Ecological Fire Management in North East Victoria.

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ABSTRACT

In 1998, the Department of Sustainability and Environment (DSE) and Parks Victoria (PV) formed a State-wide Fire Ecology Working Group tasked to review ecological burn planning and implementation across the State (DNRE, 2002). An outcome was the development of a scientific framework to guide ecological burning on public land entitled '*Guidelines and Procedures for Ecological Burning on Public Land in Victoria 2004*'. This document sets out a framework for combining life history characteristics and vital attributes of key fire response plant species to determine maximum and minimum time frames between fires. Also included is an analysis of age-class and spatial distribution of the ecological vegetation communities (EVC's) within a landscape in order to identify areas that need protection or exposure to fire for the purpose of ecological outcomes.

Utilizing this scientific framework, five landscape scale Ecological Fire Management Strategies have been developed for the Northeast Region (Victoria). The key products of these strategies are fire regimes for vegetation communities and a candidate burn map outlining areas to be included or excluded from prescribed burning. However, due to the lack of vital attribute information and inconsistencies with life history, vegetation communities known to be sensitive / intolerant to fire were being identified as candidate areas to burn.

An opportunity to solve this dilemma was identified. Through planning with other ecologists, broad EVC Fire Response Categories' were used to define Fire Dependent, Fire Influenced, Fire Sensitive and Fire Independent vegetation communities. These fire response categories are similar to those outlined by R. L. Meyers (2006) in the Nature Conservancy Global Fire Initiative Report.

Along with the Candidate Burn Map, EVC Fire Response Categories' can assist with prioritising vegetation communities to be included in the ecological burning program. Fire Dependent vegetation communities are defined as favourable for inclusion in the ecological burning program. Fire Influenced vegetation communities require a site visit to determine if a prescribed burn can enhance vegetation quality. Fire Sensitive vegetation communities are to be isolated from the prescribed fire program where possible and managed through natural wildfire occurrences.

Key Words

Fire Ecology
Fire Regimes
Age-class Distribution
Vital Attributes

1. BACKGROUND

Historically fire management in Victoria has focussed primarily on managing for wildfire events and protecting assets across the landscape. In recent times land and fire managers have recognised the need for the ecological application or exclusion of prescribed fire for the purpose of maintaining biodiversity. However, as with the rest of Australia our knowledge of fire and its role in the ecosystem is still rudimentary.

During the 1980's the State Government of Victoria realised there was a lack of knowledge regarding the ecological impacts of fire, in particular the impact fuel reduction burning has on biodiversity (Fire Ecology Working Group, 1999). Towards the end of 1994 the development of the Victorian *Code of Practice for Fire Management on Public Land* (DNRE, 1995) outlined to land managers that they must integrate fire and ecological management by developing appropriate fire regimes for native flora and fauna. In 1998, the Department of Sustainability and Environment (DSE) and Parks Victoria formed a State-wide Fire Ecology Working Group. This group was tasked to address appropriate fire regimes and ecological burn planning and implementation across the State (Fire Ecology Working Group, 2002). An outcome was the development of a scientific framework to guide ecological burning on public land titled '*Guidelines and Procedures for Ecological Burning on Public Land in Victoria 2004*'.

The *Guidelines and Procedures for Ecological Burning on Public Land in Victoria 2004* (the Guidelines) sets out a scientific framework for combining life history characteristics and vital attributes of key fire response plant species to determine maximum and minimum time frames between fires (tolerable fire frequency). Also included is a method for the analysis of age-class and the spatial distribution of ecological vegetation communities within a landscape in order to identify areas that need protection or exposure to fire to improve ecological outcomes. These guidelines have yet to include a framework for applying fauna fire regime needs into our determination process.

The best method for application of this scientific framework during prescribed burn planning is through the development of Ecological Fire Management Strategies. Currently in north-east Victoria there are 5 strategies in use or at draft stage, and they are proving their worth when it comes to planning prescribed burns. However, they are still working documents and techniques are currently being developed to tackle information gaps and / or errors in the development stages.

2. Ecological Fire Management Progression in North East Victoria

Key Components to Strategy Development

Ecological Fire Management Strategies are currently in use in Victoria, particularly in the north-east, to prioritise areas across the landscape where fire either needs to be introduced or excluded for the purpose of achieving desired ecological outcomes (DSE, 2006). These strategies are considered working documents that provide the relevant land manager with key features, which include:

- Ecological Vegetation Class maps;
- Ecological Vegetation Class fire tolerable interfire periods;
- Fire History Maps;
- Candidate Burn Maps used to highlight areas available or to exclude from prescribed burning; and
- Annual Ecological Vegetation Class (EVC) burn targets.

Ecological Fire Management Strategies are developed for a Landscape Management Unit (LMU) generally less than 250, 000 hectares in size (Fire Ecology Working Group, 2003). Each Land Management Unit (LMU) contains areas of contiguous vegetation that can carry a wildfire. LMU boundaries are determined by local geographical features such as rivers or ridgelines and infrastructure, such as roads.

The development of an Ecological Fire Management Strategy follows eight steps illustrated in Figure 1. During the Land Management Unit (LMU) selection process steps 1-3 are combined and once approved, steps 4 & 5 begin the analysis of Ecological Vegetation Class (EVC) age-class distribution across the landscape.

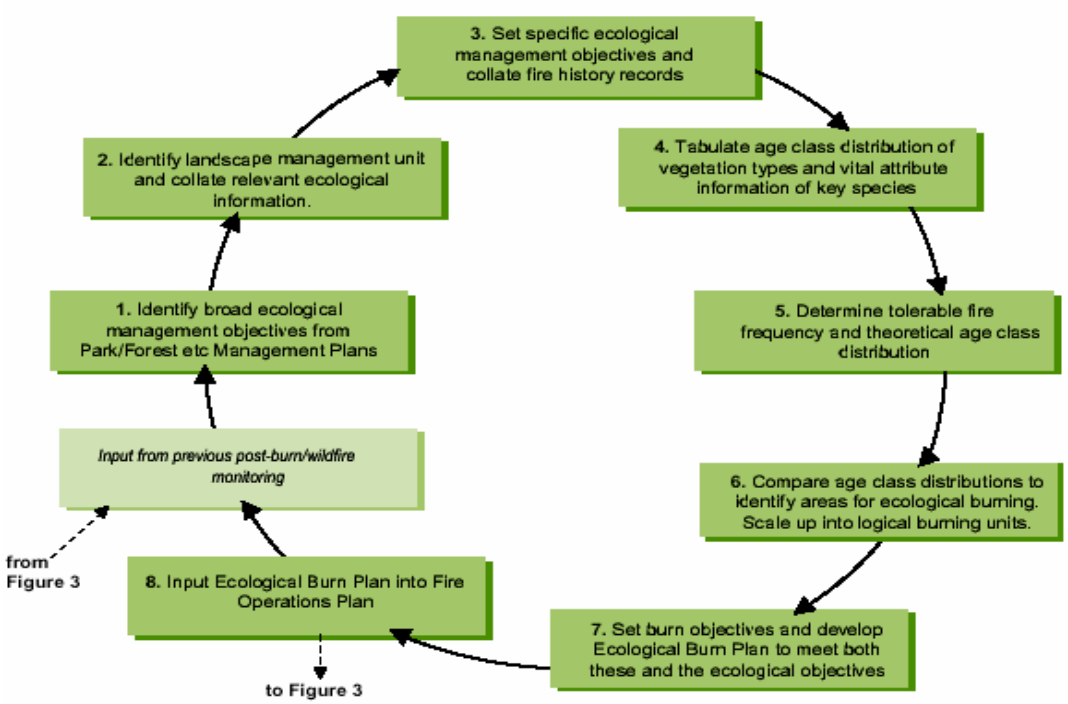

Figure 1. *Ecological Burn Planning – Biodiversity Conservation Components* (Fire Ecology Working Group, 2004)

The step by step procedure in Figure 1 is explained further in a number of documents. Three in particular include:

- *Guidelines and Procedures for Ecological Burning on Public Land in Victoria 2004*
- *Developing an Ecological Burning Strategy – A Practitioners Manual (2003)*
- *An Objective Basis for Ecological Fire Management in Victoria (Tolhurst, K. & Friend, G. 2003).*

Plant Species Data Collection for Determining EVC Key Fire Reponses Species

Step 4, Figure 1, involves collecting and collating EVC plant species information using both flora survey databases and an on-ground plant species assessment. The on-ground species assessment component is important since existing databases supply only point data and in most cases do not supply all species information for a LMU.

Descriptions of vegetation structure and floristic assemblages are described in Victoria by Ecological Vegetation Classes, or EVC's. They are not based primarily on floristic composition and diversity of species, instead the main classification component is percentage of cover of life forms. Through aerial photographs and ground-truthing, also taking into account soils, landform and species composition, EVC's have been mapped as a spatial layer (Walsh, T. V., & Williams J. E., (eds) 2005).

Collecting species presence data in the field involves ground-truthing three examples of each of the mapped EVC units within an LMU and producing a list of native plant species for each EVC. Combining the flora survey database and collected data, a detailed species list can be developed for each EVC within the LMU.

Combining the recently developed EVC species list and the fire response database, key fire response species can be determined using a similar method to that described by Noble & Slayter (1980). Key fire response species are species within an EVC with vital attribute characteristics that suggest they will be affected by either too frequent or too infrequent fire (Walsh, T. V., & Williams J. E., (eds) 2005). The life history details for key fire response species, such as the juvenile, maturity and seed lifespan periods, are used to determine minimum and maximum interfire periods for EVC's. These minimums and maximums determine the tolerable interfire period for each EVC type within the LMU.

Landscape Tolerable EVC Fire Regimes – limitations in the determination process

Step 5 requires a tolerable fire frequency to be determined for each EVC occurring within the LMU. In the northeast, season, fire intensity and scale of a prescribed burn have also been included to determine tolerable

EVC fire regimes. An EVC fire regime aims to determine the appropriate frequency of fire occurrence within vegetation communities across a landscape (Cawson, J. & Muir, A., 2006).

A fire regime includes a species tolerable minimum and maximum fire application period, or *Minimum and Maximum Interfire Period* as referred to in this paper. The minimum interfire period is determined using a key fire response plant species tolerant of competition. This species has the longest juvenile life span compared to the other tolerant species within EVC. A maximum interfire period is determined by selecting a key fire response species intolerant of competition. This species has the shortest life span compared to other intolerant species in the EVC.

Currently in south eastern Australia there are two fire response databases, which include vital attribute and plant life history information, available for determining minimum and maximum interfire periods. These are:

- the Victorian Vital Attribute Database, developed by Kevin Tolhurst (Uni Melb) and David Cheal (Arthur Rylah Institute,ARI), and
- the National Vital Attribute Register, held by Dr M. Gill (Gill & Bradstock, 1992).

Due to the recent creation of these fire response databases, vital attribute and life history information provided in these databases is often conflicting or information is absent for particular species similar to what was inferred by D. Cheal (2004). Depending on what species are present in an EVC, gaps in the databases can sometimes prevent the determination of minimum or a maximum interfire period EVC, following the method of Noble & Slayter (1980), within the Victorian High Country.

Fire can impact on EVC's differently depending on their biotic and / or abiotic components. The same EVC type located at different ends of the LMU can also experience differing impacts from fire. For a theoretical example, a Herb-rich Foothill Forest EVC includes plant species that may have a shorter life span at 300 metres in altitude compared to those living in a climatically and structurally different environment at 700 metres altitude. However, for fire planning purposes, this Herbrich Foothill Forest EVC is assigned the same fire regime across the landscape without consideration for changes in altitude.

It is widely documented that fire regimes are an important factor in the survival of plant and animal species (Allan, E. G., 2005, Whelan, R. J., *et al,* 2002). They are complex and difficult to define spatially particularly when trying to include other environmental influences, such as fire response of fauna, climatic variables, timber harvesting, and environmental pests. This dilemma relates in particular to the Victorian alpine area where there are at least two main disturbance regimes;

- fire regimes, which have been altered due to cattle grazing practices, and
- climatic regimes, such as rainfall/drought and snow

To date we have yet to properly understand the linkages between these two regimes (Wahren, H. *et al*, 2003).

Overcoming the above and identifying the need to account for other environmental influences when determining EVC fire regimes requires a substantial knowledge of native plants and EVC structure. Land and biodiversity managers must also ensure that the EVC fire regimes do not contradict current policy or management programs. In the north-east we decided to view these dilemmas as an opportunity to build on existing processes.

Northeast Broad EVC Fire Response Categorisation Development

As mentioned previously, an opportunity arose in the northeast region of Victoria to address fire regime determination dilemmas and to develop a means by which to clearly describe EVC fire regimes. Through a detailed literature search, and consultation with regional and state staff with floristic knowledge, four broad EVC fire response categories were established and are currently being applied to burn planning in the northeast. The broad EVC fire response categories were selected from *Living with Fire – Sustaining Ecosystems and Livelihoods through Integrated Fire Management* (Myers, R. L., 2006).The category definitions have evolved from those defined by R. L. Myers (2006) to include management aims and objectives in northeast Victoria.

The EVC Fire Response Categories are defined as follows:

Fire Dependent.

Fire Dependent EVC's are those where fire is an essential part of EVC development and the benchmark / key fire response species have evolved adaptations to respond positively to fire and to facilitate fire spread.

Fire Influenced.

This category includes EVC's that lie within the transition zone between Fire Dependent and Fire Sensitive EVC's. The EVC's in this fire response category contain plant species that are generally sensitive to fire but they also include some plants that respond positively to fire. This category also includes vegetation types where the response of benchmark / key fire response species have not been fully documented and/or the role of fire in maintaining biodiversity is not entirely understood. Herbrich Foothill Forest EVC, discussed previously in this paper, is an example of a Fire Influenced EVC.

Fire Sensitive.

Fire Sensitive EVC's have not evolved with fire as a significant re-occurring process. Plant species existing within this EVC category lack adaptations to positively respond to fire and species mortality is high even if fire intensity is low.

Fire Independent.

Fire normally plays little or no role in ecosystem maintenance due to being to wet, not enough consumable fuel or to patchy to burn. Examples of such ecosystems in Victoria are temperate rainforest, true alpine (snow patch & alpine bog communities) and the very dry sandy desert-like vegetation communities of the mallee.

A regional workshop conducted on the 30th November & 1 December 2006 delineated the EVC fire response categories and began the process of categorising each EVC in north-east Victoria. The process for categorising EVC fire response involved key regional and state staff with an understanding of the fire requirements for particular EVC's within the northeast. This process included two parts:

Part 1. Collection and analysis of background EVC information.

- Included developing a list of all EVC's occurring in the northeast;
- a brief description of key/benchmark plant species inhabiting these EVC types, also included a list of key fire response species and the determined EVC fire frequency;
- an analysis of key/benchmark plant species to determine proportions of species in each EVC sensitive or not requiring fire for regeneration;
- identification of other EVC disturbance regimes (e.g. seasonal - flood, drought, snow etc);

Part 2. Group delineation of each EVC to a fire response category.

Using the information from part one, each EVC was discussed by the group and a fire response category was assigned to each EVC taking into account:

- Average EVC fire cycle - <29 years = Fire Dependent; 30 – 40 yr's = Fire Influenced; 40+ yr's Fire Sensitive.
- Other disturbance regimes and how often they occur.
- Lack of knowledge regarding fire effects, towards plant species and fauna occurring within the EVC.

The end result was the grouping of each discussed EVC into a fire response category. The following table illustrates the outcome of this process.

EVC	EVC Name (2)	EVD	Minimum Interfire Period	Maximum Interfire Period	Average Fire Cycle	Fire Response Category (D=dependent, I=influenced, S=sensitive), Ind=Independent
18	Riparian Forest	Riparian (high rainfall)	10	80	40	I
20	Heathy Dry Forest	Grassy/Heathy Dry Forest	5	45	20	D
21	Shrubby Dry Forest	Grassy/Heathy Dry Forest	5	45	20	D
23	Herb-rich Foothill Forest	Foothills Forest	10	60	30	I
30	Wet Forest	Wet Forest	25	150	70	S
31	Cool Temperate Rainforest	Rainforest	45	>150	>60	Ind

Table 1. Northeast EVC Fire Regimes and Fire Response Categories. Assistance with determining EVC fire response categories was provided through a workshop including biodiversity, land and fire managers and finalised by Principle Scientist (ARI) David Cheal.

Burn Unit Selection Process for Ecological Fire Management Zones (or Fire Management Zone 3)

Applying the broad EVC Fire Response Categories occurs during both the landscape EVC age-class determination and burn unit selection phases. The landscape EVC age-class determination, or step 7 in Figure 1, involves the development of a Candidate Burn Map, illustrated in Figure 2, through the analysis of historical fire occurrences within each EVC in the LMU. The first part of this analysis is completed to determine time since last disturbance and the amount of EVC in hectares (ha) disturbed. This analysis provides an actual representation of EVC age within the LMU.

