	10-11	111		9-15	27	30		600	9-15	almost cont.	300	19	no T/P
Blanket Hill	3/ 3/65		324			38	9				in places		80	T1
Jeeralang	14/ 3/65		5											
Maryvale	17/10/68	13	54	975		29			360		Yes	240-600	48 80	T June, no P
Flynn Crk	13/10/71		16			26						Yes	19	+pinaster
Longford	13/12/77	4-13	8			28								
Longford	25/ 9/80	3-4	17			22							strong	
N.S.W.														
Woodburn	28/10/68	1-36	139			32	8						>60	+elliotii, taeda
Woodburn	25/ 9/80	18	130			33	12				near road	50	15	+elliotii, taeda, P, no T
Nowra	30/ 9/80	16-18	777	1600		34	6		50	12	immediate	400-500		no T,P
Belanglo	30/ 4/77	21	2			15				1.5		nil		P, some high P
Newnes	27/ 9/71		21			12				3-4		40	56	
Sunny Corner	27/ 9/71		63							3		200		
Sunny Corner	19/ 2/78	11	8			30	30		125		when exposed	10	light	no P
Bondi	21/ 3/80	47-48	9			32	18			3			56	+laricio
Murraguldrie	26/ 2/63	mature	3											
Lochinvar	24/12/77	2	20	1333		25	15		367				14	no P/T
Condobolas	14/ 1/78	8-9	15	1600	10	30	35			severe		35		no T, some P
Bombala	2/ 4/81	mature	8							3				+laricio
Total NSW FC	1954-1981	1900												

320 2.5 640 180 800

TABLE 1 HIGH INTENSITY FIRES IN *PINUS RADIATA*

	Date	Age (yr)	Area (ha)	Stocking (stems/ha)	HT (m)	T (°C)	RH (%)	FMC	ROS (m/h)	FLAME HT (m)	CROWNING	SPOTTING (m)	WIND SPEED (km/h)	OTHER
3. A.C.T.														
~~Stromlo~~	5/ 2/52	26-27	270			38	13						40 64	
		1-11	46			38	13						40 64	
~~Jervis Bay~~	23/12/72		122			39	39						30	
Fairbairn	7/ 1/75	15	31	750		29	18		1044		immed.		16	T 6months 5° slope
Stromlo	18/12/81	31	6	200		30	13		300		yes-individual trees		20 70	
Uriarra	9/ 8/82		21											
4. S.A.														
Wandilo	5/ 4/58		320		5-30	33	29		600-1600		yes	400-2000	40	
Glencoe	2/ 4/66	8-12	40		6-10	33	20		600-1200		full	400-600	43	no P
Nangwarry	17/ 3/67	35	5	400	37-39	34	18		280-440	1.5-2.0	1 tree		40 56	p, low fuel
Kongorong	29/ 3/71	29	328	200		33	23		70-80		not in old stands	100-800	35	heavy slash
Mt Burr	19/ 1/73	21	1		21	35	30					240		no T
Penola	18/ 1/73		2		30	38	17				2 trees	400	20 40	
Glencoe	30/ 1/74		370			34	31		600-1200		in poor stands	800	50 65	
Mt Bold South	7/ 1/77	19	50			39	37		160	10	on upslope		23	+canariensis
Caroline	2/ 2/79	8-19	3344		15-18	38	16		3000-4000	70	Yes	multiple short dist.	43 69	
5. N.Z.														
Balmoral	25/11/55		2400				33		1400		Yes	Yes		
Average	1955-1980	330/yr												

TABLE 1 HIGH INTENSITY FIRES IN *PINUS RADIATA*

	Date	Age (yr)	Area (ha)	Stocking (stems/ha)	HT (m)	T (°C)	RH (%)	FMC	ROS (m/h)	FLAME HT (m)	CROWNING	SPOTTING (m)	WIND SPEED (km/h)	OTHER
6. W.A.	many <5 ha, mostly >10 yrs ago, no worthwhile records of fire behaviour. 4/ 4/78 Forests Dep. 284 ha Cyclon Alby Private 830 ha													
7. TAS.	1935-81		494	av. size 15 ha, 18 internal ignition (= most of the recent fires), 15 external, 1-6% plantation estab.										
Mt Helen	7/ 1/64	8	67	1240	5	20	18		400-1096	5	Yes	40	40-50	only fire >5 ha since 1960

114

TABLE 2. FIRE BEHAVIOUR UNDER EXTREME FIRE DANGER.

