Department of Sustainability and Environment

Growth stages and tolerable fire intervals for Victoria's native vegetation data sets

David Cheal

Fire and adaptive management

report no. 84

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Department of Sustainability and Environment

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Outside Cover: Scene from Five Mile Road, Wilsons Promontory National Park, Victoria after wildfire event in 2009;
Inside Cover: Scene from Five Mile Road, Wilsons Promontory National Park, Victoria 1 year after wildfire event showing recovery of wetland.

(PHOTOS COURTESY STEPHEN PLATT)

To learn more:
www.dse.vic.gov.au/fireecology

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Heathland vegetation communites at Billywing, Grampians National Park. Left image showing flowering *Xanthorrhoea caespitosa* (Tufted Grass-tree).

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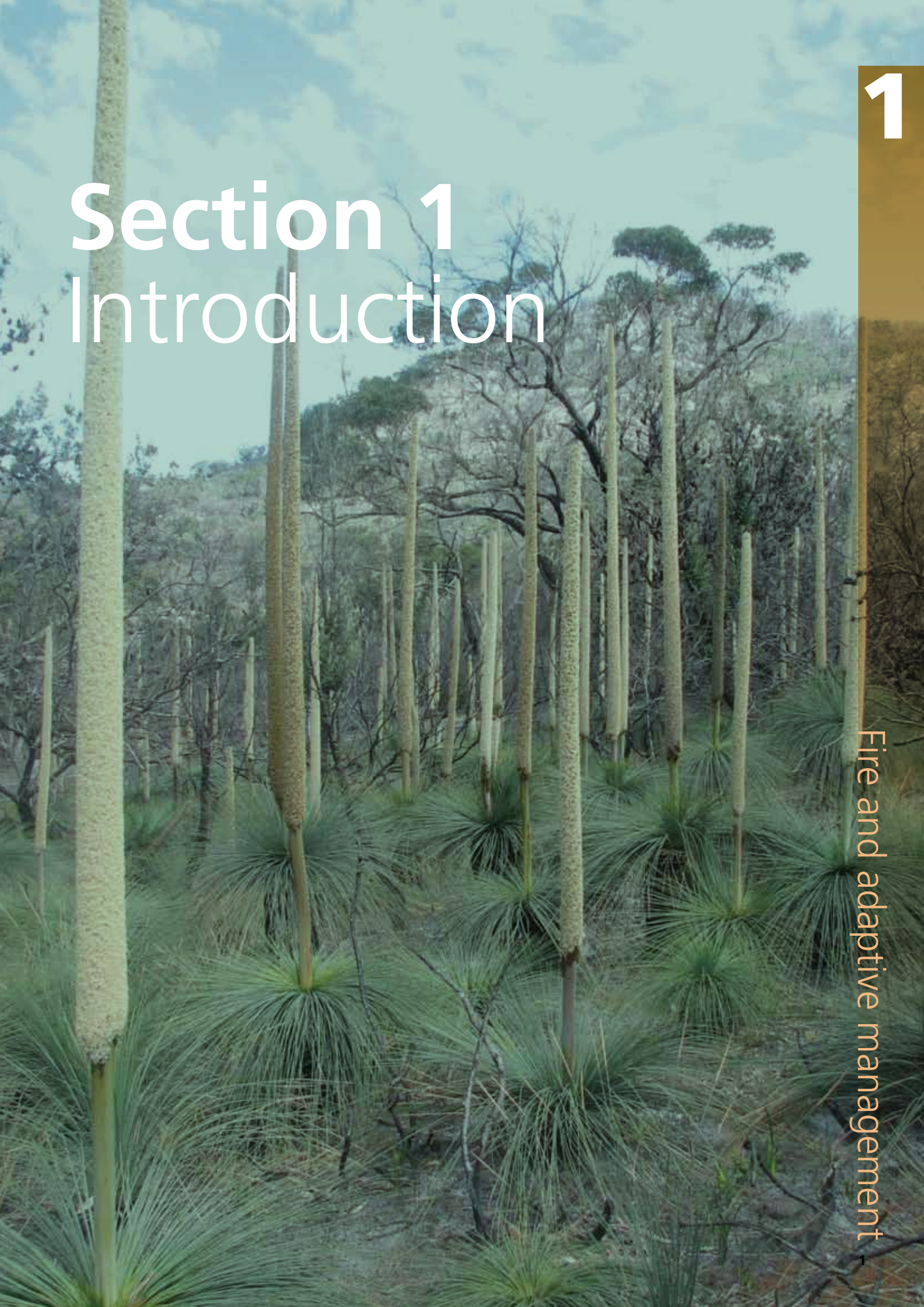
Heathland vegetation community at Wilsons Promontory National Park, Victoria showing flowering *Xanthorrhoea australis* (Austral Grass-tree), one year after bushfire.



Section 1
Introduction

Section 1 Introduction

Fire and the environment

Fire has been a part of the Australian environment over geological time-scales, largely shaping the richness, composition, distribution and adaptations of the organisms and ecosystems that are present today.

A substantial proportion of Australia's unique biota depends to varying degrees on fire, and on a variety of fire regimes, for its continued existence and development. Understanding the relationship between fire events, fire regimes and biodiversity outcomes in an environment that experiences unpredictable wildfires is a complex task, but considerable advances have been made in recent years.

We know that fire plays a major role in determining the abundance and distribution of Victoria's flora and fauna species, and has a profound influence on the structure and composition of native vegetation (i.e. 'habitats'). The challenge is to incorporate current knowledge into standard management procedures and protocols, information products and decision-making tools[1] that can be applied to land and fire management planning and operations.

Fire is a major driver of biodiversity and ecological processes in Victoria (and Australia in general).

Including fire ecology in fire management

Since 1999, ecological principles and guidelines have been progressively integrated into Victoria's fire management planning and policy. The rationale for this integrated approach was first presented and comprehensively explained in the early 2000s, notably by Tolhurst and Friend (2001), Wouters *et al*. (2002) and Friend *et al*. (2004). In 2004, the publication of *Guidelines and Procedures for Ecological Burning on Public Land in Victoria* (Fire Ecology Working Group, 2004) synthesised, for the first time, this new thinking and provided universal principles, based on the best available science, for the application of fire for ecological purposes.

The scientific basis for integrating ecology with fire management planning was achieved initially through the application of life history characteristics or 'vital attributes' of flora species. A key assumption is that the life history of a species reflects its evolutionary past, and thus the influence of fire events. This enabled the identification of the species most sensitive to fire, called 'key fire response species' (KFRS), that set the minimum and maximum fire tolerance intervals between successive burns. The use of flora KFRS provided for ecologically informed decision-making to minimise risk of local flora species extinctions, but was recognised as limited in that the application of these data did not provide for ecological management guidelines for maintaining a variety of native vegetation growth stages that are important for the survival of resident fauna species.

1 It is accepted that our knowledge of some critical aspects of flora, fauna and native vegetation habitat responses to fire is sometimes rudimentary, but this does not prevent managers from 'learning by doing' or 'being adaptive' as new and improved information becomes available.

To progressively enhance the range of ecological data and guidelines that could be utilised by fire planners and managers and improve their decision-making, a project was initiated in 2006 that would assign tolerable fire intervals to spatially explicit native vegetation data sets, and describe habitat parameters for each growth stage through time. This is the report of that project.

In addition, a complementary project was undertaken concurrently to develop a conceptual model that links the needs of terrestrial vertebrate fauna to vegetation growth stages after fire, via changes in habitat parameters (MacHunter et. al. 2009).

The extent of native vegetation communities across Victoria is represented spatially by ecological vegetation classes (EVCs). EVCs consist of approximately 300 classification units representing native vegetation at map scales of 1 : 25000 to 1 : 100000. A significant challenge was therefore to develop a methodology that could assign this new learning consistent with the EVC data sets, and ensure it could be accessible for a wide range of uses.

Purpose of this report

This report summarises how fire tolerance intervals and growth stage attributes have been developed for native vegetation across Victoria to create new, spatially explicit data sets for fire management planning and fire ecology assessments. Specifically, it provides:

- the context and rationale of the project and its relationship to the Fire Ecology Program
- a discussion of the development and application of Victoria's native vegetation data sets for fire management, and the classification and nomenclature used — how EVCs have been grouped into 'ecological vegetation divisions' (EVDs), and how their fire response characteristics have been attributed using an 'ecological fire group' (EFG) attribute field
- the minimum and maximum tolerable fire intervals for EVDs
- descriptions of growth stages for EVDs.

The report also provides examples of the use of these datasets to summarise and display the distribution of growth stages in the landscape.

The report is essential reading for fire ecology practitioners and will also be of interest to anyone interested in fire management and the interplay between spatial and temporal patterns (patterns and processes) of biodiversity.

Although the report focuses on the use of growth stages for fire management planning, they have much wider potential application, including to the sustainable management of vegetation for water, forestry, carbon sequestration and other outcomes.

Knowledge gaps and currency

It is envisaged that the data in this report will be updated as new information becomes progressively available. For this reason, those wishing to apply data should always check the current data sets online at **www.dse.vic.gov.au/fireecology**.

Some of the summary data are based on a long history of ecological research, while others are extrapolated from field studies in somewhat different vegetation communities. All data are subject to review and correction as further ecological research is completed.

The 'best available knowledge' is summarised in this report in order to provide further tools for application to fire management in native vegetation across the State. Expert knowledge, while perhaps inferior to detailed research studies, is an improvement on what is otherwise available to practitioners. Further refinement, testing and critique of these frameworks and data sets through research are encouraged. In the meantime, decisions about ecologically appropriate regimes need to be made, as doing nothing is a decision not to burn.

The data are developed mainly at the scale of EVDs because knowledge at finer scales is generally, although not exclusively, less available.

Fires both destroy and create opportunities for biodiversity when vegetation communities are burnt. Our knowledge of the interaction of fire and biodiversity will progressively improve as new research and monitoring data becomes available in the future. The above photographs present four different vegetation communities after they were burnt by fire. Each community will have evolved their own unique ecological adaptation to fire [top left, Alpine treeless community; top right, *Eucalyptus crenulata* (Buxton gum), a rare and threatened species endemic to Victoria; bottom left, burnt *Sphagnum* hummocks of a high altitude wetland community; bottom right, foothills forest landscape following a high severity burn].

Policy context: the Fire Ecology Program

Fire management in Victoria is based on a number of key policies. *Living With Fire – Victoria's Bushfire Strategy (2008)* outlines a new approach to fire management in Victoria, based on risk management, that advocates a significant increase in planned burning as a response to the history of wildfire management and increased risks resulting from climate change. The Fire Ecology Program[2] relates closely to two themes of the Strategy — 'Managing the Land with Fire' and 'Risk and Adaptive Management'.

The *Fire Ecology Program: Strategic Directions 2009–2011* provides the strategic framework needed to implement an effective Fire Ecology Program. The key requirements for the program in the immediate years ahead are as follows:

- reduce the occurrence, spread and severity of bushfires *(Forests Act 1958)*
- achieve ecologically appropriate fire regimes to maintain biodiversity (*Flora and Fauna Guarantee Act 1988)*
- provide guidance to landscape-scale planned mosaic burning, as proposed under the Bushfire Strategy
- develop Fire Management Plans (integrated plans that include protection and ecological considerations) under the revised *Code of Practice for Fire Management on Public Land* (Revision 1, 2006)
- progressively improve knowledge of vital attributes of flora, and develop sound vital attributes for

2 The Fire Ecology Program is coordinated by the Department of Sustainability and Environment in partnership with Parks Victoria and the Country Fire Authority.

fauna to use in fire planning
- develop and refine adaptive monitoring programs for flora and fauna, and other key variables
- increase our understanding through research, particularly in relation to the management of fire, to achieve ecological outcomes and minimise the risk of inappropriate fire regimes
- ensure that fire management policies and practices remain contemporary
- develop a better understanding in the community of the role of fire in ecosystems and for well-informed and supported fire ecology practitioners.

These requirements must be considered in light of longer-term issues, including the effects of climate change.

The ecological effects of fire

Fires consume plant material and radically change vegetation structure (especially the spatial distribution of plants), plant density, ground cover and many other physical features of plant and animal habitats (Gill 1975, Lonsdale and Braithwaite 1991, Whelan 1995). As vegetation provides the bulk of the biomass in most terrestrial ecosystems and acts as the principal energy fixer, it also determines the habitat structure and resource availability for animals, fungi and the rest of the biota.

Fires produce changes in the chemical environment, such as the abundance of nutrients that may limit plant growth and reproduction, soil pH and seasonal soil moisture (Rundel 1983, Kutiel and Naveh 1987, Adams *et al*. 1994, Blair 1997, Hopmans 2003).

Fires also affect soil structure (Carreira *et al*. 1992), water run-off and yield (Langford 1974, Lonsdale and Braithwaite 1991, Fagg 2006) and many other environmental attributes.

Biotic–abiotic interactions may also change dramatically because of fire, or because of a long-term absence of fire (Eldridge and Green 1994). Through the creation of gaps, fires also provide a regeneration opportunity for plant species that is often the major, or even sole, regeneration opportunity (Gill 1975, 1981a, 1981b; Pate and Beard 1984; Whelan 1995). Many species have scant regeneration in the absence of fires, and a long-term lack of fire may lead to local extinctions (Bradstock *et al*. 1995, Crosti *et al*. 2007, Pierce and Cowling 1991, Williams 2006). For other species, and sometimes the same species as those adversely affected by infrequent fires, repeated fires at too short an interval may lead to local extinctions (Bradstock *et al*. 1995, McCarthy *et al*. 2001).

Victorian landscapes are subject to both bushfires and planned burning. Bushfires occur every year, mostly in summer, and they are numerous and largely unpredictable in their extent and intensity. Planned burns are conducted to protect life and property, or to achieve ecological and other outcomes. In comparison to bushfires they are relatively predictable in extent, season and intensity. Both types of burning affect the fire regime experienced by flora and fauna, and both types of fire must be considered in the development of tolerable fire intervals and growth stages.

Fire is a natural event and many plant species have adapted to regenerate after bushfire events.

(TOP LEFT AND RIGHT PHOTOS COURTESY STEPHEN PLATT)

Inter-relationship of native vegetation, fuel and fire management

Fire, or lack of fire, is an essential component of the ecology of Victoria's native vegetation communities and their constituent species. Vegetation communities exhibit a variety of adaptations to fire. Fires depend on vegetation as a source of fuel (quantity, quality, distribution in space). Fuel characteristics vary across vegetation types (Whelan 1995, Tolhurst 1999), as do habitat structures.

Most of Victoria's native vegetation communities are dominated by sclerophyllous trees and shrubs that usually have precise relationships to local fire regimes (Whelan 1995). Indeed, much of the native vegetation of Victoria has been described as 'fire-dependent' or 'pyrogenic' (Bell *et al*. 1984, Whelan 1995, Wouters *et al*. 2002).

However, some vegetation communities are dominated by species with few adaptations to fire, and it is reasonable to assume that fires have been an insignificant feature in these communities. Consequently, fire in these communities is likely to compromise essential ecosystem processes[3]. Even occasional fires that occur too frequently or too severely in these communities may be detrimental (Thomas and Kirkpatrick 1996, McKenzie 2002, Tierney 2006). Fire management still has an important role for such communities, as they may need to be protected from damaging bushfires by planned burning of the surrounding vegetation. Vegetation communities within which planned fire is not usually appropriate include rainforests (Bowman 2000), many wetlands (Kershaw *et al*. 1993, Pinder and Rosso 1998), Raak saline shrublands (Morcom and Westbrooke 1998) and inland woodlands dominated by *Casuarina* species (Callister 2004). Fire management in and around these communities is usually focused on fire exclusion.

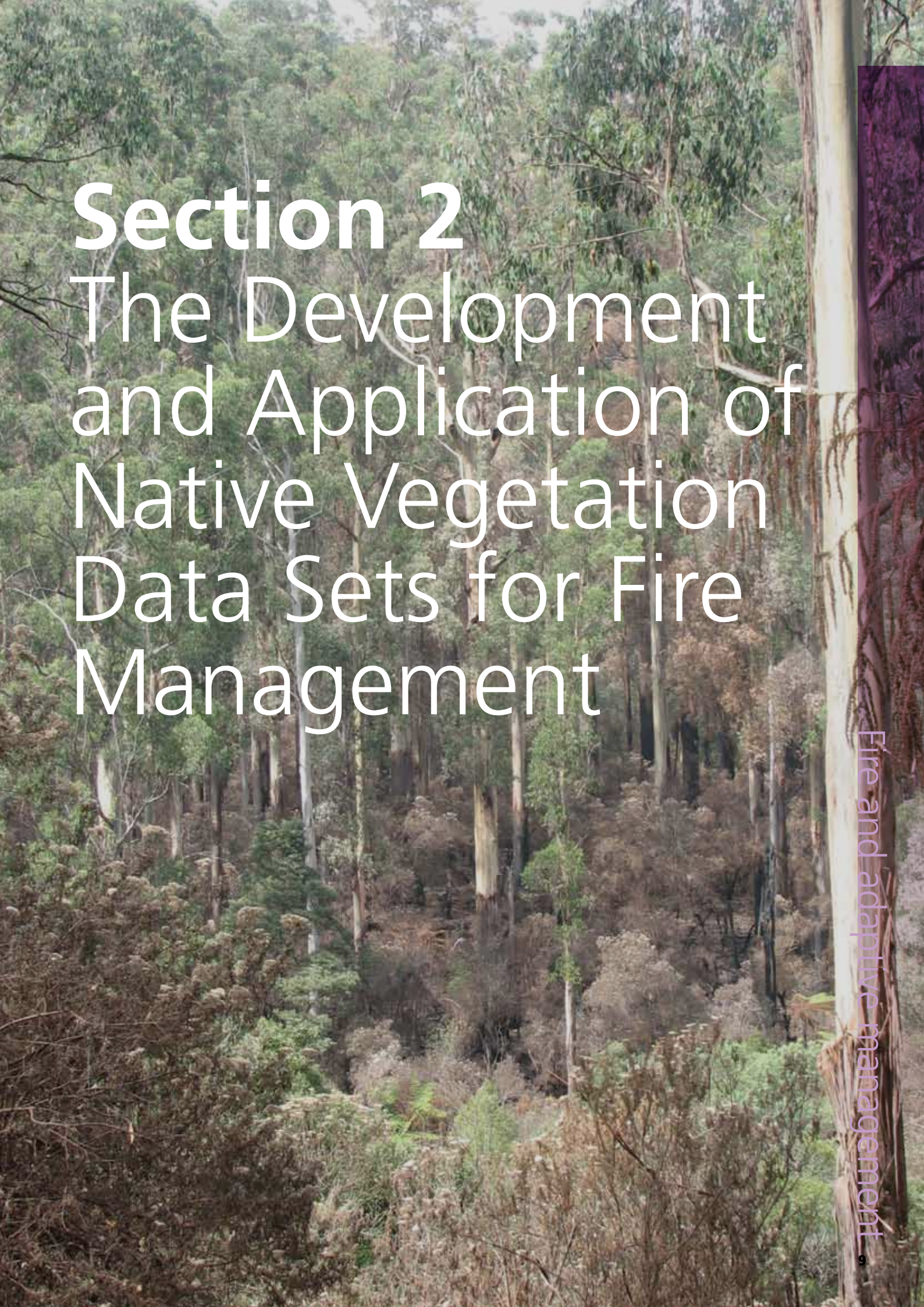
In summary, fire regimes may result in both extinctions and regeneration opportunities for vegetation communities and their flora and fauna. Applying an inappropriate fire regime may lead to undesirable changes in species composition and local extinctions. Applying an appropriate fire regime may lead to the maintenance of desirable species composition and the recovery of threatened species.

Responses to fire events vary between species even within the same vegetation community. The above images were taken one year after the 2009 bushfire in the O'Shannessy Catchment, Victoria. The left image shows regrowth of one tree species *Eucalyptus nitens* (Shining gum) and understorey tree ferns. In contrast, those trees with no regrowth are the species *Eucalyptus regnans* (Mountain ash). The Mountain ash will regenerate as new seedlings from the soil seed bank. The right image is a close up of *Eucalyptus nitens* regrowth.

(PHOTOS COURTESY STEPHEN PLATT)

3 *Inappropriate fire regimes causing disruption to sustainable ecosystem processes and resultant loss of biodiversity* is listed as a threatening process under the *Flora and Fauna Guarantee Act 1988*.

Tall mist forest vegetation (O'Shannassy Catchment, Victoria) – three weeks after a low intensity bushfire. ▶
Note the patchy nature of the burn showing unburnt canopy with burnt understorey and lower strata.



Section 2
The Development and Application of Native Vegetation Data Sets for Fire Management

2

Section 2 The Development and Application of Native Vegetation Data Sets for Fire Management

Victoria's native vegetation base data set – Ecological Vegetation Classes (EVCs)

Over the past decade the Department of Sustainability and Environment (DSE) has progressively developed spatially explicit native vegetation data sets, classified by ecological vegetation class (EVC). The classification is based on the ecological characteristics of vegetation (e.g. dominant species, community structure) and physiographic variables (e.g. soil type, annual rainfall). Mapping of EVCs has occurred at scales of at least 1 : 100000 and in some areas 1 : 25000. There are approximately 300 EVCs in Victoria.

The EVC data have a wide range of uses for natural resource management and provide the basis for *Native Vegetation Management: A Framework for Action* (2002) and *Native Vegetation: Sustaining a Living Landscape* (2006). The Framework's main goal is to achieve, across the entire landscape, a reversal of the long-term decline in the extent and quality of native vegetation, leading to a net gain. A summary of EVC data sets developed by DSE is provided in Table 2.1.

Table 2.1: Summary of DSE's native vegetation data sets* at 2007

2007 Data set	Data set name
NV1750_EVC	Native Vegetation, 1750 – Ecological Vegetation Classes
NV1750_EVCBCS	Native Vegetation, 1750 – Bioregional Conservation Status of EVCs
NV2005_EXTENT	Native Vegetation, 2005 – Extent
NV2005_EVCBCS	Native Vegetation, 2005 – Bioregional Conservation Status of EVCs
NV2005_QUAL	Native Vegetation, 2005 – Quality

* Data set names are in the form **NV{Year}_{attribute}**, where **NV** stands for native vegetation, {**Year**} is the year to which the data applies, e.g. 1750 is just prior to the first European settlement in Australia and 2005 is the year of the modelled current extent (the next year may be 2010 or 2015, depending on monitoring frequency), and {**attribute**} is the type of information stored in the data set (EVC, EVCBCS, QUAL, etc.).

EVCs in bioregions

The conservation status of an EVC is typically assessed in terms of the biogeographical region (bioregion) in which it occurs, giving a bioregional conservation status (BCS) for the EVC (data set NV2005_EVCBCS). The BCS is a 'measure 'of the current extent and quality of each EVC compared to its pre-1750 extent and condition. Threatening processes are also considered. On this basis an EVC will have a BCS of endangered, depleted, vulnerable, least concern or rare. This is the basis for describing EVC benchmarks and assists with natural resource management at the landscape scale.

EVC benchmarks

EVC benchmarks have been developed for each EVC to describe dominant species and habitat features, as well as other characteristics such as presence of typical weed species. The EVC benchmarks are used not only as descriptive tools, but provide a basis for assessing the 'vegetation quality' of EVCs at the site scale. Vegetation at a particular site can be compared to the 'benchmark' condition to provide an objective assessment of the quality of the vegetation at that particular site.

Application of EVC data sets to fire management

In deciding what system of vegetation classification would be most appropriate for fire management, a number of factors was considered. The system would need to be at a scale that corresponded with the information and knowledge that is available, while also being usable at finer scales as knowledge improved and more detail is added. It would also need to be capable of being incorporated into database attribute fields that can be applied in geographical information systems. It was decided that a system already devised for another purpose would, with minor modifications, suffice. The system was called 'ecological vegetation division' (EVD).

This section explains how the EVC data set was:

- grouped into larger EVD map units based on grouping those EVCs that share similar ecological characteristics (including fire histories), and
- attributed using an 'ecological fire group' (EFG) attribute field that provides specific fire response information for particular (subsets of) EVDs.

Ecological Vegetation Divisions (EVDs)

Because of the value of DSE's existing comprehensive, spatially explicit data layer on vegetation, there was sense in aggregating these map units into larger, ecologically based groupings. The existing schemes for major vegetation groups were surveyed. Around 30 units was thought useful for large-scale uses in relation to fire management. A previous project for Parks Victoria (Long *et al*. 2003) erected larger-scale vegetation units, and these proved very useful. That project, which focused on the impact of rabbits on vegetation and habitats in the reserves system at a statewide scale, included the recognition of large-scale vegetation units termed 'ecological vegetation divisions'.

Rather than devise a novel scheme, the 300 EVC units of the NV2005_EVCBCS data layer were investigated by Long *et al*. (2003) and grouped into 32 units based on their ecological similarities. The unit 'EVD' was named in analogy to the former system of botanical nomenclature, in which the next major taxonomic unit above 'class' was termed 'division'.[1]

Each EVD is a grouping of more than one EVC. This approach enables EVDs to be mapped using the NV2005_EVCBCS data layer (Table 2.1 and Figure 2.1). It should be noted that the names for nine of the EVDs devised by Long *et al*. (2003) were renamed to avoid confusion with similarly named EVCs in the NV2005_EVCBCS data layer (refer Table 2.2 below for name changes).

Table 2.2: EVD name changes, Long *et al*. (2003) to current report

EVD No.	EVD Name (Long *et al*. 2003)	EVD Name, this report
4	Swampy Scrub	Damp Scrub
7	Lowland Forest (eastern)	Tall Mixed Forest (eastern)
10	Damp Forest	Moist Forest
12	Wet Forest	Tall Mist Forest
13	Rainforest	Closed-forest
18	Rocky Outcrop Shrubland	Rocky Knoll
22	Semi-arid Woodland (non-eucalypt)	Dry Woodland (non-eucalypt)
23	Alluvial Plains Woodland	Inland Plains Woodland
29	Chenopod Mallee	Saltbush Mallee

Table 2.3, page 19, lists the 32 EVDs and summarises their ecological characteristics and their attributes that substantially affect fire behaviour and the planned application of fire in each EVD. Each of the 32 EVDs captures the variation in a particular ecological landscape and set of related EVCs, and has a recognisable set of characteristics (the 'ecological signature') in the field. Detailed descriptions of all 32 EVDs are presented in Section 4.

1 The name 'phylum' has now replaced 'division' in botanical nomenclature, bringing it into line with zoological nomenclature.

It is important to note that EVDs are not a suitable substitute for displaying EVCs for fine-scale vegetation mapping and other ecological assessment requirements. For example, the Heathland (sands) EVD comprises a grouping of approximately 50 EVCs. The EVD names are merely labels, not definitive descriptions. For example, vegetation in a local area that is classified as Saltbush Mallee EVD may comprise EVC units that lack saltbushes (shrubs and herbs of the genus *Atriplex*). Nevertheless, it is intended that the names chosen are reminders of some of the most characteristic features of these vegetation communities.

Ecological Fire Group (EFG) attribute fields

EVDs are useful for grouping EVC units into larger map units for statewide and landscape-scale fire management purposes. However, in some instances specific fire response characteristics (often referred as 'tolerable fire intervals') of subsets of EVCs within a particular EVD group are known, or the fire response characteristics of a particular EVD are known to vary according to its geographic location or predominant vegetation structure, or for other reasons.

This finer-resolution data, where available, has been incorporated by creating a separate data field termed the 'ecological fire group' (EFG) attribute field. For example, EVC units that are grouped for the Coastal EVD map unit have vegetation structures dominated by combinations of grasslands, shrublands or woodlands. But because EVC subsets characterised by grassland exhibit different fire responses when compared with woodlands, different fire response data are recorded in their EFG attribute fields (see Figure 2.1 and Table 2.4, page 24, for illustration). In comparison, all EVC units within the Forby Forest EVD have, as far as we know, similar fire response characteristics, and therefore have identical data in their EFG attribute field (see Figure 2.2 for illustration).

The EFG attribute field allows for periodic revision and refinement of fire response data for Victoria's native vegetation without the need to constantly update and reclassify the larger EVD map units in the medium term. Ongoing monitoring and research projects will assist with the progressive update of fire response data as new information becomes available.

Banksia marginata seed release after fire.

Hakea decurrens seed release after fire.

Figure 2.1: Diagrammatic representation illustrating how EVCs from the NV2005_EVCBCS data layer are grouped into the larger EVD "Coastal" map unit. This example illustrates how subsets of these EVCs may have known specific fire response characteristics attributed in a corresponding EFG attribute field. A detailed list of corresponding EVCs and EFG attribute fields for the EVD 'Coastal' map unit is presented in Table 2.4, page 24.

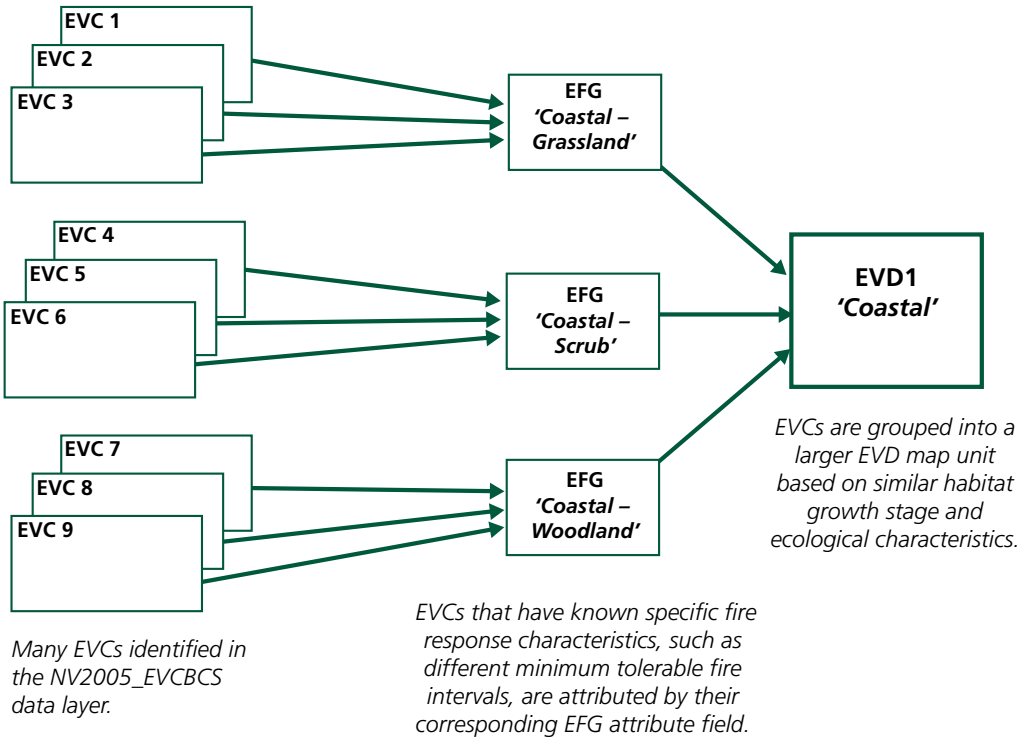
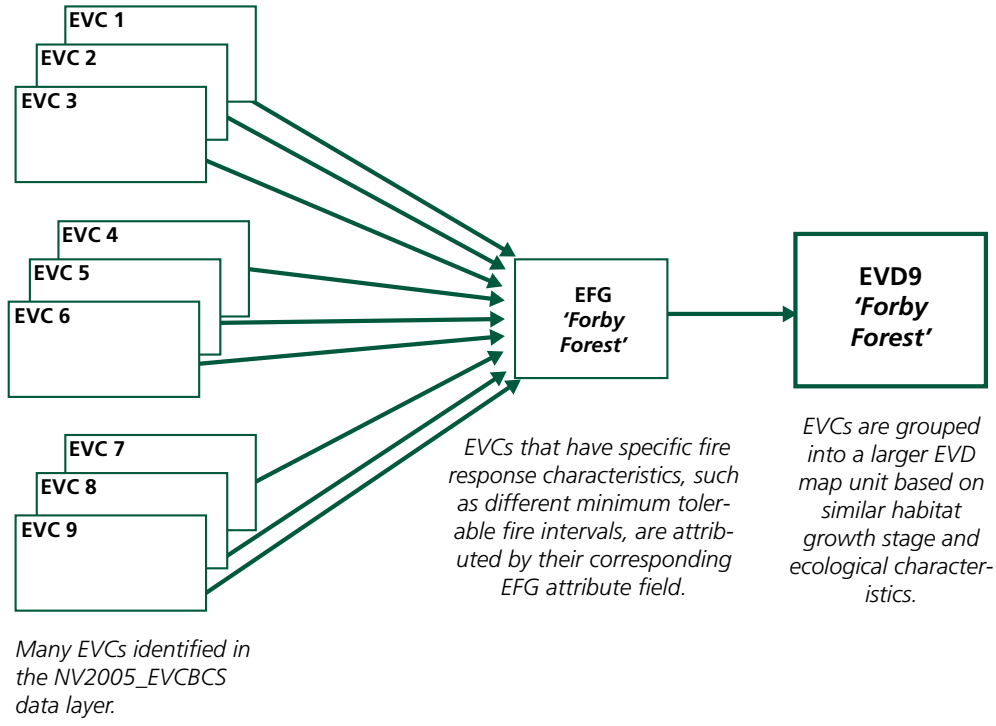


Figure 2.2: Diagrammatic representation illustrating how EVCs from the NV2005_EVCBCS data layer are grouped into the larger Forby Forest EVD map unit. In this example, the fire response data in the EFG attribute field is identical for all constituent EVCs, although this may change as new information becomes available.



Assigning tolerable fire intervals to EVDs (and EFG attribute fields)

Background

The assignment of the minimum and maximum tolerable fire intervals (TFIs) to EVDs (and EFG attribute fields) was an important component of this project to provide fire management information integrated with this native vegetation data set. TFIs give fire managers information on the ecological adaption of EVDs to fire, so that the frequency, severity and intensity of planned fires can be scheduled and conducted in ways that ensure the ecological sustainability of native vegetation communities and their constituent species.

Fire frequencies that are too high or too low threaten Victoria's biodiversity by changing the composition and structure of vegetation communities. The ideal interval between fires for any given vegetation community is determined by the time taken by the constituent species to reach maturity and set seed, and the time to extinction in the absence of fire. If fire is too frequent, species that are not able to reproduce may be lost from the community. If the interval between fires is too long, species that depend on fire for regeneration may die out.

To maintain a balance of habitat growth stages in landscapes it is essential to understand the role of fire and its management. While vegetation communities may be burnt successively at their minimum tolerable fire intervals without loss of flora species, regular burning of an entire site (or defined area) may impact on the community composition of the component EVDs and simplify the heterogeneity of the habitat structure. It is important to recognise that the use of TFIs for ecological fire planning and decisions is only one dimension, and the parameter should not be used in isolation from other ecological principles. Because many fauna species need a range of habitat growth stages over their life cycle (see MacHunter *et al*. 2009), a process for describing and characterising the habitat growth stages of EVDs was developed. This is presented in Section 3 and described in detail in Section 4.

Victoria's native vegetation communities are diverse and have adapted to a wide range of physical landscape settings, climate patterns and fire regimes [top left, High altitude Wetland EVD ; top right, Hummock-grass Mallee EVD, bottom left, Foothills forest EVD; bottom right, Heathland (sands) EVD].

(TOP LEFT PHOTO COURTESY ARN TOLSMA)

TFI assignment process

Detailed research on the fire ecology of Australian native vegetation communities is patchy (Tran and Wild 2000). Some vegetation communities, such as heathlands and mountain forests, have been well studied (see Gill 1975, 1981b, Bell *et al*. 1984, Attiwill 1994, Ashton 2000). However, even for these vegetation communities, information on the long-term influences of fire is still limited. Therefore, the ecological futures of most vegetation communities under various fire regimes are estimated using expert knowledge and opinion (e.g. Cheal 1994). In the context of adaptive management, it is acceptable to use information based on the best available knowledge, provided that the uncertainties in using assumed data are recognised (Table 2.3, page 19).

Adaptive experimental management (Oglethorpe 2000) provides a theoretical framework for incorporating unreliable and uncertain data into applied fire management, on the assumption that experience gained while applying a fire management plan feeds back into the planning process, enabling later plans to be more soundly based. This 'learning by doing' has been recognised as an integral part of the Fire Ecology Program for the past 10 years (Fire Ecology Working Group 1999 and 2010, Friend *et al*. 2004). Ultimately, long-term data (derived from research and survey) will provide for greater certainty and strengthen assumptions.

In spite of these uncertainties and assumptions, a process was undertaken to assign maximum and minimum TFIs for each EVD (and EFG attribute fields). The process followed by Wouters *et al*. (2000) was used where data were available. This process considers the responses of key fire response species (KFRS) of plants (Cheal in press) that are typical components of EVDs.

Flora records were accessed using DSE's Flora Information System (FIS) and KFRS were identified using the Vital Attributes fields in the FIS database (Cheal in press). Vascular plant species with the longest juvenile period were identified, concentrating on those with a propagule bank that is exhausted immediately after fire and those with the shortest time to senescence and local extinction. In each EVD the long juvenile period species ('JUVEN' in the Vital Attributes data set) should be prime determinants of the minimum tolerable fire interval, and the short senescence/local extinction species ('SPECIES LIFE' in the Vital Attributes data set) should be the prime determinants for the maximum tolerable fire interval.

For EVDs with limited data, TFIs were assigned by using expert knowledge, experience, and modelling to derive reasonable approximations of the maximum and minimum TFIs (Table 2.5, page 25). A commitment to adaptive management using data derived from ongoing monitoring and research will enable these assumptions to be refined in the future when specific data is available.

TFI nomenclature

TFIs were assigned to each EVD (and EFG attribute field) using the following nomenclature:

- **Max TFI** — This describes the maximum time required between two successive fire events at a site in order that a vegetation community or its constituent species can persist in the absence of fire.
- **Min TFI – High Severity Fires** — This describes the minimum time required between two successive fire events at a site, the first of which is a high-severity fire, in order that a vegetation community or its constituent species can persist and have every reasonable chance of reaching maturity and producing propagules before the following fire event. High-severity fires usually burn complete stands of larger trees and their crowns, and other component plants, leaving few and scattered unburnt patches within the fire perimeter.
- **Min TFI – Low Severity, Patchy Fires** — This describes the minimum time required between two successive fire events at a site, the first of which is a low-severity fire with a high proportion of unburnt landscape scattered within the fire perimeter, in order that a vegetation community or its constituent species can persist and have every reasonable chance of reaching maturity and setting seed. Low-severity fires usually burn shrubs and lower strata plants, but do not usually appreciably burn tree canopies. Low-severity fires are also significantly patchy, with many unburnt patches within the fire perimeter.

A summary of all TFIs for each EVD (and EFG attribute field) is presented in Table 2.5, page 25.

Interpretation and application of TFIs in fire management

The fire behaviour and responses of a few vegetation communities are fairly well known, notably basalt grasslands, some heathlands, mountain forests and some foothill forests (Gill 1975, Whelan 1995, Bradstock *et al*. 2001, Tolhurst and Friend 2001). However, the fire behaviour and responses of other vegetation communities and their component species are not as well known. Nevertheless, to ensure that ecological considerations are incorporated into fire management, expert opinion and assumptions have generated recommended figures for maximum and minimum tolerable fire intervals. The figures offered in this study are based on the best available knowledge, and will be adjusted following further study and the publication of new data.

There is a paucity of detailed research on the ecological effects of fire for some EVDs. However, so as not to stymie the incorporation of ecological considerations into planning and management, expert opinion was applied. Ideally, all component EVCs should be incorporated into, and managed sensitively, for each EVD and its recommended fire intervals.

EVCs vary in species composition and relative abundance, their physiognomy and their fuel characteristics (Burgman *et al*. 1996, Woodgate *et al*. 1996). EVDs consist of two or more EVCs and are thus even more heterogeneous than EVCs. The slowest-maturing EVC within an EVD will substantially determine the minimum tolerable fire interval recommended for the EVD, and the fastest-senescing EVC will substantially determine the maximum tolerable fire interval for the EVD.

The assignment of TFIs in the current study considered the constituent vegetation communities that are most susceptible to any recommended maximum or minimum interval. As such, the recommended intervals are conservative, suitable for fire management, and based on a precautionary approach (Mueller-Dombois and Ellenberg 1974, Kriebel *et al*. 2001). They are the intervals *least likely to lead to local extinctions or dramatic changes in long-term species abundances or dominance patterns*.

The minimum tolerable fire interval (based on the minimum maturity requirements of KFRS sensitive to extinction under frequent fire regimes) is the shortest needed to avoid any localised declines or losses of species as a result of too-frequent fires. It should be noted that this is an extreme minimum value, as it is based on primary juvenile periods and does not include the time needed to replenish propagule reserves. Fires at shorter intervals than the specified minimum interval are therefore predicted to result in the depletion of populations and local losses of species over the affected area, particularly when sustained without interruption (e.g. more than two successive intervals less than specified minimum).

Within the general domain of appropriate fire intervals suggested here, application of fire at the site or patch level should aim to achieve *variable* fire intervals. Fire intensity is usually patchy across a burn area and thus a proportion of sensitive plant populations may survive in low-intensity patches or areas protected from fire. The data available on many historical fires, where the fire boundary is often the only record, are insufficient for determining the detailed on-ground post-fire situation and should be interpreted cautiously, as the effects of a fire may be overstated.

While recurrent burning at the minimum threshold (i.e. several successive short intervals) may lead to a critical decline in species sensitive to frequent disturbance, repetition at long intervals may have the same effect on those sensitive to infrequent fire. Sustained intervals in the mid-range of the domain could lead to dominance of particular species at the expense of others (Keith *et al*. 2002). Greatest species diversity may be maintained in some plant communities by ensuring variation in the length of inter-fire intervals (e.g. Bradstock *et al*. 1995).

The fire intervals recommended in this document are not intended to be used to hamper the application of fire regimes to intentionally change vegetation community composition, nor planned fires for priority fuel reduction or asset protection.

Planned burning is an important land management tool that is undertaken for both ecological and asset protection reasons.

(PHOTO COURTESY DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENT)

Land managers may have good conservation reasons to recommend use of fire to change vegetation species composition or structure to meet priority conservation objectives — for example, to remove fire susceptible weeds such as *Acacia longifolia* var. *sophorae* (Coast Wattle) or *Leptospermum laevigatum* (Coast Tea-tree) (Offor 1990, McMahon *et al*. 1994, Emeny 2007, Gent and Morgan 2007). A land manager may also deliberately skew habitat growth stages to juvenile or adolescent phases to provide suitable habitat for priority threatened species. Likewise, it may be that a land manager determines that the maximum tolerable fire interval can be exceeded in order to achieve a management aim such as increasing the area of rainforest in previously eucalypt dominated areas. In many instances, patchiness of species and communities is a desirable biodiversity outcome. Thus, TFIs should be interpreted in the context of the management objectives set for an area, specific knowledge of a species or communities' response to fire at a site, and how fire will be used to influence biodiversity outcomes.

It can be assumed that the risk to KFRS and communities increases if burning occurs more frequently than the minimum TFI, especially if an actual fire interval is below the minimum TFI. This will be a particular concern in the Ecological Management Zone[2]. In such cases, planned fires may still be considered if, after undertaking an appropriate risk management assessment, including ground-truthing and establishment of monitoring sites (see Cawson and Muir 2008a and 2008b), it is determined that biodiversity, including KFRS, can be protected through appropriate burn prescriptions or other means. For example, fire-dependent EVDs are unlikely to lose flora species if selected areas are frequently burnt at intervals below their TFIs using low-intensity, patchy burn prescriptions (provided the prescription across an area retains approximately 50% or more of unburnt vegetation or, if species at risk are protected from fire by, for example, landscape features). The unburnt vegetation patches should comprise enough mature adult plants to successively enable regeneration to appropriate population levels. In some instances a pilot burn over a small section of the area may

2 Ecological Management Zone is a fire management planning zone defined by the *Code of Practice for Fire Management on Public Land* (Revision 1) (2006).

be an appropriate method to test assumptions and effects of fire on plants and animals at the site. In areas where the application of fire in the Ecological Management Zone is below the minimum TFI, high standards of risk assessment should be applied, and the desired outcomes for biodiversity should guide the appropriate use of fire.

Eucalyptus regnans (Mountain Ash) is a dominant canopy tree in wet higher altitude forests of Victoria. Individuals live for up to 400 years. The species tends not to recover by re-shooting after severe fires, and regenerates from the soil seed bank. The top photograph shows a large tree killed at Cambarville, two months after the 2009 bushfire. In contrast, the lower photograph shows surviving trees after a less severe fire at Black Spur, one year after the 2009 bushfire. Together theses images illustrate how different outcomes arise for this species from fires of different severity.

(TOP PHOTO COURTESY ANDREW BLACKETT; LOWER PHOTO COURTESY STEPHEN PLATT)

Table 2.3 Summary descriptions of the 32 ecological vegetation divisions (refer to section 4 for detailed descriptions)

EVD no.	Ecological vegetation division	Principal ecological features	Fire behaviour
1	Coastal	Salt deposits (wind or tide), soils often barely consolidated and sandy, often calcareous, low growth rates, vegetation often notably succulent (high tissue water content), varying from open herblands to tall closed shrublands	Fire regimes variable in space, low severity and low likelihood on beach fronts to high severity on secondary dunes, flammable mainly in summer to early autumn, dominant species with little capacity for resprouting, slow recovery, regeneration not fire-cued
2	Heathland (sands)	Strongly leached (usually) acid sands, nutrient-deficient, very low growth and decomposition rates, soils sandy (with or without hardpan at depth), vegetation highly sclerophyllous, dry to very dry in summer, dominated by shrubs but includes vegetation with scattered trees, grasses effectively absent (except for *Triodia* species in semi-arid heaths), sedges and restiads common, mesic herbs rare	Regime of relatively high frequency and severity fires, flammable for most of the year (possibly not winter), rapid recovery to full species complement post-fire and relatively rapid recovery to maturity for most species, regeneration fire-cued, may irretrievably mature in long-term absence of fire
3	Grassy/ Heathy Dry Forest	Low open-forests on infertile sandy soils, often adjacent to Heathlands (sands), low growth and decomposition rates (except after fires), sclerophyllous shrubs and/or bracken dominate the lower strata, high species richness, grasses may be rare on sandy soils and/or not forming continuous swards, sedges and sclerophyllous monocots common throughout	Regime of high frequency and very high severity fires, flammable for most of the year (possibly not winter), rapid recovery post-fire, much regeneration fire-cued
4	Damp Scrub	Soils with permanently high fresh water table, significant organic matter in soil (may be peats), soil often lower pH than surrounding, dense sclerophyllous scrub, apart from peats little litter accumulation, high stem density	Moderate (to low) frequency and very high severity fires, flammable only in summer, and shrubs may burn even when the ground is saturated or flooded; peaty soils may smoulder for extended periods
5	Freshwater Wetland (permanent)	High water table (often with free water; non-saline), soils variable but often relatively fertile, tree layer usually absent but not always so, taller vegetation may be sclerophyllous, ground layer of mesic herbs	Largely non-flammable (tree and shrub layer usually too discontinuous to support a fire), although the margins may occasionally burn, can act as fire breaks
6	Treed Swampy Wetland	High water table, particularly in winter, soils relatively fertile, with significant organic matter (but not peats), lower strata mixed mesic and sclerophyllous, with a tree layer, often along either small or seasonal drainage lines or fringing Freshwater Wetland (permanent)	Only flammable in summer or after extended droughts, fires present a rare regeneration opportunity for many species but most species do not need fires for regeneration, in cooler seasons may act as firebreaks for adjoining vegetation
7	Tall Mixed Forest (eastern)	Tall open-forests on infertile soils (often duplex), moderate and reliable rainfall throughout the year, many-layered forests with species-rich lower strata, low rates of decomposition	Flammable for much of the year (although barely so in winter); severity, coverage and whether a crown fire or not (more or less) dependent on season of burn, rapid recovery, frequent fires and long-term fire absence change species composition and structure, including tree architecture
8	Foothills Forest	Fine-grained clays and duplex loams, on slopes, moderate fertility but poor structure (low water-holding capacity), open shrub stratum, ground stratum more or less dense and dominated by tussock grasses, dry in summer, damp in winter	Highly flammable in the warmer months and flammable from spring to autumn; if the ground layer can burn then difficult to keep fires out of the canopy, rapid recovery post-fire, fire a major regeneration opportunity
9	Forby Forest	Loamy surface soils (may be duplex), on slopes and valley floors, moderate fertility and moderate water-holding capacity, open shrub layer, tussock grasses may be present but other mesic grasses and forbs dominate the ground stratum, damp in winter, dry (but not parched) in summer	Flammable in the warmer months, fires tend to be 'all-consuming' but also provide a major regeneration opportunity, although many species able to regenerate without fires

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Table 2.3 Summary descriptions of the 32 ecological vegetation divisions *continued*

EVD no.	Ecological vegetation division	Principal ecological features	Fire behaviour
10	Moist Forest	Tall open-forests on fertile loams or loamy clays, moderately high rainfall and cool in summer, may include a scattered understorey and with dense tall shrubs, including mesic species, species-rich ground stratum, often including ferns and mesic forbs	Flammable only in summer on high fire danger days, high and elevated fuel levels, fires of low frequency but very high intensity and high severity, major regeneration opportunity post-fire, tend to develop more mesic composition in the long-term absence of fire
11	Riparian (higher rainfall)	Tall open-forests (often very tall) on fertile loams with a high water table at all times (may be boggy in winter), sheltered in gullies in the ranges, understorey present, tall dense shrubs dominate the lower strata and a mesic ground layer, often incorporating ferns and shade-loving mesic herbs	Flammable only in high summer on high fire danger days, high and elevated fuel levels, fires of low frequency but very high severity, tend to develop more mesic composition in the long-term absence of fire
12	Tall Mist Forest	Very tall open-forests on well-drained fertile loams (not boggy in winter), high rainfall, on slopes at moderate altitudes in the ranges, understorey present, plus a layer of tall mesic shrubs and incorporating tree-ferns (at lower altitudes), fern-dominated ground stratum in relatively undisturbed sites	Flammable only in summer on extreme fire danger days, fires of very low frequency but extreme severity, tend to develop more mesic composition in the long-term absence of fire (even towards rainforest), generally only the short-lived fire ephemerals and canopy eucalypts require fire for regeneration
13	Closed-forest	Closed-forests in fire-protected and often high rainfall sites, fertile loams with significant organic matter incorporated and high decomposition rates, lower strata dominated by ferns and mesic herbs, often with significant epiphytes (including many cryptogams) and lianes, sclerophyll shrubs rare	Flammable only in very rare conditions (e.g. after extended droughts), take many decades to recover from fire, few (if any) species adapted to regenerate post-fire, usually damaged by fire, may be managed as natural fire breaks (but subject to gradual destruction by attrition of margins)
14	High Altitude Shrubland / Woodland	Low open-forests or shrublands in exposed locations or at high altitudes, on a variety of soils (although not sandy), poor soil profile development on slopes but tending to duplex soils (with a clay sub-surface) on flatter country, moderate to high rainfall, with a species-rich and dense tall to small sclerophyll shrub stratum or strata	Flammable only in very rare conditions (e.g. after extended droughts), most stands take many decades to recover full species complements and structure after fire (although a few stands on rocky sites recover rapidly), few species adapted to regenerate post-fire, usually damaged by fire, fires favour shrubs over herbs and change vegetation structure towards more shrubby and less treed states
15	High Altitude Wetland	Open water to wet heathlands on peaty loams and peats, at high altitudes, high water tables throughout the year, low pH, with significant bryophytes (often including sphagnum), high precipitation (snow in winter, rain in summer) and moist throughout summer, sclerophyll shrubs and sedges/restiads may dominate, abundant mesic herbs	Flammable only in very rare conditions (e.g. after extended droughts), takes centuries to fully recover from fire, few species require fires for regeneration, habitat usually damaged by fire, soils may burn/smoulder for extended periods after fire front has passed, prone to erosion in the first few seasons post-fire
16	Alpine Treeless	Open woodlands to heathlands and grasslands on loams with high organic matter content, neutral to low pH (dependent on parent material), at high altitudes (or in frost hollows), high precipitation (snow in winter, rain in summer), does not dry out in summer, tussock-grasses prominent and scattered to dense sclerophyll shrubs, mesic forbs common and locally dominant	Flammable only in very rare conditions (e.g. after extended droughts), takes many decades (up to a century or so) to recover from fire, few species adapted to regenerate post-fire, usually damaged by fire, fires favour shrubs over herbs and change vegetation structure towards more shrubby, less herbaceous, states, prone to erosion in coldest sites post-fire (e.g. snow patches)

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Table 2.3 Summary descriptions of the 32 ecological vegetation divisions *continued*

EVD no.	Ecological vegetation division	Principal ecological features	Fire behaviour
17	Granitic Hillslopes	Open-forests with a well-developed (but not dense) tree stratum, on well-developed gradational soils with good drainage (effective moisture incorporation and storage), moderate rainfall (low rainfall granites tend to Semi-arid Woodland and high rainfalls tend to Grassy/ Heathy Dry Forest or Rainforest), open shrub strata above a well-developed ground stratum dominated by a species-rich mixture including tussock-grasses, seasonal monocots (lilies, orchids etc.) and forbs	Flammable in the warmer months, fire presents a major regeneration opportunity for many species, vegetation community simplified by frequent fire, if fires crown they can be high severity, lower rainfall examples have many species able to regenerate without fire, prone to soil erosion in the 1st year post-fire, canopy regeneration depends on seasonal conditions post-fire, long-term absence of fire may favours the non-eucalypt trees
18	Rocky Knoll	Open to closed shrublands (occasionally with emergent eucalypts, often of mallee form) on exposed rocky tops and slopes at moderate to low altitude, poor soil profile development, shrubs often growing in rocky declivities, sclerophyll shrubs dominate, with few herbs	Flammable for much of the year, depending on vegetation continuity, in open stands (due to rocks) many fire refuges leading to a very diverse flora including fire-sensitive species, in more continuous stands a major regeneration opportunity post-fire including fire ephemerals, fire severity varies with vegetation continuity
19	Western Plains Woodland	Woodlands on basalt-derived (usually) loams and loamy clays, on plains or low slopes, fertile soils which are moist in winter but parched at the surface and may deeply crack in summer, tree stratum often low and sparse, no understorey but with scattered shrubs (occasionally dense), ground stratum dominated by grasses and forbs	Flammable in the warmer months, fires usually low severity and very rapid (often leaving the trees and many shrubs largely unburnt), trees rarely burnt by fires but many able to resprout after rare high severity fires, major regeneration opportunity for herbs post-fire, fires necessary to maintain species richness
20	Basalt Grassland	Grasslands (may have a few emergent trees) on basalt-derived loams and loamy clays of plains, very fertile, neutral to alkaline close to the surface, moderate rainfall, moist to boggy in winter and in summer parched at the surface and may develop deep cracks or gilgais, no understorey, shrubs largely absent, canopy of tussock grasses and forbs in inter-tussock spaces	Flammable in the warmer months, fires usually low severity and very rapid, major regeneration opportunity for herbs post-fire, frequent fires necessary to maintain species richness, lack of fires impoverishes the community by over-development of grass 'thatch'
21	Alluvial Plains Grassland	Grasslands (may have a few emergent trees) on alluvial loamy clays of plains, fertile, neutral to slightly acid at the surface, moderate to low rainfall, moist in winter and parched and may develop deep cracks or gilgais in summer, no understorey, shrubs rare (if present, not sclerophyll), canopy of tussock grasses and forbs in inter-tussock spaces	Flammable in the warmer months, non-flammable from mid-autumn to mid-spring, fires usually low severity and very rapid, regeneration opportunity for herbs post-fire but many able to regenerate between fires, largely immune to fire frequency
22	Dry Woodland (non-eucalypt)	Open-forest to open-woodland, low rainfall, often multi-layered, non-eucalypt canopy, open understorey of tall shrubs or small trees, lower shrub stratum containing many non-sclerophyll species, tussock grasses common to rare, shrubs and undershrubs and herbs with more or less succulent foliage, abundant cryptogamic soil cover (soil crust)	Flammable only in very rare conditions (i.e. in seasons with extended summer rains), take many decades to recover from fire, many occurrences have been eliminated by fire, few (if any) species geared to regenerate post-fire, usually damaged by fire, fire is not a major regeneration opportunity for typical species, subject to destruction by occasional incursive fires

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Table 2.3 Summary descriptions of the 32 ecological vegetation divisions *continued*

EVD no.	Ecological vegetation division	Principal ecological features	Fire behaviour
23	Inland Plains Woodland	Woodlands on alluvial loamy duplex clays of plains and low slopes, fertile, acid at the surface, moderate rainfall, moist in winter and parched in summer, well developed eucalypt canopy of very few species, scattered understorey and lower shrub strata, tussock grasses common and seasonal forbs in the cooler months	Flammable in the warmer months, fires rare but may occur after heavy grass growth in benign seasons, fires of low severity and very patchy (often leaving the trees and many shrubs largely unburnt), trees rarely burnt by fires but many able to resprout after fires, where non-eucalypts dominate fires more problematic as they may kill trees, fires unnecessary for regeneration, but many herbs will utilise this opportunity if it is presented, fires unnecessary but do little damage (except in non-eucalypt woodlands)
24	Ironbark / Box	Open-forests on fine-grained clays of low slopes, often with ironstone gravel, strongly duplex, moist in winter and parched in summer, moderate rainfall, well-developed eucalypt tree stratum, understorey lacking, more or less dense shrub stratum of sclerophyll species, lower shrubs with some non-sclerophyll species and species-rich seasonal herbs in winter, tussock grasses scattered, low to very lo fuel loads	Flammable in the warmer months, fires rare but may occur after heavy grass growth in wet seasons, fires of low severity and often patchy, trees resprout readily after fires, fires unnecessary for regeneration, but many herbs will utilise the opportunity if it is presented, fires do little damage when at low frequency
25	Riverine Woodland / Forest	Open-forest to woodlands associated with drainage lines that may flood for extended periods seasonally (particularly along inland-flowing rivers), may be years between floods, on alluvial loams and clays, well-developed tree stratum usually of only one eucalypt species, open understorey, few shrubs, lower strata dominated either by divaricate shrubs or summer-growing grasses and other herbs, fringed by distinctive non-sclerophyll shrubs and often associated with Freshwater Wetlands	Flammable only occasionally (i.e. in seasons with extended summer rains or post-flooding), few species adapted to regenerate post-fire, floods the main regeneration events, fire is not a major regeneration opportunity for typical species.; if fires occur usually rapid and relatively low severity as driven by fine fuels in the ground layer, intact stands less flammable than logged and/or grazed stands (as lower strata in intact stands reduce grass growth)
26	Freshwater Wetland (ephemeral)	Open herbland to shrubland (occasionally with emergent eucalypts or other small trees from Riverine Woodland / Forest) in areas subject to sporadic but extended inundation by fresh water, on fertile loams and clays which vary from anoxic and saturated (when inundated) to deeply cracking and parched for the long periods between inundation, dominant shrubs often divaricate, with abundant herbs and subshrubs (but of relatively few species) when sites moist and as the floodwaters recede, drying through a succession of vegetation communities to (often) crustal cryptogams or bare soil for extended periods	Largely non-flammable, although the margins may occasionally burn
27	Saline Wetland	Open herbland to shrubland dominated by succulent plants, on sodic soils which are regularly moist (from tides or ground water) from saline water and alternately dry (between inundations), high salinity at all times, often adjoining unvegetated areas with exposed salt, includes fringing zones of gradually less saline influence	Largely non-flammable, although the margins may occasionally burn in exceptional years when extended summer rains promote vigorous grass growth, in which event they are damaged by even rare fires

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Table 2.3 Summary descriptions of the 32 ecological vegetation divisions *continued*

EVD no.	Ecological vegetation division	Principal ecological features	Fire behaviour
28	Chenopod Shrubland	Open shrubland to 1.5 m tall dominated by mesic or succulent chenopods, occasional emergent non-eucalypt trees, on relatively fertile fine-grained soils (sometimes moderately sodic), low rainfall, seasonal subshrubs and herbs between the large shrubs	Flammable only in very rare conditions (i.e. in seasons with extended summer rains), takes many decades to recover from fire, few (if any) species adapted to regenerate post-fire, usually damaged by fire, fire is not a major regeneration opportunity for typical species, subject to destruction through occasional incursive fires
29	Saltbush Mallee	Tall open mallee shrubland on more or less fertile red loams, strongly calcareous at depth and tending to less calcareous at the surface, in broad dune swales and loamy plains, low rainfall, largely lacking understorey, scattered mesic shrubs throughout, particularly including chenopods and arid-affinity genera, *Triodia* absent, sclerophyll shrubs uncommon to lacking, often adjoining saline wetland or Chenopod Shrubland lower in the catena and either Hummock-grass Mallee or Semi-arid Woodland (non-eucalypt) higher in the catena	Flammable only in very rare conditions (i.e. in seasons with extended summer rains), take many decades to recover from fire, few species adapted to regenerate post-fire but very rare fires required to maintain the canopy; shrub and herb strata damaged by fire, fire is not a regeneration opportunity for typical species, subject to very rare incursive fires predictable on season
30	Hummock-grass Mallee	Open mallee shrubland on more or less fertile red sandy loams, on dune slopes and slacks and broad low dune crests and on broad sand plains, calcareous at depth, tending to neutral or slightly acid at the surface, low rainfall, scattered tall shrub stratum, with more or less continuous hummock-grass stratum or (particularly soon after fire) diverse small shrubs and long-lived herbs	Flammable in all seasons, relatively fast fires of moderate severity but often with many refuges as fuel continuity is weak, many species adapted to regenerate post-fire and require fire for maintenance, growth rates low so only occasional fires required, fires driven by hummock-grass fuel
31	Lowan Mallee	Open mallee shrubland on infertile, mostly siliceous pale loamy to unconsolidated sands, on dunes and sandplains, mildly acid sands throughout the soil profile, low rainfall, scattered tall shrubs and an open lower shrub stratum, all of sclerophyll species (chenopods rare), either an open hummock-grass ground stratum and/or abundant perennial herbs (tussock-grasses inconspicuous) and low sclerophyll shrubs	Flammable in all seasons including (occasionally) winter, fires of moderate severity, refuges depend on fuel continuity, many species adapted to regenerate post-fire and require fire for maintenance, growth rates low so only occasional fires required
32	Broombush Whipstick	Dense shrubland (occasionally with emergent eucalypts) or very dense mallee shrubland, all 2–4 m tall on infertile sands (often lateritic and with ironstone gravel) or on gravelly sediments, mildly acidic throughout the soil profile which is markedly duplex, low rainfall, lower shrubs sparse, diverse but decidedly ephemeral dwarf herb ground stratum, hummock-grasses and chenopods absent	Flammable in all seasons except winter, not flammable under moderate weather conditions but highly flammable under more extreme weather conditions, fires rapid and often of high severity, few refuges, many species. geared to regenerate post-fire and require fire for maintenance, fires of moderate frequency have little adverse effect on species richness, long-term absence of fire may degrade the EVD

Notes:

Vegetation types and fuel conditions are continua and not the discretely bounded entities implied in mapping classification schemes. Hence anomalous stands that do not match these units well can be found in nature.

