

# ***Towards Adaptive Forest Management in the Bateman Bioregion***

***DRAFT RESEARCH PAPER for PUBLIC COMMENT***

Robert Bertram  
Forest Ecologist  
for the Friends of the Five Forests

[bertram.r@acr.net.au](mailto:bertram.r@acr.net.au)

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## **Introduction**

The first step in 'active' Adaptive Forest Management is to assess and define the spatial and temporal scale of the management problem and the factors to be considered (Nyberg 1999). In doing so both knowable and unknowable uncertainties with regard to science and policy, require consideration (Bormann and Kiester 2004).

The Bateman sub-Bioregion forms part of the South East Corner Bioregion considered by the CSIRO to be a 'pressure point' for development (CSIRO 1992). In New South Wales the Bateman Bioregion extends along the coast from Ulladulla in the north to the Victorian border, encompassing the Eurobodalla and Bega Local Government Areas and the Southern and Eden Forest Management Areas.

Soil erosion and its related effects have been described as the '*... single most significant issue affecting the Far South Coast*' (Tulau, 1997). The major issues of concern are forestry, fire management, stream bank erosion, sedimentation, and the management of water bodies and coastal estuaries (Crowe 1992). The Bioregion has generally poor soils which, because of the antiquity of the geologies (rocks) on which they have evolved, lack inherent fertility (Tulau 1997).

By the 1860s most of the agricultural land on the south coast had been cleared, although Koala numbers were considered to be high, even supporting an export trade in Koala skins in the early 1900's (Tulau 1997). A rapid decline in Koala numbers is reported to have occurred between 1905 and 1909 when they looked '*... sick and dejected in the trees before they were found in hundreds at the foot of trees.*' (Lunney & Leary 1988). The Koalas' only habitat was then the previously less fertile 'commercial forests' that contained suitable eucalyptus species. .

Other populations of native species also had their numbers dramatically reduced and several have become either locally or regionally extinct (Lunney and Leary, 1988) as a result of habitat destruction, feral predators, hunting etc. Some of these species (e.g. potoroos, bettongs and bandicoots) play a critical role in maintaining the interrelationships between flora and fauna that are essential for the health of forest ecosystems (Commonwealth of Australia, 1992, NPWS, 2000).

Due to the reduced density and diversity of fauna species, the materials required to maintain soil fertility and structural integrity are also reduced. As a consequence, the potential for soils in forested areas to erode and disperse increased, leading to the massive loss of soil from forested lands in the Murrumbidgee and Cuttagee catchments over the last 30-40 years, (CSIRO, 1999). By this time (1950-60), the erosion of streambanks on agricultural land had reached its maximum extent (Healthy Rivers Commission, 2000).

In response to a perceived decline in forest vigour, the NSW Forestry Commission (now trading as Forests NSW) convinced Governments that clear-felling was the way to produce a 'new forest' of sawlogs. The first large clear-felling trial in the region was undertaken during the early 1960's in Wapengo Catchment in the Five Forests.

By the late 1960s Harris Daishowa (now trading as South East Fibre Exports) provided a market for most of the trees cut, and clear-fell logging or 'integrated harvesting' continues to this day. Integrated logging removes the bulk of the trees including those ". . . *too small a diameter or too young in age to saw*" (Smith 2000). The intention of management is to reset the 'stand age' to zero by converting, over a 40-year period, all old growth forest to regrowth forest (Forestry Commission 1982). In early 1998, the first recorded broad area dry weather or drought associated eucalyptus dieback (DAD) occurred throughout forests in the Bioregion (Bertram 2001-ongoing). This unprecedented dieback was followed by another more severe event in 2002-03 (Bertram 2001-ongoing, Jurskis 2004a).

In the next year (1999), the NSW Forestry Commission's operations were approved for 20 years under the Integrated Forestry Operations Approval (IFOA) (Refshauge et al. 1999).

Also in 1999, the Murrumbidgee/Bungala Koala Recovery and Riparian restoration project received funding from the Natural Heritage Trust to implement alternative forest management practises including a 'protected area' in the Murrumbidgee Catchment.

In 2001, the remaining Five Forests Koalas were nominated as an Endangered Population on Part 2 of Schedule 1 of the New South Wales Threatened Species Conservation Act (1995), and the NSW Scientific Committee have prevaricated on the nomination ever since.

### **The Five Forests - Cuttagee Catchment**

Cuttagee catchment is located centrally in the Five Forests and includes about 4,800 hectares of public forest. The majority of this forest was logged over the 13 years between 1982 and 1995 (Table 1). The NSW Forestry Commission's Environmental Impact Statement (1994) indicates that all compartments in Cuttagee catchment, like the rest of the region, had been at least half logged by that time.

The approximate area of unlogged public forest (about 1800 hectares) in Cuttagee Catchment may be an over-estimation of the actual unlogged area because the areas listed only reflect 'integrated' logging operations. In many cases, the exact

areas logged are not well-mapped and intensive sawlog and sleeper-cutting operations were also happening in some compartments up until the early 1990's.

Areas considered by Forests NSW to be suitable for thinning in Cuttagee catchment are located in three compartments, 2050, 2056 and 2057. These areas are suggested to be regrowth from a wildfire in 1952, although Forests NSW apparently has no records of this fire (SFNSW 1994, Smith 2000). Forests NSW Acting Southern Regional manager (Bega District News 27 May 2005), Steve Dodds, talking about the areas proposed for integrated logging in Murrah State Forest suggested, ' . . . *much of the current stand dates from this fire event* '.

There is a fifty metre 'fauna and flora' corridor each side of Cuttagee Creek that extends for the length of the catchment and another shorter 'corridor' that traverses the catchment. The main corridor connects to narrower 'filter strips' along mapped watercourses in sub-catchments running into the creek. These areas are supposed to be retained during logging operations to limit the amount of sediment entering waterways. However, by the early 1990s, the post logging spread of eucalyptus dieback in these areas pointed to a spatial connection with the gross disturbance logging creates.

In response to community concerns about dieback in the Five Forests, Forests NSW claimed it was 'ridiculous' to suggest that their management was implicated in the spread of Bell-miners (SFNSW 1995). Bell-miner Associated Dieback (BMAD) is now recognised as a major national problem in coastal forests from Brisbane to Melbourne and has been identified in every catchment of the Five Forests (Bertram 2001-ongoing, Jurskis and Turner 2002).

As a result of forest ecosystems being used as a surrogate for biodiversity (Forests NSW 2005), approximately 2,200 hectares of the catchment, compartments, to the north of Cuttagee Creek and at the top of the catchment, were included in the newly proclaimed Biamanga National Park in 1999. No consideration was given to maintaining viable populations of native species.

On 22 May 2005, the NSW Forestry Commission erected a map restricting entry to 920 hectares of Cuttagee catchment. The description indicated the 'restricted forest area' was Cpt. 2032 and a logging crew moved in. A week later and after Forests NSW had assaulted one and arrested two other local residents opposed to their management, the logging crew decided to move out of Murrah State Forest.

There are two data sets related to logging in the catchment (Table1). The first is the information Forests NSW provided to the Bureau of Resource Sciences (Commonwealth Government, 1996) for the Eden CRA process. This information was required to determine the remaining timber resource in the Eden Region. Forests NSW attributed broad confidence limits (30% either way) to the data, but this was sufficient for the Commonwealth and State Governments to approve 20-year wood supply agreements.

The second data set was provided by Forests NSW (Smith, 2000) to the Cuttagee Creek Catchment Project, an honours project undertaken by Emily Young (ADFA, Canberra). The discrepancy between the two areas logged is 687 hectares, which

could represent habitat for several Koalas and is somewhat more than all the unlogged coupes thought to be remaining and proposed by Forests NSW for logging in Cuttagee catchment. That is, the generous confidence limit of 30% applied by Forests NSW appears to have already stretched before including substantial inaccuracies in wood resource estimates.

**Table 1. Hectares logged by year in public forest of Cuttagee Catchment**

BRS (1996)		SFNSW (2000)	
Year Logged	Total hectares	Year	Gross Area (ha)
1982	476	1982/83	508.9
1983	115	1983/84	121.5
1984	235	1984/85	503.6
1985	312	1985/86	210.8
1986	250	1986/87	320
1988	433	1987/88	63
1989	113	1988/89	280.7
1993	107	1990/91	75.3
1995	194	1992/93	47
		1993/94	169.7
		1994/95	120.1
		1995/96	501
Total	2235		2921.6

### **Description of Proposal**

Forests NSW have begun building roads in and logging the remaining critical Koala habitat in Compartments 2032 and 2035. These compartments occupy approximately 11% of the public forested land in Cuttagee Catchment. The coupes proposed for logging (142 hectares) represent approximately 8% of the remaining Koala habitat in the catchment and over 25% of that remaining in 'production forest' in the catchment. Both of these Compartments were half logged in the 1980's and determined to be part of the 'Least Sensitive Area' (LSA) and available for logging ten years later (SFNSW, 1994).

Compartment 2035 was logged most recently in 1995 as part of the LSA. At that time Coupes 2, 3 and 4 were Coupe 2. Coupe 4 was created as a result of a Koala being located in a tree by a logger prior to felling and toward the completion of logging the compartment. As a consequence, Forests NSW decided not to log the remaining thin, 18 hectare strip, in the middle of Coupe 2, now approved for logging. Seventeen sites with koala faecal pellets were located during Community Koala surveys in Cpt. 2035 after the logging and burning operations in 1997 (Bertram 2001- ongoing).

As chance would have it, a Koala was also located by Forests NSW in Cpt. 2032, next on the Plan of Operations (PoO) at the time and to protect them, the Murrah/Mumbulla Residents Group had to take legal action and were successful against the NPWS, stopping them from issuing a 'Take or Kill' Koala licence. There

have been no other Koalas located during the last ten years of logging in other parts of the Bioregion.

The figures in Table 2 provide the gross and net area excluding rainforest, slopes steeper than 30 degrees and 'filter strips' along mapped watercourses, where logging used to be excluded (BRS 1996). The Logging Area in the table is that indicated in the Harvesting Plan for Cpts 2032 and 2035 (Forests NSW 2005).

The exact location of State Forest compartment boundaries is clouded by the overlap of compartment boundaries with what the publicly-available maps indicate to be National Park boundaries. The 'overlap' of compartment boundaries means that the gross area includes roads and logging exclusion areas that are 'shared' between compartments.

**Table 2. Area Description Compartments 2032 & 2035**

(data from BRS 1996, Forests NSW 2005)

Compartment 2032: Gross area of Compartment; 248 hectares				
		Gross Area	Net Area	Logging area
Coupe	1	124.2		
	3	62.4	55.8	51.4
	4	61.4	48.2	52.7
Compartment 2035: Gross area of Compartment; 267 hectares				
		Gross Area	Net Area	Logging area
Coupe	1	143.9		
	2	53.7	48.2	
	3	50.7	45.1	
	4	18.6	16.6	18.6

According to the BDRR (1991), there were 248 hectares of unlogged coupes in the compartments, yet the Logging Plan has no information on the outcomes of previous integrated logging in the Compartments or the catchment. Similarly, the negative impacts on Koalas at a local level, and in terms of avoiding species extinction, are not considered. The minimal areas retained during logging are expected to perform many functions into the future, although the gross area of Coupe 4 (18.6 ha) in Cpt 2035 is proposed for logging. This anomaly provides an example of how logging activities may be approved outside the 'net area' notionally available for logging.

## **Geology**

Upper Devonian Merrimbula Group sediments are the parent materials for Yellow Pinch Soils (Tulau, 1997). These sandstones, shales and conglomerates occur from Ulladulla to near Murrumbidgee (ibid) and are present in the western half of Cpt 2035 and much of the western and northern area of Cpt 2032.

Adaminaby Group Ordovician meta-sediments are present in the eastern half of Cpt 2035 and the south-eastern corner of Cpt 2032. Ordovician meta-sediments, parent

materials of the Murrah soil landscape, are the oldest rocks in the Five Forests. Despite their age, these rocks are among those with the highest nutrient status in the southeast forests (Kelly & Turner, 1978).

Release of the nutrients in these soils occurs through the action of macro- and micro-biological processes, particularly insects and fungi, which can be either improved or inhibited by management (Tulau 1997). Logging and burning disrupts and, in heavily disturbed areas, completely destroys these processes. The geology of areas previously logged and those proposed to be logged, are indicated below (Table 3).

Ordovician meta-sediments are highly prone to erosion and mass movement (landslides and slumping) (Gunn 1978), and the potential for mass movement in any particular area is assessed on an array of information including forest structure and soil cover (Tulau 1997). The Environment Protection License (Schedule 3, Step 1 Consideration of Existing Information) states Forests NSW must consider all relevant information with regard to actual and potential mass movement, yet no further information is provided on the claim that there is 'nil' potential for mass movement (Forests NSW 2005).

**Table 3. Geology of Logged and Unlogged coupes in Cpts. 2032 & 2035**

Geology	To be logged	1982	1985	1995	Total
Adaminaby Group	35.4	46.6	45.1	91.7	218.8
Merrimbula Group	107.0	77.6	98.8	12.6	296.0
Total hectares	142.4	124.2	143.9	104.4	514.9

For the purposes of the IFOAs, soil fertility was based on geology, and the dominant Merrimbula Group rocks in the Compartments are considered to have a 'high quartz' content and 'low fertility'. The Adaminaby Group sediments are considered to be 'low quartz' and slightly more fertile, although both geologies are highly variable, and there is much evidence to demonstrate that most trees require soil for growth.

Irrespective of this evidence, all tree growth models, employed during and since the IFOAs in NSW, use an estimate of the nutrients in rocks as a surrogate for soil fertility.

## **Soils**

Soils in the Compartments form part of the erosional Yellow Pinch and Murrah Soil Landscapes (Tulau, 1997). These soils share some physical limitations including low-weight bearing strength, stoniness, dispersion, sodicity and low to very low Cation Exchange Capacities that limit nutrient availability to plants.

Over the past decade, evidence of Koalas (faecal pellets) has only been located in forests growing on the Murrah Soil Landscape, which makes up approximately 45% or 38,000 hectares of the Five Forests.

**Table 4. Soils by Log year Compartment 2032**

Soil Landscape	Year Logged		Total
	0	1982	
Murrah	49.9	41.0	90.9
muc	1.9	0.5	2.4
Yellow Pinch	65.1	80.2	145.3
ypd	6.9	2.6	9.5
Total Hectares	123.8	124.2	248.1

**Table 5. Soils by Log year Compartment 2035**

Soil landscape	Year Logged			Total
	0	1985	1995	
Murrah	7.5	2.0	43.2	52.6
Yellow Pinch	11.1	135.1	61.2	207.4
ypd		6.8		6.8
Total	18.6	143.9	104.4	266.8

Sodic soils are invariably dispersible, yet the DIPNR employee seconded from DIPNR to Forests NSW, rarely locates dispersible soils using the EPA approved test, and the IFOA does not require the use of laboratory test results. Forests NSW's logging plans for 150 Compartments, collected by south coast community groups over the past decade, indicate that dispersible soils were located on only two occasions.

Despite the fact that all the soils indicated in the tables above are known to be dispersible (Tulau 1997), for the purposes of logging they are all non-dispersible. In the event dispersible soils are located in a logging area, the EPA's Environment Protection License requires gravel to be placed either side of stream crossings.

It has been suggested that “. . . *In addition to salt, a 1993 study listed 13 types of insects, five types of fungi, five kinds of vertebrate animals, four climate perturbations and a parasitic plant that had been implicated as major agents of dieback in south-eastern Australia.* (Jurskis and Turner 2002)

Missing from the list is sodium, that is, salt without the chloride. The problem of soil sodicity covers a far greater area of NSW than salt-affected land (CRC for Soil and Land Management 1999). The distribution of sodic soils on the east coast appears to coincide with the areas where Bell-miners have established themselves.

