THE MINIMUM DATA SET AND INFORMATION NECESSARY FOR THE PREPARATION OF FIRE MANAGEMENT PLANS FOR NATIONAL PARKS AND CONSERVATION RESERVES

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SUMMARY

The approaches to fire management planning in national parks and conservation reserves have and are changing at the present time as the role of fire as a process in the conservation of our native biota is increasingly understood and appreciated. The change from a simplistic and at times inflexible fire management approach to scientifically based programs including planned burning regimes has been made possible by the development of predictive models which can integrate and manipulate detailed and very large data bases compiled for national parks and conservation reserves.

These data are foremost biogeographical, but individually they provide only limited input into the development of a fire management plan. An information set must be drawn from the integration of these data bases through modelling and overlay techniques. The minimum information set is that of fire behaviour prediction and the associated hazard and risk analysis, such that values at risk can be identified in terms of the extent, degree, frequency and regularity of potential impact.

Only when the above minimum data and information sets are compiled and generated on an holistic basis for a park or reserve, can sound and professional fire management plans be prepared.

INTRODUCTION

The science of fire management has a background of very conservative attitudes where changes in concepts and practices have occurred very slowly. This slow change has provided the opportunity for the development of entrenched concepts and ideas on fire management to the extent that many of the principles and practices of fire management today have little or no basis except that of experience and time. This is no more evident than with prescribed burning, now commonly referred to as hazard reduction burning or protection burning. The principles and concepts for such burning were developed in the 1950s, and little in the way of applications research has been undertaken since that time with respect to specific vegetation types or communities.

Prescribed burning has over the years been the core of all fire management plans and in some well documented plans is the only program. Fire management plans which are based on such a single objective program may be adequate for some commercial forestry and vacant crown lands, but are far too simplistic for implementation in natural areas set aside for conservation of the natural biota. The integration of conservation objectives with fire management objectives makes planning far more complex than that in other areas. To address the complexity of issues, managers must have available to them relevant detailed data on the natural resources which contribute to fire occurrence and behaviour, and the resources of value which may potentially be affected by a fire event.

Data Bases

Fuel

With the wide acceptance of prescribed burning for the reduction of combustible fuel in natural lands, and the consequent reduction in potential maximum intensities of a wildfire event occurring subsequent to a prescribed fire, a widespread belief has evolved which infers that all forest, shrub and grass land fuels over a perceived level pose fire hazards. It is undisputed that increasing fuel loads provide increasing fire intensities under a given set of weather parameters. However, similar fuel loads in different vegetation types may not have the same flammability, and hence potential, to generate similar fire intensities.

Where prescribed burning for fuel reduction is the major component of any fire management plan it is to be recognised that not all the vegetation types of a reserve may contribute to hazardous fuel levels or hazard fire situations. It is obvious that where such a perception is held a detailed knowledge of the fuel complexes of a reserve is essential to assist planning and to develop prescriptions for the weather conditions under which burning is carried out. The objectives of any planned burning, such as proportion of area to be burnt and the proportion of fuel to be removed, also need to be known.

The acceptance that fine litter fuels in excess of ten tonnes per hectare are a hazard makes two inaccurate assumptions. The first is that only the fine fuels contribute to the perceived fire hazard, and the second is the actual concept of hazard. To assess the potential contribution of fuels to a fire hazard situation all parameters which make up the fuel complex must therefore be considered.

Table 1
Components Of Fuel Complex

- Litter fall rate (tonnes per hectare per year)
- Proportion of litter in total fine fuel
- Proportion of grass and herbs in total fine fuel
- Proportion of 6 mm material in total fine fuel
- Proportion of shrub foliage in total fine fuel
- Proportion of shrub branchwood in total fine fuel
- Percentage cover of various strata
- Packing ratios of various strata
- Weight of dead material >6 mm and <25 mm
- Weight of dead material >25 mm and <75 mm
- Weight of dead material >75 mm

Terrain Features

Slope and Aspect

Slope has long been recognised as a major natural terrain element which makes a significant contribution to fire behaviour, its influence increasing with length of slope and steepness. The orientation of the slope to prevailing fire weather conditions controls the potential maximum influence slope has on fire behaviour, with the worst situation being the strongest winds prevailing directly up the steepest slope.

To accurately predict the potential maximum fire behaviour in terms of rate of spread (ROS) and intensity, the slopes must be defined within small slope class ranges. Such detail is readily acquired from the digitising of available topographic maps and aerial photographs. Aspect data can similarly be acquired from the above digitising and the minimum slope and aspect data set should be slope classes to five degrees extrapolated from twenty metre contours and integrated with eight aspect classes.