The second part involves comparing the actual age-class with the theoretical age-class. The theoretical age-class is a theoretically desirable EVC age-class which should provide the optimal diversity in age structure across a landscape management unit (Fire Ecology Working Group, 2003). The outcomes of this comparison are best viewed using a Candidate Burn Map. Regionally determined Fire Sensitive EVC's are transposed as a GIS layer on the Candidate Burn Map and applied as a filter, illustrated in Figure 2.

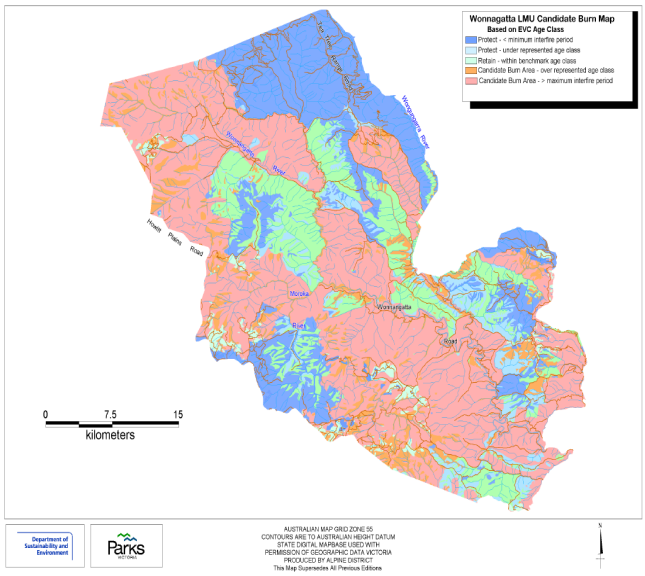

Figure 2. Landscape Management Unit Candidate Burn Map

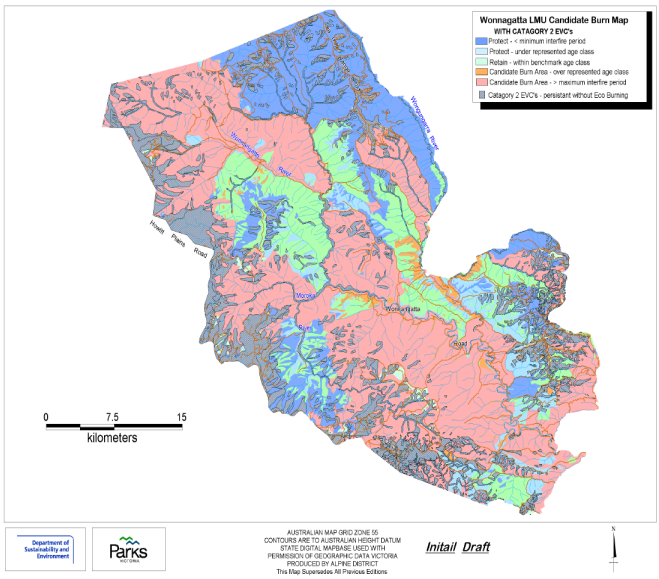

Figure 3. Candidate Burn Map with Fire Sensitive EVC's (Cat2 EVC's) filter applied.

The method for selecting a burn unit from the Ecological Fire Management Strategy includes:

1. Establishing the types of EVC's identified as candidates or available to burn on the Candidate Burn Map by using the LMU EVC map.
2. Use the EVC fire response categories to determine:
    a. Fire Dependent – proceed to 3.
    b. Fire Influenced – requires ground-truthing to determine wether the treatment of fire is needed to maintain the EVC structure and/or key fire response species.
    c. Fire Sensitive – are to be isolated from prescribed fire program where possible and left for a natural wildfire event.
    d. Fire Independent – EVC's determined not to be suitable for prescribed burning and to be protected during a wildfire event.
3. Define the specific objectives of the burn and check that they complement the objectives set out in relevant Parks & Forests Management Plans.
4. Identify any compounding issues, such as weed infestations after fire, and consider their response to fire.
5. Ensure that the requirements of any threatened species and/or community Action Statements/Recovery Plans are addressed (*refer to threatened species maps in the appendices*).
6. Include conditions needed to protect specific values within a burn area (e.g. damp gullies, habitat trees, or soil erosion).
7. Conduct the prescribed burn in accordance with the approved burn plan. Record the environmental conditions on the day and map the amount of burnt area.