In 1994 the Murrah/Mumbulla Residents Group engaged a soil chemist to undertake chemical and physical analysis of soils in the area. A total of 11 sites were sampled

with 84 samples retained for laboratory examination from private and public land on the southern side of the lower Murrumbidgee River (Ian Little, 1994).

Little (op cit) found that sodium increased with depth at most soil sampling sites and, although all soils were dispersible, dispersion potential increased with increasing sodium. Little also found that Calcium, known to be deficient in most forest soils and the only element depleted after logging and burning (Turner and Lambert 1986), is the most significant soil material countering sodium's tendency to disperse clay aggregates. The reduction of Calcium into soils and the consequent reduction in soil fertility are a direct consequence of management practices that alter the habitat of native species thus reducing fauna diversity and abundance. (Parker and Chatres 1983, Aztiwill and Leeper 1987).

As a retained consultant, Little represented community interests at a meeting in 1995 with the EPA, Forestry Commission etc., where he proposed pre-logging tests for the Exchangeable Sodium Percentage (ESP) of soils, the key indicator for soil erosion and dispersion potential. Even though testing for ESP would have provided a basis for Government claims to 'scientific credibility', this proposal was rejected by Forests NSW in favour of the current subjective technique that continued with the implementation of the IFOA.

Ordovician meta-sediments are highly prone to sheet erosion and erosion from concentrated surface water (Hortonian) flows (Tulau 1997). The very gravelly nature of the soils has previously been thought to indicate a low erosion risk, if the soils are exposed, due to a perceived "armouring" effect from the stone content.

Despite this, the consultant found water, which travels around or over rock, would readily enter these gravelly soils without apparently causing erosion. The combination of 'uncontrolled' water in soils with high ESP coupled with low Calcium, breaks down clay aggregates that, along with the silty fines in the subsoil, readily disperse, so that any water discharged from the soils carries a heavy sediment load. This process leads to general landscape degradation, as the soil water holding capacity is reduced on slopes and ridges, creating conditions conducive to the onset of dieback.

On the other hand, it appears that Forests NSW believes all eucalyptus dieback results from too much nutrient (Nitrogen) and too much moisture in areas with 'poor drainage' (Jurskis and Turner 2002). Part of the theory of 'too much water' is consistent with reduced upslope soil water holding capacity, particularly after logging, increasing soil moisture and the spread of BMAD downslope in gullies and along streams in the Five Forests.

However, studies on the interactions between fish, bears and forests in British Columbia, have confirmed that a reduction in these biological activities has reduced nutrient (Nitrogen) inputs into soils. As a consequence tree growth rates have reduced in areas known to have previously had greater species density (Reimchen 2001)

On the Periodic Table of Elements, Nitrogen is classified as a non-metal and makes up some 78% of the earth's atmosphere, unlike soil materials such as Sodium and

Calcium that are metals, although all are considered critical elements for life on earth (Farndon 1999). It is perhaps because concerns about soils are 'taken care of' by the Environment Protection License that Forests NSW focuses their dieback research away from soil's physical and chemical properties.

### **Soils Under Current Management in the Five Forests**

In the last round of logging in the Five Forests, a rubber-tired log-snigger was used to extract timber, a method with much lighter local impact than recent logging, where three steel-tracked machines are employed. The resulting roads cut deep into the soil and form wide channels with soils pulverized into deep fine dust with rock fragments. At the postponement of logging in Cpt. 2032, a bulldozer was used to gouge even deeper holes, the soil from which has been pushed up with the dust and stones, logs and bark and heaped into mounds across the roads known as cross-banks.

These 'mounds', and many others from 'blading-off' snig and extraction tracks, are randomly placed throughout the logged area and pushed into exclusion areas. These soils are unlikely to ever support vegetation and will continue to provide a significant source of water pollution for many years. The cross-banks on roads are a condition of the Environment Protection License, although the 'blading-off' is not allowed. Both practices appear to represent examples of how demonstrably inappropriate land management methods are both condoned and encouraged by government agencies. Similarly much of the bark has been stockpiled instead of being spread over exposed soils.

During the planning stage for logging operations, Forests NSW are supposed to identify any 'unmapped' exclusion areas, particularly slopes steeper than 30°. To the east of a large cleared and heavily disturbed area (approx 1 ha.) around log dump B in Cpt 2032, the 50 metre 'buffer' adjacent to Cuttagee Creek, contains several areas where slopes are very steep (>30°).

In this location, down-slope snigging has been used. Soil disturbance is evident down to the buffer and tree heads have been pushed over the 'buffer' boundary. The steepness of slopes adjacent to waterways reduces the horizontal distance from the waterway, and the EPL specifies a measurement along the ground that doesn't account for slope. In the case of an 80° slope a fifty metre buffer provides for a horizontal distance of 8 metres to the creek. For a 30° slope the horizontal distance is 43 metres; the steeper the slope, the less water retention up-slope, due to thinner soils and the greater velocity of runoff in peak rainfall events. Clearly a more effective (deeper) buffer depends on the flatness of the land.

The Logging Plans for Cpts 2035 and 2032 (1995, 2005) all claim there are 'nil' dispersible soils. In 1995 soil dispersion was 'determined from field inspection' and in 2005 the EPL test was employed by the same person and produced the same result. However, this outcome is inconsistent with the most comprehensive soils information available for the Five Forests (Little 1994). The soil landscape data (Tulau 1997) and the negative impacts on the environment (BMAD, DAD) are the

same in both areas. It is clear that the FNSW conclusion of 'nil' soil dispersion in these Cpts is incorrect.