These combinations of slope and aspect are the minimum for reasonably accurate fire prediction, but more detail may be required in extremely dissected terrain such as in the Blue Mountains west of Sydney. The digitised data should ideally be extracted from the smallest contour interval available on the largest scale maps.

Topography

The influence of slope and aspect on fire behaviour is only predictable when other topographic features do not influence the prevailing wind conditions. In terrain which is very dissected winds are vectored and unexpected wind eddies and wind directions can occur during a fire event. Predicting these unexpected wind conditions is extremely difficult as they are a result of micro-scale topographic features. The more detailed the slope and aspect data the greater is the amelioration of the unexpected fire weather features. Detailed slope and aspect data integrated with elevation data also enable a topographic moisture sequence to be generated with respect to fuel moisture and vegetation.

Vegetation

In many fire management programs in the past it is evident that very simplistic vegetation data has been an input to fire prediction and the planning of fire management strategies. As prescribed burning has dominated fire management, forest and grassland fuels have been the major biological factor and input. With respect to fire the latter will continue in the future but it is to be recognised that the fuel complex is a function of the vegetation type, the species of the vegetation complex, the prevailing weather conditions and terrain. Too much acceptance has been made of the simple concept that Australian sclerophyllous vegetation contributes similar components, in similar time frames to the fuel complex of a forest. To determine or predict the fuel loads existing in forest, woodland, shrubland, or grassland, vegetation must firstly be classified and mapped as basic data. The vegetation formation classes must be further detailed by species association and structural types. For each species association a maximum potential fuel load can be calculated and fuel accumulation rates generated using terrain data as it affects the topographic moisture sequence.

Structural vegetation data are also necessary to provide for prediction of fire behaviour as both live and standing components of the fuel complex are consumed in a fire. The degree of physical impact or damage to the vegetation by a fire is partly determined by the structure of the vegetation.

The minimum vegetation data for fire prediction therefore are those which enable "fuels" to be determined and the physical impact of fire to be predicted. The actual detail or scale of vegetation data is a factor of the number of vegetation types or associations and their relationships to terrain features. In Morton National Park in New South Wales, for example, 98 vegetation associations occur in an area of approximately 200 000 hectares, but the fuel complexes can be accounted for in 12 fuel accumulation curves. Recognition of all vegetation associations is still required however, as the impacts of fires vary widely in all associations within the expected ranges of fire intensities.

Fire History

Wildfire events have generally been poorly documented in the past, with at best the gross area of a fire being mapped. As vegetation structural and species regeneration rates (and hence fuel accumulation rates) are a response to fire intensities, the latter must be accurately mapped both in the future and where possible for past fire events.

A minimum fire history data set is a record of all wildfire and planned fire events which have occurred within the life cycle of the oldest species of the vegetation. Such a record is required to model the influence of each fire event on the accumulation of fuels in each vegetation association, and to assess the past and potential impact of fire on vegetation trends. The limitations of the minimum fire history data set are obvious, the limitations on modelling only being minimised by the acquisition of very detailed resource data.

Historic Weather Data

Where prediction of fire behaviour is made in the planning of fire management strategies such as prescribed burning, hypothetical or the "prescribed weather conditions" are generally used. In many areas this may suffice as the minimum data set, but for accurate predictions covering large tracts of land such as a national park, the hypothetical weather set is inappropriate for the determination of management strategies.

Historic weather data sets are therefore the minimum required to provide an assessment of the likely potential of a prescribed weather set being met within the season or time frame in which planned burning is proposed. Historic data sets also provide for the generation of accumulative percentile weather conditions which are much more meaningful in selecting the prescribed conditions to implement a prescribed fire to meet prescribed objectives. Percentile weather data sets also provide for the prediction of the potential number of days during a fire season that a design day with respect to wildfire would exceed maximum manageable fire intensities. The latter is a more defined and accurate way of assessing planned or unplanned fire effects and in planning fire suppression strategies.

