NSW **National Parks and Wildlife Service**

Kosciuszko National Park
Fire Management Strategy 2008–2013

Department of **Environment & Climate Change** NSW

Acknowledgment

The Kosciuszko National Park Fire Management Strategy 2008 - 2013 recognises that the Park is within landscape that gives identity to Aboriginal people, who have traditional and historical connections to this land. Aboriginal people are recognised and respected as the original custodians of the lands, waters, animals and plants now within the Park. Their living and spiritual connections with the land through traditional laws, customs and beliefs passed on from their ancestors are also recognised.

NPWS will continue to be committed to actively engage traditional custodians and relevant Aboriginal organisations, in protecting managing and interpreting the needs of Kosciuszko National Park.

The landscapes of Kosciuszko National Park are the sum total of the interactions between the basic natural elements of water, air, rocks, soils, fire, plants and animals. Each of these living and non-living attributes have been altered by thousands of years of human habitation and use which have left behind layers of human artefacts, memories, stories and meanings.

The management of these attributes, and the values bestowed upon them, is a complex task and will not always be based upon a complete understanding of the implications of individual management decisions. A precautionary and adaptive approach to management is required - one that appreciates the interconnective and inseparable nature of the elements of the landscape. (NPWS, 2006c pg 37)

ACKNOWLEDGMENTS

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EXECUTIVE SUMMARY

This Fire Management Strategy provides direction for fire management activities within Kosciuszko National Park (the Park) to fulfil the Service's obligations under various legislation and Government policy. The specific fire management strategies developed to protect the significant natural and cultural heritage values, and the built assets, both within and adjacent to the Park, have a strong scientific basis utilising the latest available science.

NPWS is both a fire fighting authority and a public authority and therefore has dual responsibilities for fire fighting and land management. The NPWS is seeking the cooperation of all fire authorities in adopting the management guidelines contained within this strategy to fulfil our obligations under S.38 (4) of the Rural Fires Act, 1997.

The Park covers an area of approximately 688,846 hectares and is located in the south-eastern corner of the Australian mainland between latitudes 35°30s and 37°02'S and longitudes 148°10'E and 148°53'E. The Park straddles the Great Dividing Range, known in this region as the Snowy Mountains.

The Park forms part of the interstate Australian Alps National Parks system and part of a significant natural corridor that includes the Alpine National Park in Victoria north to Bimberi Nature Reserve and Brindabella National Park in NSW, and Namadgi National Park in the ACT.

The Park contains vast tracts of naturally vegetated areas, a range of threatened species and rare vegetation communities and habitats, has the most significant Alpine areas within NSW and contains large areas gazetted as wilderness. The Park also contains significant Aboriginal and historic heritage and many local communities identify strongly with historic connections to prior use of the Park. Catchments within the Park provide clean water for major irrigation schemes on the Murray River system, for hydroelectric electricity generation, and drinking water.

This strategy identifies the primary objectives of fire management operations, the characteristics of the bush fire environment, and the key values of the Park. The Strategy includes a risk assessment of fire threats to assets, including natural and cultural heritage assets, and provides a range of fire management guidelines to facilitate fire management planning and fire suppression operations. The Park has been divided into fire management zones commensurate with the management objectives of the Park, and is consistent with the approach used in the cross tenure Bush Fire Risk Management Plans (RMPs).

The key bush fire risk management strategies in this section include:

- Ongoing commitment to Bush Fire Management Committees as the key vehicle for coordinated fire management in the region including the Park;
- Maintenance of bush fire management zones to identified standards;
- Continued early detection and rapid suppression of unplanned fires;
- Ongoing commitment to trail maintenance;
- A new series of operations maps detailing assets requiring protection, cultural and natural heritage values, fire advantages, topography, trails etc;
- Proposed development of Village Protection Plans for built up residential areas within the Park e.g. Alpine Resort Areas, and Waste Point;
- Proposed prescribed burning schedule to minimise fires leaving the Park and to protect built and environmental assets; and
- Continuation of a broad area ridge top burning strategy to manage fuels in remote areas, frequent ignition areas, and to reduce spotting potential;
- Development of detailed prescribed burn plans and implementation of suppression operations guidelines to protect threatened species, threatened communities and priority habitats.

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1 INTRODUCTION

1.1 Scope, Term and Purpose

This document describes the fire management strategies that the National Parks and Wildlife Service (NPWS) will implement within the Kosciuszko National Park (KNP or the Park) for the period 2008-2013. NPWS is a branch of the Department of Environment and Climate Change (DECC) and for the purposes of this strategy any reference to DECC is also a reference to NPWS. The strategies contained within this document will assist NPWS to meet its fire management obligations under the *Rural Fires Act 1997*, *National Parks and Wildlife Act 1974*, *Threatened Species Conservation Act 1995* and other relevant legislation, Government policies, inter- agency and inter state agreements. Under the *Rural Fires Act 1997*, the NPWS is a prescribed fire authority and is responsible for the control and suppression of all fires on areas that it manages.

Section 50 of the *Rural Fires Act 1997* sets up provisions for the establishment of local Bush Fire Management Committees (BFMC) with the task of developing and coordinating cooperative fire management between fire authorities across the State. NPWS is a member of these committees that are responsible for the development of both cooperative fire fighting and programs and strategies for the prevention, mitigation and suppression of bush fire hazards. Within the scope of this strategy NPWS is an active member of the Snowy Monaro BFMC (Cooma Monaro and Snowy River local government areas) Bombala BFMC (Bombala local government area) and Riverina Highlands Zone BFMC (Tumut, Gundagai and Tumbarumba local government areas).

The Park is managed by two Regions being Snowy Mountains Region, based in Jindabyne and the South West Slopes Region, based in Tumut. The Regions are divided into Areas with relevant Area offices being located in Jindabyne, Khancoban, and Tumut.

This strategy has been prepared in accordance with the policies and procedures detailed in the NPWS Fire Management Manual (NPWS, 2006b), NPWS State Incident Plan (NPWS, 2006a) and the Kosciuszko National Park Plan of Management (KNP POM) (NPWS, 2007b). Development of this strategy has involved consideration of the bush fire risks, risk management strategies and cooperative fire fighting agreements outlined in the Bombala, Riverina Highlands and Snowy Monaro Bush Fire Management Committee (BFMC) Risk Management and Operations Plans, and in a range of inter-state and inter-agency agreements. NPWS is an active member of the Border Fire Coordinating Committees on the Victorian/NSW border and has a Memorandum of Understanding with the ACT Emergency Services Agency. NPWS is also an active member of the Australian Alps Liaison Committee which has produced a range of scientific and historical publications related to fire management in the Park and the broader Australian alps.

This strategy is a relevant Bush Fire Management Plan under Section 38(4) and Section 44 (3) of the Rural Fires Act 1997 and should be implemented accordingly. This strategy and supporting documentation will be made available to relevant agency staff for use in multi-agency fire suppression operations involving NPWS estate.

This strategy includes:

- A series of eight A0 size Operations maps which identify natural, cultural and capital assets to be protected from bush fire, trails and fire control advantages. Bush fire operations maps which contain sensitive information e.g.: cultural heritage sites and threatened species locations will remain internal NPWS documents. Revised map versions with sensitive information removed will be available to the general public;
- A Radio Coverage map sheet;
- A Suppression Operations Guidelines text sheet summarising key considerations for first attack operations; and
- A Visitor Safety map identifying key visitor locations and key walking routes.

This strategy is supported by:

- Regional Operations Plans prepared annually which include Fire Management Works Schedules listing the on ground fire management activities to be implemented each year;
- Snowy Mountains and South West Slopes Regional Incident Procedures which are prepared annually and detail the levels of bush fire preparedness related to various aspects of incident management; and
- A Geographic Information System database maintained by the NPWS Southern Branch Office and disseminated regularly to Area offices at Tumut, Jindabyne and Khancoban and the Regional office at Queanbeyan.

This strategy will be implemented through the development of annual works programs that identify specific strategies to be implemented.

The implementation of the strategy will be assessed in accordance with NPWS performance indicators specified in the NPWS *Fire Management Manual* (2006). Performance indicators related to State of Parks reporting are currently being developed and will be utilised for the purpose of evaluating this strategy when finally approved.

The strategy will be reviewed every five years, next due in 2013. If required by circumstance, the operational life of the strategy may be shortened or extended.

1.2 The Fire Management and Planning Framework

1.2.1 Introduction

NPWS considers fire management to be one of the most important management tasks in managing its estate (NPWS, 2003). A wide range of legislation and policy underpins fire management planning in NPWS estate. For details on NPWS legislative and policy requirements refer to chapters 1 & 2 of the NPWS Fire Management Manual (NPWS 2006a).

1.2.2 Fire management operational framework

The NPWS operational framework for fire management, fire fighting and prescribed burning is reviewed annually. Key policy and management procedures are detailed in:

- The NPWS Fire Management Manual (NPWS, 2007a), which contains all corporate policies and standard operating procedures relating to fire management;
- Regional Incident Procedures – documents that detail Region specific procedures for managing incidents. May include regional contacts as well depending on current formats; and
- Regional Contact Lists – a document that details equipment and contact information for NPWS staff, contractors and providers of equipment and services.

In summary these documents provide the operational guidelines for preparedness, detection, incident management, visitor safety and rehabilitation. They include guidelines on: readiness levels for initial response and response procedures, the duty officer role, crew standby arrangements, lists of available resources, out-of-area support procedures and guidelines, remote area fire fighting team (RAFT) use, aerial surveillance and standby guidelines, Park closure and fire bans, visitor evacuation, natural area fire management, post fire pest and weed invasion, monitoring and rehabilitation, chemical use, financial accountability and responsibility, training and fitness requirements as well as other fire management policies, guidelines and procedures that are specific to fire response.

1.2.3 Coordinated fire management

NPWS may, under various co-operative inter-agency Bush Fire Suppression Agreements, and under the *Rural Fires Act 1997*, provide resources for the first response to ignitions and the suppression of bush fires on private property for up to 8 kilometres from the Park boundary. These agreements are based on the Policy Statement of the NSW Bush Fire Coordinating Committee and the Manual of Procedures for Coordinated Fire Fighting. NPWS has

agreements with the ACT and Victorian governments that allow NPWS staff to respond to fires across the border and vice versa. The agreements are detailed in relevant Bush Fire Operations Plans, and the policies or regulations of other involved organisations. These documents are used to contribute to annual updates of the local BFMC Operations Plans which detail the cooperative arrangements for the management of fires.

1.2.4 Legislation

Under the *National Parks and Wildlife Act 1974* NPWS is responsible for the conservation of the natural and cultural heritage of NSW. NPWS has statutory obligations under the *Rural Fires Act 1997* to protect life and property on its lands and to prevent fire from leaving its estate.

The NPWS must give appropriate consideration in its fire management planning to the requirements of protection for both human life and property as well as the protection of the environment. Thus, by its fire management policies the NPWS must not only safeguard the direct protection of human life, it must also ensure the protection, for future generations, of the natural and cultural values of NSW. These obligations, though not mutually exclusive, require a flexible and adaptive approach to fire management.

As a public authority and as a Fire Authority under the *Rural Fires Act 1997* the NPWS has certain rights and responsibilities to undertake appropriate measures to prevent fire from entering or leaving its estate. As a Fire Authority the NPWS is required to implement the provisions of Bush Fire Management Plans.

Under the *Threatened Species Conservation Act 1995* relatively high frequency fire is listed as a key threatening process. NPWS is obliged by the Priority Action Statement under this act to:

- Develop protocols for minimising risk to fire sensitive species and ecosystems when undertaking fuel-reduction burning;
- Design burning prescriptions for purposes of maintaining ecological processes;
- Identify fire sensitive species and ecological communities; and
- Support the implementation of the Bush Fire Environmental Assessment Code and provide information relevant to maintaining the Threatened Species Hazard Reduction List (RFS, undated b).

Other relevant legislation for fire management includes the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* which provides for the identification and listing of threatened species and ecological communities.

1.2.5 Fire management policies of NPWS

A wide range of fire management policies are outlined in the NPWS Fire Management Manual (NPWS, 2007a). This manual is updated annually and is the primary source of direction for all aspects of fire management in NPWS reserves.

The primary fire management objectives of NPWS are (NPWS, 2006a):

- protect life, property and community assets from the adverse impacts of fire;
- develop and implement cooperative and coordinated fire management arrangements with other fire authorities, reserve neighbours and the community;
- manage fire regimes within reserves to maintain and enhance biodiversity;
- protect Aboriginal sites and places, historic sites and places and culturally significant features known to exist within NSW from damage by fire; and
- Assist other fire agencies, land management authorities and landholders in developing fire management practices to conserve biodiversity and cultural heritage across the landscape.

All prevention and suppression works will, where possible, be pre-planned and coordinated with neighbours and other agencies likely to be affected by NPWS activities. The NPWS will undertake its fire prevention program, through public education and through local implementation and enforcement of the Acts and Regulations applying to fires.

This strategy is consistent with the key policy directions of the Parks and Wildlife Division Plan 2006-2008 and actions outlined in the NPWS Southern Branch Strategic Plan 2008/2009.

1.2.6 Fire management objectives for the Park

The overall management of the Park is prescribed by objectives stated in the *National Parks and Wildlife Act 1974*. It is a requirement under that Act that no operations and actions are to be undertaken which are contrary to the Plan of Management (POM). The KNP POM (NPWS, 2007b) states as an overarching principle: "Maintain or improve the condition of the natural and cultural values that together make the Park a special place."

The KNP POM (NPWS, 2007b) further states the following specific fire management objectives:

- Fire management is aimed at ensuring:
  - No human life is lost or person injured as a result of fire;
  - Infrastructure within and beyond the boundaries of the Park is not damaged from fire;
  - Important natural features, especially alpine areas, restricted, rare or endemic plant or animal communities and species, and karst systems, are protected from detrimental impacts associated with fire;
  - A natural diversity of vegetation communities and age classes is promoted;
  - Fire does not contribute to catchment instability and water quality problems;
  - Sites and features of cultural significance are protected from fire; and
  - wilderness quality and scenic amenity are retained.
- Fire suppression and protection operations are undertaken in ways that minimise adverse effects on the values of the Park;
- Fire detection and access infrastructure and operations permit rapid suppression of fire;
- Prescribed burning is strategic in nature and undertaken in ways that minimise associated adverse effects;
- The incidence of unplanned fires ignited from human causes in the Park is minimised;
- Fire management decision-making is informed by the results of relevant research; and
- Fire management is strategically coordinated across the greater landscape and multiple land tenures and involves the community.

Further, the KNP POM outlined a range of key actions that need to be considered in this strategy. The actions are listed in Table 1 below.

Table 1 KNP Plan of Management actions for Fire management

POM ref.	Action	Priority
11.5.1.6	Review the Fire Management Plan every five years.	Medium
11.5.1.7	Ensure fire protection strategies are prepared by leaseholders for all lease areas. Ensure these strategies are consistent with the relevant Bush Fire Management Plan for the region and the Fire Management Plan for the Park. These strategies will be reviewed every five years concurrent with the review of the Fire Management Plan.	High
11.5.2.2	Ensure early detection and rapid suppression are key elements of the fire suppression strategy for the Park.	High
11.5.2.3	Ensure fire suppression operations are consistent with the operational guidelines contained in the Fire Management Manual and are undertaken in ways that minimise impacts on the values of the Park.	Ongoing
11.5.2.6	Undertake environmental impact assessments for proposed fire management works programs as required.	Ongoing
11.5.3.3	Maintain aerial surveillance during severe fire weather conditions or specific periods identified in the Fire Management Plan.	Ongoing
11.5.3.4	Maintain a strategic road access, water point, and helipad network as prescribed in the Fire Management Plan. Periodically review the operational utility of these features.	Ongoing
11.5.3.5	Assess the operational utility of new management trails, helipads, breaks and water points resulting from suppression operations as soon as practicable after a fire. Rehabilitate these works unless they are assessed	High

POM ref.	Action	Priority
	as being required for ongoing use under the Fire Management Plan.	
11.5.4.2	Undertake environmental impact assessments for proposed fuel reduction and habitat manipulation burns as required.	Ongoing
11.5.4.4	Inform local communities of intended prescribed burning operations.	Ongoing
11.5.5.1	Investigate the cause of all unplanned fires.	Ongoing
11.5.5.2	Work with fire management authorities to investigate ways of improving the level of unplanned fire investigation and success in identifying and prosecuting arsonists.	Ongoing
11.5.5.3	Implement Park wide or site-specific bans on the use of solid fuel fires whenever warranted by fire danger conditions.	Ongoing
11.5.5.4	Brief all contractors working in the Park on measures designed to minimise fire risks associated with their activities and ensure all contractors carry fire suppression equipment where required.	Ongoing
11.5.7.2	Continue to participate in community-based fire management planning and operations primarily through involvement in local Bush Fire Management Committees.	High
11.5.7.3	Continue to liaise with all relevant public and private authorities and individuals regarding fire management including the Rural Fire Service, State Forests, Department of Planning, NSW Fire Brigades, Snowy Hydro Limited, lessees, local councils and Park neighbours.	Ongoing
11.5.7.4	Promote the development and adoption of common data-sharing agreements for the transfer of fire information amongst relevant agencies communities and individuals.	High
11.5.7.5	Raise awareness of fire management issues within neighbouring communities and amongst Park visitors.	Ongoing
12.2.1.17	Maintain a system of trails for fire management, pest species management, and other essential Park or emergency operations.	Ongoing
13.2.1.3	Develop cooperative arrangements with Park neighbours, residents and lessees concerning matters such as fire management and weed and feral animal control (Chapter 11).	Ongoing
14.3.1.1	Pursue cooperative management arrangements with the owners and managers of in-holdings in relation to weed and feral animal control programs fire protection and suppression operations access and boundary-related issues.	Ongoing

Following the 2003 fire season, during which 69% of the Park, and other significant areas of the Australian Alps in Victoria, were burnt at varying intensities, the Australian Alps Ministerial Liaison Council endorsed a set of broad fire management principles for the Australian Alps. These principles are outlined in Appendix 1 and are adopted, in principle, for this strategy.

1.2.7 Local & Regional Environmental Plans and SEPPs

the Park lies within five local government areas of Tumbarumba, Tumut, Cooma–Monaro, Snowy River and Bombala.

The planning instruments that set the general direction for land use regulations are the *Local Environment Plan (LEP)* and the *Development Control Plan (DCP)* pursuant to Section 72 of the *Environmental Planning and Assessment Act 1979*, for each of these local government areas.

As defined in the New South Wales Government Gazette No. 81: Part 8 (Environmental Protection and Nature Conservation), the Park is *Zone 8: National Parks and Nature Reserve Zone* in these plans. In *Zone 8* an activity can be carried out without development consent if it is authorised by or under the *National Parks and Wildlife Act 1974*. Any other development that does not come under this category is prohibited on land zoned *Zone 8*.

State Environmental Planning Policies (SEPP) deal with issues of environmental significance to the State. NPWS is permitted to carry out fuel reduction activities under SEPP 4, 11 D, (Development without Consent and Miscellaneous Complying Development) under its current zoning. However SEPP 4 does not apply to Alpine resort areas. SEPP (Kosciuszko National

Park - Alpine Resorts) 2007 is a relevant planning instrument for Alpine resort areas that strengthens the assessment framework for development within the alpine resorts and reinforces environmentally sustainable development and recreational activities within these resorts. The Policy also facilitates the protection of the natural and cultural setting of the alpine resorts in the Park.

1.2.8 NSW Biodiversity Strategy

The *NSW Biodiversity Strategy (1999)* was developed by the New South Wales Government and develops a collaborative approach to biodiversity conservation. This strategy's over-riding goal is:

> "To protect the native biological diversity of NSW and maintain ecological processes and systems".

The strategy identified inappropriate fire regimes as one of the nine key threatening processes affecting the biological diversity of NSW. This issue is targeted within the Biodiversity strategy through:

- Action 43: manage fire in accordance with ecologically sustainable development principles;
- Action 44: improve the consideration of fire threat in land-use planning and incorporate the results of applied fire research, including the knowledge and experience of Aboriginal and local communities, in land management and land-use planning; and
- Action 45: continue a research program to examine the effects of fire on biodiversity.

1.3 Description of the Park

1.3.1 Location

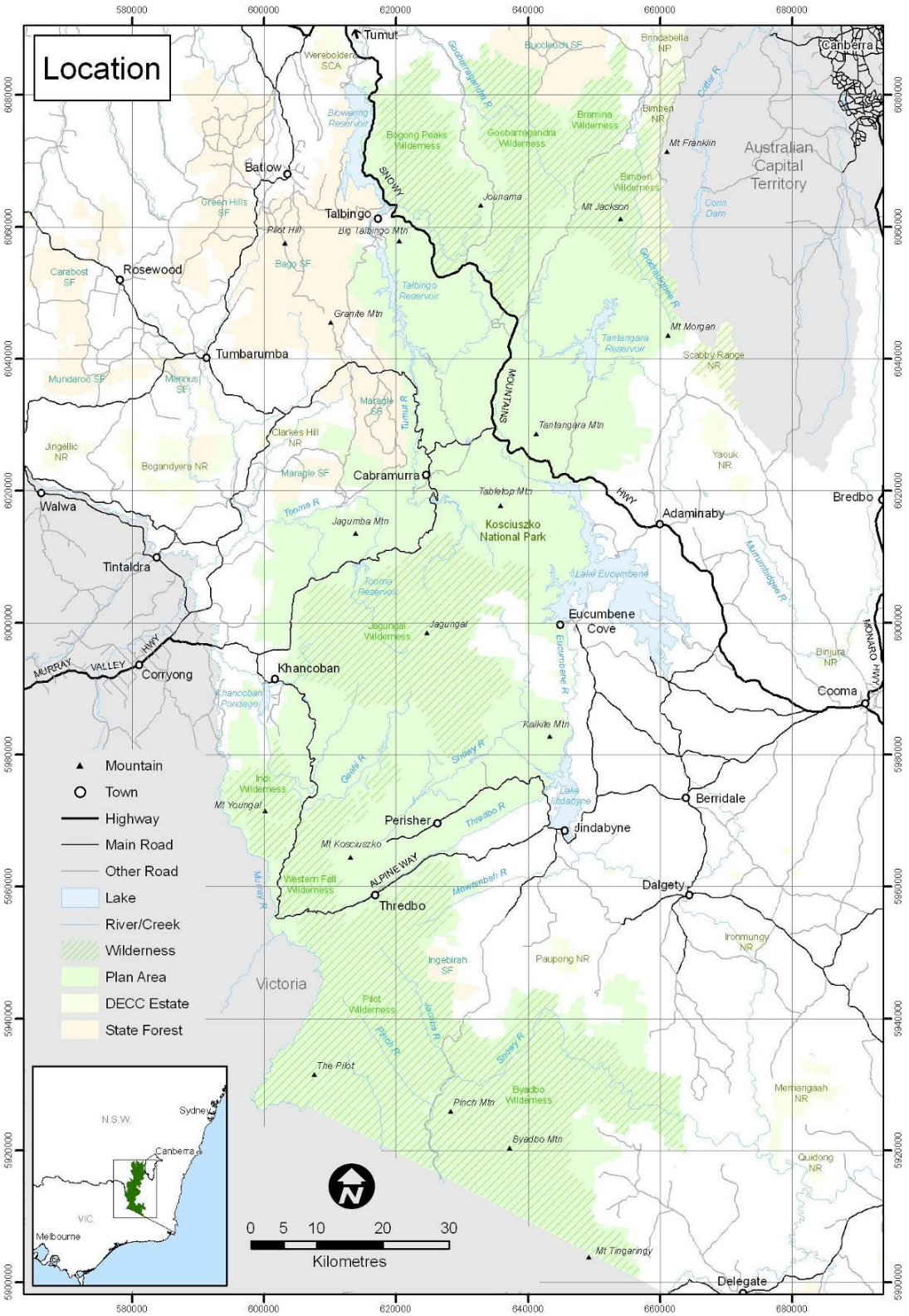
Kosciuszko National Park, which encompasses 688,880 ha, is the largest national Park in NSW and one of the largest conservation reserves in Australia (Figure 1). Located in the south-eastern corner of the Australian mainland between latitudes 35°30s and 37°02'S and longitudes 148°10'E and 148°53'E, the Park straddles the Great Dividing Range, known in this region as the Snowy Mountains (NPWS, 2007b).

The Park has continuous connection with adjacent National Parks and Reserves including Namadgi National Park in the ACT, and the Alpine and Snowy River National Parks in Victoria. As a result, this strategy also considers, in some locations, adjacent fuels, assets, fire control advantages and strategies.

Land use adjacent to the Park includes publicly and privately owned forestry operations (hardwood and softwood), agricultural grazing lands, crown lands and various private properties. The mix of various land tenures surrounding the Park, together with their differing management priorities and regimes, demands cooperative and community-wide approaches to many shared issues and opportunities including fire management (NPWS, 2007b).

Key population centres near to the Park include Canberra, Adaminaby, Berridale, Cooma, Jindabyne, Delegate, Bombala, Tumut, Talbingo, Tumbarumba, Khancoban and Corryong. The Park has two major transport routes being the Snowy Mountains Highway and the Alpine Way. Catchments within the Park provide clean water for major irrigation schemes on the Murray River system, for hydroelectric electricity generation, and drinking water.

Figure 1 Location map



1.3.2 Terrain

The Park includes some of the highest ranges and mountains in Australia and elevations range from 227 metres ASL along the Snowy River to 2228 metres ASL at the summit of Mount Kosciuszko, Australia's highest peak. The terrain consists of generally moderate slopes from the east leading up to the well rounded mountains along the north-south axis of the Great Dividing Range. The western side of the Park and the Byadbo area in the south east are characterised by often very steep gorges and valleys. Within the Park there are nationally significant karst systems, deep river valleys, many frost hollows and a wide range of localised land forms. The landforms contribute significantly to localised variations in weather conditions, wind patterns, vegetation, fuel loads and arrangements, and fuel moisture. Such topography and inherent variations are frequently a challenge in fire suppression operations.

Outside of the principal tourist destinations and the public road network, the Park is largely remote with limited vehicle access. The remote terrain necessitates a reliance on aircraft and the deployment of remote area fire fighting teams for fire suppression. Remote and rugged terrain also contributes to varying levels of radio communication effectiveness (refer Radio coverage maps accompanying this strategy). Access difficulties in the rugged mountainous terrain sometimes results in extended response times and subsequently larger fire events particularly during drought conditions.

1.3.3 Natural Heritage

The Park has significant natural heritage values including its soils, rocks, karst and landforms; rivers and lakes; native plants and animals; wilderness; ecosystem processes and aesthetic values (NPWS, 2007b). These values have evolved under a long history of regular bush fire events of varying frequency, intensity and size. The season, frequency, intensity and type of bush fires affecting an area is known as a 'fire regime' (Gill, 1975) although other definitions do not use the "type" of fire and add "spatial extent" as a factor e.g. Brown *et al*, (1998). The natural values of the Park are sensitive in many different ways, to variations in the fire regime. These values may be easily compromised by inappropriate fire regimes and related activities including fire suppression operations.

Many natural ecological processes of regeneration and renewal are triggered by fire and it is recognised that fire plays an important role in the life cycle of numerous plant and animal species (NPWS, 2007b). Predicted future climate change, in combination with changes to aspects of the fire regime such as increased frequency, has the potential to significantly influence the life cycles of both plants and animals, and the future geographic extent of some vegetation communities' in the Park e.g. Alpine Ash, remnant rainforests.

Currently much of the vegetation in the Park is skewed, (to varying degrees according to fire intensity), to a young post fire age due to the 2002-2003 fires. This is significant in terms of biodiversity thresholds and fuels as discussed later in this strategy.

Fire represents one of the most significant issues in the management of the extensive eucalypt-dominated forests and woodlands of the Park. Human interaction often seeks to control bush fire events by limiting the area burnt and the intensity, and managing the frequency, to minimise the risk to life and property. In particular, the high incidence of fire from the mid-nineteenth century onwards has contributed to:

- Changes in age classes, especially a reduction in the proportion of old-growth vegetation present;
- Changes in vegetation structure and composition;
- Widespread loss of topsoil; and
- Invasion by pest and weed species.

1.3.3.1 Catchments, soils and karst values

The Park has a wide range of catchment and geomorphological values which are outlined in the KNP POM (NPWS, 2007b). Of significance for fire management are the karst areas in the north

of the Park and on the Victorian border, the sensitivity of Alpine lakes, peat lands and bogs to fire and suppression operations, and the influence of fire on soils and catchment values.

Catchment
Bush fires can have a significant effect on a landscape's hydrology. Intense bush fires can remove vegetation cover, fine fuels and decomposing organic matter that protect soils from erosion. Water run off can increase after fires due to the decrease in foliage which intercepts rain and utilises ground water in transpiration processes, and a decrease in fine and coarse surface litter. After an intense fire, soils can be unprotected and potentially exposed to higher than normal levels of erosion by heavy rain. Forests with high water use in the regrowth phase e.g. Ash forest, can potentially reduce water yield in the catchment for a period.

The catchments of the Park contribute clean drinking water to the water storages of the resort areas and neighbouring towns, and to the water supply systems of the Murray River, Murrumbidgee, and Snowy River catchments. The headwaters of these three major river systems are located within the Park. Drinking water quality and yield can be significantly affected by high intensity bush fires when extensive areas have been burnt (White *et al*, 2006). The major impacts include increased sediment, nutrient and organic matter loads in river systems and water storages with the erosion of soil and ash following post fire rains. Such events are generally limited to high to extreme rainfall events occurring within twelve months of an intense and widespread fire. Low intensity bushfires of small extent generally have very little impact on catchment values.

Fires also impact on the water retention capacity of bogs due to reduced vegetative cover, increased erodibility, increased channel incision and collapse of channels (URS, 2006). The percentage of fully functioning bogs in the Park has been significantly reduced following the impacts of grazing and unplanned fires in the last 100 years. The impacts of the 2003 fires on the bog system were also extensive (Good, 2006). An ongoing Alpine fen and bog rehabilitation program was commenced after the 2003 fire season and is ongoing.

Soils
The soils of the Park are derived from a diverse range of parent materials including alkaline limestone and basalt, and acidic granites and sediments. Beyond their intrinsic, ecological and scientific values, all of the soils of the Park have vital 'service functions' such as the maintenance of the supply of clean water for domestic and industrial uses, irrigation, and hydro-electric power. The alpine and subalpine soils in particular, receive, store, process and supply a larger quantity of high quality water than any other group of soils on the continent (NPWS, 2007b).

Soils in the Park are highly variable from the deeper loams at lower elevations to the skeletal soils on north aspects with steep slopes. The most erodible soils are in the lower and warmer elevations and consist of brown and medium-brown podsols and red loams. Soils in the higher elevations consist of the alpine and trans-alpine and grey podsolic soils and these are considered the least erodible (URS, 2006). Large areas of the Park are of soils with high organic content which have been impacted significantly by past land use including grazing and fire regimes. Concerns about widespread soil degradation due to grazing practices, and recognition of the importance of the mountain soils for catchment stability and water yield, were key considerations in the establishment of Kosciusko State Park in 1944 (NPWS, 2007b).

Karst
There are eight karst areas within the Park (Yarrangobilly, Jounama Creek/Black Perry Mountain, Cooleman Plain, Ravine, Upper Goodradigbee and Cooinbil in the north and Indi and Cowombat Flat in the south) and these are considered to be nationally significant (NPWS, 2006b). These areas are significant in relation to geomorphology, including surface and subterranean landforms and karst processes, and biological values. Individually, both Cooleman Plain and Yarrangobilly are regarded as nationally significant in terms of their geological, geomorphological, hydrological and zoological values. Beyond their scientific

attributes, the karst areas are also significant for their historical, aesthetic and recreational values. Fire management is considered a key management issue for maintenance of the values of karst areas.

Karst systems are essentially finite and non renewable within human timeframes, and are amongst the most vulnerable of ecosystems within the Park. The integrity of karst systems relies upon the interactive relationship between rock, water, soil, vegetation and air. Some disturbances to these relationships, such as a disturbance resulting from some types of fire, may result in undesirable impacts on karst values (NPWS, 2007b)

1.3.3.2 Flora

Over 850 species of native flora and 221 introduced flora species have been recorded within the Park (NPWS 2007b). The Park contains seven endangered species and ten vulnerable species listed under the *Threatened Species Conservation Act 1995* (Appendix 7). Under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, one species found in the Park is regarded as endangered and ten species are considered to be vulnerable. In addition there are fifty two species listed as being rare or threatened plants (ROTAP) by Briggs and Leigh (1996). Thirty-six species of plants are endemic to the Park, while the Park is the only known location in NSW for ninety six species. Most of the species listed as endangered or vulnerable and those with restricted distributions are found in the alpine and subalpine areas.

1.3.3.3 Vegetation Communities

The Park contains 54 distinct vegetation communities (Gellie, 2005). Much of the Parks flora and vegetation communities are of international and national significance (NPWS, 2007b).

From west to east at lower elevations, Black Sallee (*E. stellulata*) and Broad-leaved Sallee (*E. camphora*) along the Geehi and upper Murray (Indi) Rivers give way to dry sclerophyll forests of Brittle Gum (*E. mannifera*), Red Stringybark (*E. macrorhyncha*) and Broad-leaved Peppermint (*E. dives*) on the lower, drier slopes of the Great Divide. With increasing elevation, the dry forests are replaced by a broad band of wet sclerophyll or Montane forest which occupies most of the western mountain slopes. A band of Ribbon Gum (*E. viminalis*), Brown Barrel *(E. fastigata*), Eurabbie (*E. bicostata*) and Narrow-leaved Peppermint (*E.radiata*) grades into stands of Alpine Ash (*E. delegatensis*), Mountain Gum (*E. dalrympleana*), White Sallee or Snow Gum (*E. pauciflora*) and the rarer Bogong Gum (*E. chapmaniana*). At around 1500 m, sclerophyll forest gives way to more open subalpine woodland of Twisted Snow Gums (*E. niphophila*).

In the more gradual easterly descent from the high tops, where it is considerably drier than the western escarpment, the upper wet sclerophyll forest belt contains less Alpine Ash and the lower belt is largely replaced by a dry sclerophyll forest of Broad-leaved Peppermint and Candlebark (*E. rubida*). Associated woodland on the gentler eastern slopes contains White Sallee, Candlebark and Ribbon Gum.

The Snowy River valley encloses a lower, drier and warmer environment that supports woodlands and scrubs not found elsewhere in the Park. Of particular interest is the White Box (*E. albens*) - White Cypress Pine (*Callitris endlicheri*) woodland, which is the largest occurrence of this association east of the Great Divide. In the warmer and drier Byadbo country patches of so called ‘black scrub’ are found. These communities are dominated by the coastal Bodalla Silver Wattle (*Acacia silvestris*), the inland Currawang (*A. doratoxylon)* and the Rock Wax-flower (*Philotheca trachyphylla*).

The ecological sequence from the north to the south of the Park along the top of the Fiery Range and the Great Dividing Range is far simpler, consisting primarily of an elevated north-south plateau occupied by subalpine Snow Gum woodlands. Much of this community has been burnt in recent decades, and extensive areas of dead Snow Gum stems now dominate many of the subalpine landscapes of the Park. The woodlands of this undulating plateau are broken by

treeless frost hollows. Bogs, fens, heaths and sod tussock grasslands grow in these places, the largest of which occur in the northern end of the Park.

Beyond the upper treeline, alpine meadows of dwarf plant communities prevail. Tall alpine herbfields of the Snow Daisy - Snow Grass (*Celmisia* spp - *Poa* spp) alliance are the most widespread community. Elsewhere, the alpine vegetation consists of heathlands, sphagnum bog and fen communities, and very rare communities such as short alpine herbfield, windswept feldmark and snow patch.

The Park contains two endangered ecological communities listed in the Threatened Species Conservation Act:

- Montane Peatlands and Swamps of the South East Corner, South Eastern Highlands and Australian Alps bioregions (occurs in the Alpine area); and
- White Box Yellow Box Blakelys Red Gum Woodland (occurs in the Lower Snowy).

Significant vegetation communities, in relation to fire management within the Park are:

- Subalpine woodlands, shrublands, treeless plains and streambanks including the rare *Eucalyptus lacrimans*. Threatened by high frequency fire and large spatial extent of 2003 fires resulting in loss of many areas previously characterised by a long time since fire. Recovery time is very slow;
- Alpine Ash forests. Potentially threatened by predicted increases in fire frequency as a result of climate change;
- Cool temperate rainforest sheltering in the fire protected gullies of the Geehi Valley, in the Pilot Wilderness and in the Bogong Peaks wilderness area. This community is threatened by predicted fire regime changes resulting from climate change;
- Karst grasslands in the Cave Creek and Yarrangobilly Caves area are a unique limestone based grassland requiring special consideration for fire management;
- White Box (*Eucalyptus albens*) and Cypress Pine (*Callitris endlicheri*) woodlands of the lower Snowy River. These areas are included as they are listed as endangered ecological communities;
- The black scrubs (*Acacia sylvestris - Eriostemon spp*) of the Byadbo area occur as discrete patches and appear to be maintained by occasional high intensity fires;
- Alpine communities such as feldmark and species such as *Podocarpus lawrencii* were impacted extensively by the 2003 fires and are extremely slow to recover;
- Headwaters of Kosciusko Creek is a long unburnt old growth Snow Gum community with a mature shrub understorey. As such it is an important remnant and refuge area; and
- Old growth Ash forest in the Tooma area and remnant old growth subalpine woodlands are now of restricted distribution.

Matching of forest ecosystems determined during the Comprehensive Regional Assessment program in the late 1990s and subsequent work by Gellie (2005) to broad vegetation formations are presented in Appendix 5. For most analyses the broader vegetation formations have been used as they are at a more appropriate scale for the purposes of fire management outlined in this strategy

1.3.3.4 Fauna

The Park supports a high diversity of fauna including, 31 mammals, over 200 birds, 31 reptiles, 11 amphibians, and an unknown number of invertebrate species. Some species are alpine specialists, having become genetically isolated at higher elevation and now only persist as a series of discrete and sometimes endemic populations e.g. Mountain Pygmy Possum (*Burramys parvus*).

Mammals that are considered to be extinct within the Park include the Eastern Bettong (*Bettongia gaimardi*), the Eastern Quoll (*Dasyurus vivverinus*) and the Brush-tailed Rock Wallaby (*Petrogale penicillata*).

Nearly 40% of all bird species known to occur in NSW have been recorded in the Park, reflecting the remarkable diversity of habitats present. Most of these species have widespread distributions across the greater landscape, with the highest diversity of birds occurring in the dry forests and woodlands.

Two bird species that formerly occurred in the region, the Orange-bellied Parrot (*Neophema chrysogaster*) and the Australian Bustard (*Ardeotis australis*) are locally extinct while a number of other species have not been sighted in the area for many years.

The highly diverse reptile fauna of the Park is unusual in that almost half of the species present occur above the snowline.

Eleven species of frogs inhabit the Park, five of which are known from the subalpine area. Five of these cold-climate specialists are undergoing rapid population declines and range contractions. The Northern Corroboree Frog (*Pseudophryne pengilleyi*) and Southern Corroboree Frog (*Pseudophryne corroboree*) occupy wetlands of the alpine and subalpine areas and are both endangered. The once widespread Alpine Tree Frog (*Litoria verreauxii alpina*) has suffered a similar decline as has the threatened Booroolong Frog (*Litoria booroolongensis*) and the endangered Spotted Tree Frog (*Litoria spenceri*).

Thirty two species found in the Park (including mammals, birds and frogs) are listed as threatened under the *Threatened Species Conservation Act 1995* and two resident fish species are listed as threatened under the *NSW Fisheries Management Act 1994*. A high proportion of these threatened species inhabit the alpine and subalpine areas of the Park.

1.3.3.5 wilderness

In addition to the management requirements of a National Park, approximately 50% of the Park is also managed for wilderness values. Declared wilderness Areas within the Park include the Bogong Peaks, Bramina, Goobarragandra, part of Bimberi, Indi, Jagungal, Western Fall, Pilot, and Byadbo.

The *wilderness Act 1987* defines wilderness as an area that together with its plant and animal communities is in a state that has not been substantially modified by humans and their works, or is capable of being restored to such a state. Ecologically inappropriate fire regimes and fire management activities can affect wilderness values. Activities that are incompatible with wilderness values include the construction of fuel breaks and access tracks with earth moving equipment, the felling of trees for helipads and the intensive use of people and aircraft in remote fire fighting situations.

Some fire situations demand a response that may be incompatible with wilderness values, both in the short term and the long term, in order to protect life and property and significant ecological values. In such circumstances the protection of life and property and significant ecological values may take precedence over wilderness values.

1.3.4 Cultural Heritage

The capacity for fire to significantly impact upon cultural material was illustrated by the 2003 bushfires that destroyed or seriously damaged 19 historic huts and a number of other cultural features. A number of significant Aboriginal sites were also damaged due to suppression efforts and the impacts of fire itself such as the burning of old shield and scarred trees.

The Park has significant cultural heritage values including its Aboriginal heritage; histories of pastoralism, mining, water harvesting; a range of historic huts; scientific research; conservation and recreation values (NPWS, 2007b). Culturally important places, sites and objects of both Aboriginal and non-Aboriginal origin occur throughout the Park. These provide a record of human interaction with the natural landscape.

Evidence is strong for the historic Aboriginal occupation of all areas of the Park. It must therefore be assumed that there are Aboriginal sites in virtually all parts of the landscape, even though they may not be recorded. The majority of recorded sites occur along the Snowy River in the southern end of the Park and these sites are primarily open camp sites (artefact scatters). Open camp sites account for 90% of all known Aboriginal features within the Park. Current records indicate 82% of known open camp sites and all recorded scarred trees are located within 500 m of roads and trails. As a result, the known distribution of Aboriginal sites does not reflect the real spatial distribution. The known sites represent a fraction of the potential number of sites throughout the Park (Grinbergs, A. pers. comm. 2004).

Significant cultural heritage values include:

- Over 600 recorded Aboriginal archaeological sites and other culturally significant areas; and
- Nearly 1000 recorded historic places including buildings, mines, quarries, lookouts, picnic areas and walking tracks occur in the Park. These latter sites reflect changing land use, phases of settlement, the development of tourism, outdoor recreation and conservation movements in the latter part of last century and early this century.

Coolamine homestead, classified as an historic building by the National Trust, Currango homestead complex and Yarrangobilly Caves House and associated buildings have exceptional value as rare examples of architectural design and structure. The other huts distributed throughout the Park are equally as important. Some outlying huts have associations with other homesteads (e.g. Currango, Coolamine) or past events. The huts are a significant component of the total cultural landscape and contribute to the overall significance of other features and events that have occurred throughout the Park.

Other features of cultural heritage significance in the Park include: ruins (e.g. Jounama homestead, Southern Cloud, etc); sites (e.g. SMA camps, dwellings, sawmills, exotic gardens, etc); landscapes (Kiandra goldfields); and miscellaneous features (including telegraph lines, fence lines, hawkers trails, stock routes, roads, etc).

1.3.5 Recreational use and facilities

The Park provides a wide range of recreational opportunities in a natural setting. The Park is in close proximity to Canberra and can be accessed easily from the north, east and west. As a consequence it receives over one million local and international tourists per year, although two thirds of these visitors are in winter. Other key peak periods include the summer school holidays and Easter, both periods in which bushfires have occurred.

Although recreational activities are undertaken throughout the Park, there are a number of discrete areas of concentrated use. The alpine resorts are major assets within the Park. Apart from the alpine resorts, the major road corridors of the Barry Way, Alpine Way, Khancoban-Cabramurra Rd, and Snowy Mountains Highway with their associated picnic and camping areas, short walks and lookouts are especially popular. So too is the Main Range, and in particular Mount Kosciuszko, which is a key visitor attraction in summer. In the northern end of the Park, the show caves at Yarrangobilly are popular visitor destinations, as are Blue Waterholes, Coolamine and Currango Homesteads, Cabramurra Township and Eucumbene, Tantangara, Talbingo and Blowering Dams.

The wilderness areas of the Park provide visitors with opportunities to undertake self-reliant recreational activities in remote settings where they can experience a sense of solitude. Even in wilderness areas, recreational use is concentrated along certain management trails and walking tracks, and at particular huts and landscape features. Assessment of the risks to visitors to the Park is addressed in the risk assessment section of this strategy.

A number of private and commercial groups use the Park for remote area recreation, including during the bushfire season. Contacting and evacuating visitors in a remote area under threat from a bushfire can sometimes be difficult although in the past such evacuations have always been successful. Procedures are in place for licensed operators to provide their contact details

and specific trip planning information to ensure that location of their group is known at any given time.

Potential numbers of visitors and visitor locations are tabled in Appendix 2. This table, and the new visitor safety and operations maps, shall be referred to for the purpose of identifying locations where evacuations may be required in the event of a bushfire threatening those areas.

1.3.6 Major non ecological assets

Within and adjacent to the Park there are a large number of capital assets at a potential risk from damage from bush fires. These include:

- Numerous NPWS facilities that are distributed throughout the Park;
- Numerous assets throughout the Park associated with the operations of the Snowy Mountains Hydroelectric Scheme which are owned and maintained by Snowy Hydro Limited;
- Ski resort lease holdings, principally at Thredbo, Perisher, Guthega, Smiggin Holes, Charlotte Pass and Mt Selwyn;
- Rural lands adjacent to the Park in the north, east and west;
- Major infrastructure and utilities such as power lines, sewerage systems, transmission and communications, water supply and monitoring equipment; and
- Commercial pine plantations (both State-owned and private).

A range of infrastructure has been established within and adjacent to the Park to support Service operations, including:

- Field depots at Waste Point, Blowering, Khancoban, Yarrangobilly and Bombala;
- Staff accommodation located at Yarrangobilly Caves, Currango Homestead, Blowering, Waste Point, and Smiggin Holes;
- Management trails (in excess of 2500 kilometres) located throughout the Park;
- Radio communication infrastructure located at Wambrook, Perisher, Youngal, Mount Selwyn, BlackJack, Yarrangobilly Caves, Ginnini, Bugtown Hill, Big Talbingo Mountain and Ingebyra;
- Fire towers located on Mount Youngal, Mount Blackjack, Big Talbingo Mountain and at Ingebyra;
- RTA snow clearing depots at Friday Flat, Kiandra and Wilsons Valley; and
- Park entry stations located on the Alpine Way and Kosciuszko Road and seasonally on the KNP5 (Cabramurra) Road.

Assessment of the risks to all assets, and strategies to mitigate the risks, are addressed in section 2 this strategy.

1.3.7 Contribution to local economy

The local economies of the regions surrounding the Park are reliant to varying degrees, on the tourism industry. The alpine resorts provide significant contributions to the local economy and summer trade can be impacted by bushfire emergencies. The Park plays a key role in local tourism, by providing lookouts, landscape views and a wide range of recreational opportunities. The passage of uncontrolled bush fires can make areas unsafe and affect aesthetic values. During bush fire suppression operations and following a risk assessment, areas are sometimes closed to the public during or after fires or in periods of high and extreme fire danger. This can impact on the local economy by limiting recreational opportunities and access such as to walking tracks and lookouts.

1.4 The Bushfire Environment

1.4.1 Climate and fire weather

South East Australia has an inherently highly variable climate. The climate within the Park reflects the proximity of the area to maritime influences, the intersection of predominantly west-east moving pressure systems, and the elevated and deeply dissected topography. Generally the weather in the Park is dominated by southern maritime air masses bringing cool moist air to the area in winter, and easterly maritime tropical and temperate air masses bringing moisture from the coast to the tablelands in summer. Orographic uplift as the westerly airstreams rise over the range also contributes significantly to weather patterns.

Precipitation varies across the Park, ranging from an average 2800 millimetres a year in areas above 1800 metres, to approximately 400 millimetres a year in the lower rainshadow affected areas in the south east of the Park. There is a rainfall gradient based on elevation, with most precipitation falling in winter on the west side of the Park, but predominantly summer rainfall on the east side. The coastal ranges on the eastern side of the Monaro Tablelands also create a rain shadow effect, particularly in summer, but its effect on the Park is not as pronounced (Dept of Environment and Planning, 1983).

Snow is expected between May and October in areas over about 1300 metres, accounting for 60% of total precipitation in the alpine zone of the mountains. Snow may remain on the ground for three to four months in alpine areas. The north south orientation of the main ranges stand at right angles to the prevailing westerly winds. Orographic uplift resulting from this interception produces precipitation which falls on the western side of the Park but diminishes to the east.

Temperature also closely follows an altitudinal gradient, with the exception of temperature inversions in sub-alpine areas. In alpine areas, maximum monthly temperatures range from a mid-summer average of between 15°C and 20°C to a mid-winter average of below 0°C. In the lowland rainshadow areas, temperatures range from a mid-summer average of 24°C to a mid-winter average of 7°C. However, summer temperatures in lower areas may range from 30°C to 35°C, and in some areas occasionally exceed 40°C.

At higher elevations frost may occur up to 250 days a year, compared to approximately 80 days on the tablelands and 20 days in the lower Snowy area.

Throughout the year, the predominant wind across the Park is from the north-west to the south-west, but local variations are experienced as a result of the rugged topography. Valleys may funnel winds and passing fronts can cause dramatic wind shifts. The north-westerly winds tend to be warmer and drier than the south-westerlys.

There is a general weather pattern that occurs throughout the year in relation to fire risk which is shown in Table 2.

Table 2 Typical pattern of the yearly fire season in Kosciuszko National Park

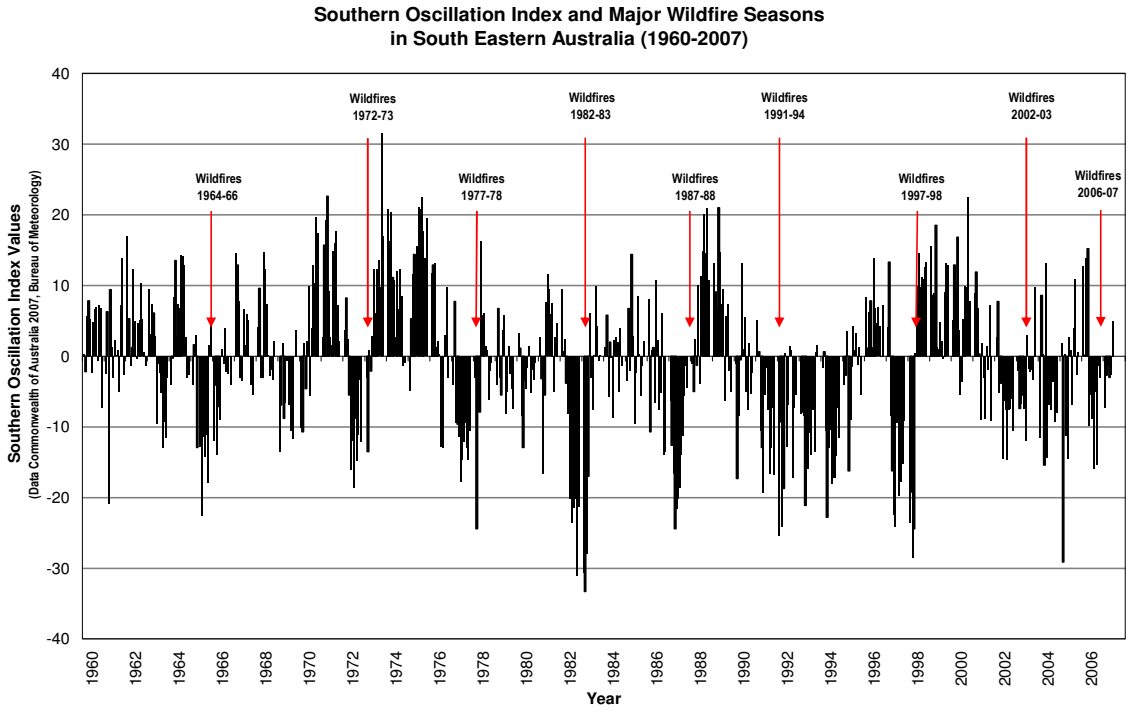
Period	Unplanned fire risk	General conditions
September – December	Moderate	- Week long high pressure synoptic patterns can bring cool dry and gusty northerly to westerly airstreams which are commonly followed by cooler south to south westerly winds in mid to late spring and occasionally in December; - Extreme fire danger days occur when strong to gusty hot-north westerly winds precede cold fronts after prolonged spells of dry weather in November and December; - Multiple ignitions can occur in remote areas of the Park with the passage of dry lightning storms during late spring and throughout the summer; - Fires can occur in frost cured vegetation at higher elevations;

Period	Unplanned fire risk	General conditions
January – April	High	- The summer period has warm to hot conditions at lower elevations and cooler conditions at higher elevations; - Warm periods can be interspersed with south-easterly or easterly airstreams that bring drizzle or rain from the coast to the east side of the Park; - Thunderstorms are frequent sometimes producing localised heavy rainfall and lightning strikes; - Severe fires are likely to occur when January and February rains are below average and dry thunderstorms occur; - Extreme fire danger days occur in December - February.
May - June	Low	- Moist mild weather occurs during this part of the year; - Severe fires unlikely.
July - August	Low	- A winter pattern of cool dry westerly airstreams dominate with occasional cold southerly fronts bringing snow about the ranges; - Weekly passage of cold fronts produces rain and snow above 1200m; - Frosts are common; - Severe fires are unlikely.

1.4.1.1 Climate and past cycles of fire seasons

Historically, evidence from past cycles of fire seasons indicates that severe unplanned fire conditions are likely to occur every 5-11 years (Bureau of Meteorology, 2007). The occurrence of severe seasons generally correlates with 'El Nino' induced droughts that can result in increased availability of fine fuels. El Nino events are associated with increased probability of drier conditions and low (negative) values of the Southern Oscillation Index (SOI). Indicators such as the SOI (Figure 2) can be used to predict the onset of severe fire seasons. Since the 1960s there has been a historical correlation between SOI negative values and major landscape scale fire seasons in the Park.

Figure 2 Southern Oscillation Index (SOI) and major unplanned fires seasons.



1.4.1.2 Climatic conditions associated with moderate fire seasons

The declared bush fire danger period from the 1st October to 31st March encompasses the most severe fire weather for the area. This period is subject to revision by BFMCs according to prevailing and predicted conditions.

Moderate fire seasons are generally associated with average temperature ranges and average to above average annual rainfall. Moderate fire seasons provide more favourable conditions for an increased likelihood of successful fire suppression operations when unplanned fires do occur.

1.4.1.3 Climatic conditions associated with extreme fire seasons

Lindesay (2003) identified key indicators of potentially severe fire seasons that could provide useful information several months before the start of the fire season including:

- A particularly wet spring and/or summer in the year preceding the fire season, in all or part of the region. *Lead time: 7-8 months*;
- Below-average rainfall within all or part of the region in the autumn and winter preceding the fire season, and the spring and summer of the fire season. *Lead time: 2-8 months*; and
- A developing El Niño event, particularly within a negative phase of the Pacific Decadal Oscillation. *Lead time: 4-5 months.*

Lindesay (2003) also identified key atmospheric anomalies that develop immediately before and during a potentially severe fire season in south-eastern Australia that should be monitored. These include:

- Above-average atmospheric pressure over the region and below-average pressure to the south;
- Above-average surface air temperature and free air temperature over the region;
- Below-average cloudiness (*i.e.* above-average Outgoing Longwave Radiation) over the region;
- Below-average relative and specific humidity over the region; and
- Anticyclonic circulation anomalies across the wider region.

These factors are monitored on a regular basis by fire management staff at all levels within NPWS.

The highest risk fire weather patterns that affect bushfire behaviour in south-east Australia occur in summer-autumn when vegetation and fuels are potentially at their driest. A high risk situation occurs when a slow-moving high pressure cell is located in the Tasman Sea, bringing hot, dry north-westerly winds to the region, and is followed by a cold front from the south-west. If a bushfire is in progress, the long north-eastern flank of the fire produced by north-westerly winds could become a very large fire front under a south-west wind change following the passage of the cold front. In addition the effects of decaying and collapsing convection columns can produce unexpected fire behaviour such as rapid shifts in wind strength and direction.

1.4.1.4 Weather conditions suitable for prescribed burns

Weather and fuel moisture conditions are only suitable for prescribed burning for a limited number of days per year. These usually occur in autumn or early spring when fire behaviour can be controlled within natural or established perimeters. Generally suitable conditions coincide with short dry spells of 5–8 days that reduce fuel moisture levels during the day with moisture recovery from over-night dew, and a low probability of dry, north-westerly winds.

1.4.1.5 Climate change and fire weather

There is a strong scientific consensus that the worlds climate is changing significantly, and principally as a result of anthropogenic activity (IPCC, 2007). Localised extinctions of flora and fauna are among the potential impacts, due in part to altered fire regimes as a result of predicted likely increased fire frequency and intensity. While much work is being done to quantify the potential impacts of climate change on variables such as rainfall, temperature,

relative humidity etc, projections are still within widely varying ranges. Fire weather factors are expressed using the Forest Fire Danger Index (FFDI).

Recent modelling of projected climate change scenarios by Lucas *et al* (2007) concluded that:

- There may be an increase of between 2-30% of "very high" and 5-65% of "extreme" fire weather days by 2020. The longer term projection is that there may be an increase between 5-100% of "very high" and between 10-300% of "extreme" fire weather days by 2050.
- This translates to Canberra having an annual average of 18-23 days of >"very high" fire danger days (FFDI >25) by 2020 compared to a current 17, and an annual average of 20-33 days by 2050;
- This translates to Canberra having an annual average of 1.7-2.2 days of >"extreme" fire danger days (FFDI >50) by 2020 compared to a current 1.6, and an annual average of 1.8-5.1 days by 2050;
- The return period for Canberra of FFDI>75 (years between occurrences) is currently 6.6 but is projected to be 6.6-4.7 by 2020 and down to 6.6-1.2 years by 2050;
- Fire seasons are more likely to be longer with an earlier start and slightly later finish while being generally more intense throughout their length; and
- Two new categories may need to be added to the forest fire danger index (FFDI) to cater for more extremes of fire weather in the future. Proposed categories to be added are "very extreme" (FFDI 75-100) and "catastrophic" (FFDI >100). It is acknowledged that such proposals will require significant debate prior to adoption.

Earlier modelling by Hennessy *et al* (2005) concluded that:

- The window available for prescribed burning is likely to shift towards winter and to be more narrow;
- The southeast of Australia will generally be hotter and drier; and
- Little is known of the potential changes to other weather variables such as wind and dew point.

Currently modelled and predicted impacts provide the following implications for fire managers:

- The increased number of days with very high to extreme FFDI provides more favourable conditions for ignitions and faster than normal rates of spread in short term fire development. This can reduce the response time available to crews to control fires in first attack operations;
- Increased or sustained very high to extreme FFDI during fire events implies that fires will be more difficult and dangerous to control, requiring possibly increased resource commitments, and taking more time to contain fires;
- Opportunities for prescribed burning operations may reduce with the window being pushed later into autumn and winter;
- Communities sensitive to inappropriate fire regimes such as Alpine Ash forests, rainforests remnants, subalpine and alpine areas may become subject to more frequent fires. The combination of such fires and increasing temperatures may provide regenerative opportunities for migration of subalpine communities upwards and thus leaving the alpine communities without higher elevation landscapes where they could re-establish (Pyper, 2003); and
- Potentially increased frequency of fires is likely to impact negatively on those species that require population recovery periods longer than the projected frequencies. Species such as Alpine Ash may not have time between fires to develop sufficiently to withstand the more frequent fires and may thus be replaced by more fire tolerant individuals or populations.

There is current research occurring through the Bushfire CRC addressing a number of currently poorly understood fire weather phenomena including:

- nocturnal low level jets which appear to be producing peak FFDIs between midnight and sunrise resulting in unexpectedly intense fire behaviour;
- dynamic channelling which can produce unexpectedly intense fire behaviour; and

- plume driven fires where fire behaviour can be unexpectedly affected by the dynamics of pyro-cumulonimbus storms (McRae *et al*, 2006).

1.4.2 Fire history

The fire history record is the result of collating maps and digital data of unplanned fire, prescribed burn and ignition data. Records have been compiled from NPWS original maps and incident reports, NSW Rural Fire Service, Forests NSW, Hume Snowy Bushfire Prevention Scheme, from service staff, local fire brigade members, and park neighbours.

Relatively little is known of Aboriginal burning practices prior to the arrival of Europeans in Australia, although there can be no doubt that some areas were subjected to deliberate fire by Aboriginal people, as well as being impacted by unplanned fires. As a direct result of early European cultural attitudes and misconceptions, Aboriginal fire management in the Alps is likely to have been misunderstood and many of the misconceptions probably persist today. What is known of traditional burning from Aboriginal oral traditions, historical accounts, fire scars on trees and charcoal deposits in lakes is consistent – Aboriginal use of fire was likely to have been highly planned and carefully executed (Zylstra 2006). Through the use of floral indicators, monitoring of population dynamics and observation of weather phenomena, burns were probably executed with prescriptions specific to ecological communities (pers, comm. R. Mason to P. Zylstra, 2005). The extent of the area burnt was tightly controlled, and serious penalties were invoked if fire escaped (pers, comm. R. Mason to P. Zylstra, 2005). While there are many gaps in the knowledge, the existing evidence consistently indicates that traditional use of fire differs to European use in two main areas. Different forest types were likely to have been given localised treatments as opposed to broad-scale burning, and the total annual area burnt was significantly less than it became under early European management (Zylstra 2006).

The arrival of graziers and early settlers from about the 1820s saw significant change in the frequency of fire (Banks 1982; Barker 1988). The overall recorded frequency of fires increased substantially in the late nineteenth century and twentieth century until the 1960s and has decreased since (Banks, 1997 cited in Mooney 2004). Evidence as early as the 1890s (Zylstra 2006) indicates that the increased frequency of introduced fires during the grazing period resulted in substantial negative ecological impacts including increased soil erosion, loss of old growth trees, significant changes in vegetation community structure and various other effects. Zylstra (2006) provides a more detailed account of various aspects of historical fire regimes including evidence of changes to vegetation community structure occurring most likely as a result of changed fire regimes.

During the period 1956 to 1986, the Hume Snowy Bushfire Prevention Scheme was responsible for fire management in large areas of the Park. This period included the construction of a vast trail network (the majority of which still exists today), the establishment of “burning blocks”, and the introduction of prescribed fire on a rotational basis within the burning blocks. During this period the Alpine area was exempted from prescribed burning. Major concerns were raised during this period about the cumulative effects of too frequent burning on ecological values including soil erosion and catchment management values.

NPWS assumed responsibility for fire management within the Park in 1986. Fire history records for the Park date back to the 1956-1957 season, a period of 51 years. To date, NPWS has compiled records of 556 unplanned fires, an average of about 11 fires per year, and 195 planned fires within the Park.

Fire frequency for all fires >1 ha since 1957, and average inter-fire interval is summarised in Table 3. Overall fire frequency, regardless of origin, is a major determinant of life cycle processes of plants and animals. Fire frequency also impacts significantly on vegetation structure and composition (NPWS, 2004). Fire frequency also influences a range of fauna interactions such as breeding potential, and habitat availability and quality. A summary of the impacts of various frequencies of fire, high and low frequency, on flora and fauna is included in Table 3 of NPWS (2003a). Areas of higher overall frequency (more than 3 fires since 1957)

tend to be concentrated on the boundaries of the Park in locations such as south of Talbingo, the southern edge of Snowy Plain, Eucumbene Cove, Bugtown (north of Providence Portal), Khancoban area, and Byadbo (see Figure 3). These areas have been subjected to more frequent prescribed burning since 1957 due to the perceived threat to property assets adjacent to the Park. At the regional scale Figure 3 demonstrates that a mosaic of frequencies is occurring in the Park regardless of fire origin.

Overall since 1957, 11% of the Park has not burnt, 51% has burnt once and 30% has burnt twice. More than 98% of the Park (total percentage of all areas burnt less than 3 times) has burnt at average inter-fire interval of more than 17 years. Only 0.17% or 1140 ha has burnt, on average, at inter-fire intervals of less than 10 years.

An opportunity exists to identify potential control sites within the 11% of unburnt area of the Parks reference areas for scientific study. It is recommended that identification of potential control sites that can be kept unburnt for as long as possible be determined within the 11% of unburnt area in the Park. Such identification of control sites will need to be carried out in consultation with the Southern Biodiversity Section of DECC.

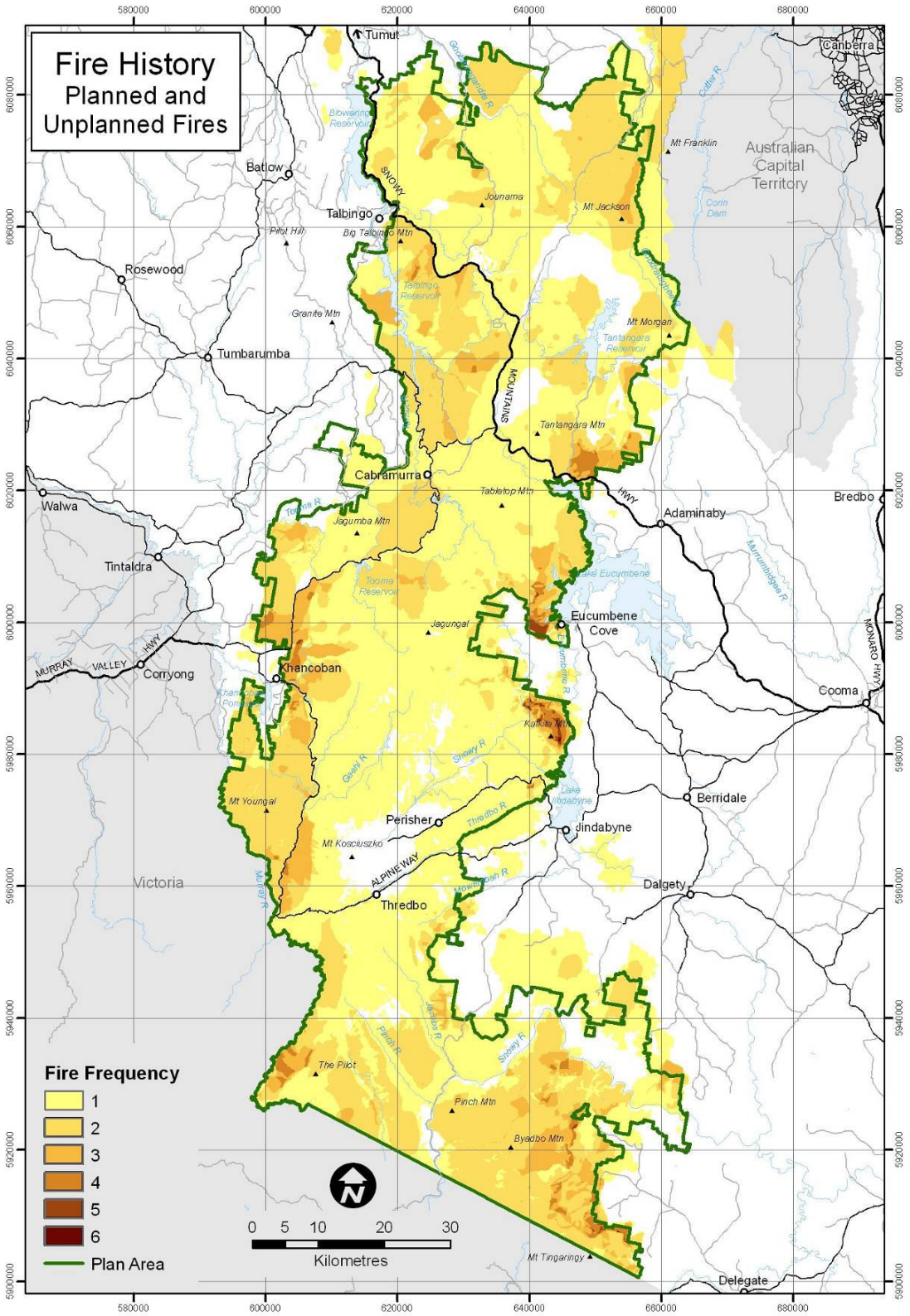
Table 3 Frequency, area and average interval of all fires >1 ha since 1957

No. of times burnt (x)	% of Park	Area (ha)	Average inter-fire interval (50/x) (years)
0	10.90	75,116	
1	50.61	348,660	50
2	30.72	211,624	25
3	6.48	44,635	17
4	1.11	7,671	13
5	0.16	1,095	10
6	0.01	45	8

1.4.2.1 Unplanned fire history

the Park is an area that always has been and always will be subject to unplanned fires due to its geographic location, climatic conditions, vegetation and topography. However large unplanned fires in the alpine and subalpine areas are relatively rare (Scherrer *et al*, 2004, Mooney, 2004). Sharp (1992) and other studies (Zylstra 2006) divide the past 6 centuries into 4 main eras defined by fire. The period 1400-1600AD saw moderate frequency and scale of fires with a slight reduction during the Maunder Minimum (a cooler climatic period), the period 1600 to 1840 had low frequency and spread of fire, the period 1840 to 1955 saw high frequency fire and many large scale events, and the period post 1955 has again seen a reduction in fire frequency and spread (Zylstra 2006). Prior to the collection of the earliest reliable mapped records (1956) major fires in the Snowy Mountains occurred in 1876, 1879, 1895, 1899, 1920, 1924, 1926, 1933, 1935 and 1939 (Banks, 1989) and 1952 (Woodruff, 1977) with major fires occurring during drought and extreme fire weather conditions (Woodruff, 1977). At least 4 of these fires (1899, 1924/26, 1939 and 1952 were of similar scale or larger than the 2003 fires. Fires of this scale only occur when there are multiple ignitions across large areas generally preceded by drought conditions. In 1939 and 1952 these ignitions were escaped prescribed burns or accidental ignitions, and in 2003 they were produced by a series of dry lightning storms (Zylstra, 2006).

Figure 3 Frequency of all fires >1 ha for all records since 1957



Area burnt by unplanned fires within the Park has varied significantly over time and is dependant on the same factors that determine whether fires will be controllable or not, namely fuel, number and location of simultaneous ignitions and weather conditions at the time. Fire frequency maps typically show the actual areas burnt and number of times burnt in a given location. Fires extinguished while small will not show up in a fire frequency map at this scale and therefore fires that have been successfully suppressed and kept under about 1 hectare in size are not represented in these maps. All fires are however included in all subsequent analyses.

Figure 4 shows the frequency and extent of all unplanned fires >1ha in size since 1975, a period of nearly 32 years, and corresponding approximately to the highest minimum biodiversity threshold (refer section 2.3.1). Since 1975 only 23% of the Park () has not been burnt which is primarily a reflection of the large extent of the widespread unplanned fires of the 2002-2003 fire season. The majority of the Park that has burnt since 1975 (60%) has only burnt once in this period. 16% of the Park has burnt twice, and these areas include the area between Talbingo reservoir and Tantangara reservoir, the area to the north west of Eucumbene Dam, areas south of Cabramurra, and some areas in the Byadbo wilderness. Less than 1% has burnt three times and a very small total area of 164 hectares has burnt four times (to the north of Snowy Plain and to the north of Mt Kalkite in Snowy Mountains Region). The northern part of the Park shows relatively low frequency occurring, particularly in the Bogong Peaks/Jounama area, as many fires have been detected and extinguished when smaller than 1 hectare, particularly in the last 10-15 years (Horsley, S. pers. comm. 2007). In summary, less than 17% of the Park has been burnt more than once since 1975, a period of 32 years.

Table 4 Unplanned fire frequency and area burnt by frequency since 1975.

Times Burnt	% of Park	Area (ha)
0	23.15%	159487
1	60.15%	414374
2	15.72%	108252
3	0.95%	6571
4	0.02%	164

Figure 5 summarises by fire season the area burnt since 1957 due to unplanned fires. Data for the 2002-2003 fire season was approximately twice the magnitude of any other year on record.

There is generally no correlation between the number of fires occurring in a season and the eventual area burnt. Area burnt is mostly a function of the weather conditions at the time of suppression affecting the suppression success. For example a storm may occur that ignites a large number of fires but if the storm includes rain then the resulting spatial extent may be very small. Number of ignitions however becomes significant when the ignitions are simultaneous. Simultaneous ignitions can severely stretch fire fighting resources, and under the right conditions the individual fires can interact with each other and greatly accelerate fire spread. Seasons such as 1998-99 indicate that a relatively large number of ignitions (25 ignitions resulting in 20 fires >1 ha) has resulted in a relatively small total area being burnt (257 ha). On the other hand seasons such as 1972-73 had relatively few ignitions recorded (7 ignitions resulting in 5 fires >1 ha) but large areas burnt (45,539 ha).

Figure 4 Unplanned fire history mapped as fire frequency since 1975.

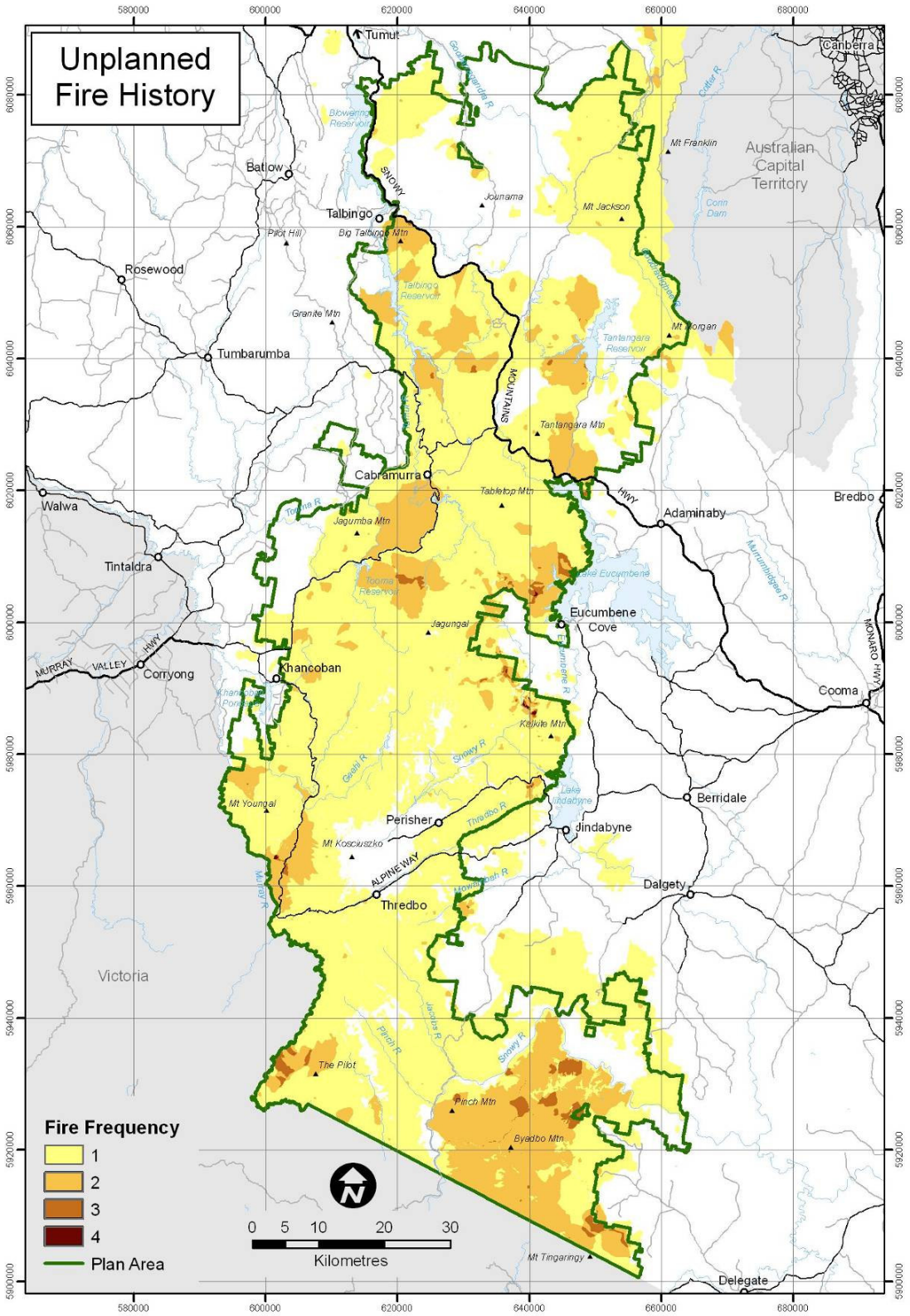


Figure 5 Area burnt by unplanned fires and number of fires >1 ha in the Park.

Note: Figure 5 does not include ignitions or fires less than 1 ha in size which are shown in Figure 9.

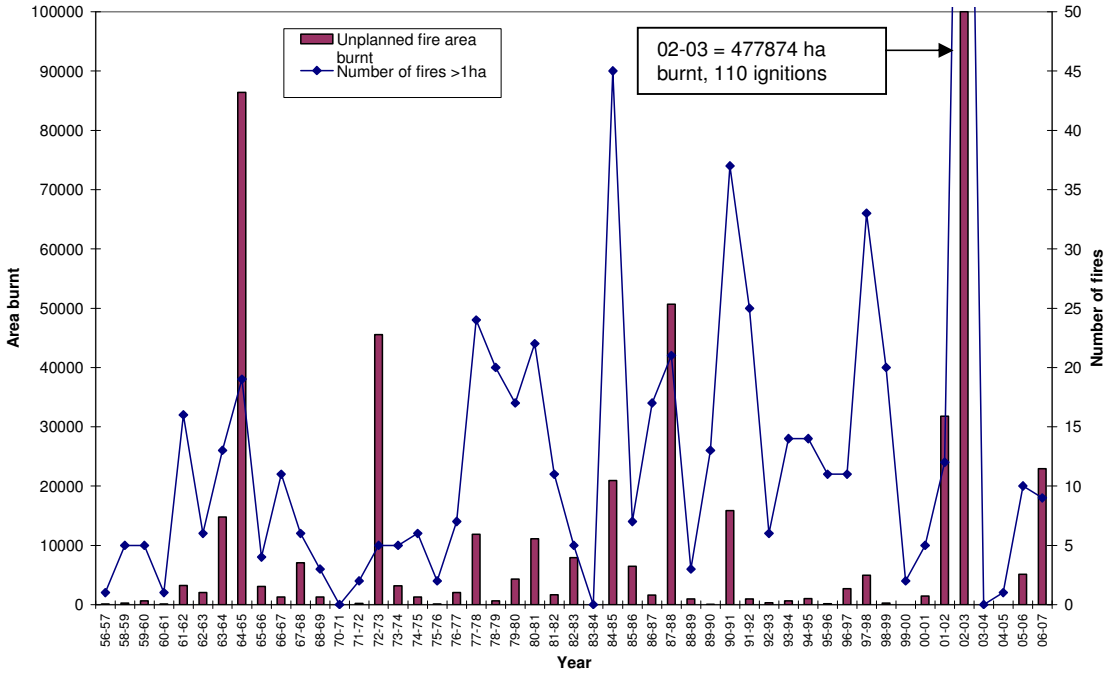


Table 5 highlights the fire seasons where areas >20,000 hectares burnt. The fire season 2002-2003 recorded more fires and larger area burnt than any other year of records. The average frequency of spatially extensive fire areas (>20,000 ha) in the last 50 years is approximately every 8 years although the sample size is very small. It is obvious that three of the seven major fire seasons have occurred in the last seven years, which may be emerging evidence of climate change impacts. The occurrence of fires of this size is a function of dry fuel moisture conditions (usually associated with drought conditions), very high to extreme fire weather conditions and ignition sources. It is recognised that in some years, large numbers of ignitions may occur that do not result in large areas burnt due principally to the suppression effort. This occurred recently (2006-2007) due to the local availability of aircraft facilitating a rapid response capacity. This situation was enabled due to the low fire danger and lack of active fires in the rest of the state. Such availability of aircraft cannot be guaranteed every year.

Table 5 Major fire seasons (>20,000 ha burnt) since 1957

Fire Season	Area burnt
1964-1965	86065
1972-1973	45539
1984-1985	20690
1987-1988	50389
2001-2002	31,801
2002-2003	477874
2006-2007	27974

1.4.2.2 Direction of overall spread of major fires

Generalised direction of spread of the leading fire edge to the furthermost edge have been determined where fire spread has been >10 kilometres from fires greater than about 700 hectares in size and where information on the origin of the fire is available. Main directions of spread, average length, maximum length and percent of directions are shown in Table 6. The majority (54%) of spread directions occur when the main wind direction is from west through northwest to north. By contrast only 11% of fire spread comes from north through to east, 16%

from east through to south and 18% from south through to west. The average length of fire spread indicates the average distance that fires have travelled generally under very high-extreme fire conditions with fires from the west-north, having a higher overall average spread of 23.77 kilometres. This is a function of the more extreme conditions occurring when hot dry winds occur from the west through to the north.

Most fires greater than 700 ha spread in all directions, for varying distances, from the same fire indicating the variability that can be expected in wind directions during the course of a fire. The directions of spread shown indicate the direction from origin directly to end point under circumstances occurring at the time of the fire and therefore do not preclude a future fire travelling in any particular direction.

Table 6 Direction of spread for fires >700ha.

Direction (°)	Compass direction	Number of fires	Average length of spread (km)	Max length of spread (km)	Percent of directions
0-90	N-E	7	16.36	21.34	11%
91-180	E-S	10	17.69	24.32	16%
181-270	S-W	11	13.75	22.47	18%
271-360	W-N	33	23.77	45.60	54%

It is noted that it is not statistically valid to attempt to define major fire paths (locations where fires regularly travel) as there is insufficient data.

1.4.2.3 2003 fires and fire severity

The 2002-2003 fire season was the most significant fire event experienced in the Park since records have been kept and the most spatially extensive fire recorded since the 1939 fire, with the possible exception of the 1952 fire which was not completely mapped. During the 2002-2003 season approximately 477,874 hectares of the Park were burnt at varying severity. This single fire season has had significant, although generally short term, impacts on a wide range of natural and cultural heritage values within the Park.

Fire severity is different from the measure of fire intensity. Fire severity is a measure of the extent of canopy burnt and scorched and can vary with uniform fire intensity because of varying vegetation height and structure, amongst other factors. As described by Barrett (2005) “A measure called the normalised burn ratio (NBR) was used to quantify the impact the fire had on native vegetation, also referred to as fire or burn severity. The NBR index is derived from two infra-red bands in the Landsat image, bands which have been shown to be sensitive to changes caused by fire in vegetation. The bigger the change in the NBR (dNBR) value ($NBR_{prefire}$ - $NBR_{postfire}$), the more severe the fire. The continuous dNBR values are classified into burn severity classes that are descriptive and reflect the proportion of green canopy that was either scorched and/or totally consumed by the fire”.

Fire severity and vegetation structure were modelled after the January 2003 fire. Fire severity models the impact of unplanned fires on native vegetation. Figure 6 shows the spatial extent of the different severity classes following the 2002-2003 fire season. (Note: some areas currently shown as burnt may not have burnt e.g. Spring Creek/Tooma River area, parts of the main range. These anomalies are due to data processing and visibility issues). The majority of the low to moderate severity was in the Byadbo area, alpine area south of Perisher (although much of this area did not burn in 2003) and on the fringes of the Park. High and very high severity areas were concentrated in alpine areas north of Perisher to the Snowy Mountains Highway, and in the more elevated country of the Pilot Wilderness. High severity in these areas is not necessarily associated with high fire intensity, but may be a result of low intensity fires under extreme conditions that may completely burn the low canopy of grasses and small shrubs. Of interest over half of the areas that may be expected to have higher fuel loads such as the Wet Sclerophyll formations burnt at relatively low-moderate severity. The result indicates that, as could be expected, the fire severity varied greatly across the landscape (Barrett, 2006). This

variation can be explained by the wide variations in vegetation structure, fuel factors (including arrangement, quantity and fuel moisture content), weather at the time of the area being burnt and topography.

The study was able to accurately model severity in all vegetation types, and found reasonably strong correlation between field measured severity and modelled burn severity classes in denser forests and on ground observations. The correlation for dry and more open forest types including grasslands was not as strong (Ecological Australia, 2005). The categories used for fire severity and their explanations are shown in Table 7 after Barrett, (2006). Very low and low categories were merged for mapping purposes as the difference between these two categories is considered to be minimal (Barrett, pers. comm. 2007).

Table 7 Categories used in burn severity mapping

Category	Explanation
No Data	All images were cloud or snow affected in these areas
Excluded	Non-natural features (pasture roads etc.) excluded from analysis
Very Low Severity (ground fire only) or Unburnt	Unburnt or very low intensity ground fire
Low Severity	Mix of green and scorched canopy with understorey burn
Moderate	Majority of top level is scorched (80% - 100% scorched)
High Severity	All scorched with some vegetation consumed
Very High Severity	Totally consumed (80% - 100% consumed)

Table 8 Area burnt (hectares) in each severity classes for broad vegetation formations.

Broad Vegetation Formation	Total Area		Low	Mod	High	V. High	Total area burnt	% of veg. form. burnt
Alpine Complex	84187	**Area burnt**	5418	10490	20026	12991	48925	58%
		% of area	11%	21%	41%	27%		
Dry Sclerophyll - Shrub/Grass	198579	**Area burnt**	33569	40994	20600	3524	98687	50%
		% of area	34%	42%	21%	4%		
Dry Sclerophyll - Shrubby	17085	**Area burnt**	1298	2332	1318	487	5436	32%
		% of area	24%	43%	24%	9%		
Grasslands	1	**Area burnt**	1	0	0	0	1	100%
		% of area	75%	40%	0%	0%		
Rainforests	106	**Area burnt**	35	19	19	6	80	75%
		% of area	44%	24%	24%	7%		
Sclerophyll Grassy Woodlands	221424	**Area burnt**	34710	57812	50315	22457	165294	75%
		% of area	21%	35%	30%	14%		
Wet Sclerophyll - grassy	152010	**Area burnt**	36039	42070	31217	8186	117512	77%
		% of area	31%	36%	27%	7%		
Wet Sclerophyll - shrubby	3973	**Area burnt**	1059	839	1174	498	3571	90%
		% of area	30%	24%	33%	14%		
		Total area burnt (ha)	**112131**	**154561**	**124670**	**48150**	**439505**	
		Total % of area	**26%**	**35%**	**28%**	**11%**		

(It is noted that the total figures for area burnt based on fire severity mapping are lower than the fire history tables due to data gaps in the fire severity modelling resulting from occasional poor satellite visibility, and data rounding).

Figure 6 2003 fire severity in the Park (Barrett, 2006).

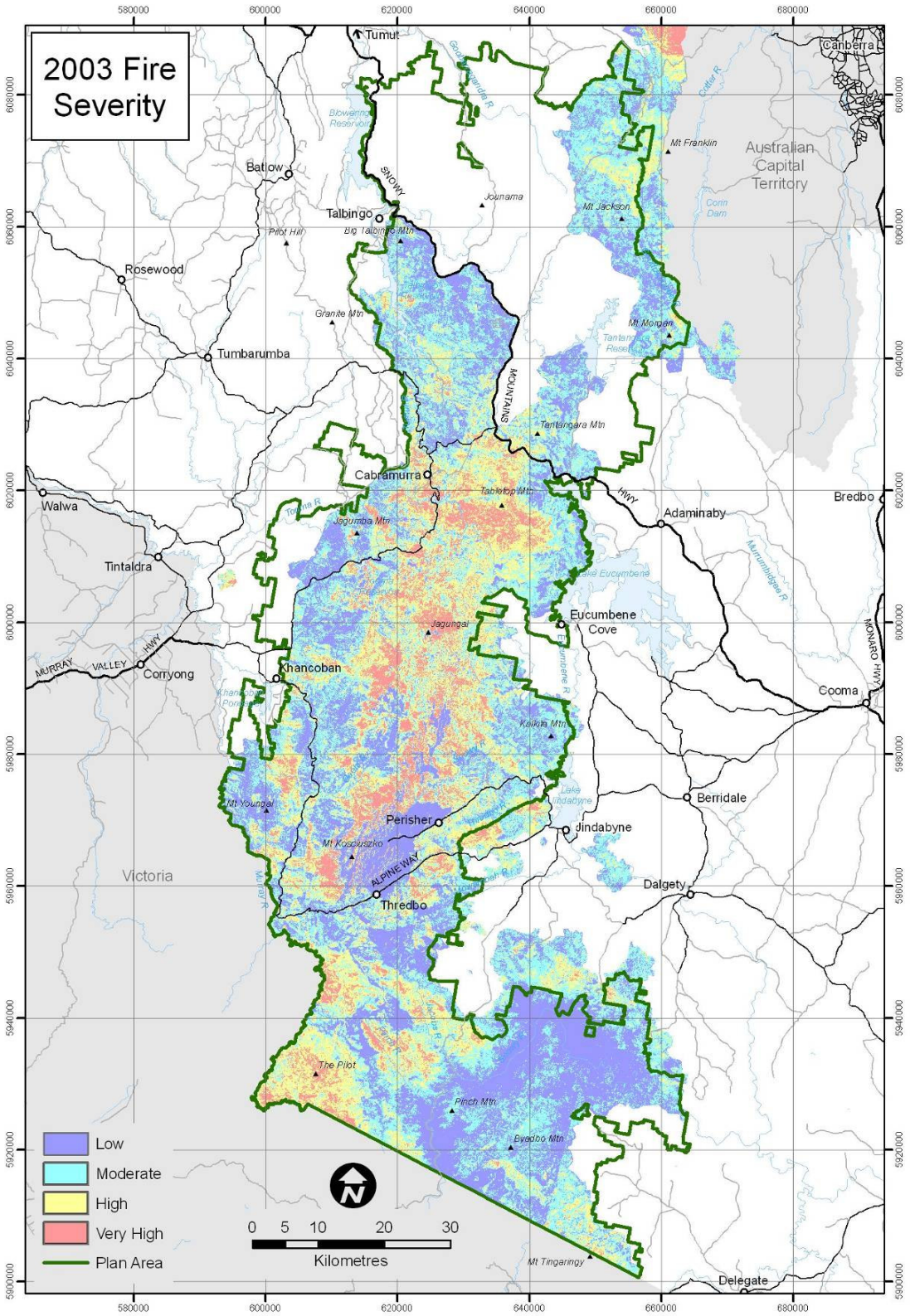


Table 8 shows the areas and percentages of each severity class against the broad vegetation formations. Overall 61% (26% low + 35% moderate) of the area burnt was in the low-moderate severity class whereas 28% was high and 11% was very high. Significantly, and due to the extended extreme fire weather, 74% (35% moderate + 28% high + 11% very high) of the area experienced at least moderate or higher severity resulting in complete canopy removal either through crown scorch, and subsequent leaf drop, or direct crown fire.

The total percentage of each severity class for broad vegetation formations in the Park is shown in Table 8. Matching of broad vegetation formations to forest ecosystems determined during the Comprehensive Regional Assessment program in the late 1990s and subsequent work by Gellie (2005) are presented in Appendix 5. Alpine vegetation was predominantly burnt at high (41%) to very high (27%) severity reflecting the impact of relatively low intensity fires on short vegetation communities. An average of about 52% of dry Sclerophyll forest types, including Sclerophyll grassy woodlands, was burnt predominantly at moderate severity. Much of the unburnt Dry Sclerophyll forests types are in areas to the west and north-west of the Park. Overall, an average of 81% of the Wet Sclerophyll forest types, including rainforest, was burnt. These vegetation formations tended to have been more severely burnt with slightly higher percentages of severity in the high categories than the Dry Sclerophyll forest types. The Wet Sclerophyll forest types were also more extensively burnt overall (average 81%) than the Dry Sclerophyll forest types (average 61%).

1.4.2.4 Prescribed burning history

Between the late 1960s and the mid 1980s the Hume Snowy Bushfire Prevention Scheme introduced prescribed fire on an almost annual basis, in the first organised and coordinated fire management program for the area now known as the Park. In the late 1970s, evidence emerged about the negative impacts of frequent large scale burning on many ecological values of the Park, particularly in the subalpine areas (Good, 1982). Consequently modern fire management focuses on burning areas of strategic value rather than blanket broad scale burning.

Since 1986, 113 prescribed burns have been completed covering a total area of 58,339 hectares (Figure 7 and Figure 8). This is an average of approximately 5 burns per year. The majority of these burns have been in close proximity to the fringes of the Park, or in locations of higher fire frequency and ignition history. The objective of prescribed burns is to minimise fuel loads thus minimising the potential for fires to damage private property adjacent to the Park and facilitating subsequent fire suppression operations. Many burns also achieve ecological objectives. The window of opportunity to implement prescribed burns is frequently short due to rapid changes in weather from too hot and dry to burn to too cold and moist to burn.

Figure 7 Area of prescribed burning within the Park between 1986 and 2007.

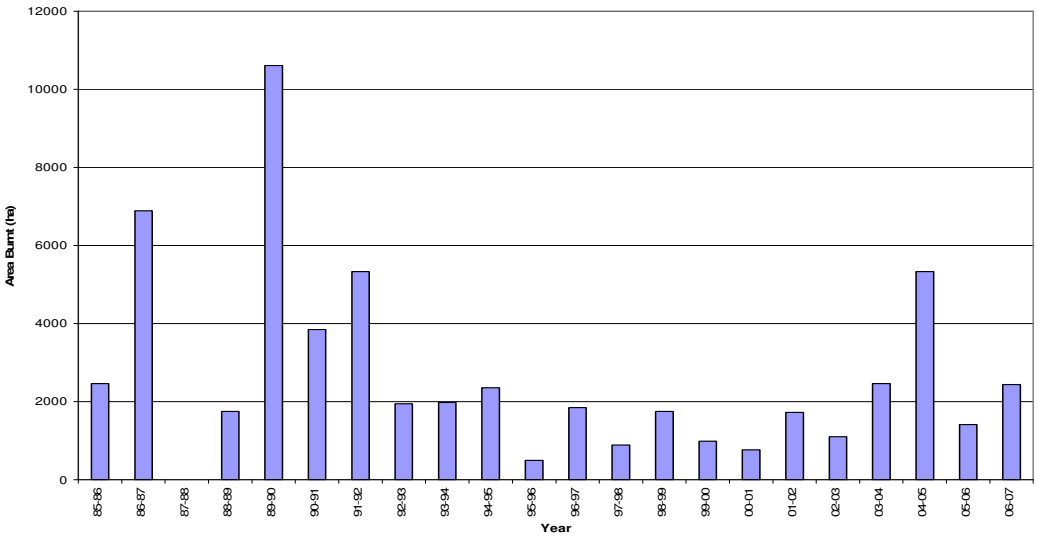
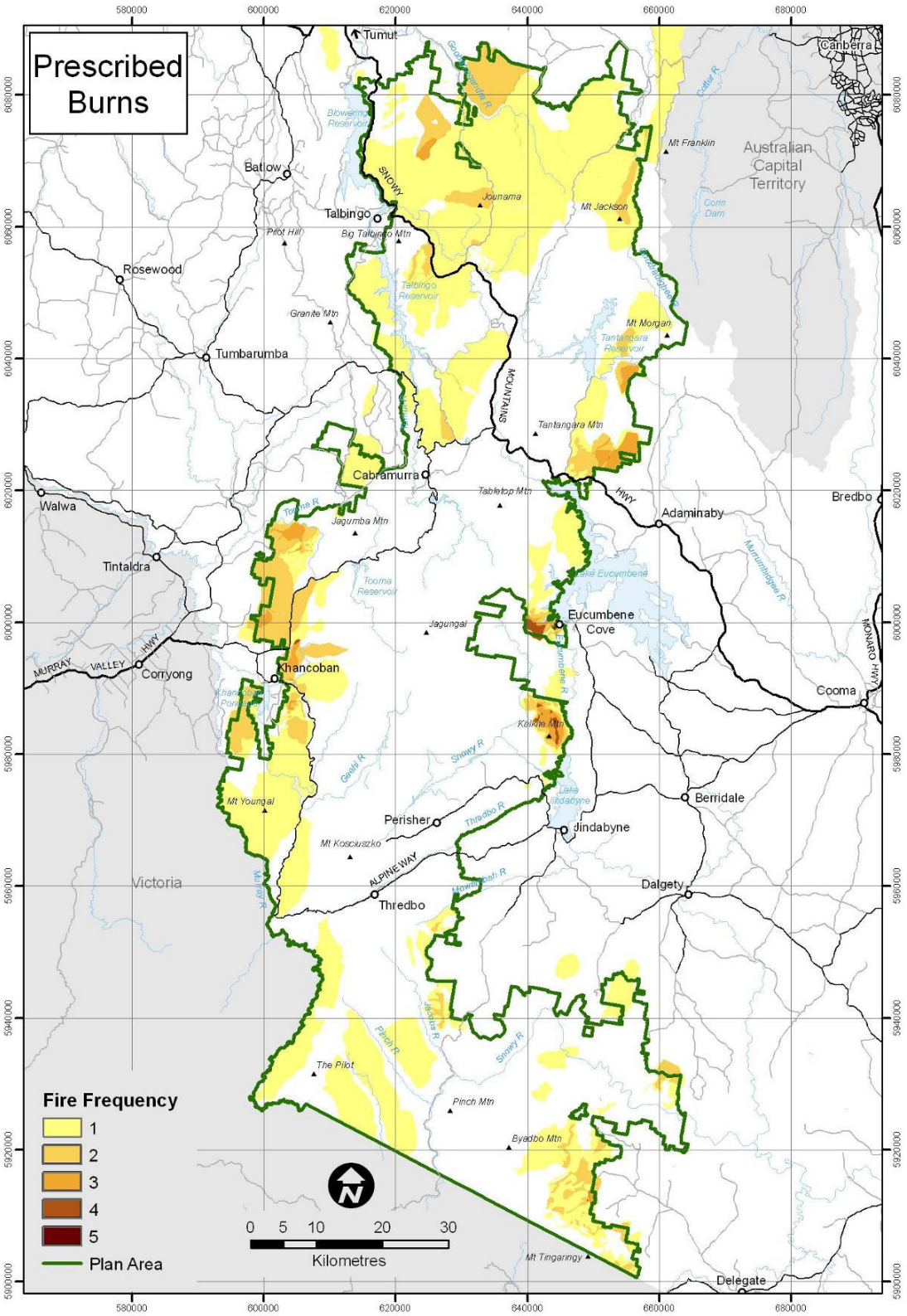


Figure 8 Prescribed burning history mapped as planned fire frequency since 1975.



1.4.3 Causes of fire-ignitions

Ignition distribution and cause provide information that can be used to mitigate some types of ignition, such as arson, and areas where ignitions are more frequently caused by lightning. Figure 9 shows a summary of all recorded ignitions for the Park in the period 1957-2007. The 2002-2003 and 2006-2007 seasons stand out as years where more ignitions were recorded than in any other year.

Figure 9 All recorded unplanned fire ignitions (1957-2007)

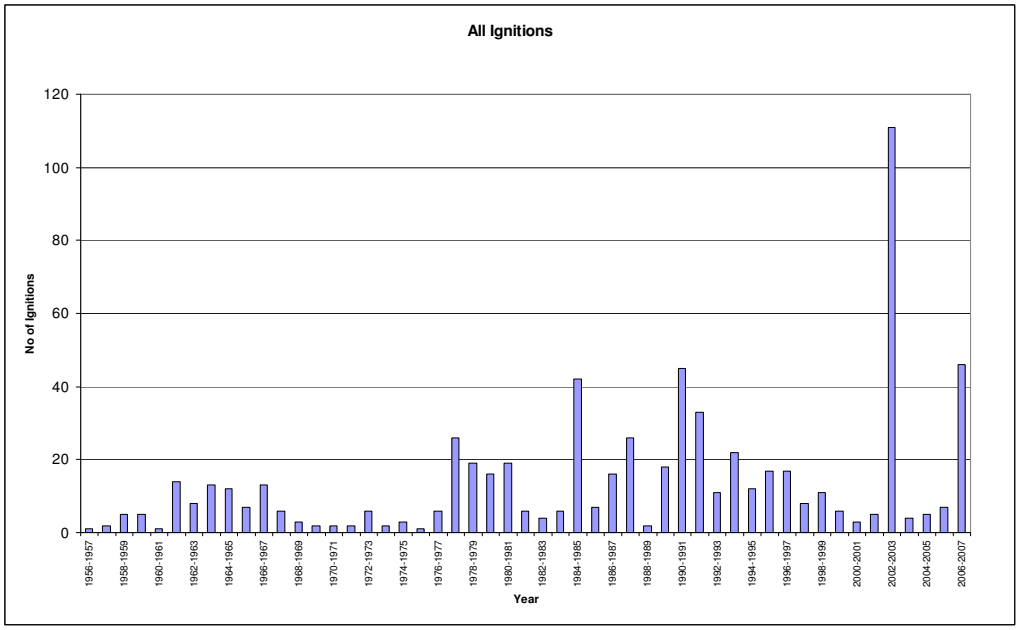
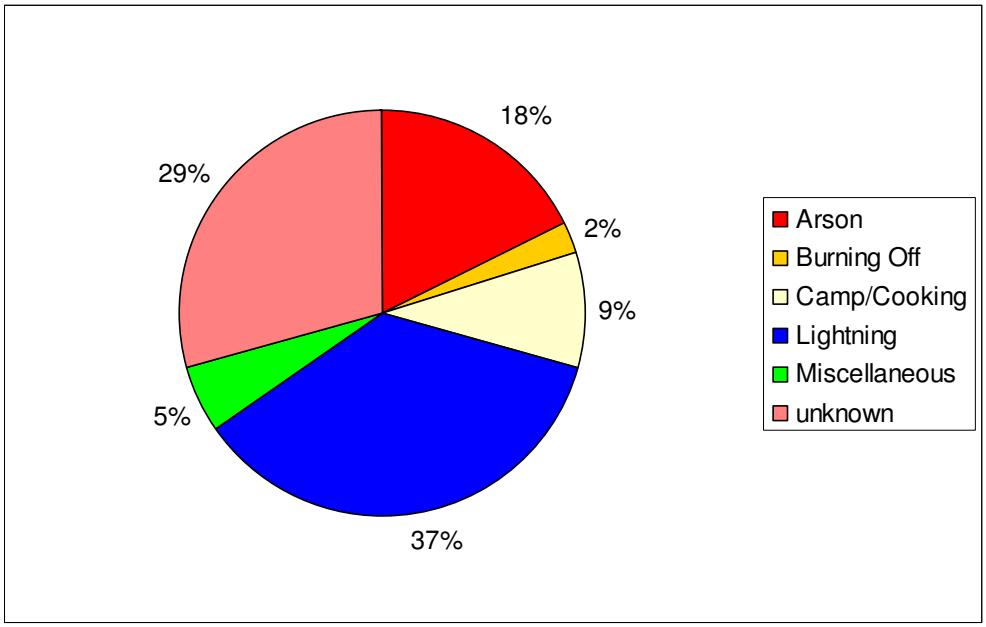


Figure 10 illustrates the proportion of ignition types recorded in the Park for the period 1957 to 2007. The main cause of ignitions within the Park is lightning (37%) while arson (including suspected arson) accounts for a further 18%. However of the recorded lightning ignitions, 86 (35% of all lightning ignitions) were recorded during the 2002-2003 fire season. Other known causes include smoking, motor vehicles, powerlines and other miscellaneous causes. Although not shown separately, power line ignitions account for 2% or 12 ignitions of which 8 of these were in the last ten years. Unknown causes account for 29% of ignitions. The high proportion of unknown causes (29%) reflects the rugged topography and isolated nature of the Park where it has often not been possible to ascertain specific causes. It is likely that a high proportion of the unknown causes in more remote areas are from lightning strikes. The average annual ignition rate is 13.4 ignitions per year.

A review of the ignition data by cause did not indicate any significant trends in any of the ignitions types beyond a slightly increasing trend in all ignition types for the period. This slight increase most likely reflects improved recording of ignitions overall rather than a statistically significant trend in any ignition type.

Figure 10 Proportion of ignitions by cause (1957-2007)

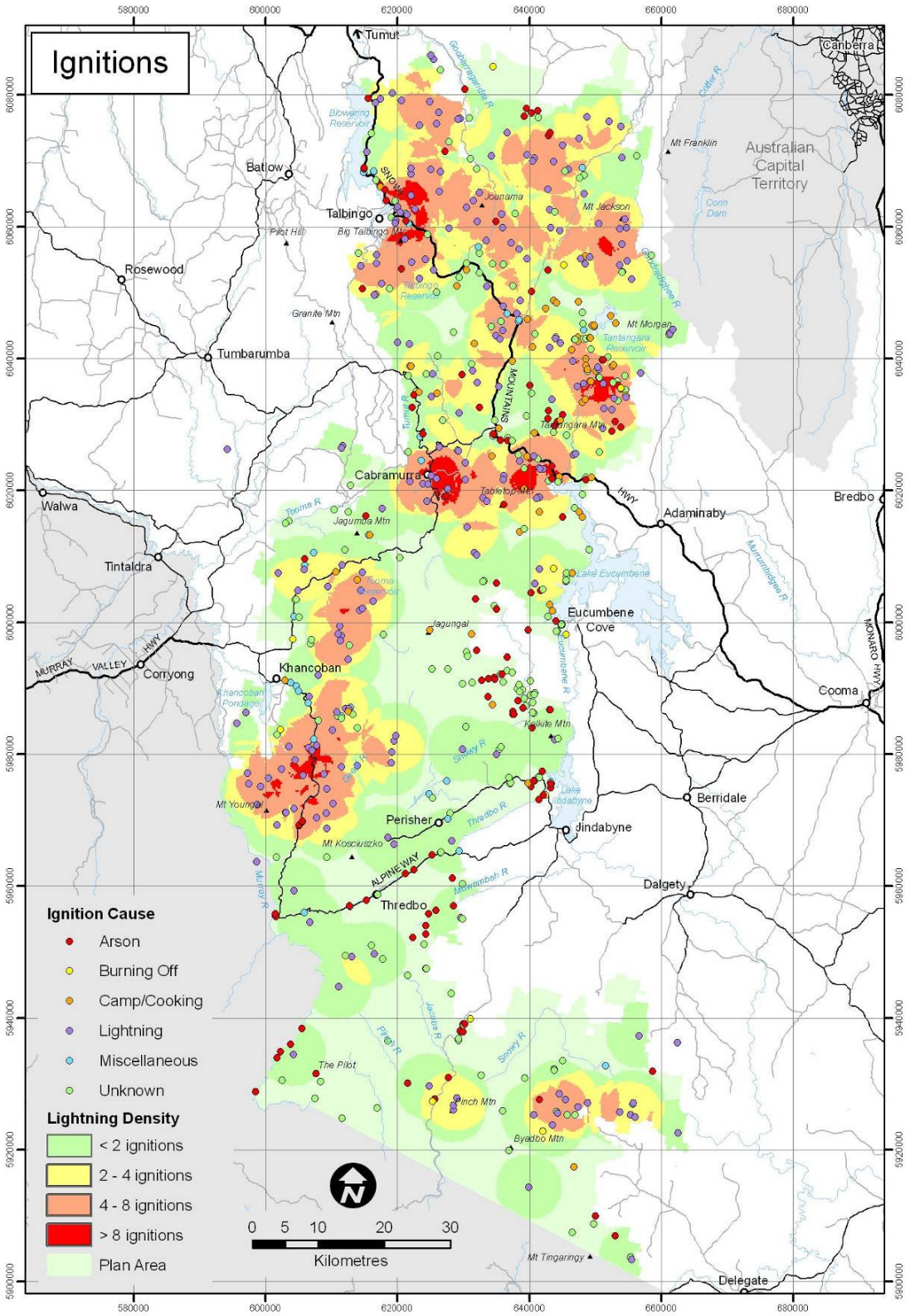


An analysis of arson ignitions (including suspected arson), by measuring proximity of ignitions to roads and trails, grassy areas, and the Park boundary, has shown that arson ignitions occur frequently near roads and trails (67% within 500m of a road or trail), on the boundary of the Park, and in grassy areas more easily accessible on foot or by horseback. Areas of high frequency and current arson will require further investigation if arson continues to be an issue in these areas. In subalpine woodlands with grassy understorey, the higher moisture conditions and high decomposition rates result in low fire ignition potential in all but the driest of years (Leaver, 2004).

Figure 11 shows all ignition points recorded and a density analysis of lightning ignitions since 1956. Lightning ignitions are distributed relatively evenly throughout the north, west and south eastern areas of the Park. Areas with lower concentrations include the Pilot Wilderness in the south west, alpine areas and the Snowy Plain area in the central east part of the Park. Areas with higher density and frequency of lightning ignitions include the area to the east of Talbingo in the Bogong Peaks, an area to the north of Tantangara Mountain, Cabramurra east to the Park boundary, the Dargals range to the north east of Khancoban, and the Scammell's ridge area to the south east of Khancoban. Lightning density to the north of the Snowy Mountains Highway is relatively more evenly distributed across the whole northern part of the Park.

The pattern of lightning strikes is highly variable and depends on the path taken by storms. The probability of a strike resulting in an ignition depends on the fuel moisture content and the amount of precipitation occurring in the storm. Lightning strikes can cause an ignition that may not become apparent for days; hence detection flights are frequently required for some days after a lightning storm has passed.

Figure 11 Ignitions causes and density of lightning ignitions.



1.4.4 Fuel Dynamics

Fuels affect ignition potential, fire intensity, rate of spread, fire size (through fuel continuity) and ease of suppression. Fuel is the principal fire behaviour factor, other than human ignitions, that fire managers can have any control over, the other uncontrollable factors being weather and topography. Although the measure of surface fuel quantity (tonnes/hectare) has been the basis for most fire behaviour modelling, e.g. McArthur meters, it is now recognised that an understanding of both quantity and arrangement is essential for managing and predicting fire behaviour (Gould & Sullivan, 2004). Such an understanding can be partially expressed in terms of overall fuel hazard (OFH) (McCarthy *et al*, 1999). It is noted however that it is not fuel that presents a hazard, but the fire that results from the burning of fuel.

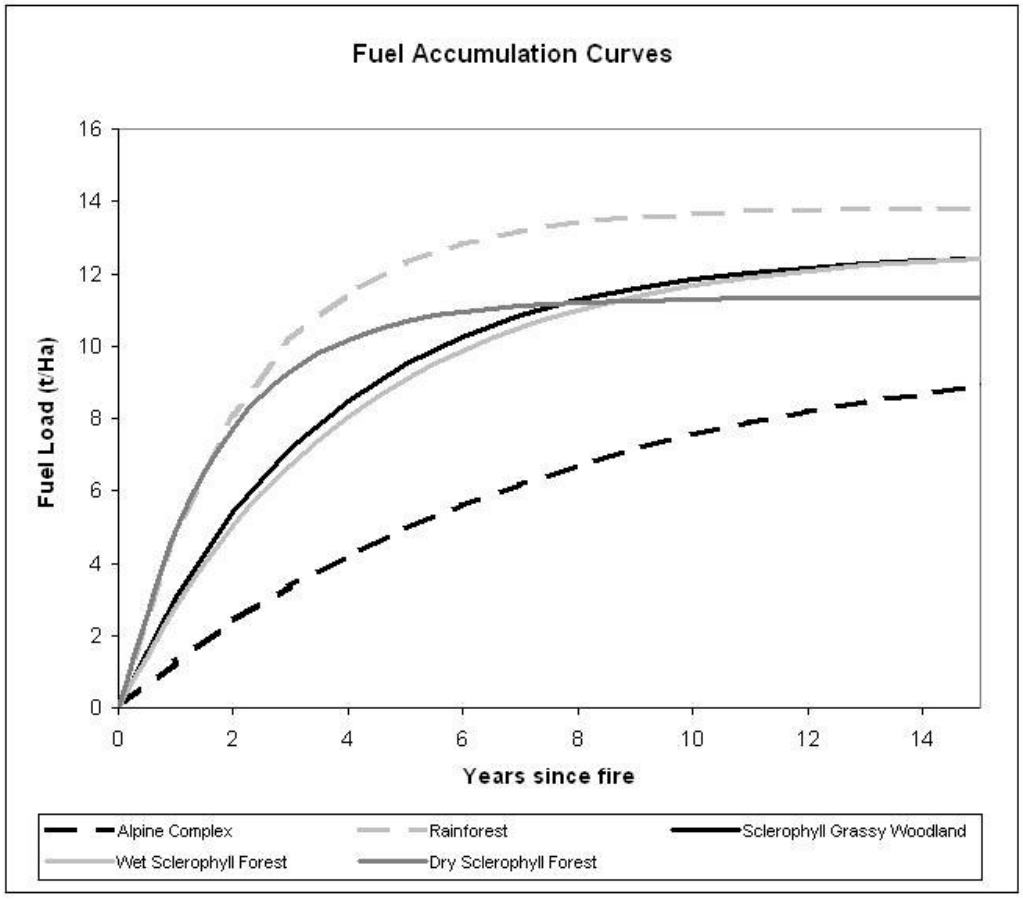
Surface fine fuel components (dead leaves, bark, grass and twigs on the ground) influence fire behaviour by facilitating fire spread under milder fire danger conditions. Under more severe fire conditions vertical fuel arrangement becomes more important in influencing overall intensity. In some forest communities there is a relationship between the weight of surface fine fuels (t/Ha) and the potential fire intensity, however the main fuel components that influence fire intensity are the elevated strata (shrubs and trees), and this relationship is complex. Each fuel layer becomes progressively involved in fire as the intensity increases (Gould and Sullivan, 2004).

The Park is characterised by three broad fuel types (i) the fuels of forests and woodlands, (ii) heathlands, and (iii) the grasslands and shrublands at higher elevations. Within forest and woodland fuel types there are four main categories of fuels, the relatively compact surface layer of fine fuels and decaying leaf litter, the elevated and relatively well aerated near surface and shrub layers, the canopy and bark. Heathlands and shrublands are characterised by more compact but low elevated fuels.

An analysis of the fuel accumulation of surface fuels only (not OFH) has resulted in the development of fuel accumulation curves (Figure 12) and a modelled surface fuel load map (Figure 13). The surface fuel load was modelled from nearly 800 fuel samples from 147 sites within the Park, by measuring surface fuel loads and comparing to time since last fire. Standard fuel accumulation curves were applied to determine generalised relative surface fuel loads. These values are based on the industry standard approach of an “Olsen model” of fuel accumulation, which shows a rapid increase in fuel load following fire, levelling out to a rough equilibrium after a few years, depending on vegetation type.

Figure 13 gives the modelled fuel load across the Park as at November 2007. The analysis indicates that areas that have not burnt since 2003 now have close to pre 2003 fuel loads including some subalpine areas. As at November 2007, the modelling of fuel accumulation indicates that surface fuels across the Park may have accumulated to about 90–95% of their pre-2003 levels, the exceptions being those areas burnt in the 2006-2007 season, and in prescribed burns since 2003.

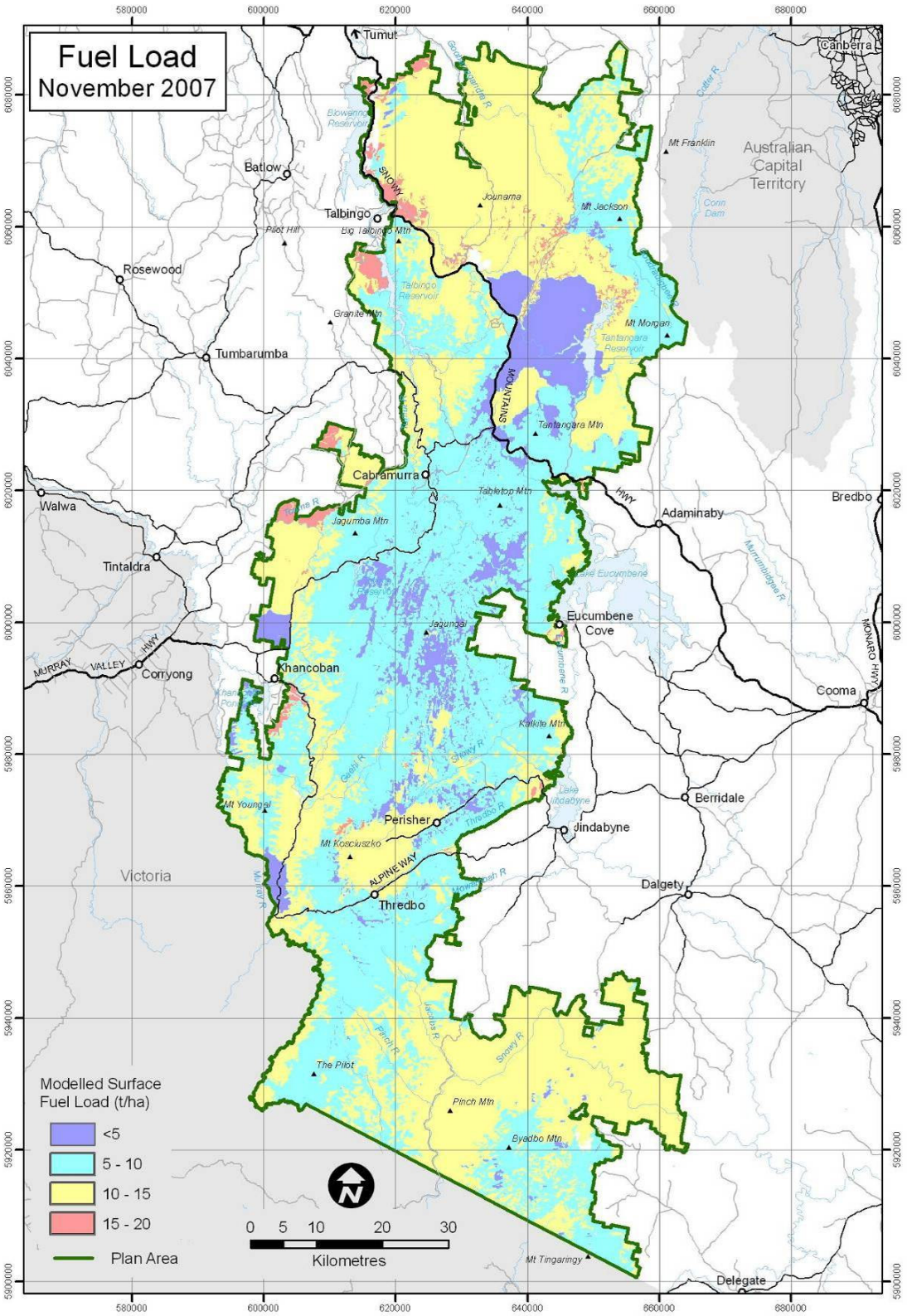
Figure 12 Fuel accumulation curves for broad vegetation groups within the Park.



Areas of modelled fuel loads >15-20 t/ha include the Maragle extension of the Park near Tumbarumba which has not had a major fire in the area since 1983, although a small fire occurred in 2003. The other main area with modelled fuel loads >15-20 t/ha is the north western section of the Park near Tumut, and south of Talbingo which have not had a major fire since the early 1980s. The Byadbo area has fuel loads between 5-15 t/ha which is likely to be a result of much of the area only burning at low severity during 2003 and rapid fuel accumulation since. Areas that show the lowest fuel loads (<5 t/ha) are those areas that have burnt in the last fire season including the 2007 Long Plain unplanned fire area (top centre of Figure 13), 2007 Spring Creek hazard reduction area, 2006 Tooma Dam unplanned fire area in the Upper Murray, and the 2007 Tom Groggin unplanned fire.

It is noted that a high modelled fuel load does not equal a higher risk of major unplanned fires as there are many factors influencing the probability of a major fire occurring including climatic factors, drought, previous fire history, fuel moisture content and ignition source and frequency. Many areas of high modelled fuel loads are at high elevations where unplanned fires are infrequent due to the short summers experienced. A dry hot summer preceded by a moist winter may have high available fuel loads at lower elevations due to increased vegetative growth but lower available fuel loads at higher elevations due to increased fuel moisture content (Leaver, 2004).

Figure 13 Relative modelled fuel loads



Many of the areas burnt in 2003 are in a regenerating phase where there is still significant epicormic growth, dense basal resprouting, and in some areas dense regrowth shrub cover. This is particularly the case in the moister vegetation communities on the western slopes. This post fire phase of regrowth has increased the difficulty of suppression operations since 2003. This is due to the higher density of near surface and elevated vegetation providing increased available elevated fuel in dry conditions, and restricting access for dozers and fire fighters. This phase can be expected to continue into the foreseeable future depending on vegetation type, climate and location. Van Loon (1977) cited in Gould and Sullivan (2004) noted that where there is a substantial shrub layer in a Eucalypt forest, the elevated fuel loads can still be increasing 25 years after burning.

Since 2003 near surface live fuels (grasses and forbs) have probably reached maximum fuel load and are likely to have begun declining in abundance in lower elevations as they are out-competed by regenerating shrubs. Grasses and forbs are also now likely to have begun declining in abundance in the higher elevations where shrubs are beginning to establish dominance.

Elevated fuels in higher elevations are now likely to cover a greater area than before 2003 due to shrub regrowth, although the plants are currently still small and the hazard score is still likely to be generally low (P. Zylstra, pers. comm. 2007). Over the next 5 to 10 years these plants will grow and are likely to present a higher elevated fuel hazard. McCarthy *et al* (2003) found that OFH scores above “high”, in alpine and subalpine areas, are rare except in Ash forests and some heathland areas. In lower elevations, elevated fuels in general are currently significantly more dense and prolific than they were prior to 2003, again due to post fire regrowth. The OFH score in lower elevations is generally likely to be higher than it was pre 2003 due to the current temporary increase in elevated fuels. Gould and Sullivan, (2004) found that the elevated fuel layers can be expected to reach a steady state of fuel hazard rating at 7-10 years of age in jarrah forests of Western Australia. Actual accumulation of elevated fuel layers in vegetation types within the Park have yet to be determined.

A significant component of OFH is the bark component as it is the bark that is principally responsible for spotting behaviour during more extreme fire events. Bark may also assist the travel of fire from the surface into the canopy. The Park contains many *Eucalyptus* species that have coarse or rough bark types that contribute to spotting potential. Bark fuels may take up to 12 years (McCarthy, G. pers comm. 2006) to return to pre-fire levels in areas burnt in 2003 depending on the severity of the fire at each location. Areas burnt at lower intensities where bark fuels were not consumed will still have bark levels similar to before the 2003 fires. These areas may include parts of Byadbo and some areas on the western side of the Park.

Fuel moisture content (FMC) provides an important indicator of potential fire behaviour. In addition, an understanding of FMC can lead to identification of areas such as gullies and creek lines where fuel moisture differentials may provide a fire suppression advantage. FMC varies daily in response to precipitation, temperature, solar radiation and relative humidity. Seasonal variation of FMC can be observed in ecological processes such as grass curing in late spring and summer. A major seasonal variation is the increasing temperature and decreasing relative humidity that occurs in the period leading up to and then into the fire season. A dry winter and spring will lead to fuels drying earlier in the season, and large fuels, such as logs on the ground, often being much drier throughout the season and therefore potentially available to burn.

Fuel accumulation varies according to the productivity of a site, weather conditions, soil moisture, flora present and other factors. However fuels can also accumulate rapidly in drought conditions to provide seasonally increased fuel loads. Tolhurst (1994) found that litter fall is at a peak in late summer and early autumn in south east Australia. Fuel availability changes at all time scales including hourly changes due to diurnal patterns of FMC variability, seasonal changes due to weather and climate, and long term changes related to vegetation succession changes over decades (Gould and Sullivan, 2004). Within the Park the patterns of fuel dryness are characterised by elevation (drier fuels earlier in the season at lower elevations), season

(drier fuels during October to April depending on seasonal weather), fuel size (finer fuels drying out more quickly than large fuel components), soil moisture (itself a function of climate conditions including drought), and weather.

1.4.4.1 Implications for fire behaviour and suppression effectiveness

A higher OFH score in general means that first attack efforts are predicted to be less successful, that average fire intensity will be higher and that fires have the capacity to become larger (McCarthy *et al*, 1999). This is an average effect over a range of weather conditions and the potential varies throughout vegetation communities.

Most areas with dense elevated fuels will vary in flammability in response to soil moisture, temperature and air dryness over a couple of days. Increased dryness in any of these factors can make fuels less likely to drop in flammability overnight or following a cool change. Conversely there can be a marked reduction in fire intensity when moist conditions cause surface/near-surface fuels to become too moist for fire to spread.

Fires in surface fine fuel loads greater than about 12 tonnes per hectare can become difficult to suppress even under moderate FFDI conditions. In terms of overall fuel hazard, McCarthy *et al* (1999) found that at a FFDI of 50 the probability of first attack success at an OFH rating of very high is about 70%. At the same FFDI of 50 the probability of first attack success where the OFH is extreme drops to about 20%. As FFDI or OFH rating increases, the probability of first attack success declines. Over an FFDI of about 50 the probability of first attack success drops fairly rapidly for OFH ratings above high.

A knowledge and understanding of OFH is becoming a more accepted standard to fire managers as it is an easy to use visual system that provides a clearer picture of the fuel availability and fuel dynamics. More scientific work (e.g. Project Vesta) is being based on this measure as opposed to the previous standard fuel measure of tonnes per hectare of surface fine fuels. Establishment of a long term OFH measurement and monitoring system for the Park will be a high priority for this strategy. Identification and monitoring of OFH in Strategic Fire Advantage Zones will be a priority. The NPWS Northern Branch has investigated this issue and an OFH monitoring model, when developed and approved, may be adopted for the Park.

1.4.4.2 Fuels and prescribed burning

A key objective of prescribed burning is to lower the total fuel load which in turn can have the following effects:

- Reducing the probability of a fire igniting;
- Reducing potential rates of spread;
- Reducing flame height;
- Reducing spotting potential by reducing the number of firebrands;
- Reducing the total heat output or intensity (Gould and Sullivan, 2004).

These effects in turn improve the safety and effectiveness, and success of fire suppression operations. Burning is often the only practical way to achieve the above effects.

Surface fine fuel accumulation occurs at varying rates depending on intensity of the previous fire, the vegetation present, productivity of the area, rate of leaf and twig drop and decomposition of litter. Generally surface fuel load in Eucalypt forests and woodlands build up rapidly in the first 10 years after a fire reaching equilibrium by about 15 years (Gould and Sullivan, 2004). Fuel loads above 10 tonnes per hectare are generally reached by about 5 years after a fire in forests and woodlands (Figure 12).

Rates of accumulation of fuels are important in assessing the effectiveness of prescribed burns where the objective has been to reduce surface fuel loads. If the objective is to reduce a fuel

load below a particular level then the burn is only effective until fuel has accumulated to a level above that prescribed. The same can be said for overall fuel hazard. In most *Eucalyptus* forests and woodlands, fuels accumulate rapidly for up to 7 years and then decline to net zero accumulation rates after about 10 years where litter fall equals decomposition (Good, 1994). Raison *et al* (1983) determined that fuels in a range of high elevation *Eucalypt* forests accumulate to pre-fire levels within 3-5 years after a fire. Raison *et al* (1986) found that litter accumulation was rapid after prescribed burning in subalpine communities in the Brindabella Ranges, reaching 10-12 tonnes per hectare within 4-5 years after burning. As mentioned above however, fuels can accumulate more rapidly in drought conditions. This research supports the fuel accumulation curves developed for forest types within the Park (Figure 12), suggesting that a prescribed burn may provide a level of surface fuel reduction for 3-4 years in dry forests and 8-10 years in wetter forests. These figures do not take into account the elevated fuels.

Fire intensity has a significant impact on the accumulation of fuels. Davis *et al* (unpublished) (cited in Ellis and Gould, 2004), found that higher intensity fires induced heavy bark shedding and leaf fall as a result of crown scorch of between 5-7 tonnes per hectare in a *Eucalyptus rossii* forest. Raison (1986) indicated that the rapid build up of surface litter after burning in the absence of litter fall from low intensity fires was most likely due to the decreased rate of decomposition of litter. Areas burnt before the lower duff layer has dried out from rainfall events also tend to leave a layer of unburnt litter which assists in prevention of soil erosion and minimises the loss of nutrients to the environment (McArthur 1962, Raison *et al*, 1986). McCarthy and Tolhurst (2001) found that the effectiveness, in terms of assisting suppression, of a fuel reduction burn, decreases significantly after about 10 years. They found that the highest probabilities for assistance from a previous burn occurred in the first four years after the fire, with probability decreasing up to about 10 years. Depending on the productivity following a fire, the benefits obtained from prescribed burning in the third and fourth years after a fire will be considerably less compared with the benefits obtained during the first and second year after a fire (Cary, G. pers. comm. 2007).

There is currently insufficient data to measure whether prescribed burns are achieving their fuel management objectives, beyond subjective observations and some limited quantitative measurements. There are currently a range of research projects e.g. Alps Post Fire Monitoring Program, occurring that are addressing components of this issue. More information is required on the fuel accumulation in the Park after fire events, with particular emphasis on the development of the species and quantities of elevated fuels.

The information outlined here suggests that prescribed burns need to be of low to moderate intensity to minimise heavy bark shedding and leaf fall, if in steep country they should ideally be carried out while the duff layer is still moist, and that such burning might provide some level of assistance for between 3 and 10 years depending on the forest type.

1.4.5 Bushfire behaviour potential

Bushfire behaviour potential (BBP) is a measure of the potential fire behaviour under moderate fire danger conditions, at a location, in terms of fuel/vegetation, aspect, elevation and slope (Dovey, 1994; NPWS, 2003a; NPWS 1998). The higher the rating allocated to the categories indicates higher potential bushfire behaviour. BBP is a snapshot of various fire behaviour factors at a point in time and indicates the potential only of fire behaviour.

Seven fuel/vegetation groups were identified in the Park for modelling potential bushfire behaviour based on Landsat imagery vegetation classes and an understanding of the broad vegetation structure (Table 9). Fuel groupings are not based on measured fuel loads but have been determined by expert opinions of experienced botanists and fire managers (Dovey, 1994) taking into account frequency that a fuel is in a cured state, fuel structure, arrangement and potential fuel quantity. Fuel groups are defined below in Table 10.

Table 9 Characteristics of fuel groups

Fuel Group	Characteristics
High	Continuous fuels, higher quantity, available to burn during average seasons (higher fire intensity expected).
Medium	Less continuous fuels, medium level quantity, available to burn during average seasons but may be less often than the higher fuel hazard class (medium or high fire intensity expected).
Low	Possibly discontinuous fuels, low–medium fuel quantity, moister fuels unlikely to contribute to high intensity fires in average season, fuel structure facilitates easier control (fire intensities may range from low to high and generally regarded as easier to control).
Negligible	Unlikely to burn or always burn within controllable limits.

Table 10 Vegetation/fuel groups for bushfire behaviour potential modelling.

Land Sat category	Vegetation group	Fuel Group	Rating
Dry sclerophyll forest	Dry forest type (DFT)	High	7
Moist/dry sclerophyll forest Unknown vegetation	Dry forest type (DFT)	Medium	6
Exotic forest Woodland White cypress pine Acacia scrub	Dry forest type (DFT)	Low	4
Wet sclerophyll forest	Moist forest type (MFT)	Medium	5
Sub-alpine woodland	Sub-alpine woodland (SAW)	Medium	3
Cleared	Cleared/Modified (Mod)	Low	2
Alpine Complex Frost Hollows Sub-alpine swamps	Alpine/Frost Hollow (AFH)	Low	1
Water bodies	Water Bodies (WB)	N/A	0

Aspect, elevation and slope are rated in Table 11, and these are the key topographical factors that can influence fire behaviour. North and westerly aspects are drier than east and south aspects. Higher elevations are subject to cooler temperature and higher relative humidity than lower elevations. Slope is a significant factor in increasing both rate of spread and intensity as slope increases.

Table 11 Aspect, slope and elevation groups for bushfire behaviour potential modelling.

Aspect	Rating	Slope	Rating	Elevation ASL	Rating
270°-360°	3	40-70°	3	0-800 m	4
0-45° & 225-270°	2	20-40 & >70°	2	801-1100 m	3
180-225°	1	10-20°	1	1101-1400 m	2
45-180° & Flat	0	0-10°	0	1401-1800 m	1
				1801-2300 m	0

In summary, the analysis of the bushfire behaviour potential classes resulted in 17 separate BBP class combinations as shown below. These 17 classes are then grouped into four classes of BBP.

Vegetation/ fuel group (0-7)	+	Aspect category (0-3)	+	Slope category (0-3)	+	Elevation category (0-4)	=	Bushfire Behaviour Potential class (0-17)

The Park has relatively large areas of very high to extreme BBP particularly on the western slopes and throughout the Byadbo area whereas the majority of the higher elevation areas have a low BBP (Figure 14). Historically, unplanned fires under very high-extreme FFDI conditions, have exhibited high rates of spread (1-2 km/hr) and spotting of up to 10 kilometres when drought, fuel and weather conditions combine to produce extreme fire behaviour. Most fires however, occur under more benign conditions where fire behaviour is such that the majority of fires are able to be contained within 3-10 days.

Significant factors contributing to bush fire behaviour potential within the Park include;

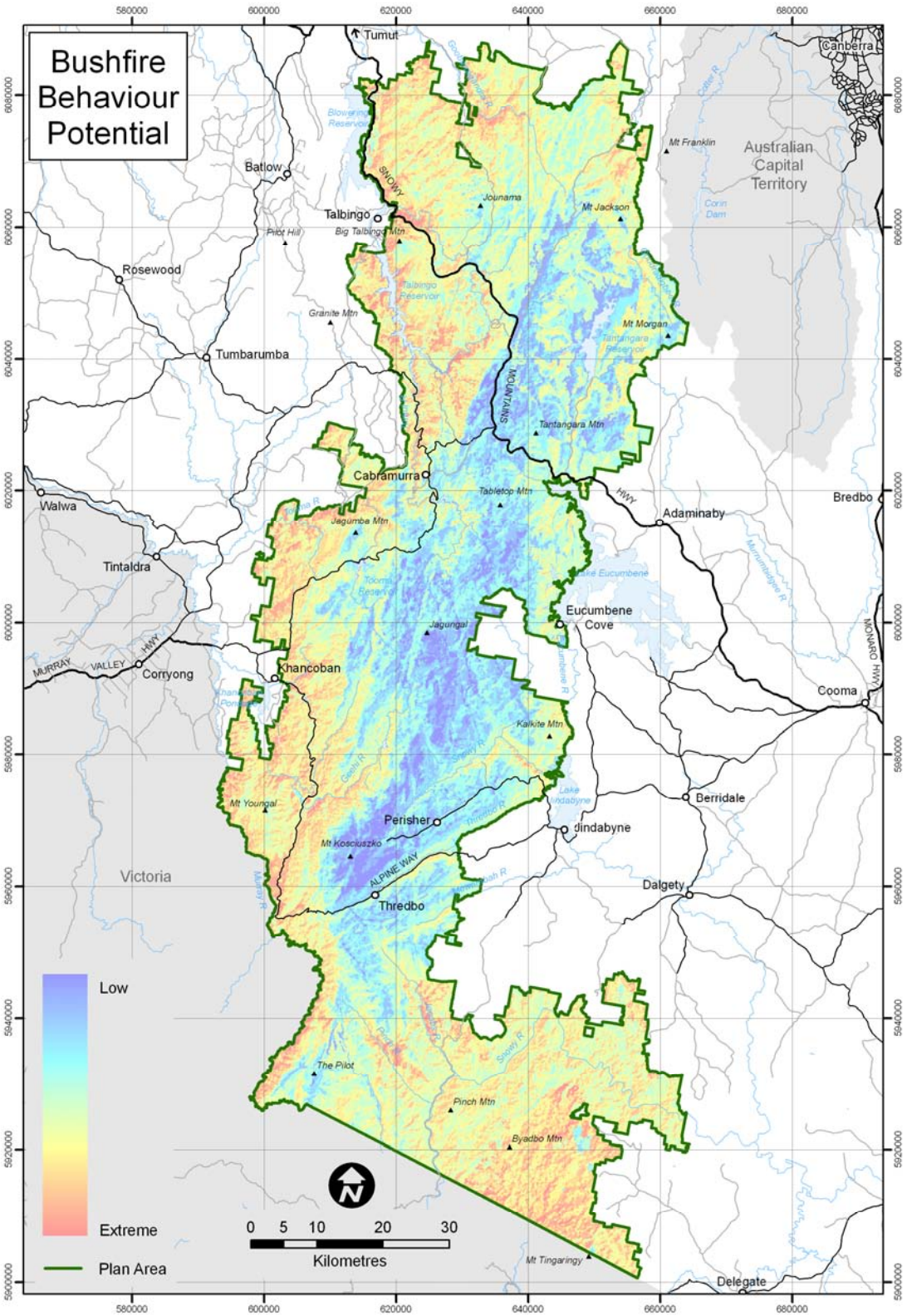
- Large areas of the vegetation at lower elevations are dominated by Eucalypt forests and woodlands that have the potential to burn intensely in an average season;
- The Park is characterised by extensive steep terrain (slopes greater than 20^{o}) with short spotting distances between ridges. Long range spotting is produced by higher intensity fires coming up the windward slope to a ridge; and
- Aspect has a significant affect on fire behaviour. Under hot westerly winds fires burn at right angles to the ridgelines along the entire western fall, which can create intense fire behaviour and spotting over a large area. Under a south westerly pattern however, fires burn along these ridge lines. These conditions produce generally lower intensity fires with significantly less convection and therefore less spotting.

Fuels tend to be drier and available longer in those areas with west to north aspects at lower elevations resulting in increased fire behaviour potential for a longer period of time during the fire season. The broad characteristics of the BBP classes are outlined in Table 12.

Table 12 Bush fire potential classes for Kosciuszko National Park

Class grouped	BBP Class	Slope, Aspect and fuel characteristics	Area (ha & %)
Low	1,2,3,4	• Flat to gentle slopes (0 –10°) where wind speed and direction, and FMC will determine the potential rate of fire spread; • South easterly aspect associated with a high probability of low to moderate FFDI conditions during an average season • Generally subalpine woodlands, alpine areas and frost hollows, cleared areas at high elevation	73,022 (11%)
Moderate	5,6,7,8,9	• Generally gentle slopes (0 – 10°) increasing the potential up hill rate of fire spread by up to 33%, • Some north easterly aspects at higher elevations associated with a higher probability of moderate to high FFDI conditions during an average season, • Subalpine woodlands, alpine and frost hollows on steeper slopes and more northerly and westerly aspects; • Moist and dry sclerophyll forest types on low slopes, higher elevations and east and south aspects.	217,321 (31%)
High	10,11, 12,13	• Hilly terrain (wide range of slopes from 10° up to 70°) increasing the potential up hill rate of fire spread by up to 200%, • North, west and south west aspects associated with a higher probability of high and very high FFDI conditions during an average season, • Lower elevations • Woodland and dry forest fuel groups that will support a high intensity fire during an average season.	373,798 (54%)
Extreme	14,15, 16, 17	• Steep slopes (>20° and up to 70°) and ridges increasing the potential uphill fire spread up to 400%, • North to westerly aspects associated with a higher probability of very high and extreme FFDI conditions during an average season, • Shrub land and woodland fuel groups that will burn intensely given a fuel continuum from ground to canopy.	24,761 (4%)
Towns/ Lakes etc		NA	3,803 (1%)

Figure 14 Bushfire behaviour potential classes



2 BUSH FIRE RISK

2.1 Introduction

A bush fire risk analysis has been undertaken to identify the level of risk to assets within and immediately adjacent to the Park. These assets include life and property, natural heritage and cultural heritage values, water catchment values and economic values. For the purpose of this strategy, bush fire risk is defined as "the chance of a bush fire igniting, spreading and causing damage to the community or assets that they value" (RFS 2007). The bush fire risk analysis method complements Bush Fire Risk Management Plans and is further described in the NPWS strategy for Fire Management Planning (NPWS, 2003). The risk assessment process is based on the best available data. However, fire ignitions and fire behaviour are subject to a range of variables, such as weather, that make fire impossible to predict with certainty. While a risk assessment outcome may indicate a low or insignificant risk, it does not preclude the possibility of a fire occurring, with subsequent consequences, in any given location as this is impossible to predict. It is also important to acknowledge that after risk management strategies and controls have been implemented in preparation for the fire season, a residual level of risk to many assets and features will still remain.

Assets at risk from bushfire have been divided into the three main categories of Life and Property, Natural Heritage and Cultural Heritage. Risks to Aboriginal cultural heritage are predominantly from the activities associated with fire suppression operations and are addressed in Table 23. The assessment process for consequence is different for each life and property asset type; human settlement (2 sub categories), economic (3 sub categories), environmental and cultural (see Appendices 3 & 4).

The risk assessment process which is a combination of likelihood and consequence results in a "risk rating". Likelihood is the chance of a fire igniting and spreading and may be based on recorded data and verifiable anecdotal information. Values were assigned across the Park using the mapped fire history database for the 50 years between 1957 and 2007. This fire frequency was then increased with an estimate to account for increased days of Very High and above fire danger as a result of predicted global warming. There are four possible likelihood ratings: unlikely, possible, likely and almost certain. Consequence is the potential outcome or impact of a bush fire event. There are four possible consequence ratings: minor, moderate, major and catastrophic. There are five possible risk ratings: insignificant, low, medium, high, and extreme as shown in Table 13.

Table 13 Risk ratings

Consequence / Likelihood	Minor	Moderate	Major	Catastrophic
Almost certain	Medium	High	Extreme	Extreme
Likely	Low	Medium	High	Extreme
Possible	Insignificant	Low	Medium	High
Unlikely	Insignificant	Insignificant	Low	Medium

Possible courses of action arising from the risk analysis are shown in Table 14. A detailed explanation of the risk assessment process used, and detailed definitions of terms is available in RFS (2007).

Table 14 Courses of action for risk ratings

Risk Rating	Possible Courses of Action
Extreme	Immediate attention required (priority action required in first year of strategy).
High	Action will be required during the plan period.
Medium	Some action may be required.
Low	Action may not be required.
Insignificant	Need for action is unlikely

The results of the assessment form the basis for determining bushfire management zones, determining treatments including setting priorities for the selection of fire management strategies and the generation of works schedules.

All data related to identified assets is stored in NPWS Geographic Information System databases, and therefore not all data is reproduced in this strategy. The results of individual risk assessments, and treatments, for assets where the risk is determined to be medium or greater, are listed in various appendices. Assets and operational guidelines for their protection are also shown on relevant operations plans and the operations guidelines. The extent of the risk analysis is limited to within the boundary of the Park as this is the extent of many of the data layers within the Geographic Information System. Hence there are locations noted in Appendix 3 on the boundary where a risk rating has been determined and which is subsequently related to assets adjacent to the Park.

A number of risk assessment processes, using Arcview databases, have been completed to determine the level of risk to life and property including analysis of:

- Location, type and distribution of built assets within and adjacent to the Park;
- Ignition cause and density;
- Fire history including unplanned fire frequency, size and location;
- Direction of spread of major fires;
- Slope, proximity to vegetation and estimated fuel loads around assets;
- Climate and weather affecting bushfire behaviour; and
- Fuels and vegetation in relation to bushfire behaviour.

Although the Park typically experiences several fires each year, these are broadly distributed over the mountains and it is unusual for one place to be burnt frequently. Most assets have a low risk rating due to the low frequency of fire and because there are reasonable clearings around the buildings. The exception to this is the non-Aboriginal historical sites such as huts and old yards. These are typically built of timber and have vegetation close to them, so the probability of them burning should a fire occur is much higher than it is for more modern built assets, and accordingly these assets have a higher risk rating. The derived risk ratings reflect the actual outcomes of past fires occurring both within and adjacent to the Park where historically there has been very little recorded damage to built assets (other than huts) and no recorded loss of life in recent times.

The results of the risk assessment for individual built assets and localities are summarised in Appendix 3 and for non-Aboriginal cultural heritage assets in Appendix 4. The risk modelling for all property assets returned only medium or lower ratings, with three exceptions (Figure 15). The NPWS Education Centre at Sawpit Creek rated “High” due to the fact that in addition to the 2 natural fires in the last 50 years, the arson fire of 1998 increased the likelihood rating. Two assets were re-assigned higher ratings based upon the decision of the Snowy Monaro BFMC, which agreed to assess likelihood at these sites based not on the number of fires that had directly impacted the site but on the number of fires that had come within a kilometre or so. Providence Portal was rated “High” due to an arson fire that was lit in 2003, and Eucumbene Cove (and Eucumbene Cove boundary) were rated “Extreme”, although it had only been

directly threatened by fire three times, all of which were escaped prescribed burns having occurred in 1968, 1977 and 2006.

2.1.1 Bushfire risks

Bushfire risk for life and property is a complex interaction between a number of variables, including:

- Ignition sources and patterns in the landscape;
- The ability of property owners, residents and visitors to take appropriate action in the event of a fire;
- The adherence of properties to the building design and construction standards detailed in Standards Australia (1999) and Australian Building Codes Board (2006);
- The establishment and maintenance of adequate asset protection zones as described by *Planning for Bushfire Protection* (RFS 2006a) within private lands;
- The degree of isolation of communities and properties, potentially making them dangerous to reach by fire fighters and making effective protection difficult owing to a lack of services, particularly under severe conditions;
- Access for fire fighters to protect property during bushfires along perimeter roads, fire trails or walking tracks at the rear of private properties;
- The adequate deployment and response times of fire fighting resources, both ground and air, to suppress fire and protect property; and
- The fire behaviour potential of the landscape based on the interaction of topography, vegetation type, fire history and fuel accumulation rates and consequent rates of spread and fire intensity.

2.1.2 Fire management activity risks

Fire management activities, including suppression activities, while generally mitigating the risks of fire can also have impacts on life and property values and natural and cultural heritage values including:

- Construction of new control lines through priority habitats and threatened species populations;
- Clearing and widening of existing trails as control lines;
- Removal of habitat roosts and nesting trees in the mop up stage;
- Potential impacts of retardants, foams and other fire fighting chemicals;
- Back burning and burning out operations;
- Damage caused by ancillary operations such as drawing water from sensitive creek edges; clearing helipads; impacts of traffic on trails and at staging areas etc;
- Introduction of exotic species;
- Water contamination through aircraft suppression operations;
- Prescribed burning operations and environmental impact; and
- Damage to cultural heritage sites by increased traffic, dozing and other operations.

2.2 Life and Property Risks

2.2.1 Risks to life

Risks to life include risks associated with resident populations within and adjacent to the Park, risks to transient populations of Park users, and risks to personnel involved in fire fighting operations.

2.2.1.1 Resident populations

Generally wherever there is a threat to private property there is a chance that there is also a risk to life. Major resident populations within the Park include some of the resort areas, Waste Point, and the township of Cabramurra.

High risk situations for residents include:

- Major unplanned fire situations where resources are stretched to the limit;

- Property protection during unplanned fires where properties have not been adequately prepared, and where neighbours do not have the appropriate asset protection zones, personal protective equipment or training; and
- Single access 'in-holdings' or other facilities (as the opportunity of escape is limited such as by a single access, and could be cut off by an approaching fire front).

2.2.1.2 Visitors

Visitor locations have been mapped and estimates of the potential number of visitors at these locations are presented in Appendix 2. It cannot be assumed that visitors are aware of the dangers of fires and the risk to such people can be high if they are in the remote or inaccessible areas when a fire occurs. High risk situations for visitors include:

- Along single access tracks where the opportunity of escape is limited and could be cut off by an approaching fire front;
- In remote areas where visitors may be unaware of Park closures, fire bans or approaching fire fronts; and
- Within a burnt area where trees and branches are falling and there is a possibility of re-ignition.
- Multiple simultaneous ignitions under >high FFDI and other situations where resources may be stretched

2.2.1.3 Fire fighters

Risks to fire fighters are discussed in detail in all training courses with an emphasis on the priority of safety for fire fighters coming ahead of fire suppression operations. High risk situations for fire fighters may include:

- Working in proximity to escarpments, cliffs, steep or rugged terrain and karst areas;
- Property protection directly adjacent to built assets where fire fighting access is limited and vegetation directly adjoins the asset;
- Remote deployment of crews for direct attack;
- Remote operations generally where there are a limited number of safety refuges and identified escape routes, and changing weather conditions may complicate crew extraction;
- Dead end tracks and trails where there are infrequent turn around bays and refuge areas;
- High fuel loads;
- Changing and variable weather conditions reducing the predictability of fire behaviour;
- Aircraft operations; and
- Working near powerlines.

2.2.2 Risks to property

Damage to property can result from direct flame contact, radiant heat or ember attack. Most destruction and damage to buildings in a bushfire is a direct result of poor preparedness and of property being left unattended during a fire. Risks to property include potential damage to assets within the Park and potential damage to assets adjacent to the Park.

Appendix 3 summarises the risk assessment for property within the Park identified as having a risk rating of medium and above.

The relevant Bush Fire Risk Management Plans detail the specific level of risk to community assets outside of the Park boundary. The locations of assets within and immediately adjacent to the Park are mapped in the NPWS geographic information system and are shown on bush fire operations maps. Townships and developments in very close proximity to the Park include Khancoban, Talbingo, Eucumbene Cove and Providence Portal. The population of these townships varies throughout the year due to seasonal visitation.

2.2.2.1 Residential areas

The residential areas within the Park, including resort areas, generally face a low risk of damage from bush fires due to being in high elevation locations where likelihood of fires is very low. Factors influencing the risk of damage to property in residential areas include:

- The aspect, wind exposure and position of buildings with respect to plateaus and spur lines that facilitate more aggressive fire behaviour;
- The proximity of contiguous flammable vegetation and fuels to buildings;
- The potential fire behaviour;
- The availability, location and standard of fire fighting access and water services particularly between the asset and any approaching front;
- Single narrow access where fire fighters and residents may be cut off from accessing the property by an approaching fire front;
- The age and design of housing;
- Availability of services (water) for fire fighting vehicles and aircraft;
- The depth and maintenance of asset protection zones; and
- Where there is a history of damage under severe conditions.

Waste Point is a residential area of moderate density at lower elevation. There can be up to 50 people resident in the area at any time. Access is via a single road and vegetation and fuels are currently often in close proximity to the buildings. Being immediately adjacent to Lake Jindabyne, there are numerous fuel free areas on the lake shores. There have been 22 unplanned fires since 1965 within a five kilometre radius of Waste Point and the ignition source for nine of these has been arson. It is proposed to develop a Village Protection Plan for this area.

Yarrangobilly Caves has a small number of residents but may also have high numbers of visitors at any time. Access is via a single road and vegetation is in close proximity to many of the buildings. This location is in an area that has been subject to relatively frequent fires having experienced ten fires within a five kilometre radius in the period 1965-2007. Buildings in this area will be protected by maintenance of asset protection zones and annual fire preparation.

Cabramurra is located at the top of a steep westerly aspect above Tumut Two Pondage. The village has been threatened directly by fire in the past but no assets have been lost within the village. There have been 15 fires within a five kilometre radius since 1964 most of which have been started by lightning. It is noted that during the 2003 fire season, operational assets associated with T1 Power Station and Tumut Ponds Dam owned by SHL, and that are in close proximity to Cabramurra were damaged due to ember attack.

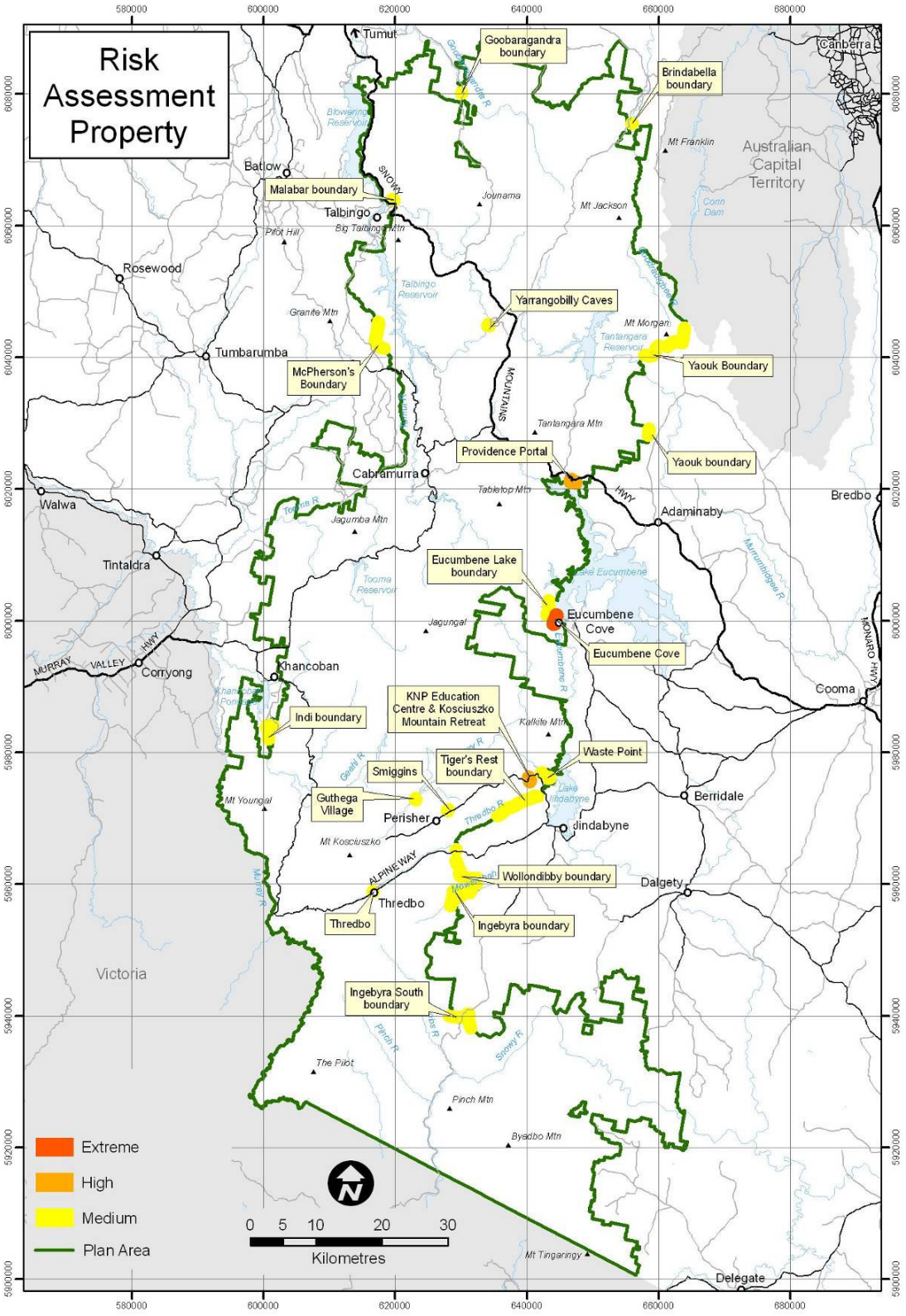
Eucumbene Cove and Providence Portal are residential areas just outside of the Park boundary. Both areas have small numbers of residents although in the summer months numbers can increase significantly with visitors and tourists. Within a five kilometre radius, Providence Portal has experienced 22 unplanned fires since 1961 while Eucumbene Cove has experienced 11 unplanned fires since 1967. None of these fires have destroyed any assets in these locations although three escaped prescribed burns have threatened assets at Eucumbene Cove, and four unplanned fires have threatened assets at Providence Portal. Treatments for these areas are detailed in the relevant BFMC Risk Management Plan while treatments have also been proposed in the strategy and within the Park to provide increased protection to these assets.

Alpine resorts within the Park, as defined by SEPP (Kosciuszko National Park - Alpine Resorts) 2007, are all at high elevation and are rarely threatened by bushfire. Accordingly the risk rating for Alpine resort areas was low or insignificant other than for Thredbo which rated as medium. The medium rating for Thredbo is a function of the potentially high consequences rather than likelihood. For all alpine resort areas, NPWS is the land manager whereas the Department of Planning is the consent authority for all development within resort areas.

In addition to the potential risk to the residential population of Thredbo Village, it is recognised that snow cover in the area (a major contributor to the viability of the local economy) is dependant on the adjoining tree cover, which in turn may be threatened by bush fire.

Figure 15 Risk assessment of human settlement and private property assets

(Note- Figure 15 only shows those areas of human settlement that have a risk rating above "medium")



2.2.2.2 NPWS facilities

The Park contains a large number of NPWS facilities including fire detection towers, sewerage treatment works in resort areas, workshops, camping areas, car parks, picnic areas, shelters, toilets, information facilities and lookouts. Factors influencing the risk of damage to these assets from fire include:

- The remote nature of some facilities where effective protection would be difficult and dangerous for crews under severe conditions;
- Single access roads where fire fighters may be cut off from protecting the facility by an approaching fire front;
- Availability of services (water);
- Depth and maintenance of asset protection zones;
- Level of seasonal preparedness around the assets e.g. clearing or mowing; and
- Proximity and extent of threatening fires.

Detection towers managed by NPWS include Ingebyra, Blackjack, Mt Youngal and Talbingo. Each of these locations has a range of infrastructure including essential radio communications equipment. Each tower site is an essential component of a number of emergency service radio networks and are therefore of very high value. Their location on hill tops makes them potentially highly vulnerable to fire although the risk assessment indicted a low risk for all detection towers.

2.2.2.3 Rural lands

Rural lands surround the Park on or near many Park boundaries. Assets that may be damaged from bush fires include houses, sheds, equipment, live stock, fences, crops and loss of pasture or grazing lands. Factors influencing the risk of damage include:

- Single access roads where fire fighters may be cut off from protecting the property by an approaching fire front;
- Availability of services (water);
- Level of preparedness on property boundaries and around assets;
- Presence and adequacy of cleared refuge areas; and
- Depth and maintenance of asset protection zones.

2.2.2.4 Public utilities and infrastructure

A number of public utilities are located adjacent to or within the Park. In extreme conditions, these could be affected or damaged by fires. They include high voltage and domestic power lines, public access road corridors, water pipes, sewerage and pumping equipment, communication lines and towers, and important drinking water catchments and storages. Factors influencing the risk of damage to public utilities and infrastructure include:

- Single access roads where fire fighters may be cut off from accessing the facility by an approaching fire front;
- Availability of services (water) and or other appropriate fire fighting equipment;
- Depth and maintenance of asset protection zones;
- The remote nature of some facilities where effective protection would be difficult and dangerous for crews under severe conditions; and
- Proximity and extent of threatening fires.

There is a range of public infrastructure within the Park that is potentially threatened by fire. Communication towers and some powerlines are located on some hill tops and ridge lines through the Park, placing them at potentially higher risk from unplanned fires. These assets (e.g., plastic-coated cables) can be damaged by fire.

Within the Park there are over 250 scientific sites, some of which have a range of scientific instruments. A review of sites and the infrastructure associated with them has been carried out and broad management guidelines prepared to protect known sites from the effects of fire and suppression efforts. Scientific sites that require protective measures are shown on operations plans.

Significant engineering works have been installed along the Alpine Way including gabion walls and wire netting at various locations. A range of engineering infrastructure is installed above the Alpine Way at Thredbo. While generally resistant to impacts of fires, the burning of galvanised wires will reduce the life of the wire.

2.2.2.5 Snowy Hydro Limited (SHL) and other electricity infrastructure

There are numerous assets owned and maintained by Snowy Hydro Limited (SHL) within the Park. All SHL infrastructures within the Park are regulated by the Snowy Park Lease and executed Snowy Management Plan Environmental Management Plan Chapters. These assets have been risk assessed by SHL as part of the development of the Emergency Management Plan (SHL, 2007). SHL has identified a number of potential asset protection zones (APZs) for specific infrastructure. These APZs are included in this strategy. Due to the large number of sites with small APZs assigned, it is not possible to provide individual maps in this strategy. All APZ locations are in the local Geographic Information System.

SHL infrastructure within the Park includes dams, communications facilities, major power stations, tunnels, aqueducts and access trails. SHL also own and maintain the township of Cabramurra. Many SHL assets, including communication assets, are located on ridgelines within the Park. Many SHL assets within the Park are also located in moist gullies, are built of moderately fire-resistant materials and generally have good road access. SHL has outlined its planning and management guidelines for bushfire risk mitigation in Annexure B of Chapter 3 of the Environmental Management Plan (SHL, 2007).

Fuel around many SHL assets is regularly reduced by slashing and clearing debris from around and under features. This reduces the bushfire behaviour and damage potential, as well as reducing the chance of ignition from arcing powerlines.

SHL proposals for implementation of prescribed burns to protect assets are subject to approval by NPWS as outlined in the Environmental Management Plan (SHL, 2007).

2.2.2.6 Commercial forests

There are significant commercial forestry resources adjacent to Park boundaries including the hardwood forests of the Bago/Maragle and Ingebyra State Forests. There are also publicly owned softwood pine plantations in the Tumut and Tumbarumba Forests NSW administrative areas and some privately owned plantations on the Park boundary at Goobarragandra and in the Byadbo area. The Ingebyra and Mowamba forests hold regenerating and mature Alpine Ash stands and could potentially be at risk, but are shielded by the more moist vegetation types in the Park/state forest. The Bago, Maragle, and Tumbarumba forests are less at risk from fires leaving the Park as they are located to the west of the Park. These forests have well developed access and are a potential source of fires originating within the forests and travelling into the Park.

2.2.2.7 Smoke sensitive areas

Fires can have a significant impact on air quality and visibility. Areas where smoke could affect services include:

- Built up areas of the ACT;
- Schools, retirement villages and hospitals at Berridale, Khancoban, Talbingo, Cooma, Jindabyne;
- Airfield facilities at Jindabyne, Khancoban and Cooma (and Canberra Airport in extreme conditions); and
- Grape production areas specifically in the Tumbarumba local Government Area. The key issue is the perceived potential impact of smoke on grape quality.

2.3 Natural Heritage Risks

The natural heritage of the Park includes its unique ecology, biodiversity, scenic landscapes, karst areas, soils, wilderness and clean water catchments. Natural heritage may be placed at risk as a result of adverse fire regimes, fire suppression operations, and pest species invasions resulting from post fire changes to habitats.

The risk assessment process for natural heritage values uses a new draft methodology being developed by DECC. Likelihood has been determined as for built assets as outlined in section 2.1.1. An Arcview analysis of the likelihood of fire spread affecting these species and habitats was then combined with the consequence rating to determine an overall risk rating. The final risk rating is derived from combining the likelihood and consequence ratings similar to the process used for built assets as described in Table 13. This methodology is new and may be subject to refinement in the future following further consultation and development.

The consequence component of the environmental risk assessment was determined by a consideration of factors including the vulnerability of the asset and the potential impacts of a fire or fire regime. There are four categories for consequence: minor; moderate; major; and catastrophic as shown in Table 15.

Table 15 Consequence ratings for the environmental risk assessment.

Vulnerability / Potential impact of bush fire	Low	Moderate	High	Very High
Exclude bush fire	Moderate	Major	Major	Catastrophic
Restrict bush fire	Minor	Moderate	Moderate	Major
No conditions	Minor	Minor	Minor	Moderate

Vulnerability is based on how rare or uncommon a species or community is (the geographic extent of a species or habitat) and its vulnerability status. The process has been adapted in this strategy to also include a range of threshold and fire suppression activities that may impact negatively on these species.

Table 16 Vulnerability ratings for the environmental risk assessment

Conservation Status / Geographic Extent	Locally important	Vulnerable	Endangered
Highly restricted	Moderate	High	Very High
Restricted	Low	Moderate	High
Widespread	Low	Low	Moderate

High fire frequency (regular short inter fire interval) has been identified as a key threatening process under the *Threatened Species Conservation Act* 1995. The long-term survival of plants and animals through repeated fires is dependent upon two key features: (i) the ability of species to maintain life cycle processes; and, (ii) the maintenance of vegetation structure over time as habitat for animal species. Where fires occur very close together in time (high frequency fire) both these key features can be disrupted. High frequency fire is defined as two or more successive fires close enough together in time to interfere with or limit the ability of plants or animals to recruit new individuals into a population, or for plants to build-up a seedbank sufficient in size to maintain the population through the next fire. Sustained high frequency fire will consequently lead to a loss of plant species, a reduction in vegetation structure and a corresponding loss of animal species (NPWS website, 2008).

The corollary to high frequency fire is the exclusion of fire for long periods of time. Many plants are dependent on fire for the stimulation of flowering, germination of seeds or for particular essential resources. The exclusion of fire for an extended period of time may lead to the senescence of plants and their seed banks and their eventual replacement by other species. Thus exclusion of fire for long periods of time may also result in local extinctions. It is generally a completely different suite of species that are sensitive to high frequency fire to those sensitive to exclusion of fire.

2.3.1 Fire Biodiversity thresholds

Biodiversity fire regime threshold is the time between a series of fire events that a suite of plants and animals within a defined community requires to recover after a fire, before being at risk from a decline in biodiversity. A decline in biodiversity (extinctions locally or regionally) can occur as a result of either too infrequent or too frequent burning. Animals and plants are interdependent, with plants forming an important component of the habitat for animals. Plants and animals with similar life-history characteristics have similar biodiversity fire regime thresholds. As such, biodiversity fire regime threshold can be specified for groups of species (e.g. communities) with similar life-history characteristics rather than for individual species. Biodiversity fire regime threshold guidelines are aimed at biodiversity conservation, and are not intended to be interpreted as prescriptions. They define “acceptable” fire intervals consistent with the maintenance of existing plant species, in accordance with current known fire ecology research (NPWS 2004).

The minimum fire interval (based on the minimum maturity requirements of species sensitive to extinction under frequent fire regimes) is the length of time between fires that should avoid any local species extinctions. For plants this is based on primary juvenile growth periods and may not include time to replenish seed-bank reserves. To allow for seed production and building up of seedbank reserves, a period of three (3) reproductive years has been added, in the Geographic Information System threshold analysis, to the minimum fire interval for all communities.

Fires at shorter intervals than the minimum specified interval are predicted to result in the depletion of populations and local losses of species over the affected area, particularly when fires occur repeatedly at or less than the specified minimum time interval (NPWS, 2004). For example, Alpine Ash may become locally extinct if a crown fire is followed within the minimum threshold by another fire, even if it is low intensity. For a majority of species within each formation, the “optimum” interval is likely to fall somewhere within the domain between the minimum and maximum intervals.

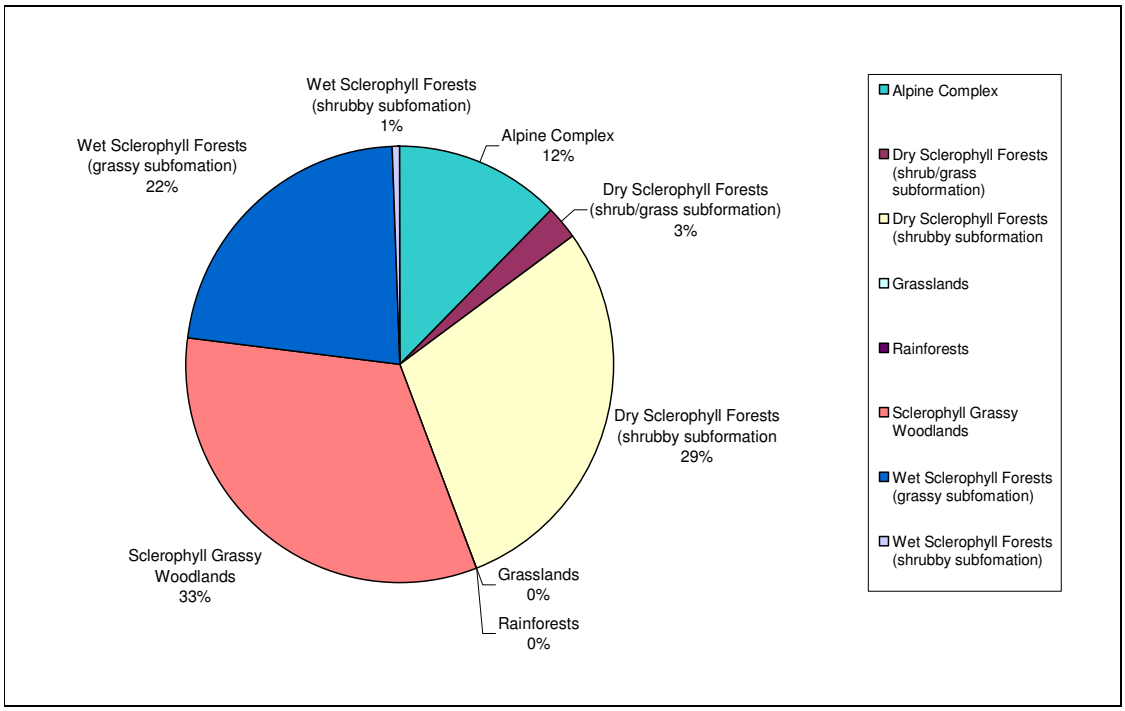
The maximum fire interval indicates the time since fire at which it may be expected that species may be lost from the community due to absence of fire. This figure is a “best estimate”, and based on a number of unverified assumptions. Having identified the minimum and maximum fire intervals, the greatest species diversity is maintained by variable inter-fire intervals, i.e. a mosaic of age classes within each community. Variability of all aspects of the fire regime including frequency are generally required for the maintenance of a variety and diversity of habitats for both flora and fauna species (Gill and Bradstock, 1995).

Biodiversity fire regime thresholds for the Park have been determined, by evaluation of known available data (NPWS, 2004) and expert opinion (Keith, D., Doherty, M. and Wright, G. pers. comm. 2007), for broad vegetation formations within the Park (Table 17). The geographic extent of the broad vegetation formations are shown in Figure 17 and their relative proportions within the Park by area are shown in Figure 16 . Thresholds will vary across any area, including those proposed for prescribed burning depending on vegetation present which is in turn partly a function of slope and aspect.

These thresholds, while accounting for some key flora and fauna variables, do not account for the whole variability of all flora and fauna responses to the fire regime and climate in the

landscape nor in specific locations such as the Park. Therefore such thresholds must be used with caution (NPWS, 2004). Interpretation of the thresholds shall be done in association with local knowledge and utilising the results of local monitoring programs where available (NPWS, 2004).

Figure 16 Proportion of broad vegetation formations



Any prescribed burn proposal shall consider the extent of likely change in threshold status, resulting from the implementation of the prescribed burn, to ensure that the prescribed burn does not compromise overall biodiversity fire regime thresholds for all formations in the Park. Planning shall provide for a range of age classes (time since fire) in all broad vegetation formations, including allowing for some long unburnt areas where possible. Accordingly the minimum thresholds may be exceeded at any time without any implication that that vegetation requires a burn, simply because the minimum threshold has been exceeded.

The thresholds, when being used to inform prescribed burning proposals should be complemented by more detailed local survey, where possible, of flora and fauna species in the proposed burn area to ensure that biodiversity values are not to be compromised by the proposed burn. It is noted that there is very little data available on the response of fauna species to fire regimes and therefore more attention shall be paid to the requirements of fauna species at the local level when considering applying the thresholds for the purpose of prescribed burning. This shall include developing an understanding of fauna species abundance and distribution status at both the local and landscape levels. Selection of areas for prescribed burning takes account of a wide range of other ecological and cultural factors and shall not be based on the outcomes of the threshold analysis alone.

Thresholds that are developed using local data will be more accurate however such a process is contingent upon the availability of local data. While much flora response data was collected following the 2003 fires, this data is yet to be added to the state wide flora response register (Tasker, L. pers. comm. 2007). Several proposed projects at various institutions including the Bushfire CRC have been proposed that may address this issue. A research project is nominated in the KNP POM (NPWS, 2007b) and is reiterated in section 4.3. An updated threshold analysis using local data would contribute significantly to being able to manage

biodiversity values with greater certainty and thus the proposed project is nominated as a high priority.

Table 17 Biodiversity thresholds

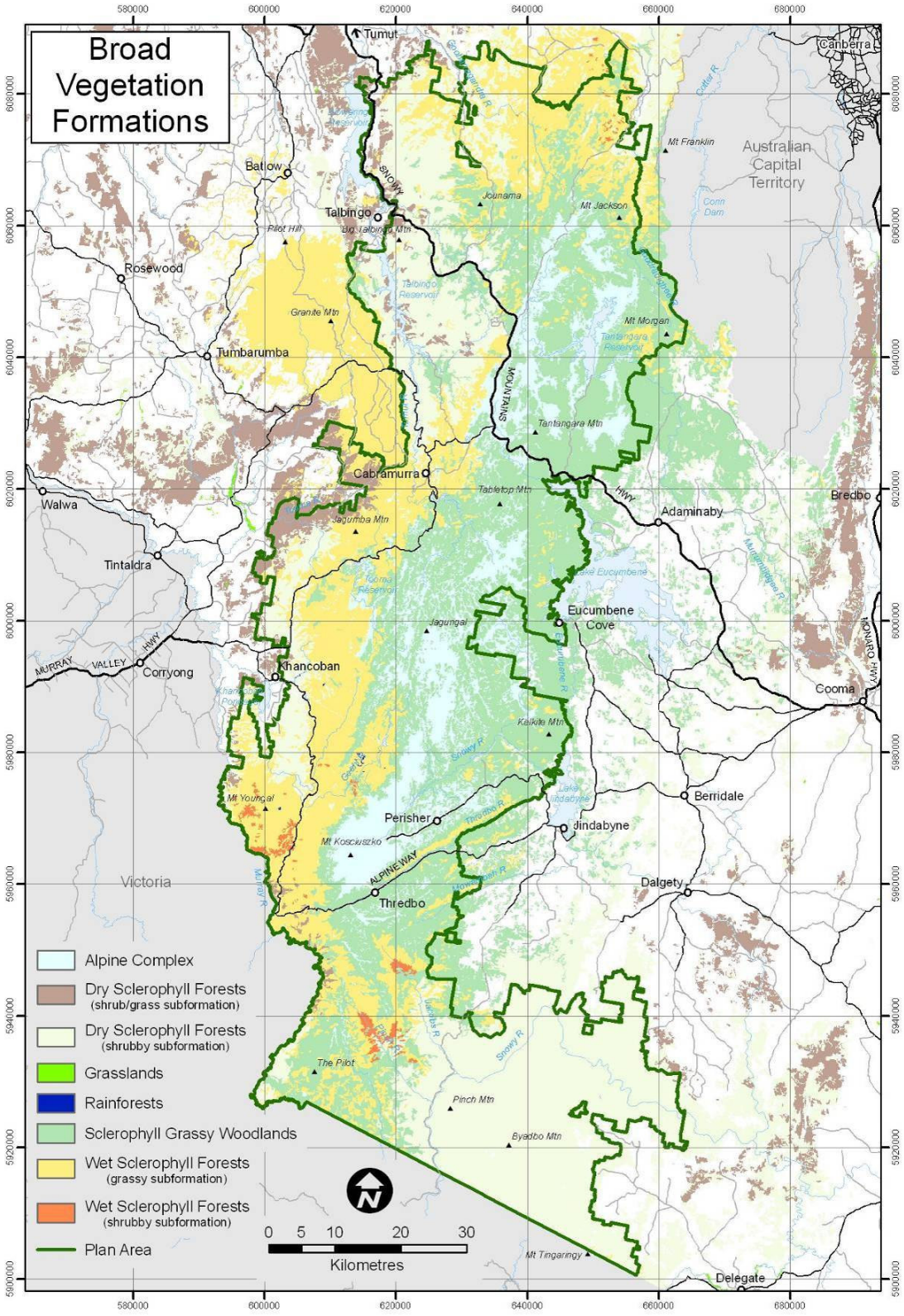
(FE = Forest Ecosystem, see **Appendix 5**) Note: The definition of Alpine vegetation formation includes a range of subalpine grasslands and heath communities, included because they have a "no burn" threshold recommendation due to their sensitivity to fire.

Code	Broad Vegetation Formation	Min	Max	A decline in biodiversity is predicted if…	Additional Guidelines
A	Alpine Complex, Rainforest (including sub alpine grasslands and heathlands)	N/A	N/A	- Any fire occurrence (a limited recovery ability exists); - Fire shall be actively excluded from these areas where possible.	- Fire occurs rarely under exceptional circumstances; - Recovery in Alpine areas can be very slow due to lower productivity at higher elevations.
B	Grasslands	2	10	- 3 or more consecutive fires with each inter-fire interval < 2yrs apart; - no fires for > 10yrs; - 3 or more consecutive fires of low intensity (i.e. grass lands need occasional medium to high intensity burns).	- Recruitment relies on inter tussock spaces that can be provided by fire; - May tolerate up to 40 years without fire but recruitment will decline.
C	Sclerophyll Grassy Woodlands	10	40	- 3 or more consecutive fires with each inter–fire interval < 10yrs apart; - no fires for > 40-50yrs.	- Some minimum intervals of 5 years may be tolerated in FE 76; - High intensity fires shall be avoided especially for subalpine woodlands (FE 95, 97, 98, 99, 128, 130 and 146).
D	Wet Sclerophyll Forest (shrubby subformation)	25	60	- 3 or more consecutive fires with inter – fires intervals of < 25yrs; - No understorey fires for > 60yrs; - Two or more canopy consuming fires within 100 yrs; - No canopy fires for >400 years.	- Some drier part of these communities may tolerate lower fire intervals of low intensity fires; - Crown fires shall be avoided in the lower end of the interval range.
E	Wet Sclerophyll Forest (grassy subformation)	10	50	- 3 or more consecutive fires with inter-fire intervals of < 10yrs; - No fires for > 50yrs; - Two or more canopy consuming fires within 25 yrs for Alpine Ash; - No canopy fires for >400 years for Alpine Ash.	- Some drier parts of these communities may tolerate low intensity fires of occasional frequency <10 years; - A minimum interval >25 min years for low intensity fires, are required in FE 86 and 87 (Alpine Ash) after a canopy consuming fire, especially at higher elevations; - Alpine Ash (FE 86 and 87) shall not be burnt for the life of this strategy in areas burnt in 2002-2003.
F	Dry Sclerophyll Forest (Shrubby subformation)	7	30	- 3 or more consecutive fires with inter- fires intervals of < 7yrs; - No fires for > 30yrs.	- Some min intervals > 10 years are required (FE 77, 78); - Too frequent fires may promote fire tolerant shrubs; - FE 73 has a max interval of 40yrs.
G	Dry Sclerophyll Forest (Shrub/Grass subformation)	5	50	- 3 or more consecutive fires with inter-fire intervals of < 5yrs; - No fires for > 50yrs.	- Some intervals > 7 years are required (FE 93); - Occasional intervals >25 years are desirable.

Sources (McCarthy *et al*, 2003; Watson, 2006, NPWS 2004; RFS, 2006; NPWS 1998)

Figure 17 Broad vegetation formations

(Note: The definition of Alpine vegetation formation includes a range of subalpine grasslands and heath communities, included because they have a "no burn" threshold recommendation due to their sensitivity to fire)



2.3.2 Biodiversity threshold status

Evaluating the fire interval status for the broad vegetation formations assists with the identification of areas that have been subject to adverse fire regimes and are therefore at greater risk of adverse impacts on biodiversity values. The current status of thresholds was analysed against the broad vegetation formations using both planned and unplanned fire history (i.e. all fires no matter what their origin) for the period 1975 to present. At the landscape level there can be significant risks to biodiversity conservation if a significant proportion of the vegetation falls outside the thresholds identified inTable 17. Table 18 provides an explanation of the threshold status classes.

In the following text, the terms over-burnt and under-burnt mean “burnt too frequently” and “long unburnt” respectively. Terms such as over-burnt and under-burnt are retained as they refer to the terms used in Arcview analysis programs.

Table 18 Explanation of biodiversity threshold status classes

Status classes	Explanation of interval status	Interpretation
Over-burnt	According to the thresholds analysis, the time between two consecutive fires has been too short and it is currently over burnt. In these areas, species and populations sensitive to short fire intervals may experience a decline in abundance to a point where they risk local extinction.	Protect from fires as far as possible.
Vulnerable	If a community has experienced at least one interval less than the appropriate minimum fire interval and is currently at an age less than the minimum interval, the community is considered vulnerable to a fire. If a fire occurs in the next year, the vegetation community will become over-burnt.	Protect from fires as far as possible.
Recently burnt	Time since fire is less than the minimum inter fire interval, but prior to the most recent fire the vegetation was within threshold. Vegetation that has an age class less than the appropriate minimum fire interval is considered recently burnt. If a second fire occurs before the appropriate minimum interval, the community will become vulnerable.	Avoid fires if possible.
Under-burnt	Where the age of a vegetation community is greater than the maximum fire interval for the community, the community is considered under-burnt. If fires continue to be excluded, a decline in biodiversity may result through the senescence of plants and their seed banks. Long-unburnt areas are, however, ecologically significant, and there may be relatively few areas represented. Long unburnt areas should be prioritised for monitoring of processes of recruitment, senescence and for their importance as fauna habitat	Consider implementing an ecological burn or allow the area to burn if possible if at least 50% of the formation or community is classified ”under-burnt”.
Almost under-burnt	Requires a burn in the next year otherwise it will fall into the under-burnt category.	Allow to burn if a fire naturally occurs.
Within thresholds (OK)	Vegetation communities with an age greater than the minimum interval and less than the maximum interval are considered to be ‘OK’ or within interval thresholds. If a fire occurs, the vegetation will become recently burnt.	A burn is not required nor shall one necessarily be avoided.
>50% of a community over-burnt or under-burnt	If more than 50% of a vegetation community becomes over-burnt and/or underburnt, there is a high risk that sensitive species may be pushed to local extinction. Overburnt areas are a high priority for fire exclusion until species and populations can recover.	Avoid fires if overburnt or allow fires if underburnt.

A summary of the biodiversity threshold status for broad vegetation formations is shown in Figure 18. Appendix 6 summarises the results of the threshold analysis in terms of the area and

percentages of each broad vegetation formation. Of particular significance are areas where greater than 50% of a vegetation formation experiences adverse regimes that are either too frequent (over-burnt) or too infrequent (long-unburnt). In these areas, if the trend in fire regimes continues, there will likely be a serious decline in the abundance of sensitive species and active management may be required to minimise potentially adverse conservation consequences (NPWS 2004). Knowing whether or not such adverse consequences are actually occurring requires monitoring.

From Figure 18 and Appendix 6, and principally due to the 2003 fires, the majority of vegetation formations are currently recently burnt and in some cases vulnerable or overburnt. Both the Alpine complex and rainforest areas are currently >50% overburnt and these vegetation formations may therefore be at greatest risk of a decline in biodiversity should fires occur in these areas again in the foreseeable future. This is a precautionary determination in the absence of more detailed data. Fire shall be actively avoided in these areas at least for the life of this strategy. No formations are >50% underburnt. 51% of the Wet Sclerophyll forests (shrubby subformation) are currently vulnerable and fire will need to be excluded from these areas where possible until at least the minimum thresholds are reached.

Approximately 12% of the Park is defined as under burnt and nearly all of that is in the Dry Sclerophyll Forests (shrubby subformation). Two areas stand out as being underburnt located in the area east of Talbingo and in various areas in the Lower Snowy. Prescribed burning proposals in these areas will consider the ecological objectives that may be achieved by implementing prescribed burns. All prescribed burn planning must give consideration to ensuring that some areas remain in an underburnt or long unburnt condition thus providing for the variety of habitats.

About 62% (10, 548 hectares) of the dry sclerophyll (shrub/grass subformation) is in a non threatened (OK) status and may, on the basis of the threshold analysis, be considered to be available for prescribed burn treatments if required. These areas are predominantly located in the North West Bogong area, the Maragle extension to the Park, between the Tooma River and Spring Creek in the Upper Murray Area, and some areas to the west of Yaouk Valley. Most other formations, other than alpine complex and rainforest, have between 10-20% of their area in a non threatened status and on the basis of the threshold analysis may be considered to be available for prescribed burn treatments if required, subject to ensuring that some areas of each vegetation formation remain in a long unburnt condition. While it may be desirable to avoid fire in these areas until the minimum threshold is reached, it does not exclude the opportunity to introduce prescribed fire for the purpose of asset protection.

Figure 18 2007 threshold status of all vegetation formations by percentage

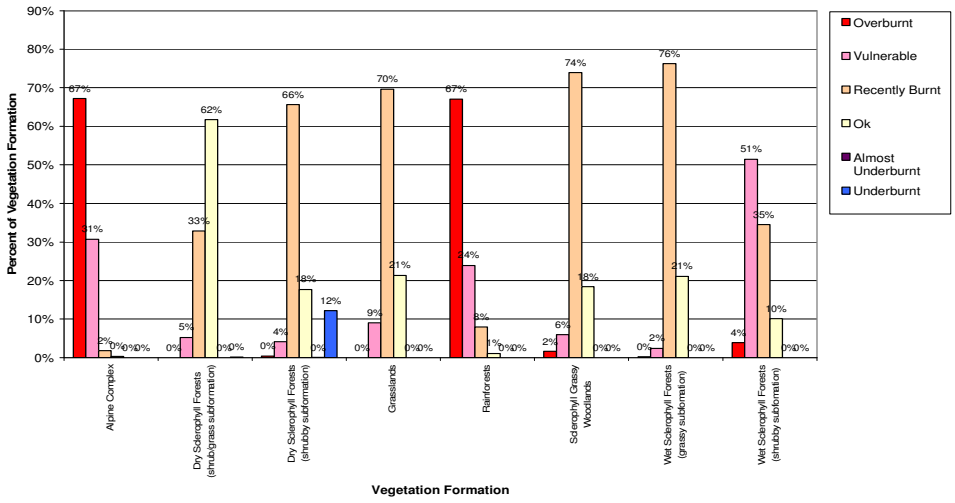
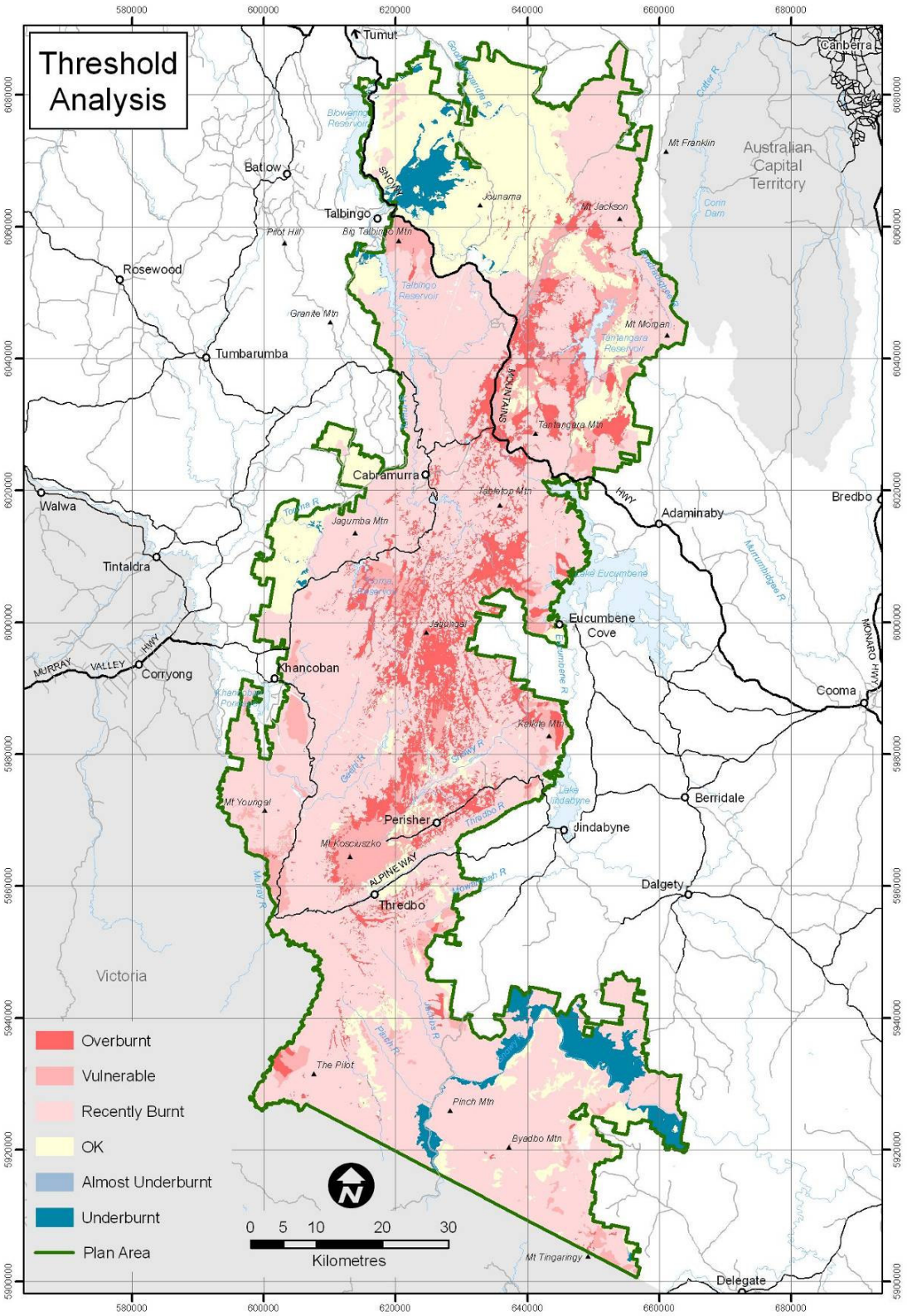


Figure 19 2007 threshold status of broad vegetation formations



2.3.3 Threatened flora

Key threats to flora in the fire context are too frequent fires, repeated low intensity fires, spatially extensive fires and impacts of fire suppression operations. Under current climate change predictions some of these factors may be expected to increase in the next few decades. Research carried out after the 2003 fires by Doherty and Wright (2004) in the Brindabella National Park found generally that flora that was present prior to the 2003 fires was also present after the fires. Generally fire does not negatively impact on floristic composition unless repeated fires are of such low intensity that seed germination of obligate seeders is not stimulated while adults are killed, or frequency is so high that species do not have time to regenerate before the next fire occurs. The Park contains some threatened flora populations that may be at risk from ecologically inappropriate fire regimes and fire management activities.

For many ROTAP listed flora species, it was determined that there is either insufficient information to carry out a risk assessment, or, where sufficient information was available to complete the risk assessment, that the level of risk resulting from the risk assessment process was so low, that it is not warranted to include specific recommendations for those species in this strategy.

The species that were identified as being most at risk and for which management guidelines have been determined are shown in Appendix 7. Of these, the following species were rated as being at high risk:

- Mueller's Burr-daisy (Calotis pubescens)
- Raleigh Sedge (Carex raleighii)
- Swamp Parrot-pea (Dillwynia palustris)
- Bog Midge Orchid (Genoplesium turfosum)
- Cotoneaster Pomaderris (Pomaderris cotoneaster)
- Rytidosperma vickeryae

A further ten species were rated at medium risk and all other flora species, where assessed, rated low.

Most known threatened flora species within the Park occur at high elevation and the knowledge of their abundance and distribution is often incomplete. A range of management guidelines have been developed for threatened flora species where information is known, and for a range of vegetation communities and habitats where management guidelines for flora species are common (Appendix 9). Further discussion of some of these vegetation communities and habitats occurs in section 2.3.5 below.

2.3.4 Threatened fauna

Inappropriate fire regimes are implicated, in combination with other factors such as grazing, drought, predation by introduced predators and habitat fragmentation, in the decline and demise of various native animal species (Gill and Bradstock, 1995) across Australia. Woinarski and Recher (1997) concluded that detrimental fire regimes had contributed to the extinction of three of the four bird species that had disappeared from Australia since European settlement, and that most threatened bird species benefited from long intervals between fires. Inappropriate fire regimes, in combination with other factors mentioned above, are likely to have contributed to the demise of some threatened species in the Park including the Brush-tailed Phascogale (*Phascogale tapoatafa*), and the endangered Spotted-tailed Quoll (*Dasyurus maculatus*). There is no single optimum fire regime for all fauna although a hypothetical optimum, as a general principal, may include ”a diversity of age classes, species and structural types of vegetation to be created and maintained and which, as a consequence, provides breeding, feeding and refuge habitat for a representative suite of native animals” (Good 1992 cited in Mooney 2004).

While individual animals and populations may be directly killed by fire, more significant impacts on fauna may occur on the post fire period through the temporary loss or modification of critical habitat attributes (e.g. Newsome and Catling, 1983) such as:

- The loss of hollow-bearing mature trees, although it is noted that fire can also contribute, in the longer term, to the development of hollows. (Tree hollows are critical for a wide range of possums, gliders and birds. All but three of the threatened bird species in the Park are hollow-dependent);
- The depletion of fallen wood debris as occurs in fires of all intensities although it is recognised that much remains after most fires;
- Changes in the abundance of food resources; and
- Temporary loss of protective vegetative cover.

The impacts of fire on any particular fauna species will depend on the extent of damage caused by fire to the habitat utilised by that species (Recher *et al*, 1981). Accordingly intense fires of large spatial extent can be considered to be more likely to have greater negative impacts rather than lower intensity fires of limited extent. However, a single fire in the habitat of a poorly distributed species can also be catastrophic for that species. Unburnt refuges, especially moist gullies and creek lines, and a mosaic of vegetation age classes or growth stages generally are considered most important for fauna survival (Lunney 1987; Lunney and Ashby 1987; Lunney *et al.* 1987; Lunney and O'Connell 1988; Lunney *et al.* 1991 cited in Brown *et al*, 1998). Catling (1991) and Tolhurst (1992) also report the importance of unburnt patches in survival of fauna species, particularly ground dwelling mammals.

Changes in habitat structure can also affect animal distributions and abundance and result in changes in dominance of different species over time (Doherty and Wright, 2004). A return to pre-fire structural complexity can occur within 2-4 years at lower elevations and higher productivity sites, whereas the lower productivity at higher elevations slows the process of habitat recovery. The recovery of canopy habitat in Alpine Ash and heath communities where obligate seeders predominate can be very slow. The pattern of habitat recovery also varies considerably with topography, aspect, climate and the fire intensity experienced.

Many threatened fauna species often have widespread distributions or large home ranges within the Park e.g. Masked Owl. This makes it difficult to make location specific recommendations for many of these species. In addition, most of the threatened fauna species in the Park are not directly threatened by a single fire per se having shown recovery even after large fire events as have occurred in 1939 and 2003. Some species are more threatened by the combination of deleterious impacts such as habitat modification, disease, predation, and competition from introduced species. High elevation threatened species, which have been assessed as being at high risk, include:

- Mountain Pygmy-possum (Burramys parvus)
- Spotted Tree Frog (Litoria spenceri)
- Southern Corroboree Frog (Pseudophryne corroboree)

The results of the risk assessment for all threatened fauna are shown in Appendix 8. Specific management guidelines are included to minimise impacts on species and habitat values for species. Only three threatened fauna species obtained a risk rating of high including Southern Corroboree Frog, Mountain Pygmy Possum, and Alpine Tree Frog. Two species were rated at medium risk, being the Northern Corroboree Frog and Broad-toothed Rat, and all other threatened fauna species rated at low.

Every effort will be made to protect the critical habitats of those fauna species most vulnerable to fire and which are most threatened in the Park e.g. Mountain Pygmy Possum, Broad Toothed Rat and Corroboree Frog. In major fires such as occurred in 2003, it is often not possible to provide resources to protect all critical fauna habitat sites. Therefore a number of priority habitats have been identified and prioritised to provide guidance for fire mangers in the event of another major landscape scale fire. These habitats are discussed in section 2.3.5, and management guidelines for first attack operations are identified in Appendix 9. Additional fire management guidelines and maps will be developed for individual identified priority habitats to provide specific guidance for suppression operations including use of retardants, location of

control lines, and other fire fighting strategies and tactics. These additional strategies will be added as addenda to this strategy when completed.

2.3.5 Priority habitats and locations

The key factors of the fire regime that influence biodiversity are season and frequency, with the interactions of these factors with fire intensity, determining structure, species composition, species richness and diversity (England *et al*, 2004).

A number of vegetation communities, fauna habitats and geographic locations have been identified as being at risk due to the combination of recent fire severity, fire extent, potential climate change impacts and in some cases high fire frequency e.g. Alpine communities. These vegetation communities, habitats and locations have been identified as being currently more sensitive to fire due to either flora sensitivity or habitat sensitivity for threatened fauna species, or for cultural heritage reasons. These areas have been risk assessed and the results and management guidelines are summarised in Appendix 9. These communities and habitats are described in Table 19 and Table 20 below and are shown as broad groups in Figure 20. Not all of these habitats are specifically identified on operations maps for display reasons, however location data is available on Geographic Information System spatial layers and will be referred to during fire suppression operations. Habitats and locations with the same management guidelines have the same map ID on operations maps, where displayed.

Alpine vegetation communities are found at the highest elevations in the Park and include feldmark, fens and bogs, herb fields and some heaths, grasslands and woodlands, and *Podocarpus lawrencii* shrublands. The biodiversity threshold for these communities is 'no burning' as the species in these communities are very sensitive to fire and fire is not required for maintenance of the species (McCarthy *et al*, 2003). Fire shall be actively excluded from these areas for the life of this strategy.

Remnant rainforest areas dominated by *Atherosperma moschatum* occur in the Geehi Valley area. Further small remnants have been identified in the Charcoal range and Suggan Buggan range areas of the Pilot Wilderness, and in the Clifford's Trail area of the Bogong Peaks wilderness. These additional areas require further mapping. These rainforest areas occur generally on south and east aspects in steep sheltered gullies which are also fire refugia. However in 2003, 67% of the rainforest areas in the Geehi valley were burnt. Fire shall be actively excluded in these areas to allow recovery of this community. Backburning may be used adjacent to this community provided fuel moisture differentials can be utilised to allow fire to go out upon reaching edge of this community.

Karst grasslands are a unique and very rare vegetation community occurring in only a very few locations, and containing a range of threatened or potentially threatened species (McDougall, K. pers. comm. 2007). Karst Grasslands are located in the Yarrangobilly and Coolamine karst areas and fire shall be avoided in these localities if possible. While this community may be expected to burn occasionally, it is also particularly sensitive to mechanical disturbance, which shall be avoided during suppression operations.

An area within the Bogong Peaks has been identified as having a range of flora, fauna and cultural heritage values and shall be protected from fire if possible. These values include northern corroboree frog habitat, sensitive alpine vegetation, a long unburnt fire history, and a range of Aboriginal sites. This location is also particularly sensitive to mechanical disturbance, which shall be avoided during suppression operations.

The headwaters of Kosciuszko Creek to the west of Mt Townsend escaped fire during the 2003 fire season and now provide a relatively rare example of ecologically mature alpine and subalpine habitat, particularly at the tree line ecotone. It is now also likely to be an important local fauna refuge area. All fire shall be actively excluded from this location and suppression operations shall be directed to protect this now unique example of alpine and subalpine habitat.

Table 19 Priority vegetation habitats and cultural heritage areas

(Note: Map ID commencing with EH refers to locations identified on operations maps as well as in Figure 20 in the text. Detailed location information is available in regional Geographic Information System databases)

Map ID	Habitat	Forest Ecosystems
Polygon Fig 20	Alpine vegetation communities including Montane peats and swamps, *Podocarpus lawrencii* shrublands and other shrublands	36, 123, 125, 129, 132, 133, 204, 205, 206 and 207
EH6	Remnant rainforest in the Geehi, Pilot and Bogong Peaks Wilderness areas	172
EH6	Karst grassland	Part of 36, 38, 106, 198 and 131
EH7	Bogong Peaks	Geographic area
EH8	Headwaters of Kosciuszko Creek	36, 82, 87, 129, 130, 206
EH8	Old Growth Ash Tooma	Part of 87
EH9	Mt Trooper	Geographic area
Polygon Fig 20	Subalpine woodlands including *Eucalyptus lacrimans* woodland	37, 95, 97, 98, 99, 124, 128, 130 and 146
Polygon Fig 20	Subalpine treeless plains including subalpine stream banks, and grasslands	131 and 148
Polygon Fig 20	Alpine Ash forests	86 and 87
Polygon Fig 20	White Box Woodland	77 and 78

The extent and condition of remnant old growth Alpine Ash and Snow Gum communities within the Park is currently relatively unknown but is likely to be small in spatial extent. An area of old growth Alpine Ash is known to occur near the Manjar trail in Upper Murray Area although the extent of this community requires further mapping. Old growth forests provide a special suite of habitats for fauna including tree hollows, and above ground roosting and nesting sites. Old growth Snow Gum woodlands in the Park have declined in extent in the last 100 years due to increased frequency of fire with a consequent increase in shrublands (Good, 1992b) and many of the remnants are now in areas where there is also community pressure to introduce prescribed burning. Under climate change scenarios it is more likely that old growth communities will be at greater risk of more frequent and higher intensity fires. In the future and depending on the actual rate of climate change, consideration may be given to implementing prescribed burning in old growth communities if it can be demonstrated that such burning may result in protecting that community from the deleterious effects of frequent high intensity fires. Old growth forests, by virtue of their likely limited distribution and extent, are particularly threatened by predicted increases in fire frequency and intensity as a result of climate change. As a first step, mapping of old growth Alpine Ash and Snow Gum communities will be undertaken, particularly in those areas that had lower intensity fires in 2003 or that have not been affected by fires for longer periods. Consideration shall then be given to developing specific management strategies to protect identified old growth communities from increased fire frequency.

Mt Trooper in the Lower Snowy area has often been the subject of intensive operations to protect the area from fire to protect a range of cultural heritage values and old growth cypress pine present in the area. Protection of this area including the exclusion of earthmoving equipment shall continue in future fire suppression operations.

Subalpine vegetation communities and habitats including subalpine grasslands and shrublands (the treeless plains), subalpine woodlands, subalpine stream banks, and *Eucalyptus lacrimans* woodlands, require specific mention as they occur in a lower productivity environment, are communities particularly sensitive to frequent fires, have been extensively impacted upon by the 2003 fires and historic fire regimes, and cover large areas of the Park. These communities also occur along many Park boundaries where prescribed burns have often been implemented in the past. Generally alpine and subalpine vegetation formations are as resilient to a single fire event as any other vegetation community (McCarthy *et al*, 2003). The frequency of unplanned

fire in these areas is related to drought conditions and is generally in the order of 1-2 fires per century with many areas remaining long unburnt (McCarthy *et al*, 2003). Snow Gum woodlands (Forest Ecosystems 37, 95, 97, 98, 99, 101, 124, 128, 130 and 146) do not have a requirement for the introduction of fire for ecological reasons and there is very little to justify the introduction of prescribed fire for the purpose of hazard reduction (McCarthy *et al*, 2003). This does not, however, preclude the use of prescribed fire in these communities for the reduction of fuel for the protection of assets. It simply indicates that such use of fire shall take account of the overall need for variability of frequency, and generally aiming for a low frequency to maintain habitat values. Banks (1988), using tree-ring evidence, reports infrequent fire (one to two large fires per century) in Snow Gum *(E. pauciflora)* woodlands prior to European settlement, followed by a sudden increase in the frequency of fire after the introduction of European settlers and their livestock to the alpine and subalpine areas of south eastern Australia. The increase in fire frequency during the last 150 years has had a range of deleterious impacts on flora, fauna and catchment stability values in subalpine woodlands (NPWS 1998). Due to the low productivity and slow recovery rates of these areas, it will be many years and in the case of soil probably centuries (NPWS, 2007b) before these values have recovered.

Alpine Ash is particularly at risk of higher frequency, high intensity stand replacement fires. The Park contains about 75,241 hectares of Alpine Ash (forest ecosystems 86 and 87), of which 65,071 hectares were burnt (at varying intensities) in the 2003 fire season. Doherty and Wright (2006) found that approximately 30% of the Ash in their study area (Brindabella Ranges) was killed in the 2003 fires, and 70% survived. Observations of the 2003 fires in the Park found some areas where the Ash had been killed but many areas where the under storey had been consumed but the canopy remained completely unscorched (Miles and Cameron, 2006). Ash trees that suffer 100% leaf scorch are killed and regeneration is dependant on the release of canopy stored seed. DEC (2002) lists the primary juvenile period for this species at about 10 years which shall be considered an absolute minimum interval, even for a low intensity fire. McCarthy (1999) cited in Watson (2006) gives a juvenile period of Mountain Ash (*Eucalyptus regnans)* at 20 years although McCarthy has observed significant seed set by 15 years at Swifts Creek Victoria (McCarthy pers. comm. 2007). Doherty and Wright, (2006), however suggest that 30 years may be required for sufficient recovery of mature trees to be able to set sufficient seed to survive another high intensity fire. A further fire in a regenerating stand within the juvenile period may eliminate this species from an area, to be replaced by more fire tolerant species such as Mountain Gum (*Eucalyptus dalrympleana*).

The fauna habitat role played by Ash communities is also important. Doherty and Wright (2004) suggest that changes in habitat structure within Ash communities following fire will occur in the short to medium term affecting both fauna abundance and distribution. Low intensity fires do occur in Alpine Ash without affecting the canopy, indicating that provided the recommended minimum threshold guidelines are adhered to, then flora and fauna species are unlikely to be lost as a result of low intensity fires. High intensity fires shall be avoided in Alpine Ash for periods up to 150 years where possible to enable development of fauna habitat such as tree hollows. Due to the slower regrowth at higher elevations and the widespread extent of the 2003 fires, it is recommended that even low intensity fires be avoided where possible, in Alpine Ash communities for the life of this strategy. Further research into the life history of Alpine Ash, particularly to determine the minimum threshold for this species, is required.

White Box (*Eucalyptus albens*) and Cypress Pine (*Callitris endlicheri*) woodlands of the lower Snowy River only occur in the Park in the rainshadow-affected Snowy River Valley where they occupy 1.9 % of the Park. It is of significance as the only White Box-White Cypress alliance to occur on the eastern side of the Great Dividing Range. This community is most typical in the Western Plains of New South Wales (Clayton-Green and Wimbush 1986; Pulsford 1991). This community is also part of a listed Endangered Ecological Community in the *Threatened Species Conservation Act.* Fire scar analyses by Pulsford (1992) indicate that prior to European influence fire may have been relatively rare in this community. After European settlement in about 1840, fires occurred about every 6 years until about 1900 and then frequency declined (Pulsford, 1992 cited in Mooney 2004).

A range of priority fauna habitats have been mapped for the species shown in Table 20. These species are of particular concern because the long term survival or otherwise is directly threatened by inappropriate fire regimes and suppression activities. Broad management guidelines in the form of recovery plans under the *Threatened Species Conservation Act 1995* have been developed for many threatened fauna species including the species listed below. Site specific fire suppression guidelines shall be prepared for each of the priority locations identified with a view to minimising the impacts of fires generally and fire suppression operations. Priority habitat sites for Northern Corroborree frog may be determined during the life of this plan. The risk rating for all of these species is medium with the key risk assessment influence being the susceptibility of these species to any fire in their habitats.

Table 20 Priority fauna habitats

Map ID	Species	Priority habitats
EH2	Mountain Pygmy Possum	Mt Kosciuszko - Mueller's Peak, Summit Road, Charlotte Pass, Spencers Creek, Paralyser - Mt Perisher, Blue Cow – Guthega, Whites River Hut to Gungarten Pass
EH3	Broad-toothed Rat	Smiggin Holes, Perisher Creek, Guthega Power Stn - Horse Camp Hut, Munyang river to Whites River Hut
EH4	Southern Corroboree Frog	Mt Jagumba, Jagumba Fire trail, Maragle Range
EH5	Eastern Bentwing Bat	Yarrangobilly karsts 1 & 2
Not mapped	Northern Corroboree Frog	To be determined

The habitat of Mountain Pygmy Possum is particularly sensitive to frequent fire and requires complete protection from fire (Broome and Mansergh, 1989). Accordingly the boulder fields habitat of this species has been mapped and is shown on operations maps and Figure 20. The mapping includes a 200 metre buffer around the boulder fields to pick up any areas of heath habitat utilised by this species and surrounding their core habitat. In addition these polygons include the currently known extent of Podocarpus heathland communities which is known to be extremely sensitive to, and is threatened by all fire.

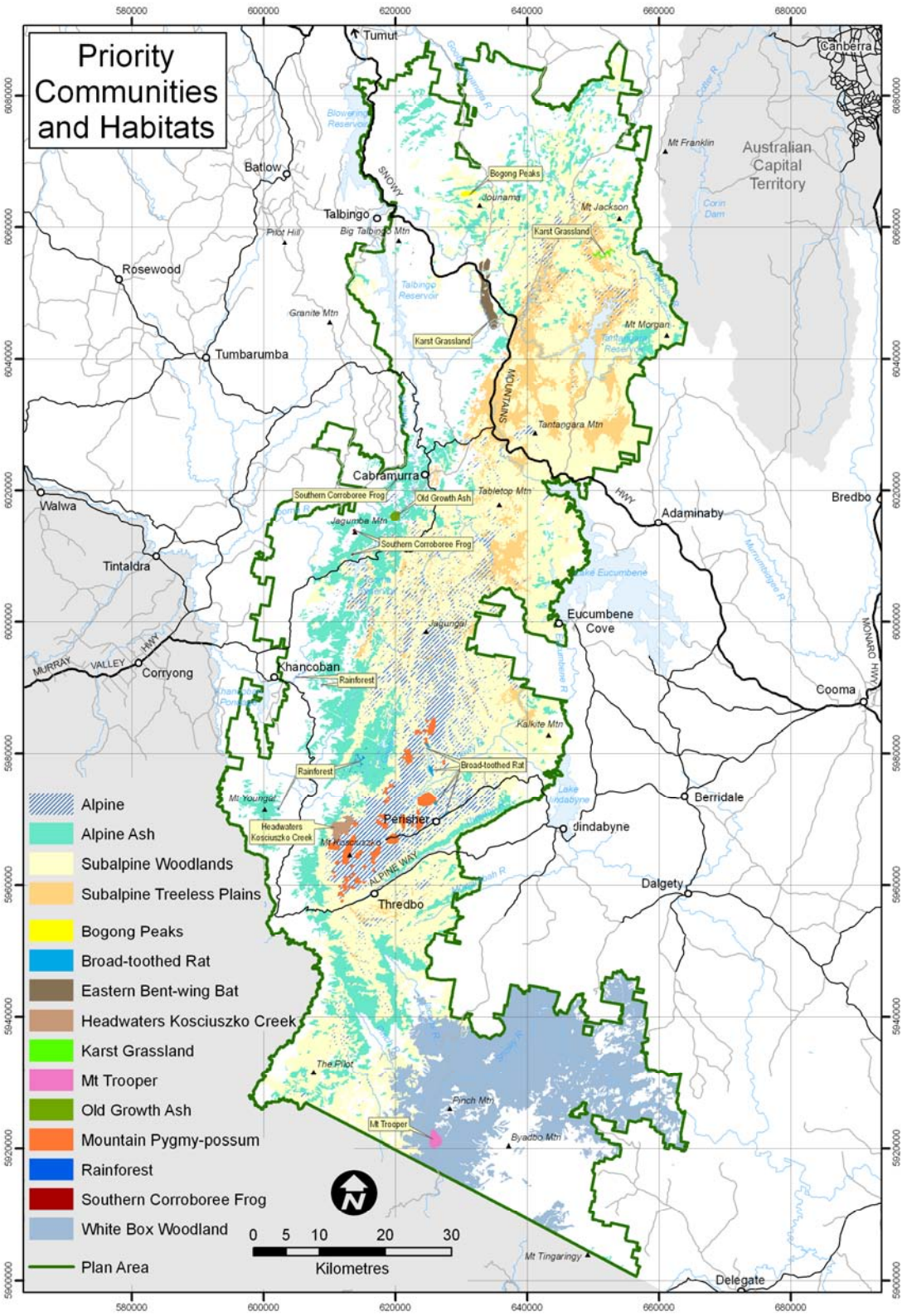
Additional specialised habitats

The black scrubs (*Acacia sylvestris - Eriostemon spp*) of the Byadbo area also deserve special mention separately to the above communities. These scrubs occur as discrete patches with sharp boundaries with adjacent woodlands. It appears that these communities are maintained by occasional high intensity fires. In the absence of such fires it is possible that these communities could decline as fires are required for seedling recruitment (Clayton-Green and Wimbush 1986).

The Smoky Mouse (*Pseudomys fumeus*) appears to prefer heathy ridge-tops and slopes within sclerophyll forests, heathland and open forest from the coast to sub-alpine regions of up to 1800 m and is only found in small isolated populations (Menkhorst & Broome 2008). While there are some records of this species within the Park, its distribution is poorly known. Threats to this endangered species include inappropriate fire regimes, as too frequent burning, e.g. 4-7 and up to 20 years for hazard reduction, is likely to be deleterious to the shrub and hypogeal fungi resource required by this species (Ford et al 2003 cited in Menkhorst & Broome 2008). On the other hand, lack of burning can result in senescence of the heathy vegetation and could lead to intense, large-scale wildfires that are likely to eliminate metapopulations (Menkhorst & Broome 2008). Given that the locations of this species are poorly known it is very difficult to

plan for this species being present when developing prescribed burning programs. The specific needs of the

Figure 20 Priority vegetation communities and habitats



Smoky Mouse require further research, including the scale, intensity and timing of burning that might best suit the Smoky Mouse in different parts of its range (Menkhorst & Broome 2008). Prescribed burn planners are required to address any factors that may impact on threatened species when planning for a prescribed burn and are thus referred to the National Recovery Plan for Smoky Mouse (Menkhorst & Broome 2008) for further information. Some actions in Appendix 8 will depend on future identification of priority habitat areas for this species.

2.3.6 Catchment and soils

Surveys conducted by the Soil Conservation Service of NSW during the 1940s and 1950s documented widespread soil erosion attributed to the destruction of vegetation cover by fires and grazing (including rabbits), (e.g. Costin 1960). At the time it was recorded that up to half a metre of topsoil had been lost in some areas (NPWS, 2007b). The greatest potential for widespread disturbance to the soils of the Park is from fire, as it removes or reduces the protective ground cover, thereby mobilising surface soil and nutrients, and potentially leading to erosion. During the last 50 years there has been a reduction in the number and extent of unplanned fires and, more recently, in the total area subjected to prescribed burning, with a subsequent improvement in soil stability. Despite this, periodic and widespread reversals in soil stability can still occur due to unplanned fires, as evidenced in 2003 (NPWS, 2007b).

Due to extensive and extended use of fire for grazing up to the late 1950s, combined with the impacts of drought and rabbits, many areas of the Park have soils that are still in a state of regeneration which is likely to last many years to come. Over 33% (232,989 hectares) of the Park has slopes over 18° which render them more susceptible to erosion than lower slopes. Changes to soils and some level of post fire erosion are a natural geological process however increased frequency and extent of fires can have increased and cumulative impacts on soil, water and catchment values.

The role of catchments in the Park in water harvesting for consumption and electricity production is of major significance, and these values can be compromised by too frequent and spatially extensive fires. Fires affect a range of catchment and soil values through a range of complex mechanisms including loss of stabilising vegetation and litter cover, post fire weather conditions, slope, extent of fire, fire intensity and fire frequency. Erosion risk is generally highest after more intensive and extensive fires, on steeper slopes (>18°) and on more erodible soils. Costin (1960) stated that “it is the occasional heavy rain, falling at times when the catchment happens to be most erodible, which causes the greatest damage”.

Potential impacts of fires on soils can include:

- Consumption of the surface litter and vegetation which play a significant role in maintaining soil stability by protecting the soil surface (Good, 1982);
- Increased hydrophobicity (non-wettability) of soil particles which reduce porosity, infiltration, and cohesiveness (Leitch, *et al,* 1983, Prosser and Williams, 1998, Shakesby *et al*, 2003 in Scherrer *et al*, 2004) which can in turn contribute to higher erosion potential;
- Changes to nutrient levels;
- Increased potential for landslides in identified areas;
- Loss of topsoil, nutrients and seed bank through erosion of the soil and ash bed into waterways;
- Threats to aquatic habitats and water supply through increased ash and sediment deposits.

Hydrological processes are affected by fires. Impact on water yield is variable with some vegetation communities e.g. Alpine Ash, having significant long term reduced yield due to regrowth while other communities have shown no significant difference to pre fire yields (White *et al*, 2006). Water yield can increase, in some cases substantially (e.g. Rustomji and Hairsine, 2006), following fires due to reduced interception and evapotranspiration and dependent on the occurrence of extreme rainfall events in the 12-24 month period following a fire. However some catchments show a long term decreased water yield e.g. mixed Ash forests (Kuczera, G. A.

1987 cited in Esplin *et al*, 2003). A study by Sinclair Knight Mertz (2004) on streamflow into the Murray Darling basin following the 2003 fires predicted an initial, large increase in streamflow that ranged from 14 to 106%, expected to persist for approximately 7 years. The same study found that the long term impact would be only a small reduction in the total inflows to the Murray River (compared with the no fire scenario) with a maximum reduction in the total stream inflow varying between -129 GL per year and +4 GL per year depending on the assumptions made concerning the relationship between fire severity and tree death.

There are limited opportunities to mitigate negative fire effects at the catchment level so adaptive responses to impacts of fires on water quality issues are required. Such responses may include use of the wide range of soil erosion and sediment control mechanisms available e.g. straw bales, silt fences, installation of drainage structures etc.

Nutrient cycling is fundamental to all ecological processes and can be severely compromised by inappropriate fire regimes, particularly frequent high intensity fires. Many nutrients are lost through fire due to volatile conversion including nitrogen and phosphorous. Re-accumulation of nitrogen in alpine and subalpine areas can be very slow due to slower productivity rates. Raison *et al* (1993) found that fire free periods of up to 10-12 years may be required in many forest types to allow some nutrients such as nitrogen and phosphorous to reach pre fire levels. Erosion of soils can further increase nutrients lost and therefore longer fire free periods may be required if post fire erosion is significant. Such factors are taken into account when developing prescribed burn plans.

Good (1996) provides expert estimations of the amount of litter required in a range of environments and slope classes to prevent soil erosion, although the work does not appear to utilise experimentally determined values. The amount of cover required to prevent soil loss will vary across the landscape depending on soil and terrain characteristics. Currently there is little information available providing recommended litter cover to mitigate soil erosion. Prescribed burning undertaken when the lower litter levels are still moist can provide some degree of soil stability while achieving fuel reduction objectives by retaining a protective layer of unburnt material.

Glacial lakes in the Park including Blue Lake, Cootapatamba Lake, Lake Albina, Hedley Tarn and Club Lake are potentially at risk from suppression activities. These lakes have a unique benthos fauna which are susceptible to even minor changes in water quality (Green, K. pers. comm. 2007). The use of foam or retardants in these areas shall be prohibited. Extraction of water from these lakes for fire suppression operations shall also be minimised when other water sources are available.

A major study that modelled post fire erosion and slope stability was carried out for the areas burnt during the 2003 fire season within the Park. The study found that the greater the fire severity and slope angle, then the greater potential there is for soil loss. The study identified catchments within the Park (Table 21) that are more susceptible to erosion and/or slope instability following bushfires (URS, 2006) and these are mapped in the NPWS Geographic Information System. Even moderate rainfall events can result in severe slippage and erosion as occurred in some locations after the 2003 fires. However the window of opportunity for such events is generally only in the first 6-12 months and is progressively mitigated by the ongoing regrowth of vegetation after a fire.

Table 21 Catchments with highest soil loss post the 2003 bushfires

Catchment ID	Catchment	Location
2	Cooleman Creek	Cooleman Plains
4	Peppercorn Creek	McLeod's Fire Trail
7	Tumut River	Tumut Valley
9	Tooma River	Tooma Valley
15	Snowy River	Perisher Valley

Catchment ID	Catchment	Location
16	Geehi River	Geehi Valley
18	Leather Barrel Creek	West of Thredbo Valley
19	Cascade Creek	South West of Thredbo Valley
22	Snowy River West	South West KNP Boundary
24	Bulls Flat Creek	North East KNP Boundary
25	Little Thredbo River	Thredbo Valley
26	Tin Mine Creek	South West Murray River
27	Broken Back Creek	East of Khancoban Dam

Riparian buffers adjacent to streams and rivers are particularly important in protecting water values and shall be protected from prescribed burning operations. Subalpine stream banks are also particularly sensitive locations due to the likely presence of a range of threatened flora species. Extraction, by vehicle based crews, of water for fire suppression operations can negatively impact on such areas. Locations for extraction of water by vehicle based crews, in subalpine areas shall utilise existing disturbed areas where possible to minimise potential impacts.

Soil and slope instability has the potential to have major impacts on Snowy Hydro Limited infrastructure including damage to aqueducts, tunnels, power and communication lines and facilities, and silting of dams and aqueducts. The potential consequences can be of national significance due to the potential impacts on national electricity and water supply. Other key areas that may be subject to impacts resulting from soil and slope instability resulting from fires include Perisher Range resorts, Thredbo Village, and various public utilities. Impacts can include physical damage to structures, restrictions to access due to blocked or damaged trails and resultant social and economic impacts (URS, 2006).

In addition to potentially increased soil and slope instability following fires, URS (2006) advised that landslide types potentially influenced by bushfire include sheet/rill erosion, stream, flood erosion, soil movements into karst depressions, and possibly shallow soil slides/flows in certain areas. Areas identified as being highly susceptible to landslide processes as a result of bushfire impacts are in Table 22. Many other areas, particularly those subject to disturbances such as road cuttings, spoil heaps etc may be subject to increased erosion potential depending on the fire intensity and post fire weather.

Table 22 Areas highly susceptible to landslide.

Landslide type	Typical locations	Mechanism	Velocity of movement
Shallow soil slides/flows	Happy Jacks Road, Snowy Mountains Highway	Development of high pore water pressures on steep slopes and liquefaction type failures.	Moderate to rapid
Sheet/rill erosion	Cooleman Plains	High and concentrated runoff, dispersive soils.	NA
Stream flood erosion	Yarrangobilly, Snowy River, Section Creek Road embankment failure: Elliot Way	Extreme flood flows caused by high runoff causing sever bank erosion.	NA
Soil movement into karst depressions	Yarrangobilly karst region	Erosion and deposition.	NA

Potentially increased fire frequency due to climate change may have increased impacts on soil values including increased erosion and increased nutrient leaching. Key issues associated with soil conservation and rehabilitation in the Park includes the need for strategic management of fire so as to reduce fire hazards without contributing to soil erosion problems. Containment line route selection and rehabilitation of containment lines are also key soil erosion issues.

2.3.7 Karst

Fires, and fire management activities, can impact upon karst values by:

- Smoke and ash discolouring cave formations;
- The disturbance or removal of vegetation leading to soil erosion, siltation and changes to hydrological regimes and cave atmospheres;
- Physical damage or destruction of surface karst features by heat or through the use of earth-moving machinery;
- The use of fire chemicals that may change the chemical properties and nutrient levels of water, which can adversely impact on cave fauna. (NPWS, 2007b); and
- Frequent fire, especially in autumn, can adversely impact on the food supply for cave dwelling bats, as well as increasing the potential for soil erosion through frequent vegetation removal.

Priority action statement 7 of the KNP POM (NPWS, 2007b) aims to manage fire so as to mimic natural fire regimes for the vegetation types in karst catchments. Such “natural” fires regimes have not been determined for these catchments.

2.3.8 Scenic landscapes

The Park is an area of national tourism significance and one of the nation’s major eco-tourist destinations. Bush fires have the potential to affect the aesthetic quality of the landscape and deter visitors for safety reasons. Extreme fire danger conditions also trigger restrictions on Park access. The regional economy is dependant on tourism and decreased visitation associated with bush fires can have significant impacts.

Operations associated with bush fire suppression such as the construction of trails, fuel breaks and helipads also have the risk of affecting scenic values by breaking landscape continuity.

Generally the most intense fires result in a scenic landscape of dead trees and stems protruding from the vigorous epicormic regrowth. As the aesthetic values of a burnt landscape are subjective values and differ widely between people, they shall not compromise management objectives of protecting life and property and conserving biodiversity. Increased public education and interpretation of burnt landscapes shall address public questions and concerns.

Short term visual impacts for fuel reduction programmes shall take into consideration public access areas and vantage points. Small non-burn areas close to public access areas would reduce visual impact degradation without compromising the strategic values of fuel reduction. In areas of public viewing, low intensity strategic fuel reductions with minimal leaf scorch would also reduce visual impact, but as long as ecological requirements for higher intensities are not compromised.

2.3.9 Wilderness

Ecologically inappropriate fire regimes and fire suppression activities can affect wilderness values. Activities that are incompatible with wilderness values include the construction of fuel breaks and access tracks with earth moving equipment, the felling of trees for helipads and the intensive use of people and aircraft in remote fire fighting situations. However, such activities may be inevitable in fire suppression operations and will be required in many wilderness areas to protect life and property, and other natural and cultural heritage values.

2.3.10 Colonisation by exotic species

The higher risk locations for exotic weed species impacts include alpine areas, locations adjacent to tracks and trails, drainage lines and power line easements. Weeds that present a threat as a result of bushfires in alpine areas include Orange Hawkweed (*Hieracium aurantiacum*), Broom (*Cytisus scoparius*), and potentially Fireweed (*Senecia spp.*). Location information for these species is held at the area level and local area staff shall be consulted to

identify these areas. Such areas shall be surveyed after fires if there is an identified risk such as the use of dozers through known weed populations. Consideration shall also be given to developing specific pest management programs following wildfire e.g. fox control around resort areas, where there is an identified risk of increased predation of threatened species by pest species.

The establishment and increased distribution of pest and weed species as a result of fires and fire suppression activities presents a significant risk to natural heritage values. Bushfires provide the following opportunities for colonisation and movement of pest and weed species:

- Opening up of areas allowing greater access for introduced species;
- Reduction in habitat cover for fauna making them more vulnerable to predation;
- Competition for scarce resources;
- Introduction of new species through vehicle movements from outside the Park;
- Transport of weed seed and soil pathogens in earthmoving equipment and fire fighting vehicles, including increasing the extent of existing populations;
- Colonisation of disturbed areas by weeds;

2.3.11 Areas under rehabilitation

At any one time, there are sites within the Park subject to rehabilitation programs. This includes areas of historic disturbance such as former Snowy Hydro Limited sites, alpine bog recovery works, temporary fire access trails, and specific threatened species recovery programs. Many of these sites are shown on the operations maps. Fire threatening these areas shall be actively suppressed.

2.4 Cultural Heritage Risks

The park has a range of cultural heritage values some of which are at risk of damage from bush fires and fire management operations. Their locations are mapped in the NPWS Geographic Information System, in the corporate databases AHIMS and HHIMS, and on bush fire operations maps. Sensitive cultural sites, e.g. Aboriginal sites will only be shown on internal operations maps.

2.4.1 Aboriginal sites

There are over 600 records of Aboriginal sites within the Park. Bush fires, foams and wetting agents, retardants, vehicles and earthmoving equipment can have negative impacts on these sites. Table 23 below summarises the potential impacts of fires and fire management activities on Aboriginal sites.

2.4.2 Aboriginal culturally significant areas

Many landscapes within the Park are important in Aboriginal culture. Bush fires can impact on valued landscape features such as story places (e.g. a mountain, waterholes etc) by removing vegetation, promoting soil erosion and weed growth. The health of the environment associated with these types of places is often directly linked to their cultural significance. For the same reasons, the construction of fire trails, helipads or other works can degrade the cultural environment. Bush fires can also reduce the availability of food and medicine plants or diminish the value for recreational, educational or ceremonial purposes. Particular care must be taken around the high country peaks. A number of Aboriginal groups and individuals maintain an active interest in the management of such areas.

Table 23 Risk to Aboriginal Sites

Potential Risk	Site type	Impacts of bush fires and fire management operations
Very high	Scarred and carved trees	- High intensity fire may cause tree death, erode tree stability, or damage scars. Fire may also lead to a decline in tree health and promote rot; - Fires may destroy dead trees; - Low intensity prescribed burn has a low impact if site is protected by a buffer zone; - Slashing, mowing and dozer lines construction could result in trees being destroyed if the site is not identified.
High	Rock engravings	- High intensity unplanned fire may cause spalling of the rock and therefore damage engravings. A build up of soil due to post fire erosion may contribute to chemical weathering; - Low intensity prescribed burns have a low impact if the site is protected by buffer zone; - Slashing, mowing or dozer line construction could have a moderate to high impact if the site is driven over.
Moderate	Axe grinding grooves	- As above; - Low intensity prescribed burning has a low impact if the site is protected by a buffer zone; - Slashing, mowing or dozer line construction could have a moderate to high impact if the site is driven over.
Moderate	Rock art Site	- High intensity fires may damage shelter surface and cause the loss of art. Smoke blackening will obscure or damage art motifs. The removal of protective vegetation at shelter entrance may promote weathering; - Low intensity prescribed burning has a low impact if the site is protected by a buffer zone; - Sites may be affected by smoke damage, and removal of protective vegetation; - Slashing, mowing or dozer line construction will have a low to negligible impact except if protective vegetation is damaged or removed.
Moderate	Stone arrangements	- High intensity unplanned fire may cause spalling of stones in an arrangement. Post fire soil erosion may lead to displacement of stones; - Low intensity Prescribed burn has a low impact if the site is protected by a buffer zone; - Slashing, mowing or dozer line construction could have a moderate to high impact if the site is driven over.
Low	Middens	- High intensity unplanned fire may remove protective vegetation and promote post fire erosion. There will be low impact if post fire soil erosion is not caused; - Low intensity prescribed burning has a low impact if the site is protected by a buffer zone; - Slashing, mowing or dozer line construction could have a moderate to high impact if the site is driven over.
Low	Burial grounds	- High intensity unplanned fire may remove protective vegetation and promote post fire erosion. This can expose remains especially in sandy soils; - Low intensity prescribed burning has a low impact on the site if protective vegetation is not significantly altered; - Slashing, mowing or dozer line construction could have a high impact if the site is driven over.
Very Low	Quarry	- High intensity unplanned fire may remove protective vegetation and promote post fire erosion; - Slashing, mowing or dozer line construction could have a high impact if the site is driven over.

2.4.3 Historic cultural heritage sites

There are over 700 historic sites within the Park that are listed on the NPWS Historic Heritage Information Management System. These include huts, homesteads, mining sites, stock yards, walking tracks, and other evidence of early European settlement. Many sites have been identified as items of State heritage significance. A risk assessment of cultural heritage sites identified 85 sites that are at medium risk and one site that is at high risk due to fires. The results of the risk assessment are presented in Appendix 4.

The following factors contribute to the risk and potential impacts of damage to cultural heritage sites:

- Fire may directly destroy combustible material such as timber structures;
- Post fire soil erosion may lead to displacement of foundations, artefact movement and damage to archaeological deposits;
- Post-fire erosion may lead to changes to the fabric of a site;
- Earth moving equipment and vehicles may cause physical damage to features if driven over;
- High intensity fires may cause spalling of rock constructions. Removal of protective vegetation may promote erosion especially along drainage lines;
- Depending on the intensity, fire may cause damage to historically significant vegetation; and
- Radiant heat may cause spalling of rock artifacts. Post fire soil erosion may lead to displacement of rock artifacts.

Nineteen huts were either severely damaged or destroyed in the 2003 bushfires. Many hut and other cultural heritage sites were also impacted either directly by fire or by suppression efforts to save those sites. These suppression impacts included dozing breaks around huts, application of retardant to sites and significantly increased vehicle traffic around sites. Dozing of fuel breaks, while a reasonable method of attempting to save a site, can also have significant negative impacts on the fabric of the site (Godden, Mackay and Logan, 2005). Since 2003 many huts have been repaired or rebuilt and this work is ongoing.

3 BUSH FIRE RISK MANAGEMENT STRATEGIES

3.1 Introduction

This section presents the strategies and controls that can be used to protect the assets and values at risk that were identified in section 2. The development of these strategies is premised on the understanding and acceptance that unplanned bushfires do and will continue to occur. Significantly, research and experience have shown that no one management option is effective in isolation, and optimal outcomes are achieved only through a multifaceted approach involving the community and all relevant stakeholders.

The key bush fire risk management strategies in this section include:

- Ongoing commitment to Bush Fire Management Committees as the key vehicle for coordinated fire management in the region including the Park;
- Maintenance of bush fire management zones to identified standards;
- Continued early detection and rapid suppression of unplanned fires;
- Ongoing commitment to trail maintenance;
- A new series of operations maps detailing assets requiring protection, cultural and natural heritage values, fire advantages, topography, trails etc;
- Proposed development of Village Protection Plans for built up residential areas within the Park e.g. Alpine Resort Areas, and Waste Point;
- Proposed prescribed burning schedule to minimise fires leaving the Park and to protect built and environmental assets; and
- Continuation of a broad area ridge top burning strategy to manage fuels in remote areas, frequent ignition areas, and to reduce spotting potential;
- Development of detailed prescribed burn plans and implementation of suppression operations guidelines to protect threatened species, threatened communities and priority habitats.

3.2 Bushfire Management Zones

The Park has been assigned into bushfire management zones according to the zoning system outlined in the strategy for Fire Management (NPWS, 2003). This is consistent with the approach outlined in the Bushfire Risk Management Planning Guidelines for Bushfire Management Committees (RFS, 2007) and subsequent amendments. Zones have been determined in consultation with Bush Fire Management Committees (BFMC) to ensure consistency and compatibility with BFMC Risk Management Plans, and zoning adjacent to the Park.

Determination of zones is governed by the outcomes of the risk assessment process, while also taking into account areas of similar topography, cultural and social characteristics. The boundaries of zones have been determined, where possible, using practical fire control advantages such as roads, water storage's, drainage lines and areas of low bush fire behaviour potential. Zone boundaries and locations may be subject to change in the future pending the outcomes of future research, BFMC Risk Management Plan reviews and changes to zoning classifications.

While zoning provides general guidelines for asset protection and how fuels may be managed, NPWS also considers in detail the wide range of natural and cultural heritage values that may be found in an area. Accordingly management practices will vary between zones even though two areas may have the same zone type. This management flexibility is essential for the maintenance of natural and cultural heritage values unique to each area. The definitions and guidelines for zones are shown in Table 24.

Table 24 Definitions of zones

Note: locations of zones are listed in Table 25 and shown on Figure 21

	Definition	Guidelines
APZ	• To protect human life, property and highly valued public assets and values. • To enable the safe use of direct attack suppression strategies within the zone. • To minimise bush fire impacts on undefended assets.	• As far as possible the standards outlined in the RFS document *Standards for Asset Protection Zones* are applied.
SFAZ	• Provide strategic areas of fire protection advantage which will reduce the speed and intensity of bush fires, and reduce the potential for spot fire development. • To improve the likelihood and safe use of: o parallel attack suppression strategies within the zone; and/or o indirect attack (back burning) in high to very high fire weather conditions within the zone. • To reduce the likelihood of: o crown fire development; and o spot fire ignition development within the zone.	• Manage fire trails to BFCC standards. • Assess Overall Fuel Hazard (OFH) once vegetation communities reach minimum fire thresholds within this plan. • Management practices should aim to achieve mosaic fuel reduction patterns so that the majority of the SFAZ has an OFH less than high. • Implement prescribed burning as per schedule.
LMZ 2	• Areas where the protection of sensitive natural and cultural heritage values are the highest priority. • Areas identified on or near the Park boundary where fire management options are a higher priority than in LMZ1. • Areas on or near the Park boundary where co-operative and cross tenure fuel management options may be required. Such options will be developed in consultation with neighbours and the BFMC. • Areas where fuel hazard development will be monitored more closely than in LMZ 1. • Where fuel management options will be considered in consultation with the BFMC once minimum thresholds have been reached.	• Manage fire trails to BFCC standards; • Contain unplanned fires in spring and summer to small areas and lower potential intensity and manage to produce a mosaic burn pattern; • Asses OFH on an ongoing basis once vegetation communities have reached minimum threshold then consider management options in consultation with BFMC; • Where assessment of forest health results in recommendations to implement prescribed burning; • Broad area prescribed burning possible e.g. ridge tops, once minimum thresholds have been reached; • Manage fire to produce mosaic burn patterns (where weather conditions permit). • (Note: Steep topographic conditions and limited fire trail access combine to minimise likelihood that parallel suppression and back burning activities will be successful when high fire danger conditions exist. Crown fire potential is likely to be high under adverse weather conditions irrespective of fuel loads because of slope steepness.)
LMZ 1	• Areas where the protection of sensitive natural and cultural heritage values are the highest priority; • Includes all areas within the Park not covered by other zone definitions.	• Manage fire trails to BFCC standards; • Contain unplanned fires in spring and summer to small areas and lower potential intensity, and manage to produce a mosaic burn pattern; • Manage fire regimes, where possible, to ensure that minimum biodiversity thresholds are reached for all vegetation communities, and some maximum thresholds are reached for all communities;

	Definition	Guidelines
		• Conduct prescribed burns to maintain fire regimes within the biodiversity thresholds specified or for other ecological purposes; • Mosaic burning may be undertaken to reduce the likelihood of spread of fires; • Minimise impacts of unplanned fires on cultural heritage.
FEZ	• Areas of fire intolerant assets for which it is appropriate to exclude fire; • These areas include: o Alpine vegetation communities; o Mt Trooper; o Headwaters of Kosciuszko Ck; o Old Growth Ash stand-Manjar.	• Exclude planned and unplanned fires where possible; • Suppress all unplanned fires in and threatening these zones ASAP; • Particularly suppress ignitions to the west of these zones ASAP.

3.2.1 Asset Protection Zones (APZ)

APZs are designated to protect life and highly valued property assets. The zone provides for fuel-reduced areas around assets or groups of assets, which are adjacent to bushfire hazards. These zones are the most intensively managed fire management zones (NPWS 2006a) and maintaining fuels loads at <5 tonnes per hectare for surface fuels is generally expected. Further standards for the implementation and management of APZs are outlined in "Standards for Asset Protection Zones (RFS, undated).

The establishment of specific APZs is a very successful strategy for the protection of buildings against bush fires (RFS, undated). The implementation and maintenance of APZs is the responsibility of the land owner, lessee or land management authority and is most effective when it is maintained immediately adjacent to the asset. Fuel reduction procedures within APZs may include slashing, selective shrub removal, vegetation replacement, watering and irrigation, herbicide treatments, and occasionally prescribed burning.

APZs are most effective when buildings within them are built and maintained to the required standards. Buildings need to be protected against burning debris by meeting, where practical, appropriate components of the Australian Standard AS 3959 (Standards Australia 1999). This includes building materials, building design and sprinkler systems.

For new developments, excluding the resort areas defined in the State Environmental Planning Policy (Kosciuszko National Park Alpine Resorts) 2007**,** the NSW Rural Fire Service provides guidelines for identifying appropriate APZs in *Planning for Bush Fire Protection* (RFS 2006) and appropriate building standards are specified in the Australian Standards AS 3959 (Standards Australia, 1999) and the Building Code of Australia. Outside the resort areas, NPWS will apply the same standards to any new developments in the Park. NPWS will also encourage local government, through relevant BFMCs, to implement and monitor these standards with neighbours.

The Department of Planning is the consent authority for future developments within the resort areas. Much of the land in these areas is classified as "tourist accommodation" and falls into the category "Special Fire Protection Purpose Developments" under *Planning for Bush Fire Protection* (RFS 2006). The majority of developments, if they fall within Bushfire Prone Land require issue of a Bush Fire Safety Authority by the Rural Fire Service.

Asset protection zones have been determined for a number of NPWS and Snowy Hydro Limited assets within the Park. These assets have been identified as being of such significance as to require APZs. All buildings and facilities for which APZs have been identified are shown in Figure 21.

NPWS will carry out an assessment of NPWS assets within identified APZs to ensure appropriate compliance with the required standards.

3.2.2 Strategic Fire Advantage Zones (SFAZ)

The management priority within Strategic Fire Advantage Zones (SFAZs) is to reduce the risk of damage from bushfire to life and property within and adjacent to the Park. SFAZs are located in areas where they will be most effective to assist in reducing the probability of large landscape-scale bushfires (NPWS 2006a), and will provide the greatest protection to assets.

The most common method for maintaining fuels in SFAZs is through the use of prescribed burning. Such burning is implemented to achieve a mosaic of fuel ages within any SFAZ. Prescribed burning in SFAZs strengthen existing fire control advantages by reducing fire intensity and minimising spotting distance which assists in the strategic control and containment of bushfires. The boundaries of SFAZs may be aligned along walking tracks, trails, roads, watercourses and other topographical features to facilitate control of prescribed burn operations, or may be expressed in terms of a distance from a geographic feature such as a trail, creek or ridge. Within the Park there are a wide range of other values that must be taken into account when carrying out mitigation measures within a SFAZ.

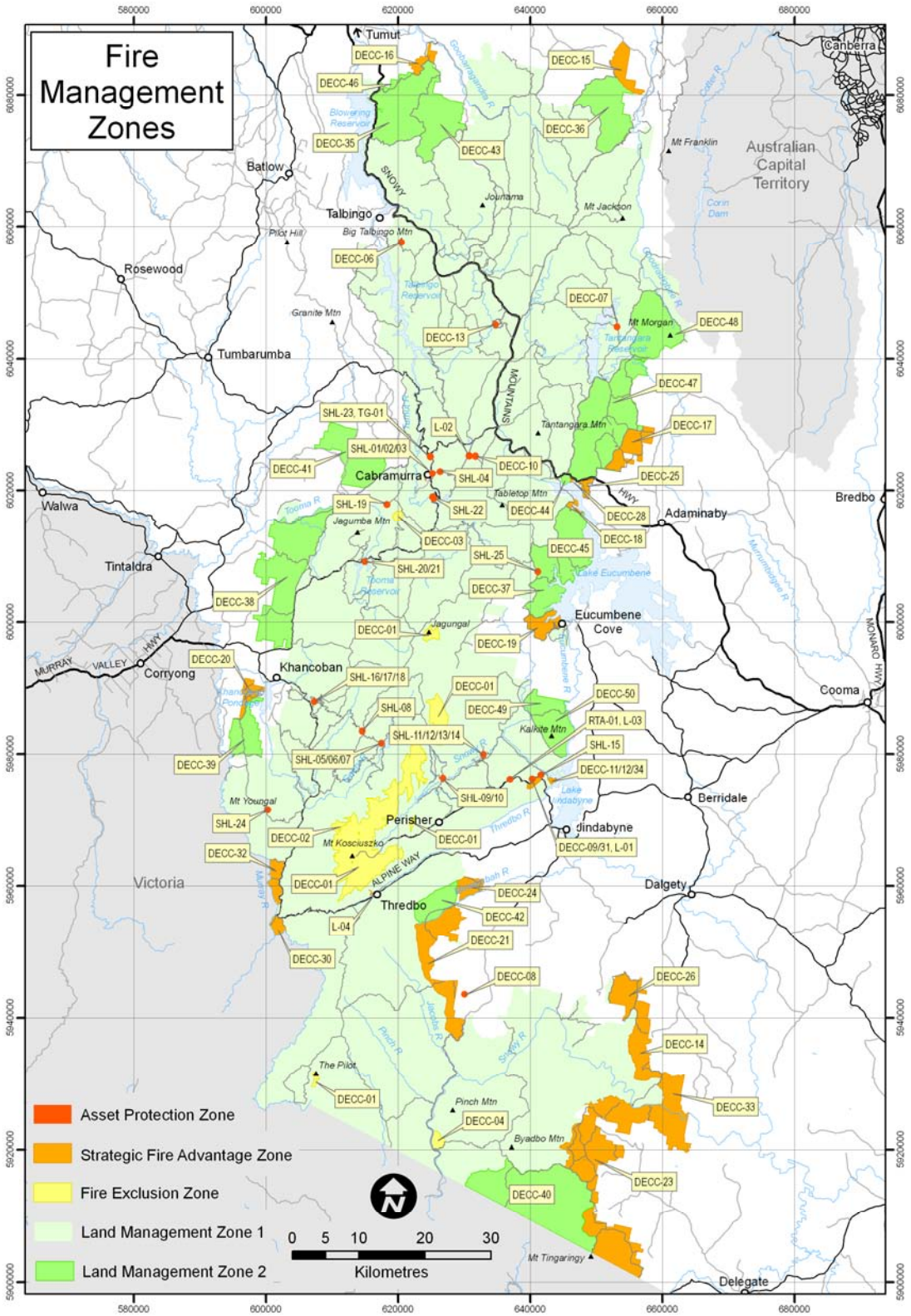
The locations of proposed SFAZs in the Park have been determined in consultation with the relevant BFMCs taking account of asset protection requirements adjacent to and within the Park. Factors influencing the determination of locations included:

- Outcomes of the risk assessment process both for this strategy and for current risk management planning processes adjacent to the Park;
- Taking into account areas of higher fire frequency;
- Capacity to realistically maintain fuel load standards in various vegetation types as prescribed in RFS (2007);
- Topographical and elevation considerations;
- Access;
- Continuity of SFAZs with areas adjacent to the Park;
- Potential to locate more effective SFAZs nearer to assets outside the Park as a component of the BFMC risk management planning processes.

3.2.3 Land Management Zones (LMZ)

The primary objective within LMZs is the conservation of biodiversity and protection of culturally significant features from fire. LMZs are generally located in areas where APZs and SFAZs are not required. The key objective within land management zones is to maintain variation in frequency and intensity to provide for a mosaic or a range of habitat types. LMZs have been separated into two sub categories (LMZ1 and LMZ 2 – refer Table 24). LMZ 2 provides for an increased focus on fire management options than in LMZ 1 while still maintaining an overall focus on biodiversity conservation. Within LMZ 2s, steep topographic conditions and limited fire trail access combine to minimise likelihood that parallel suppression and back burning activities will be successful when high fire danger conditions exist. Crown fire potential is also likely to be high under adverse weather conditions irrespective of fuel loads because of steep topography. Judicious use of prescribed fire may be implemented within LMZs if the need to maintain habitats or to achieve landscape scale fire mitigation measures is identified. Prescribed burning is used in LMZs to lower fuel loads in strategic locations and to manipulate flora and fauna habitat.

Figure 21 Fire management zones in the Park



3.2.4 Fire Exclusion Zones (FEZ)

Some areas have been identified to be extremely sensitive to fire, particularly where impacts of fires in combination with other threatening processes (e.g. climate change) have the potential to result in species extinctions. These areas are defined by analysing the current status of thresholds and by identifying communities or cultural heritage values more sensitive to frequent fire. The main fire exclusion zones are in the highest elevations of the Park where alpine vegetation communities are most sensitive to fire.

3.2.5 Strategies in identified zones

Specific fire management objectives for each zone and strategies to achieve identified objectives are identified in Table 25.

Table 25 Fire management zones, objectives and strategies.

Map ID	Name & manager	Zone	Area (ha)	Objectives	Prescribed strategy
	NPWS FEZs				
DECC-01	Alpine Environment	FEZ	12964.6	Protect zone from all fire	Suppress all unplanned fires in and threatening the zone ASAP.
DECC-02	Kosciuszko Ck headwaters	FEZ	418.16	Protect zone from all fire	Suppress all unplanned fires in and threatening the zone ASAP. Particularly suppress ignitions to the west of this zone ASAP after detection.
DECC-03	Manjar Ash	FEZ	191.85	Protect zone from all fire	Suppress all unplanned fires in and threatening the zone ASAP.
DECC-04	Mt Trooper	FEZ	414.33	Protect zone from all fire	Suppress all unplanned fires in and threatening the zone ASAP
	NPWS APZs				
DECC-06	Big Talbingo Mountain Towers	APZ	0.07	Protect built structures	Mowing, slashing and spraying to maintain fuel loads to APZ standards.
DECC-07	Currango Homestead Complex	APZ	5.24	Provide protection to the buildings and structures	Mowing, slashing and spraying to maintain fuel loads to APZ standards.
DECC-08	Ingebyra Tower	APZ	0.17	Protect built structures	Mowing, slashing and spraying to maintain fuel loads to APZ standards.
DECC-09	Sawpit Creek Education Centre	APZ	0.83	Protect built structure	Mowing, slashing and spraying to maintain fuel loads to APZ standards.
DECC-10	Selwyn Communications Site	APZ	0.11	Protect built structure	Mowing, slashing and spraying to maintain fuel loads to APZ standards.
DECC-11	Waste Point Helipad	APZ	1.03	Protect built structure	Maintain fuel loads around built structures to APZ standards.
DECC-12	Waste Point Residential	APZ	5.89	Protect built structures; Properties are prepared annually as per VPP	• Develop and implement a Village Protection Plan • Maintain fuel loads around built structures to APZ standards; • Implement annual preparedness actions.
DECC-13	Yarrangobilly Caves structures	APZ	16.42	Protect built structures; Properties are prepared annually	• Maintain fuel loads around built structures to APZ standards; • Implement annual preparedness actions.
	NPWS SFAZs				
DECC-14	Beehive Creek	SFAZ	2944.15	Mitigate the spread of fires to the east	Prescribed burning.
DECC-15	Brindabella	SFAZ	1483.42	Mitigate the spread of fires to the east	Prescribed burning.
DECC-16	Buckleys	SFAZ	653.14	Mitigate the spread of fires to the east	Prescribed burning.
DECC-17	Bugtown	SFAZ	2201.84	Mitigate the spread of fires to the east	Prescribed burning.
DECC-18	Denison Island	SFAZ	194.5	Mitigate the spread of fires to the east	Prescribed burning.

Map ID	Name & manager	Zone	Area (ha)	Objectives	Prescribed strategy
DECC-19	Eucumbene	SFAZ	1359.6	Mitigate the spread of fires to the east into Eucumbene Village	Prescribed burning.
DECC-20	Indi	SFAZ	886.9	Mitigate the spread of fires to the east into Khancoban	Prescribed burning.
DECC-21	Ingebyra	SFAZ	5179.55	Mitigate the spread of fires to the east	Prescribed burning.
DECC-23	Merambego	SFAZ	15,136.3	Mitigate the spread of fires to the east	Prescribed burning, trail upgrade.
DECC-24	Mowamba River	SFAZ	962.34	Mitigate the spread of fires to the east	Prescribed burning.
DECC-25	Mt Denison	SFAZ	370.63	Mitigate the spread of fires to the east	Prescribed burning.
DECC-26	Numbla Vale	SFAZ	1947.6	Mitigate the spread of fires to the east	Prescribed burning.
DECC-28	Providence Portal	SFAZ	30.79	Provide protection to the buildings and structures of Providence Portal by minimising spread of fire to the east	Prescribed burning and appropriate mowing and slashing.
DECC-30	Rileys	SFAZ	503.21	Mitigate the spread of fires to the east	Prescribed burning.
DECC-31	Sawpit Creek	SFAZ	192.04	Protect built structures	Prescribed burning and appropriate mowing and slashing.
DECC-32	Tom Groggin	SFAZ	1103.61	Mitigate the spread of fires to the east towards Thredbo.	Prescribed burning and rapid suppression of ignitions to the west of Thredbo.
DECC-33	Toms Farm Ck	SFAZ	1805.69	Mitigate the spread of fires to the east	Prescribed burning.
DECC-34	Waste Point	SFAZ	102.71	Mitigate the spread of fires to the east into Waste Point Village	Prescribed burning and appropriate mowing and slashing.
	NPWS LMZ 2				
DECC-35	Blowering Cliffs	LMZ 2	6864.57	Manage for natural and cultural heritage values	Prescribed burning.
DECC-36	Bramina	LMZ 2	5590.12	Manage for natural and cultural heritage values	Prescribed burning.
DECC-37	Eucumbene Lookout	LMZ 2	2058.99	Manage for natural and cultural heritage values	Prescribed burning.
DECC-38	Greg Greg	LMZ 2	11564.2	Manage for natural and cultural heritage values	Prescribed burning.
DECC-39	Indi South	LMZ 2	2653.08	Manage for natural and cultural heritage values	Prescribed burning.
DECC-40	Little Forest	LMZ 2	13,613.1	Manage for natural and cultural heritage values	Prescribed burning.
DECC-41	Maragle	LMZ 2	4771.07	Manage for natural and cultural heritage values	Prescribed burning.
DECC-42	Moonbah Mountain	LMZ 2	2286.45	Manage for natural and cultural heritage values	Prescribed burning.
DECC-43	Murphy's Swamp	LMZ 2	5252.43	Manage for natural and cultural heritage values	Prescribed burning.
DECC-44	Providence Portal	LMZ 2	188.37	Manage for natural and cultural heritage values	Prescribed burning.
DECC-45	Tollbar	LMZ 2	6402.84	Manage for natural and cultural heritage values	Prescribed burning.
DECC-46	Warogong Sugarloaf	LMZ 2	391.87	Manage for natural and cultural heritage values	Prescribed burning.
DECC-47	Yaouk	LMZ 2	11817.8	Manage for natural and cultural heritage values	Prescribed burning.
DECC-48	Mt Morgan	LMZ 2	5383.48	Manage for natural and cultural heritage values	Prescribed burning.
DECC-49	Round Mountain	LMZ 2	1510.05	Manage for natural and cultural heritage values	Prescribed burning.
DECC-50	Kalkite	LMZ 2	2423.26	Manage for natural and cultural heritage values	Prescribed burning.

Map ID	Name & manager	Zone	Area (ha)	Objectives	Prescribed strategy
	Snowy Hydro Limited				
SHL-01	Cabramurra Radio Tower	APZ	0.52	Protect built structure	Mowing, slashing and spraying to maintain fuel loads to APZ standards
SHL-02	Cabramurra Township	APZ	81.82	Protect built structures; Properties are prepared annually as per SHL EMP.	• Maintain fuel loads around built structures to APZ standards involving mowing, slashing, spraying and prescribed burning as required; • Implement annual preparedness actions.
SHL-03	Cabramurra Water Tank	APZ	0.11	Protect built structure	Mowing, slashing and spraying to maintain fuel loads to APZ standards
SHL-04	Dry Dam Pump House	APZ	0.03	Protect built structure	Mowing, slashing and spraying to maintain fuel loads to APZ standards
SHL-05	Geehi Dam Cottage	APZ	0.12	Protect built structures	Mowing, slashing and spraying to maintain fuel loads to APZ standards
SHL-06	Geehi Radio	APZ	0.15	Protect built structures	Mowing, slashing and spraying to maintain fuel loads to APZ standards
SHL-07	Geehi Sub St	APZ	0.25	Protect built structures	Mowing, slashing and spraying to maintain fuel loads to APZ standards
SHL-08	Grey Hill Comms Tower	APZ	0.02	Protect built structure	Mowing, slashing and spraying to maintain fuel loads to APZ standards
SHL-09-10	Guthega Power Station	APZ	5.02	Protect built structures	Mowing, slashing and spraying to maintain fuel loads to APZ standards
SHL-11-14	Island Bend Dam	APZ	0.39	Protect built structures	Mowing, slashing and spraying to maintain fuel loads to APZ standards
SHL-15	Jindabyne Pumping Station	APZ	5.41	Protect built structure	Mowing, slashing and spraying to maintain fuel loads to APZ standards
SHL-16-18	Murray 1 Power Station	APZ	6.57	Protect built structure	Mowing, slashing and spraying to maintain fuel loads to APZ standards
SHL-19	Mt Blackjack Towers	APZ	0.12	Protect built structure	Mowing, slashing and spraying to maintain fuel loads to APZ standards
SHL-20	Tooma Dam Area	APZ	0.25	Protect built structure	Mowing, slashing and spraying to maintain fuel loads to APZ standards
SHL-21	Tooma Dam Gate House	APZ	0.07	Protect built structure	Mowing, slashing and spraying to maintain fuel loads to APZ standards
SHL-22	Tumut Pond Control Hut	APZ	0.11	Protect built structure	Mowing, slashing and spraying to maintain fuel loads to APZ standards
SHL-23	Upper Tumut Group Control	APZ	2.0	Protect built structure	Mowing, slashing and spraying to maintain fuel loads to APZ standards
SHL-24	Youngal Tower	APZ	0.35	Protect built structure	Mowing, slashing and spraying to maintain fuel loads to APZ standards
SHL-25	Bald Hill Radio Station	APZ	0.15	Protect built structure	Mowing, slashing and spraying to maintain fuel loads to APZ standards.
	OTHER LESSEES				
L-01	Kosciuszko Mtn Retreat	APZ	12.95	Protect built structures	Mowing, slashing and spraying to maintain fuel loads to APZ standards
L-02	Mt Selwyn	APZ	0.95	Protect built structures	Mowing, slashing and spraying to maintain fuel loads to APZ standards
L-03	Ski Rider Hotel	APZ	1.84	Protect built structures	Mowing, slashing and spraying to maintain fuel loads to APZ standards
L-04	Thredbo Village	SFAZ	18.33	Protect built structures; Properties are prepared annually as per VPP.	• Develop and implement a Village Protection Plan involving mowing, slashing and spraying; • Maintain fuel loads around built structures to APZ standards; • Implement annual preparedness actions.
TG-01	Upper Tumut Switching Yard	APZ	5.77	Protect built structures	Mowing, slashing and spraying to maintain fuel loads to APZ standards
RTA-01	Wilsons Valley RTA Depot	APZ	1.14	Protect built structures	Mowing, slashing and spraying to maintain fuel loads to APZ standards

3.3 Bush Fire Prevention Strategies

3.3.1 Detection

Early detection of ignitions is critical to the success or otherwise of first attack and subsequent control of a fire. Early first attack success is in turn the major influence in preventing development of a bush fire into a larger campaign fire that can be both expensive, and threaten life and property and heritage values. Detection policies are outlined in NPWS (2007a) while standard operating procedures are outlined in the Regional Incident Procedures booklets. Detection of fires within the Park is achieved by a variety of methods that include:

- Reports from staff, contractors, lease holders and members of the public;
- Reports from observation towers;
- Aerial observations from detection flights;
- Reports from other agencies such Forests NSW;
- Reports from local RFS brigades; and
- Occasional observations from satellite based systems such as CSIRO Sentinel.

NPWS maintains a series of fire detection towers located at Ingebyra, Mt Youngal, Black Jack, and Talbingo Mountain. These sites also provide significant communication facilities for incident management within the Park. The towers form part of a larger strategic fire tower network which includes towers operated by Forests NSW, ACT Emergency Services Agency and the Department of Environment and Sustainability in Victoria. The towers provide a spread of observation cover across the entire Park although there are also many areas that are not directly visible from the towers. Towers are staffed on a contract basis during the fire danger period depending on how the season develops. Technological developments are resulting in new remote fire detection systems. New technology shall be investigated to determine options available for additional and advanced remote fire detection systems.

NPWS also maintains an active watch of lightning, weather and hotspot tracking technology that facilitates decision making about staffing of towers, setting preparedness levels and implementation of observation flights. In the event of lightning occurring followed by little rain, NPWS will, in consultation with other agencies and the relevant BFMCs, initiate observation flights to detect ignitions.

Ignitions from lightning storms may not be visible for several days after a storm has passed. Staff and contractors are also trained and reminded to be vigilant during days when FFDI is high to extreme. Aerial and ground detection activities are routinely carried out in summer, particularly after dry lightning storms. Local lookout and vantage points are also used for detection of bush fires, with crews held on standby on days of extreme fire danger or Total Fire Ban days.

3.3.2 Strategies to reduce the occurrence of human caused unplanned fires

At least 34%, (arson 18%, burning off-2%, camp/cooking-9%, miscellaneous-5%), of all fires occurring in the Park can be attributed to human causes (Figure 10) with a further 29% of causes being unknown, some of which are likely to be human caused. While the cause of many fires remains unknown this is partly due to the inaccessibility of the terrain. NPWS fire investigators will cooperate with police, RFS and NSW FB to investigate all suspicious ignitions within the Park.

NPWS may implement the following strategies, depending on circumstances, to minimise unplanned human caused ignitions:

Park visitor management

- Install and maintain locked fire trail gates where necessary and maintain key registers with other agencies and organisations in order to control access;

- Increased preparedness for heightened probability of bush fire ignitions during severe fire weather conditions and long weekends;
- Prohibiting the lighting of fires during total fire bans, Park fire bans, and/or conditions associated with severe fire weather to minimise the chance of fires being started by visitors;
- Limiting public access by closing all or part of the Park during severe fire weather conditions, total fire bans, Park fire bans, periods of extended fire danger or if bushfires occur adjacent to the reserves in order to control the risk of arson or accidental fires and to ensure public safety;
- Limiting public access by maintaining and installing strategic signage and gates, and minimising the construction of trails in locations that may lead to increased ignition risk;
- Liaise with infrastructure authorities to determine appropriate prevention strategies for potential ignition sources associated with their operations and assets in or adjacent to the reserves;
- Contractors will be briefed on the requirements for suspending work if using tools and equipment that may potentially be ignition sources;
- Contract conditions for contracted work within the Park during the fire danger period will include information regarding the suspension of work when required by NPWS, and shall specify the minimum level of fire fighting equipment to be carried during days of high fire danger and above;
- Campgrounds and picnic areas are regularly maintained by mowing, slashing and herbicide treatments, to minimise the availability of fuel in event of a campfire escape.

Illegal fire investigation and enforcement

- Promoting cooperative surveillance programs through BFMCs including neighbourhood watch programs and patrols in high risk areas during severe fire weather conditions;
- Undertake patrols and promote cooperative surveillance programs on days of very high and extreme fire danger to manage the risk of arson and accidental ignitions;
- Cooperatively work with NSW Police and the NSW Rural Fire Service to investigate all fires where the ignition cause is in doubt.

Powerlines

- NPWS will cooperatively liaise with energy providers to ensure measures are taken to minimise the potential for ignitions started by power line arcing and trees falling on power lines;
- NPWS will encourage energy providers to ensure that regeneration slash under powerlines is managed to minimise the potential for ignitions.

Unknown ignition sources

- NPWS will investigate and report on all fires in the Park to minimise the number of unknown ignition sources.

Prescribed burning and fire suppression operations

- Ensure that prescribed burns are planned to appropriate agency standards, are directed by appropriately trained and experienced staff, and are undertaken within defined weather prescriptions in order to prevent fire escapes;
- Ensure thorough mop-up and patrol of the perimeter of unplanned fires and prescribed burns during or before the onset of extreme weather conditions with the assistance of heat sensing technology, where available, to identify hot spots in order to minimise the potential for re-ignition of fires.

3.3.3 Strategies to reduce the occurrence of other unplanned fires

While little can be done to prevent the start of a fire from natural causes e.g. lightning, some actions can be taken to minimise the spread of those fires. NPWS will implement the following strategies to minimise the occurrence of unplanned fires:

- Utilise lightning detection systems, rainfall radar, ground detection networks (fire towers) and fixed-wing aircraft or helicopters for aerial surveillance after the passage of storms to identify the location of fires started by lightning strikes;
- Immediately investigate reports of smoke or fire activity within and adjacent to the Park;
- Maintain fire preparedness days for all fire operational staff;
- Carry out pre season checks of all equipment;
- Ensure that trails are maintained to required standards;
- Liaise closely with neighbours about areas of concern due to arson activity or fire behaviour potential; and
- Implement prescribed burns in areas of known high frequency ignitions subject to other asset protection and ecological considerations.

3.3.4 Prescribed burning

Prescribed burning in strategic locations can assist with the protection of environmental values and the protection of assets. Prescribed burning may also directly assist suppression of unplanned fires by modifying fire severity through reduced fuel availability, increasing safety for ground based fire fighters, reducing resource requirements and thus providing opportunities for changes in strategy from indirect attack to direct attack and reducing mopping up operations (Fernandes and Botelho, 2003). Fuel reduced areas are of greatest assistance to fire suppression operations when fires are small, the weather is moderate or cooler and when the fire intensity is low or moderate (Tolhurst and McCarthy, 2007 in preparation). NPWS carries out prescribed burning to reduce fuels to protect assets, to reduce fuels in areas of higher ignition and fire frequency history, to maintain biodiversity and for research (NPWS, 2007a). Prescribed burning has traditionally been in the form of “block” burning where entire blocks were burnt out to pre established control lines. While this is an effective and safe method it is also an expensive method due to the resources required to implement and contain the burn. Alternatives to block burning include:

- Broad area, ridge top and selected aspect remote burning principally implemented using aerial incendiaries;
- Edge burning using ground resources;
- Partial block burning (open ended or unbounded).

The likely effectiveness of alternative methods of prescribed burning will depend on the development of appropriate prescriptions for the known conditions of each prescribed burn proposal. Evaluation of effectiveness of alternative strategies will be recorded and communicated to staff as part of the post burn debrief process.

In higher elevation areas, the occurrence of frosts associated with dry weather may also provide an opportunity to implement burns in the winter months as the frosts kill off the top layers of grasses thus creating a drier fuel load over moister duff layers.

Prescribed burning operations may be implemented as single operations or as phased operations. Phased operations may include carrying out edge or partial block burns in one season followed by burning the interior of a block in the following season or in a subsequent operation. The advantage of phased burns is that fewer resources may be required for each operation. In addition this approach results in more variable frequencies in an area with the associated benefits for flora and fauna recolonisation and a mosaic of habitat regeneration ages.

Table 26 summarises the characteristics, risks, benefits, and considerations for each of the broad prescribed burning strategies.

Table 26 Broad prescribed burning strategies

Type	Characteristics	Benefits	Risks	Considerations
Block burning	• Hard control lines on all edges	• Easier control; • Extent of fuel consumption easily mapped.	• Over burning with few refugia; • Requires significant resources; • Expensive.	• resources required; • % of burnt area required; • % of fuel consumption required.
Broad area remote	• No or few hard control lines • In remote locations	• Relatively cheap to implement; • Can be used to reduce ignition potential and fire spread in areas of known higher ignition and fire frequency.	• Higher risk of escape if fire behaviour and weather misjudged. • Higher chance of ineffective burn if burning cautiously at lower end of prescription	• Implemented when high confidence in benign weather conditions following the burn.
Edge burning	• Hard control lines • Burning of one or more edges of a block only, but not the entire block	• Provides advantage in low intensity situations; • Breaks up resource commitment.	• Unburnt fuels within block; • May be disadvantage when attempting to implement backburns.	• May be used as part of phased burns; • Edge may be difficult to light if unplanned fire occurs.
Partial block	• Control lines on active edges	• Allows escape of mobile species; • Breaks up resource commitment.	• Unburnt fuels within block; • May continue to burn beyond intended area.	• May be used as part of phased burns.

Prescribed burns are scheduled when there is reasonable confidence that a burn can be implemented safely and within prescription. This period is also known as the “window of opportunity” to implement prescribed burns. In the Park this generally occurs in autumn after the higher fire danger of summer has passed. Prescribed burning is usually avoided in spring due to the potential for fuels to smoulder unseen into summer periods of higher fire danger thus providing an ignition source. In addition spring burning has potential ecological impacts on breeding cycles of a wide range of fauna. Prescribed burn operations are supported by an incident management team, aircraft (particularly in more remote areas), and ground crews.

It is important to recognise that fuel reduction burning in temperate forests, woodlands and heaths is generally only effective for up to 2-5 years (Gill *et al* pg 438 in Bradstock *et al* 2002) in relation to reduction of surface fuels, and potentially up to 10-12 years for bark when bark fuel has been successfully treated (McCarthy and Tolhurst, 2001, McCarthy, G. pers comm. 2006). A low intensity prescribed burn is likely to result in incomplete consumption of surface fuels (which may be positive for soil stability) and to leave the elevated fuel layer above about 2 metres unburnt. A higher intensity burn will assist with the removal of bark fuels. However, higher intensity burns can be very difficult to control and to keep inside the control lines, as well as potentially having negative soil erosion effects.

Prescribed burning in subalpine areas, and subsequent effects on vegetation structure, has long been a subject of contention (Mooney, 2004). While anecdotal experience e.g. graziers personal comments, indicate that frequent low intensity burning provided a grassier understorey (which may be suitable if the objective of management is to sustain grazing), such practices also resulted in significant increases in resprouting Snow Gum stems and shrub regrowth e.g. *Bossiaea foliosa* and *Ozothamnus hookeri* (Good 1982, Leigh and Noble, 1981, and Williams and Costin 1994 cited in Mooney, 2004) if annual burning was not sustained. Hence graziers were required to continue burning frequently to sustain a grassy understorey (Woodruff, 1977). Such frequent burning also impacted heavily on the age classes of the various Snow Gum

species by killing off the younger regrowth, and older trees, when fire residence time around stems was long and temperatures hot enough. Regrowth from killed trees was then often grazed thus reducing the distribution and density of Snow Gums. Since grazing was reduced in the late 1950s much regeneration of Snow Gums and stabilisation of soils in subalpine communities has occurred. Due to the low productivity at such elevations, many of the Snow Gum woodlands were still in a relatively small stem diameter class when the fires of 2003 occurred. The shrubby regrowth resulting from burning in these communities may be sustained for up to 40 years (Park, G. cited in Woodruff, 1977) however further research is required to better understand vegetation successional patterns and fuel development in relation to fire intensity and frequency in subalpine communities. Relatively frequent prescribed burning around Eucumbene Cove over the last 10 years has also resulted in a significant shrubby understorey (Zylstra, pers. comm. 2007). Mooney (2004) suggests that "frequent fire would be detrimental to alpine ecosystems" which include subalpine ecosystems. Mooney's comment is based on a review of literature and specifically comments attributed to the 2003 Commonwealth House of Representatives Select Committee on the Recent Australian Bushfires that "Snow Gum country" can take in excess of 50-75 years for complete recovery (Mooney, 2004).

Associated with issues of succession in subalpine communities, is the perceived level of hazard presented by such vegetation communities and the consequent threat to assets within and adjacent to the Park. McCarthy (2003) found that Overall Fuel Hazard (OFH) in alpine communities (which included subalpine communities) was rarely above "High", and could find no reason to burn such areas for flora conservation reasons. McCarthy (pers. comm. 2007) advises that surface fuels in subalpine woodlands are likely to be back to pre burn levels within 5-6 years depending on productivity. Pyne (1991, cited in Mooney 2004) stated that "burning was relatively ineffective in controlling fuels in subalpine biotas" and Leigh (1987 cited in Mooney 2004) concluded that "there is no evidence that high frequency, low intensity burning would decrease the frequency of intense unplanned fires". This is a reasonable conclusion given that extensive unplanned fires in subalpine areas are generally associated with extreme dry fuel conditions as a result of drought and very high to extreme fire weather conditions. There are areas within the Park where subalpine communities are within areas identified with historically higher fire frequency and/or where assets may be threatened by fires leaving the Park through these communities. The risk assessment identified the area to the west of Eucumbene Cove as being of "Extreme" risk, and areas north of Providence Portal identified as being "Possible" risk where Snow Gum woodlands occur. Soil erosion potential in Snow Gum communities can also be high and Wahren *et al* (1999) found that it can take up to ten years after a fire for ground cover to recover sufficiently to provide adequate protection of the soil.

The need for prescribed burning in subalpine vegetation communities, for asset protection, is generally restricted to the lower elevation and shallower slope areas where assets are directly threatened and at risk from fire. It is proposed to monitor the effects of these proposed fires on the flora, to record the successional pathways after different treatments, and to record development of OFH over time.

All prescribed burn proposals are required to set objectives for the prescribed burn. Such objectives are most often a reduction in fuel although objectives can also be related to ecological requirements. Objectives for reducing fuel must take into account the potential fuel re-accumulation that may occur under different intensities of burn. If the objective of the burn is to reduce ember spotting potential then higher intensity prescribed burns are required to ensure that the bark is removed. In this case such burning may be effective for up to 10 years (McCarthy and Tolhurst, 2001). If the intention is to maintain surface and elevated fuel load at a level below "High", then a higher frequency of burning is more important than intensity although any advantage gained will likely be effective for only 2-5 years depending on vegetation type and intensity of the burn (McCarthy and Tolhurst, 2001). It is noted that McCarthy and Tolhurst, (2001) indicate that the most effect of a prescribed burn in assisting with unplanned fire control occurs in the first four years after a fire and declines after that time. Accordingly prescribed burn planning shall consider opportunities to implement a mosaic of burns in any zone or

geographic area to maintain thresholds while providing some assistance in unplanned fire suppression.

Prescribed Burning Proposals

Proposals for prescribed burns have been determined by combining the analysis of:

- Risks to assets;
- Previous fire history;
- Status of biodiversity thresholds now and potential in the future if no unplanned fire occurs;
- Soil stability and catchment stability;
- Ignition frequency and location;
- Fuels; and
- Bush fire behaviour potential including spotting.

Prescribed burning proposals are qualified by the following factors:

- Weather and seasonal conditions can provide very small windows of opportunity that can prevent prescribed burns being implemented;
- Climatic conditions such as drought impacts;
- Unplanned fire burning an area proposed for prescribed burning may negate the need to implement a burn in an area;
- Unplanned fires affecting parts of a broad vegetation formation that had been identified as underburnt may negate the need to implement an ecological prescribed burn in an area;
- Annual endorsement of the relevant Bush Fire Management Committee;
- Availability of resources; and
- All prescribed burn proposals are subject to a more detailed assessment of environmental factors, fuel characteristics, and fire management options in that locality. Accordingly such detailed assessment may negate or promote further the need or otherwise for more or less prescribed burning.

There is scope for the addition of further prescribed burn proposals, or the removal of current proposals in the future as more detailed assessment of a range of factors is undertaken throughout the life of this strategy. Factors that may be considered include:

- Potential determination of future cooperative burn areas with neighbours including private property landholders and other Government agencies;
- Incorporating the outcomes of future and revised BFMC Risk Management Plans;
- Future ongoing assessments that indicate that fuels have accumulated or not accumulated to a hazardous level;
- Where land use changes occur adjacent to park boundaries that may necessitate consideration of a change in fire management in that area to assist with protection of those assets. It is noted however that there is still an onus on the land owner/manager to ensure that fire risk is managed on their land, not solely on NPWS estate;
- Incorporating the outcomes of new research, policy and strategies that provide clear new directions for the need or otherwise for prescribed burning;
- Future changes in climate including any predicted onset of severe drought conditions, and greater incidence of sever fire weather days; and
- Prescribed burns may be carried out in the Cabramurra Area within the APZ areas when required in accordance with relevant chapters of the Snowy Management Plan Environmental Management Plan.

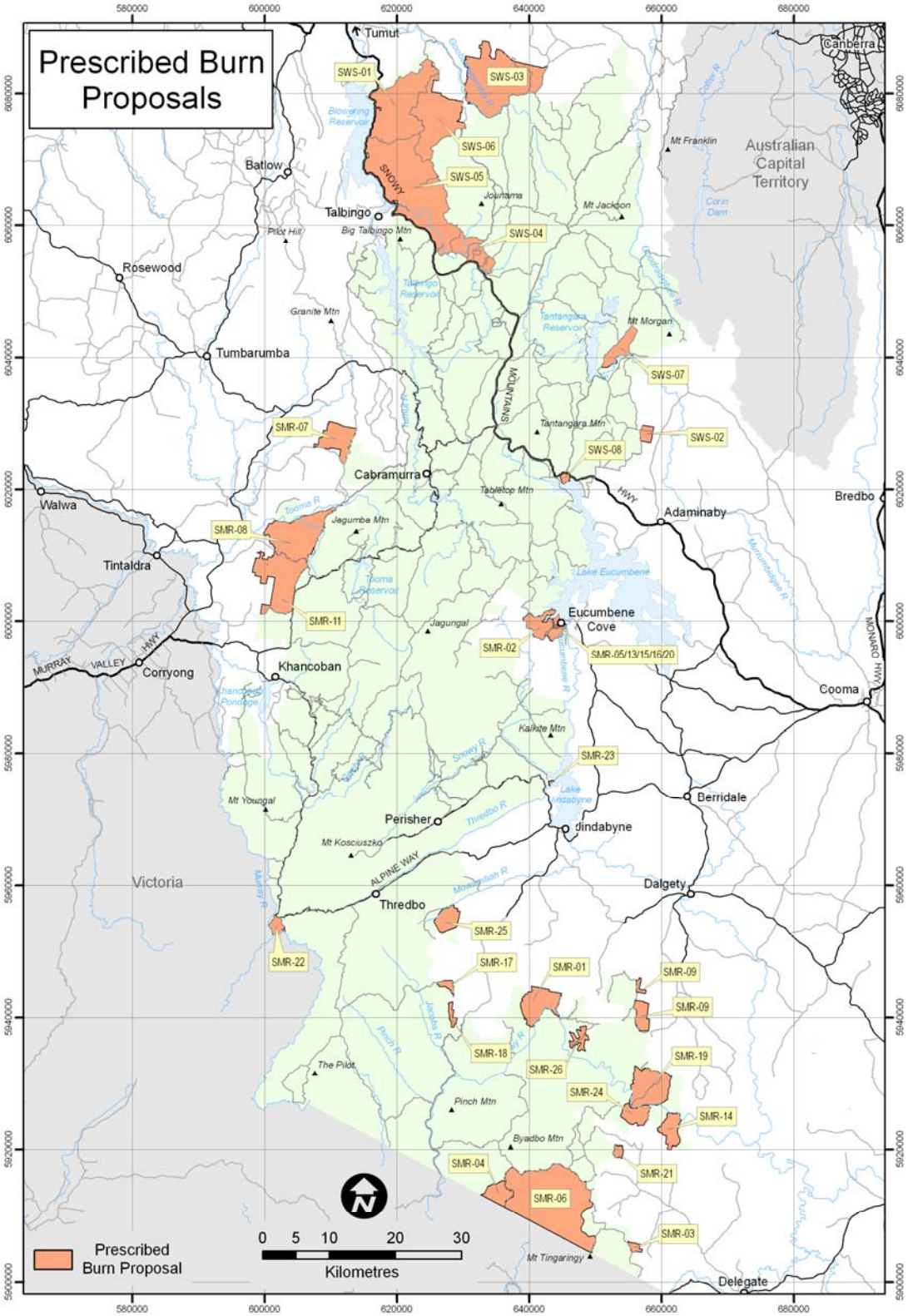
Implementing prescribed burn proposals in Strategic Fire Advantage Zones will be given a higher priority than implementing works in Land Management Zones. As part of the preparation of annual works schedules, fire managers will identify suitable sections of zones for prescribed burning. A detailed assessment of fuels and a range of other fire behaviour factors will be conducted before and after all prescribed burn operations. A detailed NPWS Prescribed Burn Plan and environmental assessment will be prepared for each prescribed burn.

Table 27 and Figure 22 detail the areas that will be considered for prescribed burns for the life of this strategy.

Table 27 Prescribed burn proposals

Map ID	Name	PB Period	NPWS Area	Region	Area (ha)	Comments
SMR-01	Reedy Creek	2010-2013	Snowy River	SMR	2172	Block fuel reduction
SMR-02	Bog Hole Ck	2010-2013	Alpine	SMR	1179	Selected ridge top fuel reduction
SMR-03	Corrowong Ridge	2008-2013	Snowy River	SMR	209	Block fuel reduction
SMR-04	Guttamah Ck	2009-2011	Snowy River	SMR	1028	Block fuel reduction-Joint DSE
SMR-05	Koala Point	2008-2013	Alpine	SMR	113	Block fuel reduction
SMR-06	Little Forest	2012-2013	Snowy River	SMR	10936	Phased selected ridge top fuel reduction
SMR-07	Maragle	2010-2013	Upper Murray	SMR	1943	Block fuel reduction
SMR-08	Welumba	2008-2010	Upper Murray	SMR	4496	Block fuel reduction
SMR-09	Numbla Vale	2009-2013	Snowy River	SMR	990	Block fuel reduction
SMR-11	Spring Ck Nth	2008-2012	Upper Murray	SMR	4338	Block fuel reduction
SMR-13	Township Eucumbene	2009-2013	Alpine	SMR	12	Block fuel reduction
SMR-14	Warm Corner	2010-2013	Snowy River	SMR	1185	Block fuel reduction
SMR-15	Watertanks	2011-2013	Alpine	SMR	24	Block fuel reduction
SMR-16	Watertanks Sth	2012-2013	Alpine	SMR	32	Block fuel reduction
SMR-17	Thatchers Hole	2009-2013	Snowy River	SMR	258	Block fuel reduction
SMR-18	Wild Bull Ck	2011-2013	Snowy River	SMR	245	Block fuel reduction
SMR-19	Windmill Hill	2010-2013	Snowy River	SMR	2972	Phased selected ridge top fuel reduction
SMR-20	Borrows	2008-2013	Alpine	SMR	415	Block fuel reduction
SMR-21	Spicer Hill	2008-2010	Snowy River	SMR	239	Block fuel reduction
SMR-22	Rileys	2013	Upper Murray	SMR	446	Block fuel reduction
SMR-23	Waste point	2009-2011	Alpine	SMR	38	Block fuel reduction
SMR-24	Snodgrass	2008	Snowy River	SMR	1021	Block fuel reduction
SMR-25	Round Mountain	2013	Snowy River	SMR	1070	Ridge top fuel reduction
SMR-26	Wild Woman Ridge	2010-2013	Snowy River	SMR	558	Ridge top fuel reduction
SWS-01	Blowering Cliffs	2008-2013	Riverina-Highlands	SWS	6865	Phased selected ridge top fuel reduction
SWS-02	Bugtown	2008-2009	Murrumbidgee	SWS	429	Block fuel reduction
SWS-03	Emu Flat	2008-2013	Riverina-Highlands	SWS	8007	Phased selected ridge top fuel reduction
SWS-04	Jounama	2008-2013	Riverina-Highlands	SWS	2011	Phased selected ridge top fuel reduction
SWS-05	Malabar Mountain	2008-2013	Riverina-Highlands	SWS	12617	Phased selected ridge top fuel reduction
SWS-06	Murphys Swamp	2008-2013	Riverina-Highlands	SWS	5252	Phased selected ridge top fuel reduction
SWS-07	Pockets Saddle	2008-2010	Murrumbidgee	SWS	1228	Block fuel reduction
SWS-08	Providence Portal	2009-2011	Murrumbidgee	SWS	188	Block fuel reduction

Figure 22 Prescribed burn proposals



3.3.4.1 Environmental assessment for prescribed burning

A Prescribed Burning Plan and an environmental impact assessment (Review of Environmental Factors (REF) (DEC, 2003) or an assessment using the Bush Fire Environmental Assessment Code (BFEAC) (RFS, 2006) will be prepared for each prescribed burn (NPWS 2007a). The BFEAC will be used as the primary environmental impact assessment for carrying out fuel reduction work in all zones in the Park (NPWS 2007a).

If the assessment under the BFEAC is not compliant, i.e. a significant impact on the environment is likely, then a REF is required. In addition the BFEAC does not apply to specific land categories in the Park including:

- Alpine areas;
- Rainforests;
- Montane bogs, fens and lakes; and
- wilderness areas.

A REF will be required for all prescribed burn proposals in these areas. Prescribed burn planners are referred to detailed information in regional datasets to assist with preparation of burn plans, including appendices to this strategy.

Environmental assessment of prescribed burn proposals will consider the wide range of potential environmental impacts of each proposal. Such assessment should include, but not be limited to:

- A review of the threshold status at the local level using all available data;
- Consideration of the overall fire history status and sensitivity of known populations, at the landscape scale, of identified flora species such as Alpine Ash, various Snow Gum species, Callitris and other rare or endangered species.
- Consideration of the conservation status of sensitive and threatened fauna such as Smoky mouse, Northern and Southern corroboree frog, and other rare or endangered species.

To assist with the protection of natural heritage values, including threatened species, planning for prescribed burning is supported by reference to various flora and fauna databases including:

- Fire and fauna database-Australian Alps National Parks;
- NSW Threatened Fauna Fire Response Database;
- NSW Flora Fire Response Database.

These databases are available from NPWS offices in the two Regions.

Due to the extent of recent fires e.g. 2002-2003 & 2006-2007 fire seasons and impacts on a range of species, advice should be sought from staff of the Biodiversity Conservation Section – South Branch when preparing environmental assessments for prescribed burns in the Park for the life of this strategy.

3.3.4.2 Smoke and prescribed burns

The generation of smoke from prescribed burning can cause impacts on the community and the environment. Smoke can lead to a range of respiratory problems and health authorities shall be advised of fires and the intended burning operations. Prescribed burn operations shall take account of the effect of predicted weather conditions on wind direction and smoke dispersal including the possibility of inversions trapping smoke in valleys.

Grape growing is an expanding industry near the Park, and smoke from fires, including prescribed burning operations, has the potential to affect grape quality. The key effect of smoke on grapes is currently understood to occur when grapes are still on the vine in the pre harvest season although the actual extent of such impacts under a range of conditions is still the subject of further research. Harvest season is climate dependant but generally occurs in the period February to April. It is often not possible to predict whether opportunities to carry out prescribed burning operations may still be available after grapes have been harvested.

Consultation shall be carried out with neighbouring grape growers prior to the implementation of prescribed burns in these areas.

It is intended that all controlled fire events should endeavour to reduce the exposure of the community to smoke. Prescribed burning, in relation to smoke management:

- Shall be undertaken in accordance with the policies and procedures outlined in the NPWS Fire Management Manual (NPWS 2007a) and this strategy;
- Shall be undertaken only when suitable weather conditions provide a reasonable degree of certainty that the prescribed burn can be maintained within control lines;
- Shall include advising neighbours of potential smoke impacts from prescribed burning operations;
- Shall take into consideration the threatened flora, fauna and priority habitat management guidelines provided in Appendix 7, Appendix 8 and Appendix 9.

3.3.5 Management trails

The Park contains approximately 2504 kilometres of roads, trails and tracks that are maintained by NPWS, and are classified in a number of ways according to the purpose of use. In addition to their occasional use for fire management, these roads, tracks and trails are maintained and used to access facilities such as lookouts, picnic and camping areas, walking track heads, and for uses such as vehicle touring, cycling and horse riding, and utilities maintenance. All roads, tracks and trails are considered a major component of the utilities used for fire management and it is recognised that any road, track or trail may potentially be of use for fire management. The network currently provides good access to the Park for fire management purposes including good access for fire fighters.

The NSW Bush Fire Coordinating Committee recently released a new policy on trails (BFCC, 2007) which outlines new standards for classification and maintenance of trails and signage. In line with the policy and in consultation with BFMCs, roads, tracks and trails within the Park that are frequently used for fire management, and that are proposed to be maintained to the BFCC policy standards are classified in accordance with the policy and are identified on Operations maps. Work is ongoing, and shall continue, to apply the new classifications to the trails within the Park in consultation with relevant BFMCs. NPWS liaises closely with other authorities through the local BFMCs in the preparation of annual trail maintenance schedules and in preparation of funding bids to maintain trails. At the strategic level the fire trail network is in place and has proved to be currently sufficient for first attack operations.

Fire trail signage, to a range of standards, is located throughout the Park. NPWS shall liaise with the BFMC to determine fire trail signage requirements according to the BFCC policy on trails (BFCC, 2007) and associated Annexure D.

Bush Fire Management Committees are required to maintain a Strategic Fire Trails Register of all fire trails within their areas. The review of the Fire Trails Register against classification standards is an ongoing consultative process within the BFMCs and is current for major areas within the Park. The maintenance and/or upgrade of registered trails to BFCC specified standards is subject to available funding and resources and is implemented in consultation with the relevant BFMC. It is not possible to list all individual trails in this strategy due to the very large number of them, therefore reference is made to this process and the Bush Fire Districts Fire Trail Register system for identification and management of strategic fire access trails.

Trails are inspected at the end of each winter to ensure that they are clear and open for the upcoming fire season. A maintenance program is determined annually according to priorities within each area. Works include removing fallen timber, clearing rock falls, cleaning out drains, regrading and shaping of trail surfaces, and repair of structures where required.

Access on some trails is restricted by locked gates which assist in the prevention of arson and accidental fire ignitions. NPWS will continue to maintain restricted access particularly in those areas where arson is an identified issue.

The major strategy to minimise the impact of high intensity fires and fire management activities on soil landscapes is to construct and maintain all trails to the standards prescribed in the Guidelines for the Planning Construction and Maintenance of Trails (NSW Soil Conservation Service, 1985).

3.3.6 Education

NPWS is committed to providing education about the roles and responsibilities of the organisation. NPWS will maintain public awareness of unplanned fire risk, and vulnerability, preparedness and prevention strategies by liaising with major stakeholders through the BFMCs. NPWS supports the approach of emphasising the importance of self preparedness and self protection on private properties.

NPWS will implement the following strategies to improve community education of the risks of fire and strategies to cope with fire while in the Park:

- Maintaining up-to-date Forest Fire Danger signage at all major public entrances to the reserves in order to promote public awareness, particularly on days of very high and extreme fire danger;
- Providing advice and information at NPWS visitor centres and facilities, and liaising with external tourism information centres highlighting the conditions for the safe use of fire and unsafe activities that lead to the ignition of bush fires;
- Promoting community education and awareness programs through BFMCs, including providing information for interpretation, signage and the media to highlight the role of fires in nature conservation;
- Providing media releases about fire conditions within the Park when appropriate;
- Assisting in fire prevention programs at local schools where possible; and
- Education of residents living within Waste Point.

3.4 Bush Fire Preparedness Strategies

3.4.1 Detection

A range of pre-season checks and tasks are required to be completed to ensure that detection capacity is at the required standard. These include:

- Testing computer based detection systems including the Lightning Tracker Systems, Bureau of Meteorology and other weather web sites, Sentinel web site;
- Prepare up to date maps, and observation equipment for each season and;
- Prepare schedules and contracts for staffing of fire towers;

3.4.2 Preparedness for ignitions

Based on the average annual ignition rate (13.4 ignitions annually), between 10 and 30 unplanned fires may be suppressed within the Park each year. NPWS will be prepared for bush fire suppression by:

- Participating in pre-season preparedness days to test equipment, fire detection, response and suppression capability;
- Preparation of annual 'Regional Incident Procedures' and 'contacts list' documents to ensure an efficient and timely response to incidents;
- Minimising the response time to ignitions by;
  a) assessing the required level of day to day preparedness by monitoring Fire Danger indexes and synoptic conditions on a continuous basis throughout the fire season;
  b) ensuring all staff have their complete personal fire fighting equipment on-hand and in operational condition;
  c) identifying pre-emptive incident management and fire-fighting teams to enable a rapid response to ignitions during severe fire weather conditions;
  d) maintaining a remote fire fighting response capability on standby for the prompt control of fires when FFDI is very high to extreme.

- Maintaining surveillance through neighbours, aircraft, towers and other vantage points within the Park to detect the location of bush fires and initiate a coordinated response;
- Rostering Duty Officers throughout the fire season to activate and coordinate responses to fires during public holidays and outside office hours;
- Providing briefings to staff and contractors about the prevention of ignitions that may be caused by use of tools and machinery, and including guidelines and agreements about suspending work when FFDI is Very High to Extreme; and
- Ensuring that Job Safety Analyses and Work Safety Methods Statements include reference to stopping work if the risk of ignition is high.

3.4.3 Fire fighting vehicles, plant and other resources

Fire management resources are shared across the state. Allocation of resources depends on the number of and threat posed by fires. Additional NPWS and other agency resources can be sourced from nearby areas and across the state if required.

A detailed list of available NPWS equipment and resources is included in the Regional Incident Procedures (RIPs) or other local documents which are updated annually. RIPs provide details on utilities, plant, equipment, contact schedules, and communications arrangements across the region available for use in fire suppression.

NPWS maintains fleets of Cat 9 fire tankers at Area offices, Waste Point, Khancoban, Blowering and Queanbeyan depots. A Cat 9 tanker is a 4WD vehicle able to carry 400 litres of water, a crew of two and basic fire fighting equipment. These small 4WD tankers are ideal when fire trail access is affected by terrain. A larger tanker, either Cat 1, 2, or 7 (water capacity up to 1000L) is also located at each of these locations. A wide range of other vehicles including motor bikes, quad bikes and general purpose 4WD vehicles are available at all NPWS locations.

NPWS has a number of dozers and other earthmoving equipment, including trucks of various sizes that can be used for fire suppression operations. The location of this plant at any point in time will vary depending on current works programs and FFDI. Such plant is utilised during fire suppression operations and in locations as required by fire management operations. In addition NPWS engages a wide range of plant contractors to assist with fire suppression operations.

A range of other resources including incendiary devices, catering trailers, remote area fire fighting equipment including pumps and hoses, chainsaw kits, buoy walls and bladders, are located throughout the two Regions.

Availability of water is a key issue in some areas, particularly in the Lower Snowy/Byadbo area. Water tanks are being installed in selected locations in the Byadbo area and will need to be topped up at the beginning and throughout each season. Further opportunities for installation of remote water tanks will be investigated.

During the fire season maintenance of fire fighting equipment is undertaken on a continual basis. NPWS will be prepared for bush fire suppression by:

- Ensuring that all plant and equipment is serviced and in operational condition prior to the commencement of each fire season;
- Ensuring that staff are re-familiarised with specialist equipment at fire preparation days.
- Following each incident all equipment is checked and lost or damaged items repaired or replaced.

3.4.4 Staff

During the fire season (typically October to March) fire related duties take precedence over other management activities. Between the two Regions, NPWS has approximately 100 staff trained in fire fighting or fire incident management. Strategies to ensure preparation of adequate resourcing for bush fire suppression operations include:

- Activation of the Regional Duty Officer systems;
- Prior to each fire season a staff fire preparation day is held to update fire fighting staff on procedures and to undertake refresher training on equipment and procedures. All fire fighting staff are required to attend the fire preparation days prior to the commencement of each season;
- Out of area support: When local resources are exhausted, the Region will seek out of area support to carry out fire fighting operations and associated operational, logistics, planning and administrative functions;
- Remote area fire fighting teams: The Region will maintain a rapid response remote area capability to suppress fires quickly and prevent escalation;
- Due to the remote and mountainous terrain within the Park ensure that an adequate number of fire fighting staff undertake annual refresher training in helicopter operations; and
- Pre-deployment of staff to key locations around the Park when fire danger or risk is deemed to require such actions.

3.4.5 Aviation

NPWS uses a variety of aircraft to access areas remote from vehicular access for aerial water bombing, laying suppression chemicals, deploying remote area fire fighting crews, reconnaissance and fire mapping during suppression operations. Both fixed wing and rotary wing aircraft are used. All aircraft used for fire purposes are required to be registered on the NSW Fire Agencies Aviation Approved operator list. During the fire season, the use of aircraft is coordinated by the State Air Desk.

The broader region is serviced by regular passenger flights to Canberra and Wagga Wagga airports. Cooma and Tumut airports have sealed runways suitable for all aircraft up to small business jets. Jindabyne and Delegate airports have unsealed runways suitable for light aircraft. Snowy Hydro Limited manages airstrips at Khancoban, Cabramurra and Talbingo which can be used subject to approval from SHL.

NPWS maintain a mobile retardant base which is located at Jindabyne airport. A new inter-agency retardant base is currently being constructed at Tumut for South West Slopes Region. The Victorian Department of Sustainability and Environment have a permanent retardant base established at Delegate, which can be accessed through the Border Fire Agreement.

A major hazard to aircraft operations is the large number of powerlines that crisscross the area as part of the Snowy Hydro Ltd electricity generation infrastructure. In addition the rugged terrain and high elevation can make flying hazardous in certain conditions. A map of powerlines is included in the RIPs.

Water for bombing operations is generally available from dams, numerous streams and watercourses within the Park. When water is difficult to locate temporary water dams or 'buoy walls' can be established for aircraft use. Buoy walls are available for field deployment at all major workshops including Jindabyne, Khancoban, Queanbeyan and Blowering depots.

Other aviation equipment available includes handheld aviation radios, maps, and software to map fires.

3.4.6 Incident management preparedness

All fire suppression operations within the Park are managed using the nationally adopted Incident Management System (IMS). Under IMS, an incident management team (IMT) will be established to manage the control, operations, planning and logistics of the bush fire suppression operation. In preparation for each fire season:

- Selected staff will be encouraged to attend inter-agency incident management briefings, workshops and exercises;
- A review of staff trained and skilled to fill specific IMT roles will be completed prior to each fire season;

- An IMT exercise will be prepared and implemented in each region prior to the commencement of each season to ensure IMT staff are familiar with current procedures.

During the fire season it may be necessary to undertake advanced planning for and establishment of an IMT under certain circumstances. An IMT will be identified and placed on standby if the forecast weather and fuel conditions are such that multiple ignitions are a high likelihood.

3.4.7 Fire operations rooms

NPWS maintains dedicated and fully equipped fire operations rooms at the Jindabyne and Tumut offices. Area offices that may also be used as operations rooms are at Queanbeyan and Khancoban. The Rural Fire Service also has dedicated control centres at Tumut, Cooma, Berridale and Bombala.

Fire operations rooms will be restocked and equipment checked for operational readiness prior to each fire season.

3.4.8 Communications

NPWS maintains a VHF radio network using linked radio bases covering the Park. Base stations and radio coverage for all NPWS frequencies are shown on a separate A0 Radio coverage map. These bases are linked into two groups, the southern group is monitored from Jindabyne and Khancoban. The northern group is monitored from Tumut and Queanbeyan.

Due to the mountainous terrain there are black spots within the radio coverage area. NPWS has solar powered portable repeaters that can be used to provide localised radio coverage if required. Portable repeaters are housed at Jindabyne, Tumut and Queanbeyan. NPWS shall use portable repeaters to boost communications capacity particularly in remote areas. A Geographic Information System review of the current coverage and strength of radio signals, and topographical advantages will be undertaken to identify and map locations where portable repeaters are required and the most suitable locations to set up the repeaters. The outcomes shall be incorporated into future fire management strategies.

In NSW each fire fighting agency has separate radio communication systems, and they are not all compatible. During incidents the inability to communicate with other agencies has previously been identified as an issue. Methods employed to overcome this issue are:

- Installation of other agency radios in vehicles of key personnel;
- Use of communication vans or trailers with multiple radios;
- Other agency radios installed in control centres;
- Use of handheld radios tuned to other agency frequencies; and
- Use of UHF radios for local communications.

The Rural Fires Service has a radio network covering its areas of main operations. The penetration of this system into the Park is limited due to the terrain and therefore the RFS frequently use UHF particularly for between vehicle communications.

Other methods used include dividing tasks or sections of an Incident by agency to reduce inter agency communication requirements. Also the embedding of liaison officers with other agencies to act as a communications relay point may be employed.

Mobile phone coverage within the Park is patchy however the use of satellite phones to overcome this issue is increasing. Satellite phones are available at all major NPWS offices and depots.

Computer systems including email and internet are utilised extensively in fire management operations. All NPWS offices are connected via a Wide Area Network (WAN).

3.4.9 Strategies for the preparation of property

Buildings and built assets at medium or greater risk from bushfires that are within the Park have been identified in Appendix 3. Pre-emptive planning and preparation of buildings in the lead up to each fire season can mitigate the potential damage to or loss of structures from radiant heat and ember attack. Ember attack is one of the main ways that buildings are set alight during bushfires and can be a threat to a structure before, during and for up to eight hours after a fire (CFA, 2004). Other threats to structures include radiant heat and direct flame contact. In each case the distance of the structure from the heat or flame source is a key factor in determining whether or not a structure may survive a fire.

Village Protection Plans which identify implementation of APZ standards and implementation of pre season preparation actions contribute to the protection of assets from damage by fire. Pre season preparation actions can also be applied to all built assets in the Park.

The Kosciuszko National Park Plan of Management (2007b pg 196) requires NPWS to ensure that fire protection strategies (Village Protection Plans) are prepared by leaseholders for all lease areas which includes all of the resort areas. Village Protection Plans will be required to be prepared for all Alpine resort areas as defined by the SEPP (Kosciuszko National Park – Alpine resorts) 2007, and those additional locations within the Park where the risk rating is medium or greater as listed in Appendix 3 and/or where resident populations occur throughout the year. Due to the large number of individual leases in some resort areas where head leases do not exist, a process involving stakeholder consultation shall be undertaken to determine an appropriate method to develop a Village Protection Plan for those areas. Such plans are required to be consistent with this fire management strategy and are required to be prepared or updated where they exist, by lessees, for:

- Sponars Chalet Alpine resort
- Kosciuszko Mountain Retreat Alpine resort;
- Ski Rider Alpine resort;
- Perisher Range Alpine resort;
- Thredbo Alpine resort;
- Charlotte Pass Alpine resort;
- Mt Selwyn Alpine resort;
- Bullocks Flat Alpine resort
- Guthega;

It is noted that there is potential for Village Protection Plans to be able to address some of the standard requirements of Bush Fire Safety Authorities issued by the RFS for development proposals. To realise this potential and to ensure a consistent approach, further negotiations between NPWS, Department of Planning and the NSW Rural Fire Service are recommended.

In addition, NPWS will prepare and implement a Village Protection Plan for the Waste Point residential and works depot area.

Several fire related plans and strategies, all in draft form, have been prepared in the past for Thredbo. These adopted a range of strategies to mitigate the risk of bushfires affecting assets and hence provide a basis for the development of new Village Protection Plans. Such strategies shall be developed as soon as possible once this strategy is approved and, in the future, shall be updated at the same time that this KNP Fire Management strategy is reviewed and/or updated.

Village Protection Plans shall take account of the following as a minimum:

- Planning for Bushfire Protection (RFS, 2006), and other plans e.g. DISPLAN and processes developed locally;
- Asset protection zone guidelines (RFS, undated);
- Various RFS home preparation guidelines (available at www.rfs.nsw.gov.au);

- Overall structure of the plan shall be written in the context of Prevention, Preparedness, Response and Recovery;
- A detailed risk assessment using the RFS risk assessment methodology involving a detailed analysis of fire history, vegetation types and topography;
- Proximity of contiguous flammable vegetation to the asset as per APZ guidelines;
- Access and egress routes;
- Adequacy of fire protection equipment including an assessment of the quantity, type and location, and the adequacy of training of personnel in use of such equipment;
- Availability, location and standard of fire fighting equipment;
- Identification of special needs e.g. elderly, children etc, and any high visitation facilities;
- Development of specific strategies for fuel management within lease or precinct areas to meet asset protection zone standards;
- Consultation with relevant agencies e.g. NPWS, Police, NSW Fire Brigades, Rural Fire Service;
- Determine evacuation procedures, responsibilities and safe refuges in consultation with relevant agencies;
- Equipment maintenance and preparedness schedules;
- Education and training (where required) of residents and staff to assist with the adequate protection of life and property from bushfire threats; and
- A checklist of required pre season actions to mitigate threat from bush fires.

Pre Season Actions

A number of actions taken prior to the commencement of each fire season can improve the survivability of buildings and other assets. Specific actions include:

- Clear all vegetation and other combustible material from under, within and up to 2 metres from the structure/feature e.g. long, dry grass, dead leaves and branches, thick undergrowth;
- Mow and water (if possible) grassed areas regularly;
- Remove dry leaves and other garden litter from the roof and guttering;
- Remove flammable liquids from around buildings;
- Regular checks of fire fighting equipment to ensure it is in good working condition;
- Fill all gaps in walls and roofs, and underneath buildings and reduce the risk of ember attack by fitting fine wire mesh over gaps;
- Screen vents into the roof space and under floor areas with fine wire mesh;
- Maintain local fire advantages such as access routes and fuel breaks e.g. keep such areas clear of fuels and overhanging limbs; and
- Check water, taps and hoses are in good working order.

The pre season actions identified above shall be implemented by all lease holders and staff living in all accommodations within the Park and the actions shall be undertaken immediately before and then periodically throughout the fire season. Where accommodation is being rented from NPWS such as at Waste Point, the rental agreements may be amended to ensure that the onus for maintenance of Asset Protection Zones rests with the tenant. Actions required as a result of implementing Village Protection Plans and pre season actions that require the removal or modification of vegetation or habitat e.g. rocks, fallen timber, shall be subject to the approval of such works by the Area Manager.

Cabramurra is a Snowy Hydro Limited (SHL) asset, identified in the Snowy Park Lease, with a permanent resident population. This strategy recognises that the maintenance of Cabramurra as an asset, for the purposes of bushfire protection and mitigation of risks is addressed in Chapter 3 and associated annexure of the SHL Emergency Management Plan (EMP). Chapter 3 of the EMP provides for a range of measures and risk mitigation processes for general SHL asset protection similar to those required for a VPP. Accordingly a separate VPP is not required to be prepared for Cabramurra.

3.4.10 Strategies for preparedness of huts

Huts are particularly vulnerable to ember attack due to the construction materials (predominantly wood), their large number of openings where embers can easily lodge, proximity of vegetation to the hut and their remote locations.

NPWS shall implement the recommendations of the Kosciuszko National Park Huts Conservation strategy (Godden *et al*, 2005). Key recommendations of this strategy related to fire management and huts include:

- Fuel breaks shall be defined and maintained;
- Fuels shall be routinely reduced around huts;
- Each HAS (Heritage Action Statement) shall include risk assessments;
- Inspect integrity of fuel breaks, levels of grass, shrub and tree fuel loads near huts;
- Cut grass, clear fuel breaks, and prune trees in accordance with relevant Heritage Action Statements.

Heritage Action Statements are currently being prepared for all huts within the Park. Such future assessments will include a detailed bushfire risk assessment and strategies to mitigate bushfire risk. The risk assessment of cultural heritage assets indicated that a number of huts were at medium risk and one hut was at high risk (Appendix 4) and this assessment should be used as a guide to prioritise further detailed risk assessment around the huts.

It is proposed to carry out a more detailed risk assessment of prioritised huts to determine vegetation management measures that can be carried out to mitigate the risk of ember attack, direct flame contact and radiant heat. Such risk assessments will be carried out in consultation with interested stakeholders including the Kosciuszko Huts Association. The outcomes of the proposed detailed risk assessments of individual huts may include designating and therefore implementing the standards of APZs around some huts. Potential management measures may include controlling vegetation using herbicides, and consideration of creating low fuel areas immediately around huts.

3.4.11 Fire control advantages

Within the Park, a range of permanent, natural and temporary fire control advantages exist that help to minimise the potential for the spread of bush fires from or into the Park. Fire advantages are also shown on the operations maps. Control lines constructed during the course of fire suppression operations will generally be linked with natural or temporary control advantages to provide complete containment of a fire. The following sections define the different advantages, their characteristics and considerations.

3.4.11.1 Permanent advantages

Table 28 summarises the permanent control advantages within the Park. NPWS works cooperatively with BFMCs to ensure that an effective permanent fire control advantage infrastructure is in place to minimise the potential for the spread of fires from or into the Park.

Table 28 Permanent fire control advantages

Control advantage	Characteristics & Considerations
Fire Management Tracks and Trails	• The five main public sealed roads through the Park are the Snowy Mountains Highway, Alpine Way, Elliott Way, KNP5 (Cabramurra or Tooma Rd) and Kosciuszko Road. Other public access routes and management trails across the Park are also useful as fire control advantages depending on fire weather conditions; • All roads, management tracks and trails within the Park are listed and maintained according to BFMCs Fire Trail Registers; • Dormant trails and walking tracks may be used as control lines for containing low intensity fires. However, prior to operations commencing, crew safety and probability of success must be assessed against track characteristics such as track/passage condition, width, vegetation, time since construction or maintenance

Control advantage	Characteristics & Considerations
	and the remoteness.
Power-line easements	• There are many power-line easements (including 330kV) traversing the Park, which may be used as advantages where no alternatives are available. In some areas, easements cross water bodies, gorges and steep ravines and may have discontinuous areas of cleared vegetation. Advantages identified on maps only identify areas with grassland or minimal vegetation where fuels are likely to be low; • Consideration shall be given to decommissioning powerlines prior to using easements as fire suppression advantages; • Easements may be linked into natural advantages, tracks and trails, hand tool lines, wet lines or retardant lines; • Crew safety must be assessed where there is a possibility of electricity arcing in dense smoke. There are extreme risks involved in using powerlines as fire control advantages and strict guidelines must always be adhered to when fighting fires near power lines.
Other cleared areas	• Cleared areas include disturbed vegetation with sparse regeneration, some picnic and camping areas, and open areas which may impede the path of progressing fire; • Other advantages include car parks, large bitumen areas, quarries, and previous control lines; • Some remote clear areas may also be used for helipads for inserting remote fire fighting crews.

3.4.11.2 Natural advantages

In general, natural fire advantages are associated with contiguous areas of low bush fire behaviour potential. These result from either low fuel loads or high moisture levels that will largely contain a moderate intensity fire with minimal effort under appropriate conditions. A description of such advantages and their limitations are outlined in Table 29 below.

Table 29 Natural fire control advantages

Control advantages	Characteristics & Considerations
Drainage lines and rivers	• The main rivers within the Park include the Eucumbene, Burrungubugee, Goobarragandra, Goodradigbee, Murrumbidgee, Murray, Snowy, Swampy Plain, Thredbo, Tooma and Tumut headwaters and catchments; • The effectiveness of drainage lines depends upon ground saturation or whether the bed is sand or stone (rather than vegetation litter) that will impede fire crossing the line; • Drainage lines are unlikely to contain high intensity fires under severe conditions due to the higher likelihood of spotting; • Drainage lines are most effectively used with aerial incendiary operations in milder conditions.
Water bodies	• Numerous permanent water bodies exist within the Park. The most sensitive of these water bodies are the alpine lakes (restricted access and use); • Larger water bodies are part of the significant catchments for drinking water, irrigation and the holding facilities for hydro-electricity generation where operations such as use of fire fighting chemicals are restricted; • Major water bodies may be used as control lines, however depending on recent rainfalls the volume of water present may vary greatly, resulting in lower water levels which may extend travel time to access the resource and or reduces the effectiveness of this resource as a control advantage, particularly around the edges.

Control advantages	Characteristics & Considerations
Cliff lines & escarpments	• Within the Park there are some major cliffs lines, outcrops, scree slopes, surface rock and rock/boulderfields that may form natural barriers and prevent the spread of bush fires under moderate conditions. Some of these areas can be used to link other temporary control lines such as hand tool lines, wet lines, retardant lines or dozer lines; • The hazards with cliff lines and scree slopes make them difficult to mop up and patrol; • In some cases, sheets of rock may also be used as heli-pads for inserting remote fire fighting crews.
Vegetation	• Alpine areas, subalpine plains and grasslands can provide some advantage under mild conditions; • Rainforests and moist steep gullies may provide a control advantage under mild conditions with effectiveness being dependant on ground and fuel moisture conditions, and prevailing weather; • Fire suppression shall aim to minimise the effect on the vegetation by planning backburns or aerial ignitions when fuel moisture levels are increasing such as in early evening or at night.
Recent fire history	• Recently burnt areas may assist with containment. Their effectiveness is limited by their depth, the level of fuel reduction, the vegetation type and regrowth, recovery time for fuel hazard and the spotting potential and spotting distance of approaching fire; • There is a period of 1 to 5 years where fuel levels are generally low enough to provide a fire suppression advantage.

3.4.11.3 Point advantages

Other advantages include water availability points (both helicopter and vehicle accessible), fire detection viewing points, helipads, radio towers, airbases, control centres, staging areas and safe areas. Point advantages are shown on the operations maps and described in Table 30.

Table 30 Point advantages

Control advantages	Characteristics & Considerations
Fire detection towers	• These include the primary viewing vantages of Youngal, Blackjack, Ingebyra and Talbingo fire towers; • Detection can also be gained from public viewing lookouts within and overlooking the Park, and a range of other high points identified on the day according to need; • Radio towers provide coverage over the Park and may provide further vantage points;
Vehicle water points	• Fire fighting vehicles may draw water from a number of natural features such as rivers and creeks.
Helicopter water points	• Helicopters can source water from natural features such as rivers and water bodies when retardant or foam is not being used or constructed features such as dams or temporary buoy walls; • Helicopter water access points are often not available in remote areas and may require prolonged turn around times.
Airbases and helipads	• NPWS manages specific helipads at the Waste Point & Blowering Works Depots. There are also numerous grassland areas and some old air-strips that are suitable for temporary operations; • Remote helipad locations include natural openings such as rock outcrops supplemented with minor tree removal or already cleared camping areas.

3.4.11.4 Temporary advantages

Temporary control advantages may be constructed where permanent advantages or natural advantages are not considered suitable for containment of a fire or prescribed burn. Temporary

control lines include dozer lines, hand tool lines, wet lines and retardant lines. Guidelines for these are included in the Operational Guidelines in Table 32.

3.4.12 Potential control lines

Potential control lines have been identified in previous fire seasons in response to particular fires. The exercise, using local knowledge, determined the most appropriate locations for some future potential control lines, estimated the amount and location of possible work required, the plant required to do the work, and an estimate of costs at the time. Determination of potential control lines is a joint exercise involving NPWS, RFS and local knowledge holders. Potential control lines may utilise fire trails, roads, walking tracks, power line easements, low fuel areas and temporary hand tool lines and dozer lines. Potential control lines may be used for implementing back burns under moderating conditions. An assessment of any identified potential control lines is essential prior to construction, as conditions may have changed from the time they were identified to the time of need. NPWS will continue to contribute through the BFMCs, to the identification of additional pre-planned potential control lines in the future.

3.5 Bush Fire Response Strategies

3.5.1 Incident management

Procedures for incident management including reporting and documentation requirements are outlined in the NPWS Fire Management Manual (NPWS, 2007a) and RIPs.

All fires are required to be reported using Situation Report forms in the first instant. As a fire escalates, an IMT may be appointed. The IMT will prepare an Incident Action Plan, detailing suppression operations. The type of plan will be in accordance with the size and complexity of the incident and will include suppression objectives, strategies, tactics, tasks, an incident map, list of resources and organisational structure. IMT structure and functions are detailed in the NPWS Fire Management Manual (NPWS, 2007a).

3.5.2 Response to ignitions

NPWS remains committed to maintaining local capability for rapid response to reports of ignitions. NPWS maintains various states of readiness according to the FFDI on the day as outlined in the RIPs. Response to reports of a single ignition is immediate using locally available and prepared resources with any necessary additional resource requirements being allocated once the extent and behaviour of the ignition is known. Response may be by ground crews or RAFT teams depending on accessibility. In most cases initial response requires immediate aerial support due to the rugged terrain and remote access. Under nearly all unplanned fire conditions within the Park, aerial support is essential to slow forward rates of spread until ground crews can mount direct or indirect strategies as the situation requires.

Response to multiple ignitions such as may occur in wide spread lightning storms may require the calling in of staff off duty and from out of area. In such circumstances most resources will be required to be readily available and fully prepared for rapid response.

3.5.3 Major suppression strategies

NPWS in cooperation with other authorities may implement a wide range of strategies, often in combination, to suppress bush fires. These include early detection using fire towers and patrols, supplemented with aerial reconnaissance. A range of offensive suppression strategies will be implemented including direct, parallel or indirect attack; and defensive strategies such as backburning and property protection. All fires will be mopped up and patrolled to minimise any possibility of re-ignition.

Selection of appropriate strategies depends on the remoteness of ignitions, the proximity of fire to vehicle access, terrain, fuel loads, weather conditions, predicted fire behaviour, availability of

resources, an assessment of the threat to assets including natural and cultural heritage assets such as cultural sites and threatened species. Broad strategies for suppression are detailed in Table 31.

Management guidelines have been prepared to minimise the impacts of fires and fire suppression operations on a range of natural and cultural heritage values. These guidelines are presented in various appendices in this strategy and the operations guidelines AO sheet and shall be referred to in all fire suppression operations. Occasionally, fire suppression objectives may require the use of more aggressive tactics than recommended in the management guidelines in order to protect life, assets, property, and other natural and cultural heritage values. Such decisions and the reasons justifying them shall be recorded by the Incident Management Team at the time.

Table 31 Major strategies and tactics to suppress unplanned bush fires within the Park

Location of fire	Risk	Fire danger	Strategies	Tactics	Factors affecting the choice of tactics
Remote fires in inaccess-ible terrain	Escalation of remote area fires can result in extended campaign fires and significant areas of the Park being burnt.	Very High to Extreme	• Fire detection by ground and aerial reconnaissance; • Direct aerial attack followed by insertion of Remote Area Fire Fighting Teams (RAFT) if safe; • Fallback to established control lines; • Property protection; • Other strategies as required.	• Maintain fire tower observation and undertake patrols of known high risk areas; • Undertake aircraft patrols especially after lightning; • Aircraft water bombings, with ground crew support, to slow ROS and reduce fire intensity; • Use of retardants if possible; • Ground crew insertion when safe; • Construction of control lines by hand or dozer; • Backburning from identified control lines.	• Fire behaviour; • Level of remote access, steep terrain and proximity of fire to assets; • Travel time for aircraft and turn around times to water; • Resource availability; • Preservation of water quality; • Communications.
		Low to High	• Monitor fire progress and conditions and suppress if assets are threatened; • Undertake strategies as above.	• As above.	
Fires in terrain accessible by vehicle or on foot	Escalation may have imminent impacts on life, property and conservation values	Very High to Extreme	• Fire detection by ground and aerial reconnaissance; • Direct Aerial attack; • Direct or indirect attack with vehicle based ground crews; • Fallback to established control lines and property protection; • Other strategies as required.	• Maintain fire tower observation and undertake patrols of known high risk areas; • Undertake aircraft patrols especially after lightning; • Backburning from identified control lines; • Aircraft water bombing with ground crew support, to slow ROS and reduce fire intensity; • Use of retardants or foam if possible; • Aerial incendiary in appropriate conditions along natural advantages to deepen backburns.	• Fire behaviour; • Ground crew access; • Vehicular access; • Communications; • Resource availability.

		Low to High	• As above; • Ground crews able to walk into fire if safe.	• Hand tool lines; • Backburning from identified control lines; • Aerial incendiary in appropriate conditions along natural containments to deepen backburns.	

3.5.4 Suppression operational guidelines

The NPWS Fire Management Manual (NPWS, 2007a) provides the comprehensive operational framework for managing fires on NPWS estate. This Manual is consulted as part of operational planning for all fires. Further operational procedures and guidelines are outlined in the RIPs. Table 32 outlines the major suppression operational guidelines that will be adhered to by all fire fighting personnel working within the Park.

Table 32 Summary of suppression operational guidelines

Note: FMM refers to the NPWS Fire Management Manual

Functional area	Suppression operation Guidelines
Command, control and fire fighting arrangements fire response (FMM 4.1, 4.2 & 4.4)	• The first responding fire authority to arrive at a fire on NPWS managed lands may assume control of the fire, and direct fire control activities until a competent NPWS officer assumes control (unless prior agreements have been made). The first authority in control must make all practical arrangements to ensure that NPWS is notified of the fire as soon as possible. • The initial incident controller will consult with other agencies on the ongoing command, control and incident management team requirements as per the relevant BFMC Plan of Operations. • The use of earth-moving equipment and aerial suppression in first attack must be approved by a senior NPWS officer (FMM 4.4).
Aircraft operations (FMM 4.5)	• The use of aircraft must be authorised by senior NPWS officer and managed in accordance with NSW Fire Agencies Aviation Standard Operating Procedures. • Aerial water bombing and aerial ignitions are permissible in the Park, however this can only commence on the instruction of the incident controller or senior NPWS officer. • Aircraft may be used for aerial water bombing, laying suppression chemicals, deploying remote area fire fighting crews (particularly in remote areas), as well as for reconnaissance and fire mapping. • Water bombing will be avoided directly over cultural heritage sites unless no alternative exists. • Pilots must be briefed on the location and type of powerlines within incident operation area. • Water bombing operations shall support containment operations by aggressively attacking hotspots, spot-overs and head fires where required. • Where possible, foams shall be used to increase the effectiveness of water, however limit use within 50m of watercourses and dams and areas where surfactants and or retardants are restricted. • No equipment contaminated with foams, surfactants or retardants shall be used in alpine glacial lakes. • The use of water bombing aircraft without the support of ground based suppression crews shall be limited to specific circumstances as determined by the senior NPWS officer. • Ground crews must be briefed and alerted to aerial ignition and water bombing operations.

Functional area	Suppression operation Guidelines
Burning Operations (FMM 4.9)	• The control and command of all burn operations will be in accordance with the ICS and all personnel participating in the burn operations must be accredited to undertake assigned tasks. • Burning operations will be planned and conducted according to Incident Action Plans during fire suppression and action plans prepared within the Prescribed Burning Plan. Any changes must be approved by the Operations Officer. • Temperature, relative humidity and wind speed and direction must be monitored carefully to determine the safest time to implement backburns. Generally, when FFDI is VH or greater, including forecast trends, burning should commence when the humidity rises in late afternoon or early evening and spotting is minimal. With a low FFDI, including forecast trends, burning may be safely undertaken during the day. Consideration must be given to the ability to control fire within designated control lines. • Monitor diurnal trends to avoid implementing backburns or prescribed burns when the relative humidity is lower than the temperature. • All crews must be briefed on the sequence and safety precautions of the operation. Consider posting lookouts to monitor the progress of the fire and location of fire crews. • Where practicable, clear 1m radius around dead (standing or fallen) and ribbon/fibrous barked trees adjacent to containment lines prior to burning, or wet down these trees as part of the back burn ignition preparation.
Chemicals – Fire Suppression Chemicals (FMM 4.11)	• Wetting agents, retardants and foam may be used for unplanned fire suppression in the Park. • Retardants shall only be used where there is a high probability that the use will be successful and only with the approval of a senior NPWS officer. • Preference shall be given to using retardants based on ammonium sulphate. • Exclude the use of wetting agents and surfactants within 50m of alpine bogs, water courses and alpine peat lands. • No chemicals or equipment contaminated with chemicals shall be used in the Alpine glacial lakes. • The use of chemical retardants, surfactants and foams in karst areas shall be kept to a minimum and are only to be used where no alternative suppression option is available. • Refer to Threatened Species guidelines for information on use of chemicals at or near threatened species locations. • The use of equipment contaminated with foam and retardants shall be avoided, where possible, if water is being sourced from water supply dams and private water supplies (i.e. contamination of dams must be actively avoided). • Retardant lines will be most effective where there is minimal or open canopy and a high probability of the retardant laying on the surface fuels. • Use of fire suppression chemicals must be mapped and recorded as part of the fire history and fire management of the Park.
Control lines (FMM 4.10)	• New containment lines shall be constructed with minimal environmental impact. • Existing constructed or natural fire control advantages or previous control lines, shall be used, wherever possible, to contain bushfires. • As a minimum, management trails identified on the operations map are maintained to a standard to provide access to Category 9 units, unless otherwise specified. • Handline construction with hand tools, air blowers or slashers will be the preferred method of constructing control lines particularly within Wilderness areas, water catchment areas and priority habitat areas generally when fires are smaller than 2-3 hectares and under low-moderate FFDI conditions. • All machine constructed control lines must avoid threatened species locations, specified priority habitats, cultural heritage sites and areas prone to erosion. • Control lines running along valley areas shall be constructed at least 50m from gullies to avoid erosion and to protect sensitive riparian zones, where possible. • Wet-lines can be used as temporary advantages and are the preferred method of control lines through threatened species locations, cultural heritage sites and areas prone to erosion in mild fire weather conditions.

Functional area	Suppression operation Guidelines
Earth moving machinery (FMM 4.4)	• Use of earthmoving equipment for all fires on NPWS managed lands must have approval from the Regional Manager or other senior NPWS officer before implementation, and then only if the probability of success is high. • Earth-moving equipment must always be supervised and guided by an experienced NPWS officer or a person recognised to be appropriately experienced. • All earthmoving equipment must be accompanied by a support vehicle that has equipment available to contact support personnel in an emergency. Plant involved in direct or parallel attack must be accompanied by either a slip-on or a fire tanker for safety purposes. • At the commencement of shifts, all operators and guides must be briefed on safety considerations and actions to prevent damage to sensitive natural and cultural heritage. • Personnel involved in construction of containment lines by earthmoving equipment shall consider the protection of drainage features, take account of soil stability and erosion potential, and observe all other NPWS guidelines including threatened species and cultural heritage guidelines. • All equipment used at night must have appropriate lighting. • All earthmoving equipment shall be washed down prior to entering the Park in order to prevent the potential relocation of weeds and pathogens. • Seek local advice about locations of Weeds of National Significance that may be spread by fire suppression plant, and establish protocols to minimise potential spread. • Use of earthmoving equipment in alpine and subalpine environments shall be limited to existing trails and roads or to ecotones between grass and herb fields and treed areas where possible. • Use of earth moving equipment within alpine and subalpine grasslands and herb fields may be permitted in exceptional circumstances where control of a fire depends on such use and no other alternatives are available. • If dozer lines are unavoidably placed in snow grass/herbfield areas then the dozer operator shall be instructed to peel the surface layer back to mineral soil depth in one pass, where possible, to allow more effective rehabilitation.

Post fire rehabilitation (FMM 5.1 & 4.10)	• Rehabilitation shall only commence once a fire edge has been declared out or is considered completely and safely blacked out.
	• Where practicable, containment lines shall be stabilised, rehabilitated and closed (if not required for other purposes) as part of the unplanned fire suppression operation and prior to the cessation of the incident.
	• Where required, undertake pest and weed control programs as part the control line rehabilitation program to control pests and weeds spreading as a result of construction works.
	• Maintain, as far as possible, unburnt buffer zones adjacent to creek lines and rivers when implementing prescribed burn and backburning operations;
	• Initiate post fire survey work to determine which areas are potentially at risk of soil erosion and land slippage.
	• Implement soil remediation works in areas identified as being at risk of erosion and land slippage where this potential is a result of previous earthworks e.g. trail and road works, former SHL sites.
	• Use unplanned fire suppression strategies to minimise the intensity of unplanned fires within 50m of stored waters and major inflows.
	• Utilise all available methods to address eroded areas and to protect water quality values including:
	  • installation of cross drains over control lines to prevent runoff;
	  • laying filter cloth and/or straw bales to intercept sediment in locations identified as having critical impacts;
	  • in consultation with SHL, consider use of floating booms in waterways to capture floating debris.
	• Refer to the Fire Management strategy for more detailed guidelines on rehabilitation.

Functional area	Suppression operation Guidelines
Safety (FMM 1.9 & 3.5)	• Evacuation of visitors threatened by fire shall be the highest priority. (Refer Appendix 2 and visitor safety maps for locations and potential numbers). • The Park or parts of the Park may be closed to the public during periods of extreme fire danger or during fire suppression operations. • Visitors will not be permitted into areas where fire suppression or prescribed burning operations are being undertaken, unless approved by the Incident Controller. • Fire fighters and fire management activities must consider the safety and welfare of all involved personnel.
Water Supplies (FMM Table 5)	• Consideration must be given to establishing buoy walls early in suppression operations where water supplies are limited. • Arrangements may be made by the Incident Controller to replace private water supplies used in suppression operations. • Where private dams are the only source of available water, negotiate with or advise the dam owner prior to use, where possible, and provided suppression objectives are not compromised. • The use of equipment contaminated with foam and retardants shall be avoided, where possible, if water is being sourced from water supply dams and private water supplies (i.e. contamination of dams must be actively avoided). • Water may not be sourced from the Alpine glacial lakes.

3.5.5 Strategies to protect life

Fires in the Park in very high to extreme FFDI conditions can pose a significant risk of damage to life and property within and adjacent to the Park. The protection of life and property is dependent on a wide range of strategies and cooperation between agencies, local government, the community and neighbours.

3.5.5.1 Protection of visitors

Major strategies to protect visitors include:

- Closure of all or part of the Park during Total Fire Bans, periods of forecast very high to extreme fire danger, or during bush fire management or suppression operations;
- Instigating Park fire bans over part or all of the Park during prolonged periods of dry conditions, and when Total Fire Bans are in place;
- Notify relevant emergency services and other organisations of access restrictions during park closures and suppression operations;
- Liaising with and disseminating information to tour operators and tourism authorities regarding, Park closures, access closures, total fire bans, Park fire bans and DISPLAN evacuation procedures;
- Identify visitor locations threatened by impending fire in the short and long term by reference to Visitor Safety Maps and Appendix 2;
- Notify Police of evacuation requirements and locations;
- Cooperatively assisting in DISPLAN procedures for the evacuation of visitors from the Park in conjunction with other emergency services; and
- Place advisory signs in prominent locations at key access points notifying of park closures, access restrictions and/or suppression operations in progress;
- Preparation of Village Protection plans will provide additional information that may be utilised to assist in the protection of life and property in built up areas within the park including Alpine resort areas and Waste Point. Reference shall be made to these plans, for location specific guidelines, that may assist during fire suppression operations.

3.5.5.2 Protection of neighbours

Major strategies to protect neighbours include:

- Maintaining local databases of contact details and asset locations to ensure timely contact and warning;

- Cooperating with neighbours, other fire fighting agencies and land managers in fire suppression and assisting BFMCs in community fire prevention planning;
- Assisting fire strategy and evacuation planning for in-holdings in remote areas;
- Providing face to face contact at visitor information centres and making publications available to the public;
- Identifying neighbouring properties threatened by impending fire in the short and long term;
- Advising neighbours and visitors of the actions required during fire bans, Park closures and other fire management operations through appropriate community education, signage, media, liaison with tour operators, and face to face liaison; and
- Referring to Village Protection Plans for Alpine Resort areas and Waste Point, for location specific guidelines that may assist during fire suppression operations.

3.5.5.3 Protection of fire fighters

Major strategies to protect fire fighters include:

- Ensuring compliance with safety directions provided in the NPWS Fire Management Manual (updated annually);
- Undertaking a thorough evaluation of the possible risks to fire fighters and support personnel before deploying crews onto the fire ground;
- Ensuring all personnel are provided with fire fighting equipment that complies with Service standards, and Australian and International Occupational Health and Safety Standards;
- Ensuring the presence of safety advisers on the fire ground where required;
- Preparation of a Medical Evacuation Plan detailing first aid procedures, evacuation procedures, hospital and ambulance locations within the Incident Action Plan;
- Ensuring fire fighters are assigned to duties that are within their physical capabilities (TBA level), skill level and level of experience;
- Providing critical incident stress support services including counsellors and peer support when required;
- Ensuring other persons (including wildlife carers, non-firefighting volunteers, and the media) have gained the permission of the Incident Controller, are accompanied by a fire trained officer, and have the minimum basic personal protective equipment prior to entering the fire ground;
- Annual review of staff competency levels and facilitating additional training where necessary; and
- Where backburning or other suppression operations are proposed in the vicinity of major powerlines, ensure all staff are briefed on “Working Safely round Powerlines”.

The presence of powerlines, many of very high voltage and near to the ground, is a particular safety and fire management issue for suppression operations. Where backburning or other suppression operations are proposed in the vicinity of major powerlines, there is increased potential for arcing to ground which could injure fire fighters or cause the power system to fail. In the past it has been necessary to shut down certain sections of major powerlines for limited periods. Such action has only been undertaken in major fire events and requires various approvals to occur.

3.5.6 Strategies to protect property

Without adequate protection, there is a possibility of damage to assets from bush fires. Research has shown that a well prepared property has a far greater chance of survival than a poorly prepared property. Where an asset is directly threatened by imminent fire, that asset may become the highest priority for protection depending on the level of threats to other possibly more valuable assets. Such protection may include allocation of fire fighting resources to the asset and water bombing from aircraft.

Residents may also take a range of actions to protect themselves and built assets from unplanned fire. Some of these actions include:

- Block down pipes with plastic bags filled with sand/earth or plugs, and fill gutters with water;
- Wet building, especially where there are crevices in structure that sparks could enter;

- Dampen ground around building and garden;
- Keep windows and doors closed to prevent embers from entering;
- After a fire has passed be prepared for the ember attack and begin hosing down structure;
- Fire trails surrounding area serve as fuel break;
- In case of a fire, bomb with fire fighting foam;
- Burn out fuels in immediate vicinity of asset.

Reference shall be made, during fire suppression operations, to Village Protection Plans for Alpine Resort areas and Waste Point, for location specific guidelines that may assist during fire suppression operations.

In addition to the above and generally only under conditions of imminent threat, backburning by fire fighters may be utilised immediately around assets to remove the fuel loads.

Scientific sites and basic management guidelines are identified on operations maps. Contact details for managers of scientific sites are available in regional datasets. In the event of a fire threatening a scientific site, the contact person for that site may be contacted, where possible, to ensure that values are protected from fire and suppression operations.

Engineering structures along the Alpine Way including gabions and wire netting, shall be protected from fire for up to 15m distance from the structure where practical.

RTA Engineering infrastructure above the Alpine Way at Thredbo is identified on operations map 6 for protection from all fire for a distance of at least 250m from the Alpine Way.

A range of rehabilitation sites, predominantly former Snowy Hydro Limited sites, exist within the park. Considerable resources have been invested in rehabilitating these sites and therefore these sites are a high priority for protection from fire and damage resulting from suppression operations. Such protection shall be required at least until the revegetation is of an age class where it can regenerate naturally following a fire event. Rehabilitated sites are identified on operations maps for protection. Rehabilitated sites shall be protected from all fire. Use of earth moving equipment shall be avoided in all rehabilitation areas.

A wide range of NPWS infrastructure including toilets, barbecues, picnic tables, interpretive signs, bollards, signs, gates etc exists in camping grounds, track heads, and other visitor facilities. Actions to minimise impacts of fire and suppression operations on such assets may include identifying assets early during operations, raking fuel away from assets such as signs, and applying other tactics mentioned above for other property.

3.5.7 Protection of smoke sensitive areas

Strategies to minimise the impact of smoke generated from prescribed burns and unplanned fires within the Park include:

- Implementing the BFCC Smoke Management policy 3/01 “Smoke Management” including:
    - Where practical and safe to do so (e.g. small scale burns along road edges or property boundaries, and pile burns) aggressive mop-up procedures (e.g. maximum use of water and the breaking up or dousing of large fuel particles such as logs and stags) will be applied so as to minimise the smouldering phase of combustion at times of poor atmospheric dispersion;
    - The use of backing fires (i.e. fires burning down slope and/or against the prevailing wind direction) is encouraged as an operational technique to maximise combustion and minimise smoke emissions;
    - When undertaking burning operations, burning crews should whenever possible, take advantage of weather conditions which optimise smoke dispersion without compromising other fire management objectives;

  - Where safe to do so, lighting techniques and patterns will be used that reduce the smouldering phase of combustion and minimise burning of material during times of the day where atmospheric dispersion is poor; and
  - In smoke sensitive areas, smoke risks and management strategies will be incorporated in neighbour notification advice.
- Coordinating with Police, local councils, RFS and the NSW Roads and Traffic Authority (RTA) regarding visibility and closing roads;
- Installing smoke signs to give motorists warning of potential hazards subject to approved traffic plans and approvals from NSW RTA where required;
- Provide media with information on remote operations where smoke could cause concern for visitors and community;
- Maintaining strong lines of communication with local grape growers when proposing to implement prescribed burning and back burning operations;
- Appropriate prescriptions for fuel moisture content, wind speed and direction, atmospheric stability will be included within prescribed burn operational burn plans, to reduce the risk of bushfire smoke impacts on smoke sensitive areas; and
- Prescribed burns will be programmed so as to minimise periods where the co-incidence of prolonged poor dispersion conditions and the risk of fog, brown haze or photo-chemical smog events is high.

3.5.8 Public and media relations

NPWS will seek community support, through the BFMCs and IMTs, when determining objectives, strategies and actions for suppression operations. Strategies to foster positive public and media relations for major incidents include:

- The appointment of a media liaison officer during incidents to coordinate public and media relations activities including liaison with relevant tourism authorities as well as traditional media; and
- Utilisation of the guidelines in the NPWS Public Information and the Management of Emergency Events (NPWS, 2003).

3.5.9 Strategies for natural heritage management

Within the Park there are significant natural heritage values that could be damaged by inappropriate fire regimes and fire management activities. The biodiversity fire regime thresholds specified for vegetation formations within the Park may not fully account for the specific requirements of threatened species. Fire management guidelines for threatened species, selected populations and priority habitats are included in various appendices where sufficient information is known. The precautionary approach will generally be applied in the absence of specific information by fostering a culture of opting for minimal impact fire suppression techniques where use of such techniques provides a reasonable chance of achieving fire suppression objectives.

3.5.9.1 Biodiversity fire regime thresholds

Communities affected by high fire frequency

In communities that are either sensitive to or are already affected by *high* frequency fire, a range of strategies will be implemented to facilitate recovery, including:

- Immediate response and rapid suppression of unplanned fires;
- Exclude fire until at least the minimum thresholds are reached for the majority of the area;
- Prescribed burning to develop a mosaic of fire ages and minimise the risk of successive severe fires once minimum thresholds have been reached; and
- Implement the provisions of any relevant Threat Abatement Plan.

Communities affected by low fire frequency

In areas where past fire frequency has been less than the specified fire regime threshold, strategies will be implemented including:

- The inrtoduction of appropriate fire into the vegetation communities to maintain ecological processes and an appropriate age distribution, if >50% of the community is in this state and;

- Where an ecological burn cannot be introduced at the threshold intensity safely, then wait for one to occur naturally. Consideration shall then be given to allowing a unplanned fire to remain unsuppressed subject to consideration of weather, asset protection and ecological objectives that may be achieved;
- Monitoring of long unburnt areas to identify if fire is needed shall be required prior to the planning to introduce prescribed burning proposals.

Wilderness areas
Major strategies to protect wilderness areas include:
- All fire management activities within declared wilderness areas will be carried out with minimal environmental impact and disturbance, where possible;
- Helipads, temporary trails and control lines will be rehabilitated unless identified as having future strategic value for fire suppression operations;
- Prescribed fire will be utilised within wilderness areas where essential for hazard reduction, unplanned fire suppression or to maintain specific natural or cultural heritage values;
- Fire trail networks will be reviewed systematically to ensure adequate access for fire fighting and property protection while maintaining the integrity of the wilderness areas; and
- Maintaining fire regimes within the biodiversity fire regime thresholds and threatened species guidelines.

3.5.9.2 Threatened flora, fauna and priority habitat management guidelines

It is generally not possible nor wise to implement specific fire regimes, or manage fire generally, solely for individual species. Many species are found within areas that have been identified as fire exclusion zones, or within priority habitat areas that have habitat guidelines. ROTAP species have been considered where these are also listed threatened species.

Known locations of some threatened species are shown on operations maps. Many fauna species are transient and thus specific locations should only be used as a guide that a species is in a particular geographic area. Simple guidelines are provided on operations maps to assist with minimising impacts of first attack suppression operations. Detailed guidelines for the purpose of planning and incident management are available for threatened flora and fauna species in Appendix 7 and Appendix 8. Incident controllers and prescribed burn planners are also referred to operations maps and relevant regional Geographic Information System layers to determine which species may be present in an area.

3.5.9.3 Priority habitat management guidelines

Priority habitats have been specifically identified that require special consideration during planning for prescribed burning and fire suppression operations. Strategies for the protection of priority habitats during suppression operations are listed in Table 33. Incident controllers and prescribed burn planners are also referred to Appendix 9, operations maps and relevant regional Geographic Information System layers to determine which habitats may be present in an area.

In the event of all Corroborree frog, Burramys and Mastacomys habitat being threatened at the same time (most likely to only occur under extreme fire weather conditions and simultaneous ignitions e.g. 2002-2003 fire season) the habitats are listed in priority order in the Geographic Information System databases to assist with decision making about which habitats to protect. Specialist advice from the Biodiversity Conservation Section – South Branch should be obtained early within fire suppression operations to assist with developing appropriate suppression strategies and prioritising allocation of resources to protect priority habitats.

Table 33 Priority habitat guidelines

Map ID commencing with EH refers to locations identified on operations maps, as well as in Figure 20 in the text.

Map ID	Priority habitat	Strategies
Polygon Fig 20 Not shown Fig 20	Alpine; Montane Peatlands and Swamps, &; Podocarpus lawrencii shrublands (included within all Burramys habitat polygons)	• Suppress all unplanned fire ASAP within and threatening this habitat. • Exclude all fire where possible for life of strategy. • Minimise all backburning. • Minimise use of all foams and retardants where possible. • Use of earthmoving equipment shall be limited to existing trails and roads or to ecotones between grass/herb fields and treed areas where possible. • Where dozer lines are unavoidably placed in snowgrass/herb field areas, the dozer operator shall be instructed to peel the surface layer back to mineral depth, where possible, to allow more effective rehabilitation. • No equipment contaminated with foams, surfactants or retardants shall be used in or within 100 metres of alpine glacial lakes. • Mechanical disturbance including use of dozers is restricted to within 50 metres of all alpine bogs and swamps, unless an essential requirement to contain a fire. • Minimise the use of any vehicles in sensitive alpine bog and swamp habitats.
EH2	All Burramys habitats including Burramys priority habitats	• As for alpine areas except: o use of foams and retardants to protect identified Burramys habitats is permitted; and o Construction of control lines within identified Burramys habitats is not permitted in any circumstances.
EH3	Mastacomys habitats	• As for alpine areas except: o Use existing water points only. Construction or disturbance to create new water points in Mastacomys habitat is not permitted; and o Construction of control lines within identified Mastacomys habitats is not permitted in any circumstances.
EH4	Southern Corroboree Frog habitats	• Protect from all wildfire wherever possible. • No prescribed burning permitted in identified habitats. • No mechanical disturbance within 50m of known habitats. • Avoid all backburning through identified habitats. • Use existing water points only. Construction or disturbance to create new water points in identified habitats is not permitted. • Construction of control lines within identified Corroboree frog habitats is not permitted in any circumstances. • Avoid use of foams and retardants in bogs, swamps and in sub alpine streams and stream banks.
EH5	Eastern Bentwing Bat habitats	• Avoid mechanical disturbance within 100m of known roosting and breeding sites in caves and man made structures. • Protect known roosting and breeding sites from flame and smoke entry where possible. • Avoid backburning within 100m of known roosting and breeding sites. • Avoid use of foams and retardants within 100m of known roosting and breeding sites. • No additional tracks/containment lines within 100m of known roosting and breeding sites. • During suppression operations and in mop up phase, prevent or remove blockages (e.g. fallen trees) in entrances to caves and known roosting and breeding sites.

Map ID	Priority habitat	Strategies
EH6	Rainforest habitats	• Exclude all fire where possible for life of strategy. • Avoid all backburning within this community. Backburning permitted adjacent to this community, as late as possible in the day to allow back burn to trickle downhill and go out. Use FMC differentials to advantage. • Use of foams and retardants permitted. • Avoid all mechanical disturbances.
EH6	Karst grassland habitats	• Unplanned fire and backburning is permitted in this community. • Use of foams and retardants is not permitted. • Avoid all mechanical disturbances. Restrict to existing roads and tracks as much as possible. If control lines are required limit to edge of identified locations where possible.
EH7	Bogong Peaks habitat	• Construction of control lines within habitat is permitted if essential to contain a fire, however minimise extent of disturbance. • Suppress all unplanned fire ASAP. • Avoid backburning within this habitat unless essential to contain fire. • Foam and retardant use on slopes permitted. Avoid use of all foams and retardants where possible in bogs and swamp areas.
EH8	Kosciuszko Ck Headwaters & Old Growth Ash (Manjar)	• Exclude all fire where possible for life of strategy. • Suppress all unplanned fire ASAP within and threatening this habitat. • Use hand tool lines only where possible if required. • Foam and retardant use permitted.
EH9	Mt Trooper	• Exclude all fire where possible for life of strategy. • Suppress all unplanned fire ASAP within and threatening this habitat. • Use hand tool lines only where possible if essential. • Foam and retardant use permitted. • Avoid all mechanical disturbances.
Polygon Fig 20	Subalpine Woodlands	• Backburning permitted. • Avoid use of foams and retardants in bogs, swamps and in sub alpine streams and stream banks. • Construction of control lines permitted.
Polygon Fig 20	Subalpine Treeless Plains	• Backburning permitted. • Minimise mechanical disturbance. Restrict to existing roads and tracks as much as possible. If required limit to edge. • Where dozer lines are unavoidable placed in snowgrass/herb field areas, the dozer operator shall be instructed to peel the surface layer back to mineral depth, where possible, to allow more effective rehabilitation. • Avoid use of foams and retardants in bogs, swamps and in sub alpine streams and stream banks. • Identify and map low risk water points. Use existing access points for water where possible and minimise disturbance to creek banks.
Polygon Fig 20	Alpine Ash Forests	• Exclude all fire where possible for life of strategy. • Minimise backburning in this habitat unless demonstrably essential to protect life and property. • Construction of control lines permitted.
Polygon Fig 20	White Box Yellow Box Woodland	• Backburning permitted. • Minimise mechanical disturbance.

Map ID	Priority habitat	Strategies
Not shown	Northern Corroboree Frog habitats	• (note: these 3-5 priority habitats have yet to be identified) • Protect from all wildfire wherever possible. • No prescribed burning permitted in identified habitats. • No mechanical disturbance within 50m of known habitats. • Avoid all backburning through identified habitats. • Use existing water points only. Construction or disturbance to create new water points in identified habitats is not permitted. Construction of control lines within identified Corroboree frog habitats is not permitted in any circumstances. • Avoid use of foams and retardants in bogs, swamps and in sub alpine streams and stream banks.

3.5.9.4 Catchment and soil erosion impacts

Some catchments have been identified as being at greater risk of soil erosion and landslide potential than others. The specific strategies for the protection of catchment values include:

- Maintain, as far as possible, unburnt buffer zones adjacent to creek lines and rivers when implementing prescribed burn and backburning operations;
- Initiate post fire survey work to determine which areas are potentially at risk of soil erosion and land slippage;
- Implement soil remediation works in areas identified as being at risk of erosion and land slippage where this potential is a result of previous earthworks e.g. trail and road works, former SHL sites;
- Use fire suppression strategies to minimise the intensity of unplanned fires within 50m of stored waters and major inflows;
- Utilise all available methods to address eroded areas and to protect water quality values including:
  - installation of cross drains over control lines to prevent runoff;
  - laying filter cloth and/or straw bales to intercept sediment in locations identified as having critical impacts;
  - in consultation with SHL, consider use of floating booms in waterways to capture floating debris.
- Conduct a risk assessment process following major bushfire events to identify areas within the burnt perimeter that are sensitive to potential soil erosion.

3.5.9.5 Scenic Landscapes & Tourism

Strategies to minimise the impacts of bush fires and fire management activities on the landscape's aesthetic values include:

- Employing minimal impact suppression techniques as part of operations in sensitive areas e.g. minimise use of earthmoving equipment adjacent to assets;
- Implementing a prescribed burning mosaic that is sensitive to scenic views and high visitation areas; and
- Implementing alternate fuel management strategies such as mowing in high visitation areas.

3.5.9.6 Weed and pest species impacts

Major strategies to minimise the impacts of fire regimes on the abundance and distribution of weed and pest species within the Park include:

- Washing down vehicles, particularly earthmoving machinery, before commencing operations within the Park;
- Seeking local advice about locations of weeds of national significance e.g. Orange Hawkweed, that may be spread by fire suppression plant, and establishing protocols to minimise potential spread;
- Undertaking post fire weed and pest species monitoring and control programs on a cooperative basis with other agencies and local community groups;
- Minimising the movement of vehicles or hand crews from weed infested to natural areas;
- Avoiding slashing, selective shrub removal or under scrubbing where it may promote weed invasion;

- Undertaking monitoring and research into the effects of fire on the weed and pest species; and
- Selecting gravel and fill materials for trail maintenance from local sources that will not affect the fertility of the soil or contain exotic seeds.

3.5.9.7 Areas under regeneration/rehabilitation

Major strategies to protect areas under regeneration or rehabilitation include:

- Assessing the regenerative capacity of flora and fauna populations to determine the affect of introducing fire;
- Utilising prescribed fire to assist in rehabilitation projects; and
- Excluding fire where possible.

3.5.9.8 Strategies for karst areas

Any fire management activities carried out in karst areas will take into consideration the fragility of karst features and catchment values. Major strategies to minimise impacts on karst areas include:

- The use of chemical retardants, surfactants or foams in karst areas shall be kept to a minimum and only be used where no alternative suppression option is available;
- The use of heavy plant shall be kept to a minimum in karst areas by using existing trails as control lines where possible;
- While it is recognised that fires do occur in karst areas, fire shall be excluded from karst areas where possible to minimise impacts on karst soils and hydrology;
- When fires occur in karst areas, immediate direct attack using RAFT crews, helicopters and/or ground crews etc shall be considered to minimise the extent of unplanned fire.

3.5.10 Strategies for cultural heritage management

The Park contains a large number of Aboriginal and historic heritage values. Some of these are at a high risk of damage from unplanned fire or fire management operations. Major strategies for cultural heritage protection include:

- Managing cultural heritage in accordance with the 'Burra Charter' ICOMOS (1988);
- Consulting relevant land council and DECC cultural heritage officers for the protection of cultural heritage values;
- Maintaining databases and a Geographic Information System on the location and nature of cultural heritage sites and landscapes. The database will be referenced as part of fire management and operational planning; and
- Developing conservation plans to protect or rehabilitate damaged sites.

Specific strategies to mitigate the risks of fires and fire suppression activities on cultural heritage are outlined in Table 34.

Table 34 Cultural heritage management guidelines

Note: FMM refers to the NPWS Fire Management Manual

General Guidelines	
Cultural Heritage (FMM 4.12)	• All personnel involved in control line construction and vehicle based fire suppression operations are to be briefed on site locations and the required management strategies for site protection. • Specific site protection strategies are to be included in Incident Action Plans. • All bush fire suppression activities being conducted on NPWS managed lands must comply with policies and directions regarding cultural heritage values by senior NPWS officers. • Liaise with the relevant cultural heritage officer and or representative where required. • In the event of a site being found during operations, action shall be taken to avoid damage, and the location and description shall be reported to senior NPWS officers.
Aboriginal Cultural Heritage	
Scarred, carved or other culturally significant trees	• All fuel shall be cleared from around identified trees when carrying out prescribed burning. Clear fuels, with hand tools, from tree base and/or foam base to 3m up the tree trunk. • Protect all sites from unplanned fire and back burning operations. • Identified trees shall be marked clearly prior to any control lines being constructed. Where possible, avoid new trail construction within 20m of trees and construct trails on the advancing fire side of the tree. • Where possible, identified trees shall be examined as soon as possible after the passage of a fire front, and embers that might cause the tree to burn must be extinguished. • Do not clear or fell trees.
Stone arrangements, ceremonial rings, rock engravings, rock art or grinding grooves	• Fuel must be cleared from in, on and around all identified stone/rock sites. Fuel clearing methods must not damage the site. Clear, by hand, excess fuels from the site. • Avoid new trail construction or ground disturbance within close proximity of site. Where possible, ensure the site is protected by constructing trails or hand tool lines on the advancing fire side. • Use parallel attack methods when deploying aerial water bombers at known sites. • Surfactants and retardants may be used adjacent to, but not directly on sites (especially rock art sites). • Prescribed burning or back burning operations shall protect sites from the potential threat of radiant heat and smoke (especially at rock art sites).
Burials, artefact scatters, potential archaeological deposits or middens	• Sites must be identified in the field, and control lines must avoid (and attempt to protect) all sites wherever possible. • Avoid all ground disturbances including the use of earthmoving machinery, handline construction and driving over sites. • Avoid water bombing which may cause ground disturbance. • Sites may be burnt by bush fire.

Historic Heritage Guidelines	
Huts and homesteads (Intact structures & Ruins)	• Clear fuels, with hand tools or hand operated equipment, from around sites. • Protect sites from back burning operations. Prescribed burning or back burning operations should minimise the potential threat of fire and radiant heat on features. • Avoid the use of earth moving equipment at historic site locations. Where possible, avoid control line construction within 30m of features. • Use parallel attack methods when deploying aerial water bombers at known sites. • Fire fighting chemicals may be used directly on sites, unless otherwise stated. • Consider temporarily wrapping huts in protective foil to protect from ember attack (section 3.5.10.1).
Sites and ruins (mines, relics and artefacts)	• Caution shall be used in areas previously mined as these areas may be unstable for heavy machinery and or vehicles and hazardous to ground crews. • Avoid the use of earth moving equipment at site locations. Where possible, avoid control line construction within 30m of features, unless otherwise stated. • Prescribed burning or back burning activities shall minimise the potential for site disturbance. • Surfactants and retardants may be used directly on sites, unless otherwise stated.
Historic areas (landscapes or places)	• Avoid the use of earth moving equipment in areas identified as having historic significance. • Prescribed burning or back burning activities shall minimise the potential disturbance or damage to the areas significance. • Surfactants and retardants may be used in areas, unless otherwise stated.

3.5.10.1 Protection of huts

Historically, huts in the high country have been protected by creating new containment lines around them, backburning or applying retardant around or on the structures. Such methods have worked in many circumstances however in extreme conditions such measures have not always been successful, with resultant loss of huts e.g. 2003 fires. The main cause of loss of huts, as for any other built structure, is the ember attack.

A recently trialled method of protecting fragile huts from ember attack has involved the wrapping of the hut in a foil such as sisalation. This approach minimises the opportunities for embers to enter the many openings generally found in older huts. Wrapping of huts for protection from effects of fire shall include:

- Slashing/removing grass and shrubs around the perimeter of the hut to a sufficient distance to prevent flame contact with the hut. Such distance shall depend on height of grass and shrubs but should be at least 2 metres;
- Thoroughly wet down timber components of the hut prior to wrapping;
- Ensure shiny/foil side is facing out;
- Starting at the bottom edge of the hut, wrap protective foil/sisalation with lower 0.5-1m of sisalation laid flat on the ground in the slashed area;
- Each successive layer is placed higher up the walls of the hut with higher layers overlapping on the outside of lower layers by at least 30cm;
- Seal overlapping edges and all joins with broad heat resistant tape;
- Peg down foil laying on ground at base of the hut with metal tent pegs.

Other potential methods of protecting huts include spraying the hut with protective foams. Further work shall be carried out to research potential hut protection measures and to investigate the feasibility of developing portable pre-prepared hut protection kits that can be taken into the field at short notice to protect huts from fire damage.

3.6 Bush Fire Recovery Strategies

Recovery after a fire involves the recovery of personnel involved, resources used, and the rehabilitation of impacts on the natural environment. DECC may also assist or facilitate with recovery actions for communities affected by major bushfires.

Strategies for recovery shall include as a minimum:

- The recovery process shall be incorporated into the Incident Action Plan at the earliest opportunity;
- Identification of disturbed areas that shall require rehabilitation e.g. trails, helipads, water points, control lines etc shall occur from the start of the incident;
- In major incidents, consideration shall be given to appointing a Situation Officer solely to manage bushfire recovery;
- Rehabilitation may commence at the earliest opportunity, particularly to utilise plant at the incident that may not be required for fire suppression operations;
- Development of rehabilitation strategies in alpine and subalpine areas shall refer to the report "The Australian Alps Rehabilitation Manual" (AALC, 2006); and
- Rehabilitation sites shall be monitored to ensure that rehabilitation works are effective.

3.6.1 Rehabilitation

The rehabilitation of helipads, tracks and hand tool lines is an integral part of fire operations. Actions undertaken as part of the fire suppression operation may have significant long- term impacts on the values of the Park. Table 35 details the major rehabilitation strategies for likely impacts caused as part of a suppression operation. Urgent works must be undertaken as part of the operation de-escalation. Longer term works may require a detailed Rehabilitation Plan to be prepared.

Table 35 Rehabilitation strategies for fire suppression impacts (NPWS, 2007a)

Cause	Condition (effect)	Management Option	Management strategy
New trails constructed	Bulldust present. Poorly drained. No erosion controls. Location not desirable for future management.	Close and rehabilitate completely. Install erosion controls.	Task heavy machinery to close and rehabilitate. Task machinery to install erosion controls.
Old trails	Bulldust present. Eroded. Widened to an unacceptable width.	Install erosion controls. Rehabilitate damaged areas.	Task machinery to install erosion controls.
Retardant/foam	Unknown impacts.	Map sites where foam/ retardant was used	Map sites and assess impacts.
Helipads	Area cleared. Resources remaining (e.g. fuel). Rubbish on site.	Close and rehabilitate. Maintain and clean up.	Task heavy machinery to close and rehabilitate. Task machinery to install erosion controls. Task logistics to collect resources and rubbish.
Staging area and assembly area control points	Area cleared. Resources remaining. Rubbish on site. Erosion.	Close and rehabilitate. Maintain and clean up.	Task heavy machinery to close and rehabilitate. Task machinery to install erosion controls. Task logistics to collect resources and rubbish.

Cause	Condition (effect)	Management Option	Management strategy
Vegetation removed	Issues include: Known threatened species, populations and communities. Pests. Slopes > 18 degrees (high erosivity). Fire frequency greater than recommended threshold.	Survey vegetation burnt for patchiness and intensity. Natural revegetation. Intervention. Monitor.	Task staff to carry out surveys. Develop a monitoring plan for natural revegetation. Develop intervention strategies (e.g. reconstruction of habitats, erosion controls).
Cultural sites	Known sites impacted by fire. Vegetation removed so unknown sites can be identified.	Survey and documentation of known and unknown sites and their condition.	Task staff to carry out surveys. Contact local Aboriginal land council and DECC sites officer.
Damage to neighbouring property assets	Water supply is depleted. Roads are damaged. Fence lines are damaged.	Survey and document damage/impacts. Activate sub-plans of the NSW State Disaster Plan (Displan).	Organise meetings to discuss the impacts with neighbours. Discuss the need to activate sub-plans of the NSW State Disaster Plan (Displan) with the incident controller if impacts are severe.

Post fire risk assessment shall include an analysis of areas subject to potential slope instability. URS (2006) provide data, available in the NPWS Geographic Information System database that may be used to identify areas of potential slope instability for monitoring, particularly if moderate to high rainfall events occur within 6-12 months following a fire.

Given the high conservation values within wilderness and priority habitat areas, special attention shall be paid to rehabilitation of any disturbance resulting from fires in these areas. The aim shall be to return disturbed areas to their natural condition as quickly and effectively as possible.

3.6.2 Fauna rescue

Fires can have major impacts on fauna if fire intensity and extent is large. Under the *NSW State Disaster Plan* (Displan), NSW Agriculture is responsible for the humane care of injured fauna during large-scale incident fires. The incident management team shall liaise with NSW Agriculture to coordinate the care of injured fauna. This applies to Class 3 fires only (NPWS, 2007a).

Detailed guidelines for the management and rescue of injured fauna are provided in the NPWS Fire Management Manual (NPWS, 2007a).

4 IMPLEMENTATION

This section summarises the actions identified in this strategy that will be carried out during the life of this strategy.

The works outlined in this strategy are to be implemented in consultation with local BFMCs, land management agencies, Rural Fire Service (RFS) brigades, Park neighbours and other stakeholders. The implementation of prevention and preparedness strategies will be prioritised on an annual basis and in consultation with relevant BFMCs where required.

The cooperation of the community is important to the success of many strategies. In particular, NPWS works with BFMCs to encourage neighbours to accept responsibility for the management of fuels on their properties, to prepare and maintain their properties in accordance with relevant advice and guidelines, and to develop personal action plans that can be activated in the event of a bushfire.

Fire Management Works are scheduled and implemented via the periodic review of respective Regional Operations Plans or Area Works Plans. Schedules and works will be implemented in accordance with further priorities identified within those plans. Implementation of works may be subject to variations due to unfavourable seasonal conditions, availability of resources, equipment break-downs or unplanned fire events which make the scheduled work inappropriate.

4.1 Fire Management Works

4.1.1 General fire management works

A range of annual and general fire management works will be carried out periodically to ensure readiness of required resources and appropriate management of supporting data.

Annual works schedules for fire trails will identify the priorities for fire management access, maintenance and construction works including grading, slashing, selective shrub removal and rehabilitation. Priorities for works will be based on the strategic value of access routes (including previous success in fire containment) with regard to BFMCs respective Fire Trail Registers. Access routes will be monitored regularly and treated appropriately for soil erosion and weed invasion.

Annual works schedules for all fire management zones will identify priority locations for specific works. The Region will use the ‘Standards for Asset Protection Zones’ (RFS, undated) as a guideline for addressing the required works within existing APZs.

General fire management works are outlined in Table 36 below.

Table 36 General fire management works

Consideration	Proposed Actions
General tasks	• Update Regional Incident Procedures annually taking account of strategies and information in this strategy. • Ensure incident operations rooms are fully restocked and equipped and operationally functional prior to the fire season and after every major incident. • Ensure Fire Danger signs at public entrances to the Park are updated as fire danger changes.
Management of databases and other information	• Review Geographic Information System and associated databases to update with new information at end of each fire season.
Zone management	• Monitor overall fuel hazards in Asset Protection Zones and Strategic Fire Management Advantage Zones to identify future priorities for fuel management activities. • Carry out a risk assessment of selected built and residential assets owned by NPWS within the Park including recommendations for mitigating the risks

Consideration	Proposed Actions
	identified. Implement results of the risk assessment. • Manage the implementation of APZ maintenance works for NPWS owned assets prior to and during each fire season.
Weather/ Climate	• Monitor drought indices as triggers for preparedness, Park closures, and Park fire bans. • Monitor weather forecast and lightning detection systems to ensure an appropriate level of preparedness is in place at all times.
Fire detection	• Evaluate and maintain all fire towers to OH & S requirements. • Ensure fire tower observation periods are commensurate with the annual assessment of the impending fire season. • Ensure maps and observation equipment for detection of fires are available and up to date for all observers. • Organise and manage contracts for annual staffing of towers.
Fire trails	• Ensure trails are inspected at the end of each winter and opened where required for the fire season. • Maintain regional fire trail datasets including status and names of trails. • Develop and implement annual maintenance schedules and programs in consultation with field staff and BFMCs. • Update fire trail Geographic Information System layers with new fields according to the current approved BFCC fire trails policy.
Biodiversity	• Rerun the biodiversity thresholds analysis annually if major fire seasons have occurred to determine renewed threshold status of proposed burn areas. • Identify long unburnt areas as potential scientific control sites and assist Southern Biodiversity Conservation Section to develop proposals for long term research.
Priority habitats	• Prepare site specific strategies for identified priority habitats to protect these sites from fire and negative impacts of suppression operations. • Identify Northern Corroboree Frog priority habitats.
Cultural heritage	• Maintain AHIMS and HHIMS records that detail the type, location, condition and sensitivity of sites. • Evaluate and record the impact of unplanned fires and fire management activities on cultural heritage sites and implement recommended rehabilitation actions. • Carry out a risk assessment in consultation with relevant stakeholders and implement mitigation works around selected huts and implement recommended actions. • Ensure that a bushfire risk assessment and implementation of any recommendations to mitigate bushfire risk for cultural heritage within the Park are included in all future HAS. • Investigate potential hut protection strategies including wrapping in sisalation or similar.
Catchments and soils	• Carry out a risk assessment of erosion potential in sensitive areas after major fires using URS (2005) report for guidance.
Post incident and post prescribed burns	• Record the location and extent of use, and justification for use of all retardants in a new Geographic Information System Layer. • Maintain Geographic Information System and other regional database files relevant to unplanned fires and prescribed burns, including ignitions data, to the standard required. • Map extent and patterns of burning and intensity inside fire perimeters wherever possible. • Update the location of fire management advantages and incorporate this data into existing regional datasets where possible. • Establish and maintain post burn reports database.
Effectiveness of suppression operations	• After each incident and during post fire debriefs, evaluate the effectiveness of suppression strategies, including planning and implementation, and in relation to priorities and objectives and implement recommendations.
This strategy and ops maps	• Set up a system for recording information that may contribute to future reviews of this strategy and operations maps. • Update operations maps annually if circumstances change sufficiently to warrant updating, e.g. many or large fires affecting thresholds etc.

Consideration	Proposed Actions
Control lines	• Contribute to future identification of potential control lines and other advantages in consultation with BFMCs.
Village Protection Plans	• Develop a Village Protection Plan for residential areas within the Waste Point area. • Assist with the development of Village Protection Plans for lessees within the Park. • Ensure that negotiations occur between RFS, DoP and NPWS to ensure consistency between agency requirements in relation to VPPs.
Fuel Management	• Collect Overall Fuel Hazard data at regular periods after fire for identified plant communities.
Communications	• review current coverage and strength of radio signals to identify and map locations where portable repeaters are required and the most suitable locations to set up the repeaters

4.1.2 Equipment and facilities

Table 37 outlines the maintenance requirements for fire management equipment and facilities to be considered in the development of annual works schedules.

Table 37 Equipment and facilities works

Equipment item	Tasks
Personal Protective Equipment	• Ensure all fire fighting staff have appropriate personal safety and fire fighting equipment as detailed in the NPWS Fire Management Manual.
Vehicles	• Ensure Cat 9s, tankers, bulk water carts, and plant equipment (bull dozers, and 4WD tractors/slashers) and associated equipment including fittings and hoses are operational from the onset of the fire season.
Communications equipment	• Undertake an annual maintenance check prior to the fire season, including mobile radios in vehicles, hand held radios, batteries and chargers. • Acquire necessary equipment to communicate with other agencies. • Ensure remote repeater trailers are operational.
Remote water tanks	• Investigate opportunities for installation of remote water tanks in areas frequently low in water availability. • Ensure water tanks are topped up at the beginning of each season.
Remote equipment	• Ensure all remote kits are operational. • Purchase new parts as required.
Retardant and foams	• Ensure adequate supply is available.
Aviation equipment	• Ensure buoy walls and aviation communications equipment are operational • Ensure fuel supplies are adequate.
Incendiary PHIL units, injection equipment.	• Ensure adequate supply of consumables. • Ensure incendiary devices are operational.
Weather equipment	• Ensure both hand held and remote weather stations are functional.
Navigational equipment	• Ensure adequate supply of topographic maps, Global Positioning Systems (GPS), and compasses.
Hut Protection kits	• Investigate the feasibility of developing portable hut protection kits.

4.1.3 Prescribed burning

Priorities for prescribed burning are scheduled annually after consultation with Bush Fire Management Committees. Proposals for prescribed burns within the Park are outlined in Table 27. Table 38 details the general processes in annual prescribed burning planning and scheduling. Prescribed burn planning and scheduling is also subject to the policies and procedures outlined in the NPWS Fire Management Manual (NPWS, 2007a) and may change annually.

Table 38 Prescribed burning works

Steps	Tasks
Review databases	• Review fire history on Geographic Information System prior to proceeding with burn planning to ensure that the proposed burn will not exceed thresholds. • Review relevant natural and cultural heritage databases and incorporate outcomes of review into the prescribed burn plan to protect natural and cultural heritage values.
Fuel Sampling	• Undertake fuel sampling in areas for proposed burns and collate data. • Measure fuels both prior to and after prescribed burning operations to determine rates of fuel accumulation and to measure success of the burn against objectives.
Prepare burn proposals for BFMCs	• Submit summary prescribed burning proposals to Bush Fire Management Committees. • Seek approval by BFMCs.
Review of Environmental Factors	• Prepare Hazard Reduction Certificate or Review of Environmental Factors (REF). • Undertake field assessments of flora and fauna values. • Assess impacts of proposed prescribed burn on biodiversity thresholds for all forest ecosystems or vegetation formations in the burn area. • Seek approval for HR certificate or REF.
Risk assessment	• Undertake field inspection to assess hazards and risks associated with implementing burns. • Ensure consultation with grape growers occurs in adjacent areas prior to implementing a prescribed burn.
Prepare operations plans	• Prepare Prescribed Burn plan. • Obtain plan approval.
Implement Burns	• Identify appropriate conditions to implement burns by monitoring weather conditions. • Notify RFS fire control centres, emergency service agencies and neighbours. • Organise resources including aviation resources. • Implement burn.
Post burn requirements	• Undertake post burn assessments as required by the Fire Management Manual and current Prescribed Burn Plan format. • Complete all post burn monitoring requirements as per current Prescribed Burn Plan format. • Ensure evaluation of implemented and possible alternative burning patterns is discussed and outcomes communicated to staff.
Reporting	• Report to BFMCs on the success of the prescribed burning program. • Maintain internal databases and reporting protocols.

4.2 Community Education and Awareness

NPWS will provide support to Community Education and Awareness programs through Bush Fire Management Committees. Table 39 outlines the community education and awareness programs to be considered in the development of annual works programs.

Table 39 Community education and awareness programs

Program	Key Projects
Ignition prevention	• Promote neighbourhood watch programs in areas with high levels of arson.
Fire wise	• Support BFMCs in approved activities.
NPWS Discovery program	• Incorporate fire management messages in displays, shows, guided walks, field study trips, where appropriate.
Media	• Provide regular public bulletins on the outlook and status of the fire season, • Provide material for newspapers, radio, television, magazines, billboards, signs posters, and newsletters.
Preparedness days	• Assist the RFS in bush fire preparedness days. • Promote inter agency involvement in selected NPWS fire preparation days.

Program	Key Projects
Smoke management	• Notify neighbours and visitors of proposed management activities through mail and public media.
Park closures and fire bans	• Install signage and interpretations to inform Park users and neighbours of total fire bans, Park fire bans, Park closures and other fire management operations.
Tourism industry	• Provide information on the actions for self preservation, total and Park fire bans, Park closures and other fire management operations.
Internet	• Provide information on the DECC web page about fire management, Park closures, and total and Park fire bans.
Media and public relations strategy	• Preparation of a media and public relations strategy as part of the Incident Action Plan for major incidents. • Development of a media protocol between agencies to ensure coordinated and accurate reporting.

4.3 Bush Fire Management Research and Development

Ongoing research and monitoring is an essential component of fire management and is strongly recommended and supported in almost all reports, references and forums related to fire management. The Park has a range of existing long term research plots established under the Australian Alps cooperative management program. However it is recognised that there is a lack of information on some essential ecological components that have a significant bearing on fire management within the Park.

Considerable monitoring and research is required to address identified gaps in knowledge and understanding in relation to fuel management, impacts of fire on flora, fauna and vegetation communities and other aspects of fire management. A range of monitoring programs already exists within the Park. Existing monitoring programs in the Park are primarily directed at detecting changes in alpine and subalpine vegetation communities, populations of certain threatened animals and feral species, vegetation responses to fire, and water quality.

The NPWS Fire Ecology unit in Hurstville also has a range of research projects scheduled that will provide useful results for fire management in the Park. Proposed relevant research programs of the NPWS Fire Ecology Unit for the next 3-5 years include:

- Identifying appropriate fire regimes for fauna, particularly threatened fauna;
- Development of a decision support system for monitoring the impacts of fires and fire regimes on plants and animals on Park;
- Examining how different fire events can directly affect survival of individual animals.

The 2007-08 Southern Branch Research Operational Plan (NPWS, 2007), provides for research priorities at the Branch level and should be referred to when establishing and implementing research programs related to fire in the Park. At the time of writing, the plan has four proposed relevant research themes which are:

1. Effectiveness of fire management practices and fuel management burns in reducing fuel loads in various vegetation classes.
2. Appropriate fire regimes for various vegetation formations.
3. Fire regimes – review suggested fire regimes for SE vegetation and suggest refinements in consideration of climate change.
4. Alpine Ash in the Park – assess impacts of fire and climate change on Alpine Ash within the Park for future management. Establish a series of permanent monitoring plots and management prescriptions.

Since the establishment of the Bushfire CRC projects in 2003, some relevant research has been undertaken however much of this research is currently incomplete. When projects appropriate to the management of fire on NPWS estate are being undertaken by the Bushfire CRC, NPWS will support and cooperate with the Bushfire CRC wherever possible. Opportunities for collaborative research with academic institutions shall be assessed and pursued as a high priority. NPWS has limited resources at the Regional level to carry out research and while some of these research projects may be undertaken by Regional staff, the

majority may only be carried out if external organisations and or specialist staff are in a position to undertake the research. Accordingly the research topics provided below are an advisory list to guide future potential research projects subject to availability of resources and staff, and priorities at Regional, Branch and State wide levels.

Table 40 Research topics and priorities resulting from this strategy

Research topic	Priority
Establish a Park wide fuel monitoring program that results in a database of fuel measurements and development of fuel accumulation curves for key vegetation communities. Monitoring of fuel shall include estimate of fuel quantity, structure, composition, continuity and height (Overall Fuel Hazard) (Gould and Sullivan, 2004). Establish and maintain common regional databases for fuel measurements.	High
Map in Geographic Information System all old growth Snow Gum remnants in the Park.	High
Map in Geographic Information System old growth Alpine Ash in the Tooma area off Manjar trail.	High
Determine options available for additional and advanced remote fire detection systems.	High
Cooperate with research projects addressing prescribed burning in sub alpine areas.	High
Undertake an experiment testing the proposed hut protection methodology outlined in section 3.5.10.1.	High
Map remnant rainforest areas in the Pilot and Bogong Peaks wilderness area.	Medium
Obtain satellite imagery of major fires to evaluate fire severity (intensity) and effects.	Medium

In addition to the potential projects listed above, some fire management research topics are prescribed in the KNP Plan of Management (2007b) (Table 41).

Table 41 Research topics and priorities from the KNP POM (2007b)

Research topic	Priority
Investigate the most appropriate fire thresholds for particular vegetation communities and individual plant and animal species. This project will review the local data available for a revised threshold analysis for broad vegetation formations or other vegetation classification deemed appropriate. This project shall consider Branch or possible Bushfire CRC projects that may overlap or negate the need for his research to occur separately.	High
Investigate the most effective strategic fire protection measures and the levels of effectiveness of the various fire suppression strategies employed in the Park.	High
Undertake research into the effects of various fire management regimes and practices on soils, landforms and catchment hydrology and stability.	Medium
Study the effects of various fire management regimes and fuel reduction treatments on fuel loads and structures.	Medium
Undertake fire behaviour prediction modelling.	Medium
Investigate the environmental effects of chemical retardants.	Medium
Investigate the contribution of prescribed burns in the Park to greenhouse gas emissions.	Low
Study the ecological impacts associated with the 2002-2003 fires.	Low
Investigate the role that fire can play in managing weed and feral animal species.	Low
Research the implications of climate change on the incidence and severity of unplanned fires and appropriate management responses.	Low
Investigate the impact of fire on karst values.	Low
Undertake surveys for rare and threatened plant species not recently located that may regenerate after fire.	Low

4.4 Review of this Strategy

4.4.1 Strategy Review

While this strategy will provide the key management directions for fire management for the life of the strategy, NPWS is committed to the principles of adaptive management. Fire management is regularly informed through the outcomes of research, debriefs after incidents, experience gained during incidents, and through changes in policy. There may be a need, during the life of this strategy, to adapt or change fire management strategies as further

information and research results into the management of fire, flora and fauna, or changes in policy direction become available. This strategy has an operation life span of approximately 5 years and shall be reviewed and updated at the end of this period.

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Appendix 1 Fire Management Principles

In 2003, the Australian Alps Ministerial Council formulated a set of key principles to guide fire management throughout the Australian Alps. In summary, the Council agreed that the key principles which should govern fire management in the Alps should be:

Firefighter safety and the protection of life and property are fundamental issues of concern to all fire authorities and land managers and will underpin every strategy.

Fire management strategies should be consistent with the primary objective of the protected area system, which is to conserve the natural and cultural heritage values of the Australian Alps.

Fire management should be broadly based involving an integration of fire prevention, preparedness, response and recovery strategies. It should make strategic use of all appropriate tools which are available, such as:

- Fuel reduction through burning or by mechanical means in areas of high potential fire intensity hazard;
- Early detection and rapid suppression of unplanned fire;
- A strategically located fire trail network;
- A properly trained and equipped workforce, including volunteers, to undertake fire management; and
- Education to help communities and individuals to be prepared for the likelihood of fire.

Fire management strategies, including fuel reduction, should:

- Be practical, achievable and cost effective;
- Be based on a strategic analysis of risk to the assets (natural, cultural and physical) that may be affected by fire;
- Be focused on the protection of significant assets and values at risk from unplanned fire;
- Be based on sound science, in particular a clear understanding of the factors which influence fire behaviour; and
- Take full account of the known and likely implications of climate change.

There should be a total landscape approach to fire management, including suppression activities, involving cooperation and collaboration both within jurisdictions and across State/Territory borders.

Community engagement and support in the development, implementation and review of fire management strategies should be sought to both ensure that local knowledge, values and resources are effectively utilised and to raise awareness, understanding and appreciation of fire management issues in the community.

Appendix 2 Visitor locations and potential visitor numbers

Name	Estimated Population in summer (per day)	Area	Reg
Behr's Flat Camping area	<20	Upper Murray	SMR
Big Talbingo/Landers Falls	<10	Riverina-Highlands	SWS
Black Perry Rest Area	<5	Riverina-Highlands	SWS
Blowering Cliffs Trackhead	<5	Riverina-Highlands	SWS
Blowering Works Depot	20	Riverina-Highlands	SWS
Blue Cow	<50 (day trip)	Alpine	SMR
Blue Waterholes Camping Area	10-80	Murrumbidgee	SWS
Bradleys/O'Briens Hut Rest Area	<5	Upper Murray	SMR
Bradneys Gap picnic area	<5	Upper Murray	SMR
Broken Cart	10	Riverina-Highlands	SWS
Buddong Falls Camping Area	10	Riverina-Highlands	SWS
Bullocks Flat	1–10	Snowy River	SMR
Bullocks Hill Camping Area	>20	Murrumbidgee	SWS
Bullocks Hut	1-12	Snowy River	SMR
Cabramurra Township	200	Riverina-Highlands	SWS
Camp Hudson	<50	Riverina-Highlands	SWS
Charlotte Pass Trackhead	20-400	Alpine	SMR
Charlotte Pass village	>100 (day trippers)	Alpine	SMR
Clover Flat Rest Area	<5	Upper Murray	SMR
Cooinbil Hut	<5	Murrumbidgee	SWS
Coolamine Homestead	>20	Murrumbidgee	SWS
Cooleman Mountain Camping Area	>20	Murrumbidgee	SWS
Coonara Point Camping Area	<50	Riverina-Highlands	SWS
Creel bay boat ramp	2-5	Alpine	SMR
Currango Homestead	10-50	Murrumbidgee	SWS
Delaneys Hut Rest Area	<20	Murrumbidgee	SWS
Denison Camping Area	<50	Murrumbidgee	SWS
Dry Dam Shelter	<10	Murrumbidgee	SWS
Dubbo Flats	<5	Murrumbidgee	SWS
Eucumbene river It's Four Mile Trail on the POM map.	10	Murrumbidgee	SWS
Eucumbene river (Snowy Mtns Highway)	5	Murrumbidgee	SWS
Eucumbene Cove & Dam	<50	Alpine	SMR
Geehi Flats Rest/Camping Area	>100	Upper Murray	SMR
Geehi Dam Camping Area	<5	Upper Murray	SMR
Ghost Gully Camping Area	2-30	Murrumbidgee	SWS
Grassy Flat Camping Area	<5	Upper Murray	SMR
Gungarlin Bridge	<10	Alpine	SMR
Gurrangorambla (Old Snowy) Camping Area	2-50	Murrumbidgee	SWS
Guthega Power Station trackhead	5-20	Alpine	SMR
Guthega township	15–30	Alpine	SMR
Halfway Flat Picnic Area	>10	Snowy River	SMR
Humes Crossing Camping Area	20	Riverina-Highlands	SWS
Island Bend	>20	Alpine	SMR
Island Bend Picnic Area	<12	Alpine	SMR
Jacks Lookout	>5	Snowy River	SMR
Jacobs Bridge Picnic Area	1-5	Snowy River	SMR
Jacobs River Camping Area	>30	Snowy River	SMR

Name	Estimated Population in summer (per day)	Area	Reg
Jounama Creek Camping Area	30	Riverina-Highlands	SWS
Khancoban	<400	Upper Murray	SMR
Kiandra Day use areas	20	Riverina-Highlands	SWS
Kosciuszko Mountain Retreat	>200	Alpine	SMR
Leatherbarrel Creek Camping Area	<10	Snowy River	SMR
Log Bridge Creek Camping Area	20	Riverina-Highlands	SWS
Long Plain Hut Camping Area	>30	Murrumbidgee	SWS
Lower Snowy	<100	Snowy River	SMR
Main Range	>20	Alpine	SMR
Mount Kosciuszko	20-2500 (day trippers)	Snowy River	SMR
Mount Selwyn	1–5	Riverina-Highlands	SWS
Murray Gates Camping Area	<5	Upper Murray	SMR
Ngarigo	20-50	Snowy River	SMR
No Name Picnic Area	>20	Snowy River	SMR
Ogilvies Creek Picnic Area	5	Upper Murray	SMR
O'Hares Rest Area	20-200	Riverina-Highlands	SWS
Old Geehi YHA Hut Camping Area	5	Upper Murray	SMR
Olsens Lookout	<5	Upper Murray	SMR
Perisher Valley	50–100	Alpine	SMR
Perkins Flat	5	Murrumbidgee	SWS
Pinch River Camping Area	5-50	Snowy River	SMR
Providence Portal	50-100	Murrumbidgee	SWS
Rainbow Lake	10-20	Alpine	SMR
Ravine	5	Riverina-Highlands	SWS
Rennix Gap Trackhead	<12	Alpine	SMR
Rock Flat Picnic Area	<30	Riverina-Highlands	SWS
Rocky Plain Camping Area	2-40	Murrumbidgee	SWS
Round Mountain Trackhead	<15	Upper Murray	SMR
Running Waters Camping Area	>30	Snowy River	SMR
Sawpit Creek	>100	Alpine	SMR
Sawpit Creek Education Centre	20-100	Alpine	SMR
Sawpit Creek Picnic Area	>10	Alpine	SMR
Sawyers Hut	<10	Murrumbidgee	SMR
Scammels Ridge Lookout	<10	Upper Murray	SMR
Scotchies Yards Camping Area	>5	Snowy River	SMR
Sewage Works	5	Alpine	SMR
Ski Rider	6	Alpine	SMR
Smiggin Holes	25–50	Alpine	SMR
Snowy River (Burungubuggee)	<10	Alpine	SMR
Spencers Creek Picnic Area	<5	Alpine	SMR
Sponars	1–5	Alpine	SMR
Talbingo	<300	Riverina-Highlands	SWS
Talbingo Dam wall area	20	Riverina-Highlands	SWS
Tantangara Dam	>100	Murrumbidgee	SWS
The Pines Camping Area	20	Riverina-Highlands	SWS
Thredbo Diggings	20-100	Snowy River	SMR
Thredbo Ranger Station	1-5	Snowy River	SMR
Thredbo River Picnic Area	5-20	Alpine	SMR
Thredbo Village	5000	Snowy River	SMR
Three Mile Dam East	<50	Riverina-Highlands	SWS
Three Mile Dam West	<50	Riverina-Highlands	SWS
Tom Groggin Rest Area	<50	Upper Murray	SMR

Name	Estimated Population in summer (per day)	Area	Reg
Tooma Dam Trackhead	5	Upper Murray	SMR
Tumut Ponds Dam	10	Riverina-Highlands	SWS
Twin Valley	<10	Snowy River	SMR
Wallace Ck Lookout	<20	Riverina-Highlands	SWS
Wallace Craigie Lookout	>5	Snowy River	SMR
Wares Yards Camping Area	2-50	Murrumbidgee	SWS
Waste Point	<50	Alpine	SMR
Waste Point-Creel Bay	10-20	Alpine	SMR
Willis Camping Area	1-5	Snowy River	SMR
Wilsons Valley	1–5	Alpine	SMR
Wilsons Valley Depot	<10	Alpine	SMR
Yachting Point Camping Area	20	Riverina-Highlands	SWS
Yarrangobilly Caves	<300 day visitors & up to 20 overnight	Riverina-Highlands	SWS
Yarrangobilly Village Complex	5-30	Riverina-Highlands	SWS
Yolde Camping Area	20	Riverina-Highlands	SWS

Appendix 3 Risk assessment of built assets

(note: All other assets not listed are rated low risk rating and are shown on operations plans as asset points)
Risk category key 1-Economic-infrastructure; 2-Human settlement-Residential; 3-Human settlement-Special fire protection; 4-Economic tourism and recreational; 5-Economic agricultural; 6-Economic commercial forests

Asset Name	Risk Rating	Risk Category	Bushfire Behaviour Potential	Comments
Eucumbene Cove boundary	extreme	2	mod-high	NPWS to implement fuel management program & maintain zone standards
KNP Education Centre	high	1,3,4	mod-high	NPWS to implement appropriate property protection actions annually
Kosciuszko Mtn retreat	high	1, 4	mod-high	Lease – actions as per Village Protection Plan and maintain zone standards
Providence Portal	high	4	mod-high	Private property – actions as per Monaro Zone BFMC Risk Management Plan.
Cabramurra	low	1, 2, 3	low-high	Lease – actions as per SHL Emergency Management Plan and maintain zone standards
Charlotte Pass	low	1, 2, 4	low-mod	Lease – actions as per Village Protection Plan and maintain zone standards
Perisher	low	1, 2, 4	low-mod	Lease – actions as per Village Protection Plan and maintain zone standards
Brindabella Valley Boundary	medium	2, 5	high	NPWS to maintain zone standards
Eucumbene Lake Boundary	medium	2, 4	mod-high	NPWS to implement fuel management program & maintain zone standards
Goobragandra Valley Boundary	medium	2, 5	high	NPWS to implement fuel management program & maintain zone standards
Guthega Village	medium	2, 4	mod-high	Lease – actions as per Village Protection Plan and maintain zone standards
Indi Boundary	medium	2, 5	high-ext	NPWS to implement fuel management program & maintain zone standards
Ingebyra Boundary	medium	2, 5	mod-high	NPWS to maintain zone standards
Ingebyra South Boundary	medium	2, 5	high	NPWS to implement fuel management program & maintain zone standards
Malabar Boundary	medium	1, 2	high	NPWS to implement fuel management program & maintain zone standards
McPhersons Plain Boundary	medium	2, 4, 5	high-ext	NPWS to maintain zone standards
Smiggin Holes	medium	1, 4	low-mod	Lease-Implement appropriate property protection actions annually
Thredbo Village	medium	2, 4	low-mod	Lease – actions as per Village Protection Plan and maintain zone standards
Tigers Rest Boundary	medium	1, 4	mod-high	NPWS to maintain zone standards
Waste Point	medium	1, 2	mod-high	NPWS actions as per Village Protection Plan
Wollondibby boundary	medium	1, 2, 4	mod-high	NPWS to maintain zone standards
Yaouk Boundary	medium	2, 5	mod-high	NPWS to implement fuel management program & maintain zone standards
Yarrangobilly Caves	medium	1, 2, 4	high	NPWS to maintain zone standards

Appendix 4 Risk assessment of cultural heritage

Theme	Item_name	Risk
Hut/Homestead (Intact)	Gavell's Hut And Yards	High
Arboretum/Garden	Bert Fraser's Garden	Medium
Hut/Homestead (Intact)	Black Jack's Hut (Associated Elements)	Medium
Hut/Homestead (Intact)	Botheram Plain Hut	Medium
Hut/Homestead (Intact)	Bradley's/O'Briens Hut	Medium
Hut/Homestead (Intact)	Brayshaw's Hut	Medium
Hut/Homestead (Intact)	Cascade Hut	Medium
Historic Complex	Caves House	Medium
Other	Caves Hydro Plant & Electrical System	Medium
Hut/Homestead (Intact)	Circuit's Hut	Medium
Hut/Homestead (Intact)	Cooinbil Hut (Multiple Sites)	Medium
Hut/Homestead (Intact)	Coolamine Homestead	Medium
Hut/Homestead (Intact)	Cootapatamba Hut	Medium
Hut/Homestead (Intact)	Currango Homestead Complex	Medium
Hut/Homestead (Site)	Daffodil Cottage	Medium
Hut/Homestead (Intact)	Daveys Hut (Grave & Associated Elements)	Medium
Hut/Homestead (Intact)	Derschkos (SMA) Hut	Medium
Shed	Engine Shed	Medium
Hut/Homestead (Intact)	Farm Ridge Hut	Medium
Hut/Homestead (Intact)	Four Mile Hut	Medium
Shed	Geehi River Shed	Medium
Hut/Homestead (Intact)	Gooandra Homestead Complex	Medium
Arboretum/Garden	Greg Greg Orchard	Medium
Hut/Homestead (Intact)	Grey Mare Hut And Mining Site	Medium
Hut/Homestead (Intact)	Happy's Hut (Associated Elements)	Medium
Hut/Homestead (Intact)	Horse Camp Hut (Associated Elements)	Medium
Skiing (Historic Places)	Kiandra Courthouse/Chalet Sheds	Medium
Hut/Homestead (Intact)	Kidmans Hut And Stockyards	Medium
Other	Kosciuszko Hotel Hydro-electric Plant	Medium
Hut/Homestead (Intact)	Love Nest in the Salleys (Oldfield Hut No. 2)	Medium
Hut/Homestead (Intact)	Mackey's/Tibeaudo's Hut	Medium
Hut/Homestead (Intact)	Matthew's Cottage, Kiandra	Medium
Hut/Homestead (Intact)	Meat Shed	Medium
Monitoring Station	Meterological Station (Bunker)	Medium
Monitoring Station	Mount Kosciusko Weather Station And Hut	Medium
Hut/Homestead (Intact)	Munyang River/White's River Aquaduct Shelter	Medium
Historic Complex	NPWS Cottage (Staff House)	Medium
Historic Complex	NPWS Manager's House	Medium
Hut/Homestead (Intact)	Office And Store	Medium
Hut/Homestead (Intact)	Old Currango Homestead	Medium
Hut/Homestead (Intact)	Old Homestead/Southwells Homestead	Medium
Yards/Fences/Sheep Dip (Site/Ruin)	Old Stockyards And Timber Fences	Medium
Hut/Homestead (Intact)	Oldfields Hut No.1	Medium
Yards/Fences/Sheep Dip (Site/Ruin)	Pasture Protection Yards	Medium
Hut/Homestead (Intact)	Paton's Hut And Curtilage	Medium
Hut/Homestead (Intact)	Pattinson's Hut	Medium
Hut/Homestead (Site)	Peden's Hut And Associated Elements	Medium
Hut/Homestead (Site)	Pine Lodge	Medium
Hut/Homestead (Intact)	Pocket's Hut	Medium
Yards/Fences/Sheep Dip (Site/Ruin)	Prosser's Turnoff Stockyards	Medium

Theme	Item_name	Risk
Hut/Homestead (Intact)	Round Mountain Hut (Associated Elements)	Medium
Hut/Homestead (Intact)	Sandy Creek Hut (Associated Elements)	Medium
Hut/Homestead (Intact)	Schlink (Hilton) Hut	Medium
Hut/Homestead (Intact)	Schofield's Hut	Medium
Yards/Fences/Sheep Dip (Site/Ruin)	Scotchies Yards	Medium
Hut/Homestead (Intact)	Seaman's Hut	Medium
Shed	Slaughter Shed	Medium
Hut/Homestead (Intact)	Slaughterhouse Creek Hut (Associated Elements)	Medium
Hut/Homestead (Site)	Snow Gum	Medium
Shed	Stable	Medium
Yards/Fences/Sheep Dip (Site/Ruin)	Stock Reserve (PPB)	Medium
Yards/Fences/Sheep Dip (Site/Ruin)	Stockyards	Medium
Yards/Fences/Sheep Dip (Site/Ruin)	Stockyards And Ramp	Medium
Hut/Homestead (Intact)	Teddies Hut Complex	Medium
Hut/Homestead (Intact)	Thermal Pool Dressing Sheds	Medium
Historic Complex	Ticket Office	Medium
Hut/Homestead (Intact)	Tin Hut (Associated Elements)	Medium
Hut/Homestead (Intact)	Tin Mines (Charlie Carter's) Hut	Medium
Hut/Homestead (Intact)	Townsend Hut	Medium
Historic Complex	Two Storey Accomodation Wing	Medium
Hut/Homestead (Intact)	Unamed Hut Ruin	Medium
Hut/Homestead (Intact)	Venables (Lindleys or Plonkey's) Hut	Medium
Hut/Homestead (Intact)	Vickery's (Chaves) Hut And Associated Sites	Medium
Hut/Homestead (Intact)	Wheelers Hut (Associated Elements)	Medium
Other	Wilson's Valley Hut	Medium
Hut/Homestead (Intact)	Witses Hut	Medium
Hut/Homestead (Intact)	Wolgal Club	Medium
Hut/Homestead (Intact)	Wombiana Lodge; Thedbo	Medium
Yards/Fences/Sheep Dip (Site/Ruin)	Yards	Medium
Yards/Fences/Sheep Dip (Site/Ruin)	Yards	Medium
Yards/Fences/Sheep Dip (Site/Ruin)	Yards	Medium
Yards/Fences/Sheep Dip (Site/Ruin)	Yards	Medium
Yards/Fences/Sheep Dip (Site/Ruin)	Yards	Medium
Hut/Homestead (Intact)	Yellow Bog No. 1 Hut	Medium
Hut/Homestead (Intact)	Yellow Bog No. 2 Hut	Medium
Hut/Homestead (Intact)	Illawong Lodge (Pounds Creek/Tin No.1)	Medium

Appendix 5 Vegetation formations, thresholds and forest ecosystems

Key: 9999=no fire recommended; Note: The definition of Alpine vegetation formation includes a range of subalpine grasslands and heath communities, included because they have a "no burn" threshold recommendation due to their sensitivity to fire.

SCRA code	Forest Ecosystem	Threshold Formations	Min interval	Max interval	Comments	Code
35	South Coast and Byadbo Acacia Scrubs	Dry Sclerophyll Forests (shrubby subformation	7	30		F
36	Montane - Sub-Alpine Dry Rocky Shrubland	Alpine Complex	9999	9999		A
37	Scabby Range Dry Shrub Woodland	Dry Sclerophyll Forests (shrubby subformation	7	30		F
38	Tableland Dry Heath Shrub-Herb-Grass Woodland	Dry Sclerophyll Forests (shrubby subformation	7	30		F
41	Lower Snowy Rain Shadow Woodland - Shrubland	Dry Sclerophyll Forests (shrubby subformation	7	30		F
58	Tableland and Escarpment Wet Layered Shrub Forest	Wet Sclerophyll forests (shrubby subformation	25	60		D
70	Western Escarpment Dry Shrub Forest	Dry Sclerophyll Forests (shrubby subformation	7	30		F
71	Western Tableland Dry Shrub Forest	Wet Sclerophyll forests (grassy subformation)	10	50		E
73	Eastern Tableland Dry Shrub-Grass Forest	Dry Sclerophyll Forests (shrubby subformation	7	30	40 max	F
74	South Eastern Tablelands Dry Shrub-Grass-Herb Forest	Dry Sclerophyll Forests (shrub/grass subformation	5	50		G
75	Tablelands Shrub-Tussock Grass Forest	Dry Sclerophyll Forests (shrubby subformation	7	30		F
76	Central Tablelands Shrub-Grass Dry Forest	Sclerophyll Grassy Woodlands	10	40		C
77	Lower Snowy Dry Shrub-Tussock Grass Forest	Dry Sclerophyll Forests (shrubby subformation	7	30	10 min	F
78	Lower Snowy White Box Dry Shrub-Herb Woodland	Dry Sclerophyll Forests (shrubby subformation	7	30	10 min	F
79	Montane Dry Shrub-Tussock Grass Forest	Dry Sclerophyll Forests (shrubby subformation	7	30		F
82	Western Montane Acacia Fern-Herb Forest	Wet Sclerophyll forests (grassy subformation)	10	50		E
83	Montane Riparian Moist Shrub-Grass-Herb Forest	Wet Sclerophyll forests (grassy subformation)	10	50		E
86	Western Sub-alpine Moist Shrub Forest	Wet Sclerophyll forests (grassy subformation)	10	50	15 min	E
87	Western Escarpment Moist Shrub-Herb-Grass Forest	Wet Sclerophyll forests (grassy subformation)	10	50		E
88	Western Escarpment Shrub-Grass Forest	Wet Sclerophyll forests (grassy subformation)	10	50		E
93	Western Tablelands Herb-Grass Dry Forest	Dry Sclerophyll Forests (shrub/grass subformation	5	50	7 min	G
94	South West Slopes Acacia Dry Herb-Grass Forest	Dry Sclerophyll Forests (shrub/grass subformation	5	50		G
95	Tableland Acacia Moist Herb Forest	Sclerophyll Grassy Woodlands	10	40	10 min	C
97	Montane Acacia-Dry Shrub-Herb-Grass Forest	Sclerophyll Grassy Woodlands	10	40	10 min	C
98	Western Montane Moist Shrub Forest	Sclerophyll Grassy Woodlands	10	40	10 min	C
99	Montane Dry Shrub-Herb-Grass Forest	Sclerophyll Grassy Woodlands	10	40		C
101	North-Western Montane Dry Shrub-Herb-Grass Forest	Wet Sclerophyll forests (grassy subformation)	10	50		E
103	Western Montane Dry Fern-Grass Forest	Dry Sclerophyll Forests (shrubby subformation	7	30		F
104	Tableland Acacia-Herb-Grass Forest	Dry Sclerophyll Forests (shrubby subformation	7	30		F

SCRA code	Forest Ecosystem	Threshold Formations	Min interval	Max interval	Comments	Code
106	Montane Dry Shrub-Tussock Forest	Dry Sclerophyll Forests (shrubby subformation	7	30		F
107	Central Tableland-ACT Montane Dry Shrub Forest	Dry Sclerophyll Forests (shrubby subformation	7	30		F
108	Western Tablelands Dry Herb-Grass Forest	Dry Sclerophyll Forests (shrubby subformation	7	30		F
110	Tablelands Dry Shrub-Grass Forest	Dry Sclerophyll Forests (shrubby subformation	7	30		F
115	South East Tablelands Dry Shrub-Tussock Grass Forest	Dry Sclerophyll Forests (shrub/grass subformation	5	50		G
119	Western Slopes Dry Shrub-Grass Forest	Dry Sclerophyll Forests (shrub/grass subformation	5	50		G
121	Western Slopes Grass-Herb Dry Forest	Dry Sclerophyll Forests (shrub/grass subformation	5	50		G
123	Montane/Sub-alpine Sedge Swamps	Alpine Complex	9999	9999		A
124	Western Montane Wet Heath-Herb Grass Woodland	Wet Sclerophyll forests (grassy subformation)	10	50		E
125	Montane Wet Heath-Herb Grassland	Alpine Complex	9999	9999		A
128	Sub-alpine Dry Shrub-Herb Woodland	Sclerophyll Grassy Woodlands	10	40		C
129	Alpine Wet Herbfield	Alpine Complex	9999	9999		A
130	Sub-alpine Shrub-Grass Woodland	Sclerophyll Grassy Woodlands	10	40		C
131	Sub-alpine Herbfield	Alpine Complex	9999	9999		A
132	Sub-alpine Dry Herb-Grassland	Alpine Complex	9999	9999		A
133	Sub-alpine Wet Herb-Grassland-Bog	Alpine Complex	9999	9999		A
146	Tableland Dry Herb-Grass Woodland	Sclerophyll Grassy Woodlands	10	40	10 min	C
148	Tableland Tussock Grassland -Sedgeland	Grasslands	2	10		B
172	Kosciuszko Western Escarpment Cool Temperate Rainforest	Rainforests	9999	9999		A
190	Rock Outcrops	N/A	9999	9999		A
198	SC-CT-ST Herb-Grass Forest on Limestone	Dry Sclerophyll Forests (shrubby subformation	7	30		F
204	Exposed Feldmark	Alpine Complex	9999	9999		A
205	Snowpatch Alpine Feldmark	Alpine Complex	9999	9999		A
206	Short Alpine Herbfield	Alpine Complex	9999	9999		A
207	Alpine Rocky Low Open Heathland	Alpine Complex	9999	9999		A

Appendix 6 Vegetation formations and biodiversity threshold status

Note: See Table 18 for definitions of terms.

		Overburnt	Vulner-able	Recently Burnt	Ok	Almost Under burnt	Under burnt	Total
	% of Group	67.19%	30.69%	1.80%	0.33%	0.00%	0.00%	100.00%
Alpine Complex	**Area (ha)**	56561.84	25838.18	1511.68	274.83	0.00	0.33	84187
Dry Sclerophyll Forests	**% of Group**	0.01%	5.20%	32.88%	61.74%	0.00%	0.17%	100.00%
(shrub/grass subformation)	**Area (ha)**	2.34	888.41	5617.91	10548.05	0.00	28.31	17085
Dry Sclerophyll Forests	**% of Group**	0.41%	4.15%	65.60%	17.65%	0.02%	12.18%	100.00%
(shrubby subformation)	**Area (ha)**	806.80	8233.34	130277.27	35039.31	41.70	24180.52	198579
	% of Group	0.00%	9.05%	69.66%	21.29%	0.00%	0.00%	100.00%
Grasslands	**Area (ha)**	0.00	0.10	0.80	0.24	0.00	0.00	1
	% of Group	67.09%	23.89%	7.96%	1.06%	0.00%	0.00%	100.00%
Rainforests	**Area (ha)**	71.19	25.35	8.44	1.13	0.00	0.00	106
Sclerophyll Grassy	**% of Group**	0.71%	3.58%	76.74%	18.96%	0.00%	0.01%	100.00%
Woodlands	**Area (ha)**	1574.14	7935.52	169924.63	41973.41	0.00	16.79	221424
Wet Sclerophyll Forests	**% of Group**	0.24%	2.41%	76.29%	21.04%	0.00%	0.02%	100.00%
(grassy subformation)	**Area (ha)**	369.03	3658.04	115970.78	31985.60	0.00	26.15	152010
Wet Sclerophyll Forests	**% of Group**	3.92%	51.47%	34.50%	10.10%	0.00%	0.00%	100.00%
(shrubby subformation)	**Area (ha)**	155.77	2044.78	1370.70	401.36	0.00	0.00	3973

Appendix 7 Management guidelines for flora species

Note:
1. Some management recommendations may need to be waived or modified occasionally in favour of more aggressive fire suppression techniques to protect life, assets, property and other natural and cultural heritage values. Such actions and reasons justifying them will be recorded.
2. Some species are not mapped as the management guidelines contain no actions that can be implemented.
3. Geographic Information System (GIS) ID refers to ID in regional Geographic Information System data layers.
4. NM = No Mapped on Ops maps

GIS ID	Ops Map ID	Common Name Scientific Name	Legal Status	Risk Rating	Prescribed Burning Application	HR mechanical measures incl. slashing	Provide protection from Unplanned fire	Back Burning	Retardant & Foam Use	Construction of control lines, temporary trails & water points
EP1	FL3	Anemone Buttercup (Ranunculus anemoneus)	V	NA	No	No mechanical disturbance	No	OK	OK	No mechanical disturbance
EP1	FL3	Archers sedge (Carex archeri)	E1	NA	No	No mechanical disturbance	No	OK	OK	No mechanical disturbance
EP1	FL3	Fairy Bluebell (Wahlenbergia densifolia)	Re	Medium	No	No mechanical disturbance	No	OK	OK	No mechanical disturbance
EP1	FL3	Hill Buttercup (Ranunculus clivicola)	Re	NA	No	No mechanical disturbance	No	OK	OK	No mechanical disturbance
EP1	FL3	Kiandra Leek Orchid (Prasophyllum retroflexum)	V	Medium	No	No mechanical disturbance	No	OK	OK	No mechanical disturbance
EP1	FL3	Monaro Golden Daisy (Rutidosis leiolepis)	V	NA	No	No mechanical disturbance	No	OK	OK	No mechanical disturbance
EP1	FL3	Shining Cudweed (Euchiton nitidulus)	V	NA	No	No mechanical disturbance	No	OK	OK	No mechanical disturbance
EP1	FL3	Spreading Hollygrass (Hierochloe submutica)	Re	NA	No	No mechanical disturbance	No	OK	OK	No mechanical disturbance
EP2	FL2	(Rytidosperma vickeryae)	Re	High	No	No mechanical disturbance	No	OK	Avoid if possible	No mechanical disturbance
EP2	FL2	Bent Grass (Agrostis joyceae)		Medium	No	No mechanical disturbance	No	OK	Avoid if possible	No mechanical disturbance
EP2	FL2	Bittercress (Cardamine robusta)	Re	NA	No	No mechanical disturbance	No	OK	Avoid if possible	No mechanical disturbance
EP2	FL2	Bog bird orchid (Chiloglottis turfosa)	Re	Medium	No	No mechanical disturbance	No	OK	Avoid if possible	No mechanical disturbance
EP2	FL2	Eyebright (Ramshead range) (Euphrasia sp. 3)	Re	Low	No	No mechanical disturbance	No	OK	Avoid if possible	No mechanical disturbance
EP2	FL2	Feldmark Grass (Rytidosperma pumilum)	V	Low	No	No mechanical disturbance	No	OK	Avoid if possible	No mechanical disturbance
EP2	FL2	Kiandra Greenhood (Pterostylis oreophila)		Medium	No	No mechanical disturbance	No	OK	Avoid if possible	No mechanical disturbance
EP2	FL2	Mueller's Burr-daisy (Calotis pubescens)	E1	High	No	No mechanical disturbance	No	OK	Avoid if possible	No mechanical disturbance

GIS ID	Ops Map ID	Common Name Scientific Name	Legal Status	Risk Rating	Prescribed Burning Application	HR mechanical measures incl. slashing	Provide protection from Unplanned fire	Back Burning	Retardant & Foam Use	Construction of control lines, temporary trails & water points
EP2	FL2	Raleigh Sedge (Carex raleighii)	E1	High	No	No mechanical disturbance	No	OK	Avoid if possible	No mechanical disturbance
EP2	FL2	Rough Eyebright (Euphrasia scabra)	E1	Low	OK	No mechanical disturbance	No	OK	Avoid if possible	No mechanical disturbance
EP2	FL2	Small Bedstraw (Galium roddii)	Re	Medium	No	No mechanical disturbance	No	OK	Avoid if possible	No mechanical disturbance
EP2	FL2	Swamp Everlasting (Xerochrysum palustre)	Re	Low	No	No mechanical disturbance	No	OK	Avoid if possible	No mechanical disturbance
EP3	FL1	Bog Midge Orchid (Genoplesium turfosum)	Re	High	No	No mechanical disturbance	Yes	No	Avoid if possible	No mechanical disturbance
EP3	FL1	Cotoneaster Pomaderris (Pomaderris cotoneaster)	E1	High	No	No mechanical disturbance	Yes	No	Avoid if possible	No mechanical disturbance
EP3	FL1	Leafy Anchor Plant (Discaria nitida)	V	Medium	No	No mechanical disturbance	Yes	No	Avoid if possible	No mechanical disturbance
EP4	NM	Swamp Parrot-pea (Dillwynia palustris)	Re	High	No	No mechanical disturbance	No	No	Avoid if possible	No mechanical disturbance
EP5	FL3	(Poa orthoclada)	Re	Medium	OK	No mechanical disturbance	No	OK	OK	No mechanical disturbance
EP5	FL3	(Ranunculus productus)	Re	NA	OK	No mechanical disturbance	No	OK	OK	No mechanical disturbance
EP5	FL3	Austral Dandelion (Taraxacum aristum)	Re	Low	OK	No mechanical disturbance	No	OK	OK	No mechanical disturbance
EP5	FL3	Austral Toadflax (Thesium australe)	V	NA	OK	No mechanical disturbance	No	OK	OK	No mechanical disturbance
EP5	FL3	Bogong Gum (Eucalyptus chapmaniana)	Re	NA	OK	No mechanical disturbance	No	OK	OK	No mechanical disturbance
EP5	FL3	Catkin Wattle (Acacia dallachiana)	U	NA	Check reproductive stage before burning	No mechanical disturbance	No	OK	OK	No mechanical disturbance
EP5	FL3	Elusive Cress (Irenepharsus magicus)	E1	NA	OK	No mechanical disturbance	No	OK	OK	No mechanical disturbance
EP5	FL3	Happy Jacks Daisy Bush (Olearia stenophylla)	Re	Low	OK	No mechanical disturbance	No	OK	OK	No mechanical disturbance
EP5	FL3	Late Forest Gentian (Chionogentias sylvicola)		NA	No	No mechanical disturbance	NA	NA	NA	No mechanical disturbance
EP5	FL3	Mauve Burr-daisy (Calotis glandulosa)	V	NA	OK	No mechanical disturbance	No	OK	OK	No mechanical disturbance

GIS ID	Ops Map ID	Common Name Scientific Name	Legal Status	Risk Rating	Prescribed Burning Application	HR mechanical measures incl. slashing	Provide protection from Unplanned fire	Back Burning	Retardant & Foam Use	Construction of control lines, temporary trails & water points
EP5	FL3	Monkey Mint Bush (Prostanthera monticola)	Re	NA	OK	No mechanical disturbance	No	OK	OK	No mechanical disturbance
EP5	FL3	Mountain Haloragodendron (Haloragodendron baeuerlenii)		NA	No	No mechanical disturbance	NA	NA	NA	No mechanical disturbance
EP5	FL3	Mountain Leek Orchid (Prasophyllum montanum)	U	NA	OK	No mechanical disturbance	No	OK	OK	No mechanical disturbance
EP5	FL3	Pale Pomoderris (Pomaderris pallida)	V	Medium	OK	No mechanical disturbance	No	OK	OK	No mechanical disturbance
EP5	FL3	Prostrate bossiaea (Bossiaea sp. aff. riparia)	Re	Medium	Interval >20 years	No mechanical disturbance	No	OK	OK	No mechanical disturbance
EP5	FL3	Small Snake Orchid (Diuris pedunculata)	E1	Low	OK	No mechanical disturbance	No	OK	OK	No mechanical disturbance
EP5	FL3	Stork's Bill (Pelargonium helmsii)	Re	NA	OK	No mechanical disturbance	No	OK	OK	No mechanical disturbance
EP5	FL3	Suggan Buggan Mallee (Eucalyptus saxatilis)	E1	NA	OK	No mechanical disturbance	No	OK	OK	No mechanical disturbance
EP5	FL3	Thyme Heath Myrtle (Euryomyrtus denticulata)	U	NA	OK	No mechanical disturbance	No	OK	OK	No mechanical disturbance
EP5	FL3	Woolly Daisy Bush (Olearia lasiophylla)	Re	NA	OK	No mechanical disturbance	No	OK	OK	No mechanical disturbance
EP6	NM	Alpine Daisy Bush (Olearia aglossa)		NA	OK	OK	No	OK	OK	OK
EP6	NM	Bertya findlayi (Bertya findlayi)	U		OK	OK	No	OK	OK	OK
EP6	NM	Mountain speedwell (Derwentia nivea)	Re	NA	OK	OK	No	OK	OK	OK
EP6	NM	Protrate Daisy Bush (Olearia rhizomatica)	U	NA	OK	OK	No	OK	OK	OK
EP6	NM	Square Raspwort (Haloragis exalata subsp. exalata var. exalata)	V	NA	OK	OK	No	OK	OK	OK
EP7	NM	Thick Leaf Star-hair (Astrotricha sp. 4)	Re	NA	Check reproductive stage before burning	OK	No	OK	OK	OK

Appendix 8 Management guidelines for fauna species

Notes:
1. Some management recommendations may need to be waived or modified occasionally in favour of more aggressive fire suppression techniques to protect life, assets, property and other natural and cultural heritage values. Such actions and reasons justifying them will be recorded.
2. Some species are not mapped as the management guidelines contain no actions that can be implemented.
3. Geographic Information System (GIS) ID refers to ID in regional GIS data layers.
4. NM = No Mapped on Ops maps

GIS ID	Ops Map ID	Common Name Scientific Name	Legal Status	Risk Rating	Prescribed Burning Application	HR mechanical measures incl. slashing	Maximise efforts to protect from unplanned fire	Back Burning	Retardant & Foam Use	Construction of control lines, temporary trails & water points	Mopping Up Activities
EA1	NM	Booroolong Frog (Litoria booroolongensis)	E1	NA	OK if within thresholds.	OK	No	OK	OK	OK	Minimise adverse impacts.
EA1	NM	Diamond Firetail (Stagonopleura guttata)	V	NA	No burning in late Winter and Spring	OK	No	OK	OK	OK	Minimise adverse impacts.
EA1	NM	Koala (Phascolarctos cinereus)	V	NA	OK if within thresholds.	OK	No	OK	OK	OK	Minimise adverse impacts.
EA1	NM	Painted Snipe (Australian subspecies) (Rostratula benghalensis australis)	E1	NA	OK if within thresholds.	OK	No	OK	OK	OK	Minimise adverse impacts.
EA1	NM	Pink Robin (Petroica rodinogaster)	V	NA	OK if within thresholds.	OK	No	OK	OK	OK	Minimise adverse impacts.
EA1	NM	Rosenberg's Goanna (Varanus rosenbergi)	V	NA	OK if within thresholds.	OK	No	OK	OK	OK	Minimise adverse impacts.
EA1	NM	Speckled Warbler (Pyrrholaemus sagittatus)	V	NA	No burning in late Winter and Spring	OK	No	OK	OK	OK	Minimise adverse impacts.
EA1	NM	Spotted-tailed Quoll (Dasyurus maculatus)	V	NA	Do not burn around known den / latrine sites	OK	No	OK	OK	OK	Minimise adverse impacts.
EA1	NM	Square-tailed Kite (Lophoictinia isura)	V	NA	OK if within thresholds.	OK	No	OK	OK	OK	Minimise adverse impacts.
EA2	FA3	Brush-tailed Phascogale (Phascogale tapoatafa)	V	NA	Protect hollow bearing trees from bark ignition, heat and smoke exposure. No burning May - July mating season in known habitat areas.	Do not fall or damage stags & hollow bearing trees, rake around base and logs.	Protect known nest trees	Rake around base of hollow bearing trees prior to burning.	OK	Do not fall stags & hollow bearing trees, rake around base and logs.	Do not fall stags & large hollow bearing trees. If tree burning attempt to extinguish fire rather than falling.

GIS ID	Ops Map ID	Common Name Scientific Name	Legal Status	Risk Rating	Prescribed Burning Application	HR mechanical measures incl. slashing	Maximise efforts to protect from unplanned fire	Back Burning	Retardant & Foam Use	Construction of control lines, temporary trails & water points	Mopping Up Activities
EA2	FA3	Eastern Pygmy-possum (Cercartetus nanus)	V	NA	Protect stags & hollow bearing trees from bark ignition, heat and smoke exposure. Do not burn in Spring and protect heathy understorey vegetation, especially Banksia spp.	Do not fall or damage stags & hollow bearing trees, rake around base.	Protect known nest trees	Rake around base of hollow bearing trees prior to burning.	OK	Do not fall stags & hollow bearing trees, rake around base.	Do not fall stags & large hollow bearing trees. If tree burning attempt to extinguish fire rather than falling.
EA2	FA3	Powerful Owl (Ninox strenua)	V	NA	Protect stags & hollow bearing trees from bark ignition, heat and smoke exposure	Do not fall or damage stags & hollow bearing trees, rake around base.	Protect known nest trees	Rake around base of hollow bearing trees prior to burning.	OK	Do not fall stags & hollow bearing trees, rake around base.	Do not fall stags & large hollow bearing trees. If tree burning attempt to extinguish fire rather than falling.
EA2	FA3	Sooty Owl (Tyto tenebricosa)	V	NA	Protect stags & hollow bearing trees from bark ignition, heat and smoke exposure	Do not fall or damage stags & hollow bearing trees, rake around base.	Protect known nest trees	Rake around base of hollow bearing trees prior to burning.	OK	Do not fall stags & hollow bearing trees, rake around base.	Do not fall stags & large hollow bearing trees. If tree burning attempt to extinguish fire rather than falling.
EA2	FA3	Yellow-bellied Glider (Petaurus australis)	V	NA	Protect stags & hollow bearing trees from bark ignition, heat and smoke exposure. Protect sap feeding trees.	Do not fall or damage stags & hollow bearing trees, rake around base.	Protect known nest trees	Rake around base of hollow bearing trees prior to burning.	OK	Do not fall stags & hollow bearing trees, rake around base.	Do not fall stags & large hollow bearing trees. If tree burning attempt to extinguish fire rather than falling.
EA3	FA1	Northern Corroboree Frog (Pseudophryne pengilleyi)	V	Medium	Not in priority areas	No mechanical disturbance within 50m of identified priority sites. No mechanical disturbance through non-priority sites. Clean up of existing trails, permitted, however no widening within 50m of sites - debris must not be pushed off trail within 50m of sites. No new trails within 100m of all sites.	Yes - only at identified priority sites.	Not in identified priority areas	Not within 100m of all sites.	No additional tracks/containment lines within 100m of identified priority sites.	Minimise adverse impacts.

GIS ID	Ops Map ID	Common Name Scientific Name	Legal Status	Risk Rating	Prescribed Burning Application	HR mechanical measures incl. slashing	Maximise efforts to protect from unplanned fire	Back Burning	Retardant & Foam Use	Construction of control lines, temporary trails & water points	Mopping Up Activities
EA3	FA1	Southern Corroboree Frog (Pseudophryne corroboree)	E1	High	No	No mechanical disturbance within 50m of known habitat.	Yes - only at identified priority sites.	Not in identified priority areas	Not within 100m of all sites.	For identified priority sites only along pre-determined routes. No additional tracks/containment lines within 100m of non-priority sites.	No vehicles in bogs.
EA4	FA2	Broad-toothed Rat (Mastacomys fuscus)	V	Medium	No	No mechanical disturbance	Yes - only at identified priority sites.	Not in habitat.	Only if absolutely necessary	Use existing watering points only. If watering points depauperate pre-plan and survey for species. No control lines or temporary trails in habitat.	Minimise adverse impacts.
EA4	FA2	Mountain Pygmy-possum (Burramys parvus)	E1	High	No	No mechanical disturbance	Protect all habitat if possible, critical to protect priority areas	Not permitted	Only if absolutely necessary	Not permitted	Minimise adverse impacts.
EA5	FA2	Eastern False Pipistrelle (Falsistrellus tasmaniensis)	V	NA	Not within 100m of known roosting and breeding trees, prevent smoke entry into hollows. Protect stags & hollow bearing trees from bark ignition, heat and smoke exposure. No burning in Spring and Summer.	Do not fall or damage stags & hollow bearing trees, rake around base.	Protect known roosting and breeding trees	Rake around base of stags & hollow bearing trees prior to burning.	OK	No additional tracks/containment lines within 50m of identified priority sites. Do not fall stags & hollow bearing trees, rake around base.	Do not fall stags & large hollow bearing trees. If tree burning attempt to extinguish fire rather than falling.

GIS ID	Ops Map ID	Common Name Scientific Name	Legal Status	Risk Rating	Prescribed Burning Application	HR mechanical measures incl. slashing	Maximise efforts to protect from unplanned fire	Back Burning	Retardant & Foam Use	Construction of control lines, temporary trails & water points	Mopping Up Activities
EA5	FA2	Eastern Freetail-bat (Mormopterus norfolkensis)	V	NA	Not within 100m of known roosting and breeding trees, prevent smoke entry into hollows. Protect stags & hollow bearing trees from bark ignition, heat and smoke exposure. No burning in Spring and Summer.	Do not fall or damage stags & hollow bearing trees, rake around base.	Protect known roosting and breeding trees	Rake around base of stags & hollow bearing trees prior to burning.	OK	No additional tracks/containment lines within 50m of identified priority sites. Do not fall or damage stags & hollow bearing trees, rake around base.	Do not fall stags & large hollow bearing trees. If tree burning attempt to extinguish fire rather than falling.
EA5	FA2	Greater Long-eared Bat (Nyctophilus timoriensis)	V	NA	Not within 100m of known roosting and breeding trees, prevent smoke entry into hollows. Protect stags & hollow bearing trees from bark ignition, heat and smoke exposure. No burning in Spring and Summer.	Do not fall or damage stags & hollow bearing trees, rake around base.	Protect known roosting and breeding trees	Rake around base of stags & hollow bearing trees prior to burning.	OK	No additional tracks/containment lines within 50m of identified priority sites. Do not fall stags & hollow bearing trees, rake around base.	Do not fall stags & large hollow bearing trees. If tree burning attempt to extinguish fire rather than falling.
EA6	FA4	Spotted Tree Frog (Litoria spenceri)	E1	High	OK if within thresholds.	No riparian vegetation to be removed in Bourke's Gorge.	No	OK	Not within 100m of Bogong Creek within Bourke's Gorge.	No riparian vegetation to be removed in Bourke's Gorge. Use existing water points.	No riparian vegetation to be removed in Bourke's Gorge.

GIS ID	Ops Map ID	Common Name Scientific Name	Legal Status	Risk Rating	Prescribed Burning Application	HR mechanical measures incl. slashing	Maximise efforts to protect from unplanned fire	Back Burning	Retardant & Foam Use	Construction of control lines, temporary trails & water points	Mopping Up Activities
EA7	FA4	Alpine Tree Frog (Litoria verreauxii alpina)	E1	NA	OK if within thresholds.	No mechanical disturbance within 50m of identified priority sites. No mechanical disturbance through non-priority sites. Clean up of existing trails, permitted, however no widening within 50m of sites - debris must not be pushed off trail within 50m of sites. No new trails within 100m of all sites.	No	OK	Not within 100m of all sites.	No additional tracks/containment lines within 100m of identified priority sites.	Minimise adverse impacts.
EA8	NM	Hooded Robin (south-eastern form) (Melanodryas cucullata cucullata)	V	NA	No burning in late Winter and Spring	Rake around logs	No	OK	OK	Rake around logs	Minimise adverse impacts.
EA9	FA1	Eastern bent-wing bat (Miniopterus schreibersii oceanensis)	V	NA	OK if within thresholds. No burning in May-June and November-February.	Avoid mechanical disturbance within 100m of known roosting and breeding sites in caves and man made structures (e.g. mine shafts,storm-water tunnels, buildings), remove fuel from entrances.	Protect known roosting and breeding sites in caves and man made structures (e.g. mine shafts,storm-water tunnels, buildings), prevent flame and smoke entry.	Not within 100m of known roosting and breeding sites in caves and man made structures (e.g. mine shafts,storm-water tunnels, buildings), prevent flame and smoke entry.	Not within 100m of known roosting and breeding sites in caves and mine shafts.	No additional tracks/containment lines within 100m of known roosting and breeding sites in caves and man made structures (e.g. mine shafts,storm-water tunnels, buildings)	Prevent /remove blockages (e.g. fallen trees) in entrances to caves and known roosting and breeding sites in and man made structures.
EA10	FA2	Smoky Mouse (Pseudomys fumeus)	E1	Low	Not within priority areas. Protect areas with diverse heathy understorey / grass trees on ridgetops from fire intervals <15 years	No disturbance of diverse heathy areas within identified priority areas.	Yes - only at identified priority sites.	Not in identified priority areas	OK	Only use existing trails. If additional trails or widening is necessary no clearing of diverse heath within priority areas.	Do not fall stags & large hollow bearing trees. If tree burning attempt to extinguish fire rather than falling.

GIS ID	Ops Map ID	Common Name Scientific Name	Legal Status	Risk Rating	Prescribed Burning Application	HR mechanical measures incl. slashing	Maximise efforts to protect from unplanned fire	Back Burning	Retardant & Foam Use	Construction of control lines, temporary trails & water points	Mopping Up Activities
Not mapped	NM	Barking Owl (Ninox connivens)	V	NA	Protect stags & hollow bearing trees from bark ignition, heat and smoke exposure	Do not fall or damage stags & hollow bearing trees, rake around base.	Protect known nest trees	Rake around base of stags & hollow bearing trees prior to burning.	OK	Do not fall stags & hollow bearing trees, rake around base.	Do not fall stags & large hollow bearing trees. If tree burning attempt to extinguish fire rather than falling.
Not mapped	NM	Grey-headed Flying-fox (Pteropus poliocephalus)	V	NA	OK if within thresholds.	OK	No	OK	OK	OK	Minimise adverse impacts.
Not mapped	NM	Large-footed Myotis (Myotis adversus)	V	NA	Not within 100m of known roosting and breeding sites in tree hollows and man made structures (e.g. mine shafts,storm-water tunnels, buildings), prevent flame and smoke entry. Protect stags & hollow bearing trees from bark ignition, heat and smoke exposure. No burning in Spring and Summer.	Avoid mechanical disturbance within 100m of known roosting and breeding sites in tree hollows and man made structures (e.g. mine shafts,storm-water tunnels, buildings). Do not fall or damage stags & hollow bearing trees, rake around base. Remove fuel from entrances to sites in man made structures.	Protect known roosting and breeding sites in tree hollows and man made structures (e.g. mine shafts,storm-water tunnels, buildings), prevent flame and smoke entry.	Rake around base of stags & hollow bearing trees prior to burning. Remove fuel from entrances to known sites in man made structures. Prevent flame and smoke entry.	OK	No additional tracks/containment lines within 100m of known roosting and breeding sites in trees and man made structures (e.g. mine shafts,storm-water tunnels, buildings). Do not fall or damage stags & hollow bearing trees, rake around base. Remove fuel from entrances to sites in man made structures.	Do not fall stags & large hollow bearing trees. If tree burning attempt to extinguish fire rather than falling. Prevent /remove entrance blockages (e.g. fallen trees) in entrances to known sites in man made structures.
Not mapped	NM	Latham's Snipe (Gallinago hardwickii)	V	NA	OK if within thresholds.	OK	No	OK	OK	OK	Minimise adverse impacts.
Not mapped	NM	Masked Owl (Tyto novaehollandiae)	V	NA	Protect stags & hollow bearing trees from bark ignition, heat and smoke exposure	Do not fall or damage stags & hollow bearing trees, rake around base.	Protect known nest trees	Rake around base of stags & hollow bearing trees prior to burning.	OK	Do not fall stags & hollow bearing trees, rake around base.	Do not fall stags & large hollow bearing trees. If tree burning attempt to extinguish fire rather than falling.
Not mapped	NM	Orange-bellied Parrot (Neophema chrysogaster)	E1	NA	OK if within thresholds.	OK	No	OK	OK	OK	Minimise adverse impacts.

GIS ID	Ops Map ID	Common Name Scientific Name	Legal Status	Risk Rating	Prescribed Burning Application	HR mechanical measures incl. slashing	Maximise efforts to protect from unplanned fire	Back Burning	Retardant & Foam Use	Construction of control lines, temporary trails & water points	Mopping Up Activities
Not mapped	NM	Squirrel Glider (Petaurus norfolcensis)	V	NA	Protect stags & hollow bearing trees from bark ignition, heat and smoke exposure. Protect understorey especially Acacia spp.	Do not fall or damage stags & hollow bearing trees, rake around base.	Protect known nest trees	Rake around base of stags & hollow bearing trees prior to burning.	OK	Do not fall stags & hollow bearing trees, rake around base.	Do not fall stags & large hollow bearing trees. If tree burning attempt to extinguish fire rather than falling.
Not mapped	NM	Turquoise Parrot (Neophema pulchella)	V	NA	Protect stags & hollow bearing trees from bark ignition, heat and smoke exposure	Do not fall or damage hollow bearing trees, rake around base.	Protect known nest trees	Rake around base of stags & hollow bearing trees prior to burning.	OK	Do not fall stags & hollow bearing trees, rake around base.	Do not fall stags & large hollow bearing trees. If tree burning attempt to extinguish fire rather than falling.
Not mapped	NM	Yellow-bellied Sheathtail-bat (Saccolaimus flaviventris)	V	NA	Not within 100m of known roosting and breeding trees, prevent smoke entry into hollows. Protect stags & hollow bearing trees from bark ignition, heat and smoke exposure. No burning in Spring and Summer.	Do not fall or damage hollow bearing trees, rake around base.	Protect known roosting and breeding trees	Rake around base of stags &hollow bearing trees prior to burning.	OK	No additional tracks/containment lines within 50m of identified priority sites. Do not fall stags & hollow bearing trees, rake around base.	Do not fall stags & large hollow bearing trees. If tree burning attempt to extinguish fire rather than falling.
Widespread	NM	Brown Treecreeper (eastern subsp.) (Climacteris picumnus victoriae)	V	NA	Protect stags & hollow bearing trees from bark ignition, heat and smoke exposure. No burning late Winter and Spring.	Do not fall or damage stags & hollow bearing trees, rake around base and logs.	Protect known nest trees	Rake around base of stags & hollow bearing trees prior to burning.	OK	Do not fall stags & hollow bearing trees, rake around base and logs.	Do not fall stags & large hollow bearing trees. If tree burning attempt to extinguish fire rather than falling.
Widespread	NM	Gang-gang Cockatoo (Callocephalon fimbriatum)	V	NA	Protect stags & hollow bearing trees from bark ignition, heat and smoke exposure	Do not fall or damage stags & hollow bearing trees, rake around base.	Protect known nest trees	Rake around base of stags & hollow bearing trees prior to burning.	OK	Do not fall stags & hollow bearing trees, rake around base.	Do not fall stags & large hollow bearing trees. If tree burning attempt to extinguish fire rather than falling.

GIS ID	Ops Map ID	Common Name Scientific Name	Legal Status	Risk Rating	Prescribed Burning Application	HR mechanical measures incl. slashing	Maximise efforts to protect from unplanned fire	Back Burning	Retardant & Foam Use	Construction of control lines, temporary trails & water points	Mopping Up Activities
Widespread	NM	Glossy Black-Cockatoo (Calyptorhynchus lathami)	V	NA	Protect stags & hollow bearing trees from bark ignition, heat and smoke exposure	Do not fall or damage stags & hollow bearing trees, rake around base.	Protect known nest trees	Rake around base of stags & hollow bearing trees prior to burning.	OK	Do not fall stags & hollow bearing trees, rake around base.	Do not fall stags & large hollow bearing trees. If tree burning attempt to extinguish fire rather than falling.
Widespread	NM	Olive Whistler (Pachycephala olivacea)	V	NA	OK if within thresholds.	OK	No	OK	OK	OK	Minimise adverse impacts.

Appendix 9 Management guidelines for priority habitats

(Note: Some management recommendations may be waived or modified occasionally in favour of more aggressive fire suppression techniques to protect life, assets, property and other natural and cultural heritage values. Such actions and reasons justifying them will be recorded; Map ID commencing with EH refers to locations identified on operations maps as well as in Figure 20 in the text)

Map ID	Full name of EEC or habitat	Risk Rating	Prescribed Burning Application	HR mechanical measures incl. slashing	Protect from Unplanned fire	Back Burning	Retardant & Foam Use	Construction of control lines, temporary trails & water points	Mopping Up Activities
Polygon Fig 20	Alpine		No	No	Yes	No	Only if absolutely necessary	Restrict to existing roads and tracks as much as possible.	Minimise adverse impacts
Not shown	Montane Peatlands and Swamps	High	No	No mechanical disturbance within 50m.	Yes	No backburning through bogs.	No	Not within 100m from bog edge.	No vehicles in bogs.
Fig 20 (within Burramys habitat)	Podocarpus lawrencii shrublands	High	None of community for life of strategy.	No mechanical disturbance. Restrict to existing roads and tracks as much as possible. If required limit to edge.	Yes	No	OK	No	Minimise adverse impacts
Fig 20	All Burramys habitat	Medium	No	No	Yes	Not in priority area	Only if absolutely necessary	Not in any Burramys habitat area	Minimise adverse impacts
EH2	Burramys Blue Cow - Guthega	Medium	No	No	Yes	Not in priority area	Only if absolutely necessary	Not in priority area	Minimise adverse impacts
EH2	Burramys Charlotte Pass	Medium	No	No	Yes	Not in priority area	Only if absolutely necessary	Not in priority area	Minimise adverse impacts
EH2	Burramys Mt Kosciuszko - Mueller's Peak	Medium	No	No	Yes	Not in priority area	Only if absolutely necessary	Not in priority area	Minimise adverse impacts
EH2	Burramys Paralyser - Mt Perisher	Medium	No	No	Yes	Not in priority area	Only if absolutely necessary	Not in priority area	Minimise adverse impacts
EH2	Burramys Spencers Creek	Medium	No	No	Yes	Not in priority area	Only if absolutely necessary	Not in priority area	Minimise adverse impacts

Map ID	Full name of EEC or habitat	Risk Rating	Prescribed Burning Application	HR mechanical measures incl. slashing	Protect from Unplanned fire	Back Burning	Retardant & Foam Use	Construction of control lines, temporary trails & water points	Mopping Up Activities
EH2	Burramys Summit Road	Medium	No	No	Yes	Not in priority area	Only if absolutely necessary	Not in priority area	Minimise adverse impacts
EH2	Whites River	Medium	No	No	Yes	Not in priority area	Only if absolutely necessary	Not in priority area	Minimise adverse impacts
EH2	Gungarten	Medium	No	No	Yes	Not in priority area	Only if absolutely necessary	Not in priority area	Minimise adverse impacts
EH3	Mastacomys Guthega Power Stn - Horse Camp Hut	Medium	No	No	Yes	Not in priority area	OK	Use existing watering points only. If watering points depauperate pre-plan and survey for species. No control lines or temporary trails in habitat.	Not relevant
EH3	Mastacomys Munyang River - Whites River Hut	Medium	No	No	Yes	Not in priority area	OK	Use existing watering points only. If watering points depauperate pre-plan and survey for species. No control lines or temporary trails in habitat.	Not relevant
EH3	Mastacomys Perisher Creek	Medium	No	No	Yes	Not in priority area	OK	Use existing watering points only. If watering points depauperate pre-plan and survey for species. No control lines or temporary trails in habitat.	Not relevant

Map ID	Full name of EEC or habitat	Risk Rating	Prescribed Burning Application	HR mechanical measures incl. slashing	Protect from Unplanned fire	Back Burning	Retardant & Foam Use	Construction of control lines, temporary trails & water points	Mopping Up Activities
EH3	Mastacomys Smiggin Holes	Medium	No	No	Yes	Not in priority area	OK	Use existing watering points only. If watering points depauperate pre-plan and survey for species. No control lines or temporary trails in habitat.	Not relevant
EH4	Sth Corroboree Frog - Jagumba Fire Trail	Medium	No	No mechanical disturbance within 50m of known habitat.	Yes	Not in priority area	Not within 100m.	Only along pre-determined routes.	No vehicles in bogs.
EH4	Sth Corroboree Frog - Maragle Range	Medium	No	No mechanical disturbance within 50m of known habitat.	Yes	Not in priority area	Not within 100m.	Only along pre-determined routes.	No vehicles in bogs.
EH4	Sth Corroboree Frog - Mt Jagumba	Medium	No	No mechanical disturbance within 50m of known habitat.	Yes	Not in priority area	Not within 100m.	Only along pre-determined routes.	No vehicles in bogs.
EH5	Eastern Bentwing Bat - Yarrangobilly Karsts 1		OK if within thresholds. No burning in May-June and November-February.	Avoid mechanical disturbance within 100m of known roosting and breeding sites in caves and man made structures (e.g. mine shafts,storm-water tunnels, buildings), remove fuel from entrances.	Protect known roosting and breeding sites in caves and man made structures, prevent flame and smoke entry.	Not within 100m of known roosting and breeding sites in caves and man made structures (e.g. mine shafts,storm-water tunnels, buildings), prevent flame and smoke entry.	Not within 100m of known roosting and breeding sites in caves and mine shafts.	No additional tracks/containment lines within 100m of known roosting and breeding sites in caves and man made structures (e.g. mine shafts,storm-water tunnels, buildings)	Prevent /remove blockages (e.g. fallen trees) in entrances to caves and known roosting and breeding sites in and man made structures.

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EH5	Eastern Bentwing Bat - Yarrangobilly Karsts 2		OK if within thresholds. No burning in May-June and November-February.	Avoid mechanical disturbance within 100m of known roosting and breeding sites in caves and man made structures (e.g. mine shafts,storm-water tunnels, buildings), remove fuel from entrances.	Protect known roosting and breeding sites in caves and man made structures, prevent flame and smoke entry.	Not within 100m of known roosting and breeding sites in caves and man made structures (e.g. mine shafts,storm-water tunnels, buildings), prevent flame and smoke entry.	Not within 100m of known roosting and breeding sites in caves and mine shafts.	No additional tracks/containment lines within 100m of known roosting and breeding sites in caves and man made structures (e.g. mine shafts,storm-water tunnels, buildings)	Prevent /remove blockages (e.g. fallen trees) in entrances to caves and known roosting and breeding sites in and man made structures.
EH6	Remnant Rainforest Geehi, Pilot and Bogong Peaks wilderness areas	Medium	None of community for life of strategy.	No mechanical disturbance. Restrict to existing roads and tracks as much as possible. If required limit to edge.	Yes	Not within community. Backburn adjacent to this community, as late as possible to allow back burn to trickle downhill and go out. Use FMC differentials to advantage.	OK	No	Minimise adverse impacts
EH6	Karst grassland Cave Ck / Cooleman Caves	NA	None of community for life of strategy.	No mechanical disturbance. Restrict to existing roads and tracks as much as possible. If required limit to edge.	No	OK	No	No	Minimise adverse impacts
EH7	Bogong Peaks	Low	No	OK	Yes	Avoid unless demonstrably essential	On slopes OK but not in bog system	No	Minimise adverse impacts

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EH8	Kosciuszko Creek Headwaters	Low	No	No	Yes. Actively suppress all ignitions to the west	Not in priority area	OK	Hand tool lines only preferred	Minimise adverse impacts
EH8	Old Growth Ash - Manjar	Low	No	No	Yes	Not in priority area	OK	Hand tool lines only preferred	Minimise adverse impacts
EH9	Mt Trooper	Low	No	No	No	No	No	No	Minimise adverse impacts
Polygon Fig 20	Subalpine Woodlands	NA	OK if within thresholds	OK	No	OK	OK	OK	Minimise adverse impacts
Polygon Fig 20	Subalpine Treeless Plains	High	None in grasslands and sub-alpine stream banks for life of strategy, otherwise OK for other communities if within thresholds.	No mechanical disturbance. Restrict to existing roads and tracks as much as possible. If required limit to edge.	No	OK	Not along sub-alpine stream banks.	Restrict to existing roads and tracks as much as possible. If additional required limit to edge. Identify and map low risk water points.	Minimise adverse impacts
Polygon Fig 20	Alpine Ash Forests	Low	Avoid unless life and property directly threatened	OK	No	Avoid unless demonstrably essential tp protect life and property	OK	OK	Minimise adverse impacts
Polygon Fig 20	White Box Yellow Box Blakely's Red Gum Woodland	Medium	OK if within thresholds	OK	No	OK	OK	OK	Minimise adverse impacts

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Not shown	Nth Corroboree Frog Priority site 1	NA	No	No mechanical disturbance within 50m of known habitat. Clean up of existing trails, permitted, however no widening within 50m of sites - debris must not be pushed off trail within 50m of sites. No new trails within 100m.	Yes	Not in priority area	Not within 100m.	No additional tracks/containment lines within 100m.	No vehicles in bogs.
Not shown	Nth Corroboree Frog Priority site 2	NA	No	No mechanical disturbance within 50m of known habitat. Clean up of existing trails, permitted, however no widening within 50m of sites - debris must not be pushed off trail within 50m of sites. No new trails within 100m.	Yes	Not in priority area	Not within 100m.	No additional tracks/containment lines within 100m.	No vehicles in bogs.
Not shown	Nth Corroboree Frog Priority site 3	NA	No	No mechanical disturbance within 50m of known habitat. Clean up of existing trails, permitted, however no widening within 50m of sites - debris must not be pushed off trail within 50m of sites. No new trails within 100m.	Yes	Not in priority area	Not within 100m.	No additional tracks/containment lines within 100m.	No vehicles in bogs.

**NATIONAL
PARKS AND
WILDLIFE
SERVICE**

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