8. Monitor the response of key fire response species and other attributes identified in the burn objectives. Refer to current state pre and post burn monitoring protocols.

3. Future Directions for Ecological Fire Management in North-eastern Victoria

Fire Severity Mapping

Fire severity mapping is important for determining whether to use the stand replacement tolerable interfire period or the low intensity tolerable interfire period, illustrated in Table 1. Most fires, wildfire or prescribed fire, are given a mapping polygon outlining the burn boundary, which excludes information regarding the actual fire affected area. It is widely documented that fire burns in mosaics of severity and/or patchiness depending on such factors as the overall fuel hazard, season and vegetation structure.

Accurate fire severity mapping, when supported by ground-truthing, is obtainable in areas affected by smaller wildfire events. Accurate fire severity mapping of larger fire events including the 2003 Alpine Fire Complex or the Great Divide Fires of 2006-2007 has proven very difficult as current techniques may not fully capture all areas of fire severity. The ability to accurately map fire severity within fire affected areas continues to be a challenge but will hopefully become a key part the fire mapping process in the future.

Fauna Vital Attributes

Victoria is in the process of building a detailed Flora Fire Response Database and a Fauna Fire Response Database will follow. Combining flora and fauna fire response information would be a challenge but fauna life history themes and attributes still need to be developed (DSE, 2006).

In March 2006 a Fauna Vital Attributes Workshop was conducted to discuss the possibilities of combining fauna vital attributes into the fire regime determination process. From this workshop an idea of using a holistic approach by combining the use of floristic key fire response species data, particularly those required for sustaining native fauna, with fauna habitat requirements. EVC names would still be used to classify habitat types. However, instead of using plant species specific succession, EVC succession stages, or Habitat Seral Stages would be used.

The Victorian Department of Sustainability and Environment (DSE) is investigating this workshop outcome and will be committing more effort towards the future development of this project.

Monitoring

There is a recognised need for monitoring the ecological effects of pre and post prescribe burning in Victoria (Cawson & Muir, 2006). For the majority of prescribed burns planned, ecological effects monitoring is not yet part of the burn plan. However this may soon change with the recent completion of state-wide flora monitoring protocols.

Monitoring of the ecological effects of wildfire and prescribed fire is particularly critical for filling in the gaps existing in the fire response databases. Pre and post fire monitoring is also the final step in the Ecological Fire Management Strategy development process. The recent development of *Fire and Biodiversity Monitoring Protocols for Flora (June 2007)* will enable a consistent approach to fire response monitoring of plants species across Victoria.

At present across the state there are monitoring trial plots set up to test the application of the state monitoring protocols'. The next steps are integrating these protocols as part of the burn plan and then transferring this captured information into the Fire Response Databases.

4. Conclusion

On–ground application of ecological fire management is still in the developmental stages in north-eastern Victoria. The methods outlined in previous sections have allowed land, fire and biodiversity managers to implement the scientific framework outlined in the *Guidelines and Procedures for Ecological Burning on Public Land in Victoria 2004*. This is being completed through the use of five Ecological Fire Management Strategies, which in recent years have been available for use in the northeast.

The dilemmas with EVC Fire Regime determination have been seen as a chance to further develop fire ecology application methods in the northeast. The dilemmas revolve around determination of EVC minimum and maximum interfire periods. Information gaps in the available Fire Response Databases, use of only two

species within the vegetation community to determine the tolerable interfire period and the complexities with determining fire regimes lead to the development of broad EVC Fire Response Categories.

There are presently four broad EVC Fire Response Categories in use in northeast Victoria. They have been developed using descriptors developed by the Global Fire Initiative and documented by R. L. Myers (2006) in *Living with Fire – Sustaining Ecosystems and Livelihoods through Integrated Fire Management.* These categories are; Fire Sensitive; Fire Influenced; and Fire Dependent.

A workshop was held for regional biodiversity, land and fire managers to categorise each EVC into one of the broad Fire Response Categories. EVC's where categorised according to their average fire cycle and dependence on fire for ecosystem maintenance. Also a process was developed for applying the use of the EVC fire response categories to the burn planning process.

There are three courses of action emerging for ecological fire management in Victoria, which should help further the accuracy of the use of ecological fire planning. These future directions will be refined through current trials and practical on-ground application within the coming years.

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