STAGE OF STAND DEVELOPMENT	FLAME HEIGHT	SPOTTING POTENTIAL	RATE OF SPREAD (ROS)
JUVENILE LIGHT GROUND FUELS *FIRE FIGHTING COST TO AGE 8 $107-136/HA	≥TOTAL TREE HEIGHT	LOW-INCREASING TOWARDS CANOPY CLOSURE	DEPENDS ON FUEL QUANTITY LOW-HIGH DEPENDIN ON ASSOCIATED VEGETATION AFTER 2ND SPRING ROS 4-5 KM/HR
DEVELOPING - SIGNIFICANT AERIAL COMPONENT - FIRST THIN HEAVY GROUND FUELS *FIRE FIGHTING COST AGE 9-15 $146-190/HA	≥TREE HEIGHT PRUNED: 1∝ DEGREE OF COMPACTION AND BREAKDOWN OF SLASH UNPRUNED; FIRE CROWNS IF NEEDLES SUSPENDED	MOD-HIGH	REDUCED WIND, ROS LOW 400-800M/HR HIGHER IF CROWNS AND SPOTS UP TO 1600 M/HR
MIDDLE A) THINNED/PRUNED GROUND FUELS LESS INCREASED ACCESSIBILITY GREATER POSSIBILITY FOR DIRECT ATTACK *FIRE FIGHTING COST 15 $240-470/HA	GROUND FIRE FLAMES 3-6 M IF SLASH WELL COMPACTED. OTHERWISE MUCH HIGHER.	LOW SHORT DISTANCE SPOTTING FROM GROUND FIRES	400-800 M/HR
B) THINNED/UNPRUNED	CROWN FIRE FREQUENT	HIGH	800-1200 M/HR
SLASH	VARIES GREATLY WITH QUANTITY AND CONDITION OF SLASH	VERY HIGH TENDENCY FOR WHIRLWINDS	≥1600-2400 M/HR

*NZ FOREST SERVICE DATA - 1980

QUESTIONNAIRE

Fire Behaviour in Conifer Plantations.

1. Locality.

   Name and subdivision(s) of forest involved, approximate latitude, longitude or AMG coordinates, estimated distance and direction from nearest major town.

2. Name of fire if applicable.

3. Date and time of start.

4. Climatic conditions.

   Rainfall deficit, temperature and humidity patterns, BKDI, SDI, drought factor.

5. Meteorological conditions.

   Temperatures, relative humidity, wind speed and direction, atmospheric stability, fronts, etc. Location of nearest station which may have recorded additional useful data. Fire danger rating.

6. Fuels - stand.

   Species, age, condition (stocking, pruning, thinning, etc. details).

   - ground.

   Clearing method, residual hardwood. Pine slash, disposition, weights, etc.

7. Topography.

   General slope and aspect of fire area, probably best illustrated by a contour map.

8. Fire behaviour.

   Location of the fire edge particularly at the end of major run(s) and the time fire reached the position. Location and time of arrival of the fire at any points where time is accurately known. Details of any spotting. Flame heights, crown fire development, etc.

9. Supression.

   Method(s) of attack. Fire line construction, hand and mechanical, performance and rates of construction. Machiner performance. Comments on strategy and tactics.

10. Miscellaneous.

    Any factors not already mentioned contributing to behaviour of the fire.

/2...

11. Summary.

For each significant run of the fire for which details are available. Tabulate if convenient - temperature, R.H., wind speed, FDI, slope, average fuel load, width of active front at beginning, area burnt, distance travelled, elapsed time.

New South Wales Government

Forestry Commission of N.S.W.

Forestry House
95-99 York St.
Sydney N.S.W.
Box 2667 G.P.O. Sydney
N.S.W. 2001

Telegrams: Newforests Sydney
Telex: Forcom 21657

Our reference: 48456 (F.C.O.)
Your reference: FH:TA

Telephone: 2 0236
Extension 552

Mr. F. Hoschke.

Dear Sir,

Fire Behaviour in Conifer Plantations.

At the last meeting of Research Working Group No. 6 - Bushfire Research, one of the topics discussed was fire behaviour in conifer plantations. Although there is some documentation available on major fires it is not sufficient to give a clear and comprehensive coverage of fire behaviour. Most forest authorities are unwilling to set aside areas of plantation for experimental high intensity fires to overcome this deficiency so it was considered that the collection and collation of all information available from wildfires that have occurred in plantations would be worthwhile.

In order to gather this data the attached questionnaire/ check list has been prepared as a basis for the reporting of all available information. Not all items will require comment, the main point being that all factors which influenced fire behaviour, particularly rate of spread are supplied. Much of the data can best be supplied as a comprehensive map or maps.

It is requested that reports be supplied for all fires in excess of 5 ha in size which had occurred since 1960 or other fires which exhibited some significant behavioural pattern.

If details of a fire have been published then a reference to the report or a copy of the publication together with any additional pertinent comments would suffice.

Yours faithfully,

R.W. DELL,
Acting Secretary.

Per: