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FIRE AND BIODIVERSITY IN VICTORIA – DISCUSSION PAPER

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On the 24th and 25th October 2011, the Victorian National Parks Association and the Royal Society of Victoria jointly held a symposium: *Fire and Biodiversity in Victoria*.

The symposium was to build on the information garnered by the 2009 Victorian Bushfires Royal Commission, in response to the statement in the Commission's Final Report:

'**The Commission notes that the decline in the health of Victoria's ecosystems – which has not been helped by the decline in the quality and maintenance of biological information – is having a deleterious impact on planning for community safety**.'

The symposium aimed to resolve three questions:

- What do we know about fire and biodiversity in Victoria?
- How should we design management burn prescriptions for biodiversity?
- How should we design research and monitoring programs to improve management of fire and biodiversity?

The following notes summarise issues raised and recommendations made in the symposium's discussion periods, which were open to all attendees. On some occasions, topics that were relevant to the three questions were discussed after individual papers and are also included here.

DISCUSSION A

Current knowledge, and knowledge gaps, for fire and biodiversity in Victoria.

Discussion led by Andrew Bennett, Deakin University.

Panel:

- Sapphire McMullen-Fisher, University of Tasmania
- David Morgan, University of Melbourne
- Tom May, Royal Botanic Gardens Melbourne
- Malcolm Gill, Australian National University
- Beth Gott, Monash University.

Biodiversity, essentially the variety of all life forms, includes the genetic diversity of plants, animals and other organisms, species diversity, and ecosystem diversity (the variety of ecological communities and their supporting processes).

First we have to decide what we need this knowledge for. Is it to prevent or avoid the extinctions of species, is it a process of minimising injury, or is our task to enhance biodiversity in ecosystems across Victoria? We need to establish what our benchmark for biodiversity is, and how we create that for particular ecosystems.

Given that management decisions have to be made now, we have to articulate the most useful knowledge we currently have for informing management decisions.

Victoria's statewide quadrat database is a very useful tool. Though many records are now quite old, the database remains particularly relevant for vascular plants. It is important to continue with the database, and to increase resources for its management.

We have good information on the fire responses of many vascular plants, and useful assessments of the minimum and maximum fire tolerances of communities expressed as Ecological Vegetation Divisions (EVDs). However we cannot currently achieve the same certainty for the fire responses of vertebrate fauna, let alone for invertebrates, fungi, bryophytes and microbes.

The most useful information is that which has been gained from long-term studies, but there are currently few of these. We have a fair understanding of the recent fire history for many parts of the state but we lack detailed information, particularly on the severity and patchiness of burns. It is important to continue to gather that data, wherever it might exist, and present it in an accessible form.

We need to know a lot more about the effects on

biodiversity of:

- intervals between fires
- seasonality of fires
- fire intensity and severity
- below ground fires
- patterns and scales of patchiness
- different fire regimes over the long-term.

There is a significant lack of information on the tens of thousands of species of invertebrates and cryptogams – the fungi, bryophytes etc. Any knowledge we might garner about fungi will be useful, but there are no ecological mycologists in Victoria.

Land managers have tended to consider the vascular flora as a surrogate for biodiversity, but vascular plants are not necessarily the best indicators of healthy ecosystem function. The bryophytes and lichens should be studied as groups of highly sophisticated environmental indicators. In small scale sampling plots in the Otways and Central Highlands, the number of taxa of bryophytes was two to five times the number of taxa per plot of the vascular plants. Few land managers, however, understand the language of bryology.

Our knowledge of the relationship of fire to microbial species is also minimal. There are 10,000 to 15,000 species of microbes that are already known in Australia, and there could be some 250,000 species.

In many ways soil, including the fungi and micro-organisms, runs the system, but we still have a lot to learn about soil and its relationship to biodiversity.

Emphasis was placed on the danger of relying only on monitoring apex plants and animals because their extinction usually follows problems in diversity in the lower level of the ecosystem.

In the past this problem was seen to be insurmountable, but it is now addressable through molecular techniques. We have the ability to pick up a sample of soil and identify a whole microbial community by using appropriate genetic techniques. Such techniques are already being explored in marine ecosystems for analysis of biodiversity for plankton and benthic flora and fauna.

We need to understand the evolutionary factors which have shaped ecosystems. Long term fire studies will help to reveal those evolutionary pressures.

We also need to have a better understanding of the ideal spatial arrangements of fire regimes, including whether they are fine-grained or course grained, and what seral stages should comprise landscape-scale mosaics.

And we need to build our understanding of the interactions of fire regimes with other processes such as climate, fragmented systems, urbanization and private land management. We need to understand unexplained variance in data, and what critical processes are driving those patterns.

DISCUSSION B

Designing planned burn prescriptions and targets for supporting biodiversity in Victoria.

Discussion led by Mike Clarke, La Trobe University

Panel members

- Richard Loyn, Arthur Rylah Institute, Department of Sustainability and Environment
- Tim New, La Trobe University
- David Cheal, Arthur Rylah Institute, Department of Sustainability and Environment

The Victorian Bushfires Royal Commission, in its Recommendation 56, asked for a long-term program of prescribed burning based on an annual target of five per cent of Victoria's public land. That equates to about 390,000 ha per year, and is to be achieved regardless of the area burnt in any year by bushfires.

In the Commission's recommendations 57, 58 and 59, however, there is a heavy emphasis on monitoring the effectiveness of fuel reduction programs, and the effects of those programs on biodiversity. It can be inferred from these latter recommendations that the Commission saw the five per cent target as an interim one, subject to further evidence as it emerged. This is consistent with DSE's and Parks Victoria's commitment to adaptive management of public land – a process of observing both the effectiveness and the impacts of management actions and changing those actions as new evidence emerges.

The 390,000 ha annual target is a large management burn area, unprecedented in Victoria's recorded history. It was not arrived at by adding up local or regional targets designed to achieve local safety and/or local biodiversity objectives. It mandates a top down planning process for planned burns on public land, and puts considerable pressure on planners designing management burn programs. Regional and local fire planners are required to achieve large specific local targets, established primarily as a contribution to the statewide target.

In many cases this means fire planners are trying to achieve the least harm to biodiversity, rather than burning (or not burning) for the maximum benefit to biodiversity. They can also be compelled to exceed already large local targets if fire managers in other regions have been unable to achieve their targets.

We are in danger of creating 'synthetic' fire regimes arising from policy rather than good management and, as a community, becoming accustomed to those regimes. The target can replace ecological objectives and public safety objectives; if we achieve the target the community can believe management has succeeded, but that is not necessarily the case.

Targets should be developed locally, independent of any proposed statewide total. They should be based on local biodiversity objectives and local safety objectives, and they should be revised as new information comes to light.

An important outcome of a planned ecological burn is to sustain the ecological processes in that area. There are many interconnected processes, including critical functional elements such as the pollinating insects. Our actions should also be scale dependent. In, say, 10,000 hectares you would want all species to remain, and common species to remain common. These sentiments do not always come through in policy documents.

Management objectives should include:

- Maintaining the natural range of variability pre 1780 (though that is difficult to establish with certainty)
- Avoiding extinctions
- Avoiding any irreversible state change in Ecological Vegetation Classes (EVCs)
- Maintaining or improving ecosystem integrity and functions. (This is an important one, though its measurement is difficult.)
- Recognition of the importance of maintenance of refugia, especially in drought years
- A clear understanding of what any given management area should look like in the future, including the future distribution of age classes.

Importantly, these objectives should not be seen in isolation. An ecosystem function such as decomposition, for example, might be achieved to a degree by non-natives, but that could well compromise other objectives.

The intervals between a series of burns is more important than time since fire. They are related of course, but there should be a range of intervals between successive fires within a landscape unit. Intensity, type and season of burn are also important variables. It is relatively easy to establish, and manage for, a minimum tolerable interval for any one species, but variability of fire regimes is important for maximal species richness.

Biodiversity objectives, of course, are just one element of the planning process. Some other important aspects that have to be considered in fire management planning include the protection of:

- human life and safety
- economic assets
- water quality and supply
- cultural and historic assets.