Table 2
Fire Analysis Using Historic Fire Weather Data
(Kosciusko National Park)

PERCENTILE	RATES OF SPREAD (M/MIN)			BYRAM'S INTENSITY (KCAL/M/SEC)		
	DOWN SLOPE	ACROSS SLOPE	UP SLOPE	DOWN SLOPE	ACROSS SLOPE	UP SLOPE
1	.0	.0	.0	0.	0.	0.
5	.0	.0	.0	0.	0.	0.
10	.0	.0	.0	0.	0.	0.
15	.0	.0	.0	0.	0.	0.
20	.0	.0	.0	0.	0.	0.
25	.0	.0	.0	0.	0.	0.
30	.0	.0	.0	18.	2.	63.
35	.1	.0	.2	23.	3.	85.
40	.2	.0	.5	31.	3.	116.
45	.4	.0	1.0	33.	4.	124.
50	.6	.1	1.8	66.	8.	254.
55	1.0	.1	3.0	112.	14.	436.
60	1.3	.1	4.0	116.	14.	455.
65	1.8	.1	5.6	120.	15.	472.
70	2.0	.2	6.4	131.	16.	514.
75	2.2	.2	7.0	142.	17.	557.
80	2.4	.2	7.6	154.	18.	603.
85	2.7	.3	8.5	166.	19.	649.
90	2.9	.3	9.3	190.	20.	735.
95	3.2	.4	10.2	218.	22.	834.
99	3.7	.4	11.7	253.	24.	962.
				357.	31.	1335.

Information Bases

Detailed natural resource data bases are essential for accurate prediction of planned and unplanned fire behaviour, these predictions then being used to carry out regional hazard and risk assessment. Hazard and risk assessment is thus the dominant component of fire management planning as it draws upon elements of fire behaviour, impacts on vegetation and the location relative to fire potential of resources of value (viz life, property, cultural, biological and landscape features).

Site Specific Hazard and Risk Assessment

As all land management agencies have statutory obligations to life and property under Bush Fire Acts or equivalent legislation, the assessment and quantification of hazards becomes an essential component in fire management in natural lands, particularly where they adjoin urban and rural/urban areas (eg Blue Mountains, New South Wales; Adelaide Hills, South Australia; Dandenong Ranges, Victoria; Darling Ranges, Western Australia).

Hazards in this context are not singularly identified in terms of fuel loads exceeding a pre-conceived level (viz ten tonnes per hectare), but include the relationship between sites of high intensity fire, the distance from sites or

