



# **FIRE MANAGEMENT STRATEGY BRISBANE WATER NATIONAL PARK**

**INCORPORATING  
HOWE AND MOONEY MOONEY ABORIGINAL AREAS**

*NSW National Parks and Wildlife Service  
Central Coast Hunter Range Region  
June 2006*



**Department of  
Environment and Conservation (NSW)**

our environment *it's a living thing*

**FIRE MANAGEMENT STRATEGY**  
**for**  
**Brisbane Water National Park**

This fire management strategy has been prepared by the Central Coast Hunter Range Region Fire Management Section with assistance from the Gosford Area Staff.

For additional information or enquires on the management of fire in Brisbane Water National Park, please visit the Central Coast Hunter Range Region Office at 207 Albany Street, Gosford or telephone (02) 43204248 during business hours.

This strategy has been endorsed by;

Bob Conroy  
Director,  
Central Branch,  
National Parks and Wildlife Service  
Department of Environment and Conservation NSW

**Cover Photo:** Brisbane Water National Park overlooking Woy Woy from the Mount Wondabyne area. Photo by Jeff Betteridge

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## 1. INTRODUCTION

### 1.1 Scope, Term and Purpose

Under the *Rural Fires Act 1997*, the National Parks and Wildlife Service (NPWS, or the Service) is a fire authority and is responsible for the control and suppression of fires on areas that it manages.

This Fire Management Strategy has been developed to provide direction for fire management activities, including bush fire mitigation and suppression, in Brisbane Water National Park, Howe Aboriginal Area and Mooney Mooney Aboriginal Area.

The strategy establishes a database of fire control advantages and provides fire management zones, with an emphasis on the protection of life and property. Guidelines are also provided for the protection of the natural and cultural heritage values of Brisbane Water National Park.

The fire management strategy will have a five year term, at which time a review will be undertaken. It is likely that unplanned fires will occur during this period which will affect hazard reduction programs. If fires occur, the prescribed burning program will be modified so that affected and adjoining zones are managed in accordance with the targeted fire regime and retain a mosaic pattern of fire history.

The strategy has been prepared in consultation with the Gosford Bush Fire Management Committee, the NSW Rural Fire Service, park neighbours and other stakeholders.

This Strategy has been prepared in accordance with the policies and procedures detailed in the NPWS Fire Management Manual, NPWS Strategy for Fire Management and the relevant Plan of Management. The strategy has considered the bushfire environment, bush fire risks and management strategies, prescribed burning program and priorities identified in the Sydney Basin Fire Management Strategy, and cooperative fire fighting agreements outlined in the relevant District Fire Management Committee Risk Management and Operations Plans

For protection of adjoining assets to be successful, adjoining property owners should have regard to the NSW Rural Fire Service guidelines for construction standards and property maintenance measures for bushfire prone areas.

## 1.2 Fire Management Objectives

The primary objectives of fire management by the NPWS are to:

- 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 known to exist within NSW and historic places and culturally significant features known to exist within reserves 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.

The maintenance of biodiversity to avoid the extinction of natural species, populations and communities within the landscape underpins fire management activities within the NPWS.

## 1.3 Description of the Reserves

### 1.3.1 Location and Terrain

Brisbane Water National Park (Lat. 33° 30'S, Long. 151° 15'E) is located north of the Hawkesbury River some 50km from Sydney (Figure 1). The Park covers an area of 11,473 hectares, forming a significant link in a reserve system that conserves the range of habitat in the Sydney Basin Bio-region from the coast to the Great Dividing Range.

The eastern boundary of the Park is formed by the residential areas along the coastal flats of Brisbane Water from Point Clare to Pearl Beach. The western boundary of the Park is delineated by the Sydney to Newcastle freeway and Peats Ridge Road. Other infrastructure within the Park includes the main northern railway that runs along the eastern bank of Mullet creek, passing through a long tunnel to Woy Woy. The Pacific Highway leaves the freeway at Calga, dissecting the park as it passes to Kariong. Woy Woy Road runs from Kariong to Woy woy in the south, and a number of fire trails and walking tracks provide access into core areas of the park.

A finger of the park extends five kilometres to the north along the Somersby plateau from the residential area of Kariong and Somersby industrial estate to Mangrove Mountain. Agriculture such as poultry farms and orchards, and other freehold lands dominate land use adjacent to the park in these areas.

The Howe Aboriginal Area adjoins Grants Road at Somersby near Floods Creek.

The Mooney Mooney Aboriginal Area adjoins the park on the north side of the Pacific Highway between the Girrakool picnic area and the Mooney Mooney bridge.

Within the park a number of isolated in holdings occur along Mullet Creek and Mooney Mooney Creek. Other in-holdings within the core of the park include Belmont Farm, Dillon's Farm, and the Kariong Rifle range.

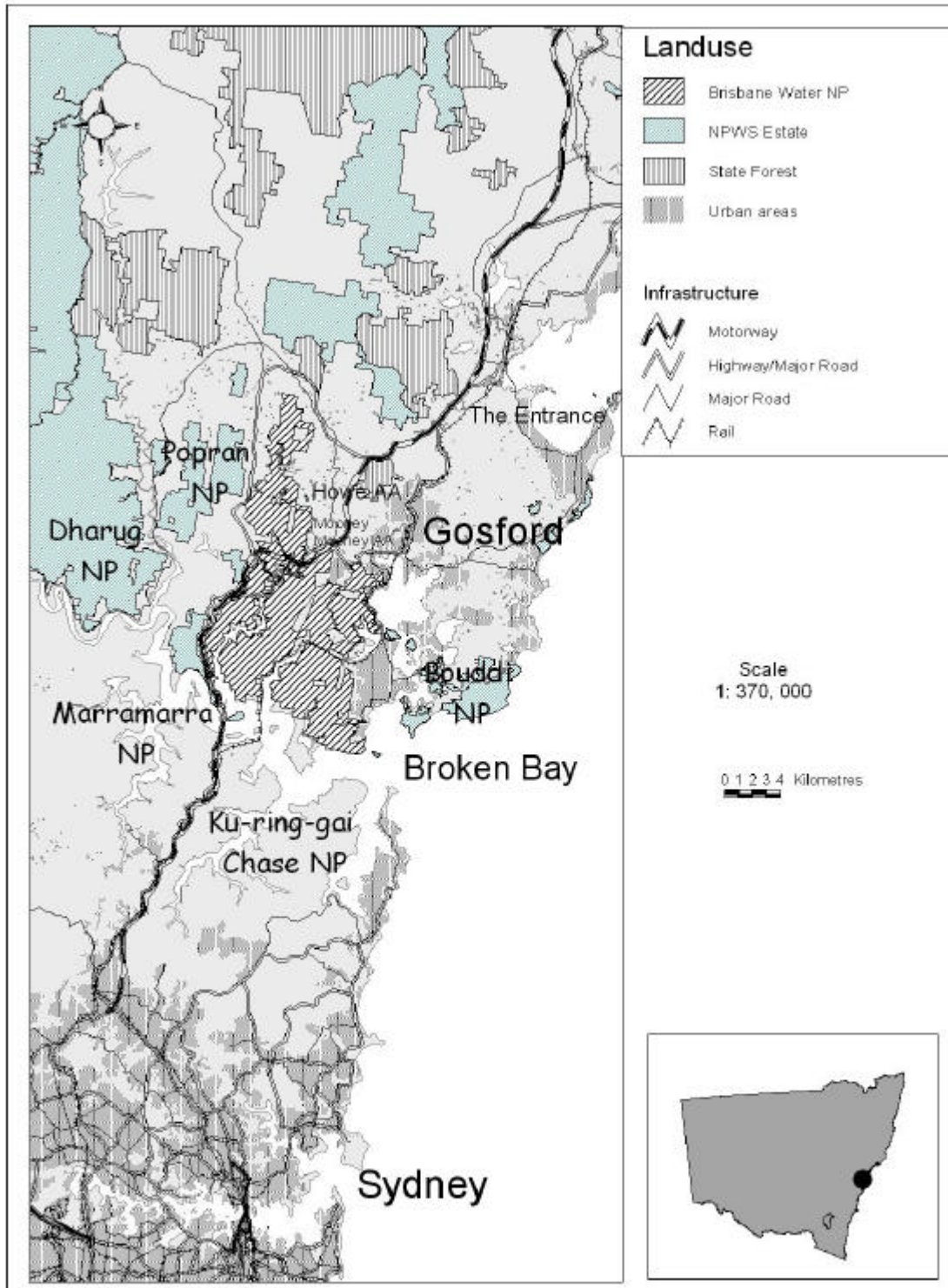
Brisbane Water National Park lies within the Sydney Basin, a major geomorphological unit of New South Wales. The terrain of the park is characterised by sandstone plateau of moderate relief (maximum elevation of 250m at Mt Kariong). The drainage lines of Mooney Mooney, Mullet and Patonga creeks dissect through the plateau. The park varies from undulating to rolling hills on the plateau tops to rugged to very steep hills along drainage lines.

On the plateau tops, slopes are usually less than 20% with wide sandstone benches with small broken scarps 1-4m high covering approximately 50% of the landscape. Small, poorly drained hanging valleys are common. Slopes along major drainage lines on the other hand are rolling to very steep with gradients generally greater than 25%. Rock outcrop covers greater than 50% of the landscape and occurs as horizontal benches and broken scarps and cliffs up to 10 m high.

Most of the major soil landscapes of the park are prone to erosion in the post fire environment Murphy (1993).



Figure 1: Location of Brisbane Water National Park



### 1.3.2 Planning Framework

NPWS participates as a member of the NSW Bush Fire Coordinating Committee and assists in the development and review of policies and procedures relating to fire management.

NPWS also participates as a member of the Gosford District Bush Fire Management Committee (BFMC). The BFMC is responsible under section 52 of the Rural Fires Act 1997 for the development of bush fire risk management plans and plans of operations across the local government area. The Brisbane Water National Park Fire Management Strategy will form part of the NPWS input into the Plan of Operations and the Bush Fire Risk Management Plan for the Gosford Local Government Area.

Within NPWS there are three tiers of fire management planning

- NPWS strategic policy, including the NPWS *Fire Management Manual* and the NPWS *Strategy for Fire Management* which provide consistent and state wide policies for fire management.
- Fire Management Strategies (such as this document) which define specific management approaches for individual or a group of NPWS reserves.
- NPWS operational fire plans, these include annual hazard reduction burn programs or individual prescribed burn operational plans. These also include Incident Action Plans (IAP) for managing a fire within or adjoining the reserve.

Sections 38 and 44 of the *Rural Fires Act 1997* require any fire control officer and the Commissioner of the Rural Fire Service to take into account “any relevant plan” of an authority responsible for managed land prior to implementing the powers provided by those sections. This reserve fire management strategy is considered a “relevant plan” for managing fire within Brisbane Water National Park and associated reserves.

Other relevant legislation for fire management planning in the reserves includes

- *Rural Fires Act 1997*
- *Threatened Species Conservation Act 1995*
- *National Parks and Wildlife Act 1974*
- *Occupational Health and Safety Act 2000*
- *Environmental Planning and Assessment Act 1979*
- *State Emergency and Rescue Management Act 1989*

The management of Brisbane Water National Park is prescribed by the objectives stated in the National Parks and Wildlife Act, 1974. It is a requirement under the Act that no operations and actions are to be taken which are contrary to the plan of management.

The Brisbane Water National Park Plan of Management states the following general objectives

- To protect scenic and natural features,
- To conserve wildlife,
- To maintain natural processes as far as possible,
- To protect Aboriginal and historic heritage, and
- To promote the appropriate use, understanding and enjoyment of national parks.

In addition, the Plan of Management identifies several specific management objectives for Brisbane Water National Park relating to conservation, scenic amenity, environmental education and recreation.

The *NSW Biodiversity Strategy (1999)* was developed by the New South Wales Government. Its over-riding goal is: "to protect the native biological diversity of NSW and maintain ecological processes and systems". Inappropriate fire regimes were identified as one of the seven key threatening processes that are affecting the biological diversity of NSW. This issue is targeted within the Biodiversity Strategy by Objective 3.4 'Improve fire management regimes', and requires that fire is managed in accordance with the principles of ecologically sustainable development.

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

### 1.3.3 The Fire Environment

Brisbane Water National Park has a fire history database spanning 40 years commencing in 1964/65 recording a total of 532 wildfires and prescribed burns. The database has been compiled onto the Service Geographic Information System (GIS).

Figure 3 provides a fire history map showing the year each area was last burnt. Only 7.4% of the park remains unburnt since 1964. This site is in the Somersby/ Peats Ridge catchment area, which surrounds Mooney Mooney Dam.

The cause of bush fire ignitions are shown in Figure 2 and their location in the park in Figure 4. Natural lightning caused wildfires contribute to 1% while human activities including arson, illegal burn offs, motor vehicle accidents, trains, powerlines and other miscellaneous sources are responsible for 62% of ignitions. In the study area 37% of the ignition sources are unknown. This is due in part to limited information particularly for older records and limited post fire investigation and reporting. A high proportion of unknown ignition sources would be attributed to human activity, given that the majority of ignition points occur along fire trails, roads, adjacent to camping areas and neighbouring properties.

**Figure 2: Causes of bush fire ignitions in the vicinity of Brisbane Water National Park**

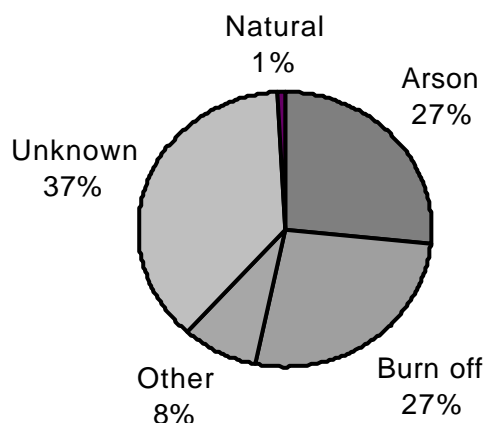


Figure 3: Year last Burnt (Time since last fire) in Brisbane Water National Park

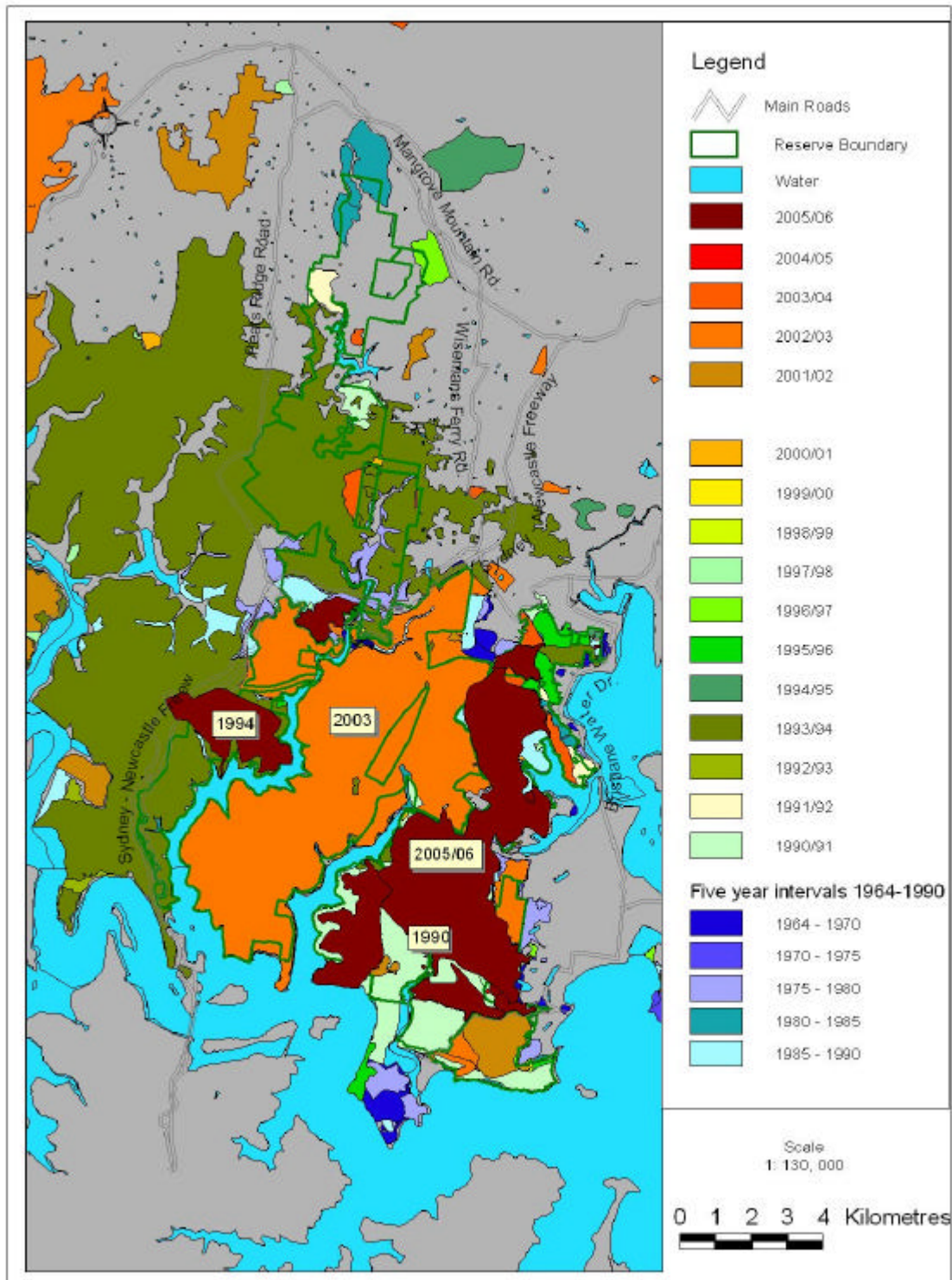
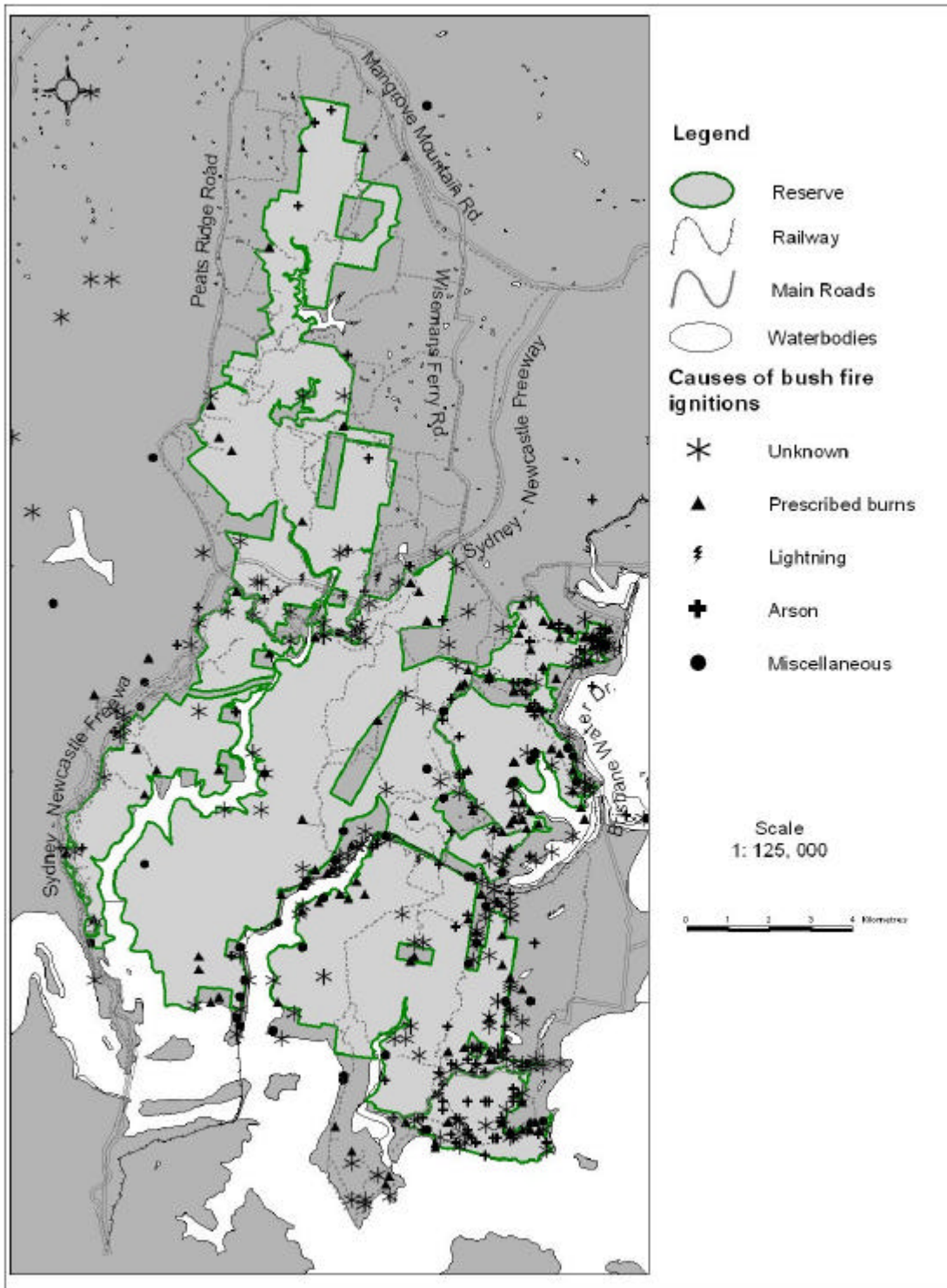




