CASINO MANAGEMENT AREA EIS

SUPPORTING DOCUMENT No. 10

FUEL MANAGEMENT PLAN
CASINO DISTRICT
NORTHERN REGION
STATE FORESTS OF NEW SOUTH WALES

September 1995

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NORTHERN REGION

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1 INTRODUCTION

State Forests has a clear responsibility to protect life and property from wildfire; to minimise the spread of wildfire from State forests; and to protect forests under its control from the damaging effects of wildfire. To carry out these responsibilities, SFNSW has developed policies and procedures for fire management, including fuel management.

Fuel management is part of the broader fire management process in New South Wales. Information relating to this process (policies, guidelines and instructions) has been collated in the Fire Management Manual (Forestry Commission of NSW, 1992) and is progressively updated by SFNSW.

This plan prescribes the procedures developed to implement SFNSW policies for fuel management in the State forests of Casino District.

In determining priorities for fuel management, State Forests has a community obligation to protect life and property, as well as valuable forest assets such as pine plantations. In considering ecological factors relevant to fuel managament by hazard reduction burning and the setting of priorities, the precautionary principle will be applied. This does not necessarily imply exclusion of fire.

Fire should be excluded from some plant communities which are not fire dependent, for example, rainforest. For fire tolerant plant communities, it is ecologically undesirable for fire to be excluded. To do so risks the often devastating effects of uncontrolled wildfire, in unmanaged fuels, on rare and threatened species or communities. Fire is an integral part of the overall forest environment and has been widely used as a fuel management tool. The ecological impact of excluding fire from large areas is unknown.

Fire will only be excluded where it is known to be ecologically undesirable. In general, the precautionary principle to be applied in fuel management for Casino District will be to:

- maintain current practice by carrying out hazard reduction burning to protect life and property;
- carry out hazard reduction burning to protect the broad range of forest resources and assets from the effects of uncontrolled wildfire;
- maintain current practice over the broader area of forest until further research demonstrates the impact of fire, particularly with regard to Critical Weight Range mammals and some flora communities.

In areas adjacent to high value assets and where life and property are at risk, the objective of strategic fuel management is to maximise fire suppression options in the event of a wildfire. Fuel management in these zones aims to allow a direct method of wildfire suppression, under most weather conditions.

Other areas will be identified where the range of fire suppression options required will be related to the value of the asset. In some areas, because of the assets at risk, fuel management aims to provide a range of fire suppression options, direct fire suppression not

being mandatory. In these areas, fire suppression will focus more on indirect options, such as backburning.

In the broader forest area, where life and property are not directly at risk, fuel management aims to provide a mosaic of burnt and unburnt areas. This allows an indirect fire suppression effort in the event of a wildfire and maintains biodiversity in the long-term. Uncontrolled wildfires, particularly crown fires in unmanaged fuels, are unacceptable. Fuel management aims to protect all forest resource values, so that in the event of a wildfire, a range of fire suppression options is available to the forest manager.

Hazard reduction burning is the most efficient and cost effective method of fuel management, allowing protection of a broad range of assets. In determining the frequency and intensity of proposed burning, the primary consideration is the value of the asset to be protected and the range of wildfire suppression options required to protect that asset, recognising that resources for fuel management are limited.

Across the District, objectives will be met by establishing a mosaic of fire regimes in priority zones to reduce fuel levels in dry eucalypt, escarpment, and some highland and moist hardwood types. These priority zones include limited strategic burning around high population areas and valuable assets; variable frequency broad area burning; and burning for species management or ecological purposes. Pre-logging burning and burning under regrowth are carried out as part of broad area burning, whereas post-logging burning is done for specific silvicultural purposes.

In some areas, hazard reduction burning is excluded. These are identified as no burning zones and include rainforest types, regrowth areas less than 10 years old and most flora reserves.

1.1 Policy and Planning Context

This plan has been prepared in accordance with State Forests' (Forestry Commission of NSW) policy statements on fire control (Fire Management and Control, 1987) and fuel management (Fuel Management in Native Forests, 1986).

1.2 The Legal Framework

State Forests' statutory obligations regarding fire are detailed in the Bush Fires Act (1949) and the Forestry Act (1916). Under the Forestry Act (1916), Section 11(1)i provides that State Forests, subject to the Bush Fires Act (1949), may carry out measures for the protection of timber and products from fire on Crown-timber lands. The Bush Fires Act (1949), Section 54(1), requires State Forests to take all practicable steps to minimise the occurrence of fires on, and their spread from, lands under its control.

It is also an offence under the Bush Fires Act (1949), Part 2, Clause 12(1)(b), for: *any person who, being the owner or occupier of any land, permits a fire to escape from that land under such circumstances as to cause or be likely to cause injury or damage to the person, land or property of another person or the land or property of the Crown or a public authority.*

In order to meet its obligations under the Bush Fires Act (1949), State Forests must modify wildfire behaviour so that it can be controlled and contained within the forest. Section 8A(2) of the Forestry Act (1916), also provides that all practicable steps necessary or desirable must be taken to ensure the preservation and enhancement of the quality of the environment.

Other legislation, affecting fire management planning and practice, includes the National Parks and Wildlife Act (1974); Workers Compensation (Bush Fire Emergency and Rescue Services) Act (1987); Crimes Act (1900); Local Government Act (1918); Environmental Planning and Assessment Act (1979); Clean Air Act (1961); Occupational Health and Safety Act (1983); and the Endangered Fauna (Interim Protection) Act (1991).

The Bush Fires (Amendment) Act (1994), Section 41A(1), requires each Bush Fire Management Committee to prepare a Bush Fire Management Plan comprising a Fuel Management Plan and an Operational Plan, to coordinate the activities of organisations in the prevention, control and suppression of bush fires. The State forests of Casino District are within seven Bush Fire Management Areas - Kyogle, Companhurst, Lismore, Richmond River, Maclean, Byron and Tweed.

The Section 41A Bush Fire Management Plans detail fuel management strategies for private and public land, including State forest. The Fuel Management Plan for Casino District should be consistent with, and integrated with, the relevant Section 41A Plans It is also noted that State Forests Management Plans for the Casino and Murwillumbah Management Areas, cover the State forests in Casino District.

With regard to statutory planning obligations, State Forests is required, under the Environmental Planning and Assessment Act (1979), Part 5, to prepare an Environmental Impact Statement (EIS) if operations are considered to have a significant impact on the environment. The Minister for Planning will consider fuel management outlined in this plan as part of the approval process for State Forests' Casino and Murwillumbah EISs.

1.3 Policy Statements

State Forests has two policy statements relating to fire control and fuel management. Relevant extracts from these policy documents are:

- **Policy Statement No. 5 - "Fuel Management in Indigenous Forests"**
  - *Recognising that only the fuel component can be modified by human intervention, prescribed fire will be used to limit the accumulation of fuel and inflammable vegetation in appropriate forest types...* and,
  - *All fuel management activities will be carried out in accordance with a Fuel Management Plan for each forest management area.*
- **Policy Statement No. 7 - "Fire Management and Control"**
  - *Fuel management is an integral part of fire and forest management...* and,
  - *...fuel management will be administered in accordance with comprehensive plans.*

This plan has been prepared in the context of these policies.

2 FUEL MANAGEMENT

2.1 The Need For Fuel Management

The Casino District covers the area south of the Queensland border west to the Border Ranges National Park, south of Kyogle and west over the Richmond Range to Tabulam on the Bruxner Highway. The area continues south along the Timbarra River to Washpool National Park and then east to the coast where it adjoins the Grafton Forest District. A location map is shown in Figure 1-1 of Volume 1 of the EIS. Casino District covers 38 State forests with a total area of some 165,000 ha.

The climate is warm subtropical with a well defined summer/autumn rainfall peak (January to March) and a dry winter and spring. The climate in the higher altitude Ewingar forests tends towards warm temperate. Temperature and rainfall conditions vary across the District, with an average mean maximum temperature of 25.0 degrees celsius and an average mean minimum temperature of 13.1 degrees celsius.

The rainfall is variable, with a mean rainfall of 2389 mm in Whian Whian State Forest, 1107 mm in Casino and estimates of 1425 mm in Ewingar. Rainfall can be unreliable during the normal late winter/spring period, particularly on the lower altitude landforms. The earlier onset of summer rainfall in the higher altitude and coastal landforms is associated with greater spring thunderstorm activity.

Favourable conditions in summer and autumn allow continuous growth of forest vegetation. Strong south-west to north-west winds often prevail during late winter and spring, causing vegetation to dry rapidly. If spring rains are late, serious wildfire conditions may result.

In wildfire prevention, the forest manager can exert some control through the application of legislative regulation, education and community relations. In the broad area of forests under State Forests' control, the most realistic fire prevention option is fuel management. For most forests in Casino District, excluding rainforests, high altitude and moist forest, fuel reduction burning is the only practical, effective and economic means of fuel modification available to assist in wildfire control and minimise potential damage. Fuel reduction burning (hazard reduction burning, prescribed burning or fuel management burning) is also used for fauna habitat management, vegetation management and forest regeneration purposes, where appropriate.

Wildfire occurrence is documented in management plans and fire reports as the major cause of forest damage, killing regrowth and injuring larger trees, resulting in an overall reduction in forest productivity and a possible reduction in biodiversity and stability. A high proportion of wildfires occurring on State forest originate from adjacent freehold land. Co-operative fuel reduction burning is required in many of these areas to reduce the incidence of wildfire on State forest, while enabling adjacent landowners to meet their own management objectives.

Wildfire fire behaviour must be modified so that its intensity and rate of spread are reduced, enabling it to be controlled and contained in the forest, in order to meet State Forests' legal obligations and the Fuel Management Plan objective of reducing the adverse impacts of wildfire.

The biological and physical impacts of fire are directly proportional to its intensity and spread, both of which are controlled by the concentration and distribution of fuel from inflammable vegetation. Fuel management can be achieved by the use of fire under circumstances in which its behaviour can be predicted and managed. State Forests recognises that prescribed fire is the most efficient means of mitigating the damaging effects of wildfire.

Prescribed fires over broad areas are designed to produce a mosaic of burnt and unburnt areas. Under a regime of frequent low intensity fires there is a risk of encouraging those species adapted to the regime, at the expense of those that are not. For this reason, fuel management strategies are designed to maximise biodiversity by maintaining a diversity of fire regimes.

Responsible broad area fuel reduction does not aim to eliminate all inflammable fuels. Timing of the operation, together with localised site variations in altitude, topography, moisture and vegetation cover, commonly results in 35% to 60% of the gross area treated being burnt. The result is a reduction in fine fuel weight and arrangement on a proportion of the treated area, with a mosaic of burnt and unburnt areas.

Fuel management by fuel reduction burning is an essential part of the wildfire prevention and control strategy in the Casino District. In the 16 years from 1979, wildfires have burnt an average of 10,370 ha per year in 368 separate fires, mostly resulting from rural fire escapes or unauthorised fire lighting. District fire records have assisted considerably in the assessment of areas requiring fuel management.

2.2 Objectives Of Fuel Management

The primary objective of fuel management is not to eliminate wildfire, but rather to create a mosaic of fire regimes, such that the incidence and intensity of fires over time is acceptably low for protection of life and property, environmental protection and commercial forest management.

The broad aims of fire protection are to take all practical steps to minimise potential damage to the forest from fire; minimise the spread of fires once they commence; and promote cooperative fuel management and fire suppression with other fire control authorities and nearby landholders. More specifically, the objectives are to:

- protect life and property from wildfires;
- protect assets on State forests;
- provide a range of direct and indirect wildfire suppression options, depending on the assets to be protected;
- prevent the spread of wildfires onto neighbouring properties;
- minimise damage to timber values on State forests and other Crown-timber land;
- exclude fire from environmentally sensitive areas (for example, rainforest);

- maintain biodiversity.

Other benefits of active fuel management include:

- the opportunity to provide practical staff training in fire behaviour, fire safety and the use of fire control techniques and equipment;
- the establishment of good liaison and working relationships with forest neighbours, Bush Fire Brigades, Councils and other authorities, in cooperative hazard reduction burns along common boundaries;
- a reduction of resources required to suppress wildfires contained by effective hazard reduction.

Fuel reduction burning reduces hazards in several ways:

- It reduces available fuel weight, reducing potential wildfire intensity and rate of spread, resulting in reduced impacts on forest resource values, including soils, fauna, flora, watershed and aesthetics.
- It reduces fuel depth, reducing potential flame heights.
- It removes firebrand material, principally fibrous or flaky bark,reducing the potential for wildfires to generate spot fires ahead of the main front. Overall wildfire rates of spread are thus reduced, increasing the potential safety and success of suppression measures.

2.3 Forest Fuel

Definition

Forest fuel is comprised of two main components - fine fuel and large fuel.

SFNSW defines **fine fuel** as organic matter up to 25mm in diameter that is deposited on or attached to the ground surface. Fine fuel can be further subdivided into surface fuel (fuel deposited on the ground surface) and near-surface fuel (suspended and attached fuel). In forests, most surface fuel is dead, while the near-surface fuel is a combination of dead and living material. Fine fuel is the material that is most readily and easily burnt due to its size and arrangment (or degree of aeration). The weight (amount) and arrangement of fine fuel is important in determining the rate of spread and intensity of a fire.

The weight of fine fuel influences fire behaviour by contributing to fire intensity and residence time (how long flame remains at any one point). The arrangement of fine fuel influences fire behaviour through the availability of oxygen and the level of heat transfer. Combustion is most favoured when fuel is scattered enough to let ample oxygen reach the flame zone but dense enough for efficient heat transfer. These conditions are promoted by understorey vegetation, which provides a fuel source itself, as well as supporting and suspending accumulations of dead leaves, twigs and trailing plants. Combustion is promoted by a high degree of continuity in the fine fuel, providing for efficient heat transfer and maintenance of direct flame contact.

Twigs up to 25mm in diameter are the dominant fine fuel component. Leaves, fragmented and partly decomposed organic material comprise the other main components.

Large fuel is dead organic material that is greater than 25mm in diameter. Large fuel is important in relation to fire damage and fire control in that, once ignited, it burns for a long

time and generates a high level of heat. The ignition of large fuels has a role in generating and maintaining a convection column, which contributes to fire spread through long-distance spotting.

Logging slash, logging debris, or slash fuel are terms used to refer to the combination of fine and large fuels remaining on the forest floor after a harvesting operation. Large fuel makes up most of the weight of logging slash.

Accumulation

Litterfall is the process in which dead organic material falls to the forest floor to form part of the forest fuel.

The following generalisations are based on data collected from long-term sampling in State forests in New South Wales. They cover variable sampling periods, ranging from 6 to 20 years:

Fine fuel accumulation is dependent on the rate of litter fall and the rate of decomposition on the forest floor. A dynamic equilibrium is reached when litter fall is balanced by the amount of decomposition. This time period is influenced by the interplay of climate and forest types. Typically, litter falls of 3-5 tonnes per hectare per year (t/ha/yr) in dry forest types and 5-7 t/ha/yr in moist or high quality types, will reach equilibrium at 10-13 t/ha and 15-20 t/ha respectively, in periods of 4-7 years. Relative to fine fuel weight, litterfall weight is high (about 4 t/ha), indicating a natural decomposition rate of similar magnitude. A balance between litterfall and decomposition rate appears to be achieved soon after canopy closure in even aged regrowth stands and shortly after disturbance by fire in older stands (refer van Loon, 1969 and 1977; Birk and Bridges, 1989; Richmond, 1976; Dowden, 1985; and Walker, 1981).

Litterfall weight and fine fuel weight vary between years, fluctuations being both positive and negative. In time, undisturbed fine fuels approach a dynamic equilibrium weight. There is considerable spatial variation in fine fuel weight, associated with stand type, stand density and, to a lesser extent, topographic position. In general, as site productivity increases, so does fine fuel weight and litterfall weight.

Regrowth stands, especially those 5-20 years old, tend to have higher fine fuel weights than more open, uneven aged stands. From studies in south-eastern NSW, in dry sclerophyll forests, the fine fuel weight in uneven aged stands commonly averages 10 t/ha, ranging between 5 and 15 t/ha. The fine fuel weight in most even aged regrowth stands over 20 years old is also in this range. Prior to age 20 years, fine fuel weights of up to 20 t/ha can be expected in even aged regrowth stands, but this higher weight only occurs during a short period of stand development, from about age 10-15 years.

Results of Fuel Management

Fuel management is aimed at the fine fuel rather than the large fuel component. Large fuels sustain fire in unmanaged fuels, but do not carry or spread wildfire in the absence of fine fuels. Fuel management on a regional scale promotes a mosaic of fuel ages, maintaining a lower average fine fuel weight across the region. It also prevents fuel weights from reaching the upper level of their equilibrium range and limits the vertical arrangement and continuity of fine fuels.

Low intensity fuel reduction burning will reduce fine fuel weight by up to 75%. Such burning rarely achieves 100% cover, with 35% to 60% cover being achieved in successful burns. After low intensity burning, the fine fuel weight will recover to 70% to 80% of the pre-burn weight in about 2-3 years. High intensity wildfire generally reduces fine fuel weight by more than 75% and a high proportion (approaching 100%) of the area is generally burnt over.

2.4 Fire Behaviour

The relationships involved in fire behaviour and the factors contributing to fire behaviour are described by Cheney (1981). Fire behaviour is strongly influenced by the availability and arrangement of fuel and by the weather. Fuel, heat and oxygen are all needed to maintain a fire. Removal or reduction of any of these will extinguish it, or slow its spread.

The intensity of fires depends on weather, topography and fuel conditions and the land manager can only manipulate fuel conditions. The manipulation of fuel loads by careful burning in periods of low fire danger, reduces the possibility of ignition, allows wildfire damage to be moderated, and facilitates wildfire control activities.

Fire Danger Rating Systems have been developed to indicate the chances of a fire starting and its rate of spread, intensity and difficulty of suppression, according to various combinations of temperature, wind speed, relative humidity and drought effects.

The McArthur Forest Fire Danger Rating System generates a numerical 100 point Fire Danger Index (FDI) and a 5 class descriptive rating of fire danger, from a number of climatic variables. The FDI, together with specific information on fuel weight, topography and forest type, allows predictions of fire behaviour to be made. Such predictions include rate of spread, flame height (and scorch) and spotting distance. Spotting distance is an important consideration in fire management in Casino District, since the bark characteristics of many tree species give them a high spotting potential.

In determining priority zones for fuel reduction burning, a number of factors, including fire behaviour, must be considered. These factors are:

- Value of the assets to be protected.
- Wildfire history.
- Topography.
- Forest type.
- Weather, especially temperature, relative humidity, drought factor, and wind speed, which provide a fire danger rating.
- Fuel loads (t/ha).
- Fire spotting distance.
- Flame height.
- Fire rate of spread.

In Casino District, the parameters determined for the fuel management priority zones are based on the the value of the assets to be protected and the potential fire behaviour expected under weather conditions experienced in the District. Parameters within these zones are directly related to the ability to suppress wildfire within each zone.

It has generally been assessed that 5% of all wildfires are responsible for 95% of the resultant asset damage. This 5% of fires tends to occur on 15% of the highest fire danger rating days in an area (P.Moore pers.comm., SFNSW). Using this assumption for Casino District, the 85th percentile (cut off point for the 15% of highest fire danger rating days), based on weather records for the 1994/95 fire season, is determined as Fire Danger Rating (FDR) 30. The fire behaviour parameters for each zone have been determined using FDR 30, assuming this will account for fire behaviour on most high fire danger days, but recognising the limitations in ability to provide protection from the "worst case" scenario (for example, FDR 100).

For FDR 30, a typical combination of weather parameters would be 30% relative humidity, 33° C temperature and 35 km/h wind speed. Under these conditions, using the McArthur meter, the following fire behaviour can be expected for various fuel loads:

FDR 30			
Fuel Loads (t/ha)	Spotting Distance (km)	Flame Height (m)	Rate of Spread (km/h)
5	0.3	2.5	0.17
10	0.8	5.5	0.34
15	1.5	9.5	0.51
20	2.2	13.3	0.72

By comparison, the fire behaviour that would be expected for various fuel loads on a "worst case" scenario at FDR 100 is:

FDR 100			
Fuel Loads (t/ha)	Spotting Distance (km)	Flame Height (m)	Rate of Spread (km/h)
5	1.9	6	.56
10	3.8	14	1.11
15	6.0 Uncontrolled	Crown Fire	1.68
20	8.1 Uncontrolled	Crown Fire	2.39

Based on the weather and Fire Danger Ratings experienced in the District, as well as the objectives assessed for the different fuel management zones, burning parameters have been determined for each zone. Operations are carried out under an Operational Burning Plan (Appendix 2).

2.5 Fuel Management Boundaries

All fuel management must be carried out within predetermined boundaries. Operational plans will define the perimeters of any proposed fire and burns will be planned to remain contained within those perimeters. Where trails or roads are not present, natural barriers such as creeks and other moisture differentials between fuel types may be used. Recently burnt areas may also be used as fuel management boundaries.

Where boundaries as defined above are inadequate, consideration shall be given to:

- contingency planning and cooperation with neighbours where fire may spread out of the forest;
- construction of strategic long- or short-term fire breaks or fire lines.

2.6 Fuel Management Zones

Fuel management zoning allows the forest manager to determine and allocate priorities for hazard reduction, based on values at risk, risk potential and the range of wildfire suppression options desired under most weather conditions. The zones discussed below are flexible, subject to review, variation and update as required, or within the specified 3 year Fuel Management Plan review period. Any variations would reflect, for example, changes in forest structure (such as additional regrowth requiring protection); settlement expansion; or variations to the conservation resource.

Zone 1 COMMUNITY PROTECTION & PROTECTION OF HIGH VALUE ASSETS

Objective:

To provide a high level of protection for life, property and other identified assets.

Strategy:

- To minimise fine fuel weight.
- To achieve up to 80% coverage in each burning unit in each operation.
- To maximise fire suppression options, particularly direct fire suppression, through ensuring this zone will absorb short distance spotting, without spot fire ignition.

Zone Width:

Based on FDR 30, the width should be approximately 300 m to allow direct fire suppression efforts. This zone will generally absorb burning embers from fires outside the zone. With low fuel loads, flame height would be up to 3 m and spotting distance up to 300 m. Zone width will be adjusted to take account of the effects of slope and topography on fire behaviour.

Burning Cycle:

- The burning cycle will depend on the rate of fine fuel accumulation, but will generally be considered in the range from 2-3 years, or when fuel loads reach 5-8 t/ha.

Burning Operations:

- *Burning Stages* - usually one.
- *Season* - winter/spring for community protection.
- *Scorch* - maximum 10% of the depth of the crowns of dominant and co-dominant trees.
- *Coverage* - up to 80% for community protection.
- *Burning Conditions* - up to FDI 10 for community protection.
- *Ignition* - ground ignition.
- *Firebreaks* - preparation may be necessary to contain these fires within desired areas.

Applications:

- Community protection, for example, Woombah settlement.
- Protection of adjoining pine plantations.
- Protection of adjacent rural land holdings.
- Protection along highway corridors.

Zone 2 STRATEGIC CORRIDORS

Objective:

To provide a strategic area which can act as a barrier to the spread of wildfire and assist in absorbing short distance spotting. These corridors will complement Zone 1 areas, particularly around settlements, pine plantations and other high value assets.

Strategy:

- To provide a mosaic of fine fuel weights between 5-8 t/ha after burning.
- To achieve up to 60% coverage in each burning unit in each operation.
- Burning under conditions when the lower layers of litter are moist enough to minimise heating of the nutrient rich litter and surface soils, to maintain a thin layer of unburnt litter, preferably 4-6 t/ha, to avoid destroying the microfauna and flora and volatilising nutrients.
- To protect sheltered south-east aspects and gullies from fire, to provide fauna refuge areas.
- To maximise fire suppression options, with direct fire suppression not being mandatory; this zone will generally absorb burning embers from fires outside the zone.

Zone Width:

Based on FDR 30, the width should be approximately 800 m to allow both direct and indirect (for example, backburning) wildfire suppression efforts. At this distance with a fuel load of 5-8 t/ha, flame height in the zone would be up to 5 m and spotting distance up to 800 m. In some instances (for example, adjacent to Banyabba Nature Reserve to protect the Banyabba pine plantation), the zone width to the west of the plantation has been increased to 3.8 km, to allow fire suppression within the zone under FDR 100 without encountering a crown fire. Zone width will be adjusted to take account of the effects of slope and topography on fire behaviour.

Burning Cycle:

- The burning cycle will depend on the rate of fine fuel accumulation but will generally be considered from 3-5 years, with a minimum of 3 years, or will be assessed when fuel loads reach 8-12 t/ha.

Burning Operations:

- *Burning Stages* - generally one, but two may be necessary initially, to encourage a more uniform spread of fuel quantity. Advanced burning of boundaries may be required.
- *Season* - late autumn/early spring. Some winter burning may be possible after periods of drought.
- *Scorch* - maximum up to 5% of the depth of crowns of dominant and co-dominant trees. Some loss of small or suppressed stems may occur.
- *Coverage* - up to 60%.
- *Burning Conditions* - up to FDI 10.
- *Ignition* - in strips from the ground, particularly along roads and boundaries. Aerial ignition may be carried out along ridge lines or preferred locations, in conjunction with ground ignition and control.
- *Firebreaks* - preparation may be necessary to contain these fires within desired areas.

Applications:

- Corridors adjacent to Zone 1, for example, for protection of adjoining pine plantations.
- Protection of adjacent rural land holdings.
- Corridors along highways.
- Provision of strategic corridors to allow backburning in the event of a major wildfire.

Zone 3 FUEL MANAGEMENT OVER BROAD FOREST AREAS

Objective:

To achieve broad area fuel management, complementary to other forest management objectives. In the broader forest area, where life and property are not directly at risk, fuel management aims to provide a mosaic of burnt and unburnt areas, which allows for indirect wildfire suppression efforts while maintaining long-term biodiversity.

Strategy:

- To provide a mosaic of fine fuel weights between 8-15 t/ha after burning.
- To maintain biodiversity.
- By providing a mosaic of burnt and unburnt areas, without large contiguous areas of unmanaged fuel, this zone will complement the other zones in broad area protection.
- Burning under conditions when the lower layers of litter are moist enough to minimise heating of the nutrient rich litter and surface soils, to maintain a thin layer of unburnt litter, preferably 4-6 t/ha, to avoid destroying the microfauna and flora and volatilising nutrients.
- To protect sheltered south-east aspects and gullies from fire, to provide fauna refuge areas.

- To achieve between 35% and 60% coverage in each burning unit in each operation.

Zone Width:

Based on FDR 30, fuels managed on a mosaic within a minimum zone width of 1.5 km, would still allow a range of indirect fire suppression options for fuel loads of 15 t/ha. Flame height would be up to 9.5 m and spotting distance up to 1.5 km.

Burning Cycle:

- The burning cycle will depend on the rate of fine fuel accumulation, but will generally be considered after a minimum of 6 years. A mosaic of areas will be considered in the 6-10 year time frame, or when fuel loads reach 12 t/ha. A mosaic of areas will also be considered beyond 10 years, or when fuel loads exceed 15 t/ha.

Burning Operations:

- *Burning Stages* - generally one, but two may be necessary initially, to encourage a more uniform spread of fuel quantity. Advanced burning of boundaries may be required.
- *Season* - late autumn/early spring. Some winter burning may be possible after periods of drought.
- *Scorch* - maximum up to 5% of the depth of crowns of dominant and co-dominant trees. Some loss of small or suppressed stems may occur.
- *Coverage* - up to 60%.
- *Burning Conditions* - up to FDI 10.
- *Ignition* - in strips from the ground, particularly along roads and boundaries. Aerial ignition may be carried out along ridge lines or preferred locations, in conjunction with ground ignition and control.
- *Firebreaks* - preparation may be necessary to contain these fires within desired areas.

Applications:

- Fuel reduction over broad areas where, under most conditions, only ridge top fuels will burn.
- Prior to logging, to assist in achieving post-logging burning prescriptions.

Zone 4 MANAGEMENT BURNING AND BURNING FOR ECOLOGICAL PURPOSES

Objective:

To provide specific burning and fuel management requirements for various purposes, such as research into the effects of fire on the environment; burning under regrowth; burning for silvicultural purposes (for example, pre- and post-logging burning); burning for specific fauna habitat; and burning for specific flora.

Strategy:

- To provide specific conditions and treatments, or to implement the fire regimes detailed in management or recovery plans.

Burning Cycle:

- This will depend on the specific plan requirements.

Examples of the types of projects are:

- *Burning Under Regrowth* - burning will commence when the dominant and co-dominant trees have reached an average diameter greater than 10cm. Burning aims to maintain an average of 5-6t/ha over the area, while avoiding damage to the dominant and co-dominant trees in the regrowth stand. The aim is to reduce fuels, particularly elevated fuels, in younger regrowth forests.
- *Pre-logging Fuel Management* - burning aims is to reduce the intensity and facilitate control of post-logging burning. Pre-logging burning may be carried out as early as 12-18 months ahead of logging. This type of burning may not be appropriate adjacent to fire sensitive regrowth; where moist seasonal conditions render burning difficult; or where fuel needs to be conserved to ensure adequate post-logging or top disposal burning.
- *Post-logging (Top Disposal) Fuel Management* - burning aims to reduce fuel loads resulting from harvesting operations. It is a routine operation and is an essential precursor to subsequent fuel management burning. The silvicultural aspects of this type of fuel management are discussed in Section 3.5 of this plan. The location of post-logging burning will be planned from the Order of Working for harvesting operations. Post-logging burning will be undertaken within 18 months of harvesting, where it is necessary for hazard reduction. Post-logging fuel management will be carried out in accordance with the "Guidelines For The Conduct of Post-Harvest Burning in Native Forests".
- *Fauna Management* - fire regimes may be a specific requirement of the management plan or recovery plan developed for particular species.
- *Flora Management* - burning regimes detailed in the approved flora reserve working plan will be implemented, for example, for areas reserved for inadequately conserved communities, rare or threatened species requiring a specific fire regime, as listed in Appendix 3, and Register of Threatened Australian Plants (ROTAP) species sensitive to fire.

Zone 5 FUELS TO BE MANAGED WITHOUT BURNING OR TO REMAIN UNMANAGED

Objective:

These are fuels in areas where management priorities exclude prescribed burning, or areas where fuels are to remain unmanaged.

Strategy:

- To exclude deliberate ignition, burning or fuel management from these areas.

Applications:

- Rainforest areas, to protect the rainforest components.
- Filterstrips, to protect riparian vegetation and soil and water conservation values.
- Regrowth stands where most stems are under 10cm diameter.
- Preferred Management Priority (PMP) classified areas such as Historical, Research and Archaeological areas.
- The north-eastern corner of Bungabbee State Forest where Powerful, Masked and Sooty Owl occurrences are recorded.
- Part Compartment 161 Double Duke/Tabbimoble State Forest, along the Richmond Range to the west of Cypress Road - to be excluded from fuel management, to provide a reference enabling comparison of the effects of fuel management within surrounding areas.
- Most flora reserves (except Needlebark Flora Reserve) - to be excluded from fuel management to provide a reference enabling comparison of the effects of fuel management within surrounding areas.
- Part Compartment 347 Richmond Range, south of Cambridge Plateau Flora Reserve - to protect habitat of Golden Tip Bat populations along Culmaran Creek.

In some cases the areas in this zone will need to be actively protected from fire and may be surrounded by Zone 1 or Zone 2.

Across the Casino Management Area (MA), the area of each zone is as follows:

ZONE	TOTAL AREA ha	% MA AREA IN ZONE	BURNING CYCLE years	% MA AREA TREATED ANNUALLY	% MA AREA ACTUALLY BURNT ANNUALLY	ANNUAL AREA BURNT ha
1. Community Protection	2,896	2%	1-3, av. 2	1%	1% x 80% = 0.8%	1,158
2. Strategic Corridors	35,695	26%	3-5, av. 4	6%	6% x 60% = 3.6%	5,354
3. Broad Area	48,953	35%	6-10, av.8	4%	4% x 60% = 2.4%	3,355
	16,060	11%	>10, av.12	1%	1% x 60% = .6%	799
4. Management & Ecological Burning	18,253	13%	Variable assume av.8	2%	Variable assume 50% = 1%	1,140
5. No Burning	17,961	13%				
TOTAL	139,818		av. 12	14%	8.4%	11,806

2.7 Other Methods of Fuel Management

2.7.1 Grazing

Grazing is carried out over 55% of the District under Occupation Permit (OP - 65,000 ha), or Crown Lease (11,000 ha) and is generally limited to dry forest types. Grazing is a cost effective method of fuel reduction which contributes to overall fuel management across the District.

Burning of these areas is carried out under a burning permit issued by State Forests. Permittees are required, under the Bush Fires Act (1949) and the Forestry Regulation (1983), to obtain authorisation from State Forests prior to conducting any burning (Appendix 1). Aspects of fire use which will be considered prior to issuance of a conditional authority to burn include:

- frequency and timing of the activity;
- distribution of ignition points;
- perimeter control;
- relationship with the Fuel Management Plan, including PMP classifications;
- outcomes arising from the Environmental Impact Statement (EIS) and Fauna Impact Statement (FIS).

The objective is to provide opportunities for useful pasturage and fuel reduction, without adverse impacts on other forest values and without fire control difficulties. Regular consultation and cooperation with graziers and forest neighbours is a very important and vital aspect of this Fuel Management Plan.

In addition to being required to obtain a burning permit and discuss burning proposals with State Forests, grazing permittees and lessees will be required to provide feedback on the extent of burning undertaken. Extension work will be undertaken to increase graziers' acceptance and use of the permit system. In cases where there is continued non-compliance with burning permit conditions on a particular OP, the OP may be cancelled and the area offered to other permit holders.

Graziers will generally carry out fuel reduction around their own assets (huts, yards), often by brief heavy stocking.

2.7.2 Mechanical; Chemical

Mowing, slashing or treatment with herbicides are not regarded as practicable or economic options for general fuel management. For small and aesthetic areas, slashing or spraying with glyphosate is carried out. General road maintenence, fire trail construction and road grading are also part of the established fire protection program, improving and maintaining access to areas for fire suppression and hazard reduction burning, as well as for other forest management purposes.

Slashing

- Around pine plantations.
- Roadside slashing in Whian Whian State Forest in the Rocky Dam catchment.

Spraying

- Along roadsides identified on an annual basis. These roads are infrequently used and spraying is a more cost effective option than road grading.

2.8 General Priorities

Practical limitations on the amount of fuel management which can be achieved are imposed by:

- Suitable weather and fuel conditions - the window of opportunity for effective hazard reduction burning in the Casino District varies from year to year.
- A small local workforce, supplemented by permittee/lessee burning in strict accordance with permit conditions.
- The area of forest in which fire can be effectively used in fuel management.

Accordingly, fuel management will be preferred over other forest works when conditions are suitable. Targeted or strategic fuel management burning, which complements distribution of the wetter rainforest, highland and moist forest types (30% of the area), can provide effective wildfire protection for identified assets. This burning can be safely undertaken under conditions in which these wetter forest types will not burn.
Priorities for implementation of the Fuel Management Plan in Casino District will be:

Priority 1: Community, asset and boundary protection (strategic) burning.
Priority 2: Post-logging fuel management (top disposal).
Priority 3: Strategic corridor burning and burning under young regrowth stands.
Priority 4: Broad area fuel management in older regrowth stands.
Priority 5: Broad area fuel management in less intensively managed areas.
Priority 6: Pre-logging fuel management and fuel management for ecological or other purposes.

Priorities in Conflicting Areas - Where a number of conflicting fuel management aims occur within a specific area, fuel management for the protection of life and property will take precedence.

Zones of No Fuel Management - These have been identified in fire sensitive areas. If a value requiring protection from fire is identified within a burn area, all practicable steps will be taken to protect it from fire.

3 ENVIRONMENTAL CONSIDERATIONS

The impacts of the proposed fire management regime in relation to flora, fauna, hydrology, grazing and other resources are discussed in this section. The overall strategy is to maintain a fire regime which mitigates high intensity fire potential, reduces risk to ecological processes and promotes biodiversity.

In adopting the precautionary principle, it is considered environmentally unacceptable to maintain large areas of unmanaged fuels likely to generate uncontrollable wildfire. Taking account of the need to protect life and property under the Bush Fires Act, a mosaic of hazard reduction burning areas will maintain biodiversity in the long-term, by assisting fire suppression efforts to minimise the area burnt by high intensity wildfire.

3.1 Flora

A comprehensive study was undertaken during 1991 and 1992 to assess the impacts of management operations in the Grafton and Casino Management Areas as part of the EIS programme for the two areas. The report (D.M.Moore and A.G.Floyd, 1994) has provided valuable background information for development of the Fuel Management Plan and for guiding District staff in its implementation.

There are 8 broad vegetation types within the District. The percentage covered by each type is:

- Dry Hardwood 47%
- Blackbutt..... 16%
- Moist Hardwood..... 17%
- New England Hardwood 2%
- Rainforest 7%
- Cleared or Non-forested 2%
- Heath..... 7%
- Untyped 2%

The spatial pattern of rainforest gullies and patches, the predominance of moist forest types and moderation of summer weather in the high altitude areas, provide many natural fire advantages. This prevents establishment of a uniform fire regime over large areas and helps to maintain a diversity of habitats. Over 30% of the District's vegetation consists of rainforest, moist hardwood or highland types, which will not burn under the conditions in which fuel management burning is carried out.

A total of 17 reserves and areas of special significance for flora have been identified throughout Casino District, including 9 flora reserves in Casino Management Area and 8 in Murwillumbah Management Area. The reserve names and locations are:

- *Bungdoozle* Richmond Range State Forest

- *Steel Box* Mount Pikapene State Forest
- *Jerewarrah* Ewingar State Forest
- *Selection Flat* Myrtle State Forest
- *Cambridge Plateau* Richmond Range State Forest
- *Pyrocarpa* Double Duke State Forest
- *Burnt Down Creek* Washpool State Forest
- *Mallanganee* Cherry Tree State Forest
- *Needlebark* Gibberagee State Forest
- *Bogarem Falls* Nullum State Forest
- *Boomerang Falls* Whian Whian State Forest
- *Minyon Falls* Whian Whian State Forest
- *Forty Spur* Mebbin State Forest
- *Big Scrub* Whian Whian State Forest
- *Black Scrub* Nullum State Forest
- *Amaroo* Wollumbin State Forest
- *Mebbin Lagoons* Mebbin State Forest

Management of these reserves is detailed in individual working plans. The plans should be referred to prior to any adjacent fuel management being undertaken, as prescriptions can vary. Generally, the reserves have the exclusion of wildfire wherever possible in order to protect rainforest components, as a management objective. This applies to all reserves except Needlebark Flora Reserve, where hazard reduction burning will be permitted.