In 1995 the soils in Cpt. 2032 were described thus " . . . *The nutrient status and water holding capacity is generally low*", although there is no reference to these limitations in the latest (2005) logging plans.

Post-logging burning exposes any soils not disturbed during the logging operations, and the whole soil environment is effectively exposed and disturbed (Tulau 1997).

Despite the passage of time, the available credible soil science remains largely ignored by land management agencies. As a consequence, the concept that soils are 'a fundamental and integral part of an ecosystem' (Tulau 1997) is not a management consideration. Forest management for timber production under the IFOA has encouraged maximising soil disturbance without consideration of the negative impacts of past and, therefore, current management.

### **Forest Condition, Dieback and Silviculture**

Silviculture is the science of growing forest trees and, in the Eden Region, most commercial forest ecosystems are managed in the same way, by intensive logging/clear felling with post-logging burning some 12 to 18 months later and then abandonment (NSW Forestry Commission 1982, Refshauge et al 1999). In the Five Forests, Silver-top Ash (*E.sieberi*) is the only eucalypt that has adapted to the soil conditions produced after intensive logging (Bridges 1982).

Integrated logging maximises ground disturbance (Smith 2000), which in turn provides the hard-setting soil surfaces suitable for Silvertop-Ash, now the most common and prolific eucalyptus species in the Eden region (Keith and Bedward 1999), or non-eucalyptus species like Forest Oak (*Allocasuarina littoralis*). This outcome is not consistent with the Objects of the Forestry Act (1a,b & c, 1916) and is very different to outcomes achieved by selective methods of harvesting (Smith 2000).

The general condition of most living trees in these and surrounding compartments ranges from fair to very poor, and the significant number of dead trees would seem to demonstrate that any benefit from 'generic forest improvement' is far from being realised. There is significant dieback on ridges and slopes, particularly of regrowth Silver-top Ash, and Bell-miners occupy gullies in most compartments.

Some of the contention, about the reasons behind eucalyptus decline, stems from disagreement about how different fauna species utilize eucalyptus trees and how this use relates to tree health and soil conditions. A review of literature has recently been undertaken which revealed research that found trees under stress are more likely to be attractive to sap-sucking insects than to leaf-chewing insects (Wardell-Johnston and Lynch 2005).

Before European occupation, forests, subsequently cleared for agriculture, would have provided for vigorous plant growth that supported dense populations of leaf-

chewing insects and marsupial herbivores, particularly Koalas but also most other species (Lunney and Leary 1988). BMAD is associated with increases in naturally occurring sap-sucking psyllids, however, Jurskis and Turner (2002) suggest that the increased shelter from predators and weather extremes in dense understoreys may increase the reproductive vigour of Koala populations. They suggest “ . . . *The highest activity level (Phillips et al 1996) detected from survey of more than 100 sites in the Bega Valley Shire occurred at a site affected by mesic dieback (C. Allen pers comm.).* No data was provided and at a recent public meeting at the Murrah Hall the NPWS Koala Recovery Worker, Mr. Chris Allen, suggested that ridges may be the most important location for Koalas. Community surveys in the Five Forests found there was no significant difference in the use of topographic positions be they ridges, slopes or gullies and no use of areas subject to BMAD (Bertram 2001-ongoing).

Similarly there is little evidence to support the notion that current silviculture results in vigorous regrowth of all species removed during logging. Part of this confusion may stem from Forests NSW's unique system of 'Forest Types' (Anon 1989), as used by Jurskis and Turner (2002) and in Harvesting Plans that are based purely on anecdotal evidence rather than comprehensive survey results.

Pre-logging flora surveys for Compartment 2181 (SFNSW 1994) in the Murrah Catchment indicate the “ . . . *Main co-dominant species Silvertop Ash (E. sieberi) White (E. globoidea), and Yellow (E. muelleriana) Stringybarks occur with minor species Woollybutt (E.longifolia), Coast Grey Box (E.bosistoana) and Red Ironbark on ridges and side slopes and Mountain Grey Gum (E. cypellocarpa) and River Peppermint (E. elata) in gullies.*”

Visual observations of BMAD in this compartment several years after logging, roading and burning, noted that the Koala secondary feed tree species, Woollybutt and Coast Grey Box, retained during logging because they were unsuitable for pulp, were affected by BMAD after logging (Jurskis and Turner, 2002). Previously a mixed species forest, after logging, the species with 'minor occurrence' became the 'Woollybutt Forest Type' (Anon 1989), a natural consequence of leaving Woollybutts and taking everything else. Unfortunately Forests NSW still does not record the species they log and a condition of approval for Forests NSW EIS (1994) that 'Forest Types' be replaced with plant community descriptions (DUAP 1995), has not been adopted.

At this location the post-logging spread of BMAD was observed by the adjacent private landholder (H. Stone, pers.comm.). This observation is consistent with surveys of Bell-miner colonies undertaken in the Murrah and Brockeloes catchments (Bertram 2001-ongoing), which found BMAD affected both the immediate area and the downstream riparian forest after logging, roading and burning.

Before logging, the most active Bell-miner populations were located in Cpt. 2035, notably coupes 2 and 3, logged in 1995 (pers.obs). BMAD is also evident further upstream where Nutleys Creek Road crosses Cuttagee Creek in Biamanga NP. In this location the adjacent Compartments are 2028, logged in 1993 and Cpts 2029 and 2030, logged in 1995. In this case BMAD stops where a small sub-catchment enters Cuttagee Creek below the Nutleys Creek Rd stream-crossing.

Based on experience in areas of the Five Forests with similar soil, flora, forest structure and topography, the current and proposed logging operations are likely to extend the area of BMAD, particularly in the creek-side 'fauna habitat corridor', and has the potential to link current Bell-miner populations along an extensive length of Cuttagee Creek in Baimanga NP and Murrah State Forest.

Within 6 months of logging during 1994 in Knights Creek Catchment (Cpt 2167), Bell-miners had occupied riparian forest along 2.5 kilometres of the creek through Mumbulla State Forest and three private properties, stopping at the entrance of the next undisturbed downstream sub-catchment on the Murrah River. These forests are still supporting high Bell-miner numbers but are generally heavily degraded, and many trees have died.

In Brockeloes catchment, BMAD extended for most of the length of the catchment after logging in 1994, according to the landholder (G Butson pers comm.), stopping where a small sub-catchment enters the creek just east of the Tathra Bermagui Rd (Jurskis and Turner, 2002). In 2004 a 'fuel hazard reduction' burn on private property went out of control and after a few weeks had burnt out much of the headwaters of the Catchment, including BMAD affected areas in most recently logged coupes. Bell-miners are still in control of the areas they occupied before the fire.

An area of nearly '100% Silver-top Ash regrowth from past sawlog operations in the 1960s and 1970s' (SFNSW 1995) has been retained during logging in Cpt 2032. The largest live trees in this stand are generally no greater than 150mm Diameter at Breast Height (DBH) and are heavily stressed with dead tops and coppice growth on the trunks. This would seem to be the fate of future regrowth, should it get that far. This growth in some 40 –45 years contrasts with Maidens Gum (*E.maidenii*) with a DBH of 350mm after 10 years and the endangered Forest Red Gum (*E.tereticornis*) with a DBH 100mm after 5 years growing in (currently) suitable conditions in the adjacent Murrah River catchment.

There is a strong argument that the general public and the environment receive no benefit from operations that are known to change conditions such that they become unsuitable for tree growth (Stone 2001 cited Wardell-Johnson & Lynch 2005) and degrade both the immediate and downstream environment. Evidence from northern NSW supports observations on the south coast that while some species, like Coastal Mahogany (*E. botryoides*) on the south coast, maybe initially be resistant to BMAD in some areas, they, too, eventually succumb.

In the Five Forests, Community Surveys for Koalas found they were most closely associated with Coastal Foothills Dry Shrub Forest (Map Unit 32) and Coastal Gully Shrub Forest (Map Unit 34) (Keith and Bedward 1999) growing on the Murrah Soil Landscape (Tulau 1997). These assemblages account for approximately 50% or 30,000 hectares of remnant forest in the Five Forests.

**Table 6. Floristic assemblages by year logged Cpt. 2032**

Floristic Assemblage	Year Logged		
	0	1982	Total
Coastal Dry Shrub Forest	12.4	5.4	17.8
Coastal Foothills Dry Shrub Forest	70.1	81.1	151.2
Coastal Gully Shrub Forest	8.4	14.5	22.9
Coastal Warm Temperate RF	0.2	0.0	0.2
Eden Dry Shrub Forest	30.8	23.2	53.9
Lowland Dry Shrub Forest		0.1	0.1
Mumbulla Dry Shrub Forest	1.9		1.9
Total Hectares	123.8	124.2	248.1

**Table 7. Floristic assemblages by year logged Cpt. 2035**

Floristic Assemblage	Year Logged			Total
	0	1985	1995	
Coastal Dry Shrub Forest		6.6	0.1	6.7
Coastal Foothills Dry Shrub Forest	7.6	73.4	65.5	146.5
Coastal Gully Shrub Forest	10.8	24.5	32.5	67.8
Coastal Warm Temperate RF		0.8		0.8
Eden Dry Shrub Forest		36.7	5.0	41.7
Lowland Dry Shrub Forest	0.2	0.1	1.3	1.5
Mumbulla Dry Shrub Forest		1.9		1.9
Total hectares	18.6	143.9	104.4	266.8

In summary, the loss of Koala habitat as a direct result of logging in these Compartments and Cuttagee Catchment, is compounded and extended by BMAD and DAD. The spatial and temporal effects of BMAD, and the ongoing impact on forests of DAD, render all floristic assemblages, both in logged areas and down streams, vulnerable to current and proposed management practices.

The 'regrowth' forest that now dominates the Five Forests generally and Cuttagee Catchment in particular, requires management that is responsive to changed forest structure and species diversity. Forest management needs to work toward re-establishing forest conditions that are conducive to a recovery of Koalas.

## **Water**

Trees pump water from their roots to their leaves, thereby controlling and slowing the flow of water through the soil by countering the effects of gravity. When trees are removed or die, they no longer perform this function, thus logging large areas has a significant impact on surface and sub-surface hydrological regimes.

From aerial photography taken in 1994, the former south-coast Total Catchment Management committee mapped degraded land within the Bega catchment system (DLWC, 1997). The types of land degradation identified in the Murrumbidgee and Cuttagee Catchments were sheet and rill erosion, gully erosion, streambank erosion and areas of mass soil movement. All of these result from the impact of water on exposed soils.

