PROJECT VESTA

The Prediction of High-intensity Fire Behaviour in Dry Eucalypt Forest

with special emphasis on the effects of fuel structure and fuel load.

Executive Summary

Project **Vesta** represents a major research initiative into the behaviour of wildfire in dry eucalypt forest. This report has been prepared by the bushfire research groups of CSIRO Division of Forestry and Forest Products (DFFP), and the Science and Information Division of the Department of Conservation and Land Management (CALM) Western Australia.

The research is vital to wildfire management in dry forests throughout Australia. Funding is being sought from CSIRO, CALM, the Australian Fire Authorities Council (AFAC) and research funding agencies.

Aims

- to develop a National Fire Behaviour Prediction System for dry eucalypt forests
- to quantify the changes in the behaviour of fires with the characteristics of high-intensity wildfires in dry forests as fuels develop with age .
- to develop new algorithms describing the relationship between fire spread and wind speed and fire spread and fuel characteristics (eg load, structure etc).
- to characterise wind speed profiles in forests with different over-storey and understorey structures.

Reasons for the project

- existing fire behaviour prediction systems were developed primarily for the prediction of the behaviour of low-intensity fires prescribed for fuel reduction. They have been developed for specific fuel types and can not be readily applied to fuels with a structure that is different to the experimental fuel type.
- these systems do not predict well at high wind speeds and may under-predict the behaviour of high-intensity wildfires by a factor of 3 or more.
- the linear relationship describing the increase in fire spread with increasing fuel load has been demonstrated only with fires of low intensity. The scientific basis for this relationship is uncertain and existing empirical studies are contradictory.
- the lack of good data to support this relationship is casting doubt on the effectiveness of prescribed burning for modifying wildfire behaviour. Critics of prescribed burning claim that:- reduced fire behaviour after fuel reduction persists for no more than a year or two; prescribed burning is costly and damaging to the environment and, cannot be justified on economic grounds.

- case studies can demonstrate reduced fire spread for up to two years; in some cases no effects were evident 18 months after fuel reduction operations. There are anecdotal reports to support both sides of the argument but there are no quantitative measures of high-intensity fire behaviour on fuels of different ages.

- new research has shown that the experimental techniques used to develop early fire behaviour models from experimental fires did not fully account for the effects of scale. This omission reduces the validity of extrapolating relationships derived from small experiments to predict the behaviour of wildfires.

National benefits of this research

- a National Fire Behaviour Prediction System which takes into account the influence of fuel structure on fire behaviour will enable fire spread models to be applied to wide range of forest types irrespective of their species composition and variations in fuel structure at local or regional levels.

- improved fire spread models are essential for:- better fire protection planning; early warning of wildfire threat; and, to assess the economic impact of fire suppression strategies.

- a quantitative measure of the impact of fuel reduction burning on wildfire behaviour will permit fire managers to identify those fuel types where fuel reduction will most benefit wild fire control and provide a sound basis to establish burn rotation.

Impact if research is not undertaken

- fire spread models will under-predict fire behaviour in certain fuel types, particularly under severe weather. This could lead to poor fire management strategies and potentially fatal decisions.

- prescribed fire may be applied to fuel types where little long-term reduction in wildfire behaviour may result, and planning on the basis of existing models may be costly if fire behaviour is greater than predicted.

- prescribed burning may be restricted in fuel types where it is quite effective because of objections by groups philosophically opposed to burning. This could result in an increase in damage from wildfires or alternative fire protection strategies (eg. wide firebreaks).

- models predicting fire spread will remain contradictory and their use in fire management (eg wildfire threat analysis, cost-benefit studies) will be limited.

Research team

- the fire research groups of CSIRO DFFP and CALM WA have expertise in fire behaviour measurement and analysis that is recognised internationally as amongst the best in the world. Collaboration between these groups will bring together an outstanding combination of skills capable of resolving difficult experimental problems.

- the team has access to expertise in specialised scientific fields (eg wind profile measurement) in other divisions of CSIRO and practical fire control in the CALM Fire Management Branch.

Funding

- the total cost of the project will be $4.44 million over 6 years. The annual cost of the project and the contribution required from stakeholders is set out in Attachments 1 and 2.