Fire behaviours are described for typical wildfire conditions in typical vegetation. In extreme weather conditions and in some (unrepresentative) stands of a vegetation community unusual (and atypical) fire behaviours may occur. In some vegetation communities wildfires are rare, but these rare occurrences are summarised here. In addition, fire impetus may mean that high-severity fires burn some distance into generally non-susceptible vegetation before fuel conditions extinguish those fires.

Table 2.4 Summary table of the ecological fire group (EFG) attribute fields and EVC map units for EVD 1 (Coastal).[1]

EFG attribute field	Corresponding ecological vegetation class (EVC) map unit	EVC map unit code
Grassland	Coastal Tussock Grassland	163
Grassland	Bird Colony Shrubland/Depauperate Coastal Tussock Grassland Mosaic	303
Grassland	Calcareous Swale Grassland	309
Grassland	Coastal Dune Grassland	879
Scrub	Coastal Dune Scrub Mosaic	1
Scrub	Dry Coast Complex	51
Scrub	Bird Colony Shrubland	154
Scrub	Bird Colony Succulent Herbland	155
Scrub	Coastal Dune Scrub	160
Scrub	Coastal Headland Scrub	161
Scrub	Coastal Headland Scrub/Headland Coastal Tussock Grassland Mosaic	162
Scrub	Sedgy Swale Shrubland	199
Scrub	Weedy Coastal Dune Scrub Mosaic	217
Scrub	Berm Grassy Shrubland	311
Scrub	Coastal Mallee Scrub	665
Scrub	Coastal Landfill / Sand Accretion	797
Scrub	Spray-zone Coastal Shrubland	876
Scrub	Granitic Coastal Headland Scrub/Depauperate Coastal Tussock Grassland Mosaic	880
Scrub	Coastal Saltmarsh / Coastal Dune Grassland / Coastal Dune Scrub / Coastal Headland Scrub Mosaic (syn. Coastal Basalt Mosaic)	900
Scrub	Coastal Dune Scrub / Bird Colony Succulent Herbland Mosaic	909
Scrub	Bird Colony Succulent Herbland/Coastal Tussock Grassland Mosaic	910
Scrub	Coastal Headland Scrub / Swampy Scrub Mosaic	911
Scrub	Dune Blowout	984
Scrub	Sandy Beach	985
Scrub	Dunes	994
Woodland	Coast Banksia Woodland	2
Woodland	Coast Banksia Woodland/ East Gippsland Coastal Warm Temperate Rainforest Mosaic	144
Woodland	Weedy Coast Banksia Woodland	216
Woodland	Dune Soak Woodland	673
Woodland	Coastal Alkaline Scrub (syn. Calcarenite Dune Woodland)	858
Woodland	Coast Banksia Woodland/Swamp Scrub Mosaic	904
Woodland	Coastal Headland Scrub/Coast Banksia Woodland Mosaic	919
Woodland	Coast Banksia Woodland/Coastal Dune Scrub Mosaic	921
Woodland	Coastal Alkaline Scrub / Bird Colony Succulent Herbland Mosaic	922

Notes

1 As at July 2010. Complete data tables can be accessed and downloaded from the DSE website (www.dse.vic.gov.au/fireecology).

Table 2.5 Summary table of tolerable fire intervals (TFI) of ecological vegetation divisions (EVD) and ecological fire group (EFG) attribute fields.

EVD no.	EVD	Max TFI (years)	Min TFI for High Severity Fires (years)	Min TFI for Low Severity, Patchy Fires (years)
1	Coastal	**(EFG)** **40** (grassland) **70** (woodland) **90** (scrub)	**(EFG)** **5** (grassland) **25** (woodland) **10** (scrub)	**(EFG)** **5** (grassland) **10** (woodland) **10** (scrub)
2	Heathland (sands)	**45**	**12** (all except Little and Big Deserts) **15** (Little and Big Deserts only)	**8** (where *Xanthorrhoea resinosa* dominant) **12** (all except *X. resinosa* dominant or Little and Big Deserts) **15** (Little & Big Deserts only)
3	Grassy/Heathy Dry Forest	**45**	**15**	**10**
4	Damp Scrub	**90**	**20**	**15**
5	Freshwater Wetland (permanent)	∞	**8**	**8**
6	Treed Swampy Wetland	**150**	**30**	**20**
7	Tall Mixed Forest (eastern)	**60**	**25**	**8**
8	Foothills Forest	**100**	**25**	**10**
9	Forby Forest	**150**	**15**	**15**
10	Moist Forest	**150**	**25**	**25**
11	Riparian (higher rainfall)	**120**	**30**	**30**
12	Tall Mist Forest	**300**	**80**	**80**
13	Closed-forest	∞	**80**	**80**
14	High Altitude Shrubland / Woodland	**125**	**50**	**35**
15	High Altitude Wetland	∞	**60**	**60**
16	Alpine Treeless	**120**	**55**	**55**
17	Granitic Hillslopes	**90** (eucalypt canopy) ∞ (non-eucalypt canopy)	**25** (eucalypt canopy) **45** (non-eucalypt canopy)	**15** (eucalypt and non-eucalypt canopy)
18	Rocky Knoll	**80**	**20**	**12**
19	Western Plains Woodland	**12**	**30**	**4**
20	Basalt Grassland	**7**	**3**	**2**
21	Alluvial Plains Grassland	**30**	**3**	**2**
22	Dry Woodland (non-eucalypt)	∞	**80**	**20**
23	Inland Plains Woodland	**150**	**30**	**5**
24	Ironbark / Box	**150**	**30**	**12**
25	Riverine Woodland / Forest	∞	**30**	**10**
26	Freshwater Wetland (ephemeral)	∞	**2**	**2**
27	Saline Wetland	∞	**20**	**10**
28	Chenopod Shrubland	∞	**30**	**30**
29	Saltbush Mallee	**200**	**40**	**40**
30	Hummock-grass Mallee	**90**	**25**	**25**
31	Lowan Mallee	**65**	**20**	**20**
32	Broombush Whipstick	**90**	**20**	**20**

Notes

Vegetation types and fuel conditions are continua and not the discretely-bounded entities implied in our mapping classification schemes. Hence, anomalous stands that do not well-match these units can be found in nature. Fire behaviours are described for typical conditions in typical vegetation. In extreme weather conditions and in some (unrepresentative) stands of a vegetation community, unusual (and atypical) fire behaviour may occur. In addition, fire impetus may mean that high-severity fires burn some distance into generally non-susceptible vegetation before fuel conditions extinguish those fires.

Notes to Table 2.5 *continued*

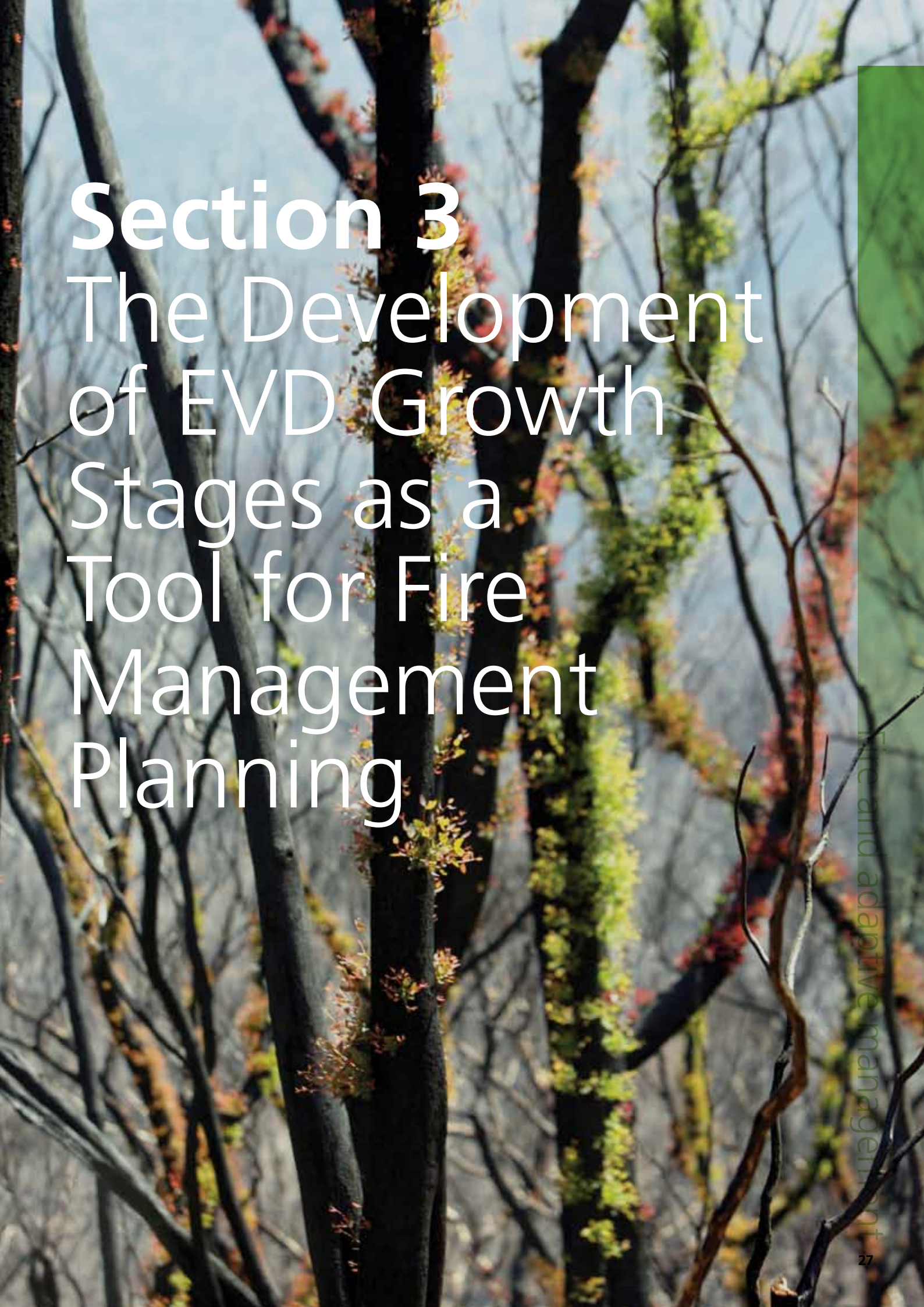
TFIs are provided for vegetation communities on the assumption that the management goal is to maintain the current occurrences of those communities. Fires may also be used to change vegetation community distributions (e.g. the invasion of coastal shrubs, such as *Leptospermum laevigatum*, into woodlands or grasslands). In such situations, following explicit management goals, fires may be applied outside the recommended intervals in order to change vegetation structure or composition (refer Section 2, page 16 for detailed discussion).

Min TFI for high severity fires
This refers to the period below which seed-regenerating dominant and other significant species will not have grown to the size whereby they will be able to tolerate a second high severity fire. In many vegetation communities rare high severity fires consume the standing vegetation leaving little but charred remains above-ground and leaving few, widely-scattered unburnt refuges. In such high severity fires, all but some of the largest individual (strata-) dominants may be killed. Unless there is a fire interval of this size at some time within the generation times of the longest-lived component species, then these species will gradually decrease (to extinction) within the vegetation. Occasional long gaps between fires are necessary to maintain both long-lived (strata-) dominants and critical habitat features (such as arboreal hollows and large coarse woody debris). In this sense, 'high severity fires' is more or less synonymous with 'stand-replacement fires' that are a result of severe bushfires. In many vegetation communities, the lack of spatial separation of vegetation strata means that nearly all fires behave as stand replacement fires, e.g. in grasslands and heathlands.

Min TFI for low severity, patchy fires
This refers to the period below which all dominant & characteristic species successfully resprout but for many species. re-establishment from seed is contra-indicated in repeatedly burnt patches. In some vegetation communities it is possible to have fires that burn only the ground strata and do not extend into the canopy (or even into the understorey or tall shrub strata). Such low severity and/or patchy fires also leave many unburnt refuges within the fire perimeters. This patchiness and low severity mean that the survival of (large) long-lived species, such as the canopy dominants, is largely unaffected by the fire. The minimum (low severity and patchy) TFI is thus determined by the maturation times of the shorter-lived species (usually the lower shrubs and ground layer herbs). In this sense, 'low severity, patchy fires' is more or less synonymous with 'cool season' or 'planned fires'. Such fires may only be reasonably applied where spatial separation of vegetation strata ensures that canopy fires are unlikely in all but extreme fire weather conditions (see also section 5 for detailed discussions on considerations, assumptions and caveats).

Vegetation regrowth shortly after the 2006/07 bushfires, ▶
Binns Road, north of Walhalla, Victoria.

(PHOTO COURTESY STEPHEN PLATT)



Section 3
The Development of EVD Growth Stages as a Tool for Fire Management Planning

3

Section 3 The Development of EVD Growth Stages as a Tool for Fire Management Planning

Introduction

The application of ecologically appropriate fire regimes involves decisions about where, how much and at what time to burn, or not to burn, across a landscape that is continually changing, particularly as a result of unpredictable bushfire events. The desired outcome is to create a system of vegetation communities, in different stages of maturity, that can support the diverse assemblages of flora and fauna that occur in Victoria over time.

The habitat that fauna prefer to occupy or utilise varies from place to place, and also depends on the vegetation community structure and composition. The vegetation will change gradually and continuously over time, but distinct stages can be recognised and are helpful in planning. They are referred to here as 'habitat growth stages', but they are also known as 'seral stages' or 'successional stages'.

To ensure that all the required habitats are available over time, there must be a 'continual supply' of habitat growth stages, in suitable proportions, across the landscape, over time. For the planner, this means not just having a map of areas burnt or unburnt, but also being able to map the distribution of habitat growth stages in a landscape at any point in time and selecting a place that, if burnt now, would result in an appropriate, continuous supply of habitat growth stages. This is a complex task and is best undertaken with the help of spatial analysis tools supplemented with regular field monitoring and assessment.

Until recently, the identification of candidate burn areas involved estimating the distribution of vegetation age classes (in three-year intervals) across a land management unit (LMU), and comparing those age classes to the vegetation's 'theoretical age class distribution' (Tolhurst 1999, Tolhurst and Friend 2001, Wouters *et al*. 2002). Vegetation age classes that deviated significantly from their theoretical age class distribution were used to guide (and in fact substantially determined) the location of candidate planned burns.

The theoretical age class distribution (a negative exponential frequency distribution) is generated from a numerical model that has contingent assumptions. The main assumption is that the theoretical age class distribution represents the typical composition of vegetation age classes resulting from the natural occurrence of random fire events over time.

While that approach provided useful guidelines for fire management planning, the three-year age class distribution did not provide enough ecological context, such as the role and contribution of habitat growth stages in providing refuge, shelter, foraging and breeding habitat for native fauna (see MacHunter *et al*. 2009). Another limitation of the approach is that three-year age classes do not describe the actual variation in maturation rates and stages between vegetation communities observed in the field. Some vegetation communities such as grasslands mature rapidly and pass into senescence equally rapidly (Lunt 1991 and 1994, Morgan 1994, Stuwe 1994, Morgan 1999a). At the other extreme, some vegetation communities such as rainforests mature very slowly if burnt and never senesce in the absence of fires (Bowman 2000), and there are various other maturation rates and stages in between (e.g. rapid maturation with no long-term senescence, as in wetlands). For this reason, a revised and more detailed and descriptive approach based on published data and expert knowledge was developed to describe the typical maturation rates and habitat growth stages for each EVD.

This section describes how EVDs were assigned characteristic habitat growth stages so they may further inform the fire management planning process. This work was undertaken concurrently with a project by MacHunter *et al*. (2009) that incorporated the preferred habitat requirements of vertebrate fauna and the identification of KFRS.

Growth stage assignment process

The 32 EVDs described in Section 2 were scrutinised, and distinctive growth stages for each were determined and described, based on published data, field observations and the data in the FIS Vital Attributes database fields. A summary of the characteristic growth stages for each EVD is presented in Table 3.1, and detailed descriptions are presented in Section 4.

The maturation rates and growth stage descriptions recognise that all the life cycle transitions of a plant species do not happen gradually, and there are times when major transitions in growth habit or phenology occur. Primary and secondary juvenile periods are maturation growth stages that mark significant transitions in a flora species' life history, and are of long standing in the literature (Mueller-Dombois and Ellenberg 1974, Kent and Coker 1994). When such transitions occur more or less contemporaneously in a number of species within a vegetation community after fire, then it is possible to recognise growth stages within that community. We are therefore able to delimit and recognise such stages as 'establishment', 'juvenility', 'maturity' and 'senescence'.

Growth stage nomenclature

The use of habitat growth stages enables ecological comparisons between EVDs (Table 3). Like most ecological classification units, growth stages are not necessarily discrete habitat states; they are merely useful concepts for planning and management. The nomenclature adopted for naming and describing each growth stage is briefly described below:

renewal — Immediately post-fire; in many vegetation communities this is the major opportunity for establishment from seedlings.

founding — First stages of establishment for some species (notably the fire ephemerals), but pre-breeding (immaturity) for many critical species, often including the dominants; used for communities in which juvenility is extended or long-lasting and for which it is possible to recognise an early juvenility versus late juvenility stage.

juvenility — Soon after immediate post-fire establishment; the period before which the full floristic complement is reproductive; in most cases includes the primary juvenile period of the dominant species.

adolescence — Relatively young vegetation, but beyond the poorly reproductive stages; the full floristic complement may be reproductive but not at the higher rate that occurs in (later) mature vegetation.

maturity — Often the conceptual 'standard' for vegetation communities (e.g. see the habitat hectares guidelines: Parkes *et al*. 2003); the dominant species are fully reproductive.

vigorous maturity — *Early maturity*; used for communities in which maturity is extended or long-lasting, and for which it is possible to recognise an early maturity versus late maturity stage. In a vigorous maturity growth stage the vegetation structure is still changing noticeably and propagule banks of the dominant species are still accumulating.

stasis — *Late maturity*; used for communities in which maturity is extended or long-lasting and for which it is possible to recognise an early maturity versus late maturity stage. In stasis, vegetation structure changes little over time (decade to decade) and propagule banks of the dominant species are neither increasing nor decreasing.

waning — *Post-maturity*; reproduction of the dominant species is in decline and propagule banks are decreasing. Restitution of the community is likely after another fire.

senescence — *Post-maturity*; at a stage where restitution of the community is problematic (or unlikely) after fire.

established — *Maturity*; the community is not likely to change substantially in species composition or structure without disturbance such as fire.

It has been difficult to develop growth stage names that can be unambiguously interpreted by different users. Terms such as 'vigorous maturity' and 'senescence' may lead to the interpretation that the former is valued and the latter is to be avoided. No such preference is implied here. The terms 'senescence' and 'waning' refer to the persistence of that particular EVD. A 'senescent' EVD is one that is in the process of changing (perhaps irreversibly) into another EVD. Whether the change is desirable or not is appropriately a management issue, and considerations other than ecology may influence a decision. A 'senescent' stand of vegetation (of an EVD) is not necessarily undesirable, and an 'established' stand of vegetation (of an EVD) is not necessarily a successful management outcome. These are (social) value judgements, not solely ecological judgements.

Foothills forest in *adolescent* growth stage at Mount Dandenong, Victoria.

(PHOTO COURTESY ANNETTE MUIR)

Foothills forest in *statsis* growth stage at Mount Dandenong, Victoria.

(PHOTO COURTESY ANNETTE MUIR)

Table 3.1: Summary of growth stages for the 32 ecological vegetation divisions

EVD no.	Ecological Vegetation Division	Growth Stages							
1	Coastal	Renewal		Juvenility	Adolescence	Maturity		Waning	Senescence
2	Heathland (sands)	Renewal		Juvenility	Adolescence	Maturity		Waning	Senescence
3	Grassy/Heathy Dry Forest	Renewal		Juvenility	Adolescence	Maturity		Waning	Senescence
4	Damp Scrub	Renewal		Juvenility	Adolescence	Vigorous Maturity	Stasis	Senescence	
5	Freshwater Wetland (permanent)	Renewal		Juvenility		Maturity			
6	Treed Swampy Wetland	Renewal		Juvenility	Adolescence	Vigorous Maturity	Stasis	Waning	
7	Tall Mixed Forest (eastern)	Renewal		Juvenility	Adolescence	Vigorous Maturity	Stasis	Waning	
8	Foothills Forest	Renewal		Juvenility	Adolescence	Vigorous Maturity	Stasis	Senescence	
9	Forby Forest	Renewal		Juvenility	Adolescence	Vigorous Maturity	Stasis	Senescence	
10	Moist Forest	Renewal	Founding	Juvenility	Adolescence	Maturity		Waning	Senescence
11	Riparian (higher rainfall)	Renewal	Founding	Juvenility	Adolescence	Maturity		Waning	Senescence
12	Tall Mist Forest	Renewal	Founding	Juvenility	Adolescence	Maturity		Waning	Senescence
13	Closed-forest	Renewal	Founding	Juvenility	Adolescence	Maturity			
14	High Altitude Shrubland/Woodland	Renewal	Founding	Juvenility	Adolescence	Maturity		Waning	
15	High Altitude Wetland	Renewal	Founding	Juvenility	Adolescence	Maturity			
16	Alpine Treeless	Renewal	Founding	Juvenility	Adolescence	Maturity			
17	Granitic Hillslopes	Renewal		Juvenility	Adolescence	Vigorous Maturity	Stasis	Senescence	
18	Rocky Knoll	Renewal		Juvenility	Adolescence	Vigorous Maturity	Stasis	Senescence	
19	Western Plains Woodland	Renewal		Juvenility	Adolescence	Maturity		Waning	
20	Basalt Grassland	Renewal		Juvenility	Adolescence	Maturity		Senescence	
21	Alluvial Plains Grassland	Renewal		Juvenility		Maturity		Senescence	
22	Dry Woodland (non-eucalypt)	Renewal		Juvenility	Adolescence	Maturity			
23	Inland Plains Woodland	Renewal		Juvenility	Adolescence	Maturity		Waning	
24	Ironbark/Box	Renewal		Juvenility	Adolescence	Vigorous Maturity	Stasis	Established	
25	Riverine Woodland/ Forest	Renewal		Juvenility	Adolescence	Early Maturity	Maturity	Established	
26	Freshwater Wetland (ephemeral)	Renewal			Maturity				
27	Saline Wetland	Renewal		Juvenility	Adolescence	Maturity			
28	Chenopod Shrubland	Renewal		Juvenility	Adolescence	Maturity			
29	Saltbush Mallee	Renewal		Juvenility	Adolescence	Maturity			
30	Hummock-grass Mallee	Renewal		Juvenility	Adolescence	Vigorous Maturity	Stasis	Senescence	
31	Lowan Mallee	Renewal		Juvenility	Adolescence	Vigorous Maturity	Stasis	Senescence	
32	Broombush Whipstick	Renewal		Juvenility	Adolescence	Vigorous Maturity	Stasis	Waning	

Note: The widths of the row sections are *not* to scale. The row sections indicate the sequence of growth stages, not their durations.

Growth stage duration

The persistence (length of time) of each growth stage depends on environmental features (such as mean annual rainfall, rainfall in the seasons that encompass each growth stage, supplementary water from flooding, soil fertility) and intrinsic features of the vegetation (such as maximum potential growth rates and the differential impacts of limiting nutrients). Exceptionally, growth stage persistence may also depend on other environmental features, such as recent fire history (Macfarlane 1994). As a result, different vegetation communities pass through growth stages at different rates. Growth stages, including the persistence of each, depend on the vegetation community.

Field testing

Some of the growth stages described here have been tested in the field (including by Andrew McMahon of *Ecology Australia* and by Arn Tolsma of the *Arthur Rylah Institute for Environmental Research*, leading to finer tuning around the timing of growth stage transitions and characteristics for field recognition of each growth stage. Field testing in 2009 (for example, the current DSE project surveying 'Old Growth' forests in Gippsland) further indicated that these growth stages are recognisable. Nevertheless, they would all benefit from further field testing. Other growth stages may be recognisable and the timing of growth stage transitions can be further clarified.

Fire Management Applications

Generating growth stages using Geographic Information Systems

EVD growth stages and their spatial distribution at a State-wide and regional scale can be generated by intersecting the EVD data layer with DSE's LASTBURNT100 data layer which displays the spatial extent of the last fires recorded primarily on public land for Victoria (wildfire or prescribed burn). By calculating the time since the last burn was recorded across all EVD polygons, the growth stage of an EVD can be modelled by comparing to a look-up table which lists the corresponding time intervals for each growth stage. An example of an EVD growth stage map product is shown in Figure 3.1.

Another use of the LASTBURNT100 data layer with EVD polygons has been to construct a fire history analysis tool (FireHAT) for EVDs. The tool allows the interrogation of any point in the landscape to display all recorded fire events and estimate if each event occurred below, within or above the TFI of the resident EVDs through time (Figure 3.2). The FireHAT tool is useful for both fire management planning and identifying sites for research and monitoring.

Decision making

The proportional composition of EVD growth stages preferred for a given site or defined area is a land management decision, based on many inputs, prime amongst which are ecological inputs. For a variety of ecological reasons it may be a legitimate management objective to skew the age class distribution towards younger age classes. For example, to assist restoration of senescent Basalt Grassland, the growth stage distribution may be intentionally skewed towards younger stages, into which one may plant some of the native component that has been lost through community senescence (Lunt 1994, Lunt and Morgan 1998, Morgan 1999b). Conversely, it may be a legitimate management objective to skew a growth stage distribution towards older stages. For example, in fostering the development of hollows now lacking in Ironbark/Box forests (Dashper 2003) or to increase the likelihood of an abundant younger growth stage maturing into an older growth stage or even another EVD (e.g. Tall Mist Forest to mature into Closed-forest).

Such decision-making should not be based on any subjective consideration such as the longevity of operations plans or on fixed term intervals. Instead, this decision is context dependent and informed by the specifics of the management objectives and long-term ecological sustainability.

Figure 3.1 Diagrammatic representation of how the growth stage data layer is developed using GIS to produce map information products.

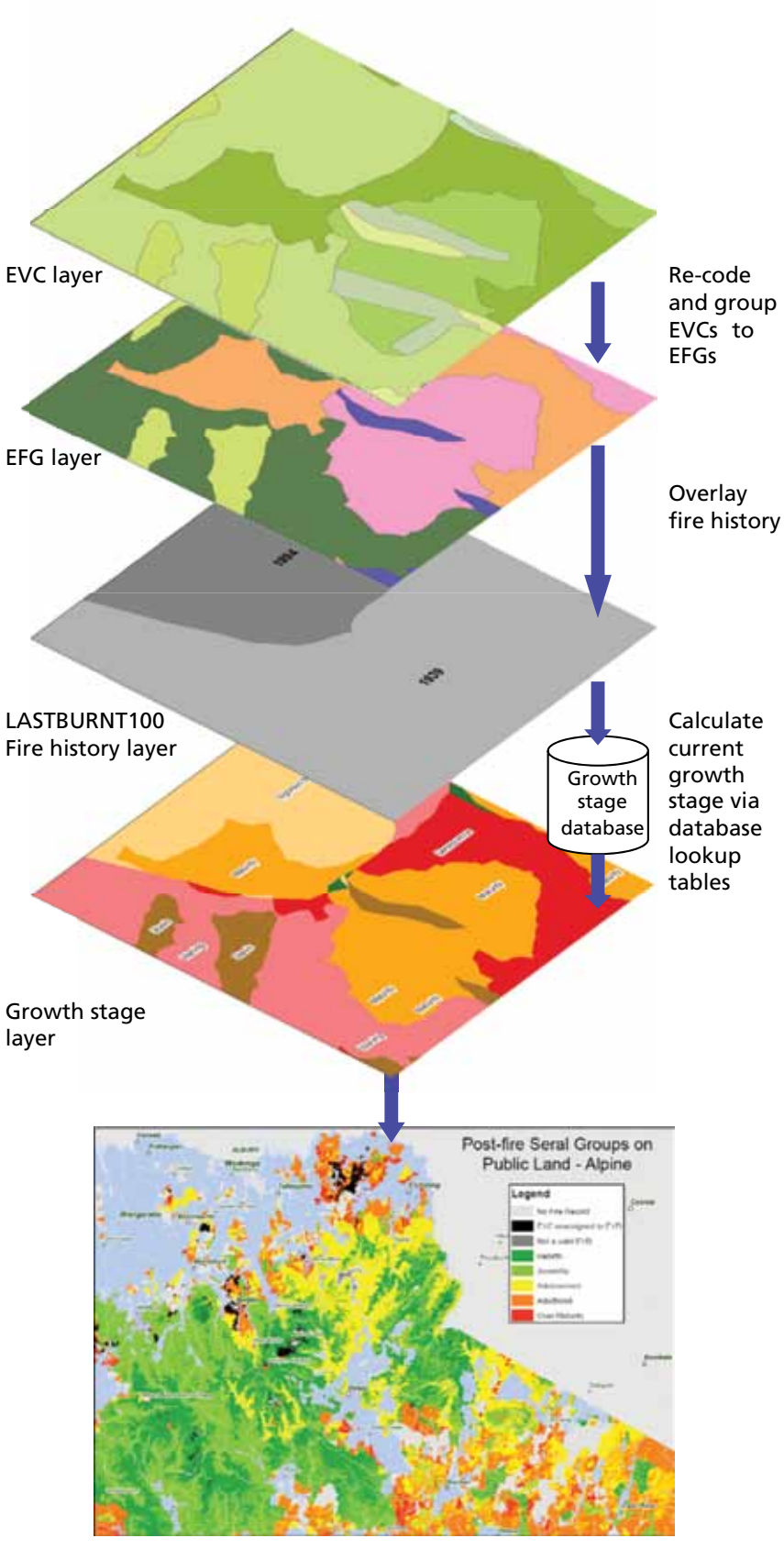
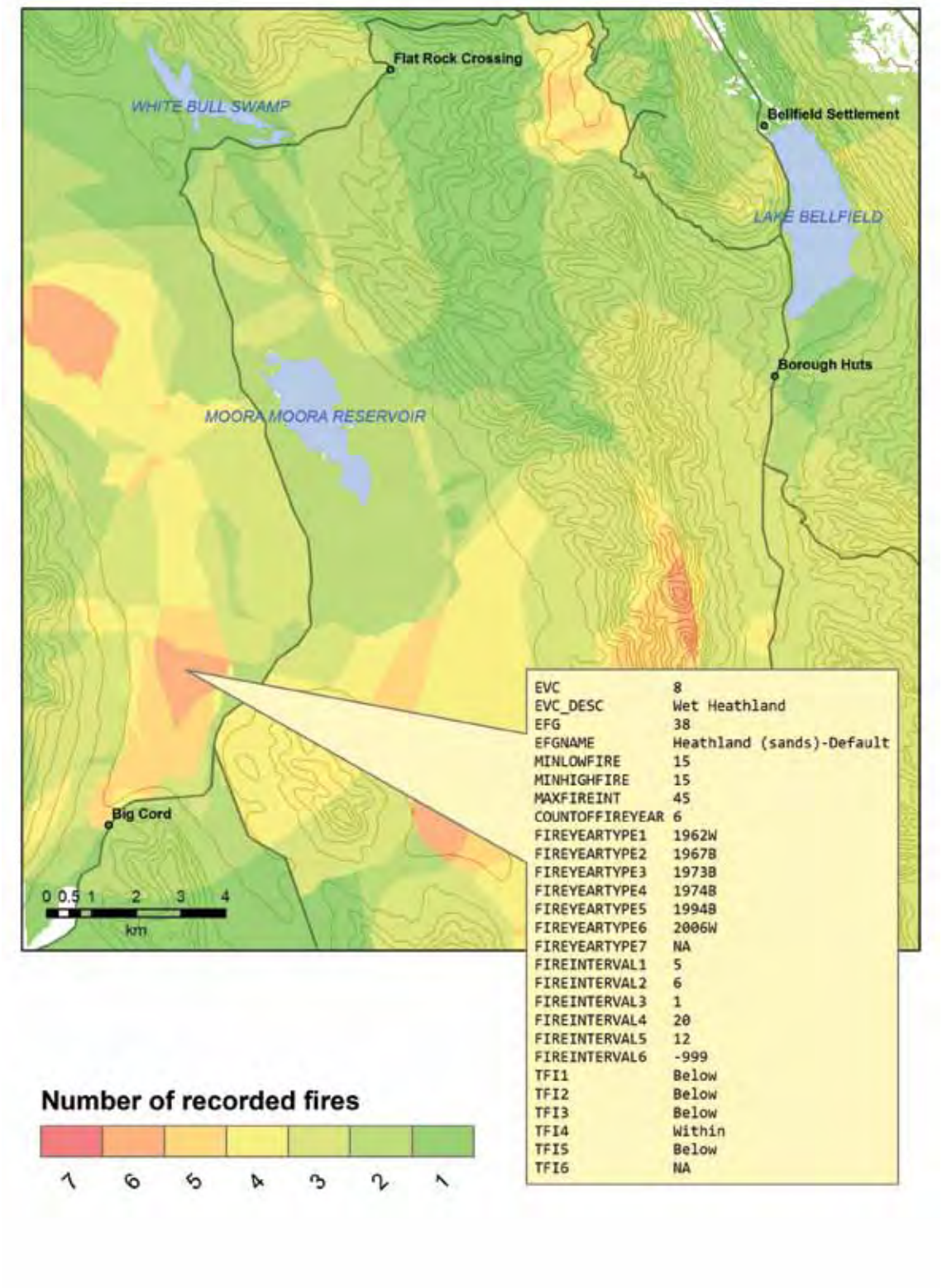


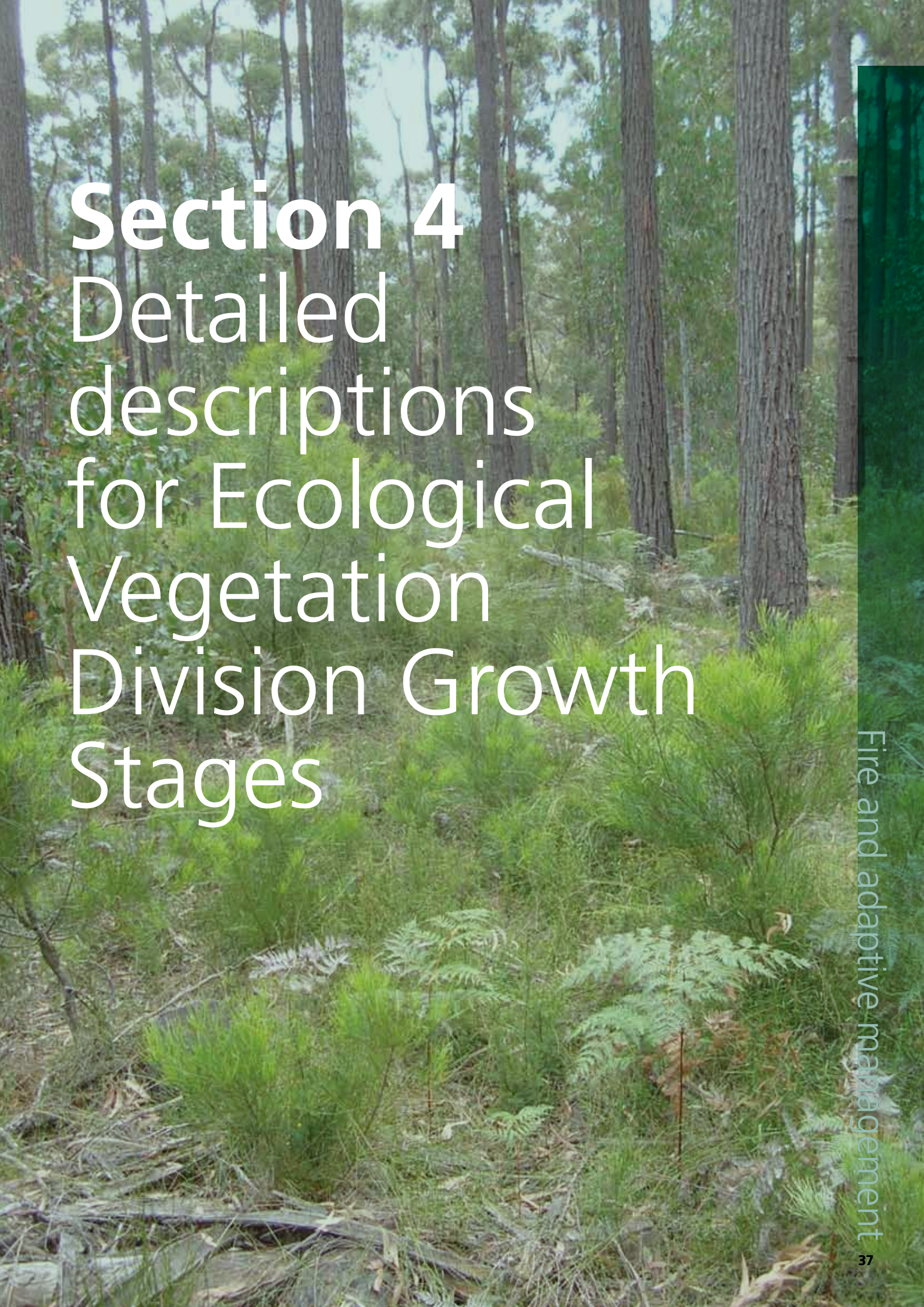
Figure 3.2 The fire history analysis tool (FireHAT) can display both historic fire events and tolerable fire intervals of resident EVDs as sequences through time. The above example 20 km² area of the Grampians National Park to illustrate the number of historic fire events. The break-out box displays the data of a frequently burnt site of Heathland (sands) EVD which has six recorded fire events since 1962.



The EVD growth stages presented in Table 3.1 and described in detail in Section 4 are offered as tools to fire planners and managers. Some possible uses include:

- To indicate EVDs in a fire-susceptible state or stage, for special protection in fire planning (due to past intervals below the minimum TFI), or EVDs which urgently require fire for maintenance of critical ecological processes.
- To indicate vegetation tolerances to fire, and need for fire, in the absence of comprehensive survey data. This data can be verified and/or refined with the establishment of monitoring and research.
- To assist understanding of fire regimes, particularly in vegetation older than current fire history records (50 to 60 years).
- To indicate the growth stage reached, and likely time intervals, for EVDs in areas without fire history records.
- To analyse regional or statewide impacts of bushfires on growth stage distributions, or the extent and proportion of each EVD burnt outside the tolerable fire intervals, or the extent and proportion of each EVD burnt most recently by wildfire or by planned fires or by repeated planned fires, and so on.
- To locate distributions of vegetation communities (EVDs) which are relatively resistant to fire and may act as fire breaks in the application of unbounded burns.
- To indicate EVD habitat growth stage suitability for various fauna, where fauna habitat can be focused on a particular growth stage or on a 'feature' that is restricted to particular growth stages (as developed by MacHunter *et. al.*, 2009).

Tall mixed forest in vigorous maturity growth stage, 15 years after last bushfire, Erica, Victoria.



Section 4
Detailed descriptions for Ecological Vegetation Division Growth Stages

Section 4 Detailed descriptions for Ecological Vegetation Division Growth Stages

EVD 1: Coastal

Maximum	40 years (grassland), 70 years (woodland), 90 years (scrub)
Minimum (high severity)	5 years (grassland), 25 years (woodland), 10 years (scrub)
Minimum (low severity)	5 years (grassland), 10 years (woodland), 10 years (scrub)

Vegetation of the Coastal EVD is extraordinarily variable and includes all fire susceptibilities, from near-bare sand which will never burn, to dense flammable scrub which will burn in most years and for much of each year. The three main fire fuel types are discussed below, with the text for each fuel type presented in contrasting colours to clearly outline Healthland (sands) EVDs dominated by scrub (■), woodland (●) and grassland (▲).

The long-term futures of vegetation communities in this EVD, particularly dense scrubs, in the absence of recurrent fires, are decidedly conjectural. The hypothesised maximums (■ 90 years for scrub, ● 70 years for woodland and ▲ 40 years for grassland) are based on problematic extrapolation of scant and somewhat contradictory data. Whether these habitats will further mature to a grassland, a woodland or an open shrubland, in the long-term absence of fire, or whether (different) shrubs will invade secondarily, is unknown.

■ In scrub, fires are often of high severity, with few unburnt refuges. Fire intervals of 90 years should have little long-term adverse impact on this vegetation and may prevent long-term (over-)domination by woody shrubs, such as *Acacia longifolia* var. *sophorae* and *Leptospermum laevigatum*.

● In woodland, fires may be of low severity, with many unburnt patches, or high severity (depending on the continuity and quantity of the shrub layers).

▲ In grassland, fires are usually of low severity, leaving many unburnt patches.

Renewal

0–1 year after fire

General	Lasts for 1 ± 0.25 years, i.e.
■ Scrub	1.1% of age span in scrub, 1.1% of maximum desirable fire interval for scrub
● Woodland	1.4% of age span in woodland, 1.4% of maximum desirable fire interval for woodland
▲ Grassland	2.5% of age span in grassland, 2.5% of maximum desirable fire interval for grassland

During this stage:

- most of the soil bare, with little to no litter
- fire ephemerals germinating and vigorously growing, and flowering by the end of this growth stage
- short-lived adventives, including exotic species, germinating and vigorously growing, and flowering by the end of this growth stage
- bradysporous species releasing seed from elevated fruit
- soil-stored seed germinating and making first appearance above ground
- resprouting species showing first signs of buds activating, but little shoot extension
- new mature seed largely lacking
- soil crusts disrupted or eliminated (▲ soil crusts absent from grasslands)
- vigorous mats of adventive and fire-ephemeral bryophytes by end of this growth stage
- limiting soil nutrients (notably nitrogen and phosphorus) in relative abundance (from mineralization of organically bound forms pre-fire)
- abundant light at ground level
- relatively high soil moisture

▲ Grasslands:

- surface soils may remobilise in exposed sites.

Juvenility

1–3 years (first few seasons) after fire

General	Lasts for 2 ± 0.5 years, i.e.
■ Scrub	2.2% of age span in scrub, 2.2% of maximum desirable fire interval for scrub
● Woodland	3% of age span in woodland, 3% of maximum desirable fire interval for woodland
▲ Grassland	5% of age span in grassland, 5% of maximum desirable fire interval for grassland

During this stage:

General:

- much of the ground cover is bare soil
- fire ephemerals (eg. *Apalochlamys*, *Calomeria*) common in the vigorously growing and substantially herbaceous field layer
- short-lived adventives, including exotic species, common, flowering and setting abundant seed
- bradysporous species germinating and establishing, but neither dominant nor a major component of the canopy (▲ largely lacking in grasslands)
- resprouting species (including sedges such as *Lepidosperma*) vigorously growing, rapid shoot extension
- herbaceous fire ephemerals and annuals with first seed set
- seed bank of all but the annuals and the shorter-lived fire ephemerals lacking
- neither flowering nor seed of the (pre-fire) dominant shrubs/trees (▲ largely lacking in grasslands)
- little to no litter
- vigorous mats of adventive and fire ephemeral bryophytes
- soil crusts disrupted or eliminated (▲ soil crusts absent from grasslands)
- limiting soil nutrients (notably nitrogen and phosphorus) in relative abundance (from mineralisation of organically bound forms pre-fire)
- abundant (but decreasing by the end of this growth stage) light at ground level
- relatively high soil moisture

● Woodlands:

- germination of the non-bradysporous woody trees and shrubs occurring at a low rate
- Bracken (*Pteridium esculentum*) vigorously growing, but not forming continuous swards
- many former canopy dominants killed by high severity fires, low severity fires have effect on the trees, fires of intermediate severity may lead to stem coppice

▲ Grasslands:

- largely lacking in shrubs
- vigorous regrowth of tussock and rhizomatous grasses
- abundant growth of tall grassland herbs (e.g. Senecio species).

Adolescence

3–9 years after fire

General	Lasts for 6 years, i.e.
■ Scrub	6.7% of age span in scrub, 6.7% of maximum desirable fire interval for scrub
● Woodland	8.6% of age span in woodland, 8.6% of maximum desirable fire interval for woodland
▲ Grassland	15% of age span in grassland, 15% of maximum desirable fire interval for grassland

During this stage:

General:

- ■ shrub canopy closing (bare soil far less common than previously) in scrub, ● shrub canopy remains open to very open in woodland (▲ largely lacking in grasslands)
- fire ephemerals largely retreated to the soil seed store
- short-lived adventives, including exotic species, uncommon, much less vigorous than previously, and increasingly restricted to open, disturbed patches such as track sides
- no further germination or establishment of bradysporous species, earlier germinants vigorously growing, mostly pre-flowering (although beginning to flower by the end of this growth stage) and neither dominant nor a major component of the canopy, mature seed of these species lacking in the community (although first seed set by the end of this growth stage) (▲ largely lacking in grasslands)
- resprouting species vigorously growing, rapid shoot extension, first flowering in resprouter shrubs but little or no seed set, mature seed lacking in the community for the longer-lived woody species, mature seed present for the more herbaceous resprouters (e.g. *Clematis* and *Lepidosperma*), ● resprouter shrubs are largely lacking in grasslands
- seed bank of fire ephemerals restored, but for all other groups either uncommon or largely absent, seed bank for the field layer restored in woodlands
- scant seed of the (pre-fire) dominant shrubs, although seed banks gradually recovering by end of this growth stage, ● shrubs not dominant in woodlands
- some litter accumulation, but litter still patchy and little incorporation into the soil
- vigorous post-fire bryophyte mats in retreat
- soil crusts disrupted or eliminated (▲ soil crusts absent from grasslands)
- limiting soil nutrients (notably nitrogen and phosphorus) in relative abundance (from mineralisation of organically bound forms pre-fire), but becoming less common
- light at ground level low
- soil moisture returning to normal (inter-fire) patterns

● Woodlands:

- germination of non-bradysporous woody trees and shrubs occurring at a low rate
- vigorous resprouting in herbaceous field layer (tussock-grasses and sedges)
- Bracken (*Pteridium esculentum*) vigorously growing, but not forming continuous swards
- many former canopy dominants killed by high-severity fires, low-severity fires have effect on the trees, fires of intermediate severity may lead to stem coppicing.

▲ Grasslands:

- largely lacking in shrubs
- tussock-grasses and rhizomatous grasses re-established
- abundant growth of tall grassland herbs (e.g. Senecio), but thinning towards the end of this growth stage.

Maturity

9–50 years after fire

General	Lasts for 41 years, i.e.
■ Scrub	46% of age span in scrub, 46% of maximum desirable fire interval for scrub
● Woodland	59% of age span in woodland, 59% of maximum desirable fire interval for woodland
▲ Grassland	77.5% of age span in grassland, 77.5% of maximum desirable fire interval for grassland

During this stage:

General:

- canopy closure complete (at maximum canopy dominance), ● canopy remains open in woodlands
- fire ephemerals retreated to soil seed store
- field layer very open (to effectively absent) in scrub, tussock-grasses and sedges very uncommon (to effectively absent), ● field layer fully restored in woodlands
- no further germination or establishment of bradysporous species, earlier germinants vigorously growing, flowering and setting seed, elevated seed storage gradually accumulating, (▲ largely lacking in grasslands)
- ■ very high stem density in scrub (maximum for this community) of dominant shrubs, ● stem density in woodlands remains low, although at a maximum, for woodlands, (▲ largely lacking in grasslands)
- leguminous shrubs at maximum abundance, flowering and setting much viable seed, (▲ largely lacking in grasslands)
- resprouting species vigorously growing, flowering and with accumulating seed store
- litter accumulating, litter cover re-established and gradually being incorporated into the soil
- terrestrial lichens re-establishing, but still very open and scattered, soil crusts disrupted or eliminated, (▲ soil crusts absent from grasslands)
- limiting soil nutrients (notably nitrogen and phosphorus) in decreasing abundance
- light at ground level decreased to a minimum
- soil moisture returned to normal inter-fire patterns

● **Woodlands:**

- germination of non-bradysporous woody trees and shrubs occurring at a low rate
- field layer (tussock-grasses and sedges) fully restored
- Bracken (*Pteridium esculentum*) decreasing in vigour, not forming continuous swards
- many former canopy dominants killed by high-severity fires, low-severity fires have effect on the trees, fires of intermediate severity may lead to stem coppicing, which by this growth stage is recovered to pre-burn condition.

Waning

50–80 years after fire

General	Towards upper limit of desirable fire age; lasts for 30 years, i.e.
■ Scrub	33% of age span of scrub, 33% of maximum desirable fire interval for scrub
● Woodland	29% of age span in woodland, 29% of maximum desirable fire interval for woodland
▲ Grassland	beyond (somewhat arbitrary) maximum desirable fire interval for grassland

During this stage:

General:

- canopy closure decreasing (from maximum canopy dominance), cover values still high, but canopy gaps appearing, particularly by the end of this growth stage, ● in woodlands canopy cover fairly constant
- annual species (not fire ephemerals) reappearing in the field layer, ● uncommon, annuals and short-lived perennials may be relatively common in the field layer of woodlands
- no further germination or establishment of bradysporous species, growth rates decreasing, but vigorously flowering and setting seed, elevated seed storage at a maximum
- resprouting shrubs growing (but growth rates decreasing), flowering and with accumulating seed store
- shrubs whose germination and establishment is not fire-cued gradually establishing in the community (e.g. *Alyxia buxifolia*, *Coprosma quadrifida*, *Exocarpos syrticola*, *Pimelea serpyllifolia*, *Pomaderris* species)
- if long-lived (non-heathland) dominants present in community (e.g. *Allocasuarina verticillata, Banksia integrifolia, Banksia serrata, Callitris rhomboidea*) then they are increasing in size and prominence, may be ongoing low-level seed establishment for these species
- tussock-grasses and long-lived sedges gradually increasing in cover, ■ with a developing field layer in scrub
- litter cover re-established and being incorporated into the soil
- terrestrial lichens may be common, particularly towards the end of this growth stage
- terrestrial bryophytes not common, but increasing in sheltered localities
- ▲ soil crusts absent from grasslands
- soil nutrient availability (notably nitrogen and phosphorus) low
- light at ground level low, but somewhat increased over previous growth stage
- soil moisture relatively low

● **Woodlands:**

- germination of non-bradysporous woody trees and shrubs occurring at a low rate
- field layer (tussock-grasses and sedges) fully restored
- Bracken (*Pteridium esculentum*) decreasing in vigour, not forming continuous swards
- many former canopy dominants killed by high-severity fires, low-severity fires have effect on the trees, fires of intermediate severity may lead to stem coppice, which by this growth stage is recovered to pre-burn condition.

Senescence

80–90+ years after fire

General	Lasts for 10+ years, i.e.
■ Scrub	11% of age span in scrub, 11% of maximum desirable fire interval for scrub) and beyond maximum desirable fire interval for scrub
● Woodland	beyond maximum desirable fire interval for woodland
▲ Grassland	beyond (somewhat arbitrary) maximum desirable fire interval for grassland

During this stage:

General:

- ■ scrub may change into another vegetation community (e.g. Coastal Woodland)
- canopy of sclerophyllous shrubs becoming noticeably more open
- above-ground species richness low but increasing
- annual species (not fire ephemerals) relatively common in the field layer
- no further germination or establishment of bradysporous species, growth rates and flowering decreasing, elevated seed storage decreasing
- resprouting shrubs with reduced growth (may have a negative growth rate), flowering and seed set decreasing
- soil seed stores decreasing
- shrubs whose germination and establishment is not fire-cued gradually becoming more common in the community (e.g. *Alyxia buxifolia, Coprosma quadrifida, Exocarpos syrticola, Pimelea serpyllifolia, Pomaderris* species)
- if long-lived (non-heathland) dominants present in community (e.g. *Allocasuarina verticillata, Banksia integrifolia, Banksia serrata, Callitris rhomboidea*) then these are increasing in size and prominence, forming the principal canopy; may be ongoing low-level seed establishment for these species
- tussock-grasses and long-lived sedges gradually dominating a well-developed field layer
- litter cover re-established and being incorporated into the soil
- lichens common on all substrates
- terrestrial bryophytes uncommon, but increasing in sheltered localities
- soil nutrient availability (notably nitrogen and phosphorus) low but very gradually increasing as the vegetation ages further
- light at ground level low, but increasing a metre or so above ground
- soil moisture relatively low

● **Woodlands:**

- continuing germination of the non-bradysporous woody trees and shrubs occurring at a low rate
- field layer (tussock-grasses and sedges), fully restored
- Bracken (*Pteridium esculentum*) present but hardly vigorous, not forming continuous swards
- canopy recovered to pre-burn condition
- coarse woody debris recovered to pre-burn condition, being augmented by falling branches.

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Left: Coastal EVD 1 dominated by scrub at Cape Bridgewater, Victoria.

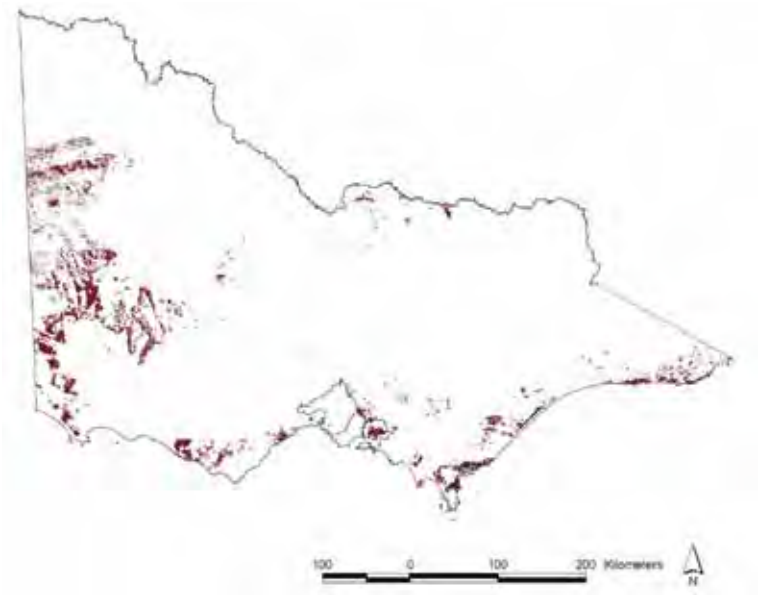
Coastal EVD 1 dominated by scrub at Bells Beach, Victoria.

Coastal EVD 1 dominated by grassland at Tort Head, French Island, Victoria.

(PHOTO COURTESY PHILLIP WIERZBOWSKI)

EVD 2: Heathland (sands)

Maximum	45 years
Minimum (high severity)	12 years (most areas), 15 years (Little and Big Deserts)
Minimum (low severity)	12 years (most areas), 15 years (Little and Big Deserts), 8 years (where *Xanthorrhoea resinosa* is dominant)



Heathlands extend from just south of Murrayville in the north-west of the state to beyond Mallacoota in the far east. This is an extraordinary range of rainfall regimes and climates, yet the nutrient poverty of their soils imparts a consistent facies to heathlands that belies this environmental range. Nevertheless, growth rates (and hence recovery times) vary across this range and it is wise to recognise local conditions in fire management. Recovery times are longer in the low-rainfall conditions of the north-west of the state and notably shorter in the far east, where shrubs do not dominate.

Renewal

0–0.5 years after fire

Lasts for 0.5 ± 0.25 years, i.e.
1% of age span, 1% of maximum desirable fire interval

During this stage:

- most of the ground is bare
- bradysporous species releasing seed from elevated fruit
- soil-stored seed germinating and making first appearance above ground
- resprouting species showing first signs of buds activating, but little shoot extension
- species not flowering, and mature seed largely lacking from the community
- little or no litter
- soil crusts disrupted or eliminated
- limiting soil nutrients (notably nitrogen and phosphorus) in relative abundance (from mineralisation of organically bound pre-fire forms)
- abundant light at ground level
- relatively high soil moisture.

Juvenility

0.5–2.5 years after fire

Lasts for 2 years, i.e. 4.5% of age span, 4.5% of maximum desirable fire interval

During this stage:

- most of the ground is bare
- fire ephemerals are abundant in, or may dominate, the vigorously growing and substantially herbaceous field layer
- bradysporous species germinating and establishing, but neither dominant nor a major component of the canopy
- resprouting species vigorously growing, rapid shoot extension
- herbaceous fire ephemerals and annuals with first seed set
- 'M' species vigorously flowering (e.g. Xanthorrhoea australis)
- seed bank of all but the annuals and the shorter-lived fire ephemerals lacking
- neither flowering nor seed of the (pre-fire) dominant shrubs
- little or no litter
- soil crusts disrupted or eliminated
- limiting soil nutrients (notably nitrogen and phosphorus) in relative abundance (from mineralisation of organically bound forms pre-fire)
- abundant light at ground level
- relatively high soil moisture.

Adolescence

2.5-8.5 years after fire

Lasts for 6 years, i.e. 13.3% of age span, 13.3% of maximum desirable fire interval

During this stage:

- canopy closing (bare soil far less common than previously)
- fire ephemerals in decline (annuals and biennials retreated to the soil seed store, longer-lived fire ephemerals fully reproductive)
- no further germination or establishment of bradysporous species, earlier germinants vigorously growing, mostly pre-flowering and neither dominant nor a major component of the canopy, mature seed of these species lacking in the community
- resprouting species vigorously growing, rapid shoot extension, first flowering in resprouters but little to no seed set, mature seed lacking in the community
- 'M' species mature and releasing seed
- seed bank of the fire ephemerals restored, but for all other groups largely absent
- no seed of the (pre-fire) dominant shrubs
- some litter accumulation, but litter still patchy and little incorporation into the soil
- soil crusts disrupted or eliminated
- limiting soil nutrients (notably nitrogen and phosphorus) in relative abundance (from mineralization of organically bound forms pre-fire)
- light at ground level decreasing
- soil moisture returning to normal (inter-fire) patterns.

Maturity

8.5–33.5 years after fire

Lasts for 25 years, i.e. 55.6% of age span, 55.6% of maximum desirable fire interval

During this stage:

- canopy closure complete or at maximum canopy cover (i.e. maximum canopy dominance)
- fire ephemerals retreated to soil seed store
- no further germination or establishment of bradysporous species, earlier germinants vigorously growing, flowering and setting seed, elevated seed storage gradually accumulating
- resprouting species vigorously growing, flowering and with accumulating seed store
- 'M' species mature but not reproductive
- litter accumulating, litter cover re-established and gradually being incorporated into the soil
- soil crusts re-establishing, but not yet continuous in open patches
- limiting soil nutrients (notably nitrogen and phosphorus) in relative abundance but decreasing
- light at ground level decreased
- soil moisture returned to normal inter-fire patterns.

Waning

33.5–55 years after fire

Lasts for 21 years, i.e. 44.4% of age span, 44.4% of maximum desirable fire interval

During this stage:

- canopy closure decreasing (from maximum canopy dominance)
- annual species (not fire ephemerals) reappearing in the field layer
- no further germination or establishment of bradysporous species, growth rates decreasing, but vigorously flowering and setting seed, elevated seed storage at a maximum
- resprouting shrubs growing (but growth rates decreasing), flowering and with accumulating seed store
- 'M' species mature, but not reproductive
- if long-lived (non-heathland) dominants present in community (e.g. *Callitris* species, *Banksia serrata, Leptospermum trinervium*) then these assuming dominance
- long-lived sedges and the like at greatest cover
- litter cover re-established and being incorporated into the soil
- soil crusts re-established, may be continuous
- soil nutrient availability (notably nitrogen and phosphorus) decreasing
- light at ground level decreased to a minimum
- soil moisture relatively low.

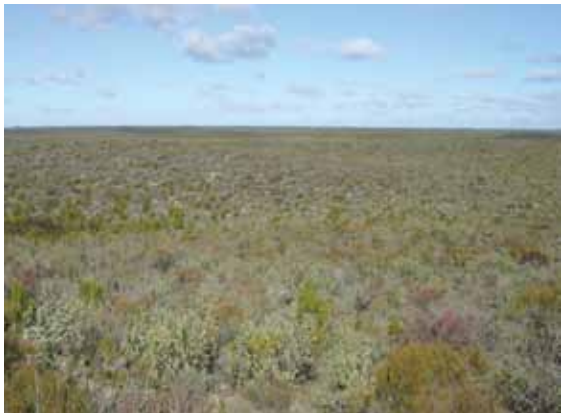
Senescence

55+ years after fire

Indeterminate length (beyond maximum desirable fire interval)

During this stage:

- canopy of sclerophyllous heathland shrubs becoming noticeably more open
- above-ground species richness at a minimum (except for immediately post-fire)
- annual species (not fire ephemerals) relatively common in the field layer
- no further germination or establishment of bradysporous species, growth rates and flowering decreasing, elevated seed storage decreasing
- resprouting shrubs with reduced growth (may have a negative growth rate), flowering and seed set decreasing
- 'M' species mature but not reproductive
- soil seed stores decreasing
- if long-lived (non-heathland) dominants present in community (e.g. Callitris species, Banksia serrata, Leptospermum trinervium) then these dominate, as the heathland shrubs decrease in abundance and species richness
- long-lived sedges and the like still with high cover values, but low growth rates and accumulating standing litter (dead foliage and stems)
- litter cover re-established and being incorporated into the soil
- soil crusts re-established, may be continuous
- soil nutrient availability (notably nitrogen and phosphorus) decreasing
- light at ground level decreased to a minimum
- soil moisture relatively low.



Heathland (sands) EVD 2 at Big Desert, Wyperfeld National Park, Victoria

Heathland (sands) EVD 2, Wilsons Promontory National Park, showing flowering *Argentipallium obtusifolium* (Blunt Everlasting)

Heathland (sands) EVD 2, showing emergent *Banksia serrata* (Saw Banksia)

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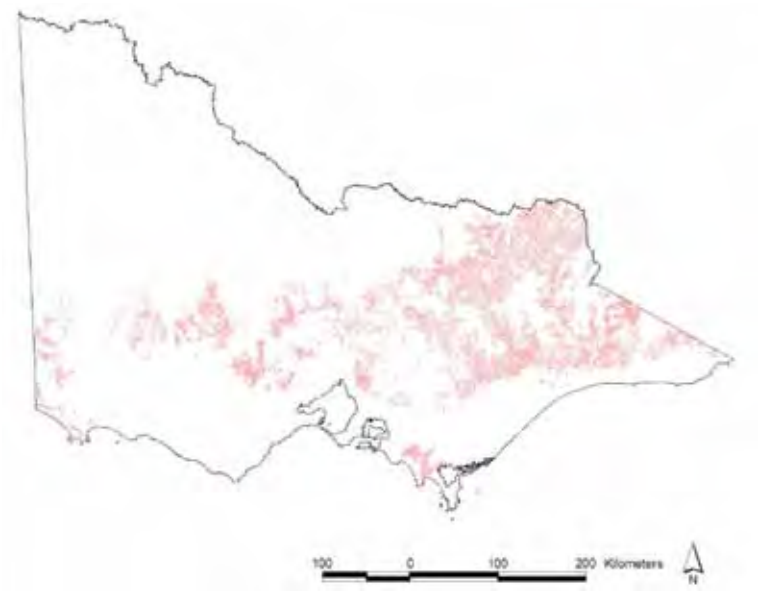
EVD 3: Grassy/Heathy Dry Forest

Maximum	45 years
Minimum (high severity)	15 years
Minimum (low severity)	10 years



Grassy/Heathy Dry Forest may burn in an intense fire (wildfire) or as a patchy prescribed burn. The black text below describes this community's response to high-severity fire (wildfire), which usually means that the canopy has been consumed.

The ◆ symbol refers to the community's response to low-severity, patchy (prescribed) fire, i.e. a fire with many unburnt patches within the fire perimeter and in which the canopy is rarely burnt or scorched. The greatest response to frequent fires (whether of high or low severity) comes after the *second* fire, and all subsequent fires, with a low (< 10–15 years) fire interval. The patchiness of low-severity fires is critical in maintaining sensitive species in the community, as it means that some vegetation within the fire perimeter escapes being burnt at such frequent intervals.

Grassy/Heathy Dry Forest EVD 3 near Orbost, Victoria.

Grassy/Heathy Dry Forest EVD 3 near Anglesea, Victoria.

Renewal

0–0.5 years after fire

Lasts for 0.5 ± 0.25 years, i.e.
1% of age span, 1% of maximum desirable fire interval
◆ same for low-severity fires

During this stage:
- most of the ground is bare
- bradysporous species releasing seed from elevated fruit
- soil-stored seed germinating and making first appearance above ground
- resprouting species showing first signs of buds activating, but little shoot extension
- Bracken (*Pteridium esculentum*) reappearing above ground (new croziers unrolling)
- eucalypt coppice growth evident by end of this stage
- species not flowering and mature seed largely lacking from the community
- little to no litter, although ash accumulated in occasional drifts
- soil crusts disrupted or eliminated
- limiting soil nutrients (notably nitrogen and phosphorus) in relative abundance (from mineralisation of organically bound pre-fire forms)
- abundant light at ground level
- relatively high soil moisture.

Juvenility

0.5–2.5 years after fire

Lasts for 2 ± 0.5 years, i.e.
4.4% of age span, 4.4% of maximum desirable fire interval
◆ same for low-severity fires

During this stage:
- most of the ground is bare
- fire ephemerals common in the vigorously growing and substantially herbaceous field layer
- bradysporous species germinating and establishing, but neither dominant nor a major component of any stratum
- tree seedlings evident (cotyledon stage)
- resprouting species vigorously growing, rapid shoot extension
- resprouting species in the tree canopy vigorously coppicing, not flowering
- Bracken (*Pteridium esculentum*) common to dominant in the field layer
- herbaceous fire ephemerals and annuals with first seed set
- 'M' species vigorously flowering (e.g. *Xanthorrhoea australis*)
- seed bank of all but the annuals and the shorter-lived fire ephemerals lacking
- neither flowering nor seed of the pre-fire dominant shrubs
- little to no litter, ash drifts still evident
- soil crusts disrupted or eliminated
- limiting soil nutrients (notably nitrogen and phosphorus) in relative abundance (from mineralization of organically bound pre-fire forms)
- abundant light to the field layer, light at ground level decreasing
- relatively high soil moisture.

Adolescence

2.5–10 years after fire

Lasts for 8 years, i.e.

18% of age span, 18% of maximum desirable fire interval

◆ same for low-severity fires, remembering that there are many unburnt patches within the fire perimeter that retain essentially mature or older vegetation

During this stage:

- canopy cover increasing, bare soil far less common than previously, lower coppice dying
- fire ephemerals in decline,annuals and biennials retreated to the soil seed store, longer-lived fire ephemerals fully reproductive
- no further germination or establishment of bradysporous species, earlier germinants vigorously growing, mostly pre-flowering and neither dominant nor a major component of the shrub strata, mature seed of these species lacking in the community; ◆ this group of species is most susceptible to frequent fires and may be locally eliminated unless high frequency fires are notably patchy
- resprouting shrubs vigorously growing, rapid shoot extension, first flowering in large resprouters shrubs but little seed set (although seed set has begun, mature seed of these species largely lacking in the community)
- 'M' species mature and releasing seed (e.g. *Xanthorrhoea australis*)
- resprouting sedges and restiads vigorous and flowering with ample seed set
- bracken often dominant in the field stratum
- seed bank of the fire ephemerals restored, but for all other groups uncommon to largely absent
- little seed of the pre-fire dominant shrubs
- some litter accumulation, litter patchy and gradually being incorporated into the soil
- soil crusts disrupted or eliminated
- limiting soil nutrients (notably nitrogen and phosphorus) in relative abundance (from mineralisation of organically bound pre-fire forms)
- light at ground level low, light to shrub strata decreasing as canopy slowly re-establishing
- soil moisture returning to normal inter-fire patterns.

Maturity

10–35 years after fire

Lasts for 25 years, i.e.

56% of age span, 56% of maximum desirable fire interval

During this stage:

- canopy (tree) cover at a maximum
- all fire ephemerals retreated to soil seed store
- most large understorey adventives (e.g. *Acacia mearnsii*) moribund
- no further germination nor establishment of bradysporous species, earlier germinants vigorously growing, flowering and setting seed, elevated seed storage gradually accumulating
- little to no shrub establishment from seed (whether of the large bradysporous species or the smaller ericoids and the like)
- resprouting species growing, flowering and with accumulating seed store
- sedges and restiads common but not vigorously flowering
- canopy eucalypts flowering and setting seed
- eucalypt seedlings first flowering but with weak seed set
- herbaceous species (not fire ephemerals) gradually reappearing and becoming more common in the field layer
- Bracken (*Pteridium esculentum*) still dominant in field layer, but with much dead material in winter
- 'M' species mature but not reproductive
- litter accumulating, litter cover re-established and being incorporated into the soil
- first notable appearance and gradual accumulation of coarse woody debris
- lichen and bryophyte cover re-establishing, but not yet continuous
- limiting soil nutrients (notably nitrogen and phosphorus) in decreasing abundance
- light at ground level at a minimum
- soil moisture returned to normal inter-fire patterns.

Waning

35–45 years after fire

Lasts for 20 years, i.e.

21% of age span, 21% of maximum desirable fire interval (towards upper limit of desirable fire age)

During this stage:

- canopy cover slowly decreasing (canopy opening out, slowly)
- canopy eucalypts flowering and setting seed, canopy seed store at a maximum
- annual species (not fire ephemerals) becoming more common in the field layer, including a few tussock grasses
- no further germination or establishment of bradysporous species, growth rates at a minimum, little flowering and seed set, elevated seed storage decreasing
- resprouting shrubs growing (but growth rates decreasing), flowering and with maximum seed store
- 'M' species mature, but not reproductive
- long-lived sedges and the like at greatest cover
- litter cover re-established and being incorporated into the soil
- lichen and bryophyte cover well established and gradually increasing
- soil nutrient availability (notably nitrogen and phosphorus) at a minimum
- light at ground level decreased to a minimum
- soil moisture relatively low.

Senescence

45+ years after fire

Indeterminate length (beyond maximum desirable fire interval)

During this stage:

- heathland may change into another vegetation community
- eucalypt canopy becoming noticeably more open
- if *Callitris* species present, these increasing in cover (to local dominance in the canopy or major shrub stratum)
- invasion and establishment opportunity for *Banksia integrifolia* (if local seed source present)
- above-ground species richness decreasing
- bracken may increase in abundance, with much dead matter in season
- annual and herbaceous species (not fire ephemerals) at greatest richness in the field layer
- no further germination or establishment of bradysporous species, growth rates and flowering decreasing, elevated seed storage decreasing, mature shrubs dying and shrub layer opening out
- resprouting shrubs with reduced growth (may have a negative growth rate), flowering and seed set decreasing
- 'M' species mature, but not reproductive, gradually decreasing in abundance
- soil seed stores decreasing
- long-lived sedges and the like still with high cover values, but low growth rates and accumulating standing litter (dead foliage and stems)
- litter cover re-established and being incorporated into the soil
- lichen and bryophyte layer reachesits greatestextent
- soil nutrient availability (notably nitrogen and phosphorus) at a minimum
- light at ground level decreased to a minimum
- soil moisture relatively low.

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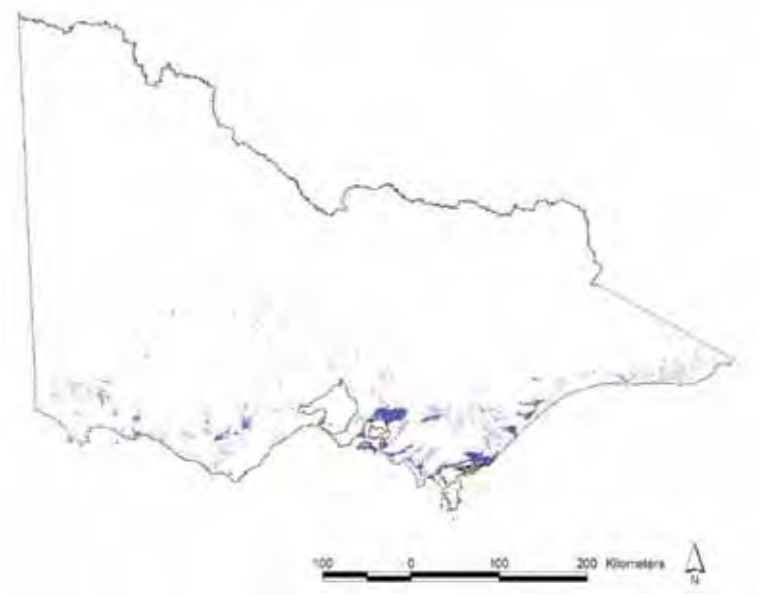
EVD 4: Damp Scrub

Maximum	90 years
Minimum (high severity)	20 years
Minimum (low severity)	15 years



Damp Scrub may burn in an intense fire (wildfire) or as a patchy low-severity burn (largely dependent on local moisture status). The text below describes this community's response to high-severity fire (wildfire), which usually means that the canopy has been consumed. Such high-severity fires are fairly common in Damp Scrub. In contrast, low-severity fires may burn with the same site severity but leave substantial patches of unburnt habitat.

Renewal

0–1 year after fire

Lasts for 1 ± 0.25 years , i.e.

1% of age span, 1% of maximum desirable fire interval

During this stage:

- most of the ground cover is bare soil
- peats may smoulder for many weeks after the main fire front has passed
- dead stems of (former) shrubby dominants extending to 2–3 m above regeneration
- luxurious growth of adventive herbs, including introduced species such as *Euphorbia peplus*
- bradysporous species releasing seed from elevated fruit
- soil-stored seed germinating and making first appearance above ground
- resprouting species showing first signs of buds activating, but little shoot extension, most resprouting is from the base (very little coppicing)
- nearly all species not flowering, and mature seed largely lacking from the community
- may be rapid establishment of adventive bryophytes
- epiphytic cryptogams removed
- little or no litter, except for ash from the fire
- limiting soil nutrients (notably nitrogen and phosphorus) in relative abundance (from mineralisation of organically bound pre-fire forms)
- abundant light at ground level
- relatively high soil moisture.

Juvenility

1–3 years after fire

Lasts for 2 years, i.e. 2% of age span, 2% of maximum desirable fire interval

During this stage:

- most of the ground cover is bare soil
- dead stems of pre-fire shrubby dominants extending to 2–3 m above regeneration
- fire ephemerals common, although not a species-rich assemblage of fire ephemerals in this community
- herbaceous fire ephemerals and annuals abundantly setting seed
- rhizomatous sedges (and the like) rapidly spreading and often dominating the field layer
- bradysporous species germinating and establishing, but neither dominant nor a major component of the canopy
- resprouting species (including rhizomatous ferns and tree-ferns) vigorously growing, rapid shoot extension, neither flowering nor setting seed
- seed regenerating shrubs (e.g. *Acacia verticillata*) established in gaps and growing vigorously
- seed bank of all but the annuals and the shorter-lived fire ephemerals lacking
- neither flowering nor seed of the (pre-fire) dominant shrubs
- extensive mats of adventive bryophytes
- epiphytic cryptogams removed
- little or no litter
- limiting soil nutrients (notably nitrogen and phosphorus) in relative abundance (from mineralization of organically bound forms pre-fire)
- abundant light at 15 cm or so height, less at ground level
- relatively high soil moisture.

Adolescence

3–9 years after fire

Lasts for 6 years, i.e. 7% of age span, 7% of maximum desirable fire interval

During this stage:

- canopy closing, bare soil far less common than previously
- dead stems of former shrubby dominants extending to above the regenerating canopy
- fire ephemerals uncommon to rare, annuals and biennials retreated to the soil seed store, longer-lived fire ephemerals reproductive to decreasing
- rhizomatous sedges and the like common and often dominating the field layer, flowering and setting seed
- no further germination or establishment of bradysporous species, earlier germinants vigorously growing, mostly pre-flowering and neither dominant nor a major component of the canopy, mature seed of these species lacking in the community
- resprouting species vigorously growing, rapid shoot extension, first flowering in resprouters but little to no seed set, mature seed lacking in the community
- regrowth rhizomatous ferns and other ferns mature, releasing spores
- seed bank of the fire ephemerals restored, but for all other groups either largely absent or scant
- little to no seed of the (pre-fire) dominant shrubs
- seed regenerating shrubs (e.g. *Acacia verticillata*) growing vigorously, flowering and setting seed
- some litter accumulation, but litter still patchy and little incorporation into the soil
- fallen dead stems contributing to the coarse woody debris
- limiting soil nutrients (notably nitrogen and phosphorus) in relative abundance (from mineralisation of organically bound pre-fire forms) but decreasing
- abundant light 1–2 m above ground, light at ground level decreasing
- soil moisture returning to normal inter-fire patterns.

Vigorous maturity

9–25 years after fire

Lasts for 16 years, i.e.
18% of age span, 18% of maximum desirable fire interval

During this stage:

- canopy closure complete at maximum canopy dominance
- dead stems of former shrubby dominants no longer extending to above the regenerating canopy
- fire ephemerals retreated to soil seed store
- rhizomatous sedges and the like common and often dominating the field layer, flowering and setting seed
- no further germination nor establishment of bradysporous species, earlier germinants vigorously growing, flowering and setting seed, elevated seed storage gradually accumulating
- resprouting species vigorously growing, flowering and with accumulating seed store
- seed regenerating shrubs (e.g. *Acacia verticillata, Olearia rugosa*) weakening, still flowering and setting seed, but vigour decreasing
- regrowth rhizomatous ferns and other ferns mature, releasing spores
- first appearance of epiphytic cryptogams
- litter accumulating, litter cover re-established and gradually being incorporated into the soil
- first signs of peat accumulation
- fallen dead stems contributing to the coarse woody debris
- limiting soil nutrients (notably nitrogen and phosphorus) in decreasing abundance
- light at ground level minimal
- soil moisture returned to normal inter-fire patterns.

Damp Scrub EVD 4 – less than two months after wildfire, at Wilsons Promontory, Victoria.

Damp Scrub EVD 4 – four year regrowth after fire, *Viminaria juncea* (a fire adventive) prominent, at Wilsons Promontory, Victoria.

Damp Scrub EVD 4, long unburnt at Wilsons Promontory, Victoria.

Stasis

25–80 years

Lasts for 55 years, i.e. 61% of age span, 61% of maximum desirable fire interval

During this stage:

- canopy closure complete (at maximum canopy dominance)
- dead stems of former shrubby dominants no longer extending to above the regenerating canopy
- fire ephemerals retreated to soil seed store
- mesic forbs and monocot herbs increasingly common, forming a more or less continuous low field layer
- rhizomatous sedges and the like less common than previously, still flowering and setting seed, often elevated and scandent (e.g. *Gahnia clarkei, Empodisma minus*)
- no further germination nor establishment of bradysporous species, earlier germinants vigorously growing, flowering and setting seed, elevated seed storage maximum
- resprouting species vigorously growing, flowering and with maximum seed store
- seed regenerating shrubs (e.g. *Acacia verticillata, Olearia rugosa*) weakening, decreasing to apparent absence
- regrowth rhizomatous ferns and other ferns mature, releasing spores
- epiphytic cryptogams common and spreading
- litter accumulating, maximum litter cover and litter being incorporated into the soil
- peat accumulation
- fallen dead stems still contributing to the coarse woody debris, but coarse woody debris declining
- limiting soil nutrients (notably nitrogen and phosphorus) at a minimum, soils increasingly organic
- light at ground level low, light 20 cm or so higher slowly increasing as the vegetation ages further
- soil moisture returned to normal inter-fire patterns.

Senescence

80–90+ years after fire

Lasts for 10+ years, i.e. at least 11% of age span, 11% of maximum desirable fire interval

During this stage:

- canopy closure decreasing from maximum canopy dominance, canopy with gaps appearing
- dead (burnt) stems of former shrubby dominants no longer evident
- mesic forbs and monocot herbs common, forming a more or less continuous low field layer, dependent on gaps in rhizomatous ferns
- long-lived sedges and the like with decreasing cover
- no further germination or establishment of bradysporous species, growth rates decreasing but still flowering and setting seed, elevated seed storage decreasing from a maximum
- resprouting shrubs growing but growth rates decreasing, flowering and seed store decreasing
- seed regenerating shrubs (e.g. *Acacia verticillata, Olearia rugosa*) no longer evident
- if long-lived (non-swamp scrub) dominants present in community (e.g. shrub or tree species of rainforests) then these gradually increasing in abundance
- regrowth rhizomatous ferns and other ferns (including tree-ferns) mature, releasing spores
- epiphytic cryptogams common and spreading
- mesic bryophytes common
- litter cover re-established and being incorporated into the soil
- peat accumulation, soils appreciably organic
- limiting soil nutrients (notably nitrogen and phosphorus) at a minimum, soils increasingly organic
- light at ground level decreased to a minimum
- soil moisture returned to normal inter-fire patterns.

Useful References

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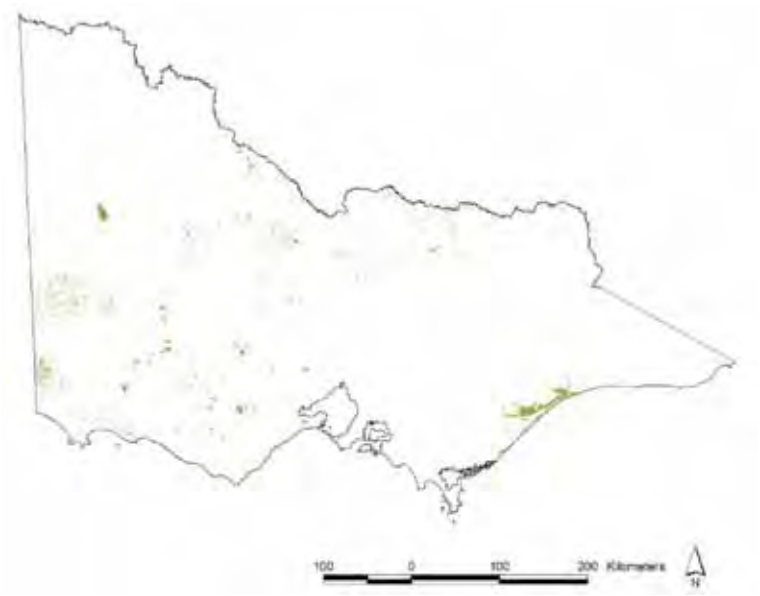
EVD 5: Freshwater Wetland (permanent)

Maximum	∞
Minimum (high severity)	8 years
Minimum (low severity)	8 years



In exceptional conditions (e.g. after protracted drought) Freshwater Wetlands (permanent) may burn. The response to such unusual events is described here, but does not imply that fire management is appropriate in this EVD.

Regeneration opportunities in this vegetation community are dependent primarily on water supply (from rainfall, flooding or ground water), not on fire regime.

Renewal

0–1 year after fire

Lasts for 1 year, i.e. 0.7% of arbitrary maximum fire interval

During this stage:

- most of the ground cover is bare soil, ash from the fire or standing water
- soil-stored seed germinating and making first appearance above ground
- trees and shrubs (if present) showing first signs of buds activating, but little shoot extension
- species not flowering and mature seed largely lacking from the community
- little to no litter (apart from ash)
- abundant light at ground level
- soil surface pH at a maximum.

Juvenility

1–2 years after fire

Lasts for 1 year, i.e. 0.7% of arbitrary maximum fire interval

During this stage:

- bare soil decreasing to a minimum by end of period
- any trees (if present) that survived the fire resprouting
- vigorous regrowth of dominant species, usually from resprouting dormant subterranean rhizomes
- seed bank being re-established
- neither flowering nor seed of any (pre-fire) shrubs
- litter quantity low, but gradually accumulating
- light at ground level decreasing.

Maturity

2–148+ years after fire

Lasts indefinitely; 98.6% of arbitrary maximum fire interval

During this stage:

- very small proportion of soil bare
- canopy cover at 80% or higher
- re-established soil seed store for all herbaceous component species
- resprouting species (trees and shrubs, if present) vigorously growing, rapid shoot extension
- shrubs and trees (if present) flowering and initiating seed set
- adequate seed bank of shrubs and trees (if present) re-established by 8 years post-fire
- tree and shrub seedlings (if woody plants present) may be scattered throughout
- litter accumulating, being slowly incorporated into the ecosystem
- light at ground level minimum.

Freshwater Wetland (permanent) EVD 5, Anglesea, Victoria.

Freshwater Wetland (permanent) EVD 5, Echuca, Victoria.

Useful References

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EVD 6: Treed Swampy Wetland

Maximum	150 years
Minimum (high severity)	30 years
Minimum (low severity)	20 years

Treed Swampy Wetland may burn in an intense fire (wildfire) or as a patchy low-severity burn (largely dependent on local moisture status). The text below describes this community's response to high-severity fire (wildfire), which usually means that the canopy has been consumed. Such high-severity fires are far from unknown in Treed Swampy Wetland Scrub. In contrast, low-severity fires may leave substantial patches of unburnt habitat. Regeneration opportunities and growth patterns in this vegetation community are primarily dependent on water supply (from rainfall, flooding or ground water), not on fire regime.

Treed Swampy Wetland EVD 6, Black Swamp, northern Victoria.

Renewal

0–1 year after fire

Lasts for 1 ± 0.25 years, i.e.
0.7% of age span, 0.7% of maximum desirable fire interval

During this stage:

- most of the (burnt) ground cover is bare soil
- dead stems of woody dominants (trees and shrubs) extending to 2–3 m above regeneration
- scorched canopy foliage falling
- luxuriant growth of adventive herbs, including introduced species, such as *Euphorbia peplus*
- bradysporous species releasing seed from elevated fruit
- soil-stored seed germinating and making first appearance above ground
- resprouting species showing first signs of buds activating, but little shoot extension, most resprouting is from the base (very little coppicing)
- nearly all species (with the exception of the adventive annuals) not flowering and mature seed largely lacking from the community
- may be rapid establishment of adventive bryophytes
- crustal cryptogams removed
- little to no litter, except for ash from the fire
- coarse woody debris largely consumed
- limiting soil nutrients (notably nitrogen and phosphorus) in relative abundance (from mineralisation of organically bound pre-fire forms)
- abundant light at ground level
- relatively high soil moisture.

Juvenility

1–3 years after fire

Lasts for 2 years, i.e.
1.3% of age span, 1.3% of maximum desirable fire interval

During this stage:

- much of the ground is bare
- dead stems of woody species extending above regeneration
- disturbance ephemerals common, may be locally dominant (e.g. *Lachnagrostis filiformis*)
- fire ephemerals uncommon to rare
- herbaceous annuals abundantly setting seed
- rhizomatous sedges and the like rapidly spreading and often dominating the field layer
- bradysporous species germinating and establishing, but neither dominant nor a major component of the canopy
- resprouting species (e.g. *Muehlenbeckia* species) vigorously growing, rapid shoot extension, neither flowering nor setting seed
- seed regenerating shrubs uncommon, but established in gaps and growing vigorously
- seed bank of all but the annuals and the shorter-lived fire ephemerals lacking
- neither flowering nor seed of the (pre-fire) common shrubs or canopy eucalypts
- canopy eucalypts with a re-established canopy in lightly burnt areas; in areas burnt in a high-severity fire, abundant coppice regrowth on stems and larger branches
- eucalypt seedlings established in gaps
- extensive mats of adventive bryophytes
- crustal cryptogams removed (possible exception of *Nostoc* and *Riccia* mats)
- little litter, apart from scorched foliage
- limiting soil nutrients (notably nitrogen and phosphorus) in relative abundance (from mineralization of organically bound pre-fire forms)
- abundant light at 15 cm or so height, less at ground level
- relatively high soil moisture.

Adolescence

3–8 years after fire

Lasts for 5 years, i.e.
3.3% of age span, 3.3% of maximum desirable fire interval

During this stage:

- shrub and field layer cover increasing, bare soil far less common than previously
- dead stems of shrubs extending above the regenerating shrubs
- fire ephemerals uncommon to rare
- disturbance ephemerals common to locally abundant
- herbaceous annuals and short-lived perennials abundantly flowering and setting seed
- rhizomatous sedges and the like common and often dominating the field layer, flowering and setting seed
- no further germination or establishment of bradysporous species, earlier germinants vigorously growing, mostly pre-flowering and neither dominant nor a major component of any stratum, mature seed of these species lacking in the community, although making a first appearance towards the end of this growth stage
- resprouting species (e.g. *Muehlenbeckia* species) vigorously growing, rapid shoot extension, first flowering and seed set
- little seed of the (pre-fire) common shrubs or trees
- seed regenerating shrubs uncommon, but established in gaps, growing vigorously, flowering and setting seed
- seed bank of all but the annuals, perennial herbs and the shorter-lived shrubs lacking
- scant flowering and little seed set of the (pre-fire) common shrubs or canopy eucalypts
- canopy eucalypts with a re-established canopy in lightly burnt areas; in areas burnt in a high-severity fire, new coppice regrowth on stems and larger branches becoming increasingly restricted to the upper canopy, and lower coppice regrowth dying
- eucalypt seedlings established in gaps, growing vigorously, but neither flowering nor setting seed
- extensive mats of adventive bryophytes retreating
- crustal cryptogams absent (possible exception of *Nostoc* and *Riccia* mats)
- some litter accumulation, but litter still patchy and little incorporation into the soil
- fallen dead stems contributing to the coarse woody debris
- limiting soil nutrients (notably nitrogen and phosphorus) in relative abundance (from mineralization of organically bound pre-fire forms) but decreasing
- abundant light 1–2 m above ground, light at ground level decreasing
- soil moisture returning to normal inter-fire patterns.

Vigorous maturity

8–30 years after fire

Lasts for 22 years, i.e. 15% of age span, 15% of maximum desirable fire interval

During this stage:

- shrub and field layer cover at a maximum
- dead stems of formerly common shrubs no longer extending above the regenerating shrubs and herbs
- disturbance ephemerals retreated to soil seed store, or rare and occasional gaps in the vigorous field layer
- herbaceous (seasonal) annuals and short-lived perennials abundantly flowering and setting seed
- rhizomatous sedges and the like common and often dominating the field layer, flowering and setting seed
- no further germination or establishment of bradysporous species, earlier germinants vigorously growing, flowering and setting seed, elevated seed storage gradually accumulating
- resprouting species (e.g. *Muehlenbeckia* species) vigorously growing, flowering and setting seed
- abundant on-site seed storage of the shrubs and trees
- canopy eucalypts with a re-established canopy, lower coppice dying
- eucalypt seedlings established in gaps, growing vigorously, first flowering and seed set
- extensive mats of adventive bryophytes only occasional
- first signs of re-establishment of crustal cryptogams, gradual spread in open patches
- litter accumulating, litter cover re-established and gradually being incorporated into the soil
- fallen dead stems contributing to the coarse woody debris
- limiting soil nutrients (notably nitrogen and phosphorus) in decreasing abundance
- light at ground level minimal
- soil moisture returned to normal inter-fire patterns.

Stasis

30–150 years after fire

Lasts for 120 years, i.e. 80% of age span, 80% of maximum desirable fire interval)

During this stage:

- shrub and field layer cover at a maximum
- dead stems of formerly common shrubs no longer extending to above the shrub and herb strata
- disturbance ephemerals retreated to soil seed store, or rare and occasional gaps in the vigorous field layer
- herbaceous (seasonal) annuals and short-lived perennials abundantly flowering and setting seed
- rhizomatous sedges and the like common and often dominating the field layer, flowering and setting seed
- no further germination nor establishment of bradysporous species, earlier germinants vigorously growing, flowering and setting seed, elevated seed storage gradually accumulating
- resprouting species (e.g. *Muehlenbeckia* species) vigorously growing, flowering and setting seed
- abundant on-site seed storage of the shrubs and trees
- canopy eucalypts with a re-established canopy, lower coppice no longer evident
- eucalypt seedlings established in gaps, growing vigorously, attained the canopy, abundantly flowering and contributing to the on-site seed bank
- extensive mats of adventive bryophytes only occasional
- crustal cryptogams sporadically established in open patches
- litter accumulating, maximum litter cover and litter being incorporated into the soil
- fallen dead stems contributing to the coarse woody debris, coarse woody debris accumulating
- hollow development in standing woody stems, particularly of the canopy eucalypts
- limiting soil nutrients (notably nitrogen and phosphorus) at a minimum, but soils relatively fertile when compared with soils of surrounding, drier vegetation communities
- light at ground level minimal
- soil moisture returned to normal inter-fire patterns.

Waning

Towards upper limit of desirable fire age.

The long-term future of Treed Swampy Wetland vegetation in the absence of recurrent fires is decidedly conjectural. The maximum of 150 years suggested here is based on problematic extrapolation of scant and somewhat contradictory data. We do not know whether these habitats will further evolve into an open woodland or dense shrubland in the long-term absence of fire, or whether (perhaps different) shrubs will secondarily invade. Fires at a frequency of 150 years should have little long-term adverse impact on this vegetation and may prevent long-term domination by woody shrubs.

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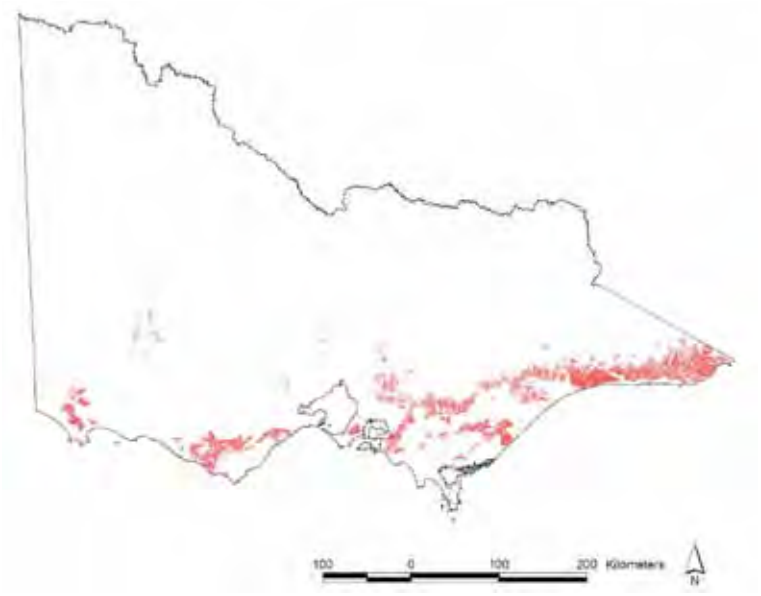
EVD 7: Tall Mixed Forest

Maximum	60 years
Minimum (high severity)	25 years
Minimum (low severity)	8 years



Tall Mixed Forest may burn in an intense fire (wildfire) or as a more patchy prescribed burn. The black text below describes this community's response to high-severity fire (wildfire), which usually means that the canopy has been consumed. Text following this symbol (◆) refers to the community's response to low severity, patchy (prescribed) fire, i.e. a fire with unburnt patches within the fire perimeter and in which the canopy is rarely burnt or scorched. The greatest response to frequent fires (whether of high or low severity) comes after the *second* and all subsequent fire(s) with a low (< 10 years) fire interval. The patchiness of low severity fires is critical in maintaining sensitive species in the community, as it means that some vegetation, within the fire perimeter, escapes being burnt at such frequent intervals.

Tall Mixed Forest (Eastern) EVD 7 – eight months after wildfire at Bunyip State Park, Victoria.

Tall Mixed Forest (Eastern) EVD 7 – 15 years after wildfire near Erica, Victoria.

Renewal

0–0.75 years after fire

Lasts for 0.75 ± 0.25 years, i.e.

1.3% of age span, 1.3% of maximum desirable fire interval

◆ same for low severity fires

During this stage:

- most of the ground is bare
- fire ephemerals growing vigorously and blooming by end of this stage
- adventive annuals uncommon, but growing vigorously
- bradysporous species releasing seed from elevated fruit
- soil-stored seed germinating and making first appearance above ground
- resprouting species showing first signs of buds activating, but little shoot extension
- bracken reappearing above ground (new croziers unrolling)
- most species not flowering and mature seed largely lacking from the community
- scant shoot extension from resprouting eucalypts
- ◆ scorched foliage falling and adding to the loose litter
- little or no litter, although ash accumulated in occasional drifts
- limiting soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralisation of organically bound pre-fire forms)
- abundant light at ground level
- relatively high soil moisture.

Juvenility

0.75–2.75 years after fire

Lasts for 2 ± 0.5 years, i.e.

3.3% of age span, 3.3% of maximum desirable fire interval

◆ same for low severity fires

During this stage:

- much of the ground is bare
- fire ephemerals common in the vigorously growing and substantially herbaceous field layer, flowering and setting abundant seed
- introduced adventive herbs decreasing
- bradysporous species germinating and establishing, but neither dominant nor a major component of any stratum
- resprouting species vigorously growing, rapid shoot extension
- tree seedlings evident (cotyledon stage to early juvenile leaves)
- resprouting species in the tree canopy vigorously coppicing (from the main trunk if the fire of high severity, ✦ from the small twigs if the foliage only scorched), not flowering
- bracken increasingly common in the field layer
- scandent species (e.g. *Rubus* species, *Tetrarrhena juncea*) with vigorous shoot extension
- herbaceous fire ephemerals and annuals with first seed set
- 'M' species vigorously flowering (e.g. *Xanthorrhoea australis*)
- seed bank of all but the annuals and the shorter-lived fire ephemerals lacking
- neither flowering nor seed of the (pre-fire) dominant shrubs
- little or no litter, ash drifts still evident
- prone coarse woody debris at a minimum
- limiting soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralisation of organically bound pre-fire forms)
- abundant light to the field layer, light at ground level decreasing
- relatively high soil moisture.

Adolescence

2.75–8 years after fire

Lasts for 5 years, i.e.

8% of age span, 8% of maximum desirable fire interval

◆ same for low severity fires, but note that there are many unburnt patches, within the fire perimeter, which retain essentially mature or older vegetation

During this stage:

- bare soil far less common than in juvenility stage
- canopy cover increasing, lower coppice dying
- fire ephemerals in decline — annuals and biennials retreated to the soil seed store, longer-lived fire ephemerals fully reproductive
- no further germination or establishment of bradysporous species, earlier germinants vigorously growing, mostly pre-flowering and neither dominant nor a major component of the shrub strata, mature seed of these species lacking in the community; ◆ this group of species is most susceptible to frequent fires and may be locally eliminated unless high-frequency fires are distinctly patchy
- resprouting shrubs vigorously growing, rapid shoot extension, first flowering in large resprouter shrubs but little seed set (although seed set has begun, mature seed of these species largely lacking in the community)
- 'M' species mature and releasing seed (e.g. *Xanthorrhoea australis*)
- seed regenerating legumes (e.g. *Acacia* species, *Indigofera australis, Pultenaea* species) abundant and vigorous, flowering and setting seed, particularly by the end of this growth stage
- most tree seedlings dead, the few survivors (in gaps in the canopy and shrub strata) slowly growing, neither flowering nor setting seed, with immature foliage
- coppice of resprouting canopy species (largely eucalypts) dying on the lower trunk and increasingly restricted to the smaller branches, canopy largely re-established by end of this growth stage, scant flowering and seed set, ◆ previously scorched foliage dead, fallen, completely replaced by mature canopy, flowering and setting seed
- resprouting sedges and restiads vigorous and flowering with ample seed set
- Bracken (*Pteridium esculentum*) often dominant in the field stratum
- scandent species (e.g. *Rubus* species, *Tetrarrhena juncea*) vigorously growing, flowering and setting seed
- seed bank of the fire ephemerals restored, seed bank of seed-regenerating legumes restored by the end of this stage, seed bank of other groups gradually accumulating but not at a maximum
- some litter accumulation, litter patchy and gradually being incorporated into the soil
- coarse woody debris being augmented by falling stems of large shrubs and trees
- limiting soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralisation of organically bound pre-fire forms and from vigorous nitrogen fixation by legumes)
- light at ground level low, light reaching shrub strata decreasing as canopy slowly re-establishing
- soil moisture returning to normal inter-fire patterns.

Vigorous maturity

8–20 years after fire

Lasts for 12 years, i.e. 20% of age span, 20% of maximum desirable fire interval

During this stage:

- canopy cover increasing to a maximum by end of this growth stage
- all fire ephemerals retreated to soil seed store
- most large understorey adventives (e.g. *Acacia mearnsii*) moribund
- no further germination nor establishment of bradysporous species, earlier germinants vigorously growing, flowering and setting seed, elevated seed storage gradually accumulating
- little or no shrub establishment from seed (whether of the large bradysporous species or the smaller ericoids and the like)
- resprouting species growing, flowering and with accumulating seed store
- seed regenerating legumes (e.g. *Acacia* species, *Indigofera australis, Pultenaea* species) flowering and setting seed, but decreasing (more so by the end of this stage),
- sedges and restiads common, vigorously flowering
- canopy eucalypts flowering and setting seed
- the few remnant eucalypt seedlings first flowering but with weak seed set
- herbaceous species (not fire ephemerals) reappearing and becoming more common in the field layer
- Bracken (*Pteridium esculentum*) still dominant in field layer, but with much dead material in season (winter)
- scandent species (e.g. *Rubus* species, *Tetrarrhena juncea*) common but gradually decreasing (particularly by the end of this growth stage)
- 'M' species mature but not reproductive
- litter accumulating, litter cover re-established and being incorporated into the soil
- coarse woody debris augmented by fallen stems of large shrubs and trees
- lichen and bryophyte cover re-establishing, but not continuous
- limiting soil nutrients (notably nitrogen and phosphorus) in decreasing abundance
- light at ground level at a minimum
- soil moisture returned to normal inter-fire patterns.

Stasis

20–60 years after fire

Lasts for 40 years, i.e. 67% of age span, 67% of maximum desirable fire interval

During this stage:

- canopy cover at a maximum
- all fire ephemerals retreated to soil seed store
- large understorey adventives (e.g. *Acacia mearnsii*) moribund, with an abundant soil seed store
- no further germination nor establishment of bradysporous species, earlier germinants vigorously growing, flowering and setting seed, elevated seed storage gradually accumulating
- little or no shrub establishment from seed of the large bradysporous species
- resprouting species growing, flowering and with accumulating seed store
- seed regenerating legumes (e.g. *Acacia* species, *Indigofera australis, Pultenaea* species) decreasing, increasingly uncommon (more so by the end of this stage), with an abundant soil seed store
- sedges and restiads common, flowering
- canopy eucalypts vigorously flowering and setting seed, maximum on-site seed store
- the few remnant eucalypt seedlings flowering but with weak seed set, reaching the canopy
- herbaceous species (not fire ephemerals) common in the field layer
- Bracken (*Pteridium esculentum*) increasingly uncommon in field layer, with much dead material in winter
- scandent species (e.g. *Rubus* species, *Tetrarrhena juncea*) uncommon, gradually decreasing (more so by the end of this stage)
- 'M' species mature but not reproductive
- litter accumulating, litter cover re-established and being incorporated into the soil
- coarse woody debris augmented by fallen stems of large shrubs and trees
- lichen and bryophyte cover re-establishing, but not continuous
- limiting soil nutrients (notably nitrogen and phosphorus) at a minimum
- light at ground level at a minimum
- soil moisture returned to normal inter-fire patterns.

Waning

60 years after fire

beyond maximum desirable fire interval

During this stage:

- canopy cover slowly decreasing
- canopy eucalypts flowering and setting seed, canopy seed store at a maximum
- large understorey adventives (e.g. *Acacia mearnsii)* retreated to an abundant soil seed store
- no further germination or establishment of bradysporous species, growth rates at a minimum, little flowering and seed set, elevated seed storage decreasing
- resprouting shrubs growing (but growth rates decreasing), flowering and with maximum seed store
- (second) regeneration opportunity for those shrubs capable of regenerating in unburnt patches (e.g. *Pomaderris* species), leading to a gradual change in shrub stratum composition
- seed regenerating legumes (e.g. *Acacia* species, *Indigofera australis, Pultenaea* species) increasingly uncommon (more so as this stage extends), some species no longer visible but present as an abundant soil seed store
- mesic species establishing in the shrub strata, particularly from long-distance dispersal, e.g. *Bedfordia arborescens, Myrsine howittiana*, *Notelaea* species
- 'M' species mature but not reproductive
- long-lived sedges and the like decreasing
- litter cover at a maximum, being incorporated into the soil
- coarse woody debris increasing, augmented by falling stems and larger branches of the shrubs and trees,
- first significant hollow formation in canopy trees
- lichen and bryophyte cover well established and gradually increasing
- soil nutrient availability (notably nitrogen and phosphorus) at a minimum
- light at ground level at a minimum
- soil moisture relatively low.

Useful References

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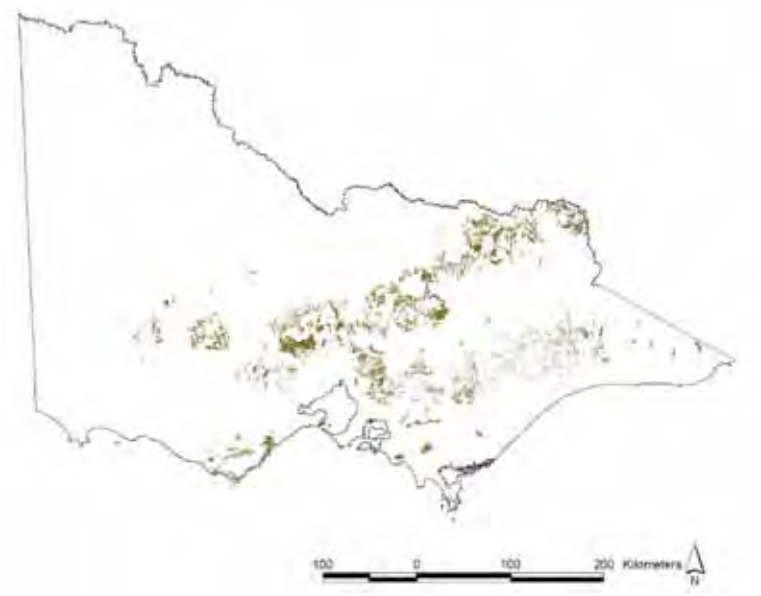
EVD 8: Foothills Forest

Maximum	100 years
Minimum (high severity)	25 years
Minimum (low severity)	10 years



Foothills Forest may burn in an intense (wild-)fire or as a patchy prescribed burn. The black text below describes this community's response to high-severity fire (wildfire), which usually means that the canopy has been consumed.

◆ This symbol refers to the community's response to low-severity, patchy (prescribed) fire, i.e. a fire that leaves many unburnt patches within the fire perimeter and in which the canopy is rarely burnt or scorched. The greatest response to frequent fires (whether of high or low severity) comes after the ***second*** and subsequent fires with a low (< 10–15 year) fire interval. The patchiness of low-severity fires is critical in maintaining sensitive species in the community, as it means that some vegetation escapes being burnt at such frequent intervals.

Renewal

0–0.5 years after fire

Lasts for 0.5 ± 0.25 years, i.e.
0.5% of age span, 0.5% of maximum desirable fire interval
◆ same for low-severity fires

During this stage:

- most of the ground is bare
- bradysporous species releasing seed from elevated fruit
- soil-stored seed germinating and making first appearance above ground
- resprouting species showing first signs of buds activating, but little shoot extension
- Bracken (*Pteridium esculentum*) reappearing above ground (new croziers unrolling)
- nearly all species not flowering, and mature seed largely lacking from the community
- little or no litter, although ash accumulated in occasional drifts
- soil crusts disrupted or eliminated
- limiting soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralization of organically bound pre-fire forms)
- abundant light at ground level
- relatively high soil moisture.

Foothill Forest EVD 8, juvenile stage, less than two years after low-intensity planned burning, Mount Dandenong, Victoria.

(PHOTO COURTESY ANNETTE MUIR)

Foothill Forest EVD 8, vigorous maturity stage, over 10 years since last low intensity planned burning, Mount Dandenong, Victoria.

(PHOTO COURTESY ANNETTE MUIR)

Foothill Forest EVD 8, stasis stage, long unburnt, Mount Dandenong, Victoria.

(PHOTO COURTESY ANNETTE MUIR)

Juvenility

0.5–2.5 years after fire

Lasts for 2 ± 0.5 years, i.e.

2% of age span, 2% of maximum desirable fire interval

◆ same for low-severity fires

During this stage:

- most of the ground is bare
- herbaceous fire ephemerals common in a vigorously growing and substantially herbaceous field layer
- bradysporous species germinating and establishing, but neither dominant nor a major component of any stratum
- legumes abundantly germinating from seed, first signs of shoot extension
- mature trees coppicing abundantly on trunks and larger branches
- ◆ lightly burnt or unburnt trees without stem coppice, canopies unaffected or resprouting from minor leaf scorch
- tree seedlings evident (cotyledon and intermediate leaf stage)
- resprouting species vigorously growing, rapid shoot extension
- resprouting species in the tree canopy vigorously coppicing, not flowering
- bracken common in the field layer
- herbaceous fire ephemerals and annuals with first seed set
- seed bank of all but the annuals and the shorter-lived fire ephemerals lacking
- neither flowering nor seed of the pre-fire dominant shrubs
- little or no litter, ash drifts still evident
- bryophyte and lichen cover disrupted or eliminated
- limiting soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralisation of organically bound pre-fire forms)
- abundant light reaching the field layer, light at ground level decreasing
- relatively high soil moisture.

Adolescence

2.5–10 years after fire

Lasts for 8 years, i.e.

8% of age span, 8% of maximum desirable fire interval

◆ same for low severity fires, but note that there are many unburnt patches, within the fire perimeter, which retain essentially mature or older vegetation

During this stage:

- canopy cover increasing (bare soil far less common than previously), lower coppice dying
- fire ephemerals in decline — annuals and biennials retreated to the soil seed store, longer-lived fire ephemerals common and fully reproductive
- legumes growing vigorously, abundantly flowering and setting seed
- no further germination or establishment of bradysporous species, earlier germinants vigorously growing, mostly pre-flowering and neither dominant nor a major component of the shrub strata, mature seed of these species lacking in the community; ◆ this group of species is most susceptible to frequent fires and may be locally eliminated unless high-frequency fires are distinctly patchy
- resprouting shrubs vigorously growing, rapid shoot extension, first flowering in large resprouter shrubs but little seed set (although seed set has begun, mature seed of these species largely lacking in the community)
- resprouting sedges, restiads and the like (e.g. *Lomandra* species) vigorous and flowering with ample seed set
- tussock grasses resprouting, flowering and setting seed
- bracken common to abundant in the field stratum
- seed bank of the fire ephemerals restored, but for all other groups uncommon to largely absent
- little seed of the pre-fire dominant shrubs
- some litter accumulation, litter patchy and gradually being incorporated into the soil
- coarse woody debris being augmented by dropping dead stems from the canopy eucalypts and the large shrubs
- terrestrial bryophyte and lichen cover disrupted or eliminated
- limiting soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralisation of organically bound pre-fire forms and from vigorous nitrogen fixation by the abundant legumes)
- light at ground level low, light reaching shrub strata decreasing as canopy slowly re-establishing
- soil moisture returning to normal inter-fire patterns.

Vigorous maturity

10–40 years after fire

Lasts for 30 years, i.e. 30% of age span, 30% of maximum desirable fire interval

During this stage:

- canopy cover at a maximum
- all fire ephemerals retreated to soil seed store
- large understorey adventives (e.g. *Acacia mearnsii*) uncommon to moribund
- legume shrubs common, flowering and setting seed, maximum soil seed bank
- no further germination nor establishment of bradysporous species, earlier germinants vigorously growing, flowering and setting seed, elevated seed storage gradually accumulating
- little or no shrub establishment from seed, whether of the large bradysporous species or the smaller ericoids and the like
- resprouting species growing, flowering and with accumulating seed store
- sedges and restiads common, flowering
- canopy eucalypts flowering and setting seed
- eucalypt seedlings first flowering but with weak seed set
- herbaceous species (not fire ephemerals) gradually reappearing and becoming more common in the field layer
- Bracken (*Pteridium esculentum*) still common in field layer, but with much dead material in winter
- litter accumulating, litter cover re-established and being incorporated into the soil
- early development of an A_0 soil horizon
- gradual accumulation of coarse woody debris
- lichen and bryophyte cover re-establishing
- limiting soil nutrients (notably nitrogen and phosphorus) in decreasing abundance
- light at ground level at a minimum
- soil moisture returned to normal inter-fire patterns.

Stasis

40–90 years after fire

Lasts for 50 years, i.e. 50% of age span, 50% of maximum desirable fire interval

During this stage:

- canopy cover at a maximum
- all fire ephemerals retreated to soil seed store
- legume shrubs increasingly uncommon, flowering and setting seed, declining soil seed bank, particularly towards the end of this stage
- no further germination nor establishment of bradysporous species, earlier germinants still growing (but growth rates declining), flowering and setting seed, elevated seed storage static
- little or no shrub establishment from seed of the large bradysporous species
- ericoid species with continuing low rate of recruitment, more common in the shrub layer by the end of this stage than at the beginning
- resprouting species growing, flowering and with established seed bank
- sedges, restiads and the like common, flowering
- canopy eucalypts abundantly flowering and setting seed
- eucalypt seedlings flowering, part of the canopy
- herbaceous species (not fire ephemerals) fairly common in the field layer
- Bracken (*Pteridium esculentum*) not uncommon in the field layer but declining, with much dead material in winter
- tussock-grasses common, flowering and setting seed
- litter at a maximum, litter cover re-established and being incorporated into the soil
- well-developed A0 soil horizon
- coarse woody debris at a maximum
- start of significant hollow formation in the larger trees
- lichen and bryophyte cover re-established, especially lichens in inter-tussock gaps
- limiting soil nutrients (notably nitrogen and phosphorus) at a minimum
- light at ground level at a minimum
- soil moisture returned to normal inter-fire patterns.

Senescence

90–100+ years after fire

Lasts for 10+ years, i.e. 10% of age span, 10% of maximum desirable fire interval towards and beyond upper limit of desirable fire age

During this stage:

- canopy cover slowly decreasing
- tree density declining, crowns more umbrageous, canopy gaps apparent
- canopy eucalypts flowering and setting seed, canopy seed store slowly declining
- annual species (not fire ephemerals) becoming more common in the field layer
- no further germination or establishment of bradysporous species, growth rates at a minimum, little flowering and seed set, elevated seed storage decreasing, mature shrubs dying without replacement
- resprouting shrubs growing (but growth rates decreasing), flowering and with declining seed store
- legume shrubs rare and declining further, declining soil seed bank
- ericoid species with continuing low rate recruitment, slowly becoming more common in the shrub layer
- long-lived sedges and the like at greatest cover
- Bracken (Pteridium esculentum) uncommon and declining in the field layer
- tussock-grasses common, flowering and setting seed
- herbaceous species (not fire ephemerals) relatively common in the field layer
- abundant litter cover, being incorporated into the soil
- well-developed A0 soil horizon
- coarse woody debris at a maximum
- significant hollow formation in the larger trees
- lichen and bryophyte cover well established and gradually increasing
- epiphytic lichens common
- soil nutrient availability (notably nitrogen and phosphorus) at a minimum
- light at ground level decreased to a minimum, light at intermediate levels (1–2 m) increasing
- soil moisture relatively low.

Useful References

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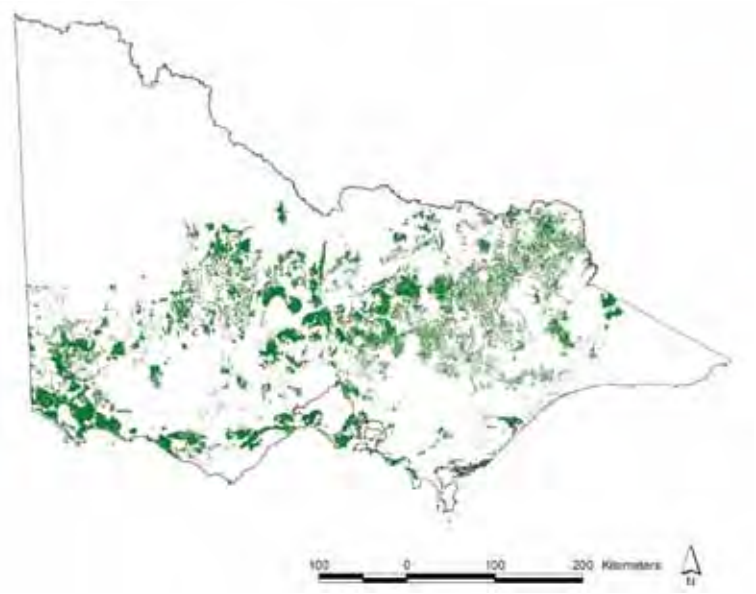
EVD 9: Forby Forest

Maximum	150 years
Minimum (high severity)	15 years
Minimum (low severity)	15 years



Renewal

0–0.75 years after fire

Lasts for 0.75 ± 0.25 years, i.e.
0.5% of age span, 0.5% of maximum desirable fire interval

During this stage:

- most of the ground is bare
- bradysporous species releasing seed from elevated fruit
- soil-stored seed germinating and making first appearance above ground
- resprouting species showing first signs of buds activating, but little shoot extension
- Bracken (*Pteridium esculentum*), if present pre-fire, reappearing above ground (new croziers unrolling)
- nearly all species not flowering, mature seed largely lacking from the community
- little or no litter, although ash accumulated in occasional drifts
- bryophyte and lichen cover disrupted or eliminated
- limiting soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralisation of organically bound pre-fire forms)
- abundant light at ground level
- relatively high soil moisture.

Juvenility

0.75–3 years after fire

Lasts for 2.25 years, i.e. 1.5% of age span, 1.5% of maximum desirable fire interval

During this stage:

- much of the ground is bare, but bare area decreasing by the end of this stage
- adventive annuals (including introduced species) common, flowering and setting abundant seed
- herbaceous fire ephemerals common in the vigorously growing and substantially herbaceous field layer
- bradysporous species germinating and establishing, but neither dominant nor a major component of any stratum
- legumes (including legume shrubs) abundantly germinating from seed, first signs of shoot extension
- mature trees coppicing abundantly on trunks and larger branches, not flowering
- lightly burnt (or unburnt) trees, without stem coppice, canopies unaffected or resprouting from minor leaf scorch
- tree seedlings evident (cotyledon and intermediate leaf stage)
- resprouting species vigorously growing, rapid shoot extension
- Bracken (*Pteridium esculentum*), if present pre-fire, vigorous but not common in the field layer
- herbaceous fire ephemerals and annuals with first seed set
- seed bank of all but the annuals and the shorter-lived fire ephemerals lacking
- neither flowering nor seed of the pre-fire dominant shrubs
- little or no litter, ash drifts still evident
- bryophyte and lichen cover disrupted or eliminated
- bryophytes rare except for a few species of fire ephemerals which form dense mats on the ground
- limiting soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralisation of organically bound pre-fire forms)
- abundant light reaching the field layer, light at ground level decreasing
- relatively high soil moisture.

Adolescence

3–10 years after fire

Lasts for 7 years, i.e.

5% of age span, 5% of maximum desirable fire interval

Note that there may be many unburnt patches within the fire perimeter that retain essentially mature or older vegetation

During this stage:

- canopy cover increasing (bare soil far less common than previously), lower coppice dying
- fire ephemerals in decline (annuals and biennials retreated to the soil seed store, longer-lived fire ephemerals (e.g. *Goodia* species) common and fully reproductive)
- legumes (including legume shrubs) growing vigorously, abundantly flowering and setting seed
- no further germination or establishment of bradysporous species, earlier germinants vigorously growing, mostly pre-flowering and neither dominant nor a major component of the shrub strata, mature seed of these species lacking in the community; this group of species is most susceptible to frequent fires and may be locally eliminated unless high frequency fires are notably patchy
- (scattered) resprouting shrubs vigorously growing, rapid shoot extension, first flowering in large resprouter shrubs but little seed set (although seed set has begun, mature seed of these species largely lacking in the community)
- resprouting sedges, restiads and the like (e.g. *Lomandra* species) vigorous and flowering with ample seed set
- tussock grasses resprouting, flowering and setting seed
- forbs of mature forests gradually re-establishing, but nowhere dominant in the field stratum
- bracken (if present) vigorous but not common in the field stratum
- seed bank of the fire ephemerals restored, but for all other groups uncommon to largely absent
- little seed of the (pre-fire) shrubs
- some litter accumulation, litter patchy and gradually being incorporated into the soil
- coarse woody debris being augmented by dropping dead stems from the canopy eucalypts
- bryophyte and lichen cover disrupted or eliminated
- fire ephemeral bryophytes in retreat, other bryophytes uncommon
- limiting soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralization of organically bound pre-fire forms and from vigorous nitrogen fixation on the abundant legumes)
- light at ground level low, light to shrub strata decreasing as canopy slowly re-establishing
- soil moisture returning to normal inter-fire patterns.

Vigorous maturity

10–40 years after fire

Lasts for 30 years, i.e. 20% of age span, 20% of maximum desirable fire interval

During this stage:

- canopy cover at a maximum
- all fire ephemerals retreated to soil seed store
- large understorey adventives (e.g. *Acacia mearnsii*) uncommon to moribund
- legume shrubs decreasing, flowering and setting seed, maximum soil seed bank
- no further germination nor establishment of bradysporous species, earlier germinants vigorously growing, flowering and setting seed, elevated seed storage gradually accumulating
- little or no shrub establishment from seed, whether of large bradysporous species or smaller ericoids and the like
- resprouting species growing, flowering and with accumulating seed store
- sedges and the like common, flowering
- canopy eucalypts flowering and setting seed
- eucalypt seedlings first flowering but with weak seed set
- herbaceous species (not fire ephemerals) gradually reappearing and becoming more common in the field layer, forb species richness increasing
- Bracken (*Pteridium esculentum*) uncommon to absent in the field stratum
- litter accumulating, litter cover re-established and being incorporated into the soil
- development of an A_0 soil horizon
- gradual accumulation of coarse woody debris
- bryophyte and lichen cover re-establishing
- bryophyte species richness increasing
- limiting soil nutrients (notably nitrogen and phosphorus) in decreasing abundance
- light at ground level at a minimum
- soil moisture returned to normal inter-fire patterns.

Forby Forest EVD 9, approximately three years after burning, King Valley, Victoria.

(PHOTO COURTESY DAN JAMIESON)

Forby Forest EVD 9, long unburnt, King Valley, Victoria.

(PHOTO COURTESY DAN JAMIESON)

Stasis

40–150 years after fire

Lasts for 110 years, i.e. 73% of age span, 73% of maximum desirable fire interval

During this stage:

- canopy cover (of trees) at a maximum
- all fire ephemerals retreated to soil seed store
- legume shrubs uncommon to rare to apparently absent, flowering and seed set decreasing, declining soil seed bank (particularly towards the end of this growth stage)
- no further germination nor establishment of bradysporous species, earlier germinants growing (growth rates declining), flowering and setting seed, elevated seed storage static initially but decreasing by the end of this stage
- little or no shrub establishment from seed of the large bradysporous species
- very small number of ericoid species (e.g. *Acrotriche serrulata*) with continuing low rate recruitment, more common in the shrub layer by the end of this stage than at the beginning, but nowhere common
- resprouting species growing, flowering and with established seed bank, decreasing towards the mid-to late ages of this growth stage
- sedges, and the like common, flowering
- canopy eucalypts abundantly flowering and setting seed
- eucalypt seedlings flowering, part of the canopy
- species rich assemblage of herbaceous species (not fire ephemerals) common in the field layer
- Bracken (*Pteridum esculentum*) usually absent, or at least uncommon
- tussock grasses common, flowering and setting seed
- litter at a maximum, litter cover re-established and being incorporated into the soil
- well-developed A_0 soil horizon
- coarse woody debris at a maximum
- significant hollow formation in the larger trees
- lichen and bryophyte cover re-established, epiphytic lichens well developed
- bryophyte species richness at a maximum for this community
- limiting soil nutrients (notably nitrogen and phosphorus) low at the beginning of this stage, but increasing by the end of this growth stage
- light at ground level at a minimum, increasing by the end of this growth stage(as the scattered shrubs thin further)
- soil moisture returned to normal inter-fire patterns.

Senescence

150+ years

Towards and beyond upper limit of desirable fire age.

The futures of these notably non-shrubby communities are uncertain and conjectural in the further absence of fire. It is likely that the eucalypts would maintain themselves in the absence of fire by an occasional 'trickle through' germination and establishment, and the herb layer would survive in the long-term without further fire, but the few shrubs would probably decrease further and perhaps disappear.

Useful References

Abbott, I., Heurck, P. V. and Wong, L. (1985) Responses to long-term fire exclusion: physical, chemical and faunal features of litter and soil in a Western Australian forest. *Australian Forestry* 47(4), 237–242

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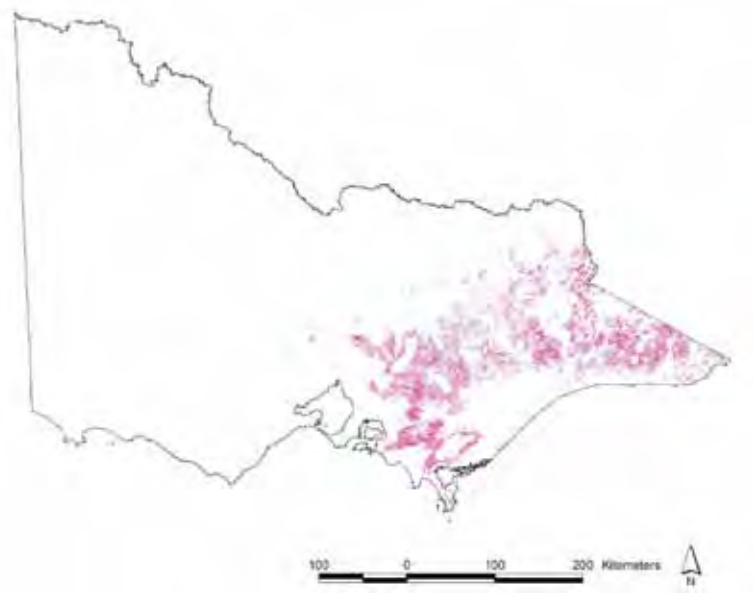
Williams, J. E., Whelan, R. J. and Gill, A. M. (1994) Fire and environmental heterogeneity in southern temperate forest ecosystems: implications for management. *Australian Journal of Botany* 42, 125–137

EVD 10: Moist Forest

Maximum	150 years
Minimum (high severity)	25 years
Minimum (low severity)	25 years



Renewal

0–1 year after fire

Lasts for 1 ± 0.2 years , i.e.
0.7% of age span, 0.7% of maximum desirable fire interval

During this stage:

- most of the ground is bare
- bradysporous species (of which there are few) releasing seed from elevated fruit, mangy germinants by the end of this stage
- soil-stored seed germinating and making first appearance above ground
- fire ephemerals vigorously growing towards the end of this growth stage
- resprouting species showing first signs of buds activating, visible shoot extension towards the end of this growth stage (small number of resprouters in vigorous growth in mid-stage)
- surviving tree-ferns and other ferns (if present) vigorously resprouting
- most species not flowering and mature seed generally lacking from the community
- little or no litter, except for large coarse woody debris (logs)
- bryophytes and lichens largely absent or invisible, by end of this stage adventive bryophtes (e.g. *Funaria hygrometrica* and *Marchantia berteroana)* becoming common
- former canopy dominants with first signs of coppice bud activation but little shoot extension
- understorey trees mostly killed by the fire
- soil nutrients (notably nitrogen and phosphorus) in increased abundance (at a maximum), from mineralization of organically bound pre-fire forms
- abundant light at ground level
- relatively high soil moisture
- run-off at a maximum, erosion risk high.

Founding

1–3 years after fire

Lasts for 2 years, i.e. 1.3% of age span, 1.3% of maximum desirable fire interval

During this stage:

- bare soil becoming uncommon but still present
- emergent standing stems of the former canopy dominants, upper branches bare
- fire ephemerals dominate the vigorously growing (herbaceous) field layer
- annual and biennial fire ephemerals common but decreasing in abundance, re-establishing the (long-lived) soil seed store
- longer-lived fire ephemerals (> 5 years) vigorously growing
- bradysporous species germinating and establishing, but neither dominant nor a major component of any vegetation stratum
- resprouting shrubs and herbs vigorously growing, rapid shoot extension
- herbaceous fire ephemerals and annuals with first seed set
- species regenerating from seed vigorously growing, but not flowering
- seed bank of all but the annuals and the shorter-lived fire ephemerals lacking
- neither flowering nor seed of the (pre-fire) dominant shrubs
- cryptogams and ferns uncommon, however may be vigorous growth of a few moss species (especially *Funaria hygrometrica*), and a few post-fire rhizomatous fern increasers such as *Histiopteris incisa* and some *Blechnum* species
- lichens scarce
- tree-ferns with canopies re-establishing, but without a skirt of hanging dead fronds
- tree-fern epiphytes lacking
- gradual litter accumulation, but litter volume very low
- soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralization of organically bound pre-fire forms and vigorous nitrogen fixation post-fire)
- abundant light at around 1-2 m above ground
- relatively high soil moisture.

Juvenility

3–11 years after fire

Lasts for 8 years, i.e. 5% of age span, 5% of maximum desirable fire interval

During this stage:

- bare soil uncommon
- annual and biennial fire ephemerals incorporated into the soil seed store
- longer-lived fire ephemeral sub-shrubs and shrubs at maximum growth, vigorously growing and setting seed (fully reproductive)
- longer-lived fire ephemeral understorey trees (e.g. *Acacia dealbata*) vigorously growing, mostly pre-flowering, little seed set
- legumes at most diverse and abundant, vigorously growing and first-flowering, soil seed store increasing
- no further germination or establishment of bradysporous species, earlier germinants vigorously growing, mostly pre-flowering and neither dominant nor a major component of any vegetation stratum, mature seed lacking in the community
- resprouting species vigorously growing, rapid shoot extension, first flowering in resprouters but little or no seed set, mature seed lacking in the community
- canopy dominants vigorously coppicing and re-establishing a canopy (but still discontinuous)
- most seedlings of canopy species weakening and disappearing
- vigorous growth of sub-shrubby or herbaceous field layer of intricately matting plants (e.g. *Rubus* species, *Tetrarrhena juncea*)
- ground ferns (e.g. *Lastreopsis, Polystichum* and *Blechnum* species) slowly recovering, but uncommon, except for the earlier adventives referred to above
- seed bank of many of the fire ephemerals restored, but for all other groups largely absent
- little seed of the (pre-fire) dominant shrubs and trees
- light litter accumulation, but litter still patchy
- bryophytes abundant but low diversity, first signs of re-establishment of lichens
- soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralisation of organically bound pre-fire forms and vigorous post-fire nitrogen fixation)
- light at ground level decreasing
- soil moisture low compared to pre-fire patterns
- run-off decreasing.

Adolescence

11–26 years after fire

Lasts for 15 years, i.e. 10% of age span, 10% of maximum desirable fire interval

During this stage:

- bare soil lacking, increasing incorporation of litter into the soil profile and (re-)development of an A_0 soil horizon
- annual, biennial and short-lived shrubby fire ephemerals invisible, incorporated into the soil seed store
- longer-lived fire responsive tall shrubs and understorey trees (e.g. taller *Daviesia* species and *Acacia dealbata*) at maximum growth, vigorously growing and setting seed (fully reproductive)
- shrubby legumes in vigorous growth, soil seed store re-established
- no further germination or establishment of bradysporous species, earlier germinants vigorously growing, flowering and increasing in prominence, mature seed present in the soil seed store
- seed regeneration of canopy species now dead (except for the very small proportion growing in any canopy gaps – these are experiencing rapid height growth)
- resprouting species vigorously growing, rapid shoot extension, flowering and setting seed, mature seed present in the community and increasing,
- thinning of any vigorous growth of sub-shrubby or herbaceous field layer intricately matting species (e.g. *Rubus* species, *Tetrarrhena juncea*)
- ground ferns recovering, rhizomatous species spreading
- mesic herbs in field layer recovering
- seed bank of the fire ephemerals restored, for all other groups seed store increasing but not at a maximum
- first seed set of the (pre-fire) dominant shrubs and trees
- litter accumulating and being incorporated into the soil
- bryophytes common and with increasing diversity
- vascular epiphytes gradually re-establishing but still rare
- soil nutrients (notably nitrogen and phosphorus) decreasing, although vigorous nitrogen fixation persisting
- light at ground level at low severity
- soil moisture still relatively low
- minimal run-off
- eucalypts and seed regenerant *Acacia* species forming a dense co-canopy
- little or no hollow development in standing stems (live or dead)
- minimal coarse woody debris, although the larger logs deriving from immediately after the last fire may still be relatively common.

Maturity

26–100 years after fire

Lasts for 74 years, i.e. 50% of age span, 50% of maximum desirable fire interval

During this stage:

- canopy cover at a maximum
- bare soil lacking, increasing incorporation of litter into the soil profile and a well-developed A_0 soil horizon
- annual, biennial and all fire ephemerals invisible, retreated to the soil seed store
- fire ephemeral tall shrubs and understorey trees (e.g. taller *Daviesia* species and *Acacia dealbata*) senescent and gradually disappearing (retreating to the soil seed store)
- except for a few long-lived trees (notably *Acacia melanoxylon*) legumes all old, senescing and retreating to the soil seed store
- no further germination or establishment of bradysporous species, earlier germinants growing, flowering and beginning to decline in abundance (although cover may be at a maximum), abundant mature seed present in the elevated seed store
- resprouting species vigorously growing, flowering and setting seed, mature seed present in the community
- tree-ferns slowly spreading from the individual remnant regrowth
- intricately matting species (e.g. *Rubus* species, *Tetrarrhena juncea*) present but declining
- ground ferns recovered, rhizomatous species spreading
- field strata with mesic herbs (e.g. *Hydrocotyle hirta, Lagenifera* species, *Stellaria flaccida*) but low diversity
- seed bank of the fire ephemerals restored, for all other groups seed store at a maximum
- vigorous flowering and seed set of the pre-fire dominant shrubs and trees
- litter accumulating and being incorporated into the soil
- bryophytes common and diversity increasing, lichens becoming common
- vascular epiphytes rare but re-established on tree-fern trunks
- soil nutrients (notably nitrogen and phosphorus) in decreasing relative abundance
- light at ground level at very low intensity
- soil moisture low, when compared with previous vegetation stages, gradually increasing run-off
- canopy consists only of eucalypts; other tree species form an open understorey
- hollow development lacking in early stages, but making first appearance in standing stems (live or dead), particularly in older stands of this growth stage
- coarse woody debris abundant and increasing.

Waning

100–150+ years after fire

Lasts 50+ years, i.e.
33% of age span, 33% of maximum desirable fire interval
towards upper limit of desirable fire age

During this stage:

- eucalypt canopy opening, with inter-tree gaps increasing
- bare soil lacking, maximal incorporation of litter into the soil profile and a well-developed A_0 soil horizon
- all fire ephemerals invisible, incorporated into the soil seed store
- except for a few long-lived trees (notably *Acacia melanoxylon*) legumes all retreated to the soil seed store
- no further germination or establishment of bradysporous species, earlier germinants declining in abundance (cover decreasing), mature seed in the elevated seed store decreasing
- resprouting species. growing, flowering and setting seed, mature seed present in the community
- intricately matting species (e.g. *Rubus* species, *Tetrarrhena juncea*) declining to rare
- ground ferns scattered in field strata, gradually increasing in cover
- field strata with high diversity and abundance of mesic herbs (e.g. *Stellaria flaccida, Mentha laxiflora, Hydrocotyle hirta*)
- mesic rhizomatous grasses (e.g. *Poa ensiformis*), if present, slowly spreading
- seed bank of the fire ephemerals restored and slowly declining, for all other groups seed store at a maximum or declining
- vigorous seed set of the dominant shrubs and trees
- tree-ferns and clumping ferns gradually spreading in the community
- litter at a maximum and being incorporated into the soil
- bryophytes common and with maximum diversity, lichens at maximum richness and diversity for this vegetation community
- vascular epiphytes uncommon, but at their most abundant in this community
- soil nutrients (notably nitrogen and phosphorus) in decreasing relative abundance
- light at ground level at very low intensity
- soil moisture increasing when compared with previous vegetation stages, run-off (water yield) at a maximum for this vegetation community
- eucalypts form the sole canopy, although this is increasingly open with substantial gaps appearing between the remnant (emergent) trees, other tree species form an increasingly dense understorey
- extensive hollow development in the standing (live or dead) stems
- canopy gaps created by falling trees increasing
- coarse woody debris abundant.

Senescence

150+ years after fire

Indeterminate length: beyond maximum desirable fire interval

During this stage:

- Damp Forest may change into another vegetation community (perhaps Dry Rainforest)
- eucalypt canopy opening, with inter-tree gaps increasing
- former understorey trees assuming dominance (e.g. *Acacia melanoxylon, Bedfordia arborescens*)
- long-term, slow invasion by rainforest trees, from long-distance dispersal from nearby Wet Forest or Rainforest
- bare soil lacking, maximal incorporation of litter into the soil profile and a well-developed A_0 soil horizon
- all fire ephemerals invisible, incorporated into the soil seed store
- except for a few long-lived trees (notably *Acacia melanoxylon*) legumes all retreated to the soil seed store
- no further germination or establishment of bradysporous species, earlier germinants declining in abundance (cover decreasing), mature seed in the elevated seed store decreasing
- resprouting species growing, flowering and setting seed but decreasing in abundance, mature seed present in the community
- vascular plant species richness declining
- intricately matting plants (e.g. *Rubus* species, *Tetrarrhena juncea*) absent
- ground ferns and tree-ferns vigorous, slowly increasing in abundance
- field strata of decreasing diversity and abundance of mesic herbs
- field layer becoming increasingly dominated by a small number of rhizomatous mesic species, e.g. *Poa ensiformis, Viola* species.
- seed bank of the fire ephemerals restored but declining, for all other groups soil seed store also declining
- litter at a maximum and being incorporated into the soil
- bryophytes common and with high richness and diversity, lichens and other cryptogams (particularly epiphytes) at high richness and diversity but increasing further
- vascular epiphytes uncommon
- soil nutrients (notably nitrogen and phosphorus) in decreasing relative abundance
- light at ground level at low intensity but increasing (as the upper shrub and tree strata open)
- soil moisture increasing when compared with previous vegetation stages, run-off (water yield) at a maximum for this vegetation community
- eucalypts decreasing in abundance
- extensive hollow development in the standing stems (live or dead), but eucalypt hollows decreasing
- coarse woody debris abundant.

Moist Forest EVD 10, one week after wildfire, Murrindindi, Victoria.

Moist Forest EVD 10, eight months after planned burning, Tonimbuk, Victoria.

Moist Forest EVD10, 26 years after wildfire, McMahons Creek, Victoria.

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EVD 11: Riparian (higher rainfall)

Maximum	120 years
Minimum (high severity)	30 years
Minimum (low severity)	30 years

Renewal

0–1 year after fire

Lasts for 1 ± 0.2 years, i.e.
0.8% of age span, 0.8% of maximum desirable fire interval

During this stage:

- most of the ground is bare
- bradysporous species releasing seed from elevated fruit
- soil-stored seed germinating and making first appearance above ground
- fire ephemerals vigorously growing towards the end of this growth stage
- resprouting species showing first signs of buds activating, visible shoot extension towards the end of this growth stage (small number of resprouters in vigorous growth in mid-stage)
- surviving tree-ferns (if present pre-fire) vigorously resprouting
- most species not flowering (except short-lived fire ephemerals), mature seed generally lacking
- little or no litter, except for large coarse woody debris
- bryophytes and lichens largely absent or invisible
- former canopy dominants with first signs of coppice bud activation but little shoot extension
- understorey trees mostly killed by the fire
- soil nutrients (notably nitrogen and phosphorus) in increased abundance (at a maximum), from mineralisation of organically bound pre-fire forms
- abundant light at ground level
- relatively high soil moisture
- run-off at a maximum, erosion risk high.

Founding

1–3 years after fire

Lasts for 2 years, i.e. 1.7% of age span, 1.7% of maximum desirable fire interval

During this stage:

- bare soil becoming uncommon but still present, ash resulting from the fire no longer evident
- emergent standing stems of the former canopy dominants, upper branches bare and dead
- fire ephemerals dominate the vigorously growing (herbaceous) field layer
- annual and biennial fire ephemerals common but decreasing in abundance, re-establishing the (long-lived) soil seed store
- longer-lived fire ephemerals (> 5 years) vigorously growing
- bradysporous species germinating and establishing, but neither dominant nor a major component of any vegetation stratum
- resprouting shrubs and herbs vigorously growing, rapid shoot extension
- herbaceous fire ephemerals and annuals with first seed set
- species regenerating from seed vigorously growing, but not flowering
- legumes growing vigorously, many flowering and setting seed by end of this stage
- seed bank of all but the annuals and the shorter-lived fire ephemerals lacking
- neither flowering nor seed of the pre-fire dominant shrubs
- mature canopy eucalypts vigorously coppicing
- canopy eucalypts not flowering, mature seed lacking from the community
- lichens, bryophytes and ferns uncommon, but may be vigorous growth of a few moss species (especially *Funaria hygrometrica*) and a few post-fire rhizomatous fern increasers such as *Histiopteris incisa*
- lichens scarce
- tree-ferns with canopies re-establishing, but without a skirt of hanging dead fronds
- tree-fern epiphytes lacking
- gradual litter accumulation, but litter volume very low
- dead timber increasingly contributing to coarse woody debris on the ground
- soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralisation of organically bound pre-fire forms and vigorous post-fire nitrogen fixation)
- abundant light about 1–2 m above ground
- relatively high soil moisture.

Juvenility

3–11 years after fire

Lasts for 8 years, i.e. 5% of age span, 5% of maximum desirable fire interval

During this stage:

- bare soil uncommon
- annual and biennial fire ephemerals incorporated into the soil seed store
- longer-lived fire ephemeral sub-shrubs and shrubs at maximum growth, vigorously growing and setting seed (fully reproductive)
- longer-lived fire ephemeral understorey trees (e.g. *Acacia dealbata*) vigorously growing, mostly pre-flowering, little seed set
- legumes at most diverse and abundant, vigorously growing and flowering, soil seed store increasing
- no further germination or establishment of bradysporous species, earlier germinants vigorously growing, mostly pre-flowering and neither dominant nor a major component of any vegetation stratum, mature seed lacking in the community
- resprouting species vigorously growing, rapid shoot extension, first flowering in resprouters but little or no seed set, mature seed lacking in the community
- canopy dominants vigorously coppicing and re-establishing a canopy (but still discontinuous at this stage)
- most seedlings of canopy species weakening and disappearing
- vigorous growth of sub-shrubby or herbaceous field layer intricately-matting species (e.g. *Rubus* species, *Tetrarrhena juncea*)
- ground ferns rapidly recovering (e.g. *Calochlaena dubia, Histiopteris incisa, Pteridium esculentum*), often locally common
- seed bank of many of the fire ephemerals restored
- seed banks of the longer-lived woody species weak or largely absent
- little seed of the pre-fire dominant shrubs and trees
- tree-ferns with established crowns and pendent dead fronds
- light litter accumulation, but litter still patchy
- bryophytes (low diversity) abundant, first signs of re-establishment of lichens and other cryptogams
- soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralisation of organically bound pre-fire forms and vigorous post-fire nitrogen fixation)
- light intensity at ground level decreasing
- soil moisture low compared to pre-fire patterns
- run-off decreasing.

Adolescence

11–26 years after fire

Lasts for 15 years, i.e. 10% of age span, 10% of maximum desirable fire interval

During this stage:

- bare soil lacking, increasing incorporation of litter into the soil profile and (re-)development of an A_0 soil horizon
- annual, biennial and short-lived shrubby fire ephemerals invisible, incorporated into the soil seed store
- longer-lived fire ephemeral tall shrubs and understorey trees (e.g. taller *Bossiaea, Oxylobium* species and *Acacia dealbata*) at maximum growth, vigorously growing and setting seed (fully reproductive)
- shrubby legumes in vigorous growth, soil seed store re-established
- no further germination or establishment of bradysporous species, earlier germinants vigorously growing, flowering and increasing in prominence, mature seed present but not common in the seed bank
- germinants of canopy species now dead, except for a very small proportion in any canopy gaps (these are growing rapidly)
- resprouting species vigorously growing, rapid shoot extension, flowering and setting seed, mature seed present in the community and increasing
- thinning of any vigorous growth of sub-shrubby or herbaceous field layer intricately matting species (e.g. *Rubus* species, *Tetrarrhena juncea*)
- ground ferns recovering, rhizomatous species vigorously spreading
- mesic herbs in field layer recovering
- seed bank of the fire ephemerals restored, for all other groups seed store increasing but not at a maximum
- first seed set of pre-fire dominant shrubs and trees
- tree-ferns fully recovered, but no new tree-ferns establishing
- litter accumulating and being incorporated into the soil
- bryophytes common and with increasing diversity
- vascular epiphytes still rare
- soil nutrients (notably nitrogen and phosphorus) decreasing, although vigorous nitrogen fixation persisting
- light intensity at ground level low
- soil moisture low compared to pre-fire patterns, minimal run-off
- eucalypts and seed-regenerant *Acacia* species forming a dense co-canopy
- little or no hollow development in standing stems (live or dead)
- minimal coarse woody debris.

Maturity

26–100 years after fire

Lasts for 74 years, i.e. 50% of age span, 50% of maximum desirable fire interval

During this stage:

- canopy cover at a maximum
- bare soil lacking, increasing incorporation of litter into the soil profile and a well-developed A_0 soil horizon
- annual, biennial and all fire ephemerals invisible, retreated to the soil seed store
- fire ephemeral tall shrubs and understorey trees (e.g. taller *Daviesia* species and *Acacia dealbata*) senescent and gradually disappearing (retreating to the soil seed store)
- except for a few long-lived trees (notably *Acacia melanoxylon*) legumes all old, senescing and retreating to the soil seed store
- no further germination or establishment of bradysporous species, earlier germinants growing, flowering and beginning to decline in abundance (although cover may be at a maximum), abundant mature seed present in the seed bank
- resprouting species vigorously growing, flowering and setting seed, mature seed present in the community
- tree-ferns vigorous, newly-established sporelings increasing
- intricately matting species (e.g. *Rubus* species, *Tetrarrhena juncea*) present but declining
- ground ferns recovered, rhizomatous species spreading
- field strata including low diversity of mesic herbs such as *Hydrocotyle* species, *Stellaria flaccida*
- seed bank of the fire ephemerals restored, for all other groups seed store at a maximum
- vigorous flowering and seed set of the pre-fire dominant shrubs and trees
- litter accumulating and being incorporated into the soil
- bryophytes common and with increasing diversity
- lichens and other cryptogams increasing
- vascular epiphytes rare but re-established on tree-fern trunks
- soil nutrients (notably nitrogen and phosphorus) in decreasing relative abundance
- light intensity at ground level very low
- soil moisture low, when compared with previous vegetation stages, run-off low but gradually increasing
- eucalypts form the sole canopy, other tree species form an open understorey
- hollow development lacking in early stages, but making first appearance in the standing stems (live or dead), particularly in older stands
- coarse woody debris abundant and increasing.

Waning

100–150+ years after fire

Lasts 50+ years, i.e. 33% of age span, 33% of maximum desirable fire interval

During this stage:

- eucalypt canopy cover at a maximum (eucalypts declining in abundance, but individual trees larger)
- bare soil lacking, maximal incorporation of litter into the soil profile and a well-developed A_0 soil horizon
- all fire ephemerals invisible, incorporated into the soil seed store
- except for a few long-lived trees (notably *Acacia melanoxylon*) legumes all retreated to the soil seed store
- no further germination or establishment of bradysporous species, earlier germinants declining in abundance (cover decreasing), mature seed in the elevated seed store decreasing
- resprouting species. growing, flowering and setting seed, mature seed present in the community
- fire-sensitive shrub species becoming increasingly common (e.g. *Coprosma* species, *Pittosporum* species)
- intricately-matting species (e.g. *Rubus* species, *Tetrarrhena juncea*) declining to rare
- ground ferns common in field strata, gradually increasing in cover
- field strata including high diversity and abundance of mesic herbs (e.g. *Stellaria flaccida, Mentha* species*, Hydrocotyle* species)
- mesic rhizomatous grasses (e.g. *Poa ensiformis*), if present, slowly spreading
- seed bank of the fire ephemerals restored and slowly declining, for all other groups seed store at a maximum or declining
- vigorous seed set of the dominant shrubs and trees
- tree-ferns and clumping ferns gradually spreading in the community
- litter at a maximum and being incorporated into the soil
- bryophytes and lichens common and at maximum diversity
- vascular epiphytes uncommon, but at their most abundant in this community
- soil nutrients (notably nitrogen and phosphorus) in decreasing relative abundance
- light intensity at ground level very low
- soil moisture increasing when compared with previous vegetation stages, run-off (water yield) at a maximum for this vegetation community
- eucalypts form the sole canopy, although this is increasingly open with substantial gaps appearing between the remnant (emergent) trees, other tree species form an increasingly dense understorey
- extensive hollow development in the standing (live or dead) stems
- canopy gaps created by falling trees increasing
- coarse woody debris abundant.

Senescence

150+ years after fire

Indeterminate length: beyond maximum desirable fire interval

During this stage:

- eucalypt canopy opening, with inter-tree gaps increasing, but continuing sporadic establishment in canopy gaps
- former understorey trees assuming codominance (e.g. *Acacia melanoxylon*)
- slow long-term invasion by rainforest trees dispersing from nearby Wet Forest or rainforest
- bare soil lacking, maximal incorporation of litter into the soil profile and a well-developed A_0 soil horizon
- all fire ephemerals invisible, incorporated into the soil seed store
- except for a few long-lived trees (notably *Acacia melanoxylon*) legumes all retreated to the soil seed store
- no further germination or establishment of bradysporous species, earlier germinants declining in abundance (cover decreasing), mature seed in the elevated seed store decreasing
- resprouting species growing, flowering and setting seed but decreasing in abundance, mature seed present in the community
- vascular plant species richness declining
- intricately matting species (e.g. *Rubus* species, *Tetrarrhena juncea*) apparently absent
- ground ferns and tree-ferns vigorous, slowly increasing in abundance
- tree-ferns at maximum abundance
- field strata of decreasing diversity and abundance of mesic herbs
- field layer becoming increasingly dominated by a small number of rhizomatous mesic species, e.g. *Poa ensiformis, Viola* species.
- seed bank of the fire ephemerals restored but declining, for all other groups soil seed store also declining
- litter at a maximum and being incorporated into the soil
- bryophytes common and at high diversity, lichens (particularly epiphytes) at high diversity but increasing further
- vascular epiphytes at most abundant for this community
- soil nutrients (notably nitrogen and phosphorus) in decreasing relative abundance
- light intensity low at ground level, but increasing as the upper shrub and tree strata open
- soil moisture increasing when compared with previous vegetation stages, run-off (water yield) at a maximum for this vegetation community
- extensive hollow development in the standing stems (live or dead), but eucalypt hollows decreasing
- coarse woody debris abundant.

Riparian (higher rainfall) EVD 11, one week after wildfire, Buxton, Victoria.

Riparian (higher rainfall EVD 11, nine months after wildfire, Narbethong, Victoria.

Riparian (higher rainfall) EVD 11, 18 years after wildfire, McMahons Creek, Victoria.

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EVD 12: Tall Mist Forest

Maximum	300 years (150 years for this exercise)
Minimum (high severity)	80 years
Minimum (low severity)	80 years

Renewal

0–1 year after fire

Lasts for 1 ± 0.2 years, i.e.
0.3% of age span, 0.7% of arbitrary maximum fire interval

During this stage:

- most of the ground is bare
- bradysporous species (of which there are very few) releasing seed from elevated fruit
- soil-stored seed germinating and making first appearance above ground
- fire ephemerals vigorously growing towards the end of this growth stage
- resprouting species showing first signs of buds activating, visible shoot extension towards the end of stage (small number of resprouters in vigorous growth in mid-stage)
- surviving tree-ferns (if present pre-fire) vigorously resprouting
- most species not flowering and mature seed generally lacking from the community
- little or no litter, except for large coarse woody debris
- bryophytes and lichens largely absent or invisible
- former canopy dominants may be dead
- understorey trees mostly dead
- soil nutrients (notably nitrogen and phosphorus) in increased abundance (from mineralisation of organically bound pre-fire forms)
- abundant light at ground level
- relatively high soil moisture
- run-off at a maximum, erosion risk high.

Founding

1–3 years after fire

Lasts for 2 ± 0.2 years, i.e. 0.6% of age span, 1.3 % of arbitrary maximum fire interval

During this stage:

- bare soil becoming uncommon but still present
- emergent standing (and often dead) stems of the former canopy dominants
- fire ephemerals dominate a vigorously growing herbaceous field layer
- annual and biennial fire ephemerals abundant but decreasing in abundance, re-establishing the long-lived soil seed store
- bradysporous species germinating and establishing, but neither dominant nor a major component of any vegetation stratum
- the few resprouting species vigorously growing, rapid shoot extension
- herbaceous fire ephemerals and annuals with first seed set
- species regenerating from seed vigorously growing, but not flowering
- often abundant seedling regeneration of the canopy dominants
- seed banks of all but the annuals and the shorter-lived fire ephemerals lacking
- neither flowering nor seed of the (pre-fire) dominant shrubs
- bryophytes, lichens and ferns uncommon, may be vigorous growth of a few moss species (especially *Funaria hygrometrica*) and a few post-fire rhizomatous fern increasers such as *Histiopteris incisa*
- lichens scarce
- tree-ferns with canopies re-established, but without a skirt of hanging dead fronds
- tree-fern epiphytes lacking
- gradual litter accumulation, but litter volume very low
- soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralisation of organically bound pre-fire forms and vigorous post-fire nitrogen fixation)
- abundant light about 1–2 m above ground
- relatively high soil moisture.

Juvenility

3–9 years after fire

Lasts for 6 years, i.e. 2% of age span, 4% of arbitrary maximum fire interval

During this stage:

- bare soil uncommon
- annual and biennial fire ephemerals incorporated into the soil seed store
- longer-lived fire ephemeral sub-shrubs at maximum growth, vigorously growing and setting seed (fully reproductive)
- legumes at most diverse and abundant, vigorously growing and first-flowering, but relatively little seed set
- no further germination or establishment of bradysporous species, earlier germinants vigorously growing, mostly pre-flowering and neither dominant nor a major component of any vegetation stratum, mature seed lacking in the community
- resprouting species vigorously growing, rapid shoot extension, first flowering in resprouters but little or no seed set, mature seed lacking in the community
- may be very vigorous growth of sub-shrubby or herbaceous field layer intricately matting species (e.g. *Rubus* species, *Tetrarrhena juncea*)
- ground ferns recovering, rhizomatous species spreading, but not dominant in field strata
- seed bank of many of the fire ephemerals restored, seed banks of other groups largely absent
- no seed of the pre-fire dominant shrubs and trees
- light litter accumulation, but litter still patchy and little incorporation into the soil
- bryophytes abundant but not diverse, first signs of re-establishment of lichens
- first signs of re-establishment of vascular epiphytes, but very uncommon
- soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralisation of organically bound pre-fire forms and vigorous post-fire nitrogen fixation)
- light intensity at ground level decreasing
- soil moisture low compared to pre-fire patterns
- run-off decreasing
- canopy of codominant *Eucalyptus* and *Acacia* species.

Adolescence

9–35 years after fire

Lasts for 25 years, i.e. 8% of age span, 17% of arbitrary maximum fire interval

During this stage:

- bare soil lacking, increasing incorporation of litter into the soil profile and development of an A_0 soil horizon
- annual, biennial and short-lived shrubby fire ephemerals invisible, incorporated into the soil seed store
- longer-lived fire ephemeral tall shrubs and understorey trees (e.g. taller *Daviesia* species and *Acacia dealbata*) at maximum growth, vigorously growing and setting seed (fully reproductive)
- except for the larger shrubs and understorey trees, legumes all old, senescing and retreating to the soil seed store
- no further germination or establishment of bradysporous species, earlier germinants vigorously growing, flowering and increasing in prominence, mature seed present in the soil seed store
- resprouting species vigorously growing, rapid shoot extension, flowering and setting seed, mature seed present in the community and increasing, but at low abundance
- may be very vigorous growth of sub-shrubby or herbaceous field layer intricately matting species (e.g. *Rubus* species, *Tetrarrhena juncea*)
- ground ferns recovering vigorously, rhizomatous species spreading, resuming dominance in field strata
- field strata including vigorous mesic herbs
- seed bank of the fire ephemerals restored, seed banks of other groups seed store increasing but not at a maximum
- first seed set of the pre-fire dominant shrubs and trees
- litter accumulating and being incorporated into the soil
- bryophytes common and with increasing diversity, re-establishment of lichens
- vascular epiphytes gradually becoming more common, filmy ferns reappearing, but extensive mats of epiphytes not yet developed
- soil nutrients (notably nitrogen and phosphorus) relatively abundant (from vigorous post-fire nitrogen fixation)
- light intensity at ground level low
- soil moisture low compared to pre-fire patterns, minimal run-off
- eucalypts beginning to emerge from the canopy, which includes vigorous *Acacia* species.
- little or no hollow development in the standing stems (live or dead)
- minimal coarse woody debris.

Maturity

35–250 years after fire

Lasts for 215 years, i.e. 72% of age span, 77% of arbitrary maximum fire interval

During this stage:

- eucalypt canopy closure complete (at maximum canopy dominance)
- bare soil lacking, increasing incorporation of litter into the soil profile and a well-developed A_0 soil horizon
- annual, biennial and all fire ephemerals invisible, retreated to the soil seed store
- fire ephemeral tall shrubs and understorey trees (e.g. taller *Daviesia* species and *Acacia dealbata*) senescent and gradually disappearing (retreating to the soil seed store)
- except for a few long-lived trees (notably *Acacia melanoxylon*) legumes all old, senescing and retreating to the soil seed store
- no further germination or establishment of bradysporous species, earlier germinants growing, flowering and beginning to decline in abundance (although cover may be at a maximum), mature seed present in the elevated seed store
- resprouting species vigorously growing, flowering and setting seed, mature seed present in the community
- intricately-matting species (e.g. *Rubus* species, *Tetrarrhena juncea*) present but declining
- ground ferns recovering vigorously, rhizomatous species spreading, dominant in field strata
- field strata including low diversity of mesic herbs such as *Australina* species
- seed bank of the fire ephemerals restored, for all other groups seed store at a maximum
- vigorous seed set of the pre-fire dominant shrubs and trees
- litter accumulating and being incorporated into the soil
- bryophytes common and diversity increasing, lichens at maximum diversity
- vascular epiphytes common, filmy ferns common, extensive mats of epiphytes well developed
- soil nutrients (notably nitrogen and phosphorus) in decreasing relative abundance
- light intensity at ground level very low
- soil moisture increasing when compared with previous stages, run-off increasing
- eucalypts form the sole canopy, other tree species form an open understorey
- increasing importance (abundance, cover and size) of typical 'rainforest' woody plants such as *Atherosperma moschatum, Elaeocarpus holopetalus, Nothofagus cunninghamii* and *Pittosporum bicolor*
- extensive hollow development in standing stems (live or dead), particularly in older stands of this growth stage, but hollows in standing dead stems decreasing as these collapse (standing dead stems are mostly trees killed in previous fire)
- coarse woody debris abundant and increasing.

Waning

250–300 years after fire

Lasts for 50 years, i.e. 17% of age span, beyond arbitrary maximum fire interval

During this stage:

- eucalypt canopy opening, with inter-tree gaps increasing
- bare soil lacking, maximal incorporation of litter into the soil profile and a well-developed A_0 soil horizon
- all fire ephemerals invisible, incorporated into the soil seed store
- except for a few long-lived trees (notably *Acacia melanoxylon*) legumes all retreated to the soil seed store
- no further germination or establishment of bradysporous species, earlier germinants declining in abundance (cover decreasing), mature seed in the elevated seed store decreasing
- resprouting species. growing, flowering and setting seed, mature seed present in the community
- intricately matting species (e.g. *Rubus* species, *Tetrarrhena juncea*) declining to rare
- ground ferns vigorous, dominant in field strata
- field strata including low diversity and abundance of mesic herbs such as *Australina* species
- seed bank of fire ephemerals restored, seed banks of other groups seed store at a maximum or declining
- vigorous seed set of the dominant shrubs and trees
- litter at a maximum and being incorporated into the soil
- bryophytes and lichens common and at maximum diversity
- vascular epiphytes common, filmy ferns common, extensive mats of epiphytes well developed
- soil nutrients (notably nitrogen and phosphorus) decreasing in abundance
- light intensity at ground level very low
- soil moisture increasing when compared with previous vegetation stages, run-off (water yield) at a maximum for this vegetation community
- canopy consisting only of eucalypts, becomingly increasingly open with substantial gaps appearing between the remnant (emergent) trees, other tree species form an increasingly dense understorey
- extensive hollow development in the standing stems (live or dead)
- canopy gaps created by falling trees increasing
- coarse woody debris abundant.

Senescence

300+ years after fire

Indeterminate length: beyond arbitrary maximum inter-fire interval

During this stage:

- Wet Forest may change into another vegetation community, usually rainforest
- eucalypt canopy opening, with inter-tree gaps increasing
- former understorey trees assuming dominance (e.g. *Acacia melanoxylon, Atherosperma moschatum, Elaeocarpus holopetalus, Nothofagus cunninghamii, Pittosporum bicolor*)
- bare soil lacking, maximal incorporation of litter into the soil profile and a well-developed A_0 soil horizon
- all fire ephemerals invisible, incorporated into the soil seed store
- except for a few long-lived trees (notably *Acacia melanoxylon*) legumes all retreated to the soil seed store
- no further germination or establishment of bradysporous species, earlier germinants declining in abundance (cover decreasing), mature seed in the elevated seed store decreasing
- resprouting species growing, flowering and setting seed, mature seed present in the community
- vascular plant species richness declining
- intricately matting species (e.g. *Rubus* species, *Tetrarrhena juncea*) absent
- ground ferns vigorous, dominant in field strata
- field strata including low diversity and abundance of mesic herbs, such as *Australina* species.
- seed bank of the fire ephemerals restored, for all other groups soil seed store declining
- litter at a maximum and being incorporated into the soil
- bryophytes common and at very high diversity, lichens (particularly epiphytes) at very high diversity but increasing further
- vascular epiphytes common, filmy ferns common, extensive mats of epiphytes well developed
- soil nutrients (notably nitrogen and phosphorus) decreasing in abundance
- light intensity at ground level very low
- soil moisture increasing when compared with previous vegetation stages, run-off (water yield) at a maximum for this vegetation community
- eucalypts decreasing
- extensive hollow development in standing stems (live or dead), but eucalypt hollows decreasing
- coarse woody debris abundant.

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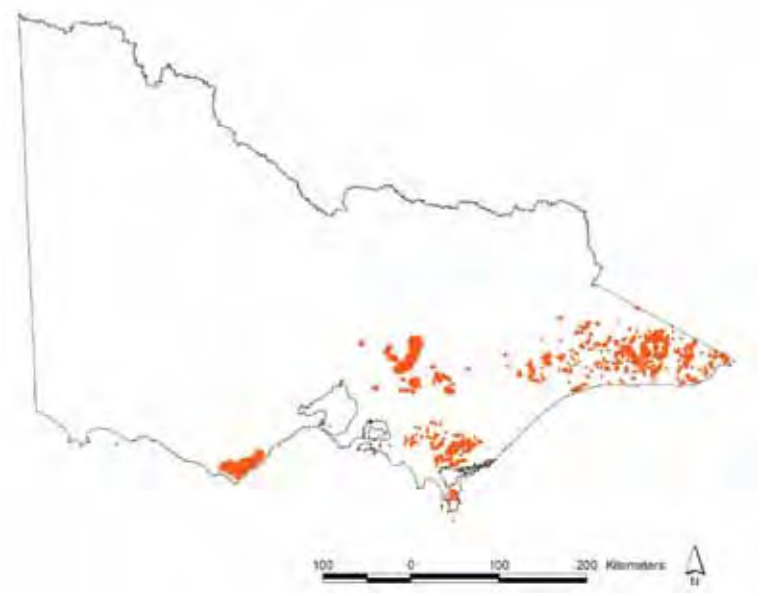
Tall Mist Forest EVD 12, one week after wildfire, Cambarville, Victoria.

Tall Mist Forest EVD 12, 69 years after wildfire, Murrindindi, Victoria.

EVD 13: Closed-forest

Maximum	∞
Minimum (high severity)	80 years
Minimum (low severity)	80 years



In this map the pixel size has been exaggerated so that the overall distribution of this EVD can be seen.

In most seasons the fuel conditions will prevent fires in closed-forests (rainforests), but in exceptional conditions (e.g. after protracted droughts) these forests may burn. Although responses to such unusual events are described below, this does not suggest that fire is an appropriate management tool in this EVD.

Renewal

0–1 years after fire

Lasts for 1 ± 0.2 years, i.e. 0.7% of arbitrary maximum fire interval

During this stage:

- most of the ground is bare or covered by ash
- soil-stored seed germinating and making first appearance above ground
- fire ephemerals (if present) uncommon to abundant, vigorously growing towards the end of this growth stage
- resprouting species showing first signs of buds activating, visible shoot extension towards the end of this growth stage
- surviving tree-ferns (if present) vigorously resprouting
- epiphytes lacking
- lianes either absent or resprouting from the base (from underground buds)
- most species not flowering and mature seed generally lacking from the community
- standing dead stems of the former dominants and other woody species
- little or no litter, except for large coarse woody debris
- bryophytes and lichens largely absent or invisible
- former canopy dominants may be dead
- understorey trees mostly dead
- soil nutrients (notably nitrogen and phosphorus) in increased abundance (from mineralisation of organically bound pre-fire forms)
- abundant light at ground level
- relatively high soil moisture
- run-off at a maximum, high erosion risk.

Closed-forest EVD 13, gully three weeks after wildfire, Cambarville, Victoria.

Closed-forest EVD 13, long unburnt, Cement Creek, Mount Donna Buang, Victoria.

Founding

1–4 years after fire

Lasts for 3 years, i.e. 2% of arbitrary maximum fire interval

During this stage:

- bare soil becoming uncommon, patches of ash still visible
- emergent standing (and often dead) stems of the former canopy dominants and other woody species
- fire ephemerals dominate the vigorously growing herbaceous field layer
- fire ephemerals may include rainforest-specific ephemerals (e.g. *Calystegia marginata, Solanum prinophyllum, Solanum silvestre*) or more general ephemerals (e.g. *Senecio linearifolius, Senecio velleioides*) shared with nearby Wet and Damp Forests
- annual and biennial fire ephemerals abundant but decreasing in abundance, re-establishing the long-lived soil seed store
- sclerophyll species (e.g. *Acacia dealbata, Acacia obliquinervia*) establishing from (likely) nearby Damp and Wet Forests
- the few resprouting species (at lower altitudes including the former dominants, and *Nothofagus* in cool rainforests) vigorously growing, rapid shoot extension from protected buds on the larger trunks, neither flowering nor setting seed
- herbaceous fire ephemerals and annuals with first seed set
- woody species regenerating from seed vigorously growing, but not flowering
- seed bank of all but the annuals and the shorter-lived fire ephemerals lacking
- neither flowering nor seed of the (pre-fire) dominant shrubs
- bryophytes, lichens and ferns uncommon, except fire-ephemeral bryophytes
- vigorous growth of a few post-fire rhizomatous fern increasers such as *Dennstaedtia davallioides, Histiopteris incisa, Pteridium esculentum*
- lichens scarce
- tree-ferns with canopies re-established, but without a skirt of hanging dead fronds
- epiphytes lacking
- fire-ephemeral bryophyte mats common, but diversity low
- lichen diversity and abundance low
- formerly standing but now dead stems contributing to coarse woody debris on the ground
- gradual litter accumulation, but litter volume very low
- soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralisation of organically bound pre-fire forms and vigorous post-fire nitrogen fixation)
- abundant light about 1–2 m above ground
- relatively high soil moisture.

Juvenility

4–24 years after fire

Lasts for 20 years, i.e. 13% of arbitrary maximum fire interval

During this stage:

- bare soil uncommon
- annual and biennial fire ephemerals incorporated into the soil seed store
- longer-lived fire ephemeral sub-shrubs at maximum growth, vigorously growing and setting seed (fully reproductive)
- resprouting species vigorously growing, rapid shoot extension, first flowering in resprouters but little seed set, mature seed largely lacking in the community
- intrusive sclerophyll species (e.g. *A. dealbata, Eucalyptus* species) vigorously growing and emergent from the slower-growing rainforest trees and elevated dense liane mat
- may be very vigorous growth of sub-shrubby or herbaceous field layer intricately matting species (e.g. *Rubus* species, *Smilax australis*, *Tetrarrhena juncea*)
- vigorous growth of elevated lianes (e.g. *Cissus hypoglauca, Clematis* species)
- ground ferns recovering, rhizomatous species spreading, common in field strata
- seed bank of many of the fire ephemerals restored, but for all other groups uncommon to absent
- no seed of pre-fire dominant shrubs and trees
- litter accumulation, but litter still barely incorporated into the soil
- bryophytes abundant but not diverse, first signs of re-establishment of lichens
- first signs of re-establishment of vascular epiphytes, particularly in protected situations such as incised drainage lines, but generally very uncommon
- formerly standing but now dead stems contributing to coarse woody debris on the ground
- emergent dead stems from former woody dominants barely evident
- soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralisation of organically bound pre-fire forms)
- light intensity at ground level low to very low
- soil moisture relatively low when compared with pre-fire patterns
- run-off decreasing
- canopy of mixed dominance, including obligate rainforest species and species from the surrounding Wet or Damp Forests.

Adolescence

24–100 years after fire

Lasts for 75 years, i.e. 50% of arbitrary maximum fire interval

During this stage:

- bare soil lacking, increasing incorporation of litter into the soil profile and development of an A_0 soil horizon
- annual, biennial and shrubby fire ephemerals invisible, incorporated into the soil seed store
- longer-lived fire ephemeral tall shrubs and understorey trees (e.g. *Acacia dealbata*) declining, setting fewer seed as the vegetation ages beyond about 25 years
- intrusive long-lived sclerophyll species (e.g. *Eucalyptus* species) vigorously growing and emergent from the slower-growing rainforest trees and elevated dense liane mat
- understorey/tall shrub stem density very high
- resprouting species vigorously growing, rapid shoot extension, flowering and setting seed, mature seed present in the community and gradually increasing, not yet at pre-fire (mature) levels
- vigorous growth of sub-shrubby or herbaceous field layer intricately matting species (e.g. *Rubus* species, *Tetrarrhena juncea*) thinning
- vigorous growth of elevated lianes (e.g. *Cissus hypoglauca, Clematis* species) may be codominant in canopy of low-altitude stands
- ground ferns recovering, rhizomatous species spreading, common in field strata
- field strata including mesic herbs
- first substantial seed set of pre-fire dominant shrubs and trees
- litter accumulating and being incorporated into the soil
- bryophytes common and diversity increasing, re-establishment of lichens
- vascular epiphytes gradually becoming more common, filmy ferns reappearing, but extensive mats of epiphytes not yet developed
- soil nutrients (notably nitrogen and phosphorus) relatively abundant
- light intensity at ground level very low
- soil moisture relatively low (but not absolutely low) when compared with pre-fire patterns, minimal run-off
- post-fire established eucalypts emergent from the rainforest canopy
- little or no hollow development in the standing stems (live or dead)
- minimal coarse woody debris
- run-off relatively low
- canopy of codominants, including obligate rainforest species and emergent eucalypts from the surrounding Wet or Damp Forests.

Maturity

100–150+ years after fire

Lasts for 50+ years, i.e. 50% of arbitrary maximum fire interval, extending indefinitely beyond this arbitrary maximum

During this stage:

- eucalypt canopy at maximum cover, but decreasing henceforth (at maximum, then decreasing, canopy dominance)
- bare soil lacking, increasing incorporation of litter into the soil profile and a well-developed A_0 soil horizon
- annual, biennial and all fire ephemerals invisible, retreated to the soil seed store
- fire ephemeral tall shrubs and understorey trees (including long-lived species such as *A. dealbata*) senescent and gradually disappearing (retreating to the soil seed store)
- soil seed store of disturbance ephemerals, such as *A. dealbata*, decreasing
- resprouting species vigorously growing, flowering and setting seed, mature seed present in the community
- pre-fire dominants vigorously flowering, setting seed and establishing at (maintenance) replacement levels or greater
- obligate rainforest species, such as *Atherosperma moschatum, Elaeocarpus holopetalus, Nothofagus cunninghamii* and *Pittosporum bicolor,* assuming dominance in all strata
- intricately-matting species (e.g. *Rubus* species, *Tetrarrhena juncea*) uncommon and declining further
- ground ferns recovering vigorously, rhizomatous species spreading, assuming dominance in field strata
- field strata including low diversity of mesic herbs such as *Australina* species
- seed bank of the fire ephemerals restored, for all other groups seed store at a maximum
- litter accumulating and being incorporated into the soil
- bryophytes common and diversity increasing, lichens at maximum diversity
- vascular epiphytes common, filmy ferns common, extensive mats of epiphytes well developed
- soil nutrients (notably nitrogen and phosphorus) in decreasing relative abundance
- light intensity at ground level very low
- soil moisture increasing when compared with previous vegetation stages, increasing run-off
- extensive hollow development in the standing stems (live or dead), particularly in older stands
- coarse woody debris abundant and increasing.

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EVD 14: High Altitude Shrubland / Woodland

Maximum	125 years
Minimum (high severity)	50 years
Minimum (low severity)	35 years

In unusual conditions (e.g. after hot dry summers) High Altitude Shrubland / Woodland vegetation may burn. The responses to such unusual events are described below, but this does not imply that fire is an appropriate management tool in this EVD within current management time-scales. In the absence of fire, the long-term future of High Altitude Shrubland / Woodland is conjectural. It may develop into open woodlands with a significantly herbaceous or grassy field layer and an open shrub stratum. If so it would become markedly less prone to damage by fire and less prone to fire than the current typical condition. The hypothesised maximum fire interval of 150 years is based on problematic extrapolation of scant and somewhat contradictory data. We do not know whether these habitats will mature to an open woodland, an open shrubland, or even an open grassland in the long-term absence of fire, or whether (perhaps different) shrubs will secondarily invade. Fires at a frequency of 150 years should have little long-term adverse impact on this vegetation.

Renewal

0–2 years after fire

Lasts for 2 years, i.e. 2% of age span, 2% of maximum desirable fire interval

During this stage:

- much of the ground is bare or covered by scorched foliage, but fires are usually patchy
- apparently low species diversity in burnt areas
- resprouting species showing first signs of buds activating, visible shoot extension towards the end of stage, small number of resprouters in vigorous growth by late stage
- abundant regrowth of rhizomatous sedges and restiads by end of stage
- obligate seed regenerators germinating and establishing by end of stage, from seed blown or brought into the site from nearby unburnt patches or possibly from soil-stored seed, e.g. *Hovea, Podolobium* and *Phebalium* species, *Westringia senifolia*)
- many long-lived species not flowering and mature seed generally lacking from the community
- some herbaceous species flowering vigorously by end of stage, e.g. some *Craspedia* and *Euphrasia* species, *Stellaria pungens, Viola betonicifolia*
- many shrubby dominants dead
- first resprouting of shrub species by end of stage
- shrub seedlings establishing by end of stage
- bryophytes and lichens largely eliminated in burnt areas, but fire-ephemeral bryophytes may be established
- litter cover (including charred litter) high
- dead stems of shrubs and trees dominate the site
- soil nutrients (notably nitrogen and phosphorus) in increased abundance, relatively (from mineralisation of organically bound pre-fire forms)
- abundant light at ground level
- relatively high soil moisture
- post-rain run-off at a maximum, high erosion risk.

Founding

2–6 years after fire

Lasts for 4 years, i.e. 3% of age span, 3% of maximum desirable fire interval

During this stage:

- bare soil decreasing but still present
- emergent standing (often dead) stems of former woody canopy dominants common
- herbaceous fire ephemerals (e.g. *Trachymene composita*) locally common at beginning of stage, but declining to disappearance by the end
- short-lived perennial dicot forbs abundant and codominant in field layer
- herbaceous species diversity low, but increasing towards the end of this growth stage
- rhizomatous sedges vigorously growing
- tussock-grasses resprouting, flowering and setting first seed by end of this stage
- bradysporous shrubs germinating and establishing, but neither dominant nor a major component of any vegetation stratum
- resprouting shrubs (e.g. *Acrothamnus hookeri, Baeckea gunniana, Hakea microcarpa, Kunzea muelleri*) vigorously growing, rapid shoot extension
- seed regenerants of formerly dominant woody shrubs establishing in scattered suitable habitat, vigorously growing
- no seed bank of pre-fire dominant shrubs and trees
- trees resprouting from the base, not flowering
- first signs of recovery of bryophytes, but these remain uncommon
- little litter accumulation, post-fire litter volumes low
- dead stems of shrubs and trees common, extending well above the regrowing vegetation
- soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralisation of organically bound pre-fire forms)
- abundant light about 1–2 m above ground and at ground level
- high erosion risk
- relatively high soil moisture.

High Altitude Shrubland/Woodland EVD 14, one year after wildfire, Brumby Point, Victoria.

(PHOTO COURTESY OBE CARTER)

High Altitude Shrubland/Woodland EVD 14, five years after wildfire, Brumby Point, Victoria.

Juvenility

6–12 years after fire

Lasts for 6 years, i.e. 5% of age span, 5% of maximum desirable fire interval

During this stage:

- bare soil or scorched foliage no longer obvious
- emergent stems of dead shrubs no longer apparent
- emergent stems of trees visually dominate the vegetation
- species diversity gradually increasing
- fire ephemerals retreating to the soil seed store
- short-lived perennial dicot forbs, notably daisies and buttercups, abundant in the field layer
- rhizomatous sedges common
- tussock-grasses common and dominant in the field layer, flowering and setting seed
- bradysporous shrubs established, common but not dominant
- resprouting shrubs (e.g. *Acrothamnus hookeri, Baeckea gunniana, Hakea microcarpa, Kunzea muelleri*) vigorously growing, rapid shoot extension, rapidly accumulating seed banks
- seed regenerants of formerly dominant woody shrubs established and vigorously growing, flowering and first seed set
- legume shrubs common, abundantly flowering and setting seed by end of this growth stage
- vigorous flowering and seed set of pre-fire dominant shrubs
- rapid shoot extension on dominant eucalypts, first weak flowering by end of this growth stage, but little or no seed set
- bryophytes and lichens gradually re-establishing but not common
- some recovery in litter volumes and cover
- soil nutrients (notably nitrogen and phosphorus) in decreasing abundance (from mineralisation of organically bound pre-fire forms)
- abundant light at around 1-2 m above ground, decreasing at ground level
- low erosion risk
- decreasing soil moisture.

High Altitude Shrubland/Woodland EVD 14, long unburnt, Mount Baw Baw, Victoria.

(PHOTO COURTESY ARN TOLSMA)

Adolescence

12–45 years after fire

Lasts for 33 years, i.e. 26% of age span, 26% of maximum desirable fire interval

During this stage:

- litter cover more or less 100%, bare ground no longer apparent
- emergent dead stems of trees scattered among vigorously growing trunks of trees (with mallee form)
- species diversity gradually increasing
- the formerly common short-lived perennial dicot forbs (e.g. *Stellaria* species) decreasing in the field layer (becoming locally rare), replaced by dicot forbs typical of mature vegetation (e.g. *Brachyscome decipiens, Ranunculus* species, *Viola betonicifolia*)
- rhizomatous sedges decreasing
- tussock-grasses common in the field layer, flowering and setting seed
- bradysporous shrubs established, common, often dominant
- resprouting shrubs (e.g. *Kunzea muelleri*) vigorously growing, rapid shoot extension, flowering and setting abundant seed
- seed regenerants of formerly dominant woody shrubs established and vigorously growing, flowering and setting abundant seed
- legume shrubs common, abundantly flowering and setting seed
- multi-stemmed eucalypts dominant, flowering and setting seed, elevated seed bank re-established
- bryophytes and lichens gradually re-establishing, but relatively uncommon
- litter gradually accumulating, litter volumes comparatively low but increasing
- coarse woody debris on ground augmented by falling stems and branches of dead eucalypts
- soil nutrient (notably nitrogen and phosphorus) levels relatively low, but still augmented by legume nitrogen fixation
- relatively low soil moisture
- light intensity at ground and about 1 m above ground low
- low erosion risk.

Maturity

45–85 years after fire

Lasts for 40 years, i.e. 32% of age span, 32% of maximum desirable fire interval

During this stage:

- litter cover more or less 100%, bare ground no longer apparent
- emergent dead stems of trees barely present
- species diversity high but static
- mesic dicot forbs with high species diversity in the field layer, but not dominant in the field layer
- short-lived perennial dicot forbs (e.g. *Stellaria* species) sporadic in the field layer, replaced by dicot forbs typical of mature vegetation (e.g. *Brachyscome decipiens, Ranunculus* species, *Viola betonicifolia*)
- rhizomatous sedges scattered
- tussock-grasses common in the field layer, flowering and setting seed
- bradysporous shrubs established, common
- resprouting shrubs (e.g. *Kunzea muelleri*) vigorous, flowering and setting abundant seed
- seed regenerants of formerly dominant woody shrubs established, flowering and setting abundant seed
- legume shrubs decreasing but still common, flowering and setting seed
- very long-lived mesic shrubs (usually not legumes) (e.g. *Orites lancifolia, Phebalium squamulosum* subsp. *alpinum, Prostanthera cuneata, Tasmannia* species) resuming dominance in the shrub stratum
- multi-stemmed eucalypts dominant, flowering and setting seed, elevated seed bank re-established
- bryophytes and lichens established and common, high diversity
- epiphytic and lithophytic cryptogams (especially lichens) establishing and becoming more common
- litter accumulation maximum, surface soils with a high organic matter content
- coarse woody debris on ground augmented by falling stems and branches of dead eucalypts
- soil nutrient (notably nitrogen and phosphorus) levels relatively low, high C:N ratio
- soils acid
- relatively low soil moisture
- light intensity at ground and about 1–2 m above ground low
- low erosion risk.

Waning

85–125+ years after fire

Lasts for 40+ years, i.e. 32% of age span, 32% of maximum desirable fire interval

During this stage:

- litter cover now 100% or thereabouts, bare ground no longer apparent
- emergent standing (and dead) stems of the trees barely present
- species diversity high and decreasing
- mesic dicot forbs with high species diversity in the field layer, but not dominant in the field layer
- the formerly common short-lived perennial dicot forbs (e.g. *Stellaria* species) sporadic in the field layer, replaced by the dicot forbs of mature vegetation (e.g. *Brachyscome decipiens, Ranunculus* species, *Viola betonicifolia*)
- rhizomatous sedges scattered
- tussock grasses common in the field layer, flowering and setting seed, forming a thick 'thatch'
- bradysporous shrubs established, decreasing
- resprouting shrubs (e.g. *Kunzea muelleri*) flowering and setting seed, decreasing
- seed regenerants of formerly dominant woody shrubs established, flowering and setting seed, decreasing
- legume shrubs scattered and locally rare, soil seed bank decreasing
- very long-lived, mesic shrubs (usually not legumes) (e.g. *Orites lancifolia, Phebalium squamulosum* subsp. *alpinum, Prostanthera cuneata, Tasmannia* species) dominant in the open shrub stratum
- eucalypts dominant, stem number decreasing (tending to monopodial), flowering and setting seed, elevated seed bank re-established
- bryophytes and lichens established and common, high diversity
- epiphytic and lithophytic cryptogams (especially lichens) common
- litter accumulation maximum, surface soils with a high organic matter content
- coarse woody debris on ground augmented by falling stems and branches of dead eucalypts
- soil nutrient (notably nitrogen and phosphorus) levels relatively low, high C:N ratio
- soils acid
- relatively low soil moisture
- light intensity at ground and about 1–2 m above ground low, but slowly increasing as gaps in shrub layer increase
- low erosion risk.

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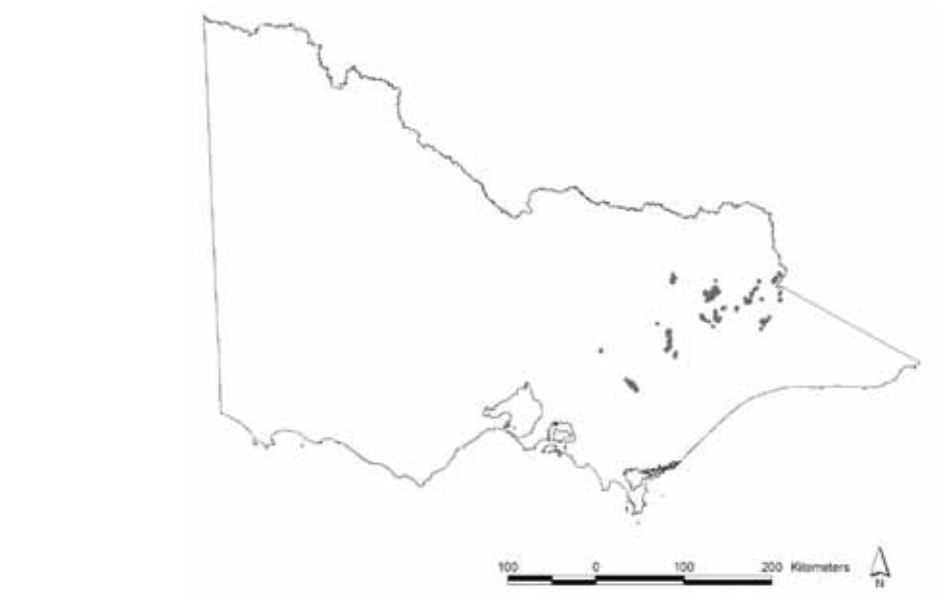
EVD 15: High Altitude Wetland

Maximum	∞ years
Minimum (high severity)	90 years (peat burnt), 40 years (peat not burnt)
Minimum (low severity)	90 years (peat burnt), 40 years (peat not burnt)



Note that the pixel sizes have been exaggerated to enable the distribution of this EVD to be seen clearly.

In exceptional conditions (e.g. after protracted drought) High Altitude Wetlands may burn. Although the responses to such an unusual event are described below, this does not suggest that fire is an appropriate management tool in this EVD.

The responses described here are based on a wildfire that burns and consumes the peat. However, after less severe fires that consume some of the standing shrub and herb layers but not the peat, the recovery period will be much shorter.

The soils are highly organic and may burn during the fire and smoulder for many months afterwards, so seed storage in the soil is weak and few species regenerate from soil-stored seed. However, epacrids may rely on soil-stored seed for post-fire recovery where the peat has not burnt, or on the peatland margins.

Renewal

0–2 years after fire

Lasts for 2 years, i.e.
1.3% of arbitrary maximum fire interval

During this stage:

- most of ground is bare soil or charred peat
- very low species diversity
- resprouting species showing first signs of buds activating, visible shoot extension towards the end of this growth stage (small number of resprouters in vigorous growth in mid-stage)
- minor seedling establishment of long-lived obligate seed regenerating shrubs such as *Epacris* and *Richea* species
- abundant regrowth of rhizomatous sedges and restiads by end of stage
- vigorous resprouting of tussock-grasses (*Poa* species) commenced
- most species not flowering and mature seed generally lacking
- except for peat, little or no litter
- extensive areas of dead or scorched *Sphagnum* moss
- former canopy dominants may be killed
- soil nutrients (notably nitrogen and phosphorus) in increased abundance (from mineralisation of organically bound pre-fire forms)
- abundant light at ground level
- relatively high soil moisture
- post-rain run-off at a maximum, high erosion risk
- water release dramatically episodic, with high run-off following rain but no release at other times (in contrast with pre-fire pattern of more or less continuous release of water)

Founding

2–12 years after fire

Lasts for 10 years, i.e.
7% of arbitrary maximum fire interval

During this stage:

- bare soil or charred peat decreasing but still present
- emergent (often dead) stems of woody canopy dominants
- short-lived perennial dicot forbs, notably daisies, abundant and codominant in field layer
- rhizomatous sedges and restiads vigorously growing and codominant in field layer
- bradysporous species germinating and establishing, but neither dominant nor a major component of any stratum
- the few resprouting shrubs (e.g. *Baeckea gunniana, Callistemon pityoides*) vigorously growing, rapid shoot extension
- seed regenerants of formerly dominant woody shrubs establishing in scattered suitable habitat, slowly growing
- scant flowering and seed bank of pre-fire dominant shrubs at the beginning of this stage, but flowering increasing to abundant by the end of stage
- recovery in *Sphagnum* under way, most obviously in least burnt and dampest sites (in less severe fires where *Sphagnum* may be unburnt, recovery and spread from the margins will be under way very early in this stage)
- little litter (peat) accumulation, litter (peat) volumes very low
- soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralisation of organically bound pre-fire forms)
- abundant light about 1–2 m above ground and at ground level
- relatively high soil moisture.

Juvenility

12–35 years after fire

Lasts for 23 years, i.e.
15% of arbitrary maximum fire interval

During this stage:

- bare soil and exposed charred peat uncommon
- emergent stems of the former woody canopy dominants still visible, but decreasing
- species diversity gradually increasing
- short-lived perennial dicot forbs, notably daisies and buttercups, abundant in field layer
- rhizomatous sedges and restiads vigorously growing and dominant in field layer
- faster-growing woody shrubs (e.g. *Baeckea* species, *Callistemon pityoides*) emerging above sedges and gradually assuming canopy dominance, abundant flowering
- scattered epacrid seedlings throughout (e.g. *Epacris* species, *Richea* species), growing slowly and neither flowering abundantly nor dominant
- *Sphagnum* and other bryophytes gradually re-establishing and slowly recovering pre-fire cover, but neither common nor dominant
- may be abundant aquatic herbs and bryophytes (e.g. *Sphagnum novozelandicum*) in open pools
- little litter (peat) accumulation, litter (peat) volumes comparatively low
- soil nutrients (notably nitrogen and phosphorus) in decreasing abundance
- abundant light about 1–2 m above ground, decreasing at ground level
- relatively high soil moisture.

Adolescence

35–60 years after fire

Lasts for 25 years, i.e.
17% of arbitrary maximum fire interval

During this stage:

- litter cover very high, charred peat no longer visible
- emergent stems of former woody canopy dominants largely disappeared
- species diversity gradually increasing
- formerly common short-lived perennial dicot forbs decreasing in field layer
- mesic dicot forbs increasing in species diversity in field layer, but with reduced abundance when compared with previous stages
- rhizomatous sedges and restiads vigorously growing and dominant in field layer
- faster-growing woody shrubs (e.g. *Baeckea* species, *Callistemon pityoides*) emergent from the sedges and dominant in the canopy, flowering and setting seed
- scattered epacrid seedlings throughout (e.g. *Epacris* species, *Richea* species), slowly growing, flowering and setting seed, gradually increasing in abundance but not dominant
- *Sphagnum* and other bryophytes gradually re-establishing and slowly recovering pre-fire cover, first signs of hummocks increasing in spread
- species typical of, and largely restricted to, peaty situations (such as prostrate *Coprosma, Diplaspis, Psychrophila* species) increasingly common
- litter (peat) gradually accumulating, litter (peat) volumes comparatively low but increasing
- soil nutrient (notably nitrogen and phosphorus) levels low
- water release tending to be continuous throughout warmer months, less episodic (peaks after rain and troughs between rainfall events)
- high soil moisture.

Maturity

60–150 years after fire

Lasts for 90+ years, i.e. 60% of arbitrary maximum fire interval

During this stage:

- litter cover now 100%, composed of peat in various stages of decay
- emergent stems of former woody canopy dominants disappeared
- species diversity high and static
- mesic dicot forbs with high species diversity in field layer, but not dominant in field layer
- rhizomatous sedges and restiads dominant in field layer
- faster-growing woody shrubs (e.g. *Baeckea* species, *Callistemon pityoides*) emergent above sedges and common in the canopy, some evidence of decreasing abundance as occasional death is not replaced by new germinants
- epacrids increasingly common and dominant in the shrub layer (e.g. *Epacris* species, *Richea* species), slowly growing, flowering and setting seed
- *Sphagnum* and other bryophytes gradually established and spreading, hummocks common and increasing in spread
- species typical of, and largely restricted to, peaty situations (such as prostrate *Coprosma, Diplaspis, Psychrophila* species) common and abundantly flowering
- litter (peat) gradually accumulating, litter (peat) volumes increasing
- soil nutrient (notably nitrogen and phosphorus) levels low
- soil pH at a minimum (well below 7)
- area of open-water pools decreasing
- water release tending to be continuous throughout warmer months, less episodic (peaks after rain and troughs between rainfall events)
- high soil moisture.

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High Altitude Wetland EVD 15, three month after 2009 wildfire, Lake Mountain, Victoria.

(PHOTO COURTESY ARN TOLSMA)

High Altitude Wetland EVD 15, one year after 2009 wildfire, Lake Mountain, Victoria.

(PHOTO COURTESY ARN TOLSMA)

High Altitude Wetland EVD 15, long unburnt, Mount Baw Baw, Victoria.

(PHOTO COURTESY ARN TOLSMA)

EVD 16: Alpine Treeless

Maximum	120 years
Minimum (high severity)	55 years
Minimum (low severity)	55 years

Note that the pixel size has been exaggerated to enable the distribution of this EVD to be seen clearly.

In exceptional conditions (e.g. after protracted drought) Alpine Treeless vegetation may burn (although usually patchily, and snowpatches and feldmark are unlikely to burn). The responses to such unusual events is described below, but there is no suggestion that fire is an appropriate management tool in this EVD, within current management time-scales.

The long-term future of Alpine Treeless vegetation in the absence of recurrent fires is decidedly conjectural. The hypothesised maximum fire interval of 120 years is based on a problematic extrapolation of scant and somewhat contradictory data. We do not know whether this vegetation would further mature to an open woodland, an open shrubland or even an open grassland in the long-term absence of fire, or whether (perhaps different shrubs would secondarily invade. Fires at a frequency of 120 years should have little long-term adverse impact on this vegetation and may prevent long-term domination by woody species.

High alpine shrubland dominated by *Podocarpus lawrencei*, although structurally a shrubland or heathland, may be more appropriately included in this EVD.

Renewal

0–2 years after fire

Lasts for 2 years, i.e.
1.7% of age span, 1.7% of maximum desirable fire interval

During this stage:

- much of the ground cover is bare soil, charred peat or other organic litter
- low species diversity in burnt areas
- resprouting species showing first signs of buds activating, visible shoot extension towards the end of this growth stage (small number of resprouters in vigorous growth in mid-stage)
- abundant regrowth of rhizomatous sedges and restiads by end of this growth stage
- obligate seed regenerators germinating and establishing by end of this stage, from seed blown or brought into the site from nearby unburnt patches
- most species not flowering and mature seed generally lacking from the community
- litter cover (including charred litter) high
- many former shrubby dominants dead
- first resprouting of shrub species by end of stage
- shrub seedlings establishing by end of stage
- bryophytes and lichens largely eliminated in burnt areas
- soil nutrients (notably nitrogen and phosphorus) in increased abundance (from mineralisation of organically bound pre-fire forms)
- abundant light at ground level
- relatively high soil moisture content
- post-rain run-off at a maximum, high erosion risk.

Founding

2–10 years after fire

Lasts for 8 years, i.e.
6.7% of age span, 6.7% of maximum desirable fire interval

During this stage:

- substantial areas of bare soil in snowpatches and feldmark (if burnt)
- bare soil or charred peat decreasing but still present
- emergent standing (often dead) stems of former woody canopy dominants common
- short-lived perennial dicot forbs, notably daisies, abundant and codominant in field layer
- herbaceous species diversity low
- rhizomatous sedges and restiads vigorously growing
- tussock-grasses resprouting, flowering and setting seed by end of this stage
- bradysporous shrubs germinating and establishing, but neither dominant nor a major component of any stratum
- the few resprouting shrubs (e.g. *Kunzea muelleri)* vigorously growing, rapid shoot extension
- seed regenerants of formerly dominant woody shrubs establishing in scattered suitable habitat, slowly growing
- neither flowering nor seed of pre-fire dominant shrubs
- first signs of recovery of bryophytes, but uncommon
- little litter accumulation, post-fire litter volumes low
- soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralisation of organically bound pre-fire forms)
- abundant light about 1–2 m above ground and at ground level
- high erosion risk
- relatively high soil moisture.

Juvenility

10–30 years after fire

Lasts for 20 years, i.e.
17% of age span, 17% of maximum desirable fire interval

During this stage:

- substantial areas of bare soil in snowpatches and feldmark (if burnt)
- bare soil or charred peat no longer obvious
- emergent stems of former woody canopy dominants no longer apparent
- species diversity gradually increasing
- short-lived perennial dicot forbs, notably daisies and buttercups, abundant in field layer
- rhizomatous sedges and restiads common
- tussock grasses common and dominant in the field layer, flowering and setting seed
- bradysporous shrubs established, common but not dominant
- the few resprouting shrubs (e.g. *Kunzea muelleri*) vigorously growing, rapid shoot extension
- seed regenerants of formerly dominant woody shrubs established and vigorously growing
- first flowering and seed set of the (pre-fire) dominant shrubs
- bryophytes and lichens gradually re-establishing and slowly recovering pre-fire cover, but not common
- some recovery in litter volumes and cover
- soil nutrients (notably nitrogen and phosphorus) in decreasing abundance (from mineralisation of organically bound pre-fire forms)
- abundant light about 1–2 m above ground, decreasing at ground level
- low erosion risk
- relatively high soil moisture.

Adolescence

30–60 years after fire

Lasts for 30 years, i.e.
25% of age span, 25% of maximum desirable fire interval

During this stage:

- areas of bare soil decreasing in snowpatches and feldmark (if burnt)
- litter cover now 100% or thereabouts, charred peat no longer visible
- emergent standing (and dead) stems of the former woody canopy dominants largely disappeared
- species diversity gradually increasing
- the formerly common short-lived perennial dicot forbs decreasing in the field layer
- mesic dicot forbs increasing in species diversity in the field layer, but with reduced abundance when compared with previous growth stages
- rhizomatous sedges and restiads common
- tussock grasses common and dominant in the field layer, flowering and setting seed
- larger woody shrubs decreasing in abundance/density, flowering and setting seed
- bryophytes and other cryptogams gradually re-established and slowly increasing in species diversity and cover
- litter (peat) gradually accumulating, litter (peat) volumes comparatively low but increasing
- soil nutrient (notably nitrogen and phosphorus) levels relatively low
- water release tending to be less episodic (peaks after rain and troughs between rainfall events)
- high soil moisture
- abundant light about 1–2 m above ground, decreasing at ground level
- low erosion risk.

Maturity

60–120 years after fire

Lasts for 90+ years, i.e. 50% of age span, 50% of maximum desirable fire interval

During this stage:

- areas of bare soil decreasing in snowpatches and feldmark (if burnt) as herbs gradually extend to former cover
- litter cover now 100%, composed of dry, fibrous matter in various stages of decay
- emergent standing stems of former woody canopy dominants disappeared
- species diversity high and more or less static
- mesic dicot forbs with high species diversity in the field layer, but not dominant in the field layer
- rhizomatous sedges and restiads common in the field layer
- tussock-grasses common and dominant in field layer, flowering and setting seed, forming thick swathes with few inter-tussock spaces
- larger woody shrubs uncommon and further decreasing in abundance and density, many areas now devoid of shrubs
- bryophytes and lichens re-established and slowly increasing in species diversity and cover
- litter accumulation at maximum volumes
- soil nutrient (notably nitrogen and phosphorus) levels low
- soil pH at a minimum (below 7)
- water release tending to less episodic (peaks after rain and troughs between rainfall events)
- high soil moisture
- abundant light about 1–2 m above ground
- low erosion risk.

Alpine Treeless EVD 16, two weeks after wildfire, Heathy Spur, Bogong High Plains, Victoria.

Alpine Treeless EVD 16, three years after wildfire, Bogong High Plains, Victoria.

(PHOTO COURTESY ARN TOLSMA)

Alpine Treeless EVD 16, long unburnt, Gow Plain, Victoria.

(PHOTO COURTESY ARN TOLSMA)

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EVD 17: Granitic Hillslopes

Maximum	90 years (eucalypt canopy), ∞ (non-eucalypt canopy)
Minimum (high severity)	25 years (eucalypt canopy), 45 years (non-eucalypt canopy)
Minimum (low severity)	15 years

Granitic Hillslopes may burn in an intense fire (wildfire) or in a patchy prescribed burn. The text below describes the community's response to high-severity fire (wildfire), which usually means that the canopy has been consumed. This symbol ◆ refers to the community's response to low-severity patchy (prescribed) fire, i.e. a fire in which there are many unburnt patches within the fire perimeter and the canopy is rarely burnt or scorched.

Eucalypts usually dominate the canopy in this vegetation community, and eucalypt canopy is assumed for the following figures on age spans. However, in some areas other trees that may dominate the canopy (e.g. species of *Brachychiton, Callitris* or *Casuarina* s.l.) are more susceptible to damage by frequent fire than the fire-tolerant eucalypts. Hence, a different orientation to fire management is required in non-eucalypt Granitic Hillslopes (assuming a goal of maintaining current community processes and composition). Comments specific to Granitic Hillslopes dominated by non-eucalypts are indicated with this symbol ★.

The greatest response to frequent fires (whether of high or low severity) comes after the *second* and all subsequent fires with a short fire interval (<10–15 years). The patchiness of low-severity fires is critical in maintaining sensitive species in the community because it means that some vegetation within the fire perimeter escapes being burnt at such frequent intervals.

Renewal

0–1 years after fire

Lasts for 1 ± 0.25 years, i.e.

1% of age span, 1% of maximum desirable fire interval

◆ same for low-severity fires

During this stage:

- most of the ground is bare soil or rock (areas previously covered by dry peats commonly lose their entire load of organic material after fire)
- standing dead tree stems dominate the canopy
- adventive annuals common by end of this growth stage
- bradysporous species releasing seed from elevated fruit
- soil-stored seed germinating and making first appearance above ground
- seed germination of the canopy eucalypts (★ and non-eucalypts)
- resprouting species showing first signs of buds activating, but little shoot extension
- Bracken (*Pteridium esculentum*), if present before fire, reappearing above ground (new croziers unrolling)
- nearly all species not flowering, and mature seed largely lacking
- little or no litter, although ash accumulated in occasional drifts
- soil bryophyte and lichen cover disrupted or eliminated
- coarse woody debris largely consumed
- limiting soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralization of organically bound pre-fire forms)
- abundant light at ground level
- relatively high soil moisture.

Granitic Hillslopes EVD 17, Mount Lawson, Victoria.

Juvenility

1–4 years after fire

Lasts for 2 years, i.e. 2% of age span, 2% of maximum desirable fire interval; these figures are the same for low severity fires

During this stage:

- much of the ground is bare
- herbaceous fire ephemerals common in a vigorously growing and substantially herbaceous field layer
- bradysporous species germinating and establishing, but neither dominant nor a major component of any stratum
- legumes abundantly germinating from seed, first signs of shoot extension
- mature eucalypts coppicing abundantly on trunks and larger branches
- lightly burnt or unburnt trees, without stem coppice, canopies unaffected or resprouting from minor leaf scorch
- tree seedlings evident (cotyledon and intermediate leaf stage); ★ similar for non-eucalypts, although these grow more slowly than eucalypts
- ◆ in low-severity fire, canopy remains largely unaffected
- resprouting species vigorously growing, rapid shoot extension
- resprouting species in the tree canopy vigorously coppicing, not flowering
- 'M' species (if present before fire) in full bloom, first germination and establishment by end of stage
- Bracken (Pteridium esculentum), if present before fire, relatively common in field layer
- herbaceous fire ephemerals and annuals with abundant seed set
- seed bank of all but the annuals and the shorter-lived fire ephemerals lacking
- neither flowering nor seed of pre-fire dominant shrubs
- little or no litter, ash drifts still evident
- coarse woody debris increasing from fallen dead stems
- soil bryophyte and lichen cover disrupted or eliminated
- limiting soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralization of organically bound pre-fire forms)
- abundant light reaching field layer, light intensity at ground level decreasing
- relatively high soil moisture.

Adolescence

4–10 years after fire

Lasts for 6 years, i.e.

7% of age span, 7% of maximum desirable fire interval

same for low-severity fires, but note that there will be many unburnt patches within the fire perimeter that retain essentially mature or older vegetation

During this stage:

- canopy cover increasing (bare soil far less common than previously), lower coppice dying
- adventive annuals uncommon
- fire ephemerals in decline — annuals and biennials retreated to the soil seed store, longer-lived fire ephemerals common and fully reproductive
- legumes growing vigorously, abundantly flowering and setting seed
- no further germination or establishment of bradysporous species, earlier germinants vigorously growing, mostly pre-flowering and neither dominant nor a major component of the shrub stratum, mature seed of these species lacking in the community; this group of species is most susceptible to frequent fires and may be locally eliminated unless high-frequency fires are notably patchy
- resprouting shrubs vigorously growing, rapid shoot extension, first flowering in large resprouter shrubs but little seed set (although seed set has begun, mature seed of these species largely lacking in the community)
- eucalypt coppice from larger branches and trunks abundant, non-flowering
- eucalypt seedlings growing rapidly, non-flowering and barely lignotuberous
- ✦ non-eucalypt trees usually killed by fire, seedlings growing slowly within the shrub stratum
- resprouting sedges and the like (e.g. *Lomandra* species) vigorous and flowering with ample seed set
- tussock-grasses resprouting, (low severity) flowering and seed set
- Bracken (*Pteridium esculentum*), if present, fairly common in the field layer
- seed bank of fire ephemerals restored, seed banks of all other groups uncommon to largely absent
- little seed of pre-fire dominant shrubs
- some litter accumulation, litter patchy and gradually being incorporated into the soil
- coarse woody debris being augmented by dropping dead stems from the canopy eucalypts and the large shrubs
- soil bryophyte and lichen cover disrupted or eliminated
- limiting soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralisation of organically bound pre-fire forms and from vigorous nitrogen fixation by abundant legumes)
- light intensity at ground level low, light reaching shrub strata decreasing as canopy slowly re-establishing
- soil moisture returning to normal inter-fire patterns.

Vigorous maturity

10–35 years after fire

Lasts for 25 years, i.e. 28% of age span, 28% of maximum desirable fire interval

During this stage:

- canopy cover at a maximum
- all fire ephemerals retreated to soil seed store
- large understorey adventives (e.g. *Acacia mearnsii*) uncommon to moribund
- legume shrubs common, often dominate the shrub stratum, flowering and setting seed, maximum soil seed bank by end of stage
- no further germination or establishment of bradysporous species, earlier germinants vigorously growing, flowering and setting seed, elevated seed storage gradually accumulating
- little or no shrub establishment from seed (whether of the large bradysporous species or the smaller ericoids and the like)
- resprouting species growing, flowering and with accumulating seed store
- sedges and the like common, flowering
- canopy eucalypts flowering and setting seed
- firs flowering of eucalypt seedlings, but with weak seed set
- non-eucalypt trees forming either an open understorey (under canopy eucalypts) or ★ regrowing as more or less dense copses or regrowing at even density and slowly emerging from the shrub stratum by end of this stage
- bracken (if present) increasingly uncommon in the field layer and with much dead material in season (winter)
- litter accumulating, litter cover re-established and being incorporated into the soil
- accumulation of coarse woody debris, particularly from fallen dead stems of woody dominants
- lichen and bryophyte cover re-establishing but not yet continuous, moss mats common in sheltered situations
- limiting soil nutrients (notably phosphorus) in decreasing abundance (vigorous leguminous nitrogen fixation persisting)
- light intensity at ground level at a minimum
- soil moisture returned to normal inter-fire patterns.

Stasis

35–80 years after fire

Lasts for 45 years, i.e. 50% of age span, 50% of maximum desirable fire interval

During this stage:

- canopy (tree) cover at a maximum
- all fire ephemerals retreated to soil seed store
- legume shrubs gradually becoming uncommon, flowering and setting seed, soil seed bank persisting
- no further germination nor establishment of bradysporous species, earlier germinants growing (growth rates declining), flowering and setting seed, elevated seed storage static
- little or no shrub establishment from seed of the large bradysporous species
- ericoid species with continuing low recruitment rate, more common in the shrub layer by the end of this stage than at the beginning
- resprouting species growing, flowering and with established seed bank
- ✦ fire-sensitive resprouters (e.g. Cheilanthes) gradually spreading throughout the lower strata
- sedges and the like relatively common, flowering
- canopy eucalypts abundantly flowering and setting seed
- eucalypt seedlings flowering, part of the canopy
- non-eucalypt trees forming either an open understorey (under canopy eucalypts) or ★ regrowing as more or less dense copses or regrowing at even density and emergent from the shrub stratum, gradually assuming canopy dominance
- herbaceous species (not fire ephemerals) relatively common (low density, high frequency, high species diversity) in the field layer
- Bracken (*Pteridium esculentum*), if present, uncommon
- tussock grasses relatively common, flowering and setting seed
- litter at a maximum, litter cover re-established and being incorporated into the soil
- first signs of development of an A_0 soil horizon
- coarse woody debris common, increasing further
- start of significant hollow formation in the larger trees by end of stage
- lichen and bryophyte cover re-established, lichens dominant in inter-tussock gaps
- limiting soil nutrients (notably nitrogen and phosphorus) at a minimum
- light intensity at ground level at a minimum
- soil moisture returned to normal inter-fire patterns.

Senescence

80–90+ years after fire

Lasts for 10+ years, i.e. 11% of age span, 11% of maximum desirable fire interval

During this stage:

- canopy cover at maximum and static
- eucalypt density declining, crowns more shady
- canopy eucalypts flowering and setting seed, canopy seed store maximum
- ✦ non-eucalypt trees co-dominant with eucalypts, or emergent from an open shrub stratum and assuming canopy dominance
- ✦ fire-sensitive resprouters (e.g. Cheilanthes) common throughout the lower strata
- fire-sensitive trees reaching the canopy and may become codominant with eucalypts
- annual species (not fire ephemerals) becoming more common in field layer
- no further germination or establishment of bradysporous species, growth rates at a minimum, little flowering and seed set, elevated seed storage decreasing, mature shrubs dying without replacement
- resprouting shrubs growing (but growth rates decreasing), flowering and with declining seed store
- legume shrubs becoming rare, declining soil seed bank
- ericoid species with continuing low recruitment rate, slowly becoming more common in shrub layer
- long-lived sedges and the like at greatest cover
- Bracken (*Pteridium esculentum*), if present, uncommon and declining in field layer
- tussock-grasses relatively common, flowering and setting seed, ★ may be common under non-eucalypt canopies but density inversely proportional to tree density
- herbaceous species (not fire ephemerals) notable but not common in field layer
- abundant litter cover, being incorporated into the soil
- recognizable A_0 soil horizon
- coarse woody debris at a maximum
- significant hollow formation in larger eucalypts
- ★ hollow formation in non-eucalypt canopy trees retarded until well after the 90 year maximum considered here for eucalypt canopies
- lichen and bryophyte cover well established and gradually increasing
- epiphytic and lithophytic lichens common
- soil nutrient availability (notably nitrogen and phosphorus) at a minimum
- light intensity at ground level at a minimum, but increasing at intermediate levels (1–2 m)
- soil moisture relatively low.

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EVD 18: Rocky Knoll

Maximum	80 years
Minimum (high severity)	20 years
Minimum (low severity)	12 years

Rocky Knolls may burn in an intense fire (wildfire) or in a patchy low-severity burn (largely dependent on the amount of exposed rock, which provides effective fire breaks and fire-sheltered sites). The responses to fire listed below relate to high-severity fire (wildfire), which usually means that the canopy has been consumed. Such high-severity fires are fairly common in Rocky Knolls. In contrast, low-severity fires may burn with the same site intensity but leave substantial patches of unburnt habitat.

'Rocky Knoll' is an extraordinarily heterogeneous vegetation community, incorporating over 60 different EVCs and mapping units. The figures offered here are based on some of the most sensitive component communities. Hence, many of the constituent vegetation communities (of 'Rocky Knoll' EVD) can be burnt, without irretrievable damage, at quite different frequencies (e.g. shorter return intervals for high-severity fires than the 20 years suggested here).

Renewal

0–1 years after fire

Lasts for 1 ± 0.25 years, i.e. 1.25% of age span, 1.25% of maximum desirable fire interval

During this stage:

- most of the ground is bare soil or rock, with drifts of scorched foliage in rocky declivities
- dead stems of pre-fire shrubby dominants extending well above regeneration
- luxurious growth of adventive herbs, including introduced species such as *Euphorbia peplus*
- bradysporous species releasing seed from elevated fruit
- soil-stored seed germinating and making first appearance above ground
- resprouting species showing first signs of buds activating, but little shoot extension, most resprouting is from the base (very little coppicing)
- nearly all species not flowering and mature seed largely lacking from the community
- may be rapid establishment of adventive bryophytes
- lichens removed, including from exposed rock
- little or no litter, except ash from the fire
- limiting soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralisation of organically bound pre-fire forms)
- abundant light at ground level
- relatively high soil moisture.

Juvenility

1–3 years after fire

Lasts for 2 years, i.e. 2.5% of age span, 2.5% of maximum desirable fire interval

During this stage:

- most of the ground is bare soil or rock, with drifts of scorched foliage in rocky declivities
- dead stems of old shrubby dominants extending well above regeneration
- fire ephemerals common, a species-rich assemblage of fire ephemerals including many species not seen for extended periods between fires
- herbaceous fire ephemerals and annuals abundantly setting seed
- bradysporous species germinating and establishing, but neither dominant nor a major component of the canopy
- resprouting species vigorously growing, rapid shoot extension but not dominant, neither flowering nor setting seed, although a few individuals may start flowering by the end of this stage
- seed regenerator shrubs (e.g. *Acacia triptera, Philotheca trachyphylla*) established in gaps and growing vigorously
- seed bank of all but the annuals and the shorter-lived fire ephemerals lacking
- neither flowering nor seed of pre-fire dominant shrubs
- extensive mats of adventive bryophytes in damp patches among and on the rocks
- lithophytic lichens and bryophytes removed
- little or no litter, although scorched foliage still common in rocky declivities
- coarse woody debris being augmented by falling dead stems and branches of former dominants
- limiting soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralisation of organically bound pre-fire forms)
- abundant light at 15 cm or so height, less at ground level
- relatively high soil moisture.

Adolescence

3–11 years after fire

Lasts for 8 years, i.e. 10% of age span, 10% of maximum desirable fire interval

During this stage:

- canopy closing (bare soil far less common than previously)
- dead stems of old shrubby dominants extending to above the regenerating canopy, but many also falling
- fire ephemerals uncommon to rare — annuals and biennials retreated to the soil seed store, longer-lived fire ephemerals (e.g. *Solanum linearifolium*) reproductive to decreasing
- no further germination or establishment of bradysporous species, earlier germinants vigorously growing, mostly pre-flowering and neither dominant nor a major component of the canopy, mature seed of these species lacking in the community
- resprouting species (e.g. *Kunzea parvifolia, Leptospermum micromyrtus, Leptospermum turbinatus*) vigorously growing, rapid shoot extension, first flowering in resprouters but little or no seed set, mature seed lacking in the community
- seed bank of the fire ephemerals restored, but for all other groups either largely absent or scant
- little or no seed of pre-fire dominant shrubs
- seed regenerating shrubs (e.g. *Acacia silvestris, Philotheca trachyphylla*) growing vigorously, flowering and setting seed
- some litter accumulation, but litter still patchy and little incorporation into the soil
- lithophytic moss mats gradually re-establishing, but still poorly developed and small
- fallen dead stems and branches contributing to coarse woody debris
- limiting soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralisation of organically bound pre-fire forms) but decreasing
- abundant light 1–2 m above ground, intensity at ground level decreasing
- soil moisture returning to normal inter-fire patterns.

Vigorous maturity

11–25 years after fire

Lasts for 14 years, i.e. 18% of age span, 18% of maximum desirable fire interval

During this stage:

- canopy closure complete (at maximum canopy dominance)
- dead stems of old shrubby dominants no longer extending to above the regenerating canopy
- fire ephemerals retreated to soil seed store
- no further germination or establishment of bradysporous species, earlier germinants vigorously growing, flowering and setting seed, elevated seed storage gradually accumulating
- resprouting species, including mallee *Eucalyptus* species such as *E. elaeophloia, E. glaucescens* and *E. saxatilis*, vigorously growing, flowering and with accumulating (elevated) seed store
- seed regenerating shrubs (e.g. *Acacia silvestris, Pimelea pagophila*) weakening, still flowering and setting seed, but vigour may be decreasing towards end of this stage
- lithophytic lichens and bryophytes re-establishing
- lichens beginning to dominate rock surfaces
- litter accumulating, litter cover re-established and gradually being incorporated into the soil
- fallen dead stems contributing to the coarse woody debris
- limiting soil nutrients (notably nitrogen and phosphorus) in decreasing abundance
- light intensity at ground level low
- soil moisture returned to normal inter-fire patterns.

Stasis

25–70 years after fire

Lasts for 45 years, i.e. 56% of age span, 56% of maximum desirable fire interval

During this stage:

- canopy closure complete (at maximum canopy dominance)
- dead stems of old shrubby dominants fallen, no longer extending above the regenerating canopy
- all fire ephemerals retreated to soil seed store
- no further germination or establishment of bradysporous species, earlier germinants growing, flowering and setting seed, maximum elevated seed storage
- resprouting species, including mallee *Eucalyptus* species such as *E. elaeophloia, E. glaucescens* and *E. verrucata*, growing, flowering and with maximum seed store
- most seed regenerator shrubs (e.g. *Acacia silvestris*) weakening, decreasing by end of this growth stage, with (re-) established soil seed bank
- longest-lived seed regenerator shrubs (e.g. *Acacia triptera, Banksia saxicola*) still vigorous and accumulating a seed bank
- lithophytic bryophytes and (particularly) lichens common and spreading
- moss mats re-established on rock surfaces, with rich vascular flora of seasonal herbs
- litter accumulating, litter cover re-established and gradually being incorporated into the soil
- fallen dead stems contributing to coarse woody debris
- limiting soil nutrients (notably nitrogen and phosphorus) at a minimum
- light intensity at ground level low
- soil moisture returned to normal inter-fire patterns.

Senescence

70–80+ years after fire

Lasts for 10+ years, i.e. 13% of age span, 13% of maximum desirable fire interval

During this stage:

- canopy closure decreasing (from maximum canopy dominance), gaps appearing in the canopy (some shrubby dominants appear able to maintain their place in the community in the absence of fire, e.g. *Philotheca trachyphylla*)
- dead stems of old shrubby dominants no longer evident
- all fire ephemerals retreated to soil seed store, soil seed store of fire ephemerals slowly declining
- mesic forbs and monocot herbs uncommon, but a now-noticeable part of field layer in sheltered locations (e.g. rocky declivities)
- no further germination or establishment of bradysporous species, growth rates decreasing, but still flowering and setting seed, elevated seed storage decreasing from a maximum
- long-lived resprouting species, including mallee *Eucalyptus* species such as *E. elaeophloia, E. serraensis* and *E. verrucata*, growing, flowering and with maximum seed store
- most seed regenerating shrubs (e.g. *Calytrix tetragona*) weakening, decreasing to apparent absence by end of this stage, with gradually decreasing soil seed bank
- longest-lived seed regenerating shrubs (e.g. *Acacia triptera, Banksia saxicola*) present but gradually decreasing, gradually decreasing seed bank
- lithophytic bryophytes and (particularly) lichens common and spreading
- moss mats re-established on rock surfaces, with rich vascular flora of seasonal herbs
- perennial component of moss mats apparent, slowly and gradually increasing in dominance and species diversity
- litter accumulating and gradually being incorporated into the soil
- fallen dead stems contributing to coarse woody debris
- light at ground level slowly and gradually increasing
- limiting soil nutrients (notably nitrogen and phosphorus) at a minimum
- soil moisture returned to normal inter-fire patterns.

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Rocky Knoll EVD 18, two years after patchy burn, Mt William, Grampians, Victoria.

Rocky Knoll EVD 18, mostly long unburnt, Mt William, Grampians, Victoria.

Rocky Knoll EVD 18, less than one year after wildfire, showing vigorous regeneration of *Stypandra glauca*, Pine Mountain, Victoria.

Rocky Knoll EVD 18, long unburnt, Pine Mountain, Victoria.

EVD 19: Western Plains Woodland

Maximum	12 years
Minimum (high severity)	30 years
Minimum (low severity)	4 years

Low-severity fire

Most fires in Western Plains Woodland are patchy, usually leaving 20% to 30% or more of the landscape unburnt and unscorched. Such fires more readily burn the more open, grassy patches (see EVD 20 Basalt Grassland). The herbaceous component recovers rapidly, and shrub encroachment or regrowth is retarded in the burnt areas. Between fires, litter and grass (fine fuel) accumulation is less in the shelter of shrubs and trees, so these tend to remain unburnt or only very lightly scorched, leading to a decidedly mosaic burn pattern (burnt grassy patches and unburnt shrubby and treed patches).

High-severity fire

Most fires in Western Plains Woodland are very patchy and low severity. High-severity fires are rare, but not unknown. They may severely burn the woody component, much of which is sensitive to fire and is likely to regenerate predominantly from seed. The full recovery of woody vegetation from a high-severity fire will therefore be substantially delayed, unlike the rapid recovery after a low-severity fire.

Renewal

0–0.75 years after fire

Lasts for 0.75 ± 0.25 years, i.e. 6% of age span, 6% of maximum desirable fire interval

During this stage:

- much of the ground bare or covered by ash from the fire
- soil-stored seed germinating and making first appearance above ground
- tussock-grasses showing regrowth within a month of fire, vigorously regrowing 10 months after fire
- other resprouting herbs showing first signs of buds activating, but little shoot extension
- no plant s flowering, mature seed largely lacking
- large trees usually scorched at the base only, and with canopies not directly affected
- in (rare) high-severity fires, trees burnt and foliage either burnt, or (more likely) scorched and soon falling
- woody seedlings rare, but soon appearing in burnt patches
- abundant *Allocasuarina* seedling germination under burnt parent crowns
- little or no litter, apart from ash
- coarse woody debris burnt, at a minimum, particularly after a high-severity fire
- pre-fire soil bryophyte and lichen cover disrupted or eliminated
- limiting soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralisation of organically bound pre-fire forms)
- abundant light at ground level
- soil surface pH at a maximum
- relatively high soil moisture.

Juvenility

0.75–2.5 years after fire

Lasts for 2 years, i.e. 15% of age span, 15% of maximum desirable fire interval

During this stage:

- bare soil decreasing, less than 30% cover
- short-lived dicot herbs dominate the vigorously growing field layer in burnt areas (these also form the canopy), many herbs in bloom and setting seed by 2 years after fire
- longer-lived sub-shrubs establishing, but neither dominant nor a major component of the community
- burnt shrubs resprouting or establishing sporadically from seed
- burnt eucalypts resprouting from coppice
- copses of *Allocasuarina* trees with dense and vigorous seedling growth
- tussock-grasses vigorously growing, early blooming and seed set
- seed bank of annuals and shorter-lived herbs re-establishing
- neither flowering nor seed of any pre-fire shrubs
- litter quantity low, but gradually accumulating
- coarse woody debris increasing by incorporation of fallen dead stems from any burnt trees
- pre-fire soil bryophyte and lichen cover disrupted or eliminated, but fire-ephemeral bryophytes common
- limiting soil nutrients (notably nitrogen and phosphorus) relatively abundant
- light intensity at ground level decreasing
- relatively high soil moisture.

Adolescence

2.5–5 years after fire

Lasts for 1.5 years, i.e. 13% of age span, 13% of maximum desirable fire interval

During this stage:

- (tussock-grass) canopy closing, bare soil far less common than in juvenility stage
- dicot herbs in decline — annuals and biennials retreated to the soil seed store, longer-lived herbs fully reproductive
- no further germination or establishment of herbaceous, sub-shrubby or woody species, earlier germinants vigorously growing, mostly pre-flowering and neither dominant nor a major component of the canopy, mature seed of these species lacking in the community
- burnt eucalypts resprouting from coppice, pre-fire tree canopy more or less re-established but still not shady, tree foliage restricted to close to the trunk and larger branches
- eucalypt seedlings small, emergent from the tussock grasses and with weak lignotubers
- copses of dead *Allocasuarina* stems with dense and vigorous seedling growth
- resprouting herb species vigorously growing (including renascent perennials such as lilies and tuberous herbs), rapid shoot extension, vigorously flowering and ample seed set, mature seed accumulating in the community
- tussock grasses dominant and inter-tussock gaps closing, first major flowering and seed set in tussock grasses
- seed bank of the dicot herbs restored, but for longer-lived components largely absent
- no seed of the (pre-fire) shrubs
- fine litter gradually accumulating and slowly being incorporated into the soil profile
- coarse woody debris increasing by incorporation of fallen dead stems and branches
- soil bryophyte and lichen cover disrupted or eliminated, except for fire-ephemeral bryophytes
- limiting soil nutrients (notably nitrogen and phosphorus) relatively abundant, but declining
- light at ground level low
- soil moisture returning to normal inter-fire patterns.

Maturity

5–9 years after fire

Lasts for 4 years, i.e. 33% of age span, 33% of maximum desirable fire interval

During this stage:

- canopy closure complete (maximum dominance by tussock-grasses)
- dicot herbs increasingly uncommon but still species rich, maintenance in the soil seed store
- no further germination or establishment of any species, except perhaps occasional establishment from scattered trees or shrubs
- unburnt eucalypts and other trees and woody shrubs fully flowering and setting seed
- burnt eucalypts with canopy restored but still pre-flowering
- copses of dead *Allocasuarina* stems with dense and vigorous seedling growth, standing dead stems collapsing
- tree germinants neither flowering nor setting seed
- sub-shrubs growing and flowering although decreasing in vigour, with an accumulating soil seed store
- germinants of woody shrubs vigorously growing and setting seed
- tussock-grasses dominant and vigorously growing, flowering and with an accumulating seed store
- litter accumulating, litter cover re-established and being incorporated into the soil
- coarse woody debris increasing by incorporation of fallen dead stems from any burnt trees soil bryophyte and lichen cover re-establishing, but not yet continuous in open patches
- limiting soil nutrients (notably nitrogen and phosphorus) decreasing
- light intensity at ground level minimal
- soil moisture returned to normal inter-fire patterns.

Western Plains Woodland EVD 19, two years after low intensity planned burn, Gellibrand Hill, Victoria.

Western Plains Woodland EVD 19, more than seven years after fire, Craigieburn, Victoria.

Western Plains Woodland EVD 19, long unburnt, showing abundant regeneration of *Eucalyptus camaldulensis* in the absence of fire, Epping, Victoria.

Waning

9–15+ years after fire

Indeterminate length: 33% of age span, 33% of maximum desirable fire interval) (may extend beyond maximum desirable fire interval

During this stage:

- woodland may change into another vegetation community
- short-lived dicot herbs invisible and decreasing (soils seed store in decline)
- renascent perennials decreasing to scattered and uncommon
- above-ground species diversity decreasing to a minimum (except compared to immediately post-fire)
- native e annual species and short-lived herbs rare in the field layer
- small number of tolerant introduced annual species established in occasional gaps
- no further germination or establishment of native herb species, growth rates decreasing, flowering of all but the dominant tussock grasses decreasing to absent
- shrubs and tress (if present) growing and flowering, re-established soil or elevated seed bank
- tree crowns shady
- non-eucalypt trees increasing in size and site dominance (at the expense of tussock grasses and other herbs)
- tussock-grasses completely dominate the field layer, with thatch of dense grass litter dominating any inter-tussock gaps
- soil seed stores for most species decreasing
- long-lived sedges and the like still with high cover values, but reduced growth rates and accumulating standing litter (dead foliage and stems)
- litter cover complete and being incorporated into the soil
- soil bryophyte and lichen cover re-established in inter-tussock gaps on drier sites
- soil nutrient availability (notably nitrogen and phosphorus) decreasing as soil organic matter increasing (high C:N ratios)
- light intensity at ground level at a minimum
- soil moisture relatively low.

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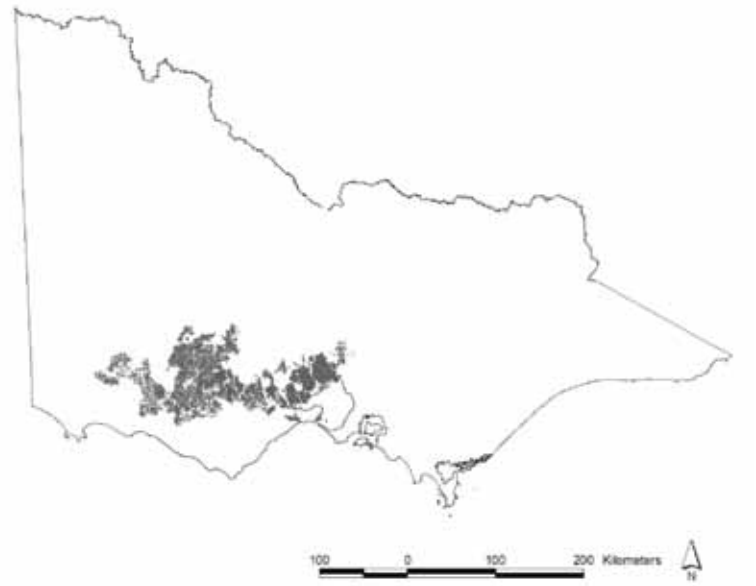
EVD 20: Basalt Grassland

Maximum	7 years
Minimum (high severity)	3 years
Minimum (low severity)	2 years



Renewal

0–0.75 years after fire

Lasts for 0.75 ± 0.25 years, i.e.
11% of age span, 11% of maximum desirable fire interval

During this stage:

- most of the ground bare or covered by ash from the fire
- soil-stored seed germinating and making first appearance above ground
- tussock-grasses showing regrowth within a month of fire, vigorously regrowing 10 months after fire
- other resprouting species showing first signs of buds activating, but little shoot extension
- (all) plant species not flowering and mature seed largely lacking from the community
- little or no litter, apart from ash
- soil bryophyte and lichen cover disrupted or eliminated
- limiting soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralisation of organically bound pre-fire forms)
- abundant light at ground level
- soil surface pH at a maximum
- relatively high soil moisture.

Juvenility

0.75–2 years after fire

Lasts for 1.25 years, i.e. 18% of age span, 18% of maximum desirable fire interval

During this stage:

- bare soil decreasing, less than 40% cover
- short-lived dicot herbs dominate a vigorously growing field layer (which is also the canopy), many herbs flowering and setting seed by two years after fire
- longer-lived sub-shrubs establishing, but neither dominant nor a major component of the visible community
- shrubs and trees (if present) establishing and growing
- any trees that survived the fire resprouting
- tussock-grasses vigorously growing, but not yet flowering and setting seed
- seed bank of the annuals and the shorter-lived herbs being re-established
- neither flowers nor seed of pre-fire shrubs
- litter quantity low, but gradually accumulating
- soil bryophyte and lichen cover disrupted or eliminated
- limiting soil nutrients (notably nitrogen and phosphorus) relatively abundant
- light intensity at ground level decreasing
- relatively high soil moisture.

Adolescence

2–4 years after fire

Lasts for 2 years, i.e. 29% of age span, 29% of maximum desirable fire interval

During this stage:

- canopy closing
- area of bare soil far less than in previous stages
- dicot herbs in decline — annuals and biennials retreated to the soil seed store, longer-lived herbs fully reproductive
- no further germination or establishment of herbaceous, sub-shrubby or woody species, earlier germinants vigorously growing, mostly pre-flowering and neither dominant nor a major component of the canopy, mature seed lacking in the community
- resprouting species (including renascent perennials such as lilies and tuberous herbs) vigorously growing, rapid shoot extension, first flowering in resprouter shrubs but little seed set, mature seed of these shrubs uncommon in the community
- tussock-grasses dominant and inter-tussock gaps closing, first significant flowering in tussock-grasses
- seed bank of the dicot herbs restored, but seed banks of longer-lived components largely absent
- no seed of pre-fire occasional shrubs
- litter gradually accumulating, being slowly incorporated into the soil profile
- soil bryophyte and lichen cover disrupted or eliminated
- limiting soil nutrients (notably nitrogen and phosphorus) relatively abundant
- light intensity at ground level low
- soil moisture returning to normal inter-fire patterns.

Maturity

4–6 years after fire

Lasts for 2 years, i.e. 29% of age span, 29% of maximum desirable fire interval

During this stage:

- canopy closure complete (at maximum canopy dominance)
- dicot herbs largely invisible and decreasing in soil seed bank
- no further germination or establishment of any species, except perhaps occasional establishment from scattered trees or shrubs
- sub-shrubs growing and flowering, although decreasing in vigour, with an accumulating soil seed store
- tussock-grasses dominant and vigorously growing, flowering and with an accumulating seed store
- shrubs and trees (if present) vigorously growing, shrubs and mature trees that survived fire may be flowering, but too soon for trees that germinated after fire
- mature seed of shrubs and trees mostly lacking
- litter accumulating, litter cover re-established and being incorporated into the soil
- soil bryophyte and lichen cover re-establishing, but not yet continuous in open patches
- limiting soil nutrients (notably nitrogen and phosphorus) decreasing
- light intensity at ground level minimal
- soil moisture returned to normal inter-fire patterns.

Senescence

6–20+ years after fire

Indeterminate length: beyond maximum desirable fire interval

During this stage:

- grassland may change into another vegetation community
- short-lived dicot herbs invisible and decreasing (soils seed store in rapid decline)
- renascent perennials decreasing to invisibility
- above-ground species diversity decreasing to a minimum (except compared to immediately post-fire)
- native annual species and short-lived herbs absent from field layer
- small number of tolerant introduced annual species established in occasional gaps
- no further germination or establishment of native herb species, growth rates decreasing, flowering of all but the dominant tussock grasses decreasing to absent
- shrubs and trees (if present) growing and flowering, gradually re-establishing an on-site soil or elevated seed store
- tussock-grasses completely dominate the field layer, with dense thatch of grass litter dominating any inter-tussock gaps
- soil seed stores for most species decreasing
- long-lived sedges and the like still with high cover values, but reduced growth rates and accumulating standing litter (dead foliage and stems)
- litter cover complete (at a maximum) and being incorporated into the soil
- soil bryophyte and lichen cover re-established in inter-tussock gaps on drier sites
- soil nutrient availability (notably nitrogen and phosphorus) decreasing as soil organic matter increasing (high C:N ratios)
- light intensity at ground level at a minimum
- soil moisture relatively low.

Basalt Grassland EVD 20, 2.5 years after fire, Craigieburn, Victoria.

Basalt Grassland EVD 20, more than five years after fire, Craigieburn, Victoria.

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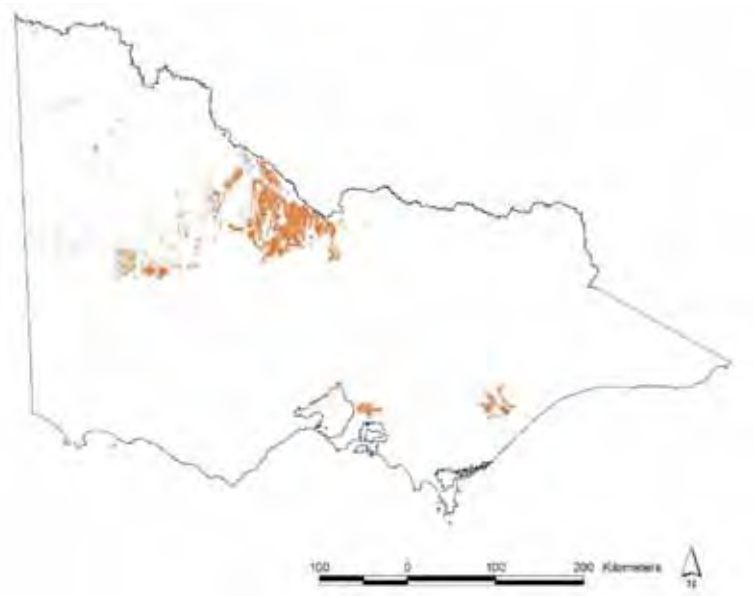
EVD 21: Alluvial Plains Grassland

Maximum	30 years
Minimum (high severity)	3 years
Minimum (low severity)	2 years



Renewal

0–1 year after fire

Lasts for 1 ± 0.5 years, i.e.
3% of age span, 3% of maximum desirable fire interval

During this stage:

- most of the ground bare or covered by ash from the fire
- soil-stored seed germinating and making first appearance above ground
- tussock-grasses showing regrowth within a couple of months of fire, vigorously regrowing one year later
- other resprouting species (including trees, if present) showing first signs of buds activating, but little shoot extension
- any shrubs largely dead
- species not flowering and mature seed largely lacking from the community
- little or no litter (apart from ash)
- soil bryophyte and lichen cover disrupted or eliminated
- limiting soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralisation of organically bound pre-fire forms)
- abundant light at ground level
- soil surface pH at a maximum (probably just above 7)
- relatively high soil moisture.

Juvenility

1–5 years after fire

Lasts for 3 years, i.e. 10% of age span, 10% of maximum desirable fire interval

During this stage:

- bare soil decreasing, less than 40% cover by end of stage
- short-lived dicot herbs dominate a vigorously growing field layer (which is also the canopy), many herbs flowering and setting seed by two years after fire
- longer-lived sub-shrubs (e.g. *Maireana* and *Atriplex* species) resprouting or germinating from seed, but neither dominant nor a major component of the visible community
- trees that survived the fire resprouting
- tussock-grasses vigorously growing, and beginning to flower and set seed by the end of the stage
- seed bank of the annuals and the shorter-lived herbs being re-established
- neither flowers nor seed of pre-fire shrubs
- litter quantity low, but gradually accumulating
- soil bryophyte and lichen cover disrupted or eliminated
- limiting soil nutrients (notably nitrogen and phosphorus) relatively abundant
- light intensity at ground level decreasing but still high
- relatively high soil moisture.

Maturity

5–20 years after fire

Lasts for 15 **y**ears, i.e. 50% of age span, 50% of maximum desirable fire interval

During this stage:

- bare soil far less common than previously, canopy cover (of tussock-grasses) at around 50%
- fire and disturbance ephemerals apparently rare but present in soil seed bank
- quick-growing dicot herbs in decline (re-established soil seed store for the shorter-lived species, longer-lived herbs fully reproductive)
- resprouting species (including renascent perennials such as lilies and tuberous herbs) vigorously growing, rapid shoot extension
- renascent sub-shrubs (e.g. *Maireana humillima, Maireana excavata, Atriplex suberecta*) vigorous, flowering, setting seed and establishing in the inter-tussock gaps
- tussock-grasses dominant and inter-tussock gaps decreasing
- seed bank of all the component species re-established
- long-lived chenopod shrubs (e.g. *Atriplex leptocarpa, Enchylaena tomentosa, Maireana decalvans, Maireana rohrlachii, Sclerolaena muricata*) reappearing from long-distance seed dispersal
- tree seedlings (if trees are present) may be scattered throughout grassland
- litter gradually accumulating, being slowly incorporated into the soil profile
- soil bryophyte and lichen cover gradually re-establishing (mosses first, lichens gradually re-establishing)
- limiting soil nutrients (notably nitrogen and phosphorus) relatively abundant, but decreasing
- light intensity at ground level moderate
- soil moisture at normal inter-fire patterns.

Senescence

20–30+ years after fire

Indeterminate length: 33% of age span, 33% of maximum desirable fire interval extends beyond maximum desirable fire interval

During this stage:

- grassland may change into another vegetation community
- increasing exposure of bare ground or soil crust
- short-lived dicot herbs invisible and decreasing (soil seed bank in gradual decline)
- renascent perennials present but decreasing, less fecund
- shrubs and trees (if present) growing and flowering, soil or elevated seed bank re-established
- occasional tree seedlings establish
- tussock-grasses dominate field layer
- an increasingly common chenopod shrub layer (e.g. *Atriplex leptocarpa, Enchylaena tomentosa, Maireana decalvans, Maireana rohrlachii, Sclerolaena muricata*), occasionally incorporating non-chenopod shrubs such as *Nitraria billardierei*
- litter cover relatively high and being incorporated into the soil
- soil bryophyte and lichen cover re-established in inter-tussock gaps on drier sites
- soil nutrient availability (notably nitrogen and phosphorus) decreasing as soil organic matter increasing (high C:N ratios)
- light at ground level at a minimum
- soil moisture relatively low.

Alluvial Plains Grassland EVD 21, long unburnt, Birthday Plains, Central Sunset Country, Victoria.

Alluvial Plains Grassland EVD 21, long unburnt, Walpeup, Victoria.

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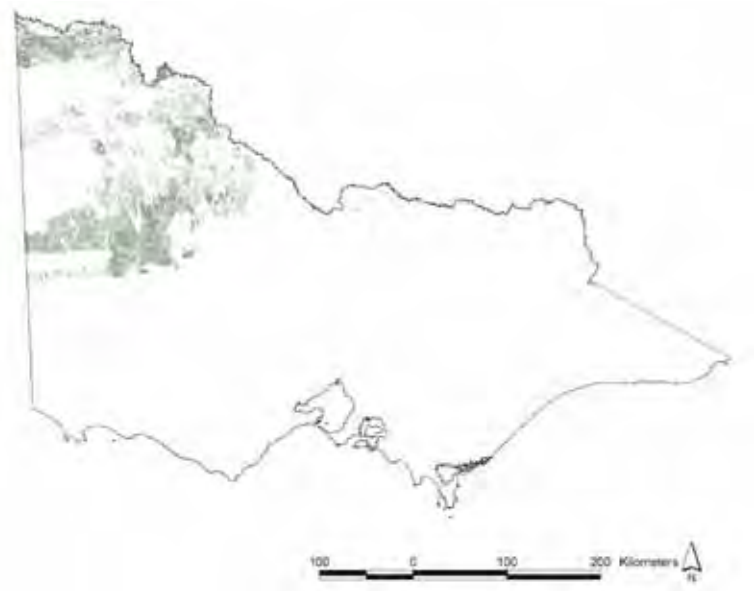
EVD 22: Dry Woodland (non-eucalypt)

Maximum	∞
Minimum (high severity)	80 years
Minimum (low severity)	20 years



In exceptional conditions (e.g. after protracted summer rains and vigorous growth of annual grasses) Dry Woodlands (non-eucalypt) vegetation may burn. Although the response to such an unusual event are described below, this does not imply that fire is an appropriate management tool in this EVD. Indeed, this community is often irretrievably damaged by fires and a single fire can lead to its permanent degradation. In most seasons, fuel conditions prevent fires in this vegetation.

Low-severity fires

Low severity fires in Dry Woodland (non-eucalypt) are restricted to more southerly woodlands with a notably grassy field layer. In such vegetation fires can be *very* patchy, usually leaving well over 50% of the landscape unburnt and unscorched. Low-severity fires are restricted to the open, grassy patches (see EVC 21 Alluvial Plains Grassland). Rapid recovery of the herbaceous component occurs and shrub encroachment or regrowth is retarded in the burnt areas. Between fires, litter and grass accumulation is less in the shelter of shrubs and trees; thus these tend to remain unburnt or only very lightly scorched, leading to a decidedly mosaic burn pattern of burnt grassy patches and unburnt shrubby and treed patches.

The figures for growth stages are based on high-severity fires.

Renewal

0–2 years after fire

Lasts for 2 years, i.e.
1.3% of arbitrary maximum fire interval

During this stage:

- much of the ground is bare or covered by ash from the fire
- seed (from the short-term seed bank or nearby refuges) germinating and making first appearance above ground
- abundant growth of annuals, flowering and setting seed by the end of the first season after fire
- many annual and other short-lived introduced weeds present and vigorous
- resprouting shrubs and trees showing first signs of subterranean buds activating, but little shoot extension
- perennial species not flowering and mature seed largely lacking
- standing dead stems of former canopy dominants and other woody species
- little or no litter, apart from ash and coarse woody debris
- abundant light at ground level
- soil surface pH high.

Juvenility

2–10 years after fire

Lasts for 8 years, i.e.
5.3% of arbitrary maximum fire interval

During this stage:

- bare ground is at a minimum, ash from the fire decreasing
- abundant growth of ecologically catholic adventives, including introduced weeds
- shrub seedlings establishing and growing but nowhere dominant in any stratum, first flowering but little seed set
- short-lived perennial chenopods (e.g. various *Atriplex* and *Maireana* species) and other arid-adapted sub-shrubs (e.g. *Zygophyllum* species) common, flowering and fruiting
- germinants of obligate seed regenerating shrubs and trees establishing (if grazing pressure from rabbits and kangaroos low) and slowly growing
- resprouting shrubs and trees showing first signs of subterranean buds activating, but little shoot extension
- neither flowering nor seed of any pre-fire dominant shrubs or trees
- perennial species not flowering and mature seed largely lacking from the community
- standing dead stems of former canopy dominants and other woody species
- dead timber falling and common, augmenting coarse woody debris
- soil lichens scarce
- a few species of bryophytes locally common in sheltered sites
- apart from coarse woody debris, litter quantity low
- soil surface pH high.

Adolescence

10–60 years after fire

Lasts for 50 years, i.e. 33% of arbitrary maximum fire interval

During this stage:

- bare ground is at a minimum, ash from the fire no longer apparent
- growth of ecologically catholic adventives decreasing and largely restricted to patches of loose, unstabilised surface soils, may be locally common
- short-lived perennial chenopods (e.g. various *Maireana* or *Rhagodia* species) and other arid-adapted sub-shrubs (e.g. *Zygophyllum* species) common, flowering and fruiting, short-lived *Atriplex* species retreated to the soil seed bank
- pre-fire dominant shrubs growing and setting seed, but still barely dominant in the shrub layers
- germinants of obligate seed regenerating shrubs and trees established (if grazing pressure from rabbits and kangaroos low) and slowly growing, not yet reached the canopy (if trees) nor the understorey nor shrub strata (if shrubs)
- resprouting shrubs and trees regrowing from dormant buds on the trunks or from below ground, early flowering and seed set but with only a scanty seed store
- standing dead stems of former canopy dominants and other woody species still apparent
- dead timber common as coarse woody debris
- soil lichens slowly increasing in inter-shrub spaces, epiphytic lichens uncommon to rare
- bryophytes apparent in shelter of dominant shrubs
- litter quantity moderate
- light intensity at ground level low (but light is rarely limiting anywhere within this community)
- soil surface pH decreasing, but still around neutral.

Dry Woodland (non-eucalypt) EVD 22, long unburnt, Wyperfeld National Park, Victoria.

Dry Woodland (non-eucalypt) EVD 22, long unburnt, Donald, Victoria.

(PHOTO COURTESY MATT WHITE)

Maturity

60–150+ years after fire

Lasts indefinitely: 60% of arbitrary maximum fire interval

During this stage:

- bare ground decreased to a minimum, with very little bare ground because of an extensive cryptogamic crust
- growth of ecologically catholic adventives at a minimum and restricted to the cool (moist) season and localised patches of unstabilised soils
- native herbs (e.g. crucifers, daisies, *Ptilotus* species) moderately common (high frequency, low density)
- short-lived perennial chenopods (e.g. various *Maireana* or *Rhagodia* species) and other arid-adapted sub-shrubs (e.g. *Zygophyllum* species) common, flowering and fruiting, short-lived *Atriplex* species retreated to the soil seed bank
- pre-fire dominant shrubs growing and setting seed, now dominant in the shrub layers
- germinants of obligate seed regenerating shrubs and trees established (if grazing pressure from rabbits and kangaroos low) and slowly growing, attained the canopy (if trees) or the understorey or shrub strata (if shrubs), flowering and setting seed
- resprouting shrubs and trees regrowing from dormant buds on the trunks or from below ground, attained the canopy (if trees) or the understorey or shrub strata (if shrubs), abundant flowering and seed set
- soil lichens common in inter-shrub spaces
- bryophytes apparent in shelter of dominant shrubs
- epiphytic lichens common
- standing dead stems of former canopy dominants and other woody species scarce
- dead and fallen timber common as coarse woody debris
- litter quantity moderate
- light intensity at ground level at a minimum
- soil surface pH around neutral in most stands, occasionally alkaline because of lime close to the surface.

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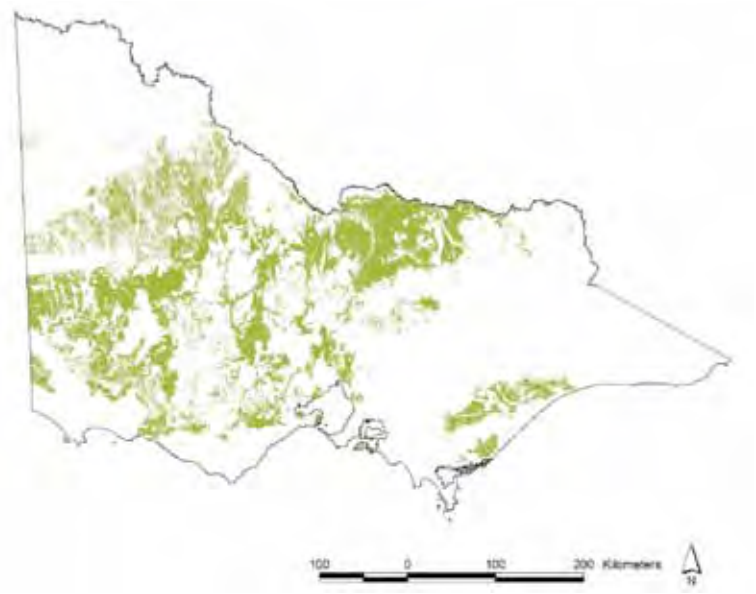
EVD 23: Inland Plains Woodland

Maximum	150 years
Minimum (high severity)	30 years
Minimum (low severity)	5 years



In most seasons, Inland Plains Woodlands will not support fires. However, in unusual conditions (e.g. after protracted rains and vigorous grass growth) Inland Plains Woodlands may burn. Although the response to such an unusual event are described below, this does not imply that fire is an appropriate management tool in this EVD. Indeed, stands of this community in which non-eucalypts (e.g. *Callitris glaucophylla* and/or *Casuarina luehmannii*) are dominant or codominant can be degraded by a single fire. In most seasons, fuel conditions do not encourage fires in Inland Plains Woodland.

The desirable fire interval of 150 years is only conjectural, as few such stands are known and species maturation patterns have not been investigated.

Low-severity fires

Most fires in Inland Plains Woodland are very patchy, usually leaving well over 50% of the landscape unburnt and unscorched. Tree canopies are often not burnt or scorched. Such fires most likely burn the more open, grassy patches (see EVC 21 Alluvial Plains Grassland). Rapid recovery of the herbaceous component occurs and shrub encroachment (or growth or regrowth) is retarded in the burnt areas. Between fires, litter and grass accumulation is less in the shelter of shrubs and trees; thus these tend to remain unburnt (or only very lightly scorched), leading to a decidedly mosaic burn pattern of burnt grassy patches and unburnt shrubby and treed patches.

High-severity fires

High-severity fires are very rare but not unknown, and are less patchy and extend into the canopies.

Renewal

0–1 year after fire

Lasts for 1 ± 0.5 years, i.e. 0.7% of age span, 0.7% of maximum desirable fire interval

During this stage:

- most of the ground is bare or covered by ash from the fire
- soil-stored seed germinating and making first appearance above ground
- tussock-grasses showing regrowth within a couple of months of the fire, vigorously regrowing by one year later, but not flowering
- if burnt, eucalypts showing first signs of dormant buds activating but little shoot extension, non-eucalypts often killed by fire
- germination of tree seedlings common
- seed-regenerating shrubs largely dead
- seed regeneration of woody species common but with little shoot extension and none flowering nor setting seed
- the few resprouting shrubs showing first signs of shoot extension, although little growth and neither flowering nor setting seed
- perennial species not flowering and mature seed largely lacking from the community
- little or no litter, apart from ash
- coarse woody debris often greatly reduced by the fire
- soil bryophyte and lichen cover disrupted or eliminated
- limiting soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralisation of organically bound pre-fire forms)
- abundant light at ground level
- soil surface pH at a maximum (probably just above 7)
- relatively high soil moisture.

Juvenility

1–4 years after fire

Lasts for 3 years, i.e. 2% of age span, 2% of maximum desirable fire interval

During this stage:

- bare soil decreasing, less than 60% cover by end of period
- short-lived herbs dominate the vigorously growing field layer, many herbs in bloom and setting seed by two years after fire
- eucalypts resprouting vigorously from trunk and branch coppice, neither flowering nor setting seed
- non-eucalypts often dead and beginning to collapse
- many tree seedlings dead, the few survivors growing in gaps
- legume shrubs vigorously growing, a few (e.g. *Acacia* species) beginning to flower by the end of this stage, but with scant seed set
- resprouting shrubs growing vigorously
- sclerophyll shrub seedlings common and establishing in gaps and in burnt areas
- tussock-grasses vigorously growing, and beginning to flower and set seed by end of stage
- seed bank of annuals and shorter-lived herbs being re-established
- neither flowering nor seed of most pre-fire shrubs
- litter quantity low, but gradually accumulating
- coarse woody debris being augmented by fallen dead timber
- soil bryophyte and lichen cover disrupted or eliminated
- limiting soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralisation of organically bound pre-fire forms and vigorous post-fire nitrogen fixation by legumes)
- light intensity at ground level decreasing but still high
- relatively high soil moisture.

Adolescence

4–19 years after fire

Lasts for 15 years, i.e. 10% of age span, 10% of maximum desirable fire interval

During this stage:

- bare soil decreasing, less than 40% cover by end of period
- short-lived herbs less common than previously but still common in gaps in the shrub stratum, with a re-established soil seed bank
- eucalypts growing vigorously from trunk and branch coppice, first flowering by the end of this stage, but scant seed set
- non-eucalypts often dead and beginning to collapsing
- many tree seedlings dead, the few survivors growing in gaps
- legume shrubs vigorously growing, most abundantly flowering and with a re-established soil seed bank
- resprouting shrubs growing vigorously, with increasingly common flowering and seed set.
- sclerophyll shrub seedlings common, well-established in gaps and in burnt areas, flowering and setting seed
- tussock-grasses vigorously growing, flowering and setting seed
- seed bank of the annuals and perennial herbs re-established
- litter quantity increasing slowly
- coarse woody debris being augmented by fallen dead timber
- soil bryophyte and lichen cover disrupted or eliminated
- bryophyte mats noticeable in the cooler seasons
- limiting soil nutrients (notably nitrogen and phosphorus) in decreased abundance (from vigorous nitrogen fixation by legumes)
- light intensity at ground level at a minimum but not substantially limiting
- reduced soil moisture.

Inland Plains Woodland EVD 23, long unburnt, Wail.
(PHOTO COURTESY MATT WHITE)

Inland Plains Woodland EVD 23, long unburnt and grazed by domestic stock, near Glenorchy, Victoria.
(PHOTO COURTESY MATT WHITE)

Maturity

19–120 years after fire

Lasts for 101 years, i.e. 67% of age span, 67% of maximum desirable fire interval

During this stage:

- bare soil far less common than previously, canopy cover (of tussock grasses) at around 50%
- fire and disturbance ephemerals apparently rare to absent (although present in the soil seed store)
- quick-growing dicot herbs in decline (re-established soil seed store for the shorter-lived species, longer-lived herbs fully reproductive)
- seed-regenerating species (including legumes such as *Acacia species*) uncommon, but maintained in the community via occasional germination and establishment into sporadic gaps
- resprouting species vigorously growing (including renascent perennials such as lilies and tuberous herbs)
- renascent sub-shrubs (often chenopods, e.g. *Maireana humillima, Maireana enchylaenoides, Maireana pentagona, Atriplex semibaccata*) slowly invading and spreading, increasingly common as the vegetation ages; flowering, setting seed and establishing in the inter-tussock gaps
- tussock-grasses dominant and inter-tussock gaps decreasing
- seed bank of all the component species re-established
- long-lived chenopod shrubs (e.g. *Atriplex leptocarpa, Enchylaena tomentosa, Maireana decalvans, Maireana rohrlachii, Sclerolaena muricata)* (re-)appearing from long-distance seed dispersal
- tree seedlings reaching the canopy
- further eucalypt seedlings very rare
- fire-sensitive non-eucalypt trees continuing to establish and becoming increasingly common, but slowly
- litter gradually accumulating, being slowly incorporated into the soil profile
- coarse woody debris increasingly common, incorporating large logs and extensive hollow formation in standing stems
- soil bryophyte and lichen cover re-established (mosses first, lichens later)
- reduced soil moisture.

Waning

120–150+ years after fire

Lasts for 50+ years, i.e.
20% of age span, 20% of maximum desirable fire interval
towards and beyond the upper limit of desirable fire age

During this stage:

- bare soil increasingly common in gaps between tussocks and shrub canopies, difficult to distinguish from extensive cover of bryophytes and lichens
- fire and disturbance ephemerals apparently rare to absent (although present in the soil seed store)
- quick-growing dicot herbs in decline (re-established soil seed store for the shorter-lived species, longer-lived herbs reproductive)
- seed-regenerating species (including legumes such as *Acacia species*) increasingly uncommon, but maintained in the community via occasional germination and establishment into sporadic gaps
- resprouting shrub species retain presence via occasional germination and establishment into sporadic gaps
- renascent sub-shrubs (often chenopods, e.g. *Maireana humillima, Maireana enchylaenoides, Maireana pentagona, Atriplex semibaccata*) may dominate the field/sub-shrub stratum
- tussock grasses decreasing
- seed bank of all the component species re-established, soil seed bank of obligate seed germinating shrubs (particularly the legumes) decreasing,
- long-lived chenopod shrubs (e.g. *Atriplex leptocarpa, Enchylaena tomentosa, Maireana decalvans, Maireana rohrlachii, Sclerolaena muricata*) gradually assuming dominance in the shrub stratum
- canopy trees continuing to recruit from sporadic establishment in gaps
- tree density gradually increasing (at the expense of the other perennial [subordinate] strata)
- fire sensitive non-eucalypt trees continuing to establish and becoming increasingly common, but slowly
- litter gradually accumulating, being slowly incorporated into the soil profile
- coarse woody debris increasingly common, incorporating large logs and extensive hollow formation in standing stems
- soil bryophyte and lichen cover re-established (mosses first, lichens later)
- reduced soil moisture.

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EVD 24: Ironbark/Box

Maximum	150 years
Minimum (high severity)	30 years
Minimum (low severity)	12 years

Ironbark / Box vegetation may burn in an intense fire (wildfire) or in a patchy prescribed burn. The black text below describes this community's response to high-severity fire (wildfire), which usually means that the canopy has been consumed. Such high-severity fires are neither common nor likely in Ironbark / Box, but they are possible, particularly following a run of years of relatively high rainfall, including rain extending into the normally dry summer.

Low-severity fires

Green text below refers to the community's response to low-severity, patchy fire, i.e. a fire with many unburnt patches within the fire perimeter and in which the canopy is rarely burnt or scorched. The greatest response to frequent fires (whether of high or low severity) comes after the *second* and all subsequent fires with a short fire interval (10–15 years). The patchiness of low-severity fires is critical in maintaining sensitive species in the community, as it means that some vegetation within the fire perimeter escapes being burnt at such frequent intervals.

Renewal

0–1 year after fire

Lasts for 1 ± 0.25 years, i.e.

0.7% of age span, 0.7% of maximum desirable fire interval

◆ same for low-severity fires

During this stage:

- most of the ground cover is bare soil
- bradysporous species releasing seed from elevated fruit
- soil-stored seed germinating and making first appearance above ground
- resprouting species showing first signs of buds activating, but little shoot extension
- canopy lacking (removed by the fire, scorched leaves dropped)
- species not flowering and mature seed largely lacking
- little or no litter, although ash accumulated in drifts and fallen scorched foliage from the canopy
- coarse woody debris uncommon (pre-fire fallen timber consumed in the fire, only newly fallen timber present)
- soil bryophyte and lichen cover disrupted or eliminated
- limiting soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralization of organically bound pre-fire forms)
- abundant light at ground level
- relatively high soil moisture (compared with mature Ironbark / Box).

Juvenility

1–3 years after fire

Lasts for 2 ± 0.5 years, i.e.

1.3% of age span, 1.3% of maximum desirable fire interval

◆ same for low-severity fires

During this stage:

- most of the ground is bare
- fire ephemerals common in a vigorously growing and substantially herbaceous field layer
- bradysporous species germinating and establishing, but neither dominant nor a major component of any stratum
- tree seedlings evident, cotyledon stage initially but reaching about 1 m high by end of stage
- resprouting species growing, rapid shoot extension, but with low cover
- resprouting species in the tree canopy vigorously coppicing, not flowering
- herbaceous fire ephemerals and annuals with first seed set
- seed bank of all but the annuals and the shorter-lived fire ephemerals lacking
- neither flowering nor seed of the (pre-fire) dominant shrubs
- little or no litter, ash drifts still evident
- coarse woody debris present largely as few large logs
- soil bryophyte and lichen cover disrupted or eliminated
- limiting soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralization of organically bound pre-fire forms)
- abundant light to the field layer, light at ground level decreasing
- relatively high soil moisture (compared with mature Ironbark / Box).

Adolescence

3–13 years after fire

Lasts for 10 years, i.e.

7% of age span, 7% of maximum desirable fire interval

◆ same for low-severity fires, but note that there will be many unburnt patches within the fire perimeter that retain essentially mature or older vegetation

During this stage:

- canopy cover increasing, lower coppice dying
- seedlings of canopy species mostly dying, the few left establishing in gaps
- bare soil far less common than previously
- fire ephemerals in decline — annuals and biennials retreated to the soil seed bank, longer-lived fire ephemerals fully reproductive
- legumes (including *Acacia* species) vigorously growing, flowering and setting seed
- no further germination or establishment of other bradysporous species, earlier germinants vigorously growing, many pre-flowering and neither dominant nor a major component of the shrub stratum, mature seed of these species lacking in the community ◆ (this group of species is most susceptible to frequent fires and may be locally eliminated unless high frequency fires are notably patchy)
- likely establishment of 'M' species (e.g. *Xanthorrhoea* species)
- resprouting shrubs vigorously growing, rapid shoot extension, first flowering in large resprouter shrubs, abundant seed set (although seed set has begun, mature seed of these species is not common in the community)
- resprouting sedges vigorous and flowering with ample seed set
- Bracken (*Pteridium esculentum*) occasionally dominant in field layer on moister sites
- seed bank of fire ephemerals restored, but seed banks of all other groups uncommon
- some litter accumulation, litter patchy and gradually being incorporated into the soil
- soil bryophyte and lichen cover disrupted or eliminated, bryophytes locally common
- limiting soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralization of organically bound pre-fire forms and vigorous nitrogen fixation from the abundant legumes), but decreasing
- light at ground level low due to vigorous shrub layer, light to shrub strata decreasing as canopy slowly re-establishing
- soil moisture returning to normal inter-fire patterns.

Ironbark/Box EVD 24, long unburnt, Rushworth, Victoria.

(PHOTO COURTESY ARN TOLSMA)

Ironbark / Box EVD 24, Cornella, Victoria.

Vigorous maturity

13–25 years after fire

Lasts for 12 years, i.e.
8% of age span, 8% of maximum desirable fire interval

During this stage:

- canopy cover of trees re-established
- all fire ephemerals retreated to soil seed bank
- large shrubby legumes, particularly *Acacia* and *Daviesia* species, still vigorously flowering and setting seed, but clumps gradually opening out as mature plants die without replacement
- no further germination nor establishment of bradysporous species, earlier germinants vigorously growing, flowering and setting seed, elevated seed storage accumulating
- little or no shrub establishment from seed, whether of large bradysporous species or smaller ericoids and the like
- resprouting species growing, flowering and with accumulating seed bank
- canopy eucalypts flowering and setting seed
- eucalypt seedlings not yet flowering
- herbaceous species (not fire ephemerals) gradually reappearing and becoming more common in the field layer
- tussock-grasses reappearing, but nowhere common, unless the field layer was dominated by tussock grasses before the most recent fire
- litter accumulating, litter cover re-established and being incorporated into the soil
- first notable appearance of coarse woody debris, but little accumulation
- lichen and bryophyte cover re-establishing, but not continuous
- limiting soil nutrients (notably nitrogen and phosphorus) in decreasing abundance
- light intensity at ground level at a minimum
- soil moisture returned to normal inter-fire patterns.

Stasis

25–140 years after fire

Lasts for 115 years, i.e.
77% of age span, 77% of maximum desirable fire interval

During this stage:

- canopy cover static and at a maximum, tree density decreasing as large trees get bigger
- canopy eucalypts heavily flowering and setting seed, canopy seed bank and nectar flow at a maximum
- eucalypt seedlings (the few that remain) reaching the canopy and flowering
- resprouting shrubs growing (but growth rates decreasing), flowering and with maximum seed bank
- long-lived heaths slowly increasing in abundance
- legume shrubs uncommon, scattered, low density being maintained by occasional successful germinant, with long-lasting but slowly decreasing soil seed bank
- shrubs at highest species diversity but reduced cover compared with previous stage
- perennial herbaceous species (not fire ephemerals) becoming more common in field layer
- tussock-grasses increasing to dominance in field layer
- annuals increasing in abundance on poorly vegetated sites
- litter cover re-established and being incorporated into the soil
- lichens and bryophytes well established and diversity gradually increasing
- soil nutrient availability (notably nitrogen and phosphorus) at a minimum
- light intensity at ground level decreased to a minimum, although the shrub layer is more open than previously
- soil moisture relatively low.

Established

140+ years after fire

Indeterminate length: 0.7% of age span, 0.7% of maximum desirable fire interval

During this stage:

- the vegetation is unlikely to change into another vegetation community in the long-term absence of fire
- eucalypt canopy noticeably open, but the few large remnant trees vigorously flowering, with spreading canopies, occasional deaths replaced by infrequent germination into gaps
- if *Callitris* species present, these increasing in cover (to local dominance in the canopy or major shrub stratum)
- above-ground species diversity high and stable
- no further germination or establishment of bradysporous species, growth rates and flowering decreasing, elevated seed storage decreasing, fire-dependent mature shrubs at low density but being maintained by infrequent germination and establishment
- soil seed banks of legumes decreasing
- long-lived ericoid small shrubs at maximum density and increasing dominance in the small shrub layer
- perennial tussock-grasses dominating field layer
- annual and herbaceous species (not fire ephemerals) at greatest diversity in field layer
- litter cover re-established and being incorporated into the soil
- lichens and bryophytes at highest diversity, and may be still increasing
- hollow formation and density at a maximum
- coarse woody debris at a maximum
- soil nutrient availability (notably nitrogen and phosphorus) at a minimum
- light intensity at ground level remains at a minimum
- soil moisture relatively low.

Useful References

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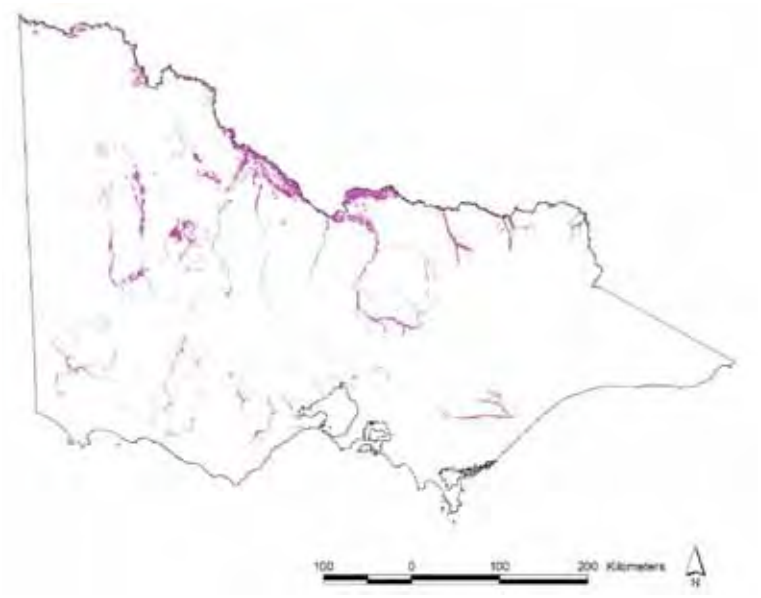
EVD 25: Riverine Woodland / Forest

Maximum	∞
Minimum (high severity)	30 years
Minimum (low severity)	10 years



In exceptional conditions (e.g. after protracted flooding and subsequent flood retreat) Riverine Woodland / Forest may burn. Although the responses to such unusual events are described below, this does not imply that fire is an appropriate management tool in this EVD. Regeneration opportunities in this vegetation depend primarily on flooding, not on fire.

Low-severity fires

Most fires in Riverine Woodland / Forest are patchy, usually leaving 20% to 40% or more of the landscape unburnt and unscorched. Such fires more readily burn the more open, grassy patches, not the more heavily wooded areas. The herbaceous component recovers rapidly and shrub encroachment or growth/regrowth is retarded in the burnt areas. Between fires, fine fuel accumulation is less in the shelter of shrubs and trees, so these tend to remain unburnt or only very lightly scorched, leading to a mosaic of burnt grassy patches and unburnt shrubby and treed patches,

High-severity fires

Most fires in Riverine Woodland / Forest are very patchy and of low severity. High-severity fires are rare but not unknown. They can severely burn the woody component, much of which is sensitive to fire and may regenerate substantially from seed, so that the full recovery of the woody component after a high-severity fire would be substantially delayed.

Renewal

0–1 year after fire

Lasts for 1 years, i.e. 0.7% of arbitrary maximum fire interval

During this stage:

- much of the ground is bare or covered by ash from the fire
- short-lived adventives (many annual, many introduced weeds) common by end of this stage
- locally stored seed germinating and making first appearance above ground
- rhizomatous monocots, such as sedges and some lightly burnt tussock-grasses, resprouting
- trees and shrubs showing first signs of buds activating, but little shoot extension
- species not flowering and mature seed largely lacking from the community
- little or no litter apart from ash
- much coarse woody debris removed by the fire
- abundant light at ground level
- soil surface pH at a maximum.

Juvenility

1–3 years after fire

Lasts for 2 years, i.e. 1.3% of arbitrary maximum fire interval

During this stage:

- bare soil decreasing to a minimum by end of stage
- short-lived adventives (many annual, many introduced weeds) common, vigorously flowering and setting seed
- native perennial herbaceous species (e.g. *Stemodia* species, *Wahlenbergia fluminalis*) resprouting in lightly burnt or unburnt areas, often locally common
- in burnt sites, native perennial species beginning to re-establish from seed coming from nearby unburnt patches
- trees resprouting from higher branches (in very low severity fires) to trunk (in more intense fires), scorched canopy being replaced
- a few shrubs regrowing from dormant protected buds (often at or below ground level), these shrubs neither flowering nor setting seed
- other (adventive) shrubs regenerating from seed (e.g. *Acacia dealbata*), neither flowering nor setting seed
- seed bank of all the long-lived perennial species largely lacking
- litter quantity low, but gradually accumulating
- coarse woody debris scarce
- soil pH high
- light intensity at ground level high and decreasing.

Adolescence

3–8 years after fire

Lasts for 5 years, i.e. 3.3% of arbitrary maximum fire interval

During this stage:

- bare soil decreasing to a minimum early in stage
- short-lived adventives (many annual, many introduced weeds) increasingly uncommon, with a restored local seed bank
- native perennial herbaceous species (e.g. *Stemodia* species, *Wahlenbergia fluminalis*) resprouting in lightly burnt or unburnt areas, often locally common
- in burnt sites, native perennial herb species re-established from seed coming from nearby unburnt patches
- trees canopies recovered (in low severity fires), scorched canopy replaced, trees in areas burnt by high severity fires still recovering
- a few shrubs regrowing from dormant protected buds (often at or below ground level), these shrubs first flowering by end of this stage, no local seed bank
- perennial shrubs characteristic of riverine environments (e.g. *Stelligera* species, *Malacocera* species., *Muehlenbeckia* species.) uncommon to rare, re-establishing from seed brought into the burnt sites from nearby unburnt patches
- other (adventive) shrubs regenerating from seed (e.g. *Acacia dealbata*), first flowering and seed set
- seed bank of all the long-lived perennial species largely lacking
- litter quantity low, but gradually accumulating
- coarse woody debris scarce
- soil pH returning to typical pre-fire level
- light intensity at ground level decreasing
- other regeneration dependent on flooding (without floods, recovery continuing slowly).

Early Maturity

8–20 years after fire

Lasts for 12 years, i.e. 8% of arbitrary maximum fire interval

During this stage:

- bare soil decreasing to a minimum early in stage
- short-lived adventives (many annual, many introduced weeds) locally rare, with a restored local seed bank
- native perennial herbaceous species (e.g. *Stemodia* species, *Wahlenbergia fluminalis*) common throughout, often locally common
- native perennial herb species re-established in burnt areas from seed coming from nearby unburnt patches
- native perennial grasses and other monocots well-established in open patches.
- tree canopies recovered, scorched canopy replaced, trees in areas burnt by high severity fires largely recovered
- shrubs regrown from dormant protected buds, often at or below ground level (e.g. *Exocarpos strictus*), these shrubs flowering and setting seed, local seed bank replaced
- perennial shrubs characteristic of riverine environments (e.g. *Eremophila divaricata, Stelligera* species, *Malacocera* species, *Muehlenbeckia* species.) re-establishing in burnt areas from seed coming from nearby unburnt patches
- other (adventive) shrubs and understorey trees (e.g. *Acacia dealbata, Acacia salicina, Acacia stenophylla*) well-established and vigorously growing, flowering and setting seed
- large shrubs and understorey trees beginning to spread rhizomatously (by root suckering) by end of this stage
- seed bank of all the long-lived perennial species recovered
- litter quantity accumulating
- coarse woody debris scarce
- soil pH returned to typical pre-fire level
- light intensity at ground level decreased to a minimum
- other regeneration dependent on flooding (without floods, recovery continuing slowly).

Maturity

20–120 years after fire

Lasts indefinitely: 67% of arbitrary maximum fire interval

During this stage:

- little bare soil, but somewhat more than in previous stage
- canopy cover at a maximum
- re-established soil seed bank for all herbaceous component species
- short-lived adventives (many annual, many introduced weeds) locally rare, with a restored local seed bank
- native perennial herbaceous species (e.g. *Stemodia* species, *Wahlenbergia fluminalis*) common throughout, often locally common
- native perennial grasses and other monocots well-established in open patches
- shrubs regrown from dormant protected buds, often at or below ground level (e.g. *Exocarpos strictus*), these shrubs flowering and setting seed, local seed bank replaced
- perennial shrubs characteristic of riverine environments (e.g. *Eremophila divaricata, Stelligera* species, *Malacocera* species, *Muehlenbeckia* species.) re-establishing in burnt areas from seed coming from nearby unburnt patches
- other shrubs and understorey trees well-established and vigorously growing (e.g. *Acacia dealbata, Acacia salicina, Acacia stenophylla*), flowering and setting seed
- adequate seed bank of shrubs and trees re-established
- litter accumulating, being slowly incorporated into soil
- coarse woody debris scarce but increasing throughout stage
- tree-hollows established by end of stage
- soil pH returned to typical pre-fire levels
- light intensity at ground level low
- other regeneration dependent on flooding (without floods, recovering continuing slowly).

Riverine Woodland/Forest EVD 25, long unburnt, Echuca, Victoria.

Riverine Woodland/Forest EVD 25, flooded and long unburnt, Lake Lockie, Hattah–Kulkyne National Park, Victoria.

Established

120–150+ years after fire

Lasts indefinitely: 20% of arbitrary maximum fire interval

During this stage:

- little bare soil, but somewhat more than in early maturity stage
- canopy cover at a maximum
- re-established soil seed bank for all herbaceous component species
- short-lived adventives (many annual, many introduced weeds) locally rare, with a restored local seed bank
- native perennial herbaceous species (e.g. *Stemodia* species, *Wahlenbergia fluminalis*) common throughout, often locally common
- native perennial grasses and other monocots well-established in open patches.
- shrubs regrown from dormant protected buds, often at or below ground level (e.g. *Exocarpos strictus*), these shrubs flowering and setting seed, local seed bank replaced
- perennial shrubs characteristic of riverine environments (e.g. *Eremophila divaricata, Stelligera* species, *Malacocera* species, *Muehlenbeckia* species.) re-established, often locally dominant in the shrub strata
- other shrubs and understorey trees established (e.g. *Acacia dealbata, Acacia salicina, Acacia stenophylla*), flowering and setting seed
- adequate seed bank of shrubs and trees re-established
- litter accumulating, being slowly incorporated into soil
- coarse woody debris common throughout
- tree-hollows well-established (a feature of this stage)
- soil pH returned to typical pre-fire level
- light intensity at ground level low
- other regeneration dependent on flooding (without floods, recovery continuing slowly).

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EVD 26: Freshwater Wetland (ephemeral)

Maximum	∞
Minimum (high severity)	2 years
Minimum (low severity)	2 years

In exceptional conditions (notably in the first two seasons after floodwaters have receded) an abundant growth of short-lived grasses may enable a fire of very low severity to occur in this EVD. Such a fire may enable further fires to occur by promoting a fresh growth of the same short-lived grasses. Although the responses to such an unusual event are described below, this does not imply that fire is an appropriate management tool in this EVD. Regeneration opportunities in this vegetation are primarily dependent on water supply from rainfall, flooding or ground water, not on fire.

Renewal

0–1 year after fire

Lasts for 1 years, i.e.
0.7% of arbitrary maximum fire interval

During this stage:

- much of the burnt ground is bare, but the ground in some areas may be unburnt or inundated
- soil-stored seed and seed coming from unburnt patches nearby is germinating and making first appearance above ground
- short-lived grasses that carried the fire abundantly germinating and re-establishing
- trees and shrubs (if present) showing first signs of buds activating, (usually from subterranean protected buds), but little shoot extension
- few shrubs burnt (grasses that carried the fire were largely restricted to inter-shrub gaps)
- species not flowering and mature seed largely lacking
- little or no litter apart from a little ash
- abundant light at ground level
- soil surface pH at a maximum.

Maturity

1–150+ years after fire

Lasts indefinitely: 99.3% of arbitrary maximum fire interval

During this stage:

- very little bare soil soon after fire, and soon after flooding
- much bare soil cover for extended periods between floods
- canopy cover very variable, from <1% to over 60%
- re-established soil seed bank for all herbaceous and shrubby component species
- resprouting (trees and shrubs (if present) vigorously growing, rapid shoot extension
- shrubs and trees (if present) flowering and setting seed
- adequate seed bank of shrubs and trees (if present) re-established by two years after fire
- tree and shrub seedlings (if parent plants present pre-fire) may be scattered throughout
- litter accumulating, being slowly incorporated into the ecosystem
- light intensity at ground level very variable (from complete exposure to moderately low when under a dense shrub cover).

Freshwater Wetland (ephemeral) EVD 26, unburnt and flooded six years ago, Lake Cooper, Victoria.

Freshwater Wetland (ephemeral) EVD 26, unburnt and flooded two years ago, Barmah, Victoria.

(PHOTO COURTESY DOUG FROOD)

Useful References

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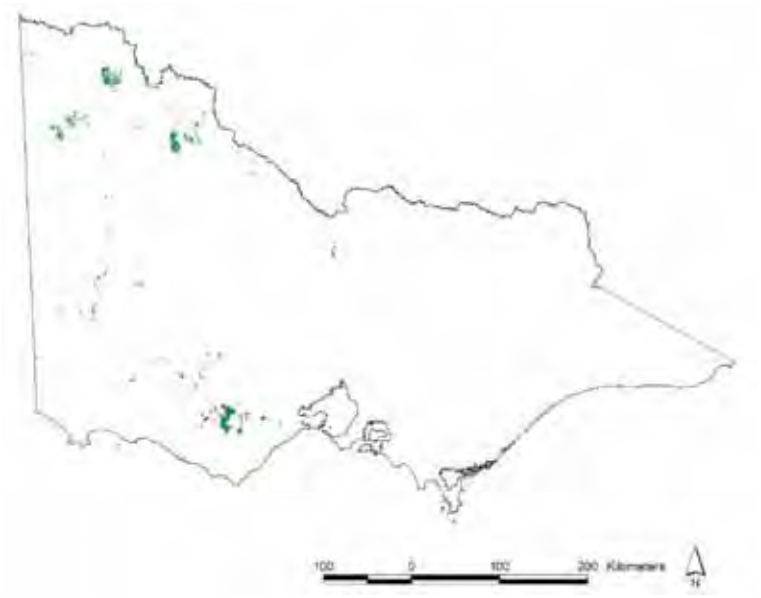
EVD 27: Saline Wetland

Maximum	∞
Minimum (high severity)	20 years
Minimum (low severity)	10 years



In exceptional conditions (e.g. after protracted summer rains) Saline Wetland may burn. Although the responses to such an unusual event are described below, this does not imply that fire is an appropriate management tool in this EVD.

Saline Wetland EVD 27, unburnt, Cowangie, Victoria.

Renewal

0–1 year after fire

Lasts for 1 years, i.e. 0.7% of arbitrary maximum fire interval

During this stage:

- much of the ground is bare or covered by ash from the fire, but may be exposed salt deposits or inundated
- seed from the short-term seed bank or nearby refuges germinating and making first appearance above ground
- shrubs (if present) showing first signs of buds activating, but little shoot extension
- species not flowering and mature seed largely lacking
- little or no litter apart from ash
- abundant light at ground level
- soil surface pH high.

Juvenility

1–5 years after fire

Lasts for 4 years, i.e. 3% of arbitrary maximum fire interval

During this stage:

- much of the ground is bare or covered by ash from the fire, but may be exposed salt deposits or inundated
- abundant growth of ecologically catholic adventives in less saline habitats, e.g. along margins or on small mounds at bases of burnt samphire shrubs
- slow regrowth of dominant species, from resprouting dormant subterranean rhizomes and seed coming from nearby refuges
- herbs and sub-shrubs typical of saline environments abundantly re-establishing from seed
- neither flowering nor seed of any pre-fire shrubs
- terrestrial lichens not visible
- surface algae common
- litter quantity low
- abundant light at ground level.

Adolescence

5–15 years after fire

Lasts for 10 years, i.e. 7% of arbitrary maximum fire interval

During this stage:

- much of the ground is bare, but may be exposed salt deposits or inundated
- ecologically catholic adventives becoming less common and physically smaller, to essential disappearance from the vegetation
- dominant shrubs (mostly succulent chenopods) vigorously growing and starting to flower and set seed, canopies still with emergent dead plant material
- herbs and sub-shrubs typical of saline environments re-established, flowering setting seed
- terrestrial lichens slowly recovering
- surface algae common
- litter quantity low but increased from previous stage
- abundant light in inter-shrub spaces, but light intensity under shrubs decreasing.

Maturity

15–150+ years after fire

Lasts indefinitely: 90% of arbitrary maximum fire interval

During this stage:

- bare soil restricted to inter-shrub spaces
- ecologically catholic adventives at minimal species diversity and abundances
- shrubby canopy cover at maximum, but usually < 20% in inland saline shrubland and < 60% in coastal saline shrubland)
- re-established local seed bank for all component species, although scant long-term soil seed bank
- all obligate saline species flowering and setting ample seed
- terrestrial lichens recovered and common under shrub canopies, within canopies on elevated wood and habitats above salt-crusted or soil frequently inundated by saline water
- litter accumulating, being slowly incorporated into the ecosystem
- abundant light in inter-shrub spaces, but light intensity under shrubs at a minimum.

Useful References

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EVD 28: Chenopod Shrubland

Maximum	∞
Minimum (high severity)	30 years
Minimum (low severity)	30 years

In most seasons the fuel conditions prevent fires in Chenopod Shrubland, but in exceptional conditions (e.g. after protracted summer rains and vigorous growth of annual grasses) this vegetation may burn. Although the responses to such an unusual event are described below, this does not imply that fire is an appropriate management tool in this EVD.

Renewal

0–2 years after fire

Lasts for 2 years, i.e. 1.3% of arbitrary maximum fire interval

During this stage:

- much of the ground is bare or covered by ash from the fire
- seed (from the short-term seed bank, or blown or brought in from nearby refuges) germinating and making first appearance above ground
- abundant growth of annuals, flowering and setting seed by the end of the first season post-fire
- many annual and other short-lived (introduced) weeds present and vigorous
- chenopod shrubs showing first signs of subterranean buds activating, but little shoot extension
- perennial species not flowering and mature seed largely lacking from the community
- little or no litter (apart from ash)
- abundant light at ground level
- soil surface pH high.

Juvenility

2–12 years after fire

Lasts for 10 years, i.e. 7% of arbitrary maximum fire interval

During this stage:

- bare ground is at a minimum, ash from the fire decreasing
- abundant growth of ecologically catholic adventives, particularly on small mounds of soil at bases of burnt dominants
- slow regrowth of dominant species, mainly from resprouting dormant subterranean woody tissue, smaller number of germinants from seed coming from nearby unburnt patches
- short-lived perennial chenopod shrubs (e.g. *Atriplex* species) common, flowering and fruiting
- little flowering nor seed of any pre-fire dominant shrubs
- terrestrial lichens and bryophytes scarce
- litter quantity low
- abundant light at ground level.

Adolescence

12–30 years after fire

Lasts for 18 years, i.e. 12% of arbitrary maximum fire interval

During this stage:

- bare ground is gradually increasing, ash from the fire no longer visible
- growth of ecologically catholic adventives decreasing and largely restricted to scattered in the inter-shrub spaces or the margins of the small soil mounds at the bases of the dominant shrubs
- pre-fire dominant shrubs resuming dominance
- pre-fire dominant shrubs flowering and fruiting
- short-lived perennial chenopod shrubs (e.g. *Atriplex* species) common but decreasing, all flowering and fruiting
- crustal lichens slowly increasing in inter-shrub spaces
- bryophytes apparent on small soil mounds at bases of burnt shrubs
- litter quantity moderate
- light intensity at ground level decreasing but rarely limiting.

Maturity

30–150+ years after fire

Lasts indefinitely: 80% of arbitrary maximum fire interval

During this stage:

- bare ground decreased to a minimum but still common
- growth of ecologically catholic adventives at a minimum and restricted to winter and early spring, mostly in the inter-shrub spaces or at margins of small soil mounds at bases of burnt shrubs
- long-lived chenopod shrubs (e.g. *Maireana* species) and their ecological analogues (e.g. *Nitraria billardierei*) dominant
- dominant shrubs abundantly flowering and fruiting
- short-lived perennial chenopod shrubs (e.g. *Atriplex* species) uncommon and scattered, all flowering and fruiting
- crustal lichens relatively common in the inter-shrub spaces
- bryophytes apparent in the shelter provided by the dominant shrubs, on small soil mounds at the bases of these shrubs
- litter quantity moderate
- light at ground level at a minimum (although light is rarely limiting anywhere within this community).

Chenopod Shrubland EVD 28, unburnt, Sunset Country, Victoria.

Chenopod Shrubland EVD 28, unburnt, Morkalla, Victoria.

Chenopod Shrubland EVD 28, unburnt, Lake Tyrrell, Victoria.

(PHOTO COURTESY MATT WHITE)

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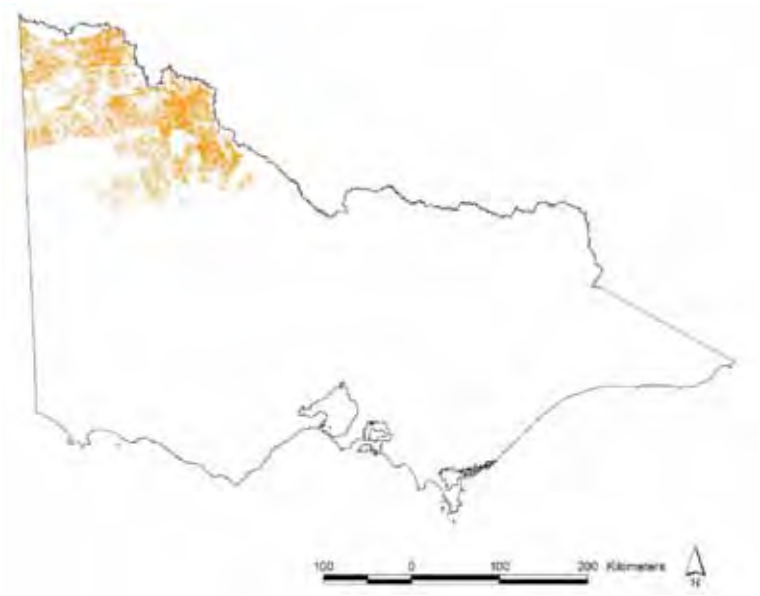
EVD 29: Saltbush Mallee

Maximum	200 years
Minimum (high severity)	40 years
Minimum (low severity)	40 years



In most seasons the fuel conditions prevent fires in Saltbush Mallee, but in exceptional conditions (e.g. after protracted summer rains and vigorous growth of annual grasses) this vegetation may burn. Although the responses to such an unusual event are described below, this does not imply that fire is an appropriate management tool in this EVD (except in the extremely long term, every 200 years or more).

Renewal

0–2 years after fire

Lasts for 2 years, i.e.
1.3% of arbitrary maximum fire interval

During this stage:

- much of the ground is bare or covered by ash from the fire
- abundant growth of annuals, flowering and setting seed by the end of the first season after fire
- many annual and other short-lived introduced weeds present and vigorous
- seed from the short-term seed bank or nearby unburnt patches germinating and making first appearance above ground
- most pre-fire chenopod shrubs killed and with scant on-site seed bank
- lightly burnt chenopods showing first signs of subterranean buds activating, but little shoot extension
- perennial species not flowering and mature seed largely lacking
- first germination in canopy eucalypts
- mature eucalypts resprouting from lignotubers
- much standing dead woody stems
- little or no litter apart from ash
- little coarse woody debris (the pre-fire material persisting after fire)
- abundant light at ground level
- soil surface pH high.

Juvenility

2–10 years after fire

Lasts for 8 years, i.e.
5.3% of arbitrary maximum fire interval

During this stage:

- bare ground and ash decreasing
- abundant growth of ecologically catholic adventives, particularly on small mounds of soil at bases of eucalypts
- small native annuals and herbs characteristic of this vegetation (e.g. native crucifers and daisies) gradually re-establishing, but still nowhere common
- slow regrowth of dominant eucalypts, mainly from resprouting lignotubers
- short-lived perennial chenopod shrubs (e.g. *Atriplex* species) and short-lived *Zygophyllum* species common, flowering and fruiting
- germinants of long-lived pre-fire common shrubs (seed coming from nearby unburnt patches) slowly growing but not dominant in any stratum
- little flowering nor seed of any pre-fire dominant shrubs
- lignotuberous eucalypt regeneration growing and first flowering by end of this stage, but no effective seed set
- no seed bank of either the dominant eucalypts or the long-lived chenopods that dominated the pre-fire shrub stratum
- terrestrial lichens and bryophytes scarce
- litter quantity low
- light intensity at ground level decreasing.

Adolescence

10–30 years after fire

Lasts for 20 years, i.e. 13.3% of arbitrary maximum fire interval

During this stage:

- bare ground is gradually increasing, ash no longer visible
- growth of ecologically catholic adventives decreasing and largely restricted to scattered on margins of small soil mounds at bases of eucalypts
- small native annuals and herbs characteristic of this vegetation (e.g. native crucifers and daisies) gradually re-establishing and becoming the most common herbs in field layer, although small herbs not common in this EVD
- short-lived perennial chenopod shrubs (e.g. *Atriplex* species) and short-lived *Zygophyllum* species decreasing, with mature seed
- germinants of long-lived pre-fire common shrubs (seed coming from nearby unburnt patches) slowly growing and assuming dominance in the low shrub stratum
- pre-fire dominant shrubs resuming dominance
- pre-fire dominant shrubs flowering and fruiting
- eucalypts resuming canopy dominance, mainly from resprouting lignotubers
- on-site eucalypt seed bank re-established
- any surviving eucalypt germinants with first flowering and seed set, and fully functioning lignotubers
- coarse woody debris at a maximum, augmented by falling stems and branches
- terrestrial lichens slowly increasing in inter-shrub spaces
- bryophytes apparent in the shelter provided by the dominant shrubs, on small soil mounds at bases of eucalypts
- litter quantity gradually increasing, although still patchy
- light intensity at ground level decreasing, but rarely limiting in this vegetation.

Saltbush Mallee EVD 29, long unburnt, Wymlet, Victoria.

Saltbush Mallee EVD 29, long unburnt, Underbool, Victoria.

Maturity

30–150+ years after fire

Lasts indefinitely: 80% of arbitrary maximum fire interval

During this stage:

- bare ground at a minimum as cryptogam crust and leaf litter accumulate and spread
- growth of ecologically catholic adventives at a minimum and restricted to winter and early spring, restricted to occasional on margins of the small soil mounds at the bases of eucalypts
- long-lived chenopod shrubs, long-lived *Zygophyllum* species and the like dominant in the shrub stratum
- dominant shrubs abundantly flowering and fruiting
- short-lived perennial chenopod shrubs (e.g. *Atriplex* species) uncommon and scattered, or apparently absent, mature seed of these shrubs and sub-shrubs
- small native annuals and herbs characteristic of this community (e.g. native crucifers and daisies) re-established and the most common herbs in the field layer, although small herbs not common in this EVD
- eucalypts dominant in the canopy
- eucalypts tending to monopodial
- on-site eucalypt seed bank re-established
- terrestrial lichens relatively common in inter-shrub spaces
- bryophytes apparent in shelter provided by dominant shrubs, on small soil mounds at bases of these shrubs
- coarse woody debris present, including small logs
- litter quantity moderate, mostly consisting of leaf litter
- light intensity at ground level at a minimum, but rarely limiting in this vegetation.

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EVD 30: Hummock-grass Mallee

Maximum	90 years
Minimum (high severity)	25 years
Minimum (low severity)	25 years

Renewal

0–1 year after fire

Lasts for 1 ± 0.5 years, i.e.
1.1% of age span, 1.1% of maximum desirable fire interval

During this stage:

- most of the ground is bare
- bradysporous species releasing seed from elevated fruit
- soil-stored seed germinating and making first appearance above ground
- resprouting species showing first signs of buds activating, but little shoot extension
- annual species abundant and larger than usual
- annual fire ephemerals vigorously growing and blooming within the first year
- renascent perennials (e.g. orchids, bulbous lilies) vigorous and blooming by end of first season
- perennial species not flowering and mature seed largely lacking from the community
- hummock-grasses (if present) re-establishing but almost insignificant in the community
- eucalypt seedlings evident, often common
- canopy of standing dead (eucalypt) stems
- first signs of eucalypt resprouting from lignotubers
- little or no litter
- soil crusts disrupted and eliminated
- soil surface barely stable and locally mobile
- limiting soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralisation of organically bound pre-fire forms)
- abundant light at ground level
- relatively high soil moisture.

Juvenility

1–4 years after fire

Lasts for 3 years, i.e. 3.3% of age span, 3.3% of maximum desirable fire interval

During this stage:

- bare soil common
- perennial fire ephemerals dominate the vigorously growing and substantially herbaceous field layer
- first flowering in perennial (i.e. > 1 year life spans) species
- annual fire ephemerals decreasing, their soil seed bank restored
- annual species abundant
- seed bank of all but the annuals and the shorter-lived fire ephemerals lacking
- bradysporous species germinating and establishing, but neither dominant nor a major component of the vegetation
- long-lived resprouting species vigorously growing, rapid shoot extension, not yet flowering
- long-lived obligate seed regenerators (e.g. most *Acacia* species) small but rapidly growing
- neither flowering nor seed of pre-fire dominant shrubs and mallees
- hummock-grasses (if present) re-establishing but largely insignificant in the community
- most eucalypt seedlings dead, a small number slowly growing in gaps but still without effective lignotubers
- canopy of standing dead eucalypt stems
- eucalypts vigorously resprouting from lignotubers
- little or no litter
- soil crusts disrupted or eliminated
- limiting soil nutrients (notably nitrogen and phosphorus) still relatively abundant
- abundant light at ground level
- relatively high soil moisture.

Hummock-grass Mallee EVD 30, one year after fire, Rocket Lake, Victoria.

Hummock-grass Mallee EVD 30, 17 years after fire, Sunset Country, Victoria.

Adolescence

4–10 years after fire

Lasts for 6 years, i.e. 6% of age span, 6% of maximum desirable fire interval

During this stage:

- longer-lived perennial fire ephemerals (e.g. *Exocarpos sparteus, Olearia lepidophylla, Olearia rudis*) decreasing, abundant soil seed bank re-established
- seasonal annuals (not fire ephemeral) re-establishing
- no further germination or establishment of bradysporous species, earlier germinants vigorously growing, mostly pre-flowering but coming into flower by the end of this phase, neither dominant nor a major component of the canopy, mature seed of these species lacking
- resprouting species vigorously growing, rapid shoot extension, first flowering in resprouters but little seed set, mature seed uncommon to lacking
- obligate seed regenerator shrubs (notably *Acacia* species) flowering and gradually restoring a soil seed bank, nevertheless mature seed of these species uncommon
- first mature seed in *Callitris verrucosa* (if present) but very few mature seed present
- seed bank of the fire ephemerals restored, but for all other groups weak or largely absent
- hummock-grasses vigorously growing, but solely as small, tight hummocks and not spreading, first flowering in *Triodia* species but little seed set
- canopy eucalypts flowering weakly by end of this phase, little or no seed set
- dead eucalypt stems emerge above the canopy
- no seed bank of pre-fire dominant mallees
- some litter accumulation, but litter still patchy and little incorporation into the soil
- dead woody stems gradually falling and contributing to the prone coarse woody debris
- first signs of restoration of soil crusts
- limiting soil nutrients (notably phosphorus) decreasing, but nitrogen relatively high in the soil from fixation from vigorous legumes
- light intensity at ground level decreasing
- soil moisture returning to normal inter-fire patterns.

Hummock-grass Mallee EVD 30, long unburnt, Sunset Country, Victoria.

Vigorous maturity

10–35 years after fire

Lasts for 25 years, i.e.
28% of age span, 28% of maximum desirable fire interval

During this stage:

- fire ephemerals occurring solely as an abundant soil seed bank
- seasonal annuals (not fire ephemeral) re-established, nowhere common
- no further germination or establishment of bradysporous species, earlier germinants vigorously growing, flowering and setting seed, elevated seed storage accumulating
- resprouting and seed regenerating species vigorously growing, flowering and with accumulating seed bank
- legumes (notably *Acacia* species) present and setting abundant seed, although density decreasing as shrubs die without replacement and remnant shrubs gradually increase in size
- hummock-grasses (if present) beginning to extend laterally but not dominant
- few mature seed on *Callitris verrucosa* (if present, still sub-dominant)
- mallees flowering and setting seed, an elevated seed bank re-established
- dead eucalypt stems fallen and part of the prone coarse woody debris
- litter accumulating, litter cover re-established and gradually being incorporated into the soil
- soil crusts re-establishing but not continuous
- limiting soil nutrients (notably nitrogen and phosphorus) decreasing
- light intensity at ground level decreased
- soil moisture returned to normal inter-fire patterns.

Stasis

35–80 years after fire

Lasts for 45 years, i.e.
50% of age span, 50% of maximum desirable fire interval

During this stage:

- fire ephemerals occurring solely as an abundant soil seed bank
- seasonal annuals (not fire ephemeral) re-established, nowhere common
- no further germination or establishment of bradysporous species, earlier germinants gradually decreasing in density as shrubs die without replacement, elevated seed storage static to decreasing
- legumes (notably *Acacia* species) decreasing to disappearance, present only or largely in the soil seed bank
- species able to regenerate in the absence of fire (e.g. *Beyeria opaca, Olearia muelleri*) slowly increasing in abundance
- hummock-grasses dominant and more or less continuous in field layer
- mature seed on *Callitris verrucosa* (if present, reaching canopy and sometimes codominant)
- mallees flowering and setting seed, an elevated seed bank re-established
- dead eucalypt stems fallen and part of the prone coarse woody debris
- canopy dominance (cover) static and maximum
- mallee eucalypts dominant or codominant, vigorously flowering and with maximum elevated seed bank
- litter cover re-established and being incorporated into the soil
- soil crusts re-established, may be continuous
- soil nutrient availability (notably nitrogen and phosphorus) at a minimum
- light at ground level (outside grass hummocks) gradually increasing
- soil moisture returned to normal inter-fire patterns.

Senescence

80+ years after fire

Indeterminate length 11+% of age span, 11+% of maximum desirable fire interval

During this stage:

- community gradually opening out
- fire ephemerals occurring solely as an abundant soil seed bank
- seasonal annuals (not fire ephemeral) re-established, gradually increasing in inter-hummock spaces, may become locally common
- above-ground perennial species diversity low
- no further germination or establishment of bradysporous species, growth rates and flowering decreasing, elevated seed storage decreasing
- legumes largely apparently absent, retreated to the soil seed bank
- long-lived species able to regenerate in the absence of fire (e.g. *Beyeria opaca, Olearia muelleri*) maintaining low density in the vegetation
- few chenopod species (e.g. *Maireana pentatropis, Sclerolaena diacantha*) but gradually increasing in abundance
- eucalypt density decreasing, with few large scattered individuals, tree-hollows at maximum abundance
- inter-crown canopy gaps increasing
- litter cover re-established and being incorporated into the soil
- soil crusts re-established, may be continuous
- soil nutrient availability (notably nitrogen and phosphorus) at a minimum
- soil moisture relatively low.

Useful References

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EVD 31: Lowan Mallee

Maximum	65 years
Minimum (high severity)	20 years
Minimum (low severity)	20 years

Renewal

0–1 year after fire

Lasts for 1 ± 0.5 years, i.e.
1.5% of age span, 1.5% of maximum desirable fire interval

During this stage:

- most of the ground is bare
- bradysporous species releasing seed from elevated fruit
- soil-stored seed germinating and making first appearance above ground
- resprouting species showing first signs of buds activating, but little shoot extension
- annual species abundant and larger than usual
- annual fire ephemerals vigorously growing and blooming within the first year
- renascent perennials (e.g. orchids, bulbous lilies) vigorous and flowering by end of first season
- perennial species not flowering and mature seed largely lacking
- hummock-grasses (if present) re-establishing but almost insignificant
- little or no litter
- soil crusts disrupted and eliminated
- soil surface barely stable and locally mobile
- limiting soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralisation of organically bound pre-fire forms)
- abundant light at ground level
- relatively high soil moisture.

Juvenility

1–3 years after fire

Lasts for 2 ± 0.5 years, i.e. 3% of age span, 3% of maximum desirable fire interval

During this stage:

- most of the ground is still bare
- perennial fire ephemerals dominate a vigorously growing and substantially herbaceous field layer
- first flowering in perennial (i.e. > 1 year life span) species
- annual fire ephemerals decreasing, their soil seed bank restored
- annual species abundant
- seed bank of all but the annuals and the shorter-lived fire ephemerals lacking
- bradysporous species germinating and establishing, but neither dominant nor a major component of the canopy
- resprouting species vigorously growing, rapid shoot extension, not yet flowering
- long-lived obligate seed regenerators (e.g. most *Acacia* species) small but rapidly growing
- neither flowering nor seed of pre-fire dominant shrubs and mallees
- hummock-grasses (if present) re-establishing but largely insignificant in the community
- little or no litter
- soil crusts disrupted or eliminated
- limiting soil nutrients (notably nitrogen and phosphorus) relatively abundant
- abundant light at ground level
- relatively high soil moisture.

Adolescence

3–9 years after fire

Lasts for 6 years, i.e. 9% of age span, 9% of maximum desirable fire interval

During this stage:

- longer-lived perennial fire ephemerals (e.g. *Codonocarpus cotinifolius, Exocarpos sparteus*) common and vigorously flowering, setting abundant seed
- no further germination or establishment of bradysporous species, earlier germinants vigorously growing, mostly pre-flowering but coming into flower by the end of this phase, neither dominant nor a major component of the canopy, mature seed of these species lacking
- resprouting species vigorously growing, rapid shoot extension, first flowering in resprouters but little seed set, mature seed uncommon to lacking
- obligate seed regenerator shrubs flowering and restoring a seed bank
- first mature seed in *Callitris verrucosa* (if present) but very few mature seed present
- seed bank of the fire ephemerals restored, but for all other groups weak or largely absent
- canopy eucalypts flowering weakly by end of this phase, little or no seed set
- no seed bank of pre-fire dominant mallees
- hummock-grasses vigorously growing, but solely as small, tight hummocks and not spreading, first flowering in *Triodia* species but little seed set
- some litter accumulation, but litter still patchy and little incorporation into the soil
- soil crusts disrupted or eliminated, first signs of restoration of bryophytes
- limiting soil nutrients (notably nitrogen and phosphorus) decreasing (from mineralisation of organically bound pre-fire forms and vigorous post-fire fixation from legumes)
- light intensity at ground level decreasing
- soil moisture returning to normal inter-fire patterns.

Vigorous maturity

9–24 years after fire

Lasts for 15 years, i.e. 23% of age span, 23% of maximum desirable fire interval

During this stage:

- maximum canopy dominance
- except for longest-lived (e.g. *Codonocarpus cotinifolius*), fire ephemerals retreated to soil seed bank
- no further germination or establishment of bradysporous species, earlier germinants vigorously growing, flowering and setting seed, elevated seed storage accumulating
- resprouting and seed regenerating species vigorously growing, flowering and with accumulating seed bank
- legumes (notably *Acacia* species) vigorously growing and setting abundant seed (often dominant in lower shrub layer)
- annuals present but not common
- hummock grasses (if present) beginning to extend laterally but not (yet) dominant
- mallees flowering and setting seed, re-establishing an elevated seed bank
- litter accumulating, litter cover re-established and gradually being incorporated into the soil
- soil crusts re-establishing, but not yet continuous in open patches
- limiting soil nutrients (notably nitrogen and phosphorus) decreasing
- light intensity at ground level decreased
- soil moisture returned to normal inter-fire patterns.

Stasis

24–60 years after fire

Lasts for 36 years, i.e. 55% of age span, 55% of maximum desirable fire interval

During this stage:

- canopy dominance (cover) static and maximum
- mallee eucalypts dominant or codominant, vigorously flowering and with maximum elevated seed bank
- annual species (not fire ephemerals) common in the field layer
- all fire ephemerals retreated to the soil seed bank
- no further germination or establishment of bradysporous species, growth rates decreasing, but vigorously flowering and setting seed, elevated seed storage at a maximum
- density of seed regenerating species decreasing, continuing flowering and seed set in (increasingly uncommon) remnant individuals
- resprouting shrubs surviving (but growth rates decreasing), density static (deaths balance new ramets)
- if *Callitris verrucosa* present, codominant with mallee eucalypts and with maximum elevated seed bank
- hummock-grasses (if present) at maximum cover and extent
- litter cover re-established and being incorporated into the soil
- soil crusts re-established, may be continuous
- soil nutrient availability (notably nitrogen and phosphorus) at a minimum
- light intensity at ground level (outside grass-hummocks) gradually increasing
- soil moisture relatively low.

Senescence

60+ years after fire

Indeterminate length
8+% of age span, 8+% of maximum desirable fire interval

During this stage:

- community gradually opening out
- above-ground species diversity low and dominated by annual species
- eucalypt density decreasing, few large scattered individuals, tree-hollows at maximum abundance
- no further germination or establishment of bradysporous species, growth rates and flowering decreasing, elevated seed storage decreasing
- resprouting shrubs with reduced growth (may be declining), flowering and seed set decreasing
- if long-lived non-heath dominants present in community (notably *Callitris verrucosa*) then their dominance increases, as the other non-eucalypt shrubs decrease in abundance and species diversity
- long-lived sedges and the like still with high cover values, but low growth rates and accumulating dead stems and foliage
- hummock-grass cover and abundance decreasing, scant flowering
- field layer increasingly dominated by annual species
- few chenopod species (e.g. *Sclerolaena diacantha*) but gradually increasing in abundance
- litter cover re-established and being incorporated into the soil
- soil crusts re-established, may be continuous
- soil nutrient availability (notably nitrogen and phosphorus) at a minimum
- soil moisture relatively low.

Lowan Mallee EVD 31, eight months after fire, Sunset Country, Victoria.

Lowan Mallee EVD 31, 20 years after fire, Sunset Country, Victoria.

Lowan Mallee EVD 31, 24 years after fire, Wyperfeld National Park, Victoria.

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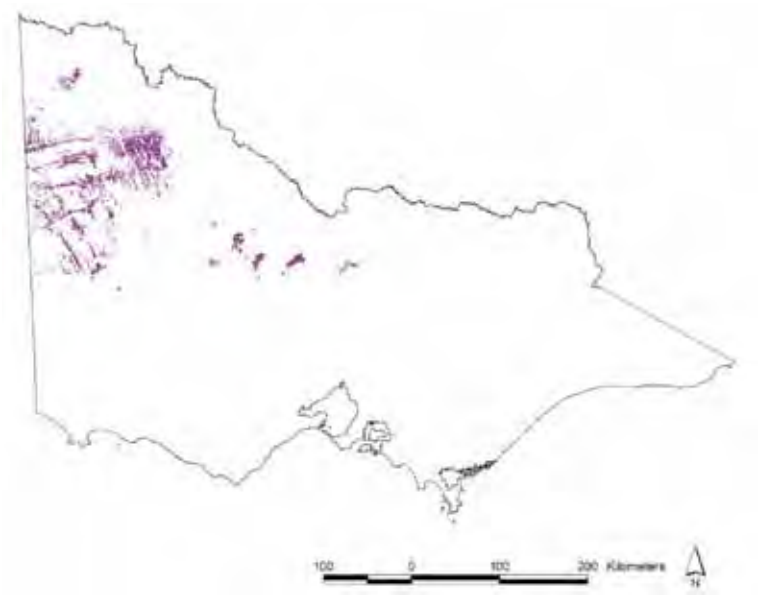
EVD 32: Broombrush Whipstick

Maximum	90 years
Minimum (high severity)	20 years
Minimum (low severity)	20 years



Renewal

0–0.5 years after fire

Lasts for 0.5 ± 0.25 years, i.e.
0.5% of age span, 0.5% of maximum desirable fire interval

During this stage:

- most of the ground is bare
- bradysporous species releasing seed from elevated fruit
- soil-stored seed germinating and making first appearance above ground
- resprouting species showing first signs of buds activating, but little shoot extension
- species not flowering and mature seed largely lacking
- little or no litter
- soil crusts disrupted or eliminated
- limiting soil nutrients (notably nitrogen and phosphorus) relatively abundant (from mineralisation of organically bound pre-fire forms)
- abundant light at ground level
- relatively high soil moisture.

Juvenility

0.5–2.5 years after fire

Lasts for 2 ± 0.5 years, i.e.
2% of age span, 2% of maximum desirable fire interval

During this stage:

- most of the ground is still bare
- ephemerals (including fire ephemerals) dominate a vigorously growing and substantially herbaceous field layer
- abundant growth of very small seasonal ephemerals (less than 2 cm tall)
- bradysporous species germinating and establishing, but neither dominant nor a major component of the canopy
- resprouting species vigorously growing, largely from the base or from below ground level, rapid shoot extension
- eucalypts (if present) with rapid lignotuberous resprouting, eucalypt seedlings rare
- herbaceous fire ephemerals and annuals with first seed set
- seed bank of all but the annuals and the shorter-lived fire ephemerals lacking
- neither flowering nor seed of pre-fire dominant shrubs
- little or no litter
- soil crusts disrupted or eliminated
- limiting soil nutrients (notably nitrogen and phosphorus) relatively abundant
- abundant light at ground level
- relatively high soil moisture.

Adolescence

2.5–10.5 years after fire

Lasts for 8 years, i.e.
9% of age span, 9% of maximum desirable fire interval

During this stage:

- canopy low in height but closing to reach maximum fire cover
- most fire ephemerals retreated to the soil seed bank (a few longer-lived, shrubby fire ephemerals fully reproductive)
- no further germination or establishment of bradysporous species, earlier germinants vigorously growing, mostly pre-flowering and neither dominant nor a major component of the canopy, mature seed lacking in the community
- legume cover and vigour, including *Acacia* species, at a maximum and may dominate the canopy
- resprouting species vigorously growing (including *Eucalyptus* species, if present), rapid shoot extension, first flowering in resprouters but little or no seed set, mature seed lacking in the community
- seed bank of the fire ephemerals restored, but for all other groups largely absent
- no seed of the (pre-fire) dominant shrubs
- some litter accumulation, but still patchy and little incorporation into soil
- soil crusts disrupted or eliminated
- limiting soil nutrients (notably nitrogen and phosphorus) relatively abundant but decreasing
- light intensity at ground level decreased to a minimum (although still high when compared with other communities)
- soil moisture returned to normal pre-fire patterns.

Vigorous maturity

10.5–40.5 years after fire

Lasts for 30 years, i.e.
30% of age span, 30% of maximum desirable fire interval

During this stage:

- canopy closure complete (at maximum canopy dominance)
- fire ephemerals all retreated to soil seed bank
- no further germination or establishment of bradysporous species, earlier germinants vigorously growing, flowering and setting seed, elevated seed bank restored
- maximum shrub species diversity and (above-ground) diversity
- resprouting species (including *Eucalyptus* species if present) vigorously growing, flowering and with restored seed bank
- litter accumulating, litter cover restored and gradually being incorporated into soil
- soil crusts re-established and more or less continuous in open inter-shrub spaces
- limiting soil nutrients (notably nitrogen and phosphorus) decreasing
- light intensity at ground level at minimum
- soil moisture returned to normal pre-fire patterns.

Stasis

40.5–80 years after fire

Lasts for 40 years, i.e.
44.5% of age span, 44.5% of maximum desirable fire interval

During this stage:

- canopy closure stable or slowly decreasing (from maximum canopy dominance)
- annual species (not fire ephemerals) at high species diversity and high abundance, but low cover in the field layer, mostly very short-lived and very small
- no further germination or establishment of resprouting bradysporous species, growth rates decreasing, but flowering and seed set continuing, elevated seed storage at a maximum
- long-lived obligate seed regenerating tall shrubs decreasing in abundance, but a few large individuals persist
- low shrubs (less than 1 m tall) uncommon to rare
- *Eucalyptus* (if present) canopy cover at a maximum and may dominate to the exclusion of most other shrubs
- litter cover re-established and being incorporated into soil
- soil crusts re-established, may be continuous in inter-shrub spaces
- soil nutrient availability (notably nitrogen and phosphorus) relatively low
- light intensity at ground level at minimum
- soil moisture relatively low.

Waning

80+ years after fire

Indeterminate length
14% and beyond maximum desirable fire interval

During this stage:

- stands including *Eucalyptus* species in the canopy may mature irreversibly into a low open-woodland
- canopy of sclerophyllous shrubs or mallees becoming noticeably more open
- above-ground woody species diversity at a minimum (except compared to immediately post-fire)
- small (micro-)annual species (not fire ephemerals) common in the field layer
- tussock grasses uncommon, but noticeable for first time
- low shrub layer (< 2 m tall) very sparse to largely absent
- no further germination or establishment of bradysporous species, growth rates and flowering decreasing, elevated seed storage decreasing
- resprouting shrubs with reduced growth; flowering and seed set decreasing
- soil seed banks decreasing, some species (such as the legumes) disappearing from the soil seed bank
- litter cover re-established and being incorporated into the soil
- soil crusts re-established, decreasing in cover as litter build-up continues
- soil nutrient availability (notably nitrogen and phosphorus) at a minimum
- light intensity at ground level slowly increasing
- soil moisture relatively low.

Broombush Whipstick EVD 32, immediately after fire, Wyperfeld National Park, Victoria.

Broombush Whipstick EVD 32, 17 years after fire, Wyperfeld National Park, Victoria.

Broombush Whipstick EVD 32, long unburnt, Little Desert National Park, Victoria.

(PHOTO COURTESY MATT WHITE)

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The 2003 bushfire event at Mount McKay Victoria was of conservation concern as it is one of the few locations known for the habitat of the Mountain Pygmy-possum (*Burramys parvus*). The possum lives amongst rock boulders and survivors were found (insert).

(PHOTOGRAPHY COURTESY DEPARTMENT OF SUSTAINABILITY AND ENVIRONMENT).

Chapter 5
Considerations, Assumptions and Caveats

Section 5 Considerations, Assumptions and Caveats

Considerations

The application of fire to the landscape must be based on the best available knowledge, although it is recognised that knowledge gaps will exist when deciding on targets for achieving ecological fire regimes. Some of the ecological aspects of fire that should be considered in fire management and planning are outlined below:

- ***The Adaptive Experimental Framework or 'learning by doing' (Oglethorpe 2000) can be used to guide fire management activities that are consistent with achieving desired ecological outcomes.*** This framework enables us to apply a fire regime that is informed by the best available ecological knowledge, but also accommodates ongoing improvements to our knowledge base through learning from our actions.
- ***Some vegetation types will change into other vegetation communities in the long-term absence of fire, or when fire is applied at too-frequent intervals.*** This may or may not be desirable and will occur at different rates in different vegetation communities. The time it may take to irreversibly change from one vegetation type to another ranges from a few years (e.g. in Basalt Grasslands) to many centuries (e.g. in Tall Mist Forest).
- ***Bushfires (unplanned fires) will continue to occur.*** No matter how careful and how efficient we become at managing for a particular desired fire regime or for facilitating suppression activities, climatic conditions will always occur from time to time that promote unavoidable bushfire outbreaks.
- ***Within the one vegetation community, species responses to fire vary.*** Some species will benefit from short intervals between fires, but others may require longer intervals between fires within a particular EVD. A balance of introduced fire frequencies across all EVDs in a landscape will need to be considered.
- ***Early growth stages can be created far more easily than can late (mature) stages.*** Recently burnt vegetation can be created in a single season. Some important habitat features occur only in mature to senescent vegetation and thus take decades, or even centuries, to develop.
- ***Small and isolated vegetation (community) stands pose particular difficulties in fire regime management.*** The likelihood of the whole stand of a particular vegetation community being burnt if that stand is small and isolated is greatly increased. Component species that may require unburnt vegetation as a refuge will be eliminated locally, and may be unable to re-establish naturally from distant unburnt refuges.
- ***Planned fires are not usually applied in the hotter and drier times of the year.*** Low-intensity fires are not a complete surrogate for high-intensity summer or early autumn fires. The burning pattern outcomes of natural bushfires are not replicated with low-intensity planned fires.
- ***Maximum conservation value is achieved with a variable fire regime*** (Bradstock *et al.* 1995, 1996). Applied fire regimes that reduce landscape variability can adversely affect conservation outcomes. Maximum habitat diversity includes a consideration of variance in the fire regime(s).

Assumptions and caveats when using data presented in this report

Data coverage and accuracy

The use of DSE's Flora Information System data and the application of geographic information systems to identify plant records within mapped EVC polygons (and thus select known or likely KFRS) may not be without some data issues, these include:

1. The EVC mapping unit may be incorrectly classified.
2. For some EVCs, there is insufficient data for likely KFRS to accurately assign maximum and minimum tolerable fire intervals.

3. The historic quadrat records available for a particular EVC polygon do not accurately represent the typical floristic communities of that EVC (see below).
4. Different populations of the same species may respond differently to fire in different habitats or different parts of their range.

Plant survey quadrats are usually placed precisely, often in homogeneous vegetation. However, in some instances the quadrat may have been placed in the landscape where vegetation changes in space or varies from the surrounding vegetation (see also below). Quadrat records are often geographically accurate to within a few metres. However, EVC polygon mapping scale varies, often around 1 : 25000 to 1 : 100000. At these scales, small stands of vegetation types different to the dominant surrounding vegetation (and too small to be mapped at that scale) will be mapped within the EVC polygon. Thus, some quadrats within the FIS may record species that are not typical of the large EVC polygon. This error was identified by Cheal (2004), who discovered on close examination that 3 of the 11 species selected as KFRS by Wouters *et al*. (2000) for a particular EVC were not typical residents of that EVC.

The reservations on data quality discussed above are not an exhaustive list. Recent curation of the Vital Attributes data set revealed data that were directly contradictory. For example, Vegetation Regeneration for *Acacia spinescens* was recorded as both category 'W' (mature remain mature post-fire) and category 'Y' (mature become juvenile post-fire). An assessment was made of these data and the species was categorised as 'Y' (although retaining the indication of contrary data and referring to that data source). Contradictory data were not uncommon within the Vital Attributes data set. These, and other imprecise data, compel a precautionary approach (Kriebel *et al*. 2001) to the recommended fire intervals.

The data effects discussed above are not additive (i.e. a precautionary 25% plus a further precautionary 25% plus a further precautionary 35% do not total a variation of 85% in the specified value). A variation of 25% or 35% was selected as a reasonable first approximation accommodation of data imprecision and variability. Further research should render the data more accurate and more precise (Sokal and Rohlf 1995), and will lead to recommended fire intervals less governed by a precautionary approach.

Vegetation heterogeneity

Native vegetation is a continuum of growth stages, and species are not distributed evenly in space and time. However, our planning processes assume a certain internal homogeneity (consistency) within mapped vegetation polygons. Growth stages (such as maturation times) vary with growing conditions and species compositions throughout a single stand of a vegetation community. Data derived from an area within a vegetation stand that has relatively benign growing conditions, or after benign growing seasons, will not equally apply to elsewhere within the same stand where growing conditions are less benign or after more unfavourable seasonal conditions. But the data entered into the Vital Attributes data set have no indication as to whether they were collected under challenging or unfavourable conditions.

Effect on the data – *Maturation stages derived from life history transition stages in the Vital Attributes data set were augmented by approximately 25% when these data were used to derive fire intervals for the contingent EVDs.*

Consistent growth rates

As with distribution, plant species do not have consistent growth rates. In drier years or on poorer sites, species grow less quickly and maturation through the various growth stages is delayed. Yet the data that were entered into the Vital Attributes data set have no indication as to whether they were collected under unfavourable or benign conditions for that species – whether the timings entered apply to a vigorously growing individual or to a population subject to harsh conditions and hence delayed maturation.

Effect on the data *– Maturation stages derived from life history transition stages in the Vital Attributes data set were augmented by approximately 25% when these data were used to derive fire intervals for the contingent EVDs.*

Vegetation one year after 2007 bushfire showing early stage of regrowth and regeneration, North of Woods Point township, Victoria.

(PHOTO COURTESY STEPHEN PLATT)

Vegetation many years after last bushfire showing regrowth of vegetation intermixed with dead tree stands, Lake Mountain, Victoria.

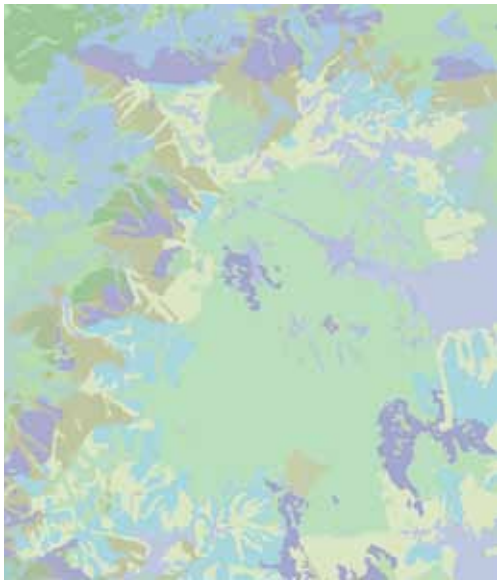
(PHOTO COURTESY STEPHEN PLATT)

Compositional variation within EVCs, and grouping to EVDs

EVCs vary in species composition and relative abundance, in physiognomy and in fuel characteristics (Burgman *et al*. 1996, Woodgate *et al*. 1996). EVDs consist of two or more EVCs and are thus even more internally heterogeneous than EVCs. Recommended maximum and minimum tolerable fire intervals must take account of this variation. Tolerable fire intervals assigned in the current study considered the constituent vegetation communities that are most susceptible to any recommended maximum or minimum interval. As such, the recommended intervals are **conservative**, suitable for fire management and based on a precautionary approach (Mueller-Dombois and Ellenberg 1974, Kriebel *et al*. 2001). They are chosen as the intervals **least likely to lead to local extinctions or dramatic changes in long-term species abundances or dominance patterns**.

Some EVCs have a paucity of detailed research on the ecological effects of fire. Nevertheless, so as not to stymie the incorporation of ecological considerations into planning and management, expert opinion was applied. EVDs are a broader vegetation unit than EVCs (i.e. in the same classification hierarchy and encompassing a number of EVCs). All component EVCs should be incorporated into, and managed sensitively, for each EVD and its recommended fire intervals. The slowest maturing EVC, within each EVD, will substantially determine the minimum tolerable fire intervals recommended for that (whole) EVD. Similarly, the fastest senescing EVC, within an EVD, will substantially determine the maximum tolerable fire interval for that (whole) EVD.

Effect on the data *– Maturation stages derived from life history transition stages in the Vital Attributes data set were augmented by approximately 25% when these data were used to derive fire intervals for the contingent EVDs.*



Representing complex vegetation communities, and their growth stages, using map polygons is a tool for landscape planning and assessment. As there will always be some inaccuracies and errors in data sets, map products should not replace the need for continued on-ground assessment.

(MAP AND PHOTO COURTESY DEPARTMENT OF SUSTAINABILITY AND ENVIRONMENT)

Population data

Because vegetation data are assumed to be normally distributed, values will have an associated uncertainty. Ideally, this uncertainty should be indicated in a standard form (e.g. 15 ± 2.3, where '2.3' is the standard error, standard deviation, variance, or some other appropriate measure of uncertainty). However, such figures do not lend themselves to the simple algorithms that are presently used in deriving ecologically based managed fire regimes (e.g. Friend *et al*. 1999, 2004; Tolhurst 1999; Tolhurst and Friend 2001). For most figures extracted from the Vital Attributes data set, we have limited knowledge as to the spread of values (sample distributions) or as to the accuracy of the means.

Effect on the data *– Data are not presented as probability intervals but as raw figures and so were augmented by approximately 35% when these data were used to derive fire intervals for the contingent EVDs.*

Minimal Vital Attributes requirement

In their original publications, Noble and Slatyer (1980, 1981) specified that a fully populated Vital Attributes data set was the *minimal* requirement for ecologically based management (in this case, applied fire management). In Victoria, an early policy decision was made that ecological fire management would be based on this seminal work. A 'fully populated Vital Attributes data set' includes accurate data on seed bank longevities and growth history transitions in a reasonable array of ecological situations for all the subject species. Noble & Slatyer (1980, 1981) further specified that this 'fully populated Vital Attributes data set' would back up decisions that would maintain species in managed landscapes, but they did not guarantee that species proportional contributions would remain unchanged. Ecological fire management in Victoria aims to maintain species composition (including species presence *and* relative abundance), and is applied at present using a Vital Attributes data set that is yet to be fully populated.

Effect on the data *– A precautionary approach must be taken in all considerations of recommended tolerable fire intervals when deriving ecological fire management plans.*

Seed bank longevities

A critical component of the Vital Attributes data set is the time to local extinction for a species (category 'SPECIES LIFE'). This includes not just death (without replacement) of mature, living individuals, but also the death of any seed bank. Many species may disappear from communities (in the sense of becoming invisible) many years or decades before they become locally extinct, because a seed bank may remain viable long after the death of the parent plants. Seed bank surveys for many species have failed to detect any notable seed banks beyond a few seasons or beyond what is on the parent plants. Many of our most common woody plants do not have long-lived seeds, either on the parent or in the soil (e.g. many *Eucalyptus* species); they are termed 'geosporous', i.e. their seeds are released annually into the soil seed bank (Merritt and Rokich 2006). For many other species, the soil seed bank has a half-life orders of magnitude greater than the half-life of the parent photosynthetic plants (Merritt and Rokich 2006). For this latter group, local extinction may only happen many decades after the parents have died without replacement. Many plant species are present in a landscape only as a viable soil seed bank for most of their life cycles. Yet we have few studies investigating soil seed banks and even fewer successful methods for soil seed bank survey. Most existing information on soil seed banks (and the longevities of species which rely on soil seed banks) is inferential and unreliable.

Effect on the data *– A precautionary approach must be taken in all considerations of recommended tolerable fire intervals when deriving ecological fire management plans.*

Spatial and temporal variations

Growth rates vary according to local conditions such as soil fertility, soil depth, recent rainfall patterns (Parsons 1968, Bever *et al*. 1997, Saracino *et al*. 1997). Life history transitions also vary temporally, for example, reduced growth rates may delay flowering and seed set (Lilley 1993, Wesselingh *et al*. 1997). For these reasons, it is unreasonable to expect that life history transitions (e.g. from juvenile

to flowering and setting seed) will occur at the same time and to the same extent in the variety of different conditions that a plant species may occupy. Life history transitions can occur after different periods of time have elapsed, depending on local growing conditions. Consequently, the precise times of transitions will vary between species populations and generations. Rather than indicate this variability with confidence limits around tolerable fire intervals,[1] which would confuse the application of figures to the process used to determine fire cycles, this field variability has been incorporated into the recommended fire intervals, using a precautionary approach. For example, the description of the Heathland (sands) EVD offers more than one figure for tolerable fire intervals attributed in the EFG field, based on the different growth rates seen within subunits.

Fire severity and intensity

The tolerable fire intervals largely address fire frequency (the time between fires). Another component of fire regimes is fire severity. The term 'severity' includes a consideration of the proportion of available fuel consumed and/or the proportion of ground burnt or habitat consumed within a fire perimeter; it also includes a consideration of the impact on individual plant species, but it is the patchiness component that is a prime consideration in this document. The related term 'intensity' refers to the heat output from a fire. Fire severities vary according to fuel conditions and quantity (hence vegetation type) but also with local topography, local weather, season of burn and time of day the fire front arrives at a site (Gill 1975, 1981a; Whelan 1995).

Many vegetation communities experience little variation in fire severity between repeat fires at a single site – either the vegetation community burns or it does not. This is commonly the situation where vegetation is not strongly stratified – where the strata are physically close, so that the flames may easily reach them all, or where intensities and fuel levels are usually so high that no stratum easily escapes the flames, no matter what distance or height separates it from other strata. An example of effectively unstratified vegetation is Basalt Plains Grassland (Lunt 1991, Stuwe 1994). An example of vegetation that usually experiences only high severity fires in which all strata are burnt is the tall wet forests of the Central Highlands (Gill 1975, Attiwill 1994, Ashton 2000).

However, in other vegetation communities it is possible to have fires of different severity at one site because of local variations in characteristics such as season of burn, weather conditions when the fire front arrives, and topography (Morrison and Renwick 2000, Harris 2002, Prober and Thiele 2004). In these communities fire behaviour and severity are less predictable and it is possible for the same site to experience fires of different severities at different times, depending on the local conditions (Gill 1975, Whelan 1995, Whelan and York 1998, Catchpole 2001). This can be a common pattern in vegetation composed of different strata that are so separated that flames in less intense fires have little prospect of reaching other strata.

Examples of vegetation after a high intensity burn at Walhalla, Victoria in 2007. Images show how a high intensity burn has consumed the tree canopy, understorey and ground layers.

(PHOTOS COURTESY GORDON FRIEND)

1 In nearly all cases, there are no field data on this variability in timing of life history stages, even for well-researched species such as *Banksia ornata* (Desert Banksia) and *Eucalyptus regnans* (Mountain Ash).

Examples of vegetation after a low severity burn at Big River, Victoria in 2010. Images show how a low intensity fire burnt the understorey and ground layer, while the larger trees and canopy layer have remained largely unburnt.

When fires are of low intensity, small fuel discontinuities or localised topography or weather conditions may (temporarily) extinguish the fire at a place, creating islands of unburnt habitat in a sea of burnt habitat (Tolhurst 1999, Thomas *et al*. 2003). Hence, a burn of variable, and in some places lower, severity results. In higher intensity fires, such small fuel discontinuities are less likely to (locally) extinguish the fire and there are fewer unburnt refuges left after the fire front has passed (Gill 1975, Williams *et al*. 1994, Whelan 1995).

In this document, two broad intensity classes have been recognized – one where scorching will result in rapid resprouting without a significant impact on structure, and one where full scorching will result in a structural change that will take a significantly longer time from which to recover. Although intensity and severity are not synonymous, higher intensity fires usually produce higher severity fires and lower intensity fires usually produce lower severity fires.

It is the patchiness of less severe fires that particularly affects the survival and regeneration of plant species at a site. A highly patchy fire (e.g. 40% or more of the land within the fire perimeter remains unburnt) will retain a substantial area of refuges in which obligate seed-regenerating species (those killed by fire) will survive, at the same time providing regeneration opportunities for seedling regeneration on adjoining burnt ground. A second fire in close succession would usually kill all the new seedlings and lead to a local extinction (Manders 1987, Macfarlane 1994, Bradstock *et al*. 1996). However, if both fires were of low severity (and hence very patchy) then it is likely that patches unburnt by both fires would remain. Thus, two high-severity fires in close succession may lead to local extinctions, but two low-severity (patchy) fires in close succession are far less likely to lead to local extinctions (Thomas *et al*. 2003). Hence, the minimum tolerable interfire interval for low severity fires may be lower than for high severity fires in the same vegetation community (Smith *et al*. 2000). Patchiness may provide some insurance against local extinctions of fire-sensitive species (Whelan 1995). However, pre-fire and post-fire monitoring are required to reliably determine the impacts of patchiness on species persistence and population size.

At the same time, it is conceivable that less intense fires may adversely affect survival chances for fire sensitive species, by killing some parent individuals and yet not providing the relevant fire-related cues for seed release nor establishment (Archer 1984, Brits *et al*. 1993, Smith *et al*. 2000).

The maximum tolerable fire intervals do not usually vary with fire severity, as these intervals are substantially determined by the longevity of species in the absence of fire. However, in some EVDs or vegetation communities the minimum tolerable fire intervals will vary according to whether fires of different severities and patchiness are likely (see Section 2 and Table 2.5). High-severity fires (sometimes referred to as 'stand replacement fires') in such communities are usually wildfires, and low-severity fires are usually planned burns (mainly ecological or fuel reduction burns).

The use of remote sensing using aerial photography and/or satellite imagery data is useful for assessing the extent, severity and patchiness of a fire event. The above image is an aerial photograph over the vicinity of Geerak Track, Grampians National Park, in 2010. The fire has produced a mosaic burn exhibiting patches of burnt (brown colours) and unburnt (green colours) vegetation of various extent. The unburnt patches may act as refuges for fauna species.

(PHOTO COURTESY DEPARTMENT OF SUSTAINABILITY AND ENVIRONMENT)

Season

In their original publications outlining the Vital Attributes approach, Noble and Slatyer (1980, 1981) did not incorporate differential impacts on species (or vegetation communities) as a result of different seasons of disturbance. Differences in responses caused by different seasons of burn are poorly understood and poorly researched (McLoughlin 1998, Tran and Wild 2000, Watson 2001), but there is good reason to believe that season of burn is a critical determinant of the likelihood of success of post-burn regeneration. Different species respond differently, depending on the season of burn (Enright and Lamont 1989, Hill and French 2004, Korczynskyj and Lamont 2005, Roche *et al*. 1998, Wright and Clarke 2007) and post-fire seasonal conditions (Bell 1999, Moreno and Oechel 1992, Roche *et al*. 1998). Because of the current dearth of data and poor understanding of seasonal impacts (including the seasons post-burn), seasonal effects have not been directly incorporated into the consideration of fire regimes and maximum and minimum tolerable fire intervals.

Notwithstanding this, some of the seasonal impacts have indirectly been partially incorporated. Fire severity (and intensity) and season of burn are correlated. In vegetation communities in which fire severity may substantially vary (see discussion above), prescribed fires tend to be low-severity fires and tend to be lit in early to late autumn. Hence, the tolerable fire intervals for low-severity fires correlate more or less with 'cool season'[2] fires. In contrast, bushfires tend to be high-severity fires and these occur mainly from late spring to late summer. In a few of the more flammable communities, such as heathlands, planned fires may be lit over an extended cool season, including throughout winter. Prescribed fires (low severity) are rarely lit in late spring to late summer. Other seasonal impacts have been excluded from consideration, such as seasonal conditions in the years following fire and the phenological state of the plants when burnt.

Mountain Ash habitat tree (*Eucalyptus regnans*) from the O'Shannassy Catchment, Victoria – over 100 years after the last bushfire event.

2 Usually mid-autumn to early winter.

Section 6
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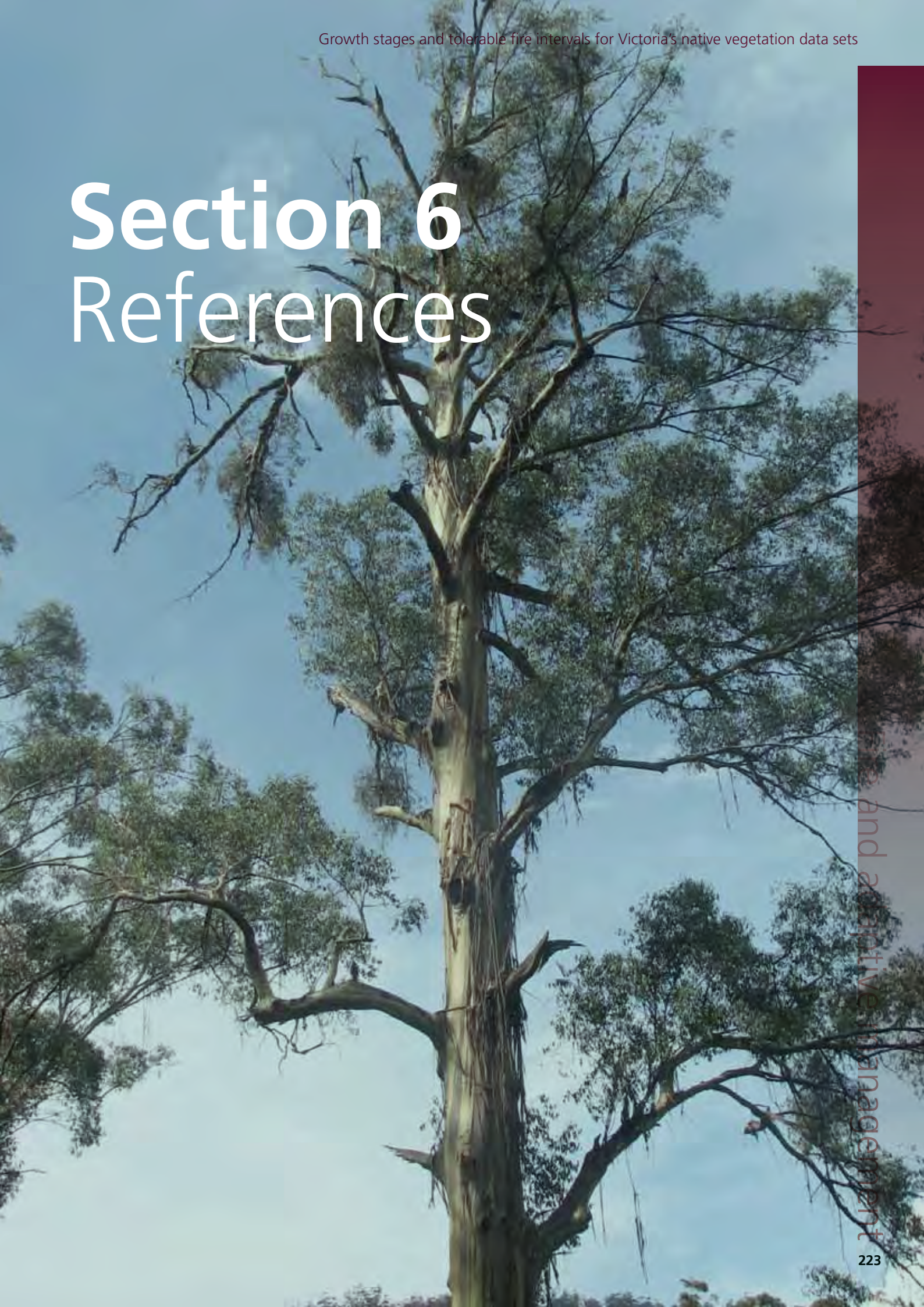

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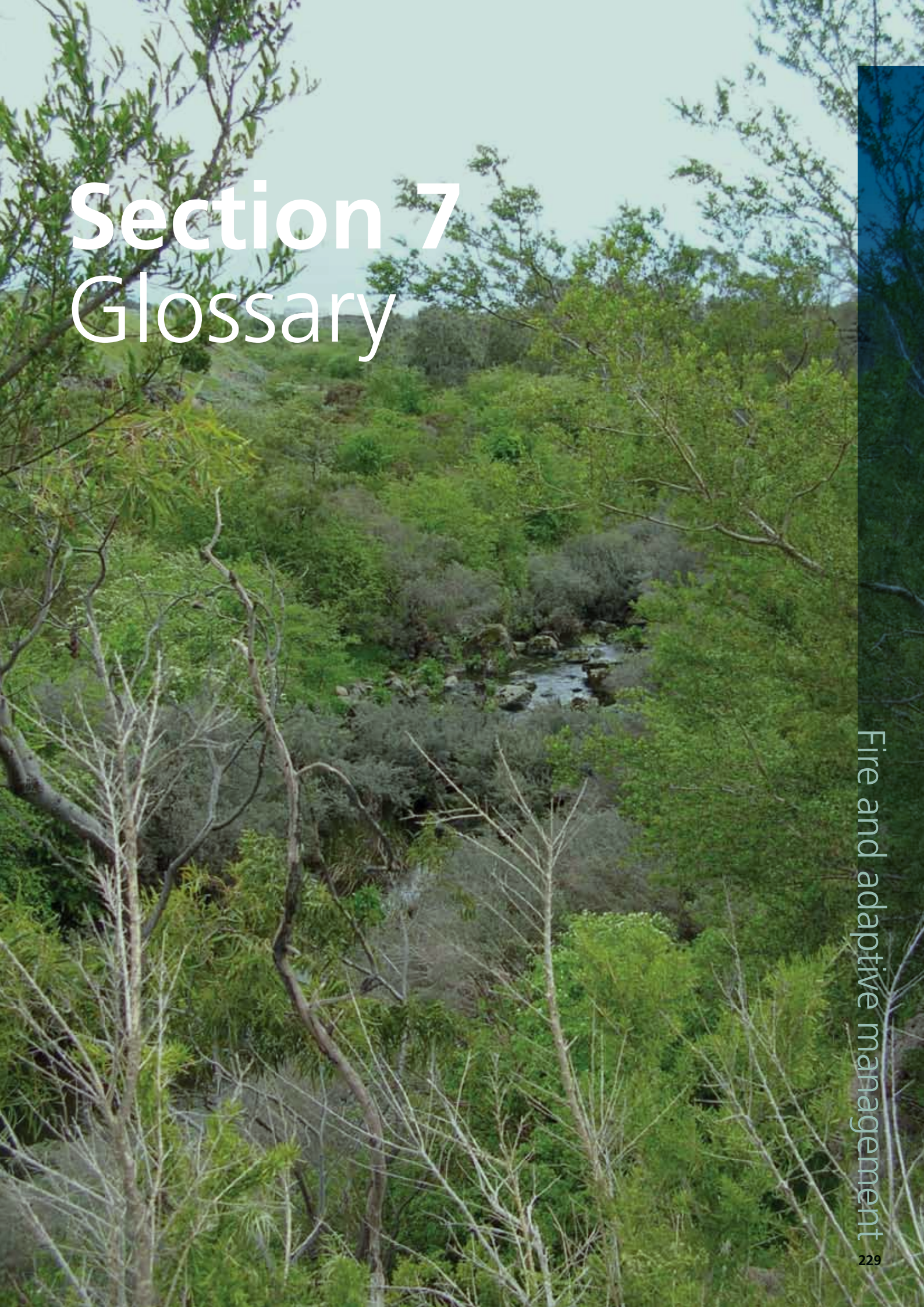
Riverine Woodland / Forest – long unburnt, ▸
Merri Creek, Craigieburn, Victoria.



Section 7
Glossary

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Adaptive management – a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs and incorporating new information.

Adventive – a plant which has been able to establish in the wild without direct human assistance.

Annuals – plants that usually germinate, reproduce (flower), and die in one year or season. True annuals will only live longer than a year if they are prevented from setting seed.

Biodiversity – biodiversity, or biological diversity, is the variety of all life on earth or in a specified region including the different plants, animals and micro-organisms, their genes, and their terrestrial, marine and freshwater ecosystems.

Biomass – the mass of living organisms, and dead matter such as wood, leaves, and other matter with an organic origin.

Biota – the living components (fauna and flora) of an ecosystem or habitat.

Bogs (eg **alpine bog community)** – an ecological community occupying sites of high to very high water availability in the soil (often or usually waterlogged), but not including sites with ample free water. Bogs are found in permanently wet areas, such as along streams, valley edges and valley floors. They are also situated on slopes where soils are waterlogged The key to bog formation is a good supply of groundwater and an impeded drainage system that keeps the water table at or near the surface. Under these conditions, the decomposition of organic materials is incomplete, eventually forming an underlying peat layer.

Bradysporous species – plant species that delay seed germination, often by the production of hard woody fruits that retain their seeds for a number of years, until the hard case is cracked by fire (or some other environmental cue), thus releasing the seed. As a result of this *bradysporous* characteristic, regeneration of these species by seedlings is usually dependent on fire. Bradyspory is typical of the Casuarinaceae, Myrtaceae and Proteaceae families.

Bryophytes – member of the division of the plant kingdom of non-flowering plants. Includes mosses, liverworts and hornworts. They are amongst the simplest of land plants that lack vascular tissue and other parts. They have an intimate relationship with free water as their sperm must travel through water for sexual reproduction.

Bulb – an underground plant storage organ that bears roots on its lower surface and modified fleshy leaves above (although still below ground). It often provides a means of reproduction for perennials.

Bushfire – any fire that burns uncontrolled in vegetative or associated flammable material (including human assets). Bushfires are usually unwanted and require control actions.

Canopy – the canopy is the aboveground portion of a plant community, formed by the tallest largely continuous plant stratum (the crowns). The canopy typically comprises a layer or multiple layers of branches and leaf foliage.

Caudex – either the apparently woody base of an otherwise herbaceous perennial plant, including underground parts of the plant's central axis, or the apparently woody trunk of a fern or monocot, such as a tree fern or a palm.

Chenopod – a member of the (former) plant family Chenopodiaceae – includes such familiar plants as Saltbushes, Samphires and luebushes, often dominant in shrublands of lowland landscapes, such as plains and drainage channels, where soil is heavy-textured and saline or in arid climates. Chenopod shrublands may intermingle with a variety of temperate woodlands and mallee shrublands.

Classification – biological classification is the process of grouping living things on the basis of features they have in common, or on the basis of their ancestry, or of both. The word classification is also used for the resulting arrangement of living things into groups.

Climate change – changes in climate attributed to the human-induced increase in concentration of greenhouse gases in the atmosphere. Climate change involves increases in temperature, sea level, and increased frequency of severe weather events such as storms.

Coarse woody debris – dead woody material, in various stages of decomposition, located above the soil, larger than 7.5 cm in diameter (or equivalent cross-section), which *is not self-supporting*. Trees and stumps (intact in ground) are considered self-supporting. Coarse woody debris includes:

- downed horizontal or suspended (not self-supporting) dead tree boles with or without roots attached;
- fallen trees which still have green foliage if they no longer have roots attached (no living cambium) to the ground to keep them alive;
- woody pieces greater than 7.5 cm at the point where the sampling line crosses the piece;
- uprooted (not self-supporting) stumps greater than 7.5 cm in diameter at the crossing point and any of their exposed dead roots greater than 7.5 cm in diameter at the crossing point;
- fallen broken tree tops which may be horizontal or leaning, or large fallen branches.

Cohort – a group of individuals of the same age (recruited into a population at the same time) or age class.

Crown fire – fire that burns in the crowns (or canopies) of a vegetation community (notably trees, occasionally shrubs) and which (often) propagates from crown to crown. Usually ignited by a surface fire. Crown fires are common in forests.

Cryptogams – refers to plants (in the wide sense of the word) which reproduce by spores. The best known groups of cryptogams are mosses, lichens, liverworts and ferns.

Decomposition – breakdown or decay of organic materials.

Duff – partially decomposed organic matter lying beneath the litter layer and above the mineral soil.

Ecological community – a naturally occurring assemblage of interacting species adapted to particular conditions of soil, topography, water availability and climate.

Ecological connectivity – the links between different ecosystems and species within a landscape. The degree of connectivity affects ecological and evolutionary processes.

Ecological processes – the interactions and connections between living and non-living systems including movements of energy, nutrients and species.

Ecological Fire Group (EFG) – this is an attribute field of the Ecological Vegetation Division (EVD) data set (see below) which provides for the recoding and updating of more specific fire response characteristics for EVDs. For example, particular EVCs within the EVD grouping may be known to exhibit different fire response characteristics such as minimum tolerable fire intervals . The EFG attribute fields will be progressively updated (as necessary).

Ecological Vegetation Class (EVC) – a native vegetation classification unit that is described through a commonality of its floristic, life form, and ecological characteristics, and through an inferred fidelity to particular environmental attributes. Mapping of EVCs has occurred at scales of at least 1:100,000 and in some areas 1: 25, 000. There are approximately 300 EVCs statewide as of 2010.

Ecological Vegetation Division (EVD) – a native vegetation classification unit based on grouping multiple EVC units that share similar ecological responses and relationships (including fire responses). There are 32 EVDs at 2010.

Ecologically sustainable development – development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends.

Ecosystem – A diverse and changing set of living organisms within a community, interacting with each other and with the physical elements of the environment in which they are found, and the abiotic features.that determine the behaviour or responses of the biotic components.

Environment – the external conditions (biotic and abiotic) affecting the plants, animals and other living organisms of a region. Includes ecosystems and their constituent parts, including people and communities; natural and physical resources; the qualities and characteristics of locations, places and areas; and their social, economic and cultural aspects.

Exotic species – the species occurring in an area and outside their historic natural range as a result of intentional or accidental dispersal by human activities.

Extinction – is the end of existence of a species, or the end of a species occupation within a defined area (when qualified as 'local extinction').The moment of extinction is generally considered to be the death of the last individual of that species. For plants, the death of all adults for a particular plant species within a defined area does not necessarily mean the species has become extinct. The species may still exist through its seed bank in the soil. The seeds will germinate when conditions are favorable.

Ephemeral – (for **plants**) – a plant that completes its life cycle in a short period, often less than six months.

Fauna – refers to all of the animal life of any particular region or time.

Fire break – is a gap in vegetation or other combustible material that acts as a barrier to slow or stop the progress of a bushfire. A fire break may occur naturally where there is a lack of vegetation or "fuel", such as a river or lake. Fire breaks may also be human in origin, such as roads (eg. logging roads, secondary roads, or highways).

Fire climate – a synthesis of daily fire weather conditions accumulated over an extended time interval.

Fire cycle – length of time for an area equal to the entire area of interest to burn – the size of the area of interest must be clearly specified.

Fire dependent – refers to species or vegetation types which depend on a particular aspect of the fire régime of an area for their establishment, growth or persistence. Some fire dependent flora species may have seeds that only germinate after stimulation by heat or smoke.

Fire duration – the length of time that combustion occurs at a given point. Fire duration relates closely to downward heating and fire effects below the fuel surface as well as heating of tree boles above the surface.

Fire ecology – the component of fire management involving the study of fire and its interaction with the natural environment.

Fire exclusion – the policy of suppressing bushfires or prohibiting the use of planned burning in a defined area.

Fire frequency – number of fires per unit time in a specified area.

Fire intensity – a general term relating to the heat energy released in a fire.

Fire interval – time (in years) between two successive fires in a designated area (i.e., the interval between two successive fire occurrences); the size of the area must be clearly specified.

Fire regime – the patterns of fire occurrence, size, timing and severity – and sometimes, vegetation and fire effects as well – in a given area. A fire regime is a generalization based on fire histories at individual sites. Fire regimes can often be described as cycles because some parts of the histories are repeated, and these repetitions can be counted and measured. The fire regime on a particular site or in a particular ecosystem is not cyclic in a deterministic sense; it is, rather, a story about climate, human use, other disturbance and species dispersion as they have all changed and interacted to affect an ecosystem, both suddenly and subtly, over millennia. A fire regime has the following components:[1]

- *Fuel Consumption and Spread Patterns* – fire can burn at more than one level. Ground fires burn through soil that is rich in organic matter. Surface fires burn through dead plant material that is on, or near,the ground. Crown fires burn in the tops of shrubs and trees. Ecosystems may experience mostly one level of fire or a mix of the three.
- *Intensity* – defined as the energy release per unit length of fireline (kW m^{-1}). Can be estimated 1) as the product of linear spread rate (m s^{-1}), low heat of combustion (kJ kg^{-1}) and combusted fuel mass per unit area, or 2) via flame length correlation].
- *Severity* – this is a term ecologists used to refer to the impact that a fire has on an ecosystem. Ecologists can define it in many ways, but one way is through an estimate of plant mortality.
- *Frequency* – this is a measure of how common fires are in a given ecosystem. It is either defined as the interval between repeated fires at a given site, or the amount of time it takes to burn the equivalent of a specified area.

- *Seasonality* – this refers to the time of year during which fires occur. They often occur during the dry season, and in some areas also co-occur with the time of year when lightning is present for fire ignition.
- *Fire severity* – degree to which a site or defined area has been altered or disrupted by fire; also used to describe the product of fire intensity and.the length of time of the burn.

Fire weather – a combination of weather conditions that favors the kindling and spread of forest or brush fires; typically, low humidity and a lack of recent precipitation.

Flora – refers to the plant life occurring in a particular region.

Forest – a dense growth of woody trees, and other plants covering a defined area.

Fuel – fuel is comprised of living and dead vegetation that can be ignited. It is often classified as dead or alive and as natural fuels or activity fuels (resulting from human actions, such as from logging operations). Fuel components refer to such items as downed dead woody material by various size classes, litter, duff, herbaceous vegetation, live foliage etc.

Fuel continuity – a qualitative description of the distribution of fuel both horizontally and vertically. Continuous fuels readily support fire spread. The larger the fuel discontinuity, the greater the fire intensity required for fire spread.

Fuel load – the amount of available and potentially combustible material, usually expressed as tonnes per hectare.

Fuel moisture – percent or fraction of oven dry weight of fuel. It is the most important fuel property controlling flammability. In living plants it is largely physiologically bound. Its daily fluctuations vary considerably by species but are usually above 80 to 100%. As plants mature, moisture content decreases. When herbaceous plants cure, their moisture content responds as dead fuel moisture content, which fluctuates according to changes in temperature, humidity and precipitation.

Geographic Information Systems (GIS) – is any system that captures, stores, analyzes, manages and presents data that are linked to location(s) . In the simplest terms, GIS is the merging of cartography and database technology. GIS systems are used in natural resource management, cartography, remote sensing, land surveying, emergency management, navigation, and localized search engines**.**

Geophyte – herbaceous plant with perennating tissue below the soil surface; possesses tuberous underground organs filled with stored foods (bulbs, corms, rhizomes, stem tubers, root tubers).

Germination – (in **plants**) is the process by which a seed begins to sprout and grow into a seedling.

Grasslands – an area, such as a prairie or meadow, dominated by grass or 'grass-like' vegetation. Grasslands.burn more readily than forest and shrub ecosystems, with fire moving through the stems and leaves of herbaceous plants and only lightly heating the underlying soil, even in cases of relatively high intensity. In most grassland ecosystems, fire is the primary mode of decomposition, making it crucial in nutrient cycling.

Ground fire – fire that burn near, but above, the ground.

Habitat – is an ecological and environmental space that is inhabited by a particular species of organism or an ecological community. It is the natural environment in which an organism lives, and includes the physical environment that surrounds (influences and is utilized by) a species population and the organisms with which it intertacts.

Heathland – vegetation dominated by small shrubs with small hard leaves, often found on nutrient-poor soils.

Herbaceous – a plant that is devoid of woody material, particularly secondary thickening. An herbaceous plant may be annual, biennial or perennial.

Heterogeneous – is an adjective often used in a scientific literature to describe an object, area or system consisting of multiple items having a large number of structural variations. It is the opposite of homogeneous, which means that an object or system consists of multiple identical items.

High intensity fire – hot fires which usually consume most vegetation (canopy trees, understorey and shrubs) and ground fuels. Such fire events also termed 'stand replacement fires. Their likelihood is higher in extreme fire weather conditions.

Invasive species – species that can move into an area and become well established , in terms of cover, resource use, numbers or other ecological aspects.

Key Fire Response Species (KFRS) – term given to those species (plant or animal) whose vital attributes (life history characteristics) indicate that they are vulnerable to a fire regime of frequent fires, or to long periods of fire exclusion (see Vital attributes below) or which can be otherwise readily used to interpret fire regimes.

Landscapes – all the natural features of land or territory encompassed in a single view (e.g. fields, hills, forests and water), which distinguish one part of the earth's surface from another.

Legume – is a plant in the families Caesalpiniaceae, Fabaceae or Mimosaceae (or *Leguminosae*), or a fruit of these plants. A legume fruit is a simple dry fruit that is also called a 'pod'. Most legumes bear nitrogen-fixing bacteria on their roots and thereby play an important role in providing soil nitrogen.

Lichen – a plant-like organism consisting of an outer fungal body enclosing photosynthetic algae or bacteria,.but lacking characteristic plant structures such as leaves, roots, flowers, vascular tissue and seeds.

Lignotuber – a woody storage structure forming a swelling, more or less at ground level, from which dormant buds can develop.

Litter – the top layer of the forest floor (01-horizon); includes freshly fallen leaves, fine twigs, bark flakes, fruits, matted dead grass and other vegetation parts that are little altered by decomposition. Some surface feather moss and lichens are sometimes considered to be litter because they may burn similar to that of dead fine fuel.

Low intensity fires – fires which are generally not lethal to the dominant vegetation (eg. trees) and do not substantially change the structure of the dominant vegetation. In treed communities, low intensity fires typically only burn plants of the lower strata and ground litter. Most grassland fires are typically low intensity. In low intensity fires in forests, approximately 80% or more of the aboveground dominant vegetation survives fires.

Mallee – is either (1) the growth habit of certain eucalypt species that grow with multiple stems springing from an underground lignotuber, usually to a height of no more than ten metres, or (2) a vegetation community dominated by such plants, or (3) a part of the state of Victoria in which such vegetation is widespread. The mallee growth habit is most common in plants of the genus Eucalyptus. Mallees are the dominant vegetation throughout semi-arid areas of Australia with reliable winter rainfall. Within this area, they form extensive woodlands and shrublands covering over 250,000 square kilometres. Mallee woodlands and shrublands are considered one of Australia's major vegetation types.

Mean fire interval – arithmetic average of all fire intervals determined, in years, for a designated area during a specified time period – the size of the area and the time period must be specified.

Mesic species – refers to plant species which require relatively moist conditions for establishment and growth.

Mixed severity fire regime – a fire regime in which fires either cause selective mortality in the dominant vegetation, depending on different species' susceptibility to fire, or vary between lower strata and stand replacement.

Organic soils – soils that are dominated by, and largely consist of, undecomposed organic matter. Deep layers of organic matter often develop in poorly drained areas such as bogs, swamps and marshes.

Peat – an accumulation of partially decayed vegetation matter, to the intensity that it becomes the principal constituent of soils. Peat forms in bogs and swamps.

Perennials – plants that usually live for more than two years.

Phenology – study of periodic plant and animal life cycle events, particularly reproduction, and how these are influenced by seasonal and interannual variations in climate.

Planned fire – any fire ignited by management actions to meet specific objectives.

Primary juvenile period – the time taken for a population of young plant seedlings, from the same species, to exhibit first flowering.

Pyrogenic– refers to 'something produced by fire (in its ecological sense) or by intense heat (in its geological sense)'. The term is used in fire ecology to characterise species or vegetation communities which promote and require fire as part of their life history.

Rainforest – a forest type which either does not experience fire or only experiences fire as a catastrophic intrusion on normal ecological processes. Rainforests are usually characterised by closed canopy and species adapted to low light levels. Rainforest in Victoria is rare, covering only 0.14% or 32,000 hectares of the state. Most of this rainforest is concentrated in just four regions: the Otways, the Central Highlands, South Gippsland and East Gippsland.

Reclamation – restoration of biophysical capacity.

Restiads – species belonging to the family of flowering plants botanically known as the Restionaceae, hence being referred to as "restiads".

Regeneration – term used to describe germination, or other reproduction, and new growth of plants, and new opportunities for (re-)establishment of animal populations, such as following fire events. The use of planned burning for ecological purposes attempts to protect and enhance the biodiversity in an area by providing conditions conducive to the recruitment and survival of plants and animals.

Resilience – the capacity of a system to experience shocks while essentially retaining the same function, structure and feedbacks and, therefore, identity. The more resilient a system, the larger the disturbance it can absorb without shifting it to an alternative state. In the context of climate change, ecosystem resilience might be considered as the extent to which species, ecosystems, landscapes and seascapes can undergo change without loss of values; that is, species do not become extinct and ecosystems continue to function as they change.

Resprouting – refers to new (vegetative) growth of a plant. Many (individual) plants are able to survive fires in some way, these are loosely termed 'resprouters'. For example, some plants have a thick bark and retain dormant buds under this thick bark. These allow the plant to resprout from the subcortical [under-bark] buds even after a fire has burned away all the leaves and killed the thinner stems. Some plant species can resprout from their base or roots following a fire even when the rest of the plant's tissue has been killed by the fire(s).

Restoration – restoration of biophysical capacity by returning sites to the previous conditions.

Rhizome – a creeping plant stem (not a root) growing beneath the surface, consisting of a series of nodes with roots commonly produced from the nodes and producing buds in the (leaf) axils.

Rhizomatous – producing or possessing or resembling rhizomes (see Rhizome).

Riparian – a riparian zone or riparian area is the interface between land and a stream or river. Vegetation communities along the margins of streams or rivers are called riparian vegetation.

Root crown – the point at which the root and stem of a plant meet and the primary vascular anatomy changes from that of a stem to that of a root. The transition point between stem and root.

Sclerophyll species – plants with hard, thick skinned leaves, such as can be seen in most eucalypts. Because the leaves contain much coarse carbohydrate and little protein, this gives the leaves a hard, harsh feel.

Sedges – refers to grass-like plant of the family Cyperaceae. Many typically grow on wet ground and have rhizomes, stems with triangular cross-sections and minute flowers in spikelets.

Seed bank – the seeds that are present in a community, dormant yet capable of germination and establishment if the right conditions appear. The seed bank may be on the plants in persistent fruit or in, or on, the soil.

Seral (stages) – the series of distinct changes exhibited by vegetation communities that develop during ecological succession from bare ground or immediately post-fire to mature vegetation condition, and beyond (see also 'Succession').

Shrubland, (a.k.a. **scrubland** or **scrub**) is a plant community dominated by shrubs, although other growth forms, such as grasses, forbs and geophytes may also be common. Shrubland may either occur naturally or be the result of human activity.[1] It may be the mature vegetation type in a particular region and remain stable over time, or a transitional community that occurs temporarily as the result of a disturbance, such as fire. A stable state may be maintained by regular natural disturbance such as fire or browsing.

Shrub – a woody plant of relatively low height, having several stems arising from near the base and lacking a single trunk; a bush.

Snag – a standing dead tree from which the leaves and some of the branches have fallen.

Sobol – a basal stem (often more or less horizontal) arising from a common underground stem system.

Soboliferous – having several loosely clumped, principal stems that arise from a common underground stem system, each distinct above ground level.

Soil crust – a soil surface layer, no more than a few centimetres deep, of more or less cemented soil particles – the cement formed by Calcium Carbonate, silica, iron oxide, fungal hyphae or other organic material. The soil crust is always harder and more compact than the soil layers below it.

Soil moisture – is the water contained in a soil, dispersed in the interstitial spaces between soil particles. Soil moisture influences fire behaviour and its ability to spread. In biology, soil moisture affects the distribution and growth of vegetation, soil aeration, soil microbial activity, soil erosion and the movement of nutrients in the soil to the roots.

Species richness – counts of the number of species in a given area. The areas considered 'richest' are those with the most species. Species richness is commonly used as a simple measure of biodiversity.

Stand replacement fire regime – fire regime in which fires kill or top-kill aboveground parts of the dominant stratum in the vegetation, substantially changing the aboveground structure. Approximately 80 percent or more of the aboveground, dominant vegetation stratum is either consumed or dies as a result of fires.

Stolon – a stem or branch that grows along the ground surface, taking root at its nodes or else growing down to the ground surface, rooting on contact. It is also a type of vegetative reproduction in which an arching branch of a shrub takes root when it comes into contact with the soil and its connection with the parent plant is subsequently broken.

Strata – (plural of '**Stratum**') is a term used in the field of vegetation management and mapping to describe the distinct 'structural layers' of a vegetation community. For example, a mature forest can be described as having three strata, i.e. a ground cover layer (lowest stratum), a shrub layer (mid stratum) and a 'tall tree canopy layer' (highest stratum).

Succession (stages) – the gradual, somewhat predictable process of community change and species or dominance replacement as vegetation ages after establishment or after disturbance; the process of continuous (re-)colonization (and extinction) of populations at a particular site.

Topography – the three-dimensional arrangement of physical attributes (such as shape, height, and depth) of a land surface in a place or region. Physical features that make up the topography of an area include mountains, valleys, plains, and bodies of water. Human-made features such as roads, railroads, and landfills are also often considered part of a region's topography.

Threatened species – species or ecological communities that are in danger of becoming extinct and whose survival is unlikely if the causal factors (for rarity) continue to operate unabated. There is a number of different classifications of the level of threat depending upon whether the species/ community is listed internationally, nationally or at a state level. These classifications use terms such as rare, vulnerable, endangered, critically endangered and presumed extinct to indicate the level of threat.

Tolerable Fire Intervals (TFIs) – a term which expresses the minimum or maximum recommended time intervals between successive fire disturbance events at a site or defined area for a particular vegetation community. The time interval is derived from the vital attributes of plant and animal species that occupy the vegetation community. The TFIs guide how frequent fires should be in the future to allow the persistence of all species at the site or defined area.

Understorey fire – fire that burns the lower strata of a vegetation community (not the canopy), including the litter, and other live and dead fuels at or near the surface of the ground. Common in forest and woodland vegetation types.

Vital attributes – this term is based on a scheme originally proposed by Noble and Slatyer (1980, 1981). Vital attributes summarize critical features of a species life history characteristics such as growth patterns, reproduction method and life history transition stages. Using these attributes, those species most susceptible to variation in fire regime are used to both identify the ecological need for applied fire, or protection from fires, and to monitor the impacts of the current (and future) fire regime. These critical indicator species are known as 'Key Fire Response Species (see above).

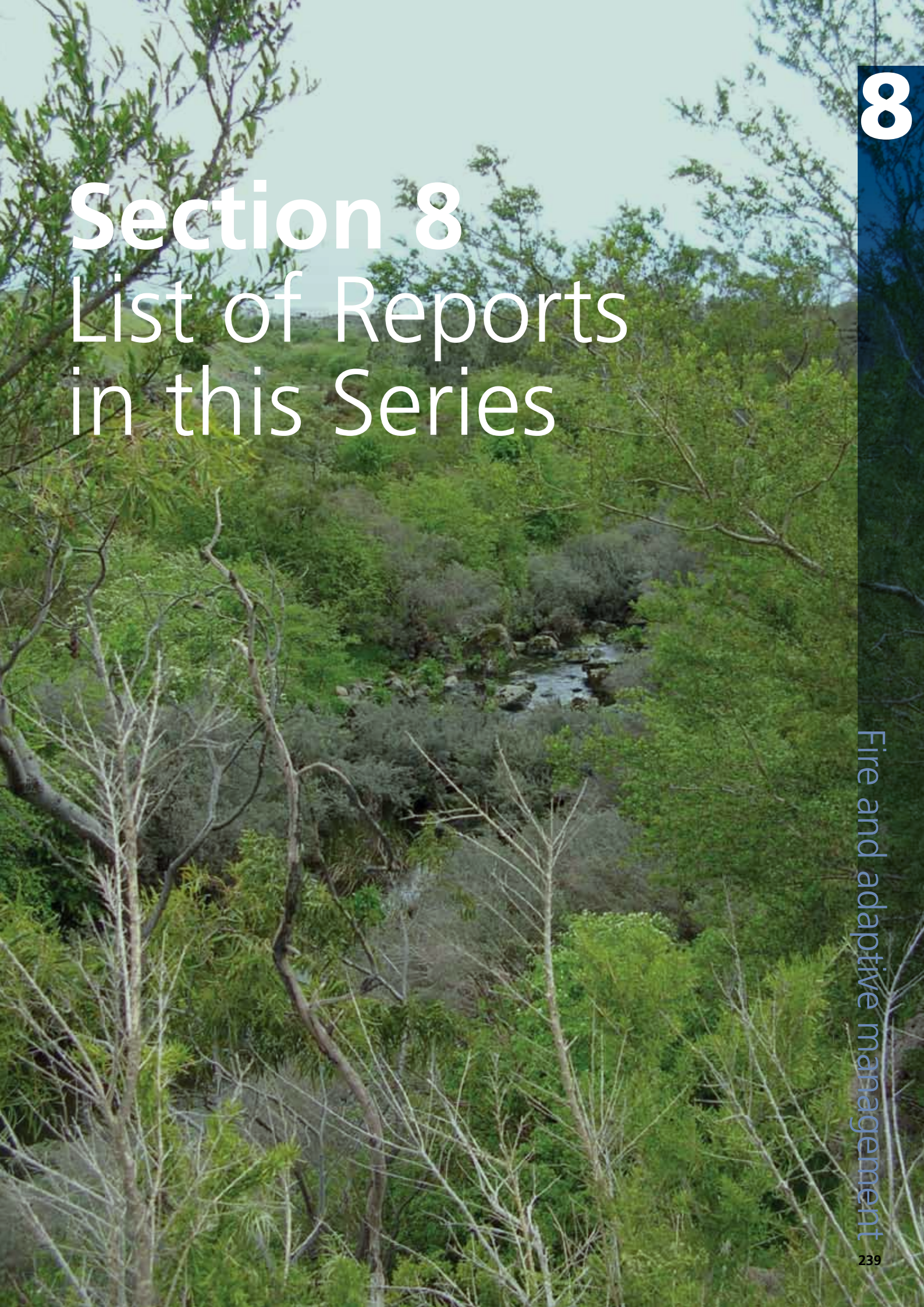
For plants there are three groups of vital attributes:

- *method of persistence* – how a species persists or arrives in an area after fire (generally seed
- based, vegetative or a combination)
- *conditions required for establishment* – the environmental factors required for germination and
- growth
- *relative longevity* – the timing of the life stages of each species

For animals, *shelter*, *food* and *breeding requirements* largely determine a species' response to fire and its post-fire occupation of preferred habitat growth stages.

Woodland – a vegetation community dominated by trees buit the tree canopy is open, discontinuous and with substantial gaps between individual trees.

Xeric – tolerating or adapted to dry conditions.



Section 8
List of Reports in this Series

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1. 1977. A Study of the distribution of aerially applied fire retardant in softwood plantations. R. Rawson.
2. 1978. Low intensity prescribed burning in three *Pinus radiata* stand types. D. S. Thomson.
3. 1978. Fuel properties before and after thinning in young Radiata Pine plantations. D. F. Williams.
4. 1979. Using fire to reduce fuel accumulations after first thinning in Radiata Pine plantations. P. R. Billing.
5. 1979. Some of the effects of low intensity burning on Radiata Pine. P. R. Billing.
6. 1980. A low intensity prescribed burning operation in a thinned Radiata Pine plantation. P. R. Billing.
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62. 2003. Effects of repeated low-intensity fire on bird abundance in a mixed eucalypt foothill forest in south-eastern Australia. R. H. Loyn, R. B. Cunningham and C. Donnelly.
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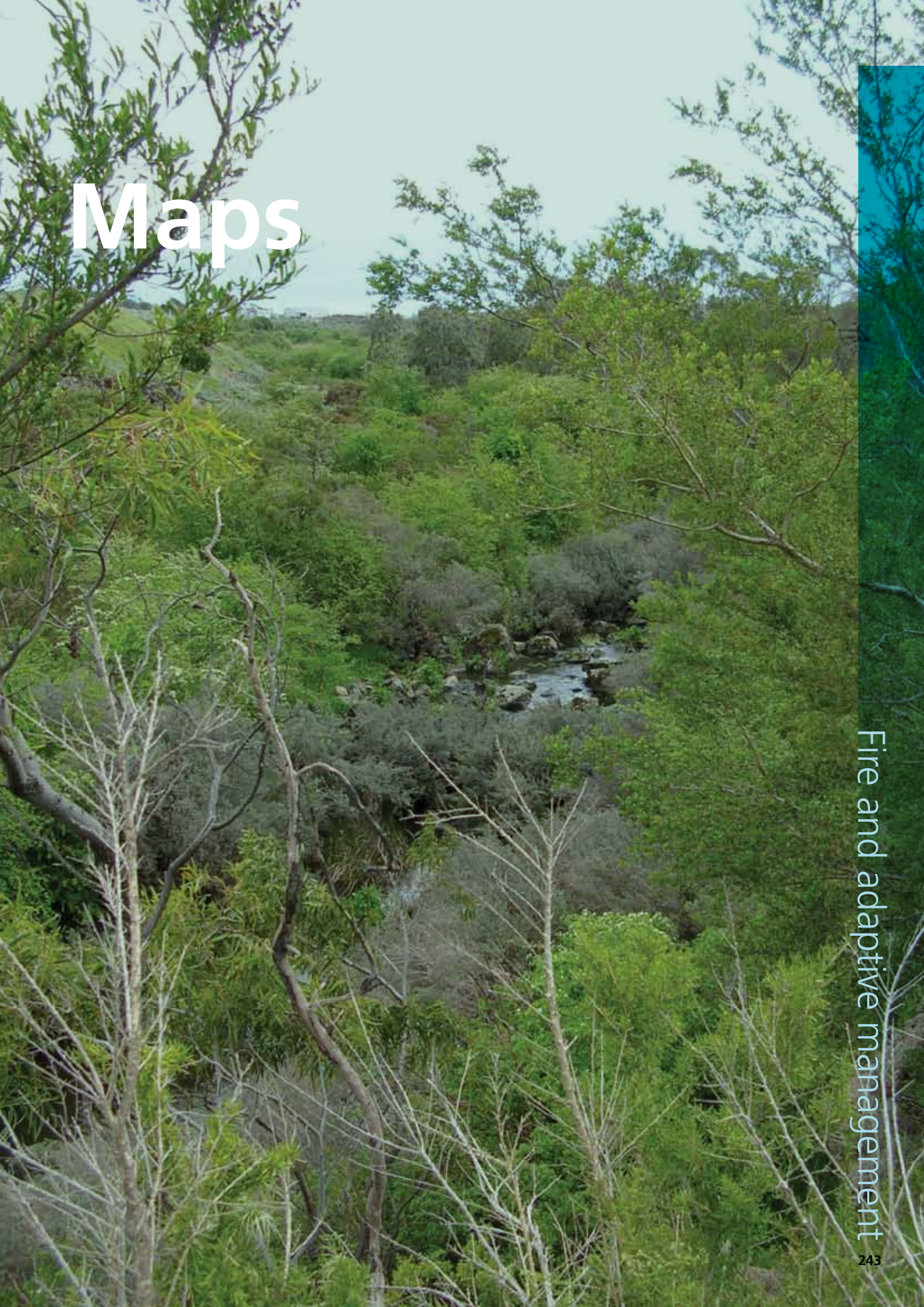
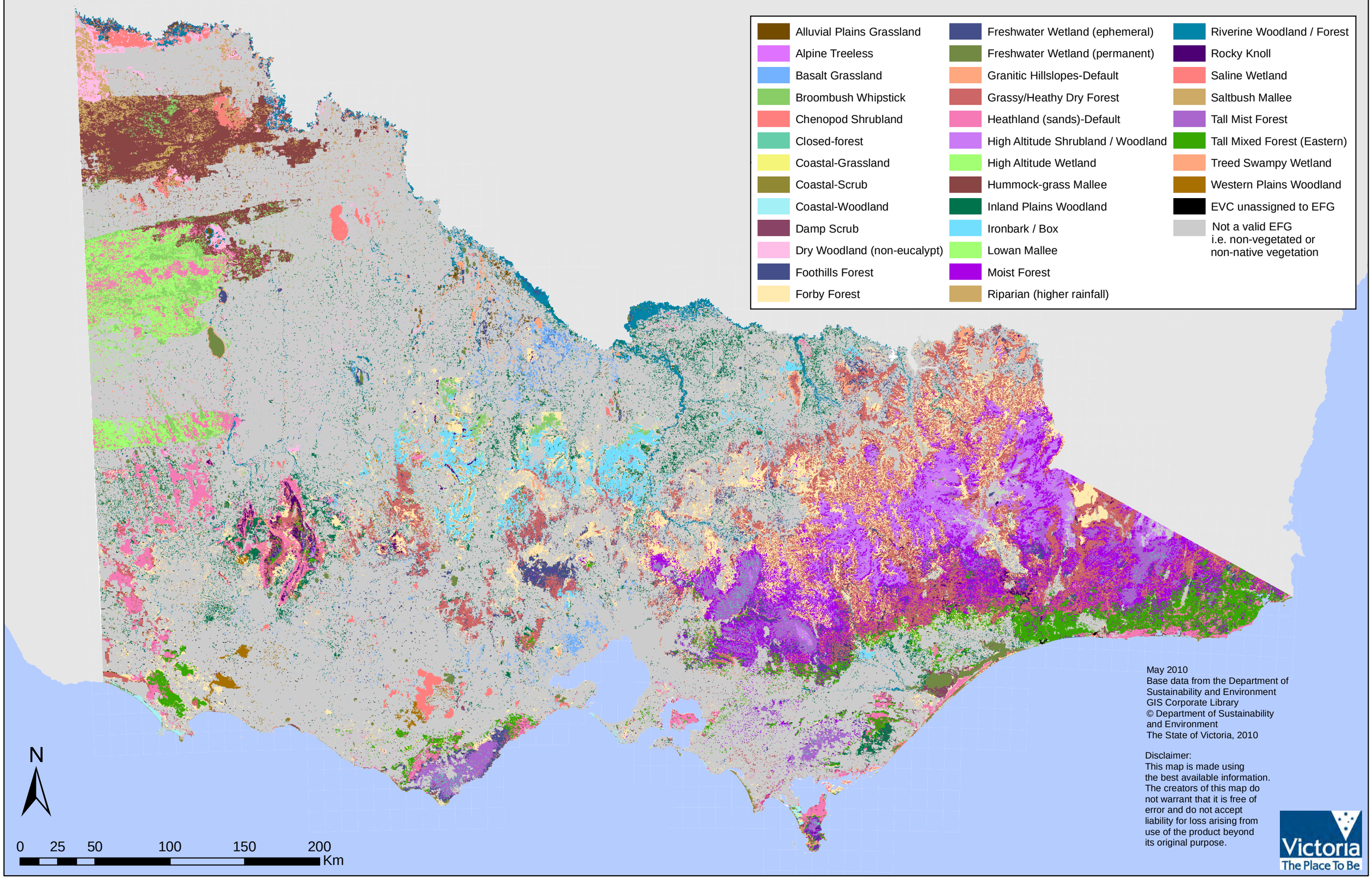


Maps

Maps

Map 1: Statewide distribution of Ecological Fire Groups (EFGs)



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Victoria
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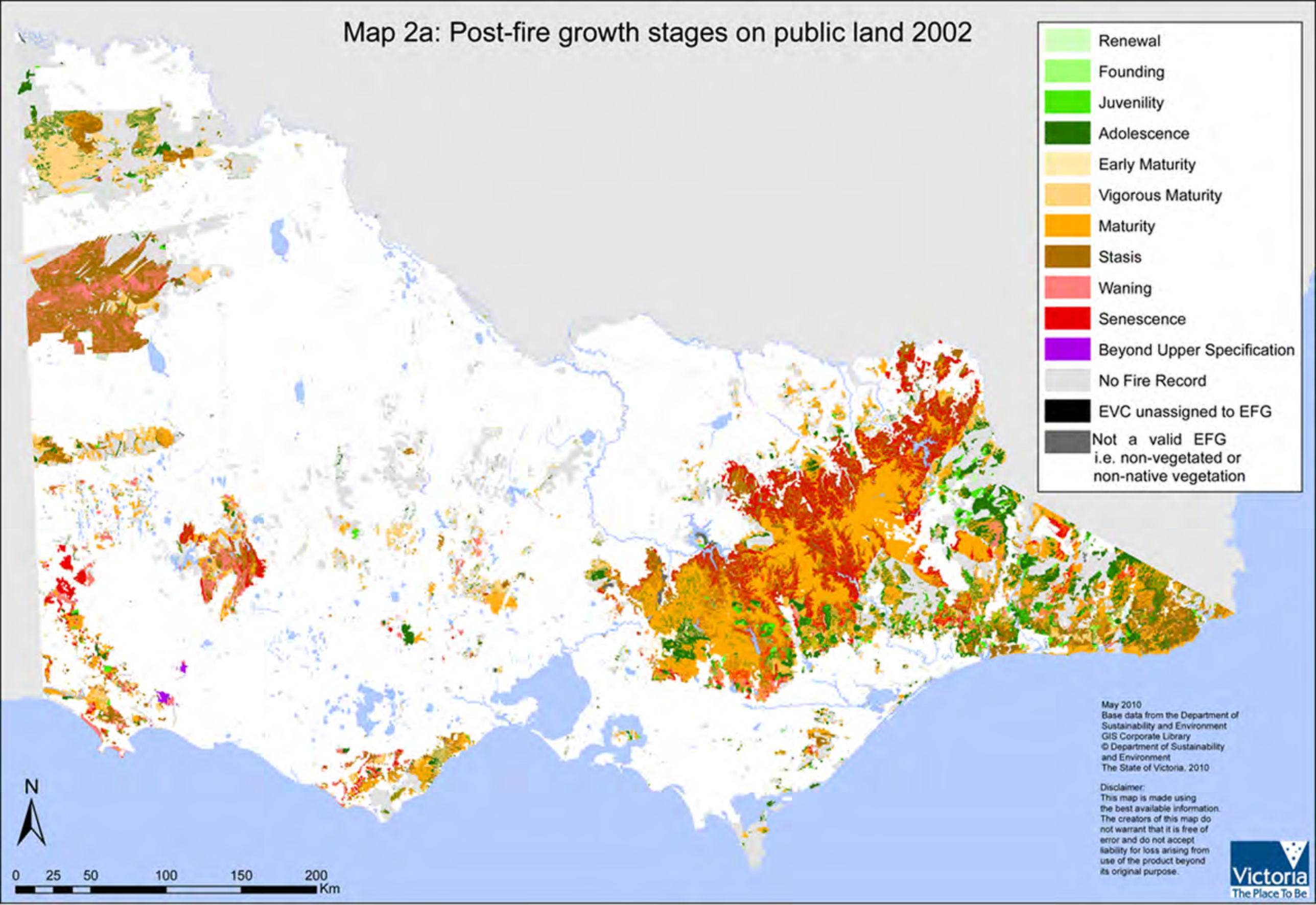
Map 2a: Post-fire growth stages on public land 2002



Map 2b: Post-fire growth stages on public land 2009

- Renewal
- Founding
- Juvenility
- Adolescence
- Early Maturity
- Vigorous Maturity
- Maturity
- Stasis
- Waning
- Senescence
- Beyond Upper Specification
- No Fire Record
- EVC unassigned to EFG
- Not a valid EFG i.e. non-vegetated or non-native vegetation

N

0 25 50 100 150 200 Km

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