Within the reserve areas, all rainforest types will have a fuel management prescription of no burning. Needlebark Flora Reserve will have a greater than 6 year cycle. This will be incorporated into the working plan for the flora reserve.

There is a clear structural and floristic division between frequently burnt dry eucalypt forest and infrequently burnt moist eucalypt and highland forest, which is reinforced by interactions between fire frequency and vegetation. Frequent fire changes vegetation structure and, probably, floristics. Fire regimes of variable frequency in dry forest types, which ensure a significant proportion remains unburnt for periods of greater than 10 years, will likely maximise opportunities for preservation of all vascular plants.

Management of existing and proposed reserves is, or will be, detailed in their individual working plans. For some rare or significant plant species and communities within reserved areas and elsewhere in the forest, special burning prescriptions may be required to ensure their survival. These will be developed as further information regarding ecological requirements, specifically those regarding fire, become known.

In the absence of specific information, the precautionary approach will be applied, adopting a fire regime which initially considers the risk to life and property and then takes account of specific environmental requirements. The precautionary approach adopted does not necessarily, or automatically, exclude fire. There is insufficient

evidence in many cases to assess the impact of changing existing fire regimes. The precautionary approach is thus to maintain current practice until the impacts of not doing so are assessed.

As more information becomes available, through the National Register for the Fire Responses of Plant Species being developed by C.S.I.R.O., Division of Plant Industries (Gill and Bradstock, 1992), and State Forests' own fire ecology research, specific guidelines for conservation of individual flora species will be developed.

Overstorey and understorey communities recorded for the Casino Management Area are detailed in the current EIS for the Management Area. Plant species and flora communities considered to be rare or significant are detailed in the EIS. A number of poorly or inadequately conserved flora communities identified under the Hager and Benson criteria (1994) have been reserved. Fire will not necessarily be excluded from these areas.

The majority of significant species occurring in rainforest, high altitude forest and flora reserves with specific working plans, would be significantly affected by hazard reduction burning.

Flora requiring specific fire regimes, or further work to determine appropriate fire frequencies, are detailed in the ecological burning zone (Zone 4). Fire will be excluded from some flora communities (Zone 5).

With the exception of Needlebark Flora Reserve, no fuel management is proposed in flora reserves except the minimum required for fire suppression (for example, backburning) in the event of a wildfire. In other special emphasis areas, fuel management regimes have been prescribed to protect identified values, including no fuel management where appropriate.

Although fire is recognised as an integral part of the forest environment, exclusion of wildfire is a normal management objective in preservation areas to protect rainforest components, with fuel reduction burning being kept to the minimum necessary for forest protection. Although Pyrocarpa Flora Reserve does not have rainforest components, fire has been excluded to evaluate the effects of fire exclusion on flora.

Hazard reduction burning, required for strategic purposes, is permitted in Needlebark Flora Reserve as it does not compromise the integrity of the reserve. It will be carried out in accordance with the approved working plan.

Measures which will mitigate the impacts of fire on flora are:

- Exclusion of hazard reduction burning from flora reserves except Needlebark Flora Reserve.
- Exclusion of fire from all rainforest types.
- Increasing the time between burns in specifically identified dry hardwood forests, without significantly impacting meeting of the objectives in Section 2 of this Fuel Management Plan.
- Identification of other flora communities requiring specific fire prescriptions, as more information becomes available through research.

- Maintenance of a wide range of burning frequencies in all forest types while meeting the objectives listed in Section 2 of this plan.

3.2 Fauna

At State and national significance levels biodiversity is high, due to the wide variety of habitat types and ecological gradients represented, ranging from high elevation moist forests to dry subcoastal heaths. The region is located in the overlap zone (Macpherson/Macleay overlap) between Torrensian (tropical) and Bassian (temperate) biogeographic regions.

Potential impacts on fauna arising from frequent low intensity prescribed fires are:

- loss or simplification of the the forest understorey, reducing biodiversity;
- accelerated decay of large logs and standing dead trees;
- reduced fauna diversity in all major habitats;
- reduced risk of infrequent severe fire.

Casino District has a large number of rare and endangered species. In considering the impact of fire and the rationale for fuel management, it is important to recognise that many forests experience fire infrequently and only in times of severe drought. Fuel management in localised areas will impact some wildlife species, with those dependent upon a dense understorey of shrubs being most adversely affected. Over the long-term in dry eucalypt forests, frequent fire may favour replacement of shrub and regrowth eucalypt communities by grassland, disadvantaging shrub dependent species.

Not all impacts are negative. Promotion of ground forage favours some species of macropods and a mosaic of burnt and unburnt areas can increase habitat diversity.

Consistent with the objectives of fuel management, where protection of life and property is the primary aim, the impacts of fire on fauna can be mitigated by reducing the area of forest frequently burnt and increasing the area subject to no fire or infrequent fire (that is, greater than10 year intervals). This is achieved by the zoning system adopted, which identifies areas of high risk (that is, frequent wildfires) and high value (for example, settlements).

Fuel management required to protect these assets requires frequent low intensity fires, but the total area involved is low. This allows specific areas to be targeted, resulting in an overall increase in the area subject to no fire or infrequent fire. This should lead to an increase in biodiversity in the long-term.

Some of the likely effects on fauna groups are:

3.2.1 Birds

The immediate direct effect of fire may be minimal, as birds have been found to easily move away from fires of low to moderate intensity, but may be killed by heat or suffocation in fires of high intensity (Christensen et al, 1985).

Populations of forest understorey and ground vegetation species may be decreased in the short-term by removal of these components by burning and could be permanently reduced by long-term frequent fire.

Tree hollow dependent species such as owls, cockatoos, parrots and tree creepers, can be affected if fire causes ignition and subsequent destruction of trees used for nest sites. Controlled fuel reduction burning is unlikely to have any significant effect on birds which use the forest canopy, on birds of prey, or on waterbirds.

Rainforest habitats will be excluded from any proposed fuel management programs. Highland and moist eucalypt sites will not normally burn under conditions prescribed for fuel reduction burning. Fuel reduction burning is not expected to affect species occupying these habitats.

Of the 130 native bird species observed in Casino Management Area, 24 species are recorded as *Rare and Vulnerable, or Threatened* on Schedule 12 of the NSW National Parks and Wildlife Act. Many are rainforest dwellers, hollow dependent, or birds of moist forest associations. Their habitat requirements are detailed in the current EIS for the Casino Management Area.

Schedule 12 species likely to be affected by fuel reduction burning are:

- *Glossy Black Cockatoo* - Rare and Vulnerable
- *Rufous Scrub Bird* - Rare and Vulnerable
- *Bush Hen* - Rare and Vulnerable
- *Eastern Bristlebird* - Rare and Vulnerable
- *Paradise Parrot* - Presumed Extinct
- *Turquoise Parrot* - Rare and Vulnerable
- *Regent Honeyeater* - Threatened

Measures which will mitigate impacts of prescribed fire on.birds are:

- Active management of fuel levels to ensure a mosaic of fire regimes occurs, with emphasis on reduction of fire frequency to less than one in 15 years in gullies and unburnt sheltered south-east aspects.
- Strict regulation and enforcement of grazier burning. Extension work will be undertaken to increase graziers' acceptance and use of the permit system. In cases where there is continued non-compliance with burning permit conditions on a particular OP, the OP may be cancelled and the area offered to other permit holders.
- Maintenance of a patchwork of fuel reduction burns, of varying frequencies in dry forest, benefitting the persistence of *Allocasuarina* species feed trees, which may otherwise be destroyed by wildfires.
- Implementation of a non-burning zone for a radius of 250 m around known Rufous Scrub Bird sites (timber harvesting is already excluded).
- Use of the zoning system and a mosaic of fire regimes, resulting in long-term protection of riparian vegetation.

3.2.2 Reptiles

Reptile species respond to successional changes in vegetation structure and ground cover. Increased sunlight penetration to the ground favours "open forest" species, whereas prolific regeneration and closed canopy favours "closed forest" species.

The distribution and abundance of reptiles is strongly influenced by microhabitat requirements, including food and feeding substrates, shelter sites, thermoregulation sites and nesting sites. The key resource elements needed to maintain reptile species diversity are diverse ground cover, particularly rocky outcrops and fallen decaying logs, and tree hollows for hollow dependent species.

The effects of fire vary, depending upon species habitat requirements. Many reptiles escape fire by burrowing, or by sheltering under or inside logs (Christensen et al, 1981). It is likely that terrestrial reptile species would be affected by fires (hazard reduction or wildfire) in the short-term, either directly through mortality, or indirectly through food shortage or increased predation. Provided opportunities for recolonization remain, it is unlikely that fire would threaten the long-term survival of populations (Gration et al, 1993).

Areas with diverse microhabitats and an open forest canopy are expected to support the richest diversity of reptile species. The mosaic of burnt and unburnt patches typical of broad area fuel reduction burns may benefit reptile populations.

The greatest threat appears to be long-term habitat modification caused by too frequent burning in dry forest types, reducing logs on the ground used for shelter and basking, resulting in low population densities. Development of non-burning zones and longer burning frequencies in some dry sclerophyll forests will assist in the long-term conservation of reptiles within the District.

The greatest diversity of open forest reptiles occurs in the Richmond Range due to the diversity of dry, open forest habitats and the presence of sandstone escarpments and rocky outcrops in that area. The Ewingar/Washpool area has the greatest diversity of closed forest reptile species, where rainforest and moist hardwood types are the most extensive.

Schedule 12 species considered to be *Rare and Vulnerable,* recorded in the District are:

- *Burrowing Skink* - preferred habitat is rotting logs and ground litter. Recorded in Ewingar and Richmond Range State Forests.
- *White naped Snake* - preferred habitat is fallen logs and leaf litter. Not recorded during recent studies.
- *Pale-headed Snake* - nocturnal and partially arboreal snake occurring in a wide range of habitats from rainforest and moist hardwoods, to drier forests on the western slopes.
- *Stephen's Banded Snake* - may require tree hollows and shrubby understorey. Recorded in Richmond Range State Forest.

Measures which will mitigate impacts of prescribed fire on reptiles are:

- Retention of large logs on the forest floor where practicable.
- Protection of riparian vegetation to act as recolonisation sources for moist, shade tolerant species after harvesting and/or burning.
- Leave for natural regeneration and exclude top disposal burning following logging, in those compartments where regeneration will be adequate and fuel loads do not increase wildfire risk.
- Continue to keep felled heads and butts away from fallen, large old-growth trees, where practicable.
- Strict regulation and enforcement of grazier burning. Extension work will be undertaken to increase graziers' acceptance and use of the permit system. In cases where there is continued non-compliance with burning permit conditions on a particular OP, the OP may be cancelled and the area offered to other permit holders.
- Use of the zoning system, focusing frequent and moderate control burning on strategic locations for hazard reduction.

3.2.3 Amphibians

The forests of Casino District support a relatively high diversity of amphibians due to their location at the junction of two major biogeographic regions. The amphibians of the area are predominantly insectivorous, requiring free water for reproduction, except *Assa darlingtoni* and *Philoria* species, which breed in moist litter and boggy seepages respectively. Habitat requirements of the other amphibians are influenced by climate, distance to water, the hydrological and morphological characteristics of water bodies, and the availability of suitable microhabitat for aestivation (state of torpor or inactivity during the dry season), and shelter (Smith et al, 1994).

The overall impact of hazard reduction burning on amphibian species diversity and species conservation is unlikely to be significant.

The most significant measures which will mitigate impacts of prescribed fire on amphibians are:

- Exclusion of grazing and burning from selected areas of swamp and ephemeral wetlands, to allow monitoring of the effects of these disturbances on important amphibian habitats.
- Use of the zoning system, focusing frequent and moderate control burning on strategic locations for hazard reduction.

3.2.4 Non-flying Mammals

Casino District has some of the most significant and diverse mammal habitat in NSW. It also has a large number of rare and endangered species, especially mammals in the Critical Weight Range. The habitat requirements of non-flying mammals occurring in Casino Management Area are detailed in the EIS for the area.

Non-flying mammals have been divided into three guilds:

1. *Arboreal Mammals*
   a) *Folivores* - Brushtail and Ringtail Possums; Greater Glider; Koala.
   b) *Nectivores/Insectivores* - Petaurid Gliders; Feathertail Glider; Burramyids.

2. *Grazers and Browsers*
   a) Kangaroos and Wallabies
   b) Domestic Stock

3. *Terrestrial Insectivores/Carnivores/Omnivores*
   a) *Insectivores* - Potoroids; Bandicoots; Dasyurids; Echidna.
   b) *Carnivores* - Dasyurids; Dingo; Fox; Cat.
   c) *Omnivores* - Rodents.

Arboreal mammal abundance increases with decreasing fire frequency and is highest in high quality moist forest types. Key resources are tree hollows and food sources. Several *Acacia* species provide edible gum exudates. Nectar from a range of eucalypts and shrub species is important, particularly for Squirrel Gliders, Sugar Gliders and Yellow-bellied Gliders.

Regular fuel reduction may, in some cases, help to reduce the chances of high intensity fires destroying habitat trees. Wildfire is considered a far greater threat to Koalas than low intensity prescribed fire, owing to their inability to escape a fast moving crown fire.

Large macropods, for example, Eastern Grey Kangaroos and Wallaroos, are widespread. These preferentially graze on grassland after fire and benefit from fuel reduction burning.

Smaller macropods are more restricted, apparently preferring the interface between moist forest and grassland. The interface between regularly burnt open forest and moist closed forest is particularly favoured by the Parma Wallaby, and Red-necked Pademelon. Others prefer unburnt moist eucalypt or rainforest habitats. Frequent burning which changes the nature of the ground cover may be detrimental to species like the Long-nosed Potoroo.

Post-harvesting fuel reduction burning (top disposal) often encourages *Acacia* species germination, but subsequent high frequency burning may reduce survival of regenerating shrubs. Grazing and frequent fire are expected to negatively impact shrub dependent species and positively impact grazing species. The maintenance of a mosaic of forests and open grasslands achieved by patchy fuel management burning may favour smaller Critical Weight Range macropods, provided adjacent refuge areas remain undisturbed by burning, to provide a recolonisation source afterwards.

Simplification of forest structure by too frequent (less than 5 years) low intensity prescribed burning, both advantages and disadvantages various mammal fauna in

south-eastern Australia (Catling, 1991). Generally, more native mammals and fewer introduced animals are disadvantaged by such a burning regime.

Burning patterns in Casino District, both historical and those proposed in this plan, avoid large scale, high frequency burning. Factors influencing this include forest types, altitude, weather and resources.

Although populations of small mammals may be temporarily reduced or changed, the long-term effects are not significant. King (1985) found that prescribed burning did not result in 100% of the area being burnt. Rather, a mosaic of burnt and unburnt sections resulted, providing refuge for mammals and invertebrates during the fire and recolonisation sources afterwards.

Most evidence suggests that disturbances giving improved access to feral predator species, pose a far greater risk to small marsupials, including *Rare and Vulnerable* species. Prescribed fuel reduction burning designed to limit the spread and intensity of wildfire, may be beneficial to the long-term survival of marsupial mammals and provide advantages over a regime of fire exclusion.

Species such as the Rufous Bettong may be subject to increased predation if large tracts of its habitat are burnt at any one time (Catling, 1991). The sporadic nature of fuel reduction burns should limit the impact of predation on native fauna.

Some of the mammal species (excluding bats) of conservation significance likely to occur in Casino Management Area are:

- Squirrel Glider *Petaurus norfolcensis*
- Yellow-bellied Glider *Petaurus australis*
- Parma Wallaby *Macropus parma*
- Black-stripeWallaby *Macropus dorsalis*
- Red-legged Pademelon *Thylogale stigmatica*
- Hastings River Mouse *Pseudomys oralis*
- Eastern Chestnut Mouse *Pseudomys gracilicaudatus*
- Broad-toothed Rat *Mastacomys fuscus*
- Brush-tailed Rock Wallaby *Petrogale pencillata*
- Rufous Bettong *Aepyprymnus rufescens*
- Long-nosed Potoroo *Potorous tridactylus*
- Tiger Quoll *Dasyurus maculatus*
- Koala *Phascolarctos cinereus*
- Common Planigale *Planigale maculata*
- Brush-tailed Phascogale *Phascogale tapoatafa*

Measures which will mitigate impacts of prescribed fire on non-flying mammals are:

- Active management of fuel levels to ensure a mosaic of fire regimes occurs, with emphasis on reduction of fire frequency to less than one in 15 years in gullies and unburnt sheltered south-east aspects.

- Leave for natural regeneration and exclude top disposal burning following logging, in those compartments where regeneration will be adequate and fuel loads do not increase wildfire risk.
- Strict regulation and enforcement of grazier burning. Extension work will be undertaken to increase graziers' acceptance and use of the permit system. In cases where there is continued non-compliance with burning permit conditions on a particular OP, the OP may be cancelled and the area offered to other permit holders.
- Use of the zoning system, focusing frequent and moderate control burning on strategic locations for hazard reduction.

3.2.5 Bats

The forests of Casino District support a high diversity of bat species. Frequent grazing and burning are expected to reduce habitats of those bats which forage in dense shrubby understorey. These are likely to be the smaller, slower flying species detected by trapping (Smith et al, 1994). Species composition of insectivorous bat communities favours those using higher substrates with increasing fire frequency (Gration et al, 1993).

Smith et al (1994), also found in the Grafton and Casino Management Areas, that fire frequency explained more of the variation in bat species and abundance than any other measured variable. The response to fire of the two different bat guilds, canopy and gap species, is opposite. Processes such as frequent fire, which suppress or destroy the shrub understorey , or reduce forest structural complexity, will cause a decrease in diversity of canopy species and an increase in diversity of gap species.

30 bat species may be present in Casino Management Area, including the following 16 species listed as *Rare and Vulnerable* on Schedule 12 of the National Parks and Wildlife Act:

- Black Flying-fox — *Pteropus alecto*
- Yellow-bellied Sheathtail Bat — *Saccolaimus flaviventris*
- White-striped Mastiff Bat — *Nyctinomus australis*
- Eastern Little Mastiff Bat — *Mormopterus norfolkensis*
- Beccari's Mastiff Bat — *Mormopterus beccarii*
- North Queensland Long-eared Bat — *Nyctophilus bifax*
- Common Bent-wing Bat — *Miniopterus schreibersii*
- Little Bent-wing Bat — *Miniopterus australis*
- Large Pied Bat — *Chalinolobus dwyeri*
- Hoary Bat — *Chalinolobus nigrogriseus*
- Large Footed Mouse-eared Bat — *Myotis adversus*
- Greater Broad-nosed Bat — *Scoteanax rueppellii*
- Golden-tipped Bat — *Kerivoula papuensis*
- Greater Pipistrelle — *Falsistellus tasma*
- Queensland Blossum-bat — *Syconycteris australis*
- Troughton's Eptesicus — *Eptesicus troughtoni*

Bats depend on tree hollows, caves or rock crevices for roosting sites, with a preference for moist gullies close to free water. Prescribed burning would not have a significant effect on these roost sites. Smith et al (1994) recommended that large winter flowering *Banksia* species in the shrub understorey be protected from logging and fire damage, as far as practicable, during and after harvesting operations.

Measures which will mitigate impacts of prescribed fire on bats are:

- Active management of fuel levels to ensure a mosaic of fire regimes occurs, with emphasis on reduction of fire frequency to less than one in 15 years in gullies and unburnt sheltered south-east aspects.
- Leave for natural regeneration and exclude top disposal burning following logging, in those compartments where regeneration will be adequate and fuel loads do not increase wildfire risk.
- Strict regulation and enforcement of grazier burning. Extension work will be undertaken to increase graziers' acceptance and use of the permit system. In cases where there is continued non-compliance with burning permit conditions on a particular OP, the OP may be cancelled and the area offered to other permit holders.
- Protection of large winter flowering Banksias from logging and fire, where practicable, by instructing logging contractors to avoid damaging mature (greater than 2m high) Banksias during felling and snigging operations. State Forests staff will avoid top disposal burns close to mature Banksias.

3.3 Fauna and Flora - General Summary

It is evident that, with a few exceptions, it is the frequency of low intensity burning which is likely to impact most on forest fauna and flora values. Fuel management planning must strike a balance between burning often enough to prevent general fuel accumulations with the potential to generate high intensity wildfire, and burning at long enough intervals to ensure the survival of plant species and wildlife habitat. This can best be achieved through a broad, cyclical mosaic of hazard reduced areas, across those parts of the District (predominantly dry eucalypt forest types) zoned for fuel management. Research and experience have demonstrated that most broad area fuel reduction leaves a patchwork of burnt and unburnt sections.

Many species and flora community issues have already been addressed in Casino District, with proposed reservations for special emphasis areas, in addition to the existing preservation and Preferred Management Priority (PMP) system. Some areas have been given PMP classification for special emphasis flora or fauna, where burning will either be kept to the minimum essential for general fire protection, excluded, or confined to key strategic protection areas only.

The Fuel Management Plan is sufficiently flexible to accommodate additional special prescriptions areas which may be identified in the future.

3.4 Grazing

Grazing is carried out over 40% - 50% of the Casino Management Area under Occupation Permit or Crown Lease and is generally limited to dry forest types. Grazing is a cost effective method of fuel reduction.

The potential impacts of grazing are:

- competition with native herbivores (for example, Kangaroos) for food;
- trampling and damage to understorey vegetation, particularly in swamps, gullies and moist areas not normally subject to natural (fire) disturbance;
- selective removal of palatable herbs and grasses;
- increased risk of unauthorised fires.

Fauna surveys have shown that forest areas with frequent burning and grazing have a lower biodiversity than unburnt, infrequently burnt, or infrequently grazed areas. This is due mainly to simplification of the ground cover and shrub understorey by frequent burning and grazing. Species preferring a complex shrubby understorey are disadvantaged by a regime of frequent, low intensity fires, while species preferring open grassy understoreys are favoured. Comparatively few species prefer a grassy understorey. Those species which do so are predominantly woodland rather than forest species.

Frequent fire combined with grazing is associated with fewer bird species and lower bird numbers. As well, more terrestrial mammals are disadvantaged than favoured by fire and those that are favoured are the more common species.

In general, macropods prefer a mosaic of open, grassy understorey for grazing and dense cover for shelter. Larger macropods, including the Red-necked Wallaby, Swamp Wallaby and Grey Kangaroo, may travel a considerable distance from shelter to graze, needing only scattered shrub cover. Like cattle, these species have been favoured by fire regimes which encourage grassy understoreys and are common throughout the MA. Smaller, less common and endangered macropods, including the Red-necked Pademelon and Parma Wallaby, also prefer a mosaic of dense understorey and grass, but do not venture far from dense understorey.

Some arboreal mammal species depend on the shrub understorey for feeding. Mammals such as the Mountain Brushtail prefer unburnt and ungrazed understorey. Both the Greater Glider and Yellow-bellied Glider are common in moderately to intensively grazed forest.

In the Grafton-Casino fauna study by Smith et al, (1993), no arboreal mammal species were positively associated with frequent grazing or burning. Closed forest species were negatively associated with fire.

Forest grazing benefits forest management in so far as it reduces fire hazard during the fire season, contributing significantly to the overall District fuel management program.

Measures which will mitigate impacts of grazing and associated prescribed fire are:

- Active management of fuel levels to ensure a mosaic of fire regimes occurs, with emphasis on reduction of fire frequency to less than one in 15 years in gullies and unburnt sheltered south-east aspects.
- Exclusion of grazing and burning from selected areas of swamp and ephemeral wetlands, to allow monitoring of the effects of these disturbances on important amphibian habitats.
- Strict regulation and enforcement of grazier burning. Extension work will be undertaken to increase graziers' acceptance and use of the permit system. In cases where there is continued non-compliance with burning permit conditions on a particular OP, the OP may be cancelled and the area offered to other permit holders.
- Grazing and burning will be excluded from representative areas of State forest to allow the effects of exclusion to be monitored.
- Communities poorly or inadequately conserved under the Hager and Benson (1984) criteria have been reserved and zoned in the ecological management burning zone. Hazard reduction burning guidelines for these areas will be developed. Grazing will be phased out in these areas, should they be permanently reserved, following a total land tenure review of conservation adequacy status.
- Grazing is excluded from flora reserves.

3.5 Silvicultural Aspects

The promotion and protection of regeneration following logging are of primary importance in long-term forest management.

Eucalypts in moist forest types require significant ground disturbance for adequate regeneration (Forestry Commission 1982). If the intensity of logging in an area is low, ground disturbance may not be enough for eucalypt regeneration, enabling moist understorey plants such as vines to quickly take over. Post-logging top disposal and regeneration burns are an efficient means of significantly improving regeneration potential, in addition to reducing fire hazard for the regrowth.

Each year, a relatively small area only is subject to these burns, following logging in forest types where it is required as a silvicultural treatment. A higher intensity fire than with other fuel reduction burns is normal during post-logging burns, due to the accumulated logging slash and the drier, warmer conditions required to burn in moister forest types. A significant proportion of logged compartments remains unburnt due to variable fuel moisture, discontinuous fuel and prescribed catchment protection measures.

Catling (1991) believes high intensity fire encourages dense scrub understorey regrowth, providing suitable habitat for many native animal species. Limited area regeneration burns, adjoining unburnt habitat areas, may prove beneficial for some fauna in the long-term, including the Long-nosed Potoroo and Parma Wallaby.

It is important to keep in perspective the limited area burnt in this way each year, compared to the total area of these forest types, a large percentage of which is not subject to any fuel reduction.

Approximately 1,000 ha (gross), of mostly moister hardwood types, is subject to post-logging burning each year, of which about 50% remains unburnt. This represents 0.3% of the District each year. Over a 25 year cycle, post-logging burning would only be carried out on approximately 8% of the total gross area.

Regeneration and regrowth stands are the most vulnerable to damage by fire. The bark of young trees is thin and provides little protection for the cambium (or growth layer). Crowns of young trees are closer to the ground and susceptible to scorch. Adequate protection from all fire is needed until young trees can withstand controlled, low-intensity fuel reduction burning.

It is proposed to exclude fire from regrowth stands until dominant and co-dominant trees are at least 10 cm diameter. Careful silvicultural and fuel management planning will be necessary to enable effective protection of the complex mosaic of young regrowth and older age class stands, which will result from "gap and cluster" type harvest and retention operations.

3.6 Soil Protection and Water Catchment Values

The forests of Casino District have a vital catchment role, providing water supplies for agricultural and domestic purposes. Rocky Creek Dam (Whian Whian State Forest) is the only major water storage with a catchment in State forests. Vegetation adjacent to gullies and streams is often dominated by rainforest and moist forest. The forest cover is important in maintaining stream flow, preserving water quality and ensuring a high level of erosion control (Forestry Commission, 1980). Prescribed burning can have positive impacts on water quality. For example, Scott and Schulze (1992), recommend that fuel management programs be implemented in eucalypt forested catchments to prevent extreme soil heating during wildfires and subsequent accelerated erosion.

Condition 35 in current licences issued to State Forests, under the Pollution Control Act (1970), Section 17A(b), requires that burning associated with the cutting and removal of timber must be carried out in a manner which minimises impacts on filter strips, to the greatest extent possible. Conditions 121-128, Division 3, Schedule 2 of the EPA Pollution Control Licence, detail conditions for pre- or post-harvest burning. These conditions have been incorporated into operational planning for burning (Appendix 2). Post-logging burning will be carried out in accordance with the "Guidelines For the Conduct of Post-Harvest Burning in Native Forests" which have been developed in accordance with the current EPA Pollution Control Licence conditions.

Maintenance of full vegetation cover in and adjacent to drainage lines, is achieved by exclusion of fuel reduction burning, or by strategic burning under mild conditions, using the moisture gradient from upper slope to gully. Scott and Schulze (1992),

report that unburnt riparian strips are effective soil and ash traps following wildfire, and would be even more effective following low intensity prescribed fire.

3.7 Apiculture

Beekeeping is a minor use of forests in the District. Excessive smoke can be harmful to bees. People engaged in fuel reduction should be aware of the presence of hives and liaise with apiarists well before intended burning. Potential damage to understorey flora important to commercial bees should also be considered.

3.8 Recreation

The forests of Casino District have significant recreational value due to:

- a wide range of attractive forest scenery in both hardwood and rainforest vegetation, together with numerous rivers and streams offering spectacular vistas amid the tranquility of natural bushland;
- proximity to the population centres of Brisbane, Byron Bay and Coffs Harbour, with an extensive network of forest roads;
- comparatively unlimited opportunities for picnicking, bushwalking, horseriding, four-wheel driving, fishing and swimming;
- extensive recreational facility developments within the District.

Popular recreation areas can be potentially high risk wildfire ignition areas. It may be necessary to balance the benefits of regular fuel reduction burning in these localities, against the possible temporary loss of some scenic amenity and educational values. Although many recreation areas are in moist gully locations and near water, the potential for campfire escapes cannot be discounted.

Fuel reduction burning adjacent to recreation areas for wildfire protection is necessary, but may temporarily compromise the aesthetic appeal of the forest environment. Smoke may also inconvenience recreationists. Burning should therefore occur outside peak visitation periods.

Where possible, other forms of hazard reduction, such as mowing, should be employed around recreation areas.

3.9 Historic Relics and Sites

Generally, known historic sites throughout Casino District are not at risk from wildfire or fuel reduction burning operations. All known sites are recorded on PMP maps and requirements are considered as part of the pre-burning checklist.

3.10 Cooperation with Neighbours

Beyond forest boundaries private land, predominantly used for grazing, occurs at lower altitudes in the undulating foothills and along the flatter valley areas. State Forests has a vested interest in the timing and control of burning by neighbouring land holders, especially where topography prevents construction of boundary roads or breaks.

Liaison with neighbours, both directly and through local Fire Control Officers and Bushfire Brigades, is important. Cooperative fuel management on either side of the boundary must be considered as an option. Occasional fuel reduction burning in other boundary areas will also be conducted with adequate notification and/or cooperation with neighbours. Local media outlets will be used whenever possible to notify residents of impending hazard reduction burns.

3.11 Smoke Management

Prescribed burning generates smoke, which periodically affects the atmosphere in the region during autumn and early winter. Smoke is also generated by prescribed burning operations on other land tenures, such as private property.

Generally, smoke is not a major hazard for population centres in the region. Prescribed burning smoke sources are relatively isolated at any one time. Hazardous concentrations, involving smoke from prescribed burning combining with industrial and motor vehicle atmospheric pollutants, are unlikely to occur. Most population centres are close to the coast where winds and the general climatic conditions combine to rapidly disperse smoke.

Smoke is a consideration when burning close to roads, settlements or tourist areas. Frequently, favourable prescribed burning conditions coincide with holiday periods.

Prescribed burning will be conducted, considering the above concerns. Weather conditions will be monitored and, where practicable, consistent with the overall aims of the burning operation, lighting patterns will reflect the need to minimise smoke drift. Specific traffic control measures will be put in place where there is any likelihood of road hazard due to smoke.

4. MONITORING PROCEDURES AND TRAINING

Fuel management burning is recognised as the most effective way of training firefighting personnel. It enables crews to become familiar with the use of firefighting equipment; fire behaviour and the methods of predicting it; and the value of records arising from the monitoring of burning results.

Fuel management planning and operations should take this training objective into account.

4.1 Monitoring of Weather and Fuels

Weather records from the Casino Airport will be used to calculate the Byram Keetch Drought Index (BKDI). This will allow periodical review of the parameters set for each burning zone.

Appropriate employees should be trained in the use of the Forest Fire Danger Meter for calculation of the Fire Danger Index (FDI) in the field.

Key personnel should be trained in the visual estimation of fuel quantities, through comparison of actual versus estimated fuel levels. Staff should also be trained in the field measure of fuel moisture content (for example, using the "Speedy Moisture Meter") which, when combined with "day of burn" site specific weather information, will provide records for future prediction of fire behaviour.

When burning, field weather kits should be used to measure temperature, relative humidity and wind prior to ignition and, if possible, at intervals during the progress of the burn. This information, recorded in the Fuel Management Operational Plan (Appendix 2), will be used to monitor fire behaviour and to refine prescriptions for future fuel management burning.

4.2 Monitoring of Burning Operations and Results

Monitoring is regarded as an essential part of the conduct of any fuel management burn, being especially relevant for:

- correlation of fire behaviour with drought and fire danger indices;
- assessing the short- and long-term effects of fire on the environment;
- modification of procedures and prescriptions;
- administrative and legal requirements.

The Daily Fire Record will be used to register all hazard reduction burning, as is routinely undertaken for wildfire recording. A long-term record of prescribed burning, including areas burnt and burn types, will be established as part of the Fuel Management Plan.

Monitoring will be carried out using the Post-burning Checklist and Checklist for Day of Burn, contained as part of the Operational Plan (Appendix 2). Supervisors should analyse reasons for changes to the plan, or for unpredicted fire behaviour, as part of the feedback and training program.

Areas burnt shall be recorded on a map. A series of 1:25 000 overlay maps will be established on which all prescribed burns and wildfires will be recorded.

4.3 Special Techniques

Personnel should be aware of particular difficulties which may be encountered and the special techniques which may be used, when appropriate, to counteract them, for example:

- Avoiding damage from low intensity but long duration "creeping" fires.
- Stimulating fire activity by running small fires uphill or down wind, or encouraging cross-radiation from closely spaced lines.
- Varying the approach to burning, depending on conditions, to achieve particular objectives.
- Burning under conditions of higher FDI but low BKDI to confine the fire to fine fuels.

4.4 Other Records

In conjunction with, or as part of the Action Fire Plan, other records which will provide useful information for fuel management planning include:

- Wildfire mapping.
- Wildfire ignition point summary map.
- Updated road and fire trail maps and maintenance programs.
- Water points.
- Helicopter landing sites.

5. OPERATIONAL PROCEDURES

The operational fuel management plan sets out a fuel management strategy which defines burning prescriptions, monitoring methods and operational procedures. It takes into account the assets to be protected, the degree of hazard, fauna and flora conservation requirements, climate, topography and the vegetation of the area.

Fuel reduction burning may be carried out on small or large areas as specified in operational plans. Ignition methods will be adapted to the particular area and will use the most suitable technology available.

Fuel reduction burning will be planned to ensure that:

- The operation can be carried out without risk to personnel or property.
- The fire can be contained within defined limits.
- Fire intensity will be at levels adequate to achieve fuel modification, while minimising adverse effects on the forest environment.

5.1 Annual Programming

An annual program covering the entire Casino District shall be prepared prior to commencement of the winter-spring burning season each year. An annual program for three successive years will be prepared and will take account of burning carried out in the previous seasons.

A map of the area showing areas proposed for fuel management activities shall be included as part of the annual program. This map should indicate the various types of hazard reduction proposed for the season, as described in Section 2.6.

The planning of any one year's program must take into account not only general fuel levels and areas of regular strategic or protective burning, but must also consider the effects of previous years' hazard reduction or wildfire burning. Planning must also take into account the progress of logging operations throughout the area.

A series of operational (action) plans, selected for implementation during the coming fuel management season, should be included with the annual program. Priorities for each operational plan should be set and any restrictions described.

The limitations imposed on the amount of hazard reduction burning which can be achieved, by the vagaries of weather and a shortage of manpower, make it necessary to have operational plans prepared for more areas than are likely to be burnt in any one season. Suitable conditions occur at irregular intervals and sufficient operational plans must be available to ensure that favourable opportunities for fuel management are not missed.

All likely options for the coming season should be included. While plans should be as complete as possible, amendments during the season are permissible.

The annual plan should include proposals for liaison with forest graziers and neighbours for cooperative burning. It should also include proposals for areas which may be burnt under permit by graziers.

5.2 Operational Planning Guidelines

The following principles should be incorporated into operational planning:

- The detail necessary for effective operational planning requires the District to be divided into a number of operational units or burning blocks, the nature, size and constitution of which will vary according to the type of fuel management to be undertaken.
- Detailed operational plans shall be prepared for each operational unit or homogeneous group of units.
- Fire must be contained within predetermined control lines to prevent its entry into areas or vegetation types, from which prescriptions specifically exclude it.
- All fuel management burning will be supervised by a Forester, either in person, or in a position to respond promptly and appropriately to changing conditions.
- EPA Pollution Control Licence conditions will be considered in the planning and conduct of all burning operations.
- Expected weather conditions must be considered. Burning should be avoided when a significant level of forecasting uncertainty exists. Advancing frontal weather is normally to be avoided.
- Security of fire edges, particularly as the burning season advances, will be given high priority. Post-logging burning shall be curtailed much earlier than other burning regimes.
- Permission shall not be given for graziers to burn without the presence of State Forests personnel beyond mid-September in any year.
- Consideration shall be given to *Rare and Vulnerable, or Threatened* fauna and significant flora known to occur in the area, and to their responses to fire. Exclusion of fire from some sections may be required.
- Consideration shall be given to the location of historical and archaeological sites. Exclusion of fire from some sections may be required.
- Fires of all kinds will be organised as one day activities, as far as practicable. The lowest level of fire intensity and the least intensive ignition pattern, consistent with a burnout on the same day and within fuel management objectives, shall be planned.
- The safety of burning crews, as well as of other persons likely to be in the area, is paramount. Planning will ensure that all personnel will be clear of severe heat or smoke and ensure there is no likelihood of anyone being trapped or injured.
- A supervisor will brief the crews and ensure that they understand the following:
  - the reason for the burn;

- the boundaries of the area to be burnt;
- the areas from which fire must be excluded;
- the appropriate control lines;
- the ignition points, patterns and direction of work;
- escape routes in the event of unexpected adverse circumstances.

- Foresters are to check the results of the previous day's burning (including fire behaviour) and, in the light of these results, discuss proposed activities for the coming day (including fire weather and fire behaviour), with burning crews prior to the burn commencing.

5.3 Operational Plans

Due to the need to prepare more plans than are likely to be used in any one season, in order to ensure that opportunities for hazard reduction are not missed, operational plans should remain current for at least three years, only being reviewed or updated as necessary.

5.3.1 Operational Plan Details

Each burning plan shall include a map, an environmental checklist, a set of written specifications, a pre-planning checklist, a checklist for the day of the burn and a record of burning which provides scope for monitoring and evaluating the burn.

Information which should be shown in the written specifications includes:

- Location and area, including descriptions of forest types and fuels.
- Objectives of burning, both general and specific.
- Environmental effects and controls, including significant fauna and flora and all necessary proposed protection measures. Fire exclusion areas must be mapped.
- Burning prescriptions, including burning cycle, FDI, desired fire behaviour and effects.
- Perimeter control details.
- Tactical details, including crew and equipment details, methods of ignition, patrol and mop-up.
- Cooperative arrangements.

On the record of burning form, the following should be recorded:

- Weather conditions - conditions at time of ignition must be recorded; details at other times during the burn are desirable, especially if there is an unexpected change.
- Fire behaviour and results.
- Area treated, fuels burnt and general evaluation of the burn.

5.3.2 Procedure for Operational Plan Preparation

In preparing an operational plan, the following procedures should be observed:

- If conducting post-logging burning, consult the "Guidelines for the Conduct of Post-Harvest Burning in Native Forests". Guidelines for broad area burning are being developed and these should be used when they are available.
- Divide the area into logical burning units.
- Prepare a map of the area, using a scale of 1:25,000 for broad area burns, with preferably a larger scale for top disposal or small area burning.
- Identify neighbours, permittees, apiarists; assemble a contact list including the local Bushfire Brigade.
- Refer to EPA Pollution Control Licence Conditions, Numbers 121-128, Division 3, Schedule 2.
- Refer to PMP maps in case special prescriptions should be made.
- Conduct field inspection where necessary and locate assets needing protection, including fences, buildings, historical sites and relics, susceptible regeneration, research plots. Locate suitable burning boundaries and control lines. Determine work required to improve them if necessary. Assess fuel levels.
- Identify areas of significant flora and *Rare and Vulnerable, or Threatened* fauna habitat. Appropriately restrict or otherwise prescribe burning in these areas.
- Allocate priorities - planning should proceed progressively on all blocks.
- Prepare strategies and tactics for burning - burning regime, timing, resources, assistance required.
- Produce operational burning plan, including a copy for crew foreman.
- Issue plan to burning supervisor.

5.4 Burn Follow-up and Monitoring

The location, success and effects of each burn should be recorded (see Section 4.2), and the operation should not be regarded as complete until this phase, at least in the short-term, is carried out. In some instances, follow-up work in the successive season may be required to achieve the burn objectives.

At the end of each season a brief report should be prepared, summarising the results achieved and commenting on any variations to the proposed program, or results that did not conform to predictions or expectations.

Records of fuel reduction burning and wildfires will assist in monitoring the effectiveness of the Fuel Management Plan. Development of the Fuel Management Plan is dynamic. Periodic review will be undertaken as new knowledge comes to light and the plan will be amended as necessary.

6 REVIEW PROCEDURES

This plan will be reviewed regularly as required, or within three years. Regular updates may be required if further research information becomes available, or if zoning requirements change. This may result from factors such as updated research, or changes such as expanding settlement areas requiring additional protection, variations to the conservation resource affecting zoning, or additional regrowth areas requiring protection.

The operational burning plan will be prepared for three years but will be revised annually. This is to provide for priorities within zones and to allow review based on burning achieved each year.

Review will also be undertaken if significant changes are required as part of the Bush Fire Management Committee's 41A fuel management planning process.

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Moore, P. Fire Protection Officer, State Forests Fire Protection Branch

STATE FORESTS OF N.S.W.

FORESTRY REGULATION 1983 CLAUSE 26

PERMIT TO LIGHT, USE OR MAINTAIN

A FIRE ON STATE FOREST

Permission is granted to _____

of _____ to light, maintain or use a fire on _____ part of _____ State Forest as shown on the attached map for the purpose of _____

_____

This permit shall be effective from _____ a.m. p.m on / / until _____ a.m. p.m. on / /

This permit is granted subject to the provisions of the Forestry Act and Regulation and the Bush Fires Act as well as the following conditions:-

1. The nearest Bush Fire Brigade and adjoining land holders shall be notified of the intention to burn and the proposed time of lighting.
2. The permittee shall indemnify and keep indemnified the Crown and State Forests in respect of

   all claims arising out of the lighting, use or maintenance of fire pursuant to this permit.
3. This permit is subject to variation, suspension or revocation at short notice by State Forests.
4. This permit is cancelled by a total prohibition on the lighting of fires under the Bush Fires Act.
5. At least one person shall be present at the site of the fire from the time it is lit until it is extinguished.
6. The permittee shall read the operational plan prepared for the proposed fire and comply with all requirements detailed within the operational plan.
7. Any other conditions:-.....

   .....

SIGNATURE: _____ PHONE (0): _____

DESIGNATION: _____ (H): _____

CASINO DISTRICT:

CASINO DISTRICT

OPERATIONAL FUEL MANAGEMENT PLAN

1. BURNING PLAN (page 1 of 8)

Year 19.....

To enable the supervising forester/foreman conducting the burn to gather all information relative to the proposed burn; to formulate a burning plan and to identify work required to ensure that the area is satisfactorily prepared for burning.

Plan Effective from ..... to.....

State Forest ..... Compartment/s .....

Gross Area .....ha

Burning Zone

Zone 1 Area (ha) _____
Zone 2 Area (ha) _____
Zone 3 Area (ha) _____
Zone 4 Area (ha) _____

PREPARED BY:

SIGNATURE

DATE

PLAN AUTHORISED BY

SIGNATURE

DATE

SUMMARY OF BURN AT COMPLETION

Zone Number (1-4) .....

Gross Area Treated .....ha

% Coverage .....

Net area burnt .....ha

Burning Block Description

Forest types and stand condition .....

Description of understorey .....

Schedule 12 species habitat identified.....

.....

Fuel Description

Fuel weight - *Litter* (% cover in 4m diam. circle) =
÷ 10 = tonnes/ha (*L*)
(if litter cover is 100%, every 2 cm depth = 10 tonnes/ha)

- *Shrubs* (% cover in 0.5m layers) 0-0.5 =
0.5-1.0 =
1.0-1.5 = _____ (*S*)

÷ 20 = tonnes/ha

Total (*L*+*S*) = tonnes/ha

Purpose of Fuel Management

Community, asset and boundary protection ..... [ ]
Young regrowth/TSI protection ..... [ ]
Top disposal..... [ ]
Broad area - logged forest ..... [ ]
Broad area - unlogged forest ..... [ ]
Pre-logging..... [ ]

Objective of Fuel Management.....

.....

.....

OPERATIONAL FUEL MANAGEMENT PLAN

1. BURNING PLAN (page 3 of 8)

Planning Checklist

Fuel management strategic plan ..... [ ]

PMP maps ..... [ ]

Schedule 12 species maps ..... [ ]

EPA requirements ..... [ ]

Other

Burning cycle ..... [ ]

Number of stages ..... [ ]

Season .....

Acceptable crown scorch (%) .....

Intended coverage (%) .....

Acceptable Fire Danger Index .....

Max.Temp .....

Min. RH .....

Max. wind speed and direction .....

Ignition method(s) .....

Protection for Schedule 12 species .....

.....

Areas to be excluded from burn

.....

Controls Required to Contain the Burn

Perimeter control lines:-

Existing .....

To be prepared .....

Other controls (describe) .....

.....

Work required to assist control (describe) .....

.....

Location of Water .....

OPERATIONAL FUEL MANAGEMENT PLAN

1. BURNING PLAN (page 4 of 8)

Equipment and Manpower

No. of slip-ons ..... [ ]

No. of people ..... [ ]

Drip torches ..... [ ]

Lighter fuel ..... [ ]

Knapsacks ..... [ ]

Rakehoes ..... [ ]

No. of tankers ..... [ ]

Smoke mask/goggles ..... [ ]

Smoke across road sign ..... [ ]

Hazard reduction burning signs ..... [ ]

Other resources (specify).....

.....

Perimeter Controls Prepared

Yes..... No.....

Co-operative Arrangements

Legal & Departmental Requirements

Details of adjoining land tenures (Name and contact no. if avail).....

.....

.....

Permits to enter (FC 312)? ..... [ ]

Notifications to be made:-

Neighbours ..... [ ]

Lessees/permittees ..... [ ]

Researches ..... [ ]

Bush Fire Brigades ..... [ ]

N.P. & W.S. ..... [ ]

Contractors ..... [ ]

Apiarists ..... [ ]

Recreationists ..... [ ]

Council F.C.O ..... [ ]

CASINO DISTRICT

OPERATIONAL FUEL MANAGEMENT PLAN

1. BURNING PLAN (page 5 of 8)

STATE FOREST.....
COMPARTMENT.....

Plan of Operations - Key

Map Scale.....

Roads for control lines - 4 x 2	orange
Roads for control lines - 4 x 4	orange dotted
Perimeter control lines (not trafficable)	blue
Internal control lines (not trafficable)	blue dotted
Gullies suitable for control lines	green
Areas to be excluded from the burn	pink
Danger points	red
Location of water	blue
Other Roads - 4 x 2.....	black
Other Track - 4 x 4.....	black dotted
Other	

General
Information.....
.....
.....
.....

OPERATIONAL FUEL MANAGEMENT PLAN

2. CHECKLIST FOR THE DAY OF THE BURN (page 6 of 8)

Date.....

Weather Forecast and Indicies:-:-

Maximum temperature .....

Minimum Relative Humidity.....

Wind direction .....

Wind speed .....

Days since last rain .....days Rainfall last rain ..... mm

BKDI ..... Drought Factor .....

Predicted FDI = ...

Is Predicted FDI outside parameters Yes/No.....

Comments on whether burn will be carried out and what will be done to take account of weather forecast and FDI if outside parameters.....
.....
.....
.....
.....
.....

Safety:-

Check the area to ensure that there are no persons or property within the proposed burn area..... [ ]

Notifications:-

Advise other bodies of the imminent burn:-

Adjacent neighbours ..... [ ]

NP&WS if within 8 km of burn ..... [ ]

Shire FCO and neighbouring Bush Fire Brigade..... [ ]

OPERATIONAL FUEL MANAGEMENT PLAN

3. RECORD OF IGNITION (page 7 of 8)

(TO BE RECORDED IN FIELD AT TIME OF BURN)

Fine Fuel Moisture Content:-

Ground ..... Elevated ..... Sub-litter layer .....

On Site Weather Before Commencement of Burn:

Time: .....
Drought Factor .....
Air Temperature .....
Rel. Humidity .....
Wind Speed ..... Wind Direction .....

FDI = ...

Ignition Time and Pattern:-

Time burn lit .....

Pattern of Lighting .....

Ground /Aerial Ignition .....

No. Capsules used .....

Monitoring:-

Time	Dry Bulb oC	Wet Bulb oC	R.H. %	Wind Speed kph	Wind Direction	F.D.I.	Comments

The foreman or employee conducting the burn is to mark the areas burnt on the map and return it to the supervising forester at the completion of the burning programme.

Net area burnt .....ha %Coverage .....

Burn Complete Yes/No .....

Follow-up Required .....

.....

Gang members .....

.....

.....

Foreman .....

Forester .....

OPERATIONAL FUEL MANAGEMENT PLAN

4. REVIEW OF BURN (page 8 of 8)

(TO BE COMPLETED BY FIRE MANAGEMENT OFFICER)

PLAN NUMBER _____

1. LOCATION _____

2. AREA INFORMATION

   Gross Area (ha) _____
   Percentage Area Burnt (%) _____
   Estimated Area Burnt (ha) _____

3. ESTIMATED CROWN SCORCH
   (percent of area in which dominant and co-dominant crowns are scorched)

   Scorch in Perimeter of Burning Area (%) _____

   Scorch over Internal Part of Burning Area (%) _____

3. FUELS BURNT (Estimate)

   < 25mm _____ % 25 to 50mm _____ % > 50mm _____ %

4. WAS BURN WITHIN OPERATIONAL PRESCRIPTIONS?

_____

_____

_____

5. DID BURN ACHIEVE THE PLANNED AIMS?

_____

_____

_____

6. OTHER COMMENTS?

_____

_____

_____

Fire Management Officer _____ Date _____

MANAGEMENT AND ECOLOGICAL BURNING AREAS

APPENDIX 3

CASINO DISTRICT FUEL MANAGEMENT PLAN

FLORA AND FAUNA MANAGEMENT

Part Compartment 24 Braemar State Forest and Part Compartment 21 Carwong State Forest

Value: Representation of the dry hardwood forest types 85, 82, 70, 72, 74, and 65. Area 417 ha.

Aim: To maintain species composition and forest stand structure.

Burning Cycle: To be determined following consideration of fuel load accumulation rates and evaluation of wildfire damage to stand structure with higher fuel loads.
Requires consideration of private property to the north of these compartments.

Operational Aspects: 3-5 year fuel management of surrounding forest areas. Maintenance of boundary roads.

Compartment 99 and Part Compartment 97 Banyabba State Forest

Value: Representation of dry hardwood forest types 65, 76, 97 and 129; and Blackbutt forest types 39 and 41. Area 738 ha.

Aim: To maintain species composition and forest stand structure.

Burning Cycle: To be determined following consideration of fuel load accumulation rates and evaluation of wildfire damage to stand structure with higher fuel loads.
Requires consideration of Banyabba Nature Reserve on the western boundary, private property to the south-east and Banyabba pine plantation to the north-east.