- both CSIRO and research funding agencies require demonstrated support from research users . Approved collaborative projects attract Federal funding up to 70% of the total cost of the project (Attachment 2). This represents good value for money invested by individual members of AFAC.

- CSIRO and CALM have invested a considerable effort in high intensity fire behaviour research and have assessed the feasibility of the project with external funding assistance from the Australian Committee for the International Decade for Natural Disaster Reduction during 1995/6 (Attachment 2). If this project is not supported the results from analysis of existing data will be limited and scientists may be directed to seek funding for projects on other problems.

- CALM Fire Management Branch have scheduled previous operational burning to provide a suitable range of age classes for the experiments in 1998. If this opportunity is missed the project will face increased costs to prepare specific sites and delays until a suitable range of fuels accumulate.

Project Tasks

This project will integrate fire spread data from the high-intensity fires conducted during Project Narrik and Project Aquarius. These data are essential to the proper design of experiments and can be included in the analysis once specific questions relating to the effects of fuel load, fuel structure and wind speed profiles have been answered. The major tasks of the project will be:-

Project feasibility
1. Examine feasibility of project.
2. Select potential sites of known fuel ages.
3. Draw up co-operative agreements between CSIRO and CALM.
4. Prepare project proposals.
5. Secure funding support from other agencies.

Fuel Measurements
1. Develop quantitative techniques for fuel sampling.
2. Evaluate sampling techniques in WA, NSW and Victoria.
3. Measure fuel characteristics on experimental plots.
4. Measure post-burn fuels.

Site Preparation
1. Survey potential sites for uniformity.

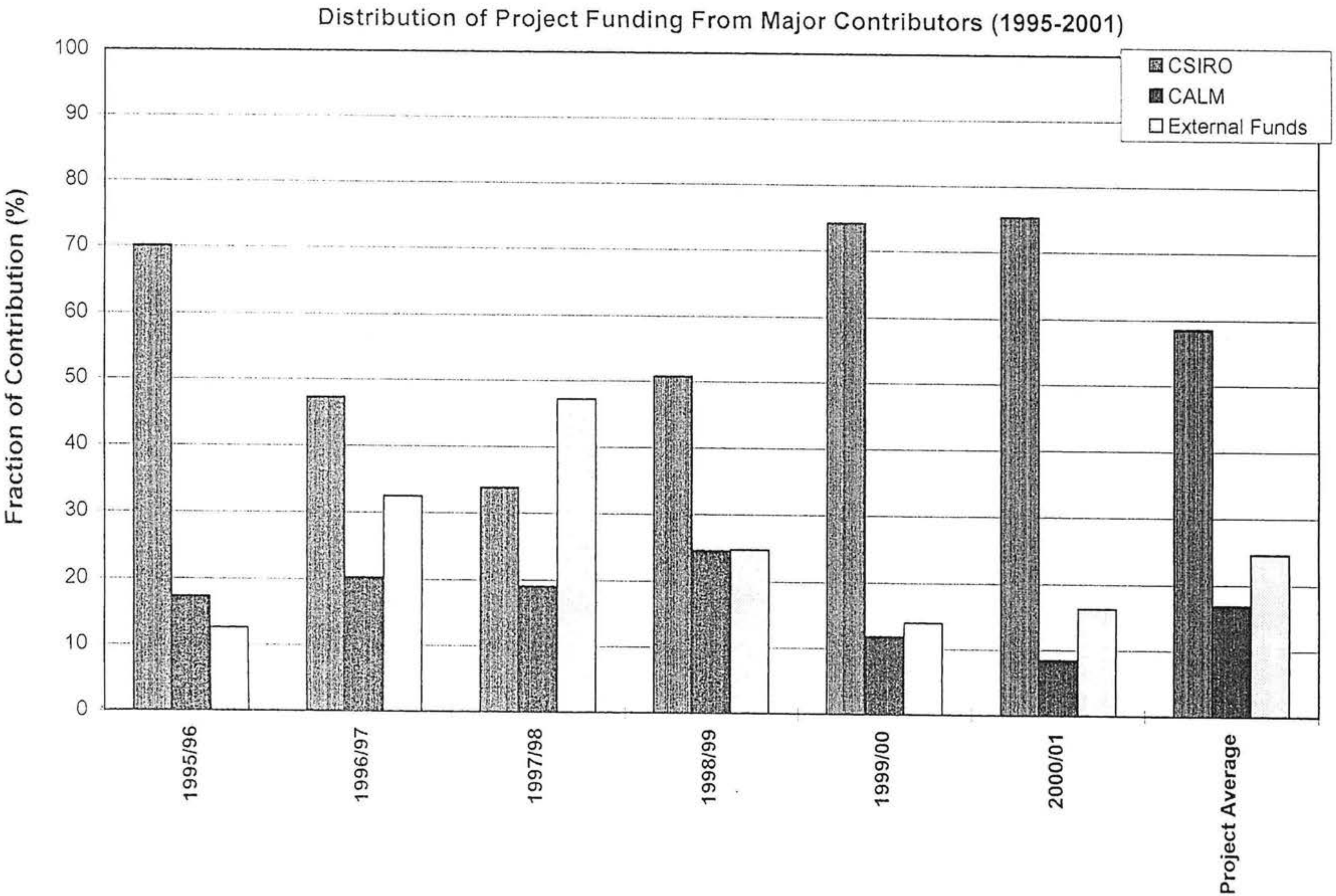
2. Construct experimental plots.
3. Hazard- reduce buffer strips and surrounds.

Burning experiments
1. Develop instrumentation to measure wind profiles under canopy, and other weather variables.
2. Evaluate equipment on pilot burns.
3. Undertake experimental burning program (summer 1998).

Analysis
1. Quantify fuel structure in representative forest fuels in eastern States.
2. Analyse wind profiles in-forest and wind structure over the terrain.
3. Analyse fire behaviour experiments and develop algorithms to predict fire behaviour from fuel load, fuel structure, fuel moisture, wind speed, and terrain variables.

Reporting
1. Update research proposals as negotiations and preliminary investigations proceed.
2. Prepare work plans for major field experiments.
3. Prepare preliminary and final reports.
4. Publish scientific findings.

Attachment 2



Attachment 1

Summary of Project Budget (1)

Contributions	1995/96 $,000	1996/97 $,000	1997/98 $,000	1998/99 $,000	1999/00 $,000	2000/01 $,000	**Cost 1996-2001 $,000**	**Total Project Cost $,000**
CSIRO Division of Forestry	327.2	365.7	476.6	352.2	401.6	421.7	**2017.8**	**2345**
WA CALM	80	156.3	267.8	169.6	63.1	47.1	**703.9**	**783.9**
Additional Support Required								
CSIRO Expenses	52.7	192.6	351.1	171.4	75.8	91.1	**882**	**934.7**
CALM Expenses	3.7	58.8	313.4				**372.2**	**375.9**
Total External Funds Required	**56.4**	**251.4**	**664.5**	**171.4**	**75.8**	**91.1**	**1254.2**	**1310.6**
TOTAL	463.6	773.4	1408.9	693.2	540.5	559.9	**3975.9**	**4439.5**

Note: (1) 1996-2001 cost are 1995/96 dollars adjusted 5 % per annum for inflation
(2) CSIRO received $42.5K grant from Austraila IDNDR committee to fund 1995/96 external requirements

Attachment 3

Proposed budget, expenses, contribution from CSIRO and CALM and grants required to fund the research project(1995-2001).