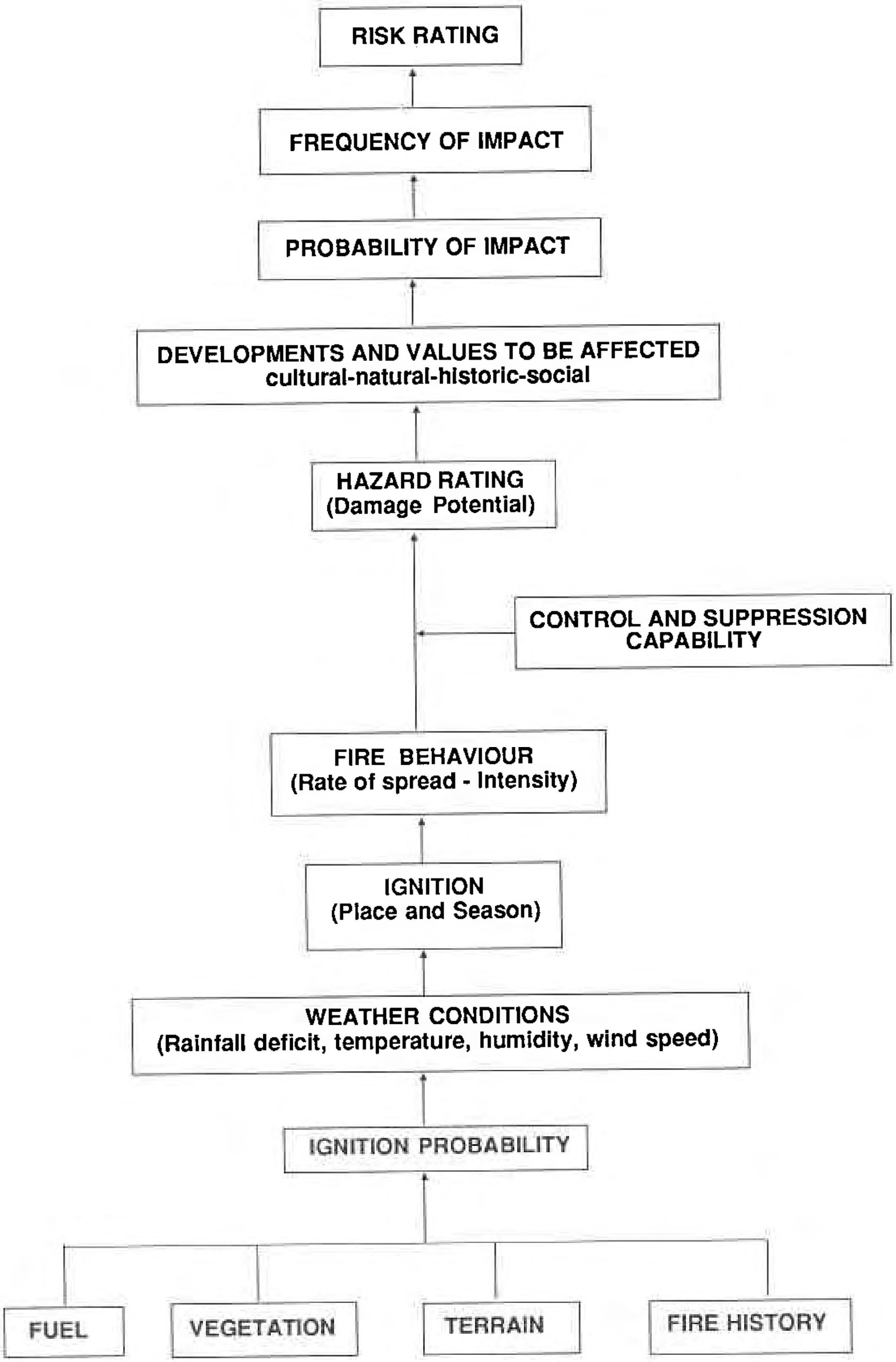

FIGURE I
Hazard And Risk Assessment Process

features of value, the potential rate of spread of a fire and the suppression capability of the land management agency on whose land a fire occurs.

The risk assessment component of the program recognises the economic and biological value of the resources and features which may be impacted by fire. It is to be recognised in fire management planning that in any one fire not all areas of the fire pose the same threat, even though the hazards may be similar. This applies even when the hazard is deemed to be fuel loads exceeding the ten tonnes per hectare level. Risk rating also includes prediction of the potential occurrence of wildfires and the regularity of occurrence at any site.

The determination of whether a fire poses an acceptable or unacceptable risk is of course subjective. Managers must identify the level of risk a development or feature of value can be exposed to and the limits of risk they are prepared to accept as the planning and management authorities (Kessell and Good 1985).

"Hazards" do not exist as static factors but are continually changing as a response to weather, fuel, public expectation and demands on the land and so on. Similarly the hazards change spatially requiring a dynamic approach to hazard and risk assessment to be made through the integration and manipulation of the data bases considered above (Figure 1).

The minimum information from such a program is thus site specific fire behaviour related to features of value and identified by a distance and time component from the fire site(s) to the site of potential impact. A case study of the use of such a program is outlined in the paper by Worboys and Gellie in these proceedings.

Legislation

As noted previously, all bushfire management is constrained by the relevant bushfires legislation in each State, but more recent environmental legislation (eg New South Wales Environmental Planning and Assessment Act), has had a greater influence on the wider program of fire management which encompasses impacts and effects on the environment.

Part V of the New South Wales Act, for example, imposes upon land management agencies the requirement to give detailed consideration to the environmental consequences of any management activity, and in assessing the likely consequences of fire management the following must be taken into account.

"Any activity that may cause:

- any environmental impact on a community
- any environmental impact on the ecosystems of the locality
- a diminution of the aesthetic, recreational, scientific or other environmental quality or value of a locality
- any effect upon a locality, place etc of special value for present and future generations

- any endangering of any species of native biota
- any long-term effects on the environment
- any degradation of the quality of the environment
- any risk to the safety of the environment
- any curtailing of beneficial uses of the environment
- any pollution of the environment
- any cumulative environmental effects."

To address these areas of assessment it is obvious that detailed data as considered above are required to enable an assessment of the significance of any fire management activity as an impact on the environment. It is important to note that an environmental impact statement will not necessarily be required but it does mean that a detailed assessment is carried out as a minimum.

Environmental Legislation and Prescribed Burning

Due to the various concepts of prescribed burning and the many conflicts over such burning in conservation areas, the requirements and obligations of the E.P. and A. Act have been applied more to this activity than any other fire management strategy.

It is contended by some authorities that the Act is an imposition restricting the use and implementation of prescribed burning as a strategy in fire management. It has also been inferred that managers of nature conservation lands use the Act to justify the limited use of prescribed burning in national parks. Taken in the correct context this is true to some degree as the widespread use of prescribed burning for the singular objective of fuel reduction is not now carried out in the national parks in New South Wales (Good 1985).

The E.P. and A. Act has not imposed this restriction but simply reinforced what managers have for some years identified; that hazards and risks are site specific requiring site specific hazard reduction. What the Act has virtually imposed is the need to collate and integrate detailed site data and carry out detailed hazard assessment. The Act has thus contributed to the resolution of conflicts over the use of prescribed burning and has ensured that fire management is now planned on a sound knowledge of the very resources for which conservation reserves have been established to preserve.

Table 3 provides guidelines to the fire management activities likely to have an impact on the environment and to which the requirements of the E.P. and A. Act apply with respect to fire management.

Ecological Data

There is an obvious requirement for an appreciation of a minimum level of ecological data in the preparation of a management plan, but what constitutes a minimum is impossible to define in general terms. The minimum level for any one plan will be that which provides an appreciation of the role of fire in a park for which a plan is being prepared. The ecological role of fire and the responses of native biota to planned and unplanned fire have been documented in many case examples and ecological guidelines must be developed from these. The minimum ecological information may be considered as a detailed knowledge of the general responses of the vegetation complex to a fire regime(s) and the post-fire vegetation/habitat trends.

Social, Economic and Cultural Information

Fire management in national parks is largely constrained by social, cultural and economic issues and not ecological conflicts. Sound fire management planning must therefore be regionally based encompassing rural and urban lands adjoining a park and which are potentially under threat from a fire event in the park.

It is often said that park management is as much a social and economic issue as one of ecological resource management and this is very much the situation in fire management. If managers are not conversant with the "local" bushfire issues the local politics can destroy the best endeavours of ecological fire management in the wider spheres of the park. Leaver, and Worboys and Gellie in their respective papers in these proceedings note in detail this aspect of fire management.

A minimum information base in this context is therefore an appreciation of local attitudes to reserve fire management, an assessment of potential impacts of fires on life and property at the park and urban/rural boundary, and an involvement of the local community in co-operative fire management. The latter would generally only extend to co-operative suppression planning and implementation.

CONCLUSION

The minimum resource data required for sound and professional fire management planning can be readily identified as those which contribute to fire occurrence and behaviour and those which may be affected by fire, including both the native biota and the built environment. The link between the two is achieved through detailed hazard and risk assessment programs; these programs drawing upon both natural resource data bases and social, economic, cultural and legislative information.

The core issue in fire management remains that of prescribed burning and until a more rational and flexible approach is taken to it through the identification and quantification of the specific hazards and risks all other ecologically based fire management objectives will be compromised and never met. Inflexible programs with singular objectives such as prescribed burning for the reduction of perceived hazard levels of fuel are inappropriate in national park management except where hazard and risk assessment identifies sites where obligatory hazard reduction with respect to wildfire intensity exists. On the other hand the general public has been brought up on the concept of prescribed burning as the panacea of protection for life and property, so managers must sell their concepts of fire management including planned burning to the wider community. To achieve this the manager of national parks must acquire and draw upon all available resource data and information, such that complex ecological fire management objectives can be met and not be compromised by obligatory requirements for "protection" of life and property.

Table 3
Fire Suppression And Mitigation Activities To Be Considered In Terms Of The NSW Environmental Planning And Assessment Act

ACTIVITY	NATURE OF ACTIVITY
Wildfire Suppression and Control	Containment using:- Hand tools Earthmoving equipment Aerial or ground based chemical retardents Backburning/burning out * Inactive containment using natural barriers
Mitigation	
- Pre suppression and fuel reduction activities	Aerial and ground based fuel reduction by burning Manual fuel removal and modification Provision of non-fuel areas Modification of the vegetation and fuel complex - planting of other species etc.
FireTrails	Construction and maintenance of fire trails for:- firebreaks suppression access physical separation of vegetation and features threat of fire occurrence physical barrier to the spread of fire ignition sites
Planning controls	Land use controls and monitoring activities.

* this containment strategy infers a degree of "do nothing approach" which under the EP and A Act is still deemed to be an activity required to be assessed for potential impact.

REFERENCES

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Kessell, S.R. and Good, R.B. (1985). Technological advances in bushfire management and planning. In: *Proceedings 9th Invitation Symposium - National Disasters in Australia.* (Ed M.F.R. Mulcahy) pp 323 - 344. Academy of Technological Sciences, Parkville, Victoria.

Appendix I
Basis Of A Fire Management Plan

1. General objectives of fire management
2. Management responsibilities and the statutory context
3. Summary list of park values
4. Vegetation and fuel descriptions
5. Terrain descriptions as they influence vegetation, fuel and fire behaviour
6. Weather data descriptions as they influence fire behaviour and fuel moisture
7. Vegetation and habitat trend objectives
8. Fire effects on the physical and biological environment
9. Fire effects on the social environment
10. Review of fire management techniques
11. Concepts of hazard
12. Management strategies to meet defined objectives and site specific fire regimes
13. Hazard and risk assessment
14. Objectives of planned burning
15. Fire management as an activity under the Environmental Planning and Assessment Act
16. Environmental assessment of fire management