Operational Aspects: Inclusion of approximately 150 ha of Compartment 98 within the ecological zone for Compartment 99, to utlilise Ogilvie Trail as a boundary break to the east.
Utilisation of moist gully lines to separate part Compartment 97 from surrounding fuel management. 3-5 year fuel management of surrounding forest areas.

Compartments 395, 396, and 397 Keybarbin State Forest

Value: Representation of dry hardwood forest types 74 and 129. Area 927 ha.

Aim: To maintain species composition and forest stand structure.

Burning Cycle: To be determined following consideration of fuel load accumulation rates and evaluation of wildfire damage to stand structure with higher fuel loads.

Requires consideration of the adjacent private property extending for 16 km on the eastern, southern and western boundaries of these compartments.

Operational Aspects: The construction of perimeter tracks to assist fire management.

Compartments 148 and 149 Double Duke State Forest

Value: Representation of heath types 30, 31, and 32; and dry hardwood forest types 70, 72, 74 and 92. Area 1,712 ha.

Habitat for open woodland and ephemeral wetland fauna species.

Aim: To encourage growth to maturity of *Melaleuca* species.

Protection of ephemeral wetland fauna and flora communities.

Burning Cycle: To be determined following site evaluation of moisture gradients between ephemeral wetland and dry hardwood areas, and fuel load accumulation rates in dry hardwood areas.

Requires consideration of private property to the south of these compartments.

Operational Aspects: Maintenance of a strategic 3-5 year zone on the western boundary of Compartment 148. Maintenance of boundary tracks.

Compartments 340, 326, and 353 Richmond Range State Forest

Value: Representation of moist hardwood forest types 46, 47, 48, 51, 60, 53 and 71; and dry hardwood forest type 65. Area: 629 ha.

Aim: To maintain species composition and forest stand structure.

Maintenance of moist understorey communities.

Burning Cycle: To be determined following consideration of fuel load accumulation rates and evaluation of wildfire damage to stand structure with higher fuel loads.

Requires consideration of surrounding regeneration areas and private property.

Operational Aspects: Maintenance of boundary roads.

Compartment 43 and Part Compartment 48 Bungawalbin State Forest

Value: Representation of heath type 31; Blackbutt forest types 40 and 41; dry hardwood forest types 65, 70, 74, 80, 84, 119, and 126; and moist hardwood forest type 60. Area 960 ha.

Aim: To encourage growth to maturity of *Melaleuca* species.
Protection of ephemeral wetland fauna and flora communities.
To maintain species composition and forest stand structure.

Burning Cycle: To be determined following site evaluation of moisture gradients between ephemeral wetland and dry hardwood areas, and fuel load accumulation rates in dry hardwood areas.
Requires consideration of adjacent private property, particularly ti-tree plantations to the south of Compartment 48.

Operational Aspects: Maintenance of boundary roads, including upgrade of the southern boundary of Compartment 43.

Compartments 14 and 15 Royal Camp State Forest

Value: Representation of dry hardwood forest types 72, 74 and 92; heath type 31; and moist hardwood forest types 48, 53 and 60. Area 1,052 ha.

Aim: To maintain species composition and forest stand structure.

Burning Cycle: To be determined following consideration of fuel load accumulation rates and evaluation of wildfire damage to stand structure with higher fuel loads.
Requires consideration of private property to the north of these compartments.

Operational Aspects: Maintenance of boundary tracks.

Compartment 372 Mt Pikapene

Value: Representation of dry hardwood forest types 72, 82, and 87; and moist hardwood forest types 53 and 71. Area 94 ha.

Aim: To maintain species composition and forest stand structure.

Burning Cycle: To be determined following consideration of fuel load accumulation rates and evaluation of wildfire damage to stand structure with higher fuel loads.
Requires consideration of private property to the north of this compartment and the Pikapene pine plantation to the south.

Operational Aspects: Maintenance of boundary tracks.

Compartment 398 Mt Belmore

Value: Representation of dry hardwood forest types 62, 82, and 87; and moist hardwood forest types 48 and 71. Area 45 ha.

Aim: To maintain species composition and forest stand structure.

Burning Cycle: To be determined following consideration of fuel load accumulation rates and evaluation of wildfire damage to stand structure with higher fuel loads.

Consideration of private property to the west of this compartment.

Operational Aspects: Maintenance of boundary tracks.

Compartments 421 and 422 Mt Belmore State Forest (West of Bennetts Road)

Value: Presence of a diverse understorey of interesting species such as *Hibbertia acuminata* (3VCi); *Astrotricha cordata,* which is an outlier of an otherwise south-east Queensland species; and *Mirbelia speciosa* subspecies *ringrosei,* the only known NSW occurrence of this Queensland species. Area 666ha.

Aim: To consider the effects of fire on the distribution of these species

Burning Cycle: Historically, the area has been burnt, on average, every 3 years. Smith et al (1993), recommended a fire frequency of 12 years in the absence of better information. An appropriate fire regime will be determined, following assessment of the extent of distribution of these species and the potential effects of fire on their distribution.

Mt Marsh State Forest (Old Growth Moratorium Area)

Value: Assessment area for old growth. Area 3,300 ha.

Aim: Maintain present structure.

Burning Cycle: To be evaluated based on fuel loads. Fuel loads up to 12-15 t/ha are considered the upper limit, given the size of area, lack of internal roads and adjacent private property to the north-east and west of the area.

Needlebark Flora Reserve

Value: Preservation of a natural stand of Needlebark Stringybark, *Eucalyptus planchoniana.* Area 47 ha.

Aim: To use prescribed burning as a protective measure within the reserve and as an aid in suppressing wildfires which threaten, or occur within, the reserve.

Justification: The flora reserve is subject to frequent wildfire. Access for fire suppression is limited due to sandstone cliffs which prevent construction of an adequate protective firebreak. Management of the area with prescribed fire is considered the most effective means of minimising the risk of damage by uncontrolled wildfire.

Burning Cycle: The prescribed fire frequency will be a minimum cycle of 6 years.

MANAGEMENT AND ECOLOGICAL BURNING AREAS

APPENDIX 3

CASINO DISTRICT FUEL MANAGEMENT PLAN

BURNING UNDER REGROWTH

The following guidelines for burning under regrowth were developed for the coastal forests in the Eden area. Over time these guidelines will be refined and adapted for the north coast escarpment, foothill and coastal regrowth forests.

As a general guideline, burning will only be carried out when the variables below are within the following parameters:

- *Ambient Temperature* - up to 25^0 C.
- *Relative Humidity* - 50%-80% Oven Dry Weight (ODW).
- *Mean Wind Speed in Open* - up to 15 km/h.
- *Near Surface Fuel Moisture* - 12%-20% ODW.
- *Stages* - usually one stage burning, but may need several if fuel load is heavy.
- *Season* - late autumn/early spring.
- *Scorch* - up to 10% of crowns of dominant and co-dominant trees in the initial burn, which may remove suppressed stems. 5% of crowns of dominant and co-dominant trees in subsequent burns.
- *Coverage* - up to 50%.
- *Ignition* - ground ignition.

Effective regrowth fuel management burns are dependent upon the quality of past top disposal burns. The above are guidelines only and will be refined over time with careful recording of burn results, fire behaviour and these variables at the time of burning.

SUMMARY OF MEASURES TO MITIGATE THE EFFECTS OF PRESCRIBED FIRE ON FLORA AND FAUNA

APPENDIX 4

CASINO DISTRICT FUEL MANAGEMENT PLAN

The following is a summary of measures detailed in Section 3 of the Casino District Fuel Management Plan, that will mitigate the impact of prescribed fire on flora and fauna in the Casino District.

FLORA

Measures which will mitigate the impacts of prescribed fire on flora are:

- Exclusion of hazard reduction burning from flora reserves except Needlebark Flora Reserve.
- Exclusion of fire from all rainforest types.
- Increasing the time between burns in specifically identified dry hardwood forests, without significantly impacting meeting of the objectives in Section 2 of this Fuel Management Plan.
- Identification of other flora communities requiring specific fire prescriptions, as more information becomes available through research.
- Maintenance of a wide range of burning frequencies in all forest types while meeting the objectives listed in Section 2 of this plan.

FAUNA

BIRDS

Measures which will mitigate impacts of prescribed fire on birds are:

- Active management of fuel levels to ensure a mosaic of fire regimes occurs, with emphasis on reduction of fire frequency to less than one in 15 years in gullies and unburnt sheltered south-east aspects.
- Strict regulation and enforcement of grazier burning. Extension work will be undertaken to increase graziers' acceptance and use of the permit system. In cases where there is continued non-compliance with burning permit conditions on a particular OP, the OP may be cancelled and the area offered to other permit holders.
- Maintenance of a patchwork of fuel reduction burns, of varying frequencies in dry forest, benefiting the persistence of *Allocasuarina* species feed trees, which may otherwise be destroyed by wildfires.
- Implementation of a non-burning zone for a radius of 250 m around known Rufous Scrub Bird sites (timber harvesting is already excluded).
- Use of the zoning system and a mosaic of fire regimes, resulting in long-term protection of riparian vegetation.

REPTILES

Measures which will mitigate impacts of prescribed fire on reptiles are:

- Retention of large logs on the forest floor where practicable.
- Protection of riparian vegetation to act as recolonisation sources for moist, shade tolerant species after harvesting and/or burning.
- Leave for natural regeneration and exclude top disposal burning following logging, in those compartments where regeneration will be adequate and fuel loads do not increase wildfire risk.
- Continue to keep felled heads and butts away from fallen, large old-growth trees, where practicable.
- Strict regulation and enforcement of grazier burning. Extension work will be undertaken to increase graziers' acceptance and use of the permit system. In cases where there is continued non-compliance with burning permit conditions on a particular OP, the OP may be cancelled and the area offered to other permit holders.
- Use of the zoning system, focusing frequent and moderate control burning on strategic locations for hazard reduction.

AMPHIBIANS

The most significant measures which will mitigate impacts of prescribed fire on amphibians are:

- Exclusion of grazing and burning from selected areas of swamp and ephemeral wetlands, to allow monitoring of the effects of these disturbances on important amphibian habitats.
- Use of the zoning system, focusing frequent and moderate control burning on strategic locations for hazard reduction.

NON-FLYING MAMMALS

Measures which will mitigate impacts of prescribed fire on non-flying mammals are:

- Active management of fuel levels to ensure a mosaic of fire regimes occurs, with emphasis on reduction of fire frequency to less than one in 15 years in gullies and unburnt sheltered south-east aspects.
- Leave for natural regeneration and exclude top disposal burning following logging, in those compartments where regeneration will be adequate and fuel loads do not increase wildfire risk.
- Strict regulation and enforcement of grazier burning. Extension work will be undertaken to increase graziers' acceptance and use of the permit system. In cases where there is continued non-compliance with burning permit conditions on a particular OP, the OP may be cancelled and the area offered to other permit holders.
- Use of the zoning system, focusing frequent and moderate control burning on strategic locations for hazard reduction.

BATS

Measures which will mitigate impacts of prescribed fire on bats are:

- Active management of fuel levels to ensure a mosaic of fire regimes occurs, with emphasis on reduction of fire frequency to less than one in 15 years in gullies and unburnt sheltered south-east aspects.
- Leave for natural regeneration and exclude top disposal burning following logging, in those compartments where regeneration will be adequate and fuel loads do not increase wildfire risk.
- Strict regulation and enforcement of grazier burning. Extension work will be undertaken to increase graziers' acceptance and use of the permit system. In cases where there is continued non-compliance with burning permit conditions on a particular OP, the OP may be cancelled and the area offered to other permit holders.
- Protection of large winter flowering Banksias from logging and fire, where practicable, by instructing logging contractors to avoid damaging mature (greater than 2m high) Banksias during felling and snigging operations. State Forests staff will avoid top disposal burns close to mature Banksias.

GRAZING AND ASSOCIATED PRESCRIBED FIRE

Measures which will mitigate the impacts of grazing and associated prescribed fire are:

- Active management of fuel levels to ensure a mosaic of fire regimes occurs, with emphasis on reduction of fire frequency to less than one in 15 years in gullies and unburnt sheltered south-east aspects.
- Exclusion of grazing and burning from selected areas of swamp and ephemeral wetlands, to allow monitoring of the effects of these disturbances on important amphibian habitats.
- Strict regulation and enforcement of grazier burning. Extension work will be undertaken to increase graziers' acceptance and use of the permit system. In cases where there is continued non-compliance with burning permit conditions on a particular OP, the OP may be cancelled and the area offered to other permit holders.
- Grazing and burning will be excluded from representative areas of State forest to allow the effects of exclusion to be monitored.
- Communities poorly or inadequately conserved under the Hager and Benson (1984) criteria have been reserved and zoned in the ecological management burning zone. Hazard reduction burning guidelines for these areas will be developed. Grazing will be phased out in these areas, should they be permanently reserved, following a total land tenure review of conservation adequacy status.
- Grazing is excluded from flora reserves.