Nevertheless, both State and Federal legislation require the protection of biodiversity, and that must be accommodated in the development of planned burning programs. We first need to articulate what we are aiming at, and what we would consider to be catastrophic

Importantly, local annual management burn plans should be based on a long-term plan to achieve a specified distribution of age classes for each EVC. Currently such long-term objectives are rarely, if ever, part of the planning process.

Long-unburnt habitat is increasingly scarce in Victoria, and highly valuable. The risk of losing long unburnt EVCs is far more serious than not having enough frequent burns. This is a critical point that we must take into account in our fire planning.

An important point emerged on the first day of the symposium with respect to fire management. The Royal Commission was concerned to minimize the risk to human life and safety, which led to the 5% planned burn target. It was pointed out that planned burns in Mountain Ash forests are in general too dangerous to attempt. We have the anomaly that many communities in Victoria are located in or near such forests. This problem needs to be addressed by state government and local councils.

Even without the statewide target fire management is, at best, an inexact science. Planned burning will have positive and negative effects. When planners try to maximise ecological benefits, mistakes will be made and things will sometimes get out of hand. Sometimes fires will escape; sometimes less will be burnt than was intended.

Biologists are, understandably, enmeshed in the complexity of their field. There is a need to communicate simple, but not simplistic, answers

to questions and provide doable solutions to fire managers. Biologists must be listened to, but that will only happen if objectives being set are pertinent, clear and accessible to non-biologists.

DISCUSSION C

How do we design research and monitoring programs to improve management of fire and biodiversity?

Discussion led by Ralph McNally, Monash University

Panel:

- Alan York, University of Melbourne
- Dick Williams, Ecosystem Sciences, CSIRO
- David Bowman, University of Tasmania
- Michael McCarthy, University of Melbourne

There are probably few areas of study as complex as the relationship between fire and biodiversity in Victoria. There are approximately 300 Ecological Vegetation Classes (EVCs) statewide, supporting something like 100,000 native species. Fire adds complexity to this situation by favouring some species and hindering others, even within the same EVC. And both planned and unplanned fire can happen in different seasons, at different intervals, with a range of intensities and exhibit different degrees of patchiness, all of which effect biodiversity.

It is clearly not possible to monitor everything, but if we are to manage fire successfully we have to make sure we are measuring those things which can usefully be applied to land management planning and implementation, and which take account of the great diversity of Victoria's life-forms.

Conceptually, there is a way of thinking about fire regimes. Four switches need to be on simultaneously to drive fires: fuel; ignitable condition; weather (wind and temperature); ignition source. The rates at which these switches are on/off define the types and frequencies of fires across the continent. In most of the temperate zone, the limiting factor is more likely to be weather than fuel amount. In the savannah it is more likely to be fuel and ignition than weather.

Importantly, while fire can have significant short term impacts on biodiversity, it is the long-term effects of a fire regime that have the most significance. And we need good baseline monitoring of areas before fire, especially of long-unburnt areas.

Long-term monitoring.

Setting up durable long-term monitoring programs, the holy grail of fire research, is hard to achieve. Indeed securing long-term datasets for natural systems is a problem worldwide. Funding tends to follow political cycles and/or changes in the priorities of land management agencies.

Given that climate impacts on biodiversity are predicted to be considerable, and that one of those likely agents of change is an increase in fire across the landscape, future land managers will increasingly have reason to call on long-term data.

Ideally, this would come from well-designed monitoring programs, with consistent methodology, that prove themselves useful enough to attract long-term funding. But we will also have to deal with inevitable changes in methodology, such as the current move, in the case of mammal surveys, from hair tube analysis to photography. The effects of such changes need to be calibrated to enable a level of continuity in data. We must also anticipate and record confounding events such as pest plant and animal impacts or timber harvesting operations.

It is important to establish reference areas, particularly in long-unburnt areas. This is difficult to achieve over the long-term as relatively little long-unburnt public land remains in the state. The chance of long-unburnt areas in many EVCs surviving future wildfires is therefore small. Fire management should be geared towards the survival of as much long-unburnt vegetation as possible, especially in those EVCs where such age classes are particularly rare or particularly prone to wildfire.