Figure 4: Cause and location of Ignition points in Brisbane Water National Park



Since 1964, 476 wildfires have occurred in Brisbane Water National Park. The scale of individual wildfires has varied from small fires less than one hectare to large-scale fires involving vast areas of the park. Historically, the area burnt by wildfires is dependant on the prevailing weather (temperature, humidity, atmospheric stability), preceding rainfall deficiencies, fuel loads, ignition sources and the response time of fire suppression activities.

Severe fire seasons burning over 2,000 hectares occurred in the seasons of 1978/79, 1988/89, 1990/91, 1993/94, 2002/03 and 2005/06. These severe bush fire seasons correlate with the occurrence of an extended drought period and lower than average rainfall through winter drying fuel for spring. These seasons were generally associated with *El nino* events except for the most recent 2005/06 which occurred under fairly neutral Southern Ocean Oscillation Index conditions.

The NPWS has conducted 107 prescribed burns in the period 1973/74-2005/06, accounting for 27% of the known fires within the park and the surrounding study area. The majority of these have been strategic area burns adjacent to assets to provide reduced fuel loads in key locations. The area burnt by prescribed burns in the park has varied significantly from year to year. This is again dependant on weather conditions where wet or unseasonally hot weather can interfere with the prescribed burning program. Individual burn areas vary from 1ha to over 300ha.

Fire frequency is a measure of the number of times an area is burnt within a given time period. During the period from 1964/65 – 2005/06 there have been numerous wildfires and prescribed burns in Brisbane Water National Park resulting in some areas burning up to eleven times in the forty years of records (Figures 5 and 6). Areas of highest fire frequency are generally adjacent to urban areas. This is a result of human activities such as arson combined with routine prescribed burning operations.

**Figure 5: Number of times burnt as a percentage of area for Brisbane Water National Park**

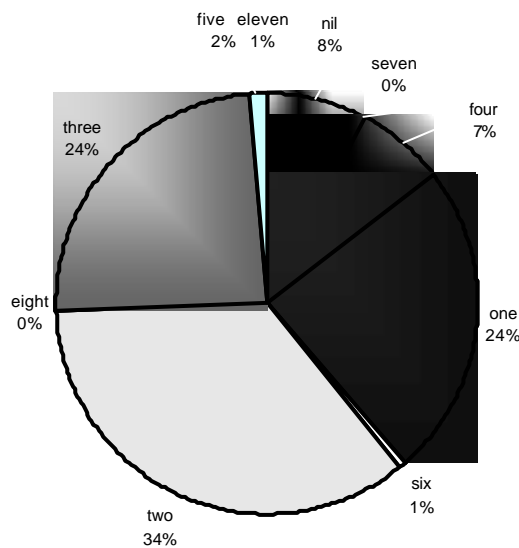
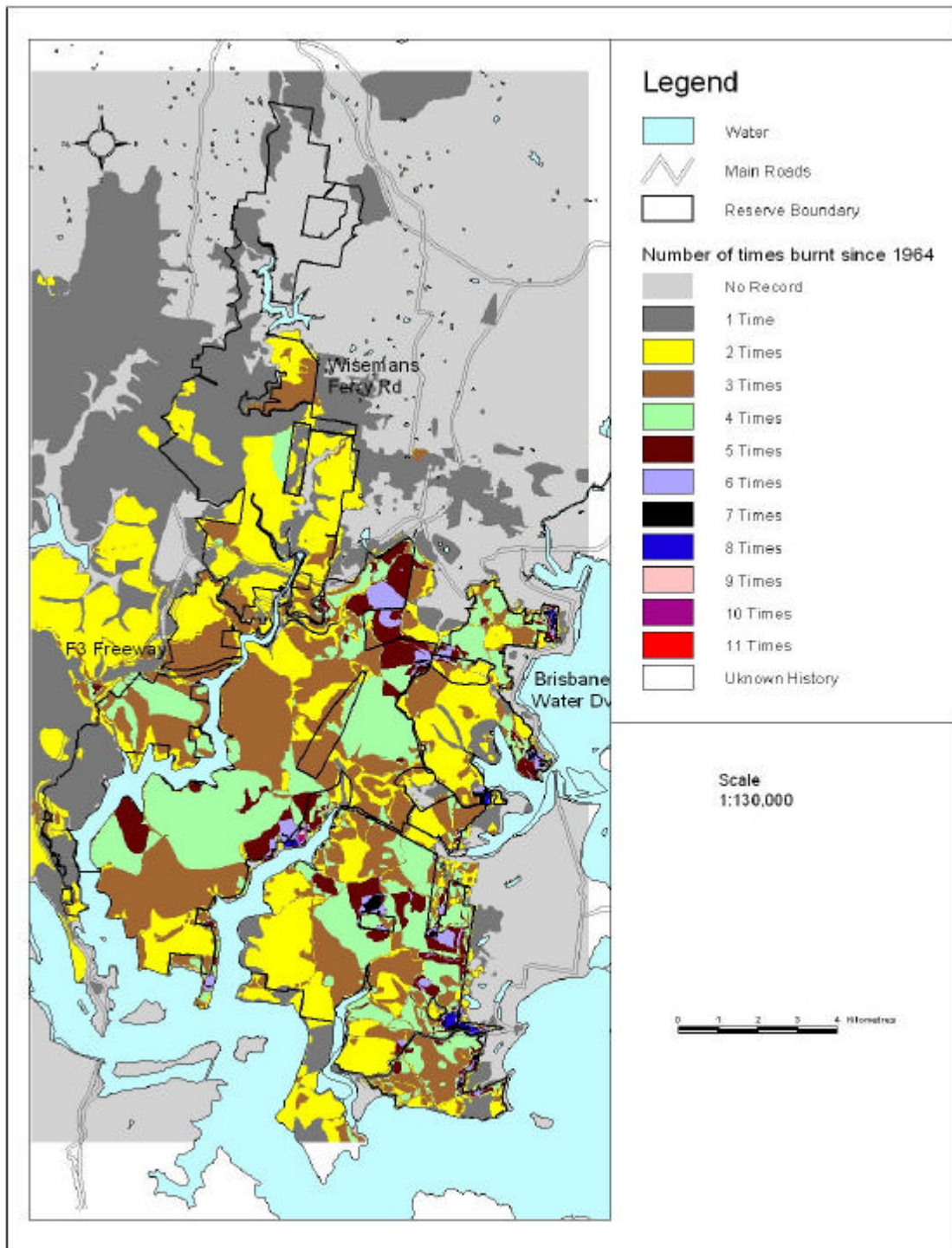


Figure 6: Fire frequency in Brisbane Water National Park.



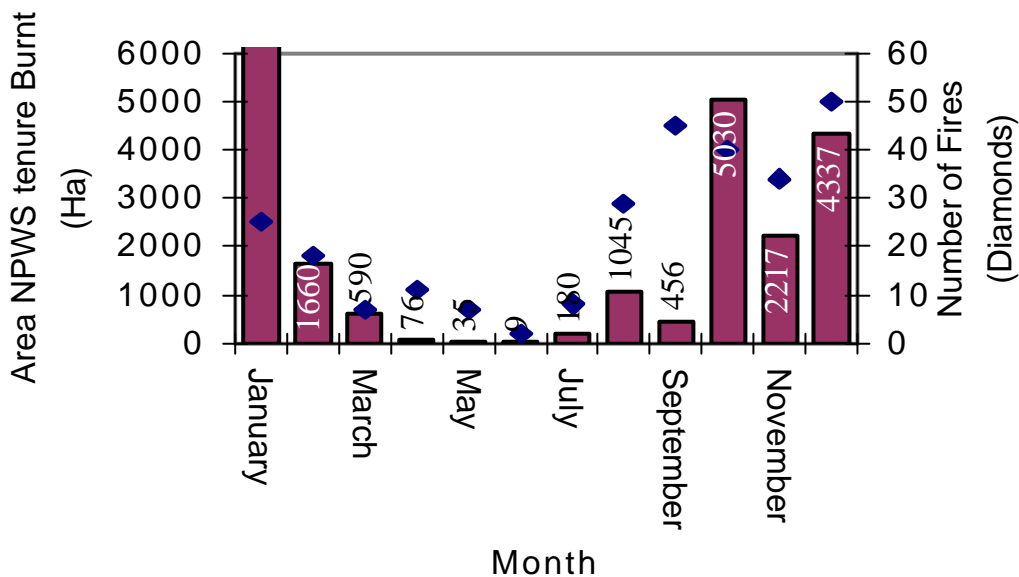


The climate of the area is characterised as warm temperate with a strong maritime influence. The bush fire danger period in the study area generally extends from 1<sup>st</sup> October to 31<sup>st</sup> March. Spring is usually a relatively dry period with the lowest average monthly rainfall (66 mm in September), low humidity and westerly winds. During summer the climate becomes warmer experiencing maximum average monthly temperatures. Severe fire weather conditions can develop when a slow moving high pressure system establishes in the Tasman Sea generating hot north westerly winds over the region. Cold frontal systems moving through with minimal rainfall and increased wind strengths can cause an increased fire spread.

The end to the bush fire season usually coincides with the occurrence of a relatively wet season between January and June, during which about 60% of the annual rainfall of 1318 mm is received. However, when summer rainfall is lower than average, the fire season can extend into early autumn.

An analysis of monthly bush fire records in Figure 7, shows that the greatest number of ignitions and area burnt by bush fires correlates strongly with the climatic regime.

**Figure 7: Total monthly area burnt and number of wildfire ignitions in Brisbane Water National Park**

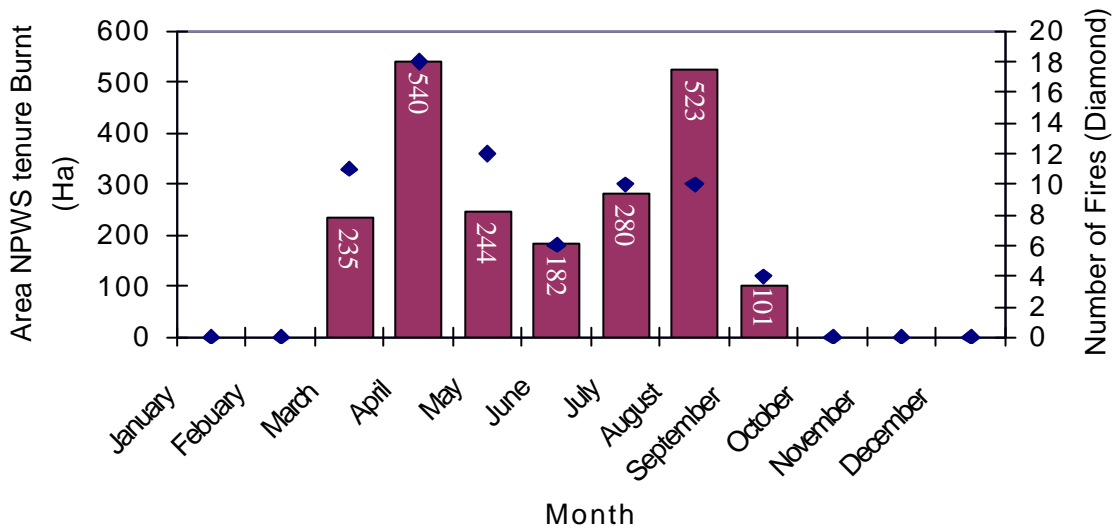


To ensure preparedness for the onset of conditions associated with bush fires, NPWS fire management monitors various drought indexes including the Byram - Keetch Drought Index (BKDI), the Forest Fire Danger Index (FFDI), the Southern Oscillation Index (SOI), atmospheric stability (Haines Index), and synoptic conditions on a continuous basis throughout the fire season. When conditions reach certain thresholds a level of bush fire alert is declared triggering a range of actions in preparedness for bushfire ignitions. The conditions associated with varying levels of bush fire alert are specified in the NPWS Fire Management Manual.

Conditions suitable for prescribed burning usually occur outside the bush fire danger period between 1<sup>st</sup> April and 30<sup>th</sup> September. This can be seen in Figure 8 which shows the highest occurrence of prescribed burns in the park during this time. Prescribed burns can occur outside these periods, with the consent of the Gosford Bush Fire Management Committee.

The chief limiting factors preventing the completion of the annual proposed burn schedule is the high probability of rain in late autumn and early winter. Conversely, strong winds, high temperature and low humidity can stop prescribed burning prematurely in drier years with an early onset of the fire season.

**Figure 8: Total monthly area burnt and number of prescribed burns in Brisbane Water National Park since 1964**



### 1.3.4 Significant Natural and Cultural Heritage Values

#### Flora

The vegetation survey by Benson and Fallding (1981) of Brisbane Water National Park and environs recorded a total of 657 plant species. Within the park the greatest species richness is to be found among shrub species (240 species), monocotyledons (179 species) and trees species (49; including 20 *Eucalyptus* species).

Also found in the park are a number of flora species that are of particular concern to fire management because of their risk of extinction due to inappropriate fire regimes. These include

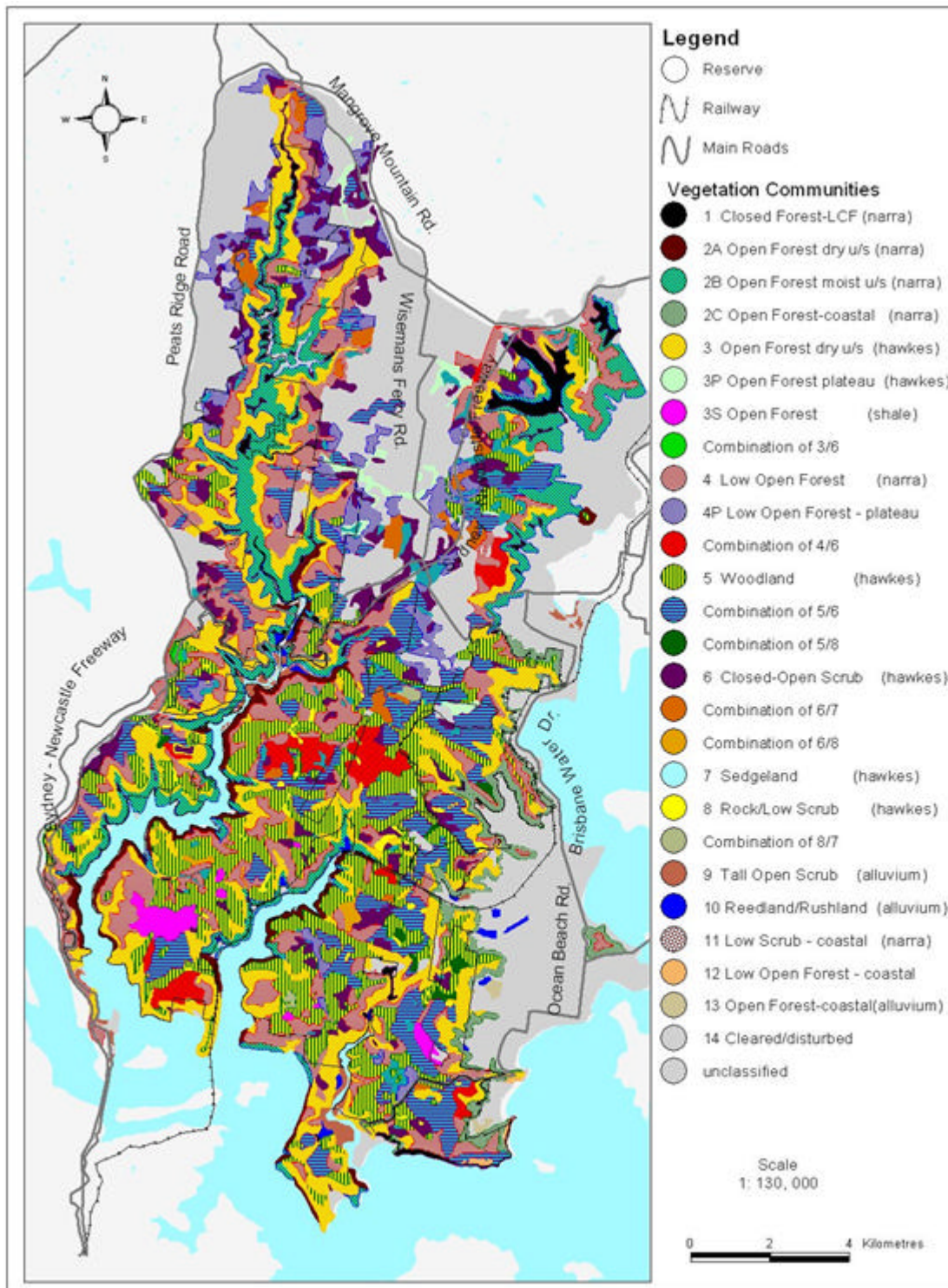
- 1 Endangered species and 5 Vulnerable species listed under the *Threatened Species Conservation Act (NSW) 1995*,
- 7 species listed as a Rare Or Threatened Australian Plants (ROTAP Briggs and Leigh, 1995), and
- 8 species of special conservation significance at the limits of their geographic distribution.

Appendix 2 provides a list of these species and summarises their fire ecology together with their fire management guidelines.

The vegetation survey of the park by Benson and Fallding (1981) identified 18 vegetation communities as well as eight (8) transition communities within the study area. The structural vegetation map figure 9 shows the distribution of the major plant communities. The dominant species and habitat characteristics are listed in Appendix 1.

The most common structural formations are low open forest, low open woodland and open woodland, with either a dry or moist understoreys. These communities extend over the ridges and slopes of Hawkesbury sandstone which covers most of the area. Open forest communities are found on cooler aspects and on Narrabeen outcrops along water courses. The more restricted closed forest (rainforest) occurs in the valleys and along streams on the Narrabeen group strata.

Figure 9: Vegetation communities of Brisbane Water National Park (Benson and Fallding 1981)



## **Fauna**

Brisbane Water National Park provides significant habitat for native animals of the region with 270 species of fauna recorded in the park. Knowledge of the fire management requirements for animal species is not as advanced as that for plants. NPWS considers that the fire management of animals and plants is interrelated. In implementing the fire regime guidelines for vegetation communities it is understood that vegetation cover and structure forms an important component of habitat and refuge for animals during fire events.

This strategy aims to minimise the occurrence and severity of large wildfires and encourage a mosaic of fire age classes across the landscape. A mosaic of recently burnt and long unburnt areas should enhance biodiversity of the reserve.

A number of species are potentially at risk from inappropriate fire regimes. Species include:

- 4 Endangered species and 24 Vulnerable species listed under the *Threatened Species Conservation Act* (NSW) 1995,
- Species at the geographic limits of their distribution,
- Other rare, restricted, or disjunct populations of species identified by NPWS staff or specialists, and
- Particularly fire sensitive species fauna with specialised habitat requirements (food, shelter, and breeding), and high site fidelity, long juvenile periods, low fecundity, and poor dispersal capacity.

A list of these species, together with a summary of their ecology and fire management guidelines can be found in Appendix 3.

## **Cultural Heritage**

Brisbane Water National Park lies within the area of the Darkinjung Local Aboriginal Land Council which is consulted on management of all Aboriginal sites.

Places of Aboriginal cultural significance are widely distributed throughout the park. Evidence of habitation is abundant with over 600 recorded sites including occupation deposits in sandstone shelters, rock engravings, stone arrangements, paintings and axe grinding grooves, scarred and carved trees middens and burial grounds. Rock engraving is the predominant art form of the park. The age of these engraving sites is unknown, although some are known to post-date European settlement.

## **Historic**

Exploration of the Central Coast area began soon after the arrival of the first fleet. In 1788-89, Brisbane Water, Mullet Creek and Mooney Mooney Creek were explored. Settlement along the Hawkesbury River began in 1794. Approximately 50 sites of significance to European cultural history occur throughout the Park. Many are associated with the building of the Sydney to Newcastle rail link. Other sites exist which relate to minor agricultural operations, quarrying for sand stone and mining for ochre pigments.

### **1.3.5 Recreational use and Park Management Facilities**

Three picnic areas are provided in the park at Girrakool, Somersby Falls and Pearl Beach. Warrah Trig and Staples lookouts are popular sites for recreation. The walking track system from Patonga to Somersby Falls is part of the Great North Walk, which has become increasingly popular in recent years.

The eastern section of the park is used for bush walking, picnicking and pack camping. It contains recreational facilities including walking trails, picnic facilities and lookouts. The spring floral display attracts a large number of visitors between mid-July and mid-October, with the area around Patonga Drive a favoured destination for viewing. The Bulgandry Aboriginal site, near Woy Woy Rd, is open to the public and is popular with visitors.

Camping within the park is limited to remote overnight camping on the Great North Walk. There is an extensive walking track system, which includes management tracks. These tracks are interconnected with roadside stops, lookouts and picnicking facilities. The northern section of the park (the area north of the freeway) has a limited system of walking tracks.

The western section of the park, including much of the Mooney Mooney Valley and the Plateau between Mooney Mooney Creek and Mullet Creek remains largely undeveloped for the purposes of recreation. However this area does provide opportunities for low key outdoor recreation activities that require few or no facilities. At present recreation facilities in this area are limited to walking tracks and camping along the Great North Walk. Little Wobby and Broken Bay Sport and Recreation Centres and the Warrah Field Studies Centre are located to the south of the park. These centres often make use of the park.

Gas BBQs have been provided at Girrakool and Somersby Falls picnic areas, replacing wood BBQs to assist with the reduction of accidental ignitions. Wood campfires are not permitted. During the summer months Brisbane Water NP may be closed during periods of high fire danger to protect visitors from the threat of fire.

## **2. BUSH FIRE RISKS**

### **2.1 Introduction**

For the purpose of this strategy, bushfire risk is defined as the chance of a bushfire or inappropriate fire regime occurring and causing damage to assets within or adjacent to the reserves. Assets include life and property, cultural heritage and natural heritage.

### **2.2 Life and Property**

The reserve has experienced and retains the potential for damaging wildfires. This is due to the fire prone vegetation, topography, arson activity and an urban interface which has been developed with a varying degree of bushfire mitigation measures.

The eastern boundary of the reserve has an urban interface of approximately seventeen kilometres. Bush fire risks vary depending on the slope and aspect of the adjoining bushland and the distance from vegetation. There is considerable variety in the bush fire mitigation measures incorporated along the interface. Recent subdivisions in Kariong are well protected with asset protection zones, perimeter fire trails, well designed access and house design requirements. Some of the older subdivisions have limited regard for bush fire protection including poor access for fire vehicles and inappropriate house design.

The Somersby Industrial Area is located to the north of the reserve. Rural properties are located to the north and west. Fire has the potential to spread from the park into these areas where bushland corridors exist. Major transport infrastructure including the F3 Freeway, the Sydney to Newcastle Railway Line and several major roads dissect the reserve. These facilities have been closed due to fire activity on several occasions.

The primary risk to life and property occurs where assets are located in close proximity to bushland with a high bush fire behaviour potential. Fire behaviour is the manner in which a fire reacts to the variables of fuel, weather and topography (AFAC 1996).

Slope has a significant influence on bush fire behaviour. Increases in slope generally increase bush fire intensity and rate of spread; likewise decreases in slope reduce fire intensity and rate of spread. Much of Brisbane Water NP (84%) is either hilly or steep resulting in potentially intense fires with substantial rate of spread.

Fire intensity and rate of spread tends to increase with drier aspects. In the Sydney Basin, high, very high and extreme Forest Fire Danger Index (FFDI) values occur most commonly on western and to a lesser degree southern aspects (Bradstock, et.al. 1998). Furthermore vegetation on these aspects is generally drier than the vegetation on the southern and eastern slopes.

Fuel characteristics such as fuel loading, fuel arrangement and fuel type influence fire behaviour. Four fuel groups were identified in the reserve for modelling fire behaviour. These fuel groups have been ranked according to their influence on fire intensity and rate of spread. Most of the park is ranked high or very high due to the continuous, relatively high volume of dry vegetative material in the shrubland, dry forest and woodland vegetation groups.

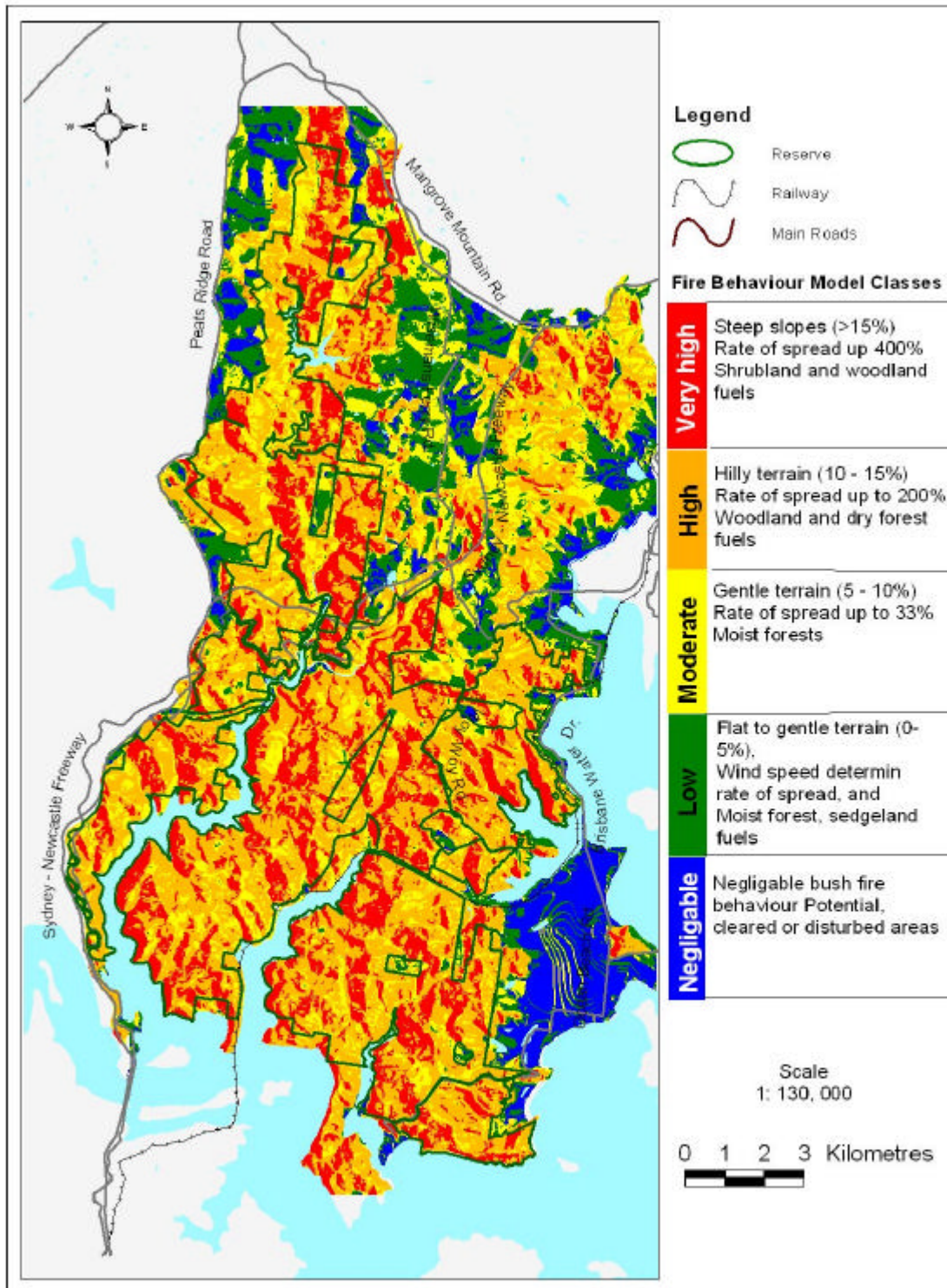
Presented in Figure 10 are the results of the bush fire behaviour potential model for the park. As can be seen from Figure 10 there are few areas of low to negligible bush fire behaviour potential in the park, with over 80% categorised as very high or high fire behaviour potential. By comparing the location of assets with the bush fire behaviour potential model, we can identify appropriate strategies for asset protection around the reserve.

**Table 1: Bush fire potential classes for Brisbane Water National Park**

Class	Rank	Probable slope, aspect and fuel characteristics	Area (ha)
<b>Very High</b>	10-12	<ul style="list-style-type: none"> <li>- Steep slopes (<math>&gt;15^{\circ}</math>) and ridges increasing the potential uphill fire spread up to 400%,</li> <li>- Westerly aspects associated with a high probability of very high and extreme FFDI conditions during an average season,</li> <li>- Shrubland and woodland fuel groups that will burn intensely given a fuel continuum from ground to canopy.</li> </ul>	3630.44 (30.4%)
<b>High</b>	8 – 9	<ul style="list-style-type: none"> <li>- Hilly terrain (<math>5 - 10^{\circ}</math>) increasing the potential up hill rate of fire spread by up to 200%,</li> <li>- North west and south west aspects associated with a high probability of high and very high FFDI conditions during an average season,</li> <li>- Woodland and dry forest fuel groups that will support a high intensity fire during an average season.</li> </ul>	6377.06 (53.3%)
<b>Medium</b>	6 – 7	<ul style="list-style-type: none"> <li>- Gentle slopes (<math>1 - 5^{\circ}</math>) increasing the potential up hill rate of fire spread by up to 33%,</li> <li>- North easterly aspects associated with a high probability of moderate to high FFDI conditions during an average season,</li> <li>- Moist forests with that will only burn intensely after extended dry periods</li> </ul>	1834.88 (15.3%)
<b>Low</b>	4 – 5	<ul style="list-style-type: none"> <li>- Flat to gentle slopes (<math>0 - 5^{\circ}</math>) where wind speed an direction will determine the potential rate of fire spread,</li> <li>- South easterly aspect associated with a high probability of low to moderate FFDI conditions during an average season</li> <li>- Moist forests, sedgeland and reed fuel types</li> </ul>	100.3 (0.84%)
<b>Negligible</b>	2 - 3	<ul style="list-style-type: none"> <li>- Cleared areas and rainforests</li> </ul>	17.25 (0.14%)



Figure 10: Bush fire behaviour potential within Brisbane water NP



Due to the large number of parameters that contribute to fire behaviour, the model provides only an indication of the likely bush fire behaviour across the park landscape. Based on this assessment, under extreme bush fire weather conditions (FFDI greater than 50) most bush fire behaviour would be potentially very high to extreme.

Information on the historical damage to economic assets, natural and cultural heritage items caused by bush fires in the vicinity of the reserve has been gathered from incident reports, NPWS staff and park neighbours and is summarised in Table 2. There has been no loss of life as a result of bush fires in Brisbane Water National Park, however, during the December 1990/91 fires two park users were severely burnt at Patonga Drive. In general, historic damage to assets correlates with the occurrence of severe fire conditions where large uncontrollable fires have made it difficult to adequately protect all assets.

**Table 2: Records of historic damage to economic and cultural heritage assets**

Assets	Year	Details of historic damage
Economic	2006	<ul style="list-style-type: none"> <li>• Fire escaped from Crown Land, entered park and adjoining residential area, and destroyed three houses at Pheagans Bay, varying degrees of damage to 26 others.</li> <li>• Damage to rail infrastructure, road signs, road guardrails and powerlines.</li> </ul>
	2003	<ul style="list-style-type: none"> <li>• Board walk damaged at Bulgandry Aboriginal Site, heat damage to engravings.</li> <li>• Damage to rail infrastructure, road signs, road guardrails and powerlines.</li> </ul>
	January 1994	<ul style="list-style-type: none"> <li>• A residence adjacent to the park near Somersby Falls was destroyed.</li> <li>• Girrakool house within the park was destroyed.</li> <li>• Board walk destroyed and burning of some of the bollards at the Bulgandry Aboriginal Site.</li> <li>• Park visitor facilities damaged and closed temporarily.</li> </ul>
	1990/91	<ul style="list-style-type: none"> <li>• Bush fire ignited on private property, travelled through park destroyed several houses at Pearl Beach and Umina.</li> </ul>
	1990/91	<ul style="list-style-type: none"> <li>• Bush fires burnt pine plantations at Somersby.</li> </ul>
European Cultural Heritage		<ul style="list-style-type: none"> <li>• The Majority of sites have been subjected to fire events in the past and therefore, little combustible material remains</li> </ul>
Aboriginal Cultural Heritage		<ul style="list-style-type: none"> <li>• Spalling of rock surfaces of Aboriginal sites from high intensity fire has been documented in many areas</li> <li>• Damage has occurred to rock engravings and middens from the use of heavy plant.</li> </ul>

### 2.3 Natural Heritage Risks

The Brisbane Water National Park contains many valuable and unique species of flora and fauna listed under the *Threatened Species Conservation Act, 1995*. High fire frequency, altered seasonality and intensities of fire regimes may present a risk of local extinction for some sensitive species of flora and fauna. High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition has recently been listed as a key threatening process under the *Threatened Species Conservation Act 1995*.

A large proportion of the reserve (56%) has been recently burnt in two broad scale and high intensity wildfires during 2003 and 2006. This is likely to have had detrimental impacts on some populations of fauna which are sensitive to fire. It will be important to exclude fire from the Mullet Creek and Mooney Mooney Creek catchments where possible to enable populations to recover.

The fire regime threshold evaluation, figure 12 indicates that 10,963 hectares of the reserve 91.2% has been recently burnt. 261 hectares 2.2% is classified as vulnerable, that is, if it is burnt again within 12 months its threshold will be exceeded. 87 hectares has been overburnt. These results indicate that the current fire regime has caused impacts on the biodiversity of the reserve. With the large proportion of communities listed as “recently burnt” any significant fires in the planning period are likely to compound this impact.

Prescribed burning in Asset Protection Zones and Strategic Fire Advantage Zones has the potential to impact on 1070 hectares (8.5%) of the reserve.

The effects include

- a) Elimination of fire sensitive (obligate seeder) species by repeated burning at time intervals that are less than the time required to produce viable seed for stand replacement (eg key species such as *Banksia ericifolia*, *Petrophile pulchella*, *Hakea teretifolia*, and *Allocasuarina distyla*),
- b) Elimination of fire resistant species (re-sprouters) by the continual weakening of resprouting mechanism of individuals from high frequency fire (eg lignotubers, root-suckers, rhizomes and epicormic buds),
- c) Reduced fruiting in both fire sensitive and fire resistant species by burning at a time of the year when plants are in flower or have immature fruits,
- d) Repeated low intensity fires may not stimulate adequate seedling germination in shrub species, resulting in increased dominance by monocotyledons, annuals and ferns which seed rapidly or are able to regenerate by rhizomes.
- e) Frequent, low intensity prescribed burns eliminate a dense understorey required by many ground dwelling mammals. Particular species of concern to fire management (see appendix 3) will be disadvantaged, and
- f) Mechanical fuel reduction including, slashing, selective shrub removal and the construction of fire trails in Asset Protection Zones (see Figure 13) will impact significantly on the local vegetation structure and composition.

## **2.4 Cultural Heritage Risks**

As described in Section 1.3.4, there are a large number of significant Aboriginal and European cultural heritage items located in the park which are susceptible to damage from bush fires, prescribed burning and other fire management activities. Damage from vehicle tow bars, chassis and tracked machines is a particular issue. Unlike many assets, Aboriginal sites can not be rebuilt and therefore their protection during fire operations should be given a high priority.

A register of site locations has been established by the NPWS to assist in identifying and avoiding impacts. Table 3 is a summary of the potential damage to Aboriginal Sites within the park.

## **2.5 Summary of Key Fire Risks**

The reserve has a high bushfire behaviour potential and a number of assets potentially at risk when extreme fire conditions occur. The key risks are

- Approximately 17km of urban interface with some areas having limited bushfire protection measures incorporated in the development. This results in a risk of property damage and a risk to life.
- Disturbance to major transport infrastructure routes and potential risk to life.
- A large number of Aboriginal sites that can be damaged by fire and fire fighting activities.
- Significant flora and fauna communities, which can be affected by adverse fire regimes.

**Table 3: Potential damage to Aboriginal sites as a result of high and low intensity fires and the use of machinery**

Site Type	High intensity wildfire	Low intensity Prescribed burn	Slashing/ Mowing and Dozer Lines
Deposits in sandstone shelters	Post fire soil erosion may lead to artefact movement and damage to archaeological deposits	Low probability of impact	Low to negligible impact except if vehicle enters shelter
Rock engravings	Fire may cause spalling of the sandstone and damage engraving. Build up of soil due to post fire erosion may contribute to chemical weathering	Low impact if protected by buffer zone.	Moderate to high impact if driven over
Axe grinding grooves	As above	Low impact if protected by buffer zone.	Moderate to high impact if driven over
Rock art Site	High intensity fire 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, especially in sites in close proximity to the ocean.	Low impact if protected by buffer zone. May be affected by smoke damage, and removal of protective vegetation	Low to negligible impact except if protective vegetation is damaged or removed.
Scarred and carved trees	High intensity fire may cause tree death, erode tree stability, or damage scar. Fire may also lead to a decline in tree health and promote rot. Fire may destroy dead trees.	Low impact if protected by buffer zone. If not protected may undermine tree health. May destroy dead trees	High impact if struck by slasher or vehicle
Middens	May remove protective vegetation and promote post fire erosion.	Low impact if protected by buffer zone. Low impact if post fire soil erosion is not caused.	High impact if driven over
Stone arrangements	May cause spalling of stones in an arrangement. Post fire soil erosion may lead to displacement of stones.	Low probability of impact	High impact if driven over
Burial grounds	May remove protective vegetation and promote post fire erosion that can expose remains especially in sandy soils.	Low impact if protective vegetation is not significantly altered	High impact if driven over

Note: vehicle damage is caused by Bulldozer tracks or towbars and chassis scraping the rock surface.

### **3. BUSH FIRE RISK MANAGEMENT STRATEGIES**

#### **3.1 Introduction**

Bush fire risk in Brisbane Water National Park will be managed in accordance with the Gosford District Bush Fire Management Plan Operations, Gosford District Bush Fire Risk Management Plan and the Brisbane Water National Park Plan of Management. Emphasis will be placed on co-operative fire management involving liaison between the NSW National Parks and Wildlife Service, Gosford Rural Fire Service, NSW Fire Brigades and residents of the area.

#### **3.2 Prevention Strategies**

The NPWS will work with Gosford City Council and the Rural Fire Service to ensure that all new developments adjacent to the park, take into consideration the need for asset protection zones, construction standards and any requirements for perimeter fire trails. These requirements should be built into development proposals in accordance with "Planning for Bush Fire Protection" (RFS 2001) and Australian Standards, "Construction of Buildings in Bushfire-Prone Areas", AS3959-1991.

##### **3.2.1 Fuel Management**

Fuel management is the primary method of reducing bush fire risks in the reserve. It modifies fuel characteristics which in turn reduces the behaviour of subsequent bushfires.

The main form of fuel management used in this reserve is prescribed burning, also known as hazard reduction burning. This is undertaken in identified Strategic Fire Advantage Zones on a cyclical basis with the aim of creating a mosaic of reduced fuels along the urban interface. The mosaic pattern of fuel loads ensures that the entire interface has some level of protection for each year during the planning period.

Individual areas are treated on a seven to ten year cycle. Burning more frequently has the potential to modify the vegetation to a more flammable type and can make prescribed burns less effective in reducing fuels under mild conditions.

There are limitations to prescribed burning

- Fuel management will not prevent bushfires from being ignited and will not ensure that bushfires in extreme conditions can be controlled or contained.
- The frequency of burning is likely to have a long term affect on flora and fauna by exceeding biodiversity thresholds in the Strategic Fire Advantage Zones.
- Prescribed burning can be inconvenient to the community by causing smoke and embers and interfering with traffic.
- Slope instability problems in some areas at Koolewong, Tascott and Point Clare limits the use of prescribed burning. Removal of vegetation can cause rockfall above houses in these excessively steep areas. The risk of falling trees and rockfall from regular prescribed burns is possibly greater than the risk of wildfire damage.

Mechanical slashing of fire trail verges and fire breaks is the second form of fuel management used in the reserve. Slashing reduces the fuel height and causes fuel to break down, decreasing fire behaviour. The main slashed fire break is located at Kariong. It was incorporated as a bushfire mitigation measure in the subdivision design process. The slashing of fire trail verges throughout the reserve increases their effectiveness as containment lines for fire suppression.

Opportunities for slashed fire breaks in Brisbane Water National Park are restricted due to limited access and steep rocky slopes behind residential areas with limited provision for bushfire mitigation.

### **3.2.2 Fire Trails**

Fire trails are important fire control advantages providing access for firefighting vehicles and potential containment lines. NPWS maintains an extensive system of fire trails in the reserve. There are 35 fire trails within the reserve with a total length of 68.3 kilometers. A complete list of trails is included in section 4.4.

Fire trail locations are limited by the slope and topography of the land. A negative aspect of fire trails is that they can provide access for arsonists. The majority of fire ignition points within the reserve have been from roads and fire trails.

### **3.2.3 Protection of Visitors**

- The park may be closed to the public when it is considered necessary due to prevailing conditions that create an extreme fire danger or during fire fighting operations.
- Display notices at appropriate locations during total & reserve fire ban periods.
- Notify visitors of prescribed fire operations within the reserve.
- Maintain road network to allow rapid evacuation of park visitors.

### **3.2.4 Protection of facilities**

Park facilities and infrastructure includes picnic areas, workshops, signage, walking tracks and reserve entry gates. Protection from fire radiation and direct flame contact will be through the establishment and maintenance of adequate fuel free or fuel reduced areas. Annual maintenance of buildings will be undertaken to reduce the probability of ignition from embers.

### **3.2.5 Prevention of human caused ignitions**

The analysis of ignition causes identified arson to be a significant cause of bush fires within the reserve. Many of these fires have resulted in property damage or substantial fire suppression costs, which are ultimately borne by the community.

Strategies to mitigate arson include

- Conducting fire investigation for all arson and suspected arson fires,
- Facilitating community education programs and explaining the negative effects of arson activity,
- Support for community fireguard programs and neighbourhood watch,
- Patrols for arson activity during conditions associated with wildfires,
- Maintenance of accurate fire cause records to enable analysis and to assist with investigation.

### **3.3 Preparedness Strategies**

NPWS maintains a level of bush fire suppression preparedness to ensure that it can meet its objectives for fire management on NPWS managed lands and to assist other agencies with coordinated responses. The level of preparedness is based on forecast fire danger and drought indices.

The NPWS prepares a set of Regional Incident Procedures prior to each bushfire danger period. This covers communications, readiness and response procedures, fire detection and surveillance. The safety of visitors is a major consideration, the procedures establish criteria for park fire bans and park closures, which are based on forecast fire danger.

A pre season fire preparedness day is held each year to check equipment and provide training. A fitness test is undertaken for all staff involved in fire operations. Fire equipment is maintained in accordance with the NPWS Fire Management Manual.

#### **3.3.1 Natural Heritage Management Guidelines**

The fire regime strategies for biodiversity conservation outlined in this section aim to minimise the risk of extinction of species brought about by fire management activities. Given that a diversity of fire regimes is required to maintain biodiversity, there will be a role for both prescribed fire and /or fire exclusion in parts of the reserve at different times in the future. Over time, fires of high, low and moderate intensity, frequency and size will be required to avoid local extinctions.

#### **Vegetation Communities**

Fire management guidelines for vegetation communities is based on the principle of maintaining appropriate fire regimes and creating a mosaic of patches with different ages and structures. Suppression strategies during wild fire will attempt to minimise burn area by strategically containing fire using existing control lines within the reserve to protect fire sensitive plant communities.

Research has shown that groups of plant species respond in a similar way to fire, according to characteristics of their life history. Therefore, fire regime guidelines for each individual species within a community are not necessary. This strategy provides for individual species to be conserved according to the fire regime guidelines applied to the communities in which they occur. Appendix 2 outlines the fire regime guidelines for particular endangered and vulnerable flora species. In



addition, any relevant Recovery Plan must be considered when planning for fire management.

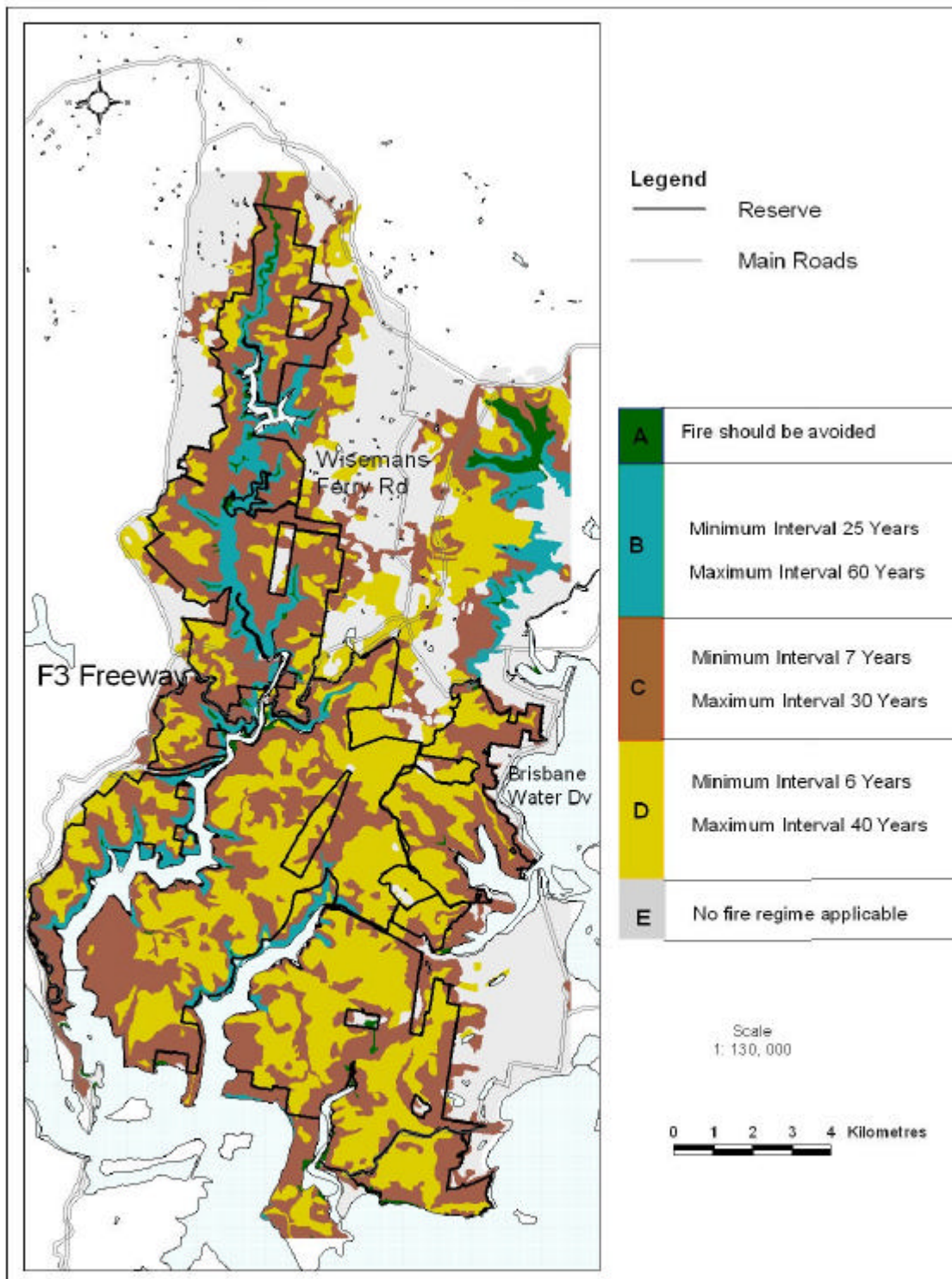
### Fire Regime Guidelines

These guidelines have been adapted from the Fire Interval Guidelines for Broad Vegetation Types (NPWS 2003) developed by the NPWS Bushfire Research Group. In some areas the vegetation survey has mapped a combination of communities together, for example 3/6. In this case the higher minimum and maximum interval is used.

**Table 4: Fire regime guidelines for Brisbane Water National Park**

Regime	Vegetation Community	Minimum Interval (years)	Maximum Interval (years)	Area ha (%)
<b>A</b>	1. Closed Forest to Low Closed Forest 9. Tall Open Scrub-Mangroves	Fire should be avoided	na	<b>145.1 (1.2%)</b>
<b>B</b>	2B. Open Forest; Moist understorey	25	60	<b>888.8 (7.4%)</b>
<b>C</b>	2A. Open Forest; dry understorey 2C. Open Forest; coastal 3. Open Forest; dry understorey 3P. Open Forest; plateau 3S. Open Forest 4. Low Open Forest 4P. Low Open Forest; plateau tops 11. Low Scrub: coastal 12. Low Open Forest; coastal 13. Open Forest; coastal	7	30	<b>9867.2 (82.5%)</b>
<b>D</b>	5. Woodland 7. Sedgeland 6. Closed Open Scrub (Hawkesbury) 8. Rock outcrops with pockets of low scrub 10. Reedland/Rushland (alluvium)	6	40	<b>1001.1 (8.3%)</b>
<b>E</b>	14. Cleared/disturbed			<b>62.1 (0.5%)</b>

Figure 11: Fire regime thresholds for biodiversity conservation



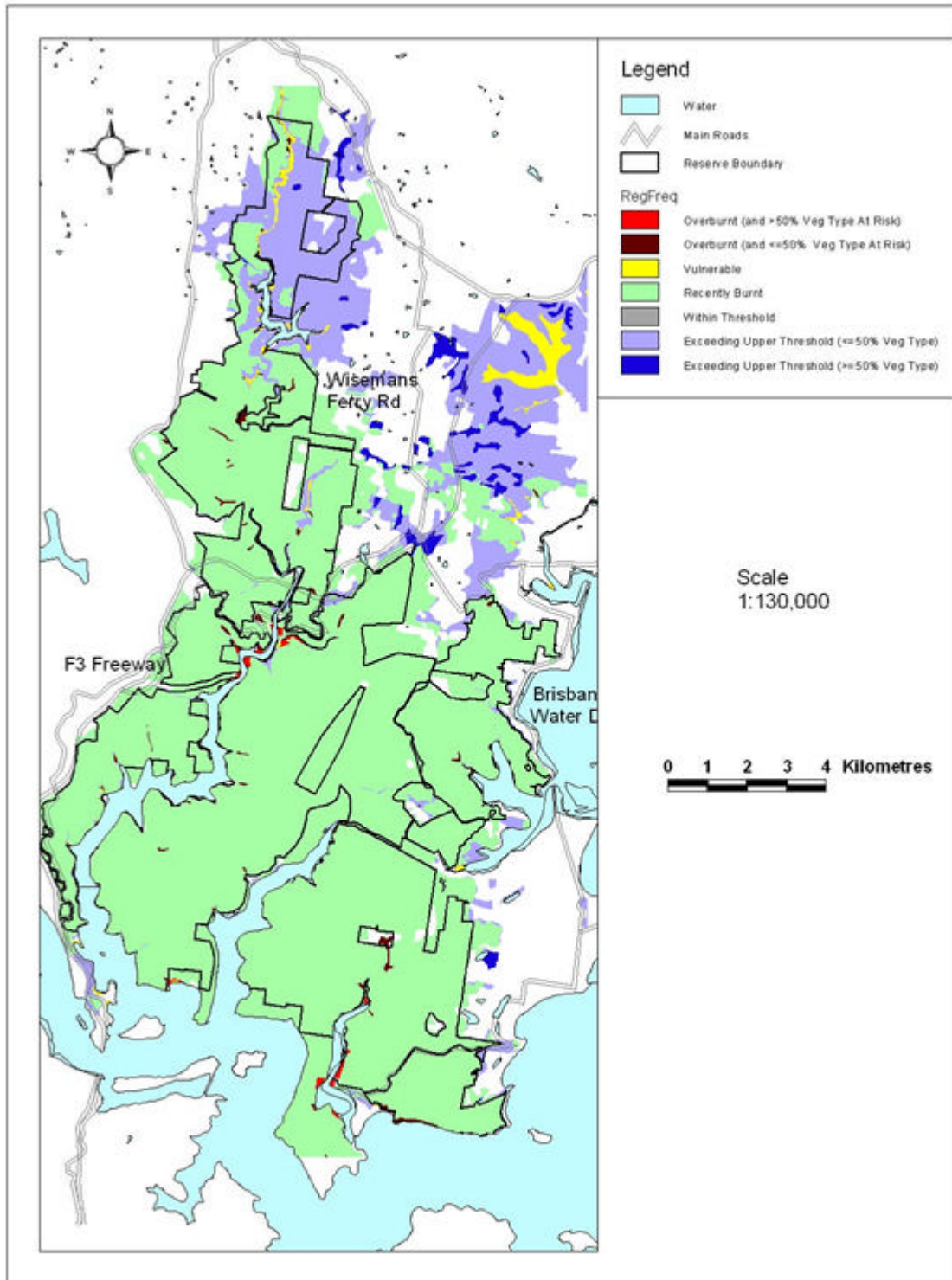
### Evaluation of current fire regimes

The evaluation of current fire regimes in this section is based on a comparison of the fire regime thresholds for vegetation communities specified in Table 4 and Figure 11 with the recorded fire history in the reserve. Areas within the park where thresholds have been exceeded, and therefore, may be contributing to a decline in biodiversity are identified in Figure 12, while the status of each fire regime threshold and their components is presented in Table 5. The following discussion identifies the major vegetation communities that are experiencing undesirable trends in fire regimes.

**Table 5: Status of fire regime thresholds**

Regime	Regime threshold	Area of Regime (ha)	Proportion of regime area (%)
<b>A</b>	Within thresholds for regime A	315.5	66.2
	Overburnt	161.2	33.8
<b>B</b>	Within thresholds For Regime B	1271.6	72.9
	Overburnt	121.4	7.0
	Approaching threshold	352.1	20.1
<b>C</b>	Within thresholds for regime C	11409.2	81.2
	Overburnt	18.4	0.1
	Approaching threshold	58.9	0.4
	Exceeded no fire for more than 30 years.	2566.8	18.3
<b>D</b>	Within thresholds for regime D	1019.1	49.1
	Overburnt	46	0.2
	Approaching threshold	264	12.8
	Exceeded no fire for more than 40 years.	787.2	37.9
<b>E</b>	Not applicable cleared and disturbed land	No data	No data

Figure 12: Fire regime threshold evaluation



**Regime A**

33% of regime A, has experienced fire and therefore exceeded its threshold. The communities effected include 25% of Closed Forest to Low Closed Forest and 54% Tall Open Scrub-Mangroves. Areas that have been exceeded are mainly located along Mooney Mooney Creek and in the Piles Creek area (Figure 12).

**Regime B**

Vegetation community 2B. Open Forest (Moist understorey) is classified according to regime B and 73% of its area is within the specified thresholds. 7% has exceeded the minimum inter-fire intervals and 20% of the community will exceed the minimum inter-fire interval threshold if fires occur within the life time of this strategy. Areas that have exceeded and are approaching the minimum threshold are mainly located in the valleys on cool south-easterly aspects along Mullet Creek, Mooney Mooney Creek and also in the Piles Creek area (Figure 12). Analysis of the longer term regimes i.e greater than 50 years, was not possible due to the limitations of the fire history database.

**Regime C**

Dry woodlands and forests fall under regime C cover 9867ha (82%) of the park. Generally, the time since last fire throughout the majority of communities within this regime has ensured a minimum interval of greater than 5 years. However, of particular concern is Low Open Forest; (coastal) that has historically experienced short inter-fire intervals due to regular prescribed burning behind the residential assets from Warrah trig in the south to Point Clare in the north along the eastern escarpment of the park (Figure 12). Furthermore, the fire regime in this area is characterised by low intensity burns that occur in either autumn or early spring. A significant area of communities have also exceeded their maximum fire free period including 51% of 4P Low Open Forest; plateau tops, 53% of 3P. Open Forest (plateau) and 58% 13. Open Forest (coastal). The areas affected predominantly occur North of the Pacific Highway, where the park is bordered by extensive agricultural land use and in the Mooney Mooney Creek Catchment Area (Figure 12).

**Regime D**

Shrubland and Heathland communities falling under regime D cover 1001ha (8.3% of the park. 10% of community 6. Closed Open Scrub (Hawkesbury) has exceeded the minimum inter-fire interval threshold. Areas that are affected are principally centred around Kariong, and to a lesser extent between Mooney Mooney Creek and the Newcastle to Sydney Freeway (Figure 12). 38% of these communities have exceeded their maximum fire free period of 40yrs. The areas affected predominantly occur North of the Pacific Highway, where the park is bordered by extensive agricultural land use and in the Mooney Mooney Creek Catchment Area (Figure 12).

**Fauna**

The fire ecology of fauna species within the reserve is more difficult to study due to mobility. It is difficult to confidently predict appropriate fire frequency thresholds for the conservation of specific fauna.

The basic management for all fauna is to ensure maintenance of vegetation cover and structure. It is desirable that any individual fire should not completely burn the entire representation of a particular community type or the entire reserve.

Appendix 3 lists the fire management guidelines for threatened fauna that are known or likely to occur within the park. These guidelines are subject to the *Threatened Species Conservation Act, 1995*. This Act provides the framework to protect and encourage the recovery of threatened species, populations and ecological communities. In addition, any relevant Recovery Plan must be considered when planning for fire management.

General principles to guide the management of fire for biodiversity conservation in the reserve are as follows;

- Groups of plant and animal species respond similarly to fire according to characteristics of their life-history. Therefore, it is not necessary to individually specify fire regimes for the conservation of every species. Rather an overview is needed of the requirements for broad groups of species. Requirements for most plant species can be summarised on the basis of a small number of groups. Knowledge of requirements for groups of animals is less advanced.
- Animals and plants are interrelated. Plants form an important component of habitat for animals. Fire management must consider this important interaction.
- A diversity of fire regimes may be needed to maintain native biodiversity. This means that over time there is a place for fires of high, low and moderate intensity, frequency and size. Local extinctions are likely when fire regimes of relatively fixed intensity, frequency and extent occur.
- For some groups of biota, thresholds separating desirable and undesirable fire regimes, for conservation, can be defined. Management should therefore be targeted towards desirable fire regimes using these thresholds as a guide.
- Assessment of fire regimes through mapping of the locality and characteristics of all fires will be ongoing so that strategies can be regularly reviewed, refined and adjusted. Depending on the circumstances (a function of community type and prevailing fire regimes) there may be a role for both prescribed fire and/or fire-exclusion in parts of a reserve at different times in the future.

### **3.3.2 Cultural Heritage Management Guidelines**

Strategies to protect Aboriginal Sites from damage include

- Facilitating Aboriginal community involvement, in relation to the effects of fire and its management on cultural values, and in survey and ongoing research.
- Mapping the location of Aboriginal cultural heritage items into the Service Geographic Information System (GIS) and sites register to assist in fire management planning, operations, and works.

- Buffering around known places before fire management activities and works.
- Undertaking pre and post fire monitoring and survey work to assess the impacts of bush fires and fire management operations.

Table 6 below summarises the aboriginal heritage guidelines for the reserve.

**Table 6 Aboriginal Heritage Management Guidelines**

Site Type	Guidelines
Deposits in sandstone shelters	As far as possible protect site from fire, Avoid all ground disturbance including the use of earthmoving machinery, handline construction and driving over sites,
Rock engravings	As Above
Axe grinding grooves	As Above
Rock art Site	As far as possible protect site from fire. Maintain any protective vegetation at shelter entrance. Avoid all ground disturbance.
Scarred and carved trees	As far as possible protect site from fire. Do not cut down trees. Avoid damage by vehicle or machinery.
Middens	As far as possible protect site from fire. Avoid all ground disturbance including the use of earthmoving machinery, handline construction and driving over sites, Avoid water bombing which may cause ground disturbance.
Stone arrangements	Avoid all ground disturbance including the use of earthmoving machinery, handline construction and driving over sites. Avoid water bombing which may cause ground disturbance.
Burial grounds	As far as possible protect site from fire, Avoid all ground disturbance including the use of earthmoving machinery, handline construction and driving over sites, Avoid water bombing which may cause ground disturbance.

Strategies to protect European places from damage include

- Identifying European cultural heritage items and establishing Asset Protection Zones where required,
- Assessing sites prior to prescribed burning to determine what actions are necessary to protect any artefacts, and
- Damage to sites of historic heritage must be avoided during any trail construction and fire fighting or hazard reduction operations.

### 3.4 Response Strategies

Detailed response strategies are outlined in the Gosford Bush Fire Management Committee Plan of Operations, NPWS Fire Management Manual and the NPWS Regional Incident Procedures, which are updated annually.

Appropriate action will be taken by the NPWS to manage all fires detected in Brisbane Water National Park.

Fire management will be achieved by adopting the most suitable strategies. Strategies will be determined by taking into account the prevailing seasonal conditions, forecast weather, predicted fire behaviour, firefighter safety, assets and values at risk, cost and the impact of strategies on biodiversity and cultural heritage.

The priorities of the NPWS in fire management are

- ensuring the safety of all incident personnel
- protecting human life and community assets
- conserving biodiversity
- conserving cultural heritage
- minimising costs to the community and the environment
- achieving community support.

The management of fire suppression in the reserve will be in accordance with the incident-control system, based on the Australian Inter-Service Incident Management System (AIIMS). An incident action plan will be prepared for all fire-suppression operations in the Reserve. The type of plan will be in accordance with the size and complexity of the incident.

#### 3.4.1 Bush Fire Suppression Guidelines

Table 7 below lists the operational guidelines for prescribed burning and wildfire suppression to be used within the reserve.

**Table 7: Fire management Operational Guidelines for Brisbane Water National Park**

Area / Resource	Operational Guidelines
<b>Threatened Flora Species</b>	<ul style="list-style-type: none"> <li>• Brief all fire fighting personnel involved in control line construction on the exact species location and route.</li> <li>• Where practical, exclude all sites containing threatened flora where the fire regime will be exceeded</li> </ul>
<b>Threatened Fauna Species</b>	<ul style="list-style-type: none"> <li>• Brief all fire fighting personnel involved in control line construction on the exact species location and route</li> <li>• Retain hollow / habitat trees where possible</li> <li>• Consider baiting for feral species or other actions after a fire event to minimise the effect of predators upon native fauna species</li> </ul>
<b>Vegetation Communities where the fire regime exceeds the threshold</b>	<ul style="list-style-type: none"> <li>• Prevent / minimise burns within this area</li> </ul>
<b>Vegetation Communities where the upper threshold value is near or above the</b>	<ul style="list-style-type: none"> <li>• Where possible retain these areas unburnt as examples of old age class communities.</li> </ul>



Area / Resource	Operational Guidelines
<b>upper threshold limit</b>	
<b>Aboriginal Site Locations</b>	<ul style="list-style-type: none"> <li>• Brief all fire fighting personnel on the site locations and maximum intensity of fire permitted within a specified distance of the site</li> </ul>
<b>Earth Moving Machinery</b>	<ul style="list-style-type: none"> <li>• Restrict use on slopes greater than 18 degrees</li> <li>• Generally rehabilitate all re-opened tracks immediately after the fire</li> <li>• Incorporate erosion control measures</li> <li>• Restrict use in areas containing Aboriginal / Cultural heritage sites</li> </ul>
<b>Fire Fighting Chemicals</b>	<ul style="list-style-type: none"> <li>• Restrict use in and surrounding wetlands, waterways and sensitive areas (eg. 20m of creek lines)</li> <li>• Restrict use where alternate methods are available (see Fire Management Manual)</li> </ul>
<b>Visitor safety</b>	<ul style="list-style-type: none"> <li>• The Reserve may be closed to the public during fire fighting activities or in extreme fire danger periods</li> <li>• Evacuation or control of campers and visitors may be required during wild fires</li> </ul>
<b>Access</b>	<ul style="list-style-type: none"> <li>• Wherever possible existing tracks will be used and the construction of new trails avoided</li> <li>• Where access into remote areas is necessary for personnel and equipment, wherever possible, aircraft should be used for transport and support in preference to new fire trail construction</li> </ul>
<b>Control Line Construction</b>	<ul style="list-style-type: none"> <li>• Wherever possible existing built and natural fire advantages will be used instead of the construction of new control lines</li> <li>• Where construction of control lines is required, wherever possible use of heavy earth moving equipment will be avoided. Handtools, air blowers or slashers will be preferentially employed</li> <li>• Where construction by heavy earth moving equipment is necessary, wherever possible side cutting should be avoided, a NPWS approved operator should be used and construction work should be under the direct supervision of an NPWS officer at all times</li> </ul>
<b>Backburning</b>	<ul style="list-style-type: none"> <li>• Where backburning and burning out are necessary, the area burnt will be the minimum necessary to achieve wild fire suppression objectives</li> <li>• Backburning will be conducted in such a way that the danger of the fire escaping pre-determined boundaries is minimised and the safety of firefighters is not compromised</li> </ul>
<b>Rehabilitation</b>	<ul style="list-style-type: none"> <li>• The need for post fire rehabilitation will be assessed by the Incident Controller as part of the incident management process</li> <li>• Where necessary urgent rehabilitation works should be undertaken during incident de-escalation, particularly the closure and drainage requirements of temporary access trails</li> <li>• Where necessary, a detailed rehabilitation plan will be prepared for the Regional Manager of the area in which the fire suppression operation occurred, and will address issues such as: <ul style="list-style-type: none"> <li>– Animal welfare</li> <li>– Soil stability</li> <li>– Water quality</li> <li>– Pest and weed species invasion</li> <li>– Impact on native flora and fauna</li> <li>– Impact on cultural heritage sites</li> <li>– Damage to assets eg. roads, gates, buildings and signs</li> <li>– Damage to neighbour's assets eg. fencing pasture, plantations and crops</li> <li>– Need for post fire monitoring eg. retardant – foam used in specific areas</li> <li>– Need for aerial or satellite photography of the fire ground</li> </ul> </li> </ul>

### **3.5 Recovery Strategies**

NPWS considers that post fire recovery and rehabilitation is an integral component of fire management. It should be addressed in incident action planning and where appropriate specific staff should be appointed to facilitate the process. Rehabilitation should be commenced as soon as possible.

Examples of issues include

- Social and economic impacts to the community
- Impacts on powerlines and transport infrastructure
- Rehabilitation of temporary containment lines and helipads
- Areas impacted by earthworks or heavy vehicle traffic
- Reopening of walking trails
- Repairs to park facilities damaged by fire
- Rehabilitation and monitoring of impacts on cultural and natural heritage values.

The NPWS Fire Management Manual outlines additional procedures for recovery and rehabilitation.

## 4.0 BUSH FIRE MANAGEMENT ZONES

The NSW National Parks and Wildlife Service uses fire management zones to facilitate broad and specific fire management objectives within its conservation Reserves.

Fire Management Zones (FMZ) define operational activities to best protect life, property, natural and cultural heritage. Three major categories of fire management zones are used in the strategy, these are:

- Asset Protection Zones
- Strategic Fire Advantage Zones
- Land Management Zones

Each zone has fire management objectives, strategies, actions and performance criteria specific to the area within its boundary. For example, zones with fire sensitive communities such as rainforest will have fire exclusion objectives; on the other hand, a zone on the fire prone side of a residential development will have objectives that specifically provide for protection of assets.

The objectives and strategies for each zone are complementary and allow the objectives of the strategy to be met.

Fire Management Zones developed for the Reserve were created following consultation with the Gosford Bushfire Management Committee and are consistent with the Gosford Bush Fire Risk Management Plan.

The objectives and strategies for the three categories of Fire Management Zones used in this strategy are outlined in Table 8.

**Table 8: Summary of Fire Management Zones**

Zone	Suppression objective	Strategies (Methods)	Width	No.	Area/ % of park
Asset Protection (APZ)	To protect residential areas, crops, plantations, utilities, camping areas, day use areas, urban interface, cultural heritage assets etc.	Fuel managed intensively by strip burning, slashing, selective shrub clearing, and construction of radiation barriers or trail construction.	As per Plan for Bush Fire Protection, (2001).	4	16.5 ha 0.1%
Strategic Fire Advantage (SFAZ)	To assist in the strategic control and containment of wild fires. To reduce wild fire intensity and spotting.	Fuel managed by burning, slashing, selective shrub clearing, construction of radiation barriers or trail construction. Suppression or containment of fires inconsistent with the fire regime prescription.	50 – 1500 metres	22	1053ha 8.4%
Land Management (LMZ)	To manage zones consistent with the conservation objectives of the national park.	Suppression or containment of fires inconsistent with the fire regime prescription.	Variable	60	11486ha 91.5%

Table 9 provides a breakdown of the vegetation type in each of the fire management zones.

**Table 9: Distribution of vegetation communities in each fire management zone**

Vegetation Type	Percentage of vegetation type in each zone		
	Asset	Strategic	Land Management
1 Closed Forest-LCF (Narrabeen)	0.0	1.2	81.2
2A Open Forest dry u/s (Narrabeen)	1.5	0.0	98.5
2B Open Forest moist u/s (Narrabeen)	0.1	0.2	99.7
2C Open Forest-coastal (Narrabeen)	5.4	46.0	48.6
3 Open Forest dry u/s (Hawkesbury)	0.3	10.6	89.1
3/6	0.0	0.0	100.0
3P Open Forest plateau (Hawkesbury)	0.7	15.0	84.3
3S Open Forest (shale)	0.0	1.9	98.1
4 Low Open Forest (Narrabeen)	0.8	8.7	90.4
4/6	0.1	0.5	99.5
4P Low Open Forest – plateau top	4.4	9.1	86.6
5 Woodland (Hawkesbury)	0.5	4.8	94.7
5/6	0.8	9.2	90.0
5/8	0.0	19.4	80.6
6 Closed-Open Scrub (Hawkesbury)	2.4	2.7	94.9
6/7	1.6	0.0	98.4
6/8	0.0	0.0	100.0
7 Sedgeland (Hawkesbury)	0.3	0.9	98.8
8 Rock/Low Scrub (Hawkesbury)	0.0	7.2	92.8
8/7	0.0	1.9	98.1
9 Tall Open Scrub (alluvium)	1.0	0.0	99.0
10 Reedland/ Rushland (alluvium)	0.4	1.8	97.8
11 Low Scrub - coastal (Narrabeen)	5.6	0.0	94.4
12 Low Open Forest - coastal	0.0	9.1	90.9
14 Cleared/disturbed	14.2	12.8	73.1
unclassified	0.0	3.5	96.5

The majority of vegetation communities are included in Land Management Zones. This is desirable in that the effects of prescribed burning and asset protection impact on a small proportion of the vegetation communities represented in the park.

Of concern is the inclusion of 46% of '2C. Open Forest; coastal (Narrabeen)' within Strategic Fire Advantage Zones. This community ranges behind the residential assets from Warrah trig in the south to Point Clare in the north along the eastern escarpment of the park. Historically these communities have been greatly disturbed by urban development and very few relatively undisturbed areas remain.

Prescribed burning programs should consider the fire regimes for these communities on a reserve wide scale.

#### **4.1 Asset Protection Zones**

The establishment of asset protection zones is regarded as one of the single most beneficial strategies for the protection of buildings. The required width and fuel loading for individual Asset Protection Zones are detailed in '*Planning for Bush Fire Protection*' (RFS 2001). The construction and maintenance of Asset Protection Zones (APZ) is primarily the responsibility of the landholder that owns the asset. Most APZ in this locality are located off park and include gardens, perimeter roads and mown verges.

Asset Protection Zones identified within Brisbane Water National Park are illustrated in Figure 13.

#### **4.2 Strategic Fire Advantage Zones**

Strategic Fire Advantage Zones (SFAZ) within the Reserve (Figure 13) aim to reduce the risk of damage to life and property within and adjacent to the Reserve. SFAZ's assist with the strategic containment and management of high intensity wild fire events.

Strategic Fire Advantage Zones also assist with protection for a wide range of assets including roads, residential areas, camping and picnic areas. SFAZ's are useful in creating buffers in higher fuel areas to reduce the intensity and spread of fire into and from Reserves.

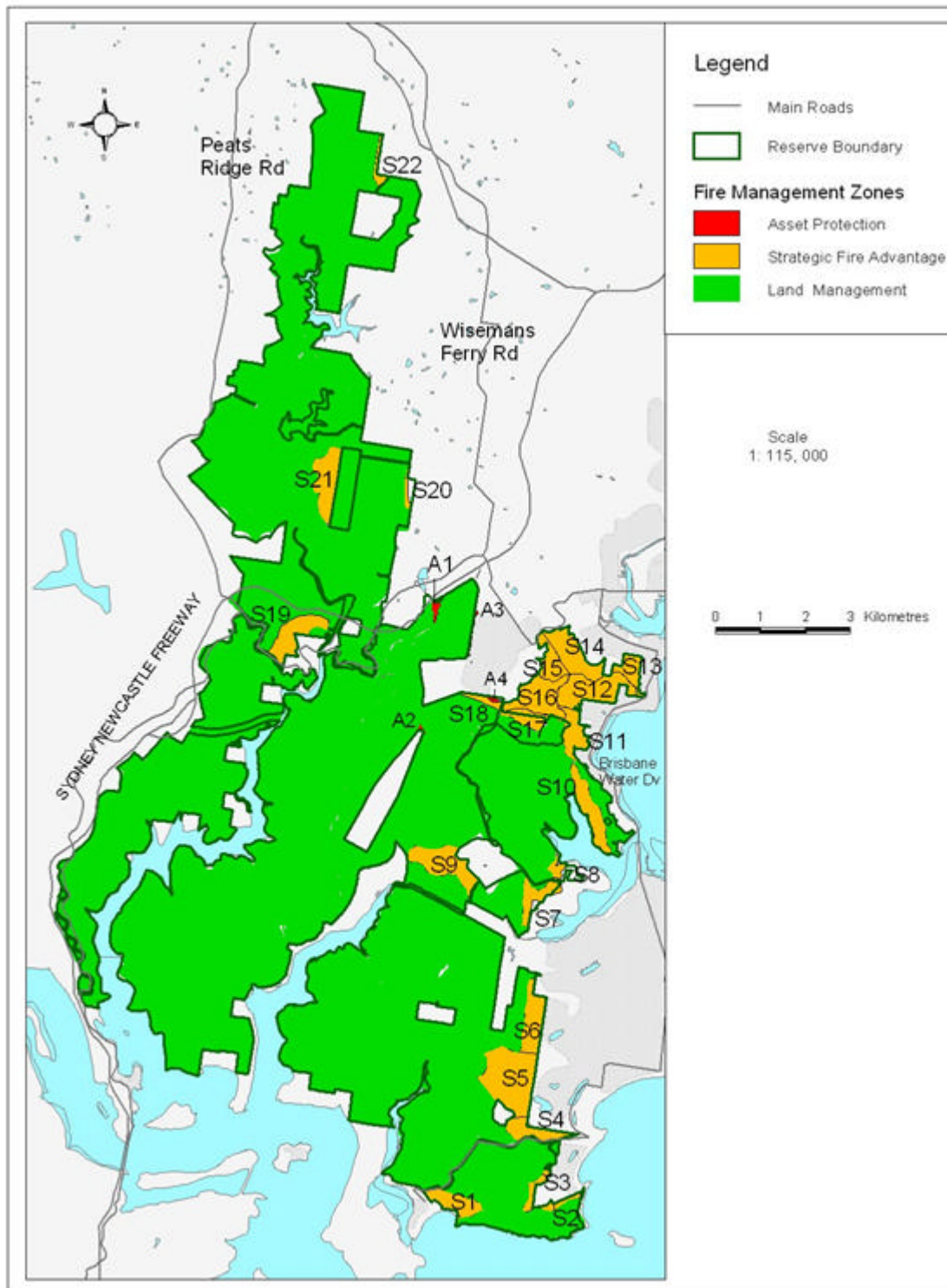
Strategic Fire Advantage Zones in the reserve are treated by conducting prescribed burns. The zones are treated in a mosaic pattern to ensure that a range of reduced fuels exist along the interface at any one time. A schedule is developed to guide the planning of burns to maximise protection of assets and create a mosaic of fuel reduced areas. Table 10 outlines the schedule for SFAZ's in the lifetime of this strategy.

#### **4.3 Land Management Zones**

Land Management Zones (LMZ) within the Reserve (Figure 13) are areas where built assets are not at direct risk from wildfire and management can concentrate on the ecological values of the area. The LMZ's are managed primarily for the conservation of biodiversity and natural and cultural heritage values. This strategy identifies LMZ's through a combination of natural and cultural heritage features.

The management of LMZ's is often undertaken in accordance with other previously determined conditions for the conservation of heritage items, including Recovery Plans, Plans of Management and Conservation Plans.

Figure 13: Fire Management Zones in Brisbane Water National Park.



The ability to implement each planned burn will be influenced by seasonal conditions and the occurrence of wildfires. The Bush Fire Management Committee will make final decisions as to which burns will be undertaken in a particular year.

**Table 10: Strategic Fire Advantage Zone Schedule (B = Earliest Burn)**

Zone	Area/Location (Refer to Figure 13)	Date of Last Burn	Regime Status	Earliest Next Burn	Year 1	Year 2	Year 3	Year 4	Year 5
S01	Patonga	11/11/2002	Recently Burnt	2010					B
S02	Pearl beach (Crystal St)	24/4/1996	Recently Burnt	2006	B				
S03	Pearl Beach/Arboretum	2/11/2001	Recently Burnt	2008			B		
S04	Mount Ettalong/ Umina	2/8/2005	Recently Burnt	2013	B				
S05	Myola Road Umina	1/1/2006	Recently Burnt	2014					
S06	Timbertop Umina	31/1/2003	Recently Burnt	2010					B
S07	Horsfield Bay	1/1/2006	Recently Burnt	2014					
S08	Woy Woy Bay	17/8/2005	Recently Burnt	2013					
S09	Tommo's Loop	18/1/2003	Recently Burnt	2011					
S10	Koolewong West	1/8/2003	Recently Burnt	2012					
S11	Indra Road Tascott	27/4/1996	Recently Burnt	2007		B			
S12	Melaleuca Cr Tascott	29/5/1994	Recently Burnt	2009				B	
S13	Tania Drive Pt Clare	9/9/1994	Recently Burnt	2008			B		
S14	Wendy Drive Pt Clare	5/8/1995	Recently Burnt	2006	B				
S15	Kariong Hill	4/5/2004	Recently Burnt	2012					
S16	Kariong East	31/8/2005	Recently Burnt	2013					
S17	Lyre Trig	1/1/2006	Recently Burnt	2014					
S18	Rat Gully	18/1/2003	Recently Burnt	2011					
S19	Old Mooney	14/8/2005	Recently Burnt	2015					
S20	Somersby Falls	9/7/2002	Recently Burnt	2009				B	
S21	Somersby Belmont	4/8/2003	Recently Burnt	2011					
S22	Konda Road	28/4/1995	Recently Burnt	2006	B				



#### 4.4 Fire Management Assets and Utilities

The Central Coast Hunter Range Region has established a detailed register of fire management tracks and trails within Brisbane Water National Park. The tracks and trails have been classified in accordance with the Bush Fire Coordinating Committee Guidelines for the Classification of Fire Trails. This guideline allows for three categories

- Primary
- Secondary
- Dormant

The tracks and trails have also been classified based on management responsibility and slope/grade as categorised in tables 11 and 12 below. The 'ID' number in table 13 can be used to locate trails within the park by referring to Figure 14. As part of ongoing management these fire trails will be reassessed for their effectiveness during fire suppression operations.

**Table 11: Access Description**

	Description		Description
1	Highway	9	(Park) 4WD Road
2	Sealed Major Public Road	10	(Park) 2WD Management Access
3	Sealed Minor Public Road	11	(Park) 4WD Management Access
4	Unsealed Public Road	12	(Park) Walking Track
5	4WD Public Road	13	Closed Track
6	Walking Track (off Park)	14	Horse Trail
7	(Park) Sealed Road	15	Other Authorities Access
8	(Park) Unsealed Road	16	Private Access

**Table 12: Track grade category**

Gradient category	Description
R1	Average grade $\leq 7.0\%$
R2	8% to 14 %
R3	15% or greater

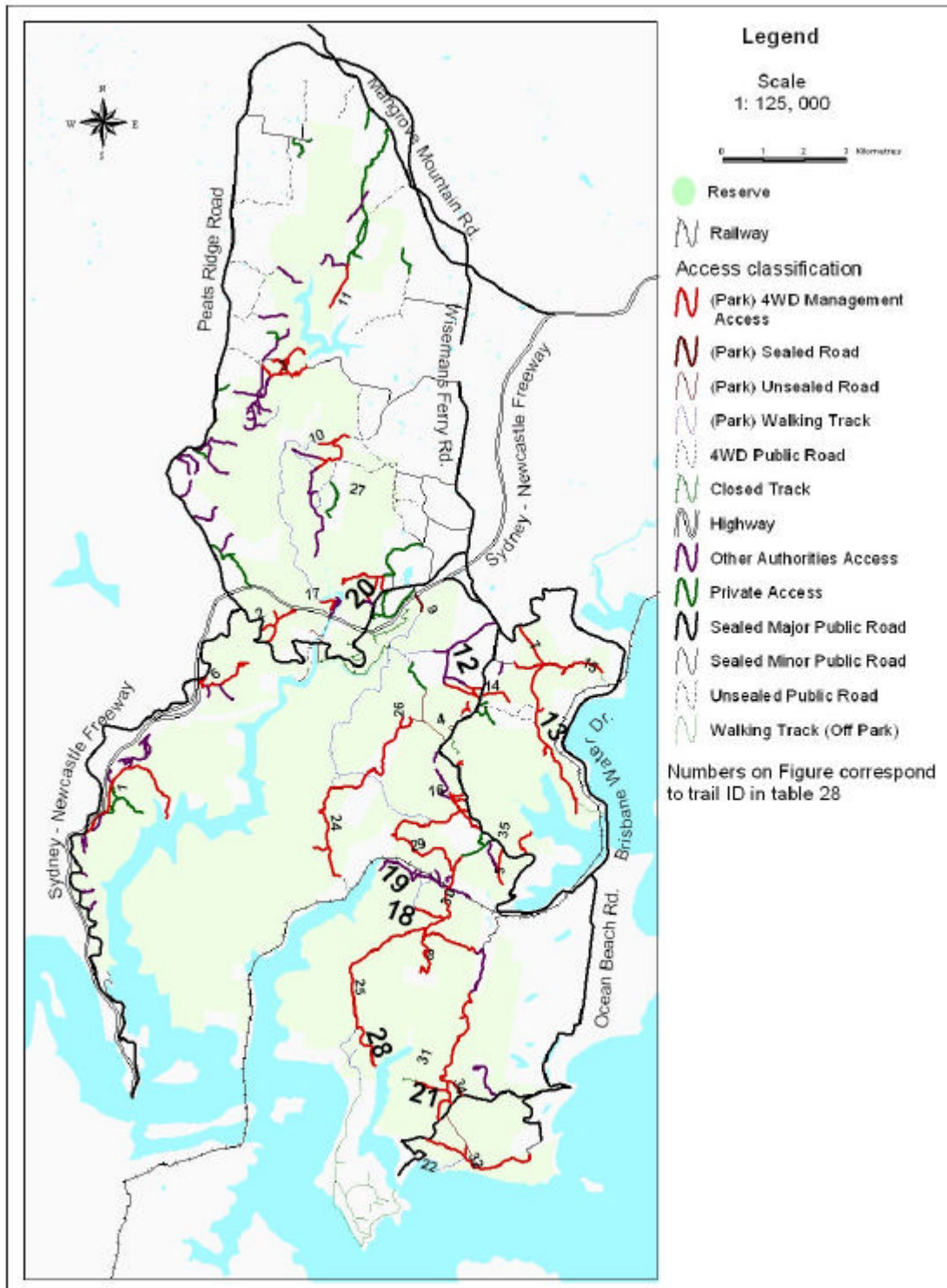
**Table 13: Fire management access trails in the vicinity of Brisbane Water National Park.**

ID	Trail	Section	Length (KM)	BFCC Class	Descrip	Grade
1	Barney Allen's Fire Trail	From Pacific Hwy past house to end of trail	4.3	Secondary	11	R2
2	Beehive Fire Trail	From Pacific Highway to end of trail	2.6	Secondary	11	R2
3	Brieze's Rd Fire Trail	From Brieze's Rd to sub station	2.7	Secondary	15/11	R2
4	Bulgandry access	From Woy Woy Rd to Aboriginal Site back to Woy Woy Rd	0.3	Secondary	8	R2
5	Bulls Hill Fire Trail	From Woy Woy Rd to end of trail	0.9	Secondary	11	R2
6	Christy Gully Fire Trail	Pacific Hwy to end of trail	1.5	Secondary	11	R1
7	Coorrumbine Creek Trail	Pacific Highway to Bambara Road	2.7	Secondary	11	R2
8	Dillon's Farm trail	From gate at tip to Dillon's farm	2.9	Secondary	11	R2
9	Girrakool Entry Road	Under Freeway to car park	0.5	Secondary	7	R1
10	Great North Walk Fire Trail	From Grants road to great north road walking track	0.8	Secondary	11	R1
11	Johns Way Fire Trail	From park boundary at the end of Konda Rd to end of trail	1.2	Secondary	11	R1
12	Kariong Circuit Trail	From Woy Woy Rd. to power line easement	0.9	Secondary	11	R1
13	Koolewong Fire Trail	From Bambara Rd to end of trail	2.5	Secondary	11	R2
14	Lyre Trig Fire Trail	Woy Woy Rd to base of trig	0.8	Secondary	11	R1
15	Milyera Fire Trail	From Gate at Milyera Rd to end of trail	2.5	Secondary	11	R1
16	ML9 loop Fire Trail	From Woy Woy Rd to Tommo's Loop Trail	0.6	Secondary	11	R1
17	Mooney camping area trail	Expressway Bridge to camping area	0.7	Secondary	10	R1
18	Mt Wondabyne Fire Trail	From Tunnel trail to base of Mt Wondabyne	0.8	Secondary	11	R2
19	Mullet Creek Fire Trail	From Tunnel Trail past Helipad to end of track	2.3	Secondary	11	R2
20	Oil & Gas Pipeline trail	From Pacific Hwy to end of track and return to Mooney Mooney	0.90	Secondary	11	R2
21	Old PMG Fire Trail	From Waratah Patch Trail to end of trail	0.8	Secondary	11	R1
22	Pearl Beach Patonga Fire Trail	From gate at Patonga Dr. to gate Crystal Ave	3.10	Secondary	11	R2
23	Pipeline Fire Trail	Gate Pacific Hwy to gate	2.20	Secondary	15	R2
24	Rifle Range Fire Trail	From Rifle Rang gate to top of Wondabyne, including Pindar trail	6.6	Secondary	11	R1

ID	Trail	Section	Length (KM)	BFCC Class	Descrip	Grade
25	Rocky Ponds Fire Trail	Tunnel track to walking track to Rocky ponds	3.6	Secondary	11	R2
26	Scout Camp Trail	Rifle Range Rd to Scout Camp gate	0.8	Secondary	8/ 16	R1
27	Somersby pipeline Trail	Somersby Falls Rd to park boundary	1.0	Secondary	4	R1
28	Tank Creek Fire Trail	From Rocky Ponds Trail to end of trail	1.5	Secondary	11	R2
29	Thommo's Loop Fire Trail	Gate at Woy Woy Rd to Tunnel Tail	4.3	Secondary	11	R2
30	Tunnel Fire Trail	Woy Woy Rd past Mullet Ck trail through to Dillon's Farm Trail	4.4	Secondary	11	R1
31	Van Dahls Fire Trail	Gate Patonga Drive to gate at tip	3.7	Secondary	11	R2
32	Warrah Trig Road	Patonga Dr to car park	1.30	Secondary	8	R1
33	Warrah Trig escape route	Warrah trig Rd to Pearl Bch track	0.30	Secondary	11	R2
34	Waratah Patch Fire Trail	From Gate Patonga Dr to end	1.30	Secondary	11	R1
35	Woy Woy Bay Fire Trail	From Gate at Woy Woy Rd to end of Trail	1.00	Secondary	11	R2

The primary objective of the fire management access works schedule is to ensure the safe access of fire fighters during fire suppression operations and hazard reduction burns. Tracks and trails on Service estate will be maintained to the Bush Fire Coordinating Committee standard by NPWS plant crew or by contractors. The maintenance of tracks which are not gazetted as park is the responsibility of the relevant authority or land manager.

Figure 14: Brisbane Water Fire Trail System (using classification codes and trail names)



## 5.0 RESEARCH, MONITORING & REVIEW

### Fire Management Research

There is a need to continue further research to provide details where major deficiencies in knowledge occur in understanding how to manage and conserve the biodiversity within the park. Particular areas of research include

- Expanding the fire regime guidelines to incorporate season, intensity, size, and patchiness of fires.
- Developing knowledge of the fire response of functional groups of fauna, including arboreal mammals, ground mammals, vertebrates and invertebrates.
- A better understanding of the requirements for refuge, post-fire dispersal and recolonisation of animal species which are depleted by fires in the short-term with a view to defining the thresholds of fire size and shape needed for conservation.
- Researching and validating the need for biodiversity burns in Land Management Zones.
- Develop a fuel load prediction model for the reserve.
- Measure the effectiveness of prescription burns.

### Fire mapping and database management

Mapped fire history of the park has been compiled onto a Geographic Information System, which is now updated after each incident. Linked to individual mapped fires are attributes tables incorporating significant information relating to fires. This information is also recorded on 1:25000 topographic map sheets and in incident reports. The Gosford RFS Fire Control Centre at Kariong also maintains records of bush fires and prescribed burns.

### Monitoring fire regimes and changes to biodiversity

Fire regimes are monitored by accurate fire mapping and GIS analysis. This is done annually for the prescribed burn program and each time this strategy is reviewed. Several biodiversity monitoring programs are under way in the reserve including;

- Warrah Trig Waratah patch
- Effects of prescribed burning on *Prostanthera junonis* at Somersby
- Eastern Chestnut Mouse survey
- Study of fire refugia for flora in the park.

### Management of works

The works programmed for the next five years will be identified in the: Central Coast Hunter Range Region Operations Plan, which lists park management works to be conducted in the Region, and the *Gosford City Bush Fire Management Committee Risk Management Plan*.

The performance of the works will be monitored by the Central Coast Hunter Range Regional Manager. An annual report on the works will be completed, which will be submitted to:

- the Gosford Bush Fire Management Committee; and
- the NPWS Regional Manager and Director Central Branch.

**Environmental assessment of scheduled works**

Environmental assessments for all scheduled works will be undertaken by NPWS. This will comply with the RFS Bushfire Environmental Assessment Code, July 2003. Otherwise, NPWS will conduct a full Review of Environmental Factors (REF) for each activity.

**Strategy Review**

To ensure that regular reviews are undertaken, this fire strategy has an operational life of five years. At the end of the operational life of this strategy, the strategy will be reviewed in relation to the specified fire management objectives.

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## APPENDIX 1: VEGETATION COMMUNITIES OF BRISBANE WATER NATIONAL PARK (ADAPTED FROM BENSON AND FALLDING 1981)

Vegetation Community	Dominant canopy species	Habitat	Area (ha)
1. Closed Forest to Low Closed Forest (Narrabeen)	<i>Angophora floribunda</i> , <i>Eucalyptus deanei</i> , <i>Syncarpia glomulifera</i> , <i>Acacia elata</i>	Deep moist valleys with cool southern and eastern aspects, usually on the Narrabeen Group.	111 (0.9%)
2A. Open Forest; dry understorey (Narrabeen)	<i>Angophora floribunda</i> , <i>Allocasuarina torulosa</i> , <i>Corymbia punctata</i>	Valley sides with dry northern or western aspects on the Narrabeen Group.	288 (2.4%)
2B. Open Forest; Moist understorey (Narrabeen)	<i>Eucalyptus deanei</i> , <i>E. acmenoides</i> , <i>Angophora floribunda</i> , <i>Allocasuarina torulosa</i> , <i>Syncarpia glomulifera</i>	Valleys or on lower valley slopes, on clayey soils on cool south-eastern aspects.	891 (7.5%)
2C. Open Forest; coastal (Narrabeen)	<i>Angophora floribunda</i> , <i>Allocasuarina torulosa</i>	On slopes with cool aspects influenced with sea breezes, from Warrah to Point Clare, along the eastern escarpment of the park.	279 (2.3%)
3. Open Forest; dry understorey (Hawkesbury)	<i>Eucalyptus piperita</i> , <i>E. gummifera</i> , <i>E. pellita</i> , <i>Angophora costata</i> .	Widespread on slopes and bordering creeks, on Hawkesbury Sandstone, with cool aspects.	2257 (18.9)
3P. Open Forest; plateau (Hawkesbury)	<i>Angophora costata</i> , <i>Eucalyptus sieberi</i> , <i>E. capitellata</i> , <i>E. gummifera</i> , <i>Syncarpia glomulifera</i> , <i>Corymbia punctata</i>	Occurs near Kariong on plateau tops on deep yellow earthy soils.	20 (0.2%)
3S. Open Forest (Shale)	<i>Angophora costata</i> , <i>Eucalyptus gummifera</i> , <i>E. umbra</i> , <i>Syncarpia glomulifera</i> , <i>Corymbia punctata</i>	Remnant shale outcrops on ridge tops in the southern end of the park.	163 (1.4%)
4. Low Open Forest	<i>Angophora costata</i> , <i>Eucalyptus piperita</i> , <i>E. oblonga</i> , <i>E. umbra</i> , <i>E. gummifera</i> , <i>E. haemastoma</i> , <i>E. pellita</i> , <i>Banksia serrata</i> .	Widespread, especially in the south on slopes below ridges or in shallow valleys.	2145 (18%)
4P. Low Open Forest; plateau tops	<i>Eucalyptus gummifera</i> , <i>E. haemastoma</i> , <i>E. sieberi</i> , <i>E. punctata</i> , <i>E. oblonga</i> , <i>Banksia serrata</i>	Plateau tops on fairly deep earthy soils, near Warrah Trig and near Kariong.	320 (2.7%)
5. Woodland (Hawkesbury)	<i>Angophora costata</i> , <i>Eucalyptus gummifera</i> , <i>E. eximia</i> , <i>E. umbra</i> , <i>E. haemastoma</i> , <i>Corymbia punctata</i>	Widespread, especially in the south on ridges, spurs and dry slopes.	2530 (21.2%)
6. Closed Open Scrub (Hawkesbury)	<i>Banksia ericifolia</i> , <i>Hakea teretifolia</i> , <i>Eucalyptus haemastoma</i> , <i>E. umbra</i> , <i>E. gummifera</i> .	Widespread on shallow moist sandy soils, on ridgetops and along drainage lines.	597 (5.0%)
7. Sedgeland	<i>Banksia robur</i> , <i>B. asplenifolia</i> , <i>B. ericifolia</i> , <i>Hakea teretifolia</i> ,	Swampy organic soil conditions. Most common on the northern sandstone plateaux.	129 (1.1%)

<b>Vegetation Community</b>	<b>Dominant canopy species</b>	<b>Habitat</b>	<b>Area (ha)</b>
8. Rock outcrops with pockets of low scrub	<i>Eucalyptus. haemastoma, E. eximia, Allocasuarina distyla, Baeckea brevifolia, Banksia Sp.</i>	In isolated depressions, on rock platforms, on ridge tops and slopes on Hawkesbury sandstone.	101 (0.8%)
9. Tall Open Scrub-Mangroves	<i>Avicennia marina var. australasica, Aegiceras corniculatum</i>	Tidal watercourses not subject to wave action.	32 (0.3%)
10. Reedland/Rushland (alluvium)	<i>Casuarina glauca, Melaleuca stypheliodes</i>	On alluvial flats and along tidal channels on alluvial flats.	14 (0.1%)
11. Low Scrub: coastal	<i>Casuarina glauca, Banksia integrifolia</i>	On Green Point, adjacent to the sea on slopes or cliffs, extending down to the rock platforms.	1.3 (<0.1%)
12. Low Open Forest; coastal	<i>Banksia integrifolia, Angophora costata, Eucalyptus botryoides, E. umbra</i>	Restricted to the south of the park near Pearl Beach, on cooler aspects with sloping well drained ground, on the Narrabeen Group.	12 (0.1%)
13. Open Forest; coastal (alluvium)	<i>Angophora floribunda, Eucalyptus maculata, E. botryoides, Livistonia Australis, Corymbia punctata</i>	Found only behind Pearl Beach on cool sheltered coastal alluvial flats with deep sandy soil.	<1 (<0.1%)
14. Cleared/disturbed		NA	53 (0.5%)

## APPENDIX 2: FLORA SPECIES OF CONCERN FOR FIRE MANAGEMENT IN BRISBANE WATER NATIONAL PARK

Outlined in the tables below are the fire management guidelines for flora species of particular concern in the study area including;

- Those species listed as either endangered or vulnerable under the *Threatened Species Conservation Act* (NSW) 1995,
- Those species listed at the geographic limit of their distribution or other rare, restricted, or disjunct populations of species identified by NPWS staff or specialists,
- Rare Or Threatened Australian Plants (ROTAP) (Briggs and Leigh, 1995).
- Particularly fire sensitive species, with long juvenile periods and thin bark.

Information on the distribution and abundance of flora diversity within the park has been sourced from surveys within the park, the Wildlife Atlas of NSW, and consultation with Service staff, and other flora specialists. The location of flora records is available on the Service Geographic Information System (GIS).

Information on the ecology/ fire ecology of flora has been sourced from detailed species profiles held by the NPWS, *The National Register of the Fire Response of Plant Species* (Gill and Bradstock 1992), the scientific literature, and consultation with NPWS Biodiversity Conservation, and threatened species unit, and other fire ecology specialists. This information has been used to derive appropriate fire regimes strategies for species conservation.

Species	Status	Life form, habitat, fire response ,	Fire management Guidelines
<i>Prostanthera junonis</i>	Endangered (TSC Act) Extremely rare, highly endangered. Local restricted distribution	<b>Life form:</b> Low spreading perennial Shrub <b>Habitat:</b> along drainage lines or in seepage areas or Open Woodland <b>Fire response:</b> Initial burning evoked a positive response. Suitable fire intervals are unknown.	Manage fire of species habitat according to regime D
<i>Astrotricha crassifolia</i>	Vulnerable (TSC Act)	<b>Life form:</b> perennial shrub <b>Habitat:</b> Coastal <b>Fire response:</b> Survives 100%scorch, resprouts from root suckers or basal sprouts	Manage fire of species habitat according to regime C
<i>Callistemon linearifolius</i>	Vulnerable (TSC Act)	<b>Life form:</b> erect perennial <i>shrub</i> <b>Habitat:</b> Found in damp woodland gullies <b>Fire response:</b> Unknown	Manage fire of species habitat according to regime C
<i>Eucalyptus camfieldii</i>	Vulnerable (TSC Act) Extension of northern limit. Gosford to Royal National Park. Found on eastern side of Kariong Rifle Range and Briezes Road.	<b>Life form:</b> Perennial tree <b>Habitat:</b> Coastal scrub on sandy soils on sandstone, often of restricted drainage (Harden 1991). According to E-RMS it occurs in low open forest on plateau tops (4). <b>Fire response:</b> Resprouts from Epicormic Shoots	Manage fire of species habitat according to regime C
<i>Grevillea shiressii</i>	Vulnerable (TSC Act) Extremely localised distribution.	<b>Life form:</b> Tall broad leaved shrub <b>Habitat:</b> Open forest with a moist understorey (Community 2B) on alluvial soils. Occurs only on Mullet Creek near Wondabyne and on Mooney Mooney Creek <b>Fire response:</b> unknown	Manage fire of species habitat according to regime A No fire acceptable
<i>Tetratheca glandulosa</i>	Vulnerable	<b>Life form:</b> Low growing spreading shrub <b>Habitat:</b> Restricted to the Central Coast. Sandy heath and scrub (Fairley and Moore, 1989 ). <b>Fire response:</b> killed by fire but recruits from seed (Bell 1989).	Manage fire of species habitat according to regime D No fire acceptable. Requires further research.
<i>Darwinia glaucophylla</i>	ROTAP 2RCa Restricted distribution.	<b>Life form:</b> perennial shrub <b>Habitat:</b> Associated with rock outcrops in low scrub or closed to open scrub vegetation types (Communities 8 and 6). Found only in Calga, Piles Creek and Kariong areas. <b>Fire response:</b> Unknown	Manage fire of species habitat according to regime D






Species	Status	Life form, habitat, fire response ,	Fire management Guidelines
<i>Darwinia procera</i>	ROTAP 2RCa Northern geographic limit	<b>Life form:</b> an erect shrub 2 – 3 m tall <b>Habitat:</b> Low open woodland with a dry shrubby understorey (Community 8) <b>Fire response:</b> Unknown	Manage fire of species habitat according to regime D, other wise no fire acceptable until further detail is available
<i>Boronia fraseri</i>	ROTAP 2RCa Restricted distribution	<b>Life form:</b> Erect shrub <b>Habitat:</b> Closed forest - low closed forest (Community 1) and open forest on Hawkesbury Sandstone (Community 3) from Menangle to Woy Woy on the Central Coast and on the lower eastern slopes of the Blue Mountains. <b>Fire response:</b> Unknown	Manage fire of species habitat according to regime D, otherwise requires further detail
<i>Boronia serrulata</i>	ROTAP 2RCa	<b>Life form:</b> small slender erect heath plant less than 1m <b>Habitat:</b> Common on damp sandy heath near the coast <b>Fire response Unknown</b>	Manage fire of species habitat according to regime D
<i>Gonocarpus salsoloides</i>	ROTAP 3RCa	<b>Life form:</b> An erect multi branched herb <b>Habitat:</b> Found on swampy heath near the sea <b>Fire response: 100% scorch kills plant</b>	Manage fire of species habitat according to regime D
<i>Eucalyptus luehmanniana</i>	ROTAP 2RCa Restricted endemic with limited range.	<b>Life form:</b> Perennial tree, <b>Habitat:</b> Low woodland to low open woodland (5) between rock outcrops on sandstone slopes. <b>Fire response:</b> Will survive %100 scorch, regenerates via epicormic growth	Manage fire of species habitat according to regime D
<i>Melaleuca deanei</i>	ROTAP 3RC- Extension of northern limit	<b>Life form:</b> 3 m tall shrub <b>Habitat:</b> Low open woodland with a dense scrub understorey (Community 5). <b>Fire response unknown</b>	Manage fire in species habitat according to regime D
<i>Blechnum ambiguum</i>	Uncommon in the area	<b>Life form:</b> Perennial fern <b>Habitat:</b> Confined to moist sheltered overhangs on Hawkesbury Sandstone in open forest (Community 2B or 3). <b>Fire response:</b> Unknown	Manage fire of species habitat according regime D. Decline expected if more than two fires in a row occur at less than intervals of 8 years apart. Decline expected if more than two fires in a row occur at more than intervals of 15 years apart.
<i>Leucopogon amplexicaulis</i>	Extension of northern limit.	<b>Life form:</b> Perennial shrub <b>Habitat:</b> Low open forest to low woodland (Communities 4 and 5) in sheltered moist places near rock outcrops. <b>Fire response:</b> !00% scorch kills adult plant seeds stored in soil	Benson & Fallding (p35) suggested that this species may be restricted to areas that have not been burnt for some time.
<i>Leucopogon margarodes</i>	Southern geographic limit.	<b>Life form:</b> Perennial shrub, <b>Habitat:</b> Open forest on Hawkesbury Sandstone with a moist dense understorey (Community 3).	Manage fire of species habitat according to regime D, needs an inter fire interval of at least 8 - 10 years (Benson and Fallding, p37).

Species	Status	Life form, habitat, fire response ,	Fire management Guidelines
		<b>Fire response:</b> will survive 100% fire scorch, epicormic regrowth	
<i>Styphelia laeta</i> <i>var latifolia</i>	Very restricted area of distribution, however widespread within its area of occurrence.	<b>Life form:</b> Perennial shrub, <b>Habitat:</b> Dense shrubby understorey in open forest on Hawkesbury Sandstone slopes (3); low open forest (4); low open forest on plateau tops with earthy soils (4P); and low woodland (5) <b>Fire response:</b> Will survive 100% scorch, basal sprouts after fire	Manage fire of species habitat according to regime C
<i>Eucalyptus multicaulis</i>	Uncommon species occurring only in small localised patches.	<b>Life form: mallee usually 4-6 m high</b> <b>Habitat:</b> Low woodland to low open woodland (Community 5) on rocky sandstone slopes. <b>Fire response:</b> Unknown	further research required
<i>Grevillea diffusa</i> <i>ssp. capitellata</i>	Very restricted distribution in the Peat's Ferry, Mount White, Calga and Mangrove Mountain area only.	<b>Life form:</b> Perennial shrub <b>Habitat:</b> Low open forest (4) with a dense shrubby understorey and scrub (6) Fire response: unknown	Manage fire of species habitat according to regime D
<i>Grevillea oldei</i>	Very restricted distribution from Mangrove Mountain to Woy Woy only.	<b>Life form:</b> Perennial shrub, <b>Habitat:</b> Heath (6) or woodland (5) on shallow sandy soils over sandstone. <b>Fire response</b> Will survive 100% scorch but regenerative mechanism unknown	Manage fire of species habitat according to regime D
<i>Grevillea diffusa</i> <i>ssp. filipendula</i>	Very restricted distribution, from Calga to the Mount White area only.	<b>Life form: Low spreading shrub</b> <b>Habitat:</b> Forest (3) or woodland (5), occasionally in swampy heath, in sandy soils usually on Hawkesbury Sandstone. <b>Fire response:</b> Unknown	Manage fire of species habitat according to regime C

The above table was developed from the BWNP POM and from Benson & Fallding (1979) and from Gill (1992) A national register for the fire responses of plant species.

### APPENDIX 3: FAUNA SPECIES OF CONCERN FOR FIRE MANAGEMENT IN BRISBANE WATER NATIONAL PARK

Outlined in the tables below are the fire management guidelines for fauna species of particular concern in the study area. Information on the distribution and abundance of flora diversity within the parks has been sourced from surveys within the park, The Wildlife Atlas of NSW, and consultation with Service staff, and other specialists. The location of fauna records is available on the Service Geographic Information System (GIS).




ID	Fire Management Strategies	Scientific Name	Common Name	Status
 FA1	<ul style="list-style-type: none"> <li>- Utilise mosaic burn avoiding high intensity fires in <i>Allocasuarina</i> thickets.</li> <li>- Avoid <i>Allocasuarina</i> thickets when undertaking mechanical forms of hazard reduction (NSW RFS 2003).</li> <li>- Avoid fire around hollow bearing trees.</li> <li>- No fire, smoke or machinery around nesting sites during breeding season (autumn and winter).</li> </ul>	<i>Calyptorhynchus lathami</i>	Glossy Black-Cockatoo	V
 FA2	<ul style="list-style-type: none"> <li>-Avoid fire around hollow bearing trees in known locations.</li> <li>-Avoid the use of fire and machinery around known nests (tree hollows / bark of eucalypts) during breeding season (late spring – early autumn).</li> </ul>	<i>Cercartetus nanus</i>	Eastern Pygmy-possum	V
 FA3	<ul style="list-style-type: none"> <li>- Habitat unlikely to be affected by fire.</li> <li>- Avoid the use of earth moving machinery around nests (holes dug into the beach).</li> </ul>	<i>Chelonia mydas</i>	Green Turtle	V
 FA4	<ul style="list-style-type: none"> <li>- As far as possible, avoid fire around large tree and log hollows in known locations.</li> <li>- Utilise mosaic burn to maintain suitable habitat and food resources, wetting down large log hollows prior to burn.</li> <li>- Avoid fire, smoke and machinery during breeding season (April – July) in known locations.</li> </ul>	<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	V
 FA5	<ul style="list-style-type: none"> <li>- Utilise low intensity / frequency mosaic burn.</li> <li>- Protect hollow bearing trees in known locations.</li> </ul>	<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	V



ID	Fire Management Strategies	Scientific Name	Common Name	Status
FA6	<ul style="list-style-type: none"> <li>- Habitat unlikely to be affected by fire.</li> <li>- Avoid machinery around nest sites (saltmarsh, grassy areas) during breeding season (August-January).</li> </ul>	<i>Haematopus longirostris</i>	Pied Oystercatcher	V
FA7	<ul style="list-style-type: none"> <li>- No burning adjacent to streams; no slashing, trittering or tree removal.</li> <li>- Utilise mosaic burn outside of breeding season (summer – autumn).</li> <li>- Avoid the use of retardants in habitats where this species is known to occur.</li> <li>- Avoid the use of machinery in habitats where this species is known to occur.</li> </ul>	<i>Heleioporus australiacus</i>	Giant Burrowing Frog	V
FA8	<ul style="list-style-type: none"> <li>- No fire around known roost sites (caves).</li> <li>- No fire, machinery around known maternity caves.</li> </ul>	<i>Miniopterus schreibersii oceanensis</i>	Eastern Bent-wing Bat	V
FA9	<ul style="list-style-type: none"> <li>- Low intensity burn in known habitat to retain suitable food resources.</li> <li>- Avoid the use of fire in known habitat during breeding season (August – January).</li> <li>- Retain hollow bearing trees to provide suitable nesting habitat.</li> </ul>	<i>Neophema pulchella</i>	Turquoise Parrot	V
FA10	<ul style="list-style-type: none"> <li>- No burning around nesting sites (tree hollows) at any time.</li> <li>- Utilise mosaic burns in foraging habitat.</li> <li>- Avoid use of machinery around nesting sites in breeding season.</li> </ul>	<i>Ninox strenua</i>	Powerful Owl	V
FA11	<ul style="list-style-type: none"> <li>- No burning around known nesting sites (large nests in tall dead trees).</li> </ul>	<i>Pandion haliaetus</i>	Osprey	V
FA12	<ul style="list-style-type: none"> <li>- Protect hollow bearing trees in locations where this species is known to occur.</li> <li>- Avoid fire, machinery around known nests during breeding season (June-November).</li> <li>- Utilise mosaic burn in habitat.</li> <li>- No slashing, trittering or tree removal.</li> </ul>	<i>Petaurus norfolcensis</i>	Squirrel Glider	V
FA13	<ul style="list-style-type: none"> <li>- Utilise mosaic burns of low intensity in known or potential habitat.</li> <li>- Avoid the use of fire, smoke and machinery in known locations during breeding</li> </ul>	<i>Phascolarctos cinereus</i>	Koala	V

ID	Fire Management Strategies	Scientific Name	Common Name	Status
	season (October-March).			
FA14	<ul style="list-style-type: none"> <li>- Utilise mosaic burn, no slashing, trittering or tree removal.</li> <li>- Utilise low frequency fires to maintain understorey and ground cover in known locations.</li> <li>- Avoid the use of machinery and fire in known locations during breeding seasons (late winter – early spring) and (late summer).</li> </ul>	<i>Potorous tridactylus</i>	Long-nosed Potoroo	V
FA15	<ul style="list-style-type: none"> <li>- Utilise mosaic burn outside breeding period (September-March).</li> <li>- No slashing, trittering or tree removal.</li> </ul>	<i>Pseudomys gracilicaudatus</i>	Eastern Chestnut Mouse	V
FA16	<ul style="list-style-type: none"> <li>- No burning adjacent to streams; no slashing, trittering or tree removal.</li> <li>- Avoid the use of retardants in habitats where this species is known to occur.</li> <li>- Avoid the use of machinery in habitats where this species is known to occur.</li> </ul>	<i>Pseudophryne australis</i>	Red-crowned Toadlet	V
FA17	<ul style="list-style-type: none"> <li>- Avoid the use of fire and machinery around known camps (gullies close to water).</li> </ul>	<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V
FA18	<ul style="list-style-type: none"> <li>- Avoid burning in known habitat during breeding season (Spring-Summer).</li> </ul>	<i>Ptilinopus superbis</i>	Superb Fruit-Dove	V
FA19	<ul style="list-style-type: none"> <li>- No burning around known nesting sites (tree hollows) at any time; no slashing, trittering or tree removal.</li> </ul>	<i>Tyto novaehollandiae</i>	Masked Owl	V
FA20	<ul style="list-style-type: none"> <li>- No burning around known nesting sites (tree hollows or dense vegetation) at any time; no slashing, trittering or tree removal.</li> </ul>	<i>Tyto tenebricosa</i>	Sooty Owl	V
FA21	<ul style="list-style-type: none"> <li>- Avoid burning in known habitat during breeding season (July-November).</li> </ul>	<i>Xanthomyza phrygia</i>	Regent Honeyeater	E1
FA22	<ul style="list-style-type: none"> <li>- Utilise mosaic burn; avoid in the breeding period (Spring) in known habitat.</li> <li>- No slashing, trittering or tree removal.</li> </ul>	<i>Burhinus grallarius</i>	Bush Stone-Curlew	E
FA23	<ul style="list-style-type: none"> <li>- Utilise mosaic burns.</li> <li>- Avoid fire in known locations during breeding season (mid summer – autumn).</li> <li>- Avoid the use of machinery in</li> </ul>	<i>Heleioporus australiacus</i>	Giant burrowing Frog	V

ID	Fire Management Strategies	Scientific Name	Common Name	Status
	known locations. - Avoid the use of retardant in known locations.			
FA24	- Habitat (terrestrial / estuarine wetlands) unlikely to be affected by fire. - Avoid the use of retardants in known habitat.	<i>Ixobrychus flavicollis</i>	Black bittern	V
FA25	- Utilise mosaic burn in habitat containing favoured tree species such as <i>Eucalyptus robusta</i> , <i>Corymbia maculata</i> and <i>C.gummifera</i> .	<i>Lathamus discolor</i>	Swift Parrot	V
FA26	- As far as possible, exclude fire from wetland habitats of known locations. - Avoid the use of machinery in known locations. - Avoid the use of retardant in known locations.	<i>Litoria aurea</i>	Green and Golden Bell Frog	E
FA27	- Unknown response to fire. - Utilise mosaic burn in known locations outside of breeding season (late spring-summer). - Avoid the use of machinery in known locations. - Avoid the use of retardants in known locations.	<i>Litoria brevipalmata</i>	Green-thighed Frog	V
FA28	- No fire around known roost sites (caves). - No fire, machinery around known maternity caves (utilised between spring and March). - Utilise mosaic burn in foraging habitat.	<i>Miniopterus schreibersii</i>	Common Bent-wing Bat	V
FA29	- Exclude fire from known habitat (rainforest, wet sclerophyll forest). - Avoid the use of machinery in known locations. - Avoid the use of retardants in known locations.	<i>Mixophyes balbus</i>	Stuttering Frog	V
FA30	- Exclude fire from known habitat (rainforest, wet sclerophyll forest). - Avoid the use of machinery in known locations. - Avoid the use of retardant in known locations.	<i>Mixophyes iteratus</i>	Giant-barred frog	E
FA31	- Avoid the use of fire around known colonies (roosts in caves). - Avoid the use of fire and machinery around known colonies during breeding	<i>Myotis adversus</i>	Large-footed Mouse-eared Bat	V

ID	Fire Management Strategies	Scientific Name	Common Name	Status
	season (November-December). - Utilise mosaic burn in foraging habitat (dense foliage near waterbodies).			
 FA32	- No burning around nesting sites (tree hollows) at any time. - Utilise mosaic burns in foraging habitat. - Avoid use of machinery around nesting sites in breeding season.	<i>Ninox connivens</i>	Barking Owl	V
 FA33	- Protect hollow bearing trees in locations where these species are known to occur. - Avoid use of machinery around known nests (tree hollows) during breeding period (August-September). - Avoid high intensity fires to maintain large mature eucalypts in the canopy.	<i>Petaurus australis</i>	Yellow-bellied Glider	V
 FA34	- Habitat unlikely to be affected by fire.	<i>Pterodroma nigripennis</i>	Black-winged Petrel	V

## APPENDIX 4: GLOSSARY OF DEFINITIONS

*The definitions described below are based on the Australian Fire Authorities Council (AFAC) **Glossary of Rural Fire Terminology** (March 1996).*

<b>Aerial Detection</b>	The discovering, locating and reporting of fires from aircraft.
<b>Aerial Fuels</b>	The standing and supporting combustibles not in direct contact with the ground and consisting mainly of foliage, twigs, branches, stems, bark and creepers.
<b>Aspect</b>	The direction towards which a slope faces, eg north-east. Slopes on a west to north-westerly aspect are the most hazardous during fire fighting operations.
<b>Asset Protection Zone (APZ)</b>	A zone which is proven to provide effective protection from radiation damage to both assets and firefighters in all but the most extreme wildfire events.
<b>Assets at Risk</b>	The natural resources or improvements that may be jeopardised if a fire occurs. Examples include: threatened species habitat, rainforests, forestry coups, human built structures or infrastructures, park information signs, transmission poles etc. and may also include scenic values. For the fire manager it may also include natural values that may be threatened by a fire (eg water catchment quality).
<b>Backburning</b>	A fire started intentionally along the inner edge of a fireline to consume the fuel in the path of a wildfire.
<b>Buffer</b>	A strip or block of land on which the fuels are reduced to provide protection to surrounding lands.
<b>Burning Program</b>	All the prescribed burns scheduled for a designated area over a nominated period of time.
<b>Bush Fire Management Zone (BFMZ)</b>	Management areas where a specified fire management operation objective, strategy and performance Indicator has been developed.
<b>Bush Fire Management Zone Area</b>	Management areas of a variable size that define containment blocks in the event of a wildfire. Alternatively they are also designated as areas of specific ecosystem types defined by fire management authorities for monitoring and prescribed burning for natural heritage management
<b>BWNP</b>	Brisbane Water National Park
<b>Byram-Keetch Drought Index (BKDI)</b>	A numerical value reflecting the dryness of soils, deep forest litter, logs and living vegetation, and expressed as a scale from 0 - 200 points. When 100 points has been reached in an area, that area is said to be in drought.
<b>Coarse Fuels</b>	Dead woody material, greater than 25mm in diameter, in contact with the soil surface (fallen trees and branches).
<b>Controlled Burning</b>	<i>see Prescribed Burning.</i>
<b>Crown Fire</b>	A fire burning in the crowns of trees and usually supported by fire in ground fuels. Its is a fast travelling fire that usually consumes all available fuels in its path.
<b>Drought Index</b>	A numerical value, such as the Byram-Keetch Drought Index,

	reflecting the dryness of soils, deep forest litter, logs and living vegetation.
<b>Ecosystem</b>	The interacting system of a biological community, both plant and animal, and its non living surroundings
<b>Edge Burning</b>	A term used to describe perimeter burning of an area in mild conditions prior to large scale prescribed burning. This practice is used to strengthen buffers and to reduce mop-up operations.
<b>Fine Fuels</b>	Grass, leaves, bark and twigs less than 6mm in diameter.
<b>Fire</b>	The chemical reaction between fuel, oxygen and heat. Heat is necessary to start the reaction and once ignited, fire produces its own heat and becomes self-supporting. Removal of any one of the three elements of fuel, oxygen and heat will extinguish a fire.
<b>Fire Behaviour</b>	The manner in which a fire reacts to the variables of fuel, weather and topography. Changes in any of these variables with result in a change in the fires behaviour.
<b>Fire Break</b>	Any natural or constructed discontinuity in a fuel bed used to segregate, stop and control the spread of a wildfire, or to provide a fireline from which to suppress a fire.
	The area burnt by a wildfire, measured in hectares. Within that area there will be "islands" of unburnt vegetation (these islands are generally included in the total fire extent).
<b>Fire Extent</b>	<i>NB: it is preferable that fire effect only part of a vegetation community at any one time so that nearby areas of more mature plants may provide a seed source for recolonisation and animals will have suitable unburnt habitat in order to seek shelter and forage.</i>
<b>Fire Front</b>	The part of a fire where the rate of spread, flame height and intensity are greatest, usually when burning downwind or upslope.
<b>Fire Intensity</b>	The rate of energy released per unit length of fire front. This is usually expressed as kilowatts per metre (kW/m).
<b>Fire Management</b>	All activities associated with the management of fire-prone land, including the use of fire to meet land management goals and objectives.
<b>Fire Perimeter</b>	The entire outer boundary of a fire area.
<b>Fire Regime</b>	The history of fire in a particular vegetation type or area including the frequency, intensity and season of burning (season in this context refers to the time of the year in which the fire occurred). It may also include proposals for the use of fire in a given area.
	The period(s) of the year during which fires are likely to occur, spread and do sufficient damage to warrant organised fire control. In New South Wales the core fire season is from 1st October to the 31st March of the following year.
<b>Fire Season</b>	<i>At the regional scale, the season may be introduced or extended by one month dependant upon the prevailing weather conditions, drought indexes and number of wildfire's that may already be burning within that area.</i>
<b>Fire Storm</b>	Violent convection caused by a large continuous area of intense fire; often characterised by destructively violent surface indrafts,

	a towering convection column, long distance spotting, and sometimes by tornado-like whirlwinds.
<b>Flame Height</b>	The vertical distance between the tip of the flame and ground level, excluding higher flame flashes. Expressed in vertical metres.
<b>Fuel</b>	Any material such as grass, bark, leaf litter and living vegetation which can be ignited and sustains a fire. Fuel is usually measured in tonnes per hectare of dry weight.
<b>Fuel Arrangement</b>	A general term referring to the spacing and arrangement of fuel in a given area.
<b>Fuel Bed</b>	The arrangement and vertical profile of all readily combustible materials lying on the ground.
<b>Fuel Load</b>	The oven dry weight of fuel per unit area. Commonly expressed as tonnes per hectare.
<b>Fuel Management</b>	Modification of fuels by prescribed burning, manual removal, slashing, grazing, or other means. The objective is to reduce the fuel thereby reducing the risk posed by wildfires.
<b>Fuel Type</b>	An identifiable association of fuel elements of distinctive species, form, size, arrangement, or other characteristics that will cause predictable rate of spread or difficulty of control under specified weather conditions.
<b>Habitat</b>	A physical portion of the environment that is inhabited by an organism or population of organisms. A habitat is characterised by a relative uniformity of the physical environment and fairly close interaction of all the biological species involved. <i>Organisms within a given habitat will express a level of co-dependency upon one-another. The loss of the physical characteristics of a given habitat can have sever and long term detrimental effects upon the organisms living in that habitat.</i>
<b>Hazard Reduction</b>	<i>see Fuel Management</i>
<b>Land Management Zone (LMZ)</b>	The priority for these zones is to allow the land manager to meet their land management objective. In relation to NPWS the priority is to conserve natural and cultural heritage values. Fire management will aim to be consistent with conservation objectives.
<b>Island</b>	An unburnt area within a fire perimeter. Islands are critical for species survival and recruitment after a wildfire event.
<b>NPWS</b>	The National Parks and Wildlife Service of New South Wales.
<b>NSWFB</b>	The New South Wales Fire Brigades.
<b>Prescribed Burning</b>	The controlled application of fire under specified environmental and weather conditions to a predetermined area and at the time, intensity, and rate of spread required to attain planned resource management objectives.
<b>Rate of Spread</b>	The forward progress per unit time of the head of the fire or another specified part of the fire perimeter.
<b>RFS</b>	The Rural Fire Service.
<b>Scorch Height</b>	The height above ground level up to where foliage has been browned by a fire. This height is roughly ten times the actual flame height of the fire.

<b>Service, the SF</b>	<p>The National Parks and Wildlife Service of New South Wales. State Forests of New South Wales.</p> <p>A fire fighting unit that can be placed on to the back of a four wheel drive vehicle to convert it to a fire tanker.</p>
<b>Slip-on Unit</b>	<p><i>Depending upon the units water carrying capacity, a four wheel drive tray top vehicle could be converted to Category 2, 7 or 9 fire tankers in a very short space of time.</i></p>
<b>Spot Fire</b>	<p>Isolated fires started ahead of the main fire by sparks, embers or other ignited material, sometimes to a distance of several kilometres.</p>
<b>Strategic Fire Advantage Zone (SFAZ)</b>	<p>Strategic Fire Advantage Zones (SFAZ) assist in the containment of wildfires to provide safe access to bush fire fighters and to assist with the achievement of a fire regime which is consistent with reserve management objectives. The zone is located in an area which is effective in reducing wildfire intensity and spotting potential and is therefore proven to be effective in assisting with the containment of wildfires within a defined area</p>
<b>Striker</b>	<p>A small four wheel drive fire tanker capable of carrying from 400 to 600 litres of water for fire fighting purposes. Also known as a Category 9 Fire Tanker.</p>
<b>Structure Fire</b>	<p>A fire burning part, or all of any building, shelter, or other human made construction.</p> <p>A mobile firefighting vehicle equipped with a water tank, pump, and the necessary equipment for spraying water and/or foam on wildfire's.</p>
<b>Tanker</b>	<p><i>Under NSW Dept. of Rural Fire Service guidelines, bush fire fighting tankers have been designated into nine 'Categories' delineating water carrying capacity and whether the unit is two or four wheel drive capable.</i></p>
<b>Topography</b>	<p>The surface features of a particular area or region, ie the lay of the land, and includes mountains, rivers etc.</p>
<b>Unplanned Fire</b>	<p><i>see Wildfire</i></p>
<b>Urban/Rural Interface</b>	<p>The line, area, or zone where structures and other human development adjoin or overlaps with undeveloped bushland. Also known as the urban/bush interface, urban interface or just the interface.</p>
<b>Wildfire</b>	<p>An unplanned fire. A generic term which includes grass fires, forest fires and scrub fires.</p>





**NATIONAL  
PARKS AND  
WILDLIFE  
SERVICE**

**43 Bridge Street  
Hurstville NSW  
Australia 2220**



**Department of  
Environment and Conservation (NSW)**