Within SF tenure, significant areas of moderate to extreme sheet erosion (exposed soils) were identified in coupes logged between 1990 and 1992 in the lower Murrumbidgee River. In 1995/96 these compartments, covering two sub-catchments, were subject to integrated harvesting in the alternate (retained) coupes.

The assessment of erosion hazard (Dissmeyer and Foster, 1980) is derived with the Universal Soil Loss Equation (USLE) that incorporates several factors, to produce an estimate of potential soil loss in tonnes per hectare per year. The calculation can provide a broad indication of the vulnerability of land to erosion in any given area " . . . so that appropriate mitigation measures may be applied" (SFNSW 1995). The USLE is not suitable for estimating soil dispersion, erosion in gullies or stream-banks or mass movement.

$$A = R \times K \times S \times C \times P$$

Where-

A = Rate of soil loss in tonnes \ha \year

R = Rainfall erosive factor

K = (subjective) Estimate of soil erodibility

S = Factor combining Slope length and Steep-ness

C = Cover factor (based on 100% ground cover in 12 months)

P = Management Factor

The rainfall erosivity factor is derived from rainfall intensity data collected by weather stations where a pluviograph is installed. These machines measure rainfall intensity, that is, how much rain falls in a given time period. The closest rainfall recording stations to the Five Forests are at Araluan and Nowra. Records for the periods 1960 to 1970 (Araluan) and 1964 to 1984 (Nowra) were used to derive average rainfall intensity for the south coast (Rosewell and Turner 1992).

Rainfall intensity calculated for the 1994-1996 logging operations employed the equation

$$R = 89.3 \times i^1$$

Where i is the log normal rainfall intensity (8.4mm/h) read from the 2<sup>nd</sup> year, 12 hour intensity master chart from Australian Rainfall and Runoff.

Unfortunately, these estimates are based on average annual rainfall intensity and do not account for intensive rainfall events known to be responsible for most erosion. Indeed 'seasonality', or when intensive and prolonged rainfall is likely to fall, cannot be predicted on the far south coast, so the rainfall erosivity factor is based on the erosive potential of quite light rain or drizzle.

One of several intensive rainfall events in the lower Murrumbidgee River during the 1990's (3/3/97) produced a rainfall intensity factor nearly ten times greater (83 mm/hr) than the average rainfall factor. A rainfall simulator and erosion field day planned by the CSIRO (CRC for Catchment Hydrology 1999) for recently logged compartments was called off after this rainfall event. Most of the topsoil had eroded or dispersed leaving white quartz sand, all cross-banks failed and all drains had blocked.

The adjacent private landholder noticed the influx of Bell-miners and witnessed the rapid decline and death of most of the trees on the Murrah River adjacent to these sub-catchments over the next few years (S.Foulkes pers. comm. 2005).

These Compartments 2062 and 2063 were logged, roaded and burned in 1996. The Harvesting Plan for these compartments indicate soil loss estimates for slopes of 23° were:

$$A = 3549 \times 0.05 \times 5.343 \times 1 \times 0.157$$
$$A = 149 \text{ tonnes per hectare}$$

The following equation incorporates a rainfall factor more appropriate for the rainfall event and an S factor (Slope length and steepness) appropriate for part of the area logged.

$$A = 335596 \times 0.05 \times 9.429 \times 1 \times 0.157$$
$$A = 26,172 \text{ tonnes per hectare}$$

A suggested guide (SFNSW, 1995) for acceptable soil loss per hectare per annum for Australian soils is:

Very deep and fertile soils < 10 t/ha.a  
Moderately deep and fertile soils < 5 t/ha.a  
Shallow or infertile soils < 1 t/ha.a

Of course these factors only account for surface soil erosion and the evidence suggests that there has been a similar negative impact on dispersible sodic soils, reducing their water holding capacity on ridges and slopes. Where DAD is evident on ridges and slopes, as found in both compartments and throughout the Five Forests, it must be assumed that the cohesive properties of the clays in sub-soils have been reduced.

These areas are most likely to be subject to mass movement when, after a period of prolonged rainfall, sub-soils liquefy and can no longer support the weight of the soil and trees above them.

Similarly, increasingly moist sodic sub-soils at lower topographies, particularly after logging and burning, cannot be accounted for with the USLE. However, given the presence of Bell-miner colonies, is relatively easy to determine, it can be assumed that where these birds occur, the trees are under stress and in decline. As a consequence, the capacity of the tree roots to retain soils along stream banks, is reduced and, in conjunction with increased soil erosion and dispersion potential, will initiate increased gully and stream bank erosion.

There is significant sediment deposition where Nutleys Creek Road crosses Cuttagee Creek, and a large 'slug' of 'reworked' rock and gravel is located immediately upstream of the crossing in Biamanga NP. These eroded materials, along with other 'slugs' observed in Cuttagee Creek, will eventually make their way

downstream forming a 'plume' that will further expand the new 'delta' in Cuttagee Lake.

In 1999 revised maps for the Brogo area (LIC 2000) were produced indicating that all the 'permanent' pools in the Murrah River were filled with sediment. However, a map covering Murrah State Forest, recently provided by Forests NSW (2005) to a local landholder (L McFerrin, pers comm.) uses the old mapping layer, suggesting the pools remain, which they do not.

## **Fauna**

According to the Logging plan for Cpts 2032 and 2035, only Yellow-bellied Gliders were detected during pre-logging surveys, although crushed Forest Oak (*Allocasuarina litteralis*) cones were located, suggesting the previous presence of Glossy Black Cockatoos (Forests NSW 2005).

This result, when compared with previous surveys, lends support to the general observations of local residents, who have noticed a significant reduction in the numbers of most native species over the past decade (Table 8 below). This reduction is particularly evident with vocal nocturnal species like sugar gliders and the large forest owls, three species of which were recorded in the compartments during pre-logging surveys in 1995, but none of which were recorded in the 2005 pre-logging fauna surveys.

## **Koalas**

At a National level Koalas are not listed as threatened or vulnerable, although the US Department of the Interior has determined Koalas are threatened across their historic range (Fish and Wildlife Service 2000). The Australian Koala Foundation submitted a nomination to have Koalas listed as 'vulnerable' across their historic range under the Environment Protection and Biodiversity Act (1994) in 2004. The Endangered Population nomination for the Five Forests' Koalas under the Threatened Species Conservation Act (1995), has been before the NSW Scientific Committee since early 2001 (Bertram 2001-ongoing).

In his thesis, the 'Future Eaters' (Flannery 1994), provides a detailed and compelling argument on the interactions between humans and Australian flora and fauna. The arrival of Aborigines rapidly led to the extinction of the easily caught mega-fauna. Those species that remained were subject to heavy predation and most have reduced in size over the past 30,000 years.

Flannery cites a paper (Parris 1948) suggesting Koala numbers in the Goulburn area increased after European occupation between 1870-1890. In other areas, like East Gippsland, Koalas were frequently observed, and it is suggested that Aboriginal hunting kept Koala numbers low. The Murray Goulburn regions supported the highest density of Aborigines and it is possible that hunting kept Koala numbers permanently low. Under these circumstances it is also possible that Koalas from these areas did not carry Chlamydia, and some of these animals were translocated to form the original 'island' Koala populations.

Most natural populations including the Five Forests Koalas carry Chlamydia. Predisposing factors for the disease are possibly linked to nutritional and environmental stress (AKF 2004). When affected by the disease, Koalas' reproductive capacity is reduced. In the absence of this disease, translocated Koalas from island populations will breed until they consume all the available resources and die out. This outcome has led to perceptions that all Koalas cause eucalyptus dieback (Jurskis and Turner 2002).

Most notable in terms of the species apparently no longer residing in Cpts 2032-35 is the Koala. Reduced species diversity can be measured at a local level because Koalas were present during the last logging operations. However, their suggested absence could reflect the inadequacy of Forests NSW Koala survey techniques that aren't actually designed to find evidence of Koalas and do not consider habitat requirements for the species.

Forests NSW did claim (M. Linehan, ABC radio) that at least 50 preferred Koala feed trees would be retained per hectare during the operations. Regrettably this claim contrasts with the actual clear-felling which, in the area (>0.6 ha) logged near the unmapped stream crossings, has resulted in all secondary Koala feed species (Monkey Gum, Woollybutt) and most supplementary (White stringy-bark) either being cut down or pushed out of the ground.

Log dump D has been located in an area previously dominated by mature secondary feed species (Woollybutt, Coast grey Box) and supplementary (Yellow Stringy-bark) which have all been cut down or uprooted. In one instance a Stringy-bark has been uprooted and its head pushed into the head of a 'retained' Woollybutt.

According to the IFOA a minimum of ten preferred Koala feed trees per hectare have to be retained, although these are the same prescriptions employed in compartments logged in 1995, where there are no longer any Koalas.

Based on a notional 100 hectares for one Koala, the remaining 1,800 hectares of unlogged forest in Cuttagee catchment could, assuming habitat suitability, support 18 Koalas. The number of Koalas required for a potentially viable population, around 500 (Flannery 1994), would require 50,000 hectares of suitable forest.

However, because Koalas have only been located in association with the particular forest ecosystems growing on Murrah Soil type and most of their habitat has been heavily degraded, maintaining and improving forest structure and species diversity and maximising areas planted with primary koala feed trees should be priorities.

### **Other Species**

The only other native arboreal marsupial in the Bioregion that depends exclusively on eucalyptus leaves is the Greater Glider (*Petauroides volans*). There are only six records of Greater Gliders in the various fauna record databases for the Five Forests and all of these are on the southern side of the Murrah River. The most recent of these is in 1997, and the only other more recent record is fur from a dead animal also from the southern side of the Murrah River (Triggs, 2003 unpublished data).

The Greater Glider identified in Cpt 2032 (SFNWSW 1995) appears to be the one and only record of the species in Cuttagee Catchment, and the lack of this species implies reduced resources for this eucalyptus-dependent species. According to Forests NSW (EIS responses 1995) “ . . . *Much of the moist forest used by the Greater Glider is reserved in wildlife corridors and filter strips.*’

It is apparent that the results from pre-logging fauna surveys are not used to inform management to avoid deleterious changes to fauna diversity and abundance, which would seem to bring into question the purpose of the pre-logging flora and fauna surveys.

### **Bell Miners**

In the year 2000, surveys were undertaken in the lower Murrah and Brockeloes Catchments to establish the presence and map the distribution of Bell-miners. These surveys were undertaken as part of the Murrah/Bunga Koala Recovery and River Restoration Project funded by the Natural Heritage Trust (NHT).

The map was presented to the NHT project evaluation team in 2002, headed by the Southern Rivers Catchment Management Authority’s catchment officer. In the ‘team’s