While fire mapping has greatly improved in recent years, we need a commitment to reliable mapping of current and future fire activity that indicates patchiness and severity.

Even if we are successful in implementing long-term research programs, they will only give us answers in years to come. If we are to make good fire management decisions now as we must, we need to assemble as much information as we can on Victoria's history of planned and unplanned fire. This can be done by assembling and compiling as much information as possible from existing fire history mapping. This is already happening, and is quite well developed in some regions of the state, but we need to rapidly establish long-term fire histories across the landscape as comprehensively as records and understanding allow.

There is potential to harvest information held within the community. Publication of such work, or assimilation of community monitoring into data bases, is important for the future. Analysis of the Ash Wednesday bushfires in the Anglesea heathlands was done entirely by amateurs for ten years, but it was extremely useful, particularly in relation to individual species. The results were published by the Royal Society in 1996.

Where local fire histories are unknown, uncertain, or where their use is limited because they don't go back far enough, fire histories can be reconstructed to a degree by using the known fire responses of particular EVCs and individual species of plants.

We should also look at possibilities of gathering relevant information from monitoring programs that may have been set up in the past for another reason.

Monitoring for complexity

If we are to be sure we have a good understanding of the impacts of fire on biodiversity, we have to develop practical ways to assess impacts on the great diversity of life-forms, including the invertebrates, microbes, non-vascular plants and fungi. The task of monitoring everything is clearly unachievable.

Use of surrogates for poorly known taxa is a possible approach, either using other correlated taxa or selected indicator taxa from within the poorly known group. However, there is great under-sampling of the poorly known groups, so effective surrogates have not yet been established for many groups.

Methods need to be developed to rapidly and cheaply sample biodiversity in megadiverse but poorly known groups. Use of molecular sampling (by extracting DNA from soil etc.) offers much promise in comparison to traditional methods of collection and identification based on morphology. For instance, it is now possible to develop DNA barcode markers (and corresponding DNA reference libraries from known species) so that biodiversity of microscopic flora and fauna can be more readily sampled and assessed. Such work is already in progress in studies of marine benthos, plankton etc. and of soil microbes.

CONCLUSIONS

There was general agreement that:-

- A single statewide hectare target for fuel reduction burns acts against the design and implementation of appropriate management burns, and is likely to cause significant adverse impacts on biodiversity.
- Conceptual models are desirable for different scenarios, habitat and fire regimes, environment on the day, size of planned burn.
- Management burn programs should be based on a clear understanding of what each management area should look like in the future, including the future distribution of age classes.
- Long term monitoring is the most informative and that consistency of sampling is necessary.
- Retention of appropriate mosaics in the design and implementation of control burns is essential for maintenance of biodiversity
- Retention of refugia in habitats exposed to control burns is essential to retention of biodiversity
- Knowledge of floral age structure, seeding regimes and drought effects should influence time and scope of control burns.
- To retain true long-term biodiversity more attention needs to be given to quicker methods of monitoring invertebrates, microbes and non vascular plants. This should be matched to sampling results.
- Methods need to be developed to estimate biodiversity in these groups by using genetic (extract DNA) and phenotypic collections (morphological samples). For instance microsatellite markers need to be developed so that biodiversity of microscopic flora and fauna can be more readily assessed. Such work is already in progress in marine studies of benthos, plankton etc.
- The reality of feasible control burns should be acknowledged and should influence future planning. Many of the people who died in major fires around Melbourne lived in forests like Mountain Ash Forests. Control burns of any magnitude are rarely conducted in these forests because of the danger. Thus the forest type that contributed to many deaths is not a target for many controlled burns.
- Novel approaches to measurements of biodiversity need to be further developed.
- Applicability of biodiversity sampling in relation to control burn practices, needs to be assessed against practicality in the field.
- The relative impact of fuel levels, ignitable condition, weather (wind and temperature) and ignition source should be assessed in different model systems. The rates at which these switches are on/off define the types and frequencies of fires across the continent.