Expenses($000)	1995 / 96					1996 / 97					1997 / 98					1998 / 99				
	CSIRO	CALM	GRANTS		TOTAL	CSIRO	CALM	GRANTS		TOTAL	CSIRO	CALM	GRANTS		TOTAL	CSIRO	CALM	GRANTS		TOTAL
			CSIRO	CALM				CSIRO	CALM				CSIRO	CALM				CSIRO	CALM	
Salary																				
Direct salary	129.8	49.2	26.6		205.6	140.4	91.6	26.6		258.6	174.9	149.4	37.5		361.8	101.8	90.1	77.6		269.5
Salary on cost	37.5	6.0	7.7		51.2	40.6	11.1	7.7		59.4	50.5	18.1	10.8		79.5	29.4	10.9	22.4		62.7
Total Salary	167.3	55.2	34.3		256.8	181.0	102.7	34.3		318.0	225.4	167.5	48.3		441.3	131.2	101.0	100.0		332.2
Overheads	150.1	24.8			174.9	160.3	46.2			206.5	203.9	75.4			279.3	172.0	45.5			217.5
OHS	1.0				1.0	2.0				2.0	3.0				3.0	1.0				1.0
Operating																				
Project Proposal	8.8				8.8	5.0				5.0										
Site Preparation																				
Plot Layout								10.8		10.8										
McCorkhill Site									15.9	15.9										
Dee Vee Site									17.1	17.1										
BufferStrips																				
McCorkhill Site														14.1	14.1					
Dee Vee Site														15.7	15.7					
Fuel Sampling																				
Preliminary surveys			14.4	3.7	18.1			14.4	3.7	18.1										
Pre-burn surveys								22.9	18.5	41.4			22.9	18.5	41.4					
Post-burn surveys													36.4	12.6	49.0					
Pilot Study																				
Site Preparation								1.5		1.5										
Fuel sampling								6.0		6.0										
Experimental Fires								27.1		27.1										
Wind / Terrain Study																				
Travel													9.8		9.8					
Computing (WAsP)			4.0		4.0			3.0		3.0			4.0		4.0					
Maintenance								5.0		5.0			5.0		5.0					
Equipment								43.4		43.4			34.9		34.9					
Fire Behaviour																				
Casual Labour													15.8		15.8					
Overtime													10.0	20.0	30.0					
Travel													73.6	13.7	87.3					
Vehicles													17.8	17.9	35.7					
Maintenance								5.0		5.0			10.0	5.0	15.0					
Equipment								10.0		10.0			30.0	5.0	35.0					
Fire suppression														100.0	100.0					
Escape fire contingency														75.0	75.0					
Data Analysis																				
Travel																		18.1		18.1
Maintenance																		10.0		10.0
Equipment																		20.0		20.0
Total Operating	8.8	0.0	18.4	3.7	30.9	5.0	0.0	149.1	55.2	209.3	0.0	0.0	270.2	297.5	567.7	0.0	0.0	48.1		48.1
TOTAL	327.2	80.0	52.7	3.7	463.6	348.3	148.9	183.4	55.2	735.8	432.3	242.9	318.5	297.5	1291.3	304.2	146.5	148.1	0.0	598.8

Attachment 3 Proposed budget, expenses, contribution from CSIRO and CALM and grants required to fund the research project(1995-2001).

Expenses($000)	1999/00					2000/01				
	CSIRO	CALM	GRANTS		TOTAL	CSIRO	CALM	GRANTS		TOTAL
			CSIRO	CALM				CSIRO	CALM	
Salary										
Direct salary	135.3	31.9	26.6		193.8	135.3	22.7	26.6		184.6
Salary on cost	39.1	3.9	7.7		50.7	39.1	2.7	7.7		49.5
Total Salary	174.4	35.8	34.3		244.5	174.4	25.4	34.3		234.1
Overheads	155.5	16.1			171.6	155.5	11.4			166.9
OHS	0.5				0.5	0.5				0.5
Operating										
Project Proposal										
Site Preperation										
Plot Layout										
McCorkhill Site										
Dee Vee Site										
BufferStrips										
McCorkhill Site										
Dee Vee Site										
Fuel Sampling										
Preliminary surveys										
Pre-burn surveys										
Pilot Study										
Site Preparation										
Fuel sampling										
Experimental Fires										
Wind / Terrain Study										
Travel										
Computing (WAsP)										
Maintenance										
Equipment										
Fire Behaviour										
Casual Labour										
Overtime										
Travel										
Vehicles										
Maintenance										
Equipment										
Fire suppression										
Escape fire contingency										
Data Analysis										
Travel			18.1		18.1			27.0		27.0
Maintenance			5.0		5.0			5.0		5.0
Equipment			5.0		5.0			5.0		5.0
Total Operating	0.0	0.0	28.1	0.0	28.1	0.0	0.0	37.0		37.0
TOTAL	330.4	51.9	62.4	0.0	444.7	330.4	36.8	71.3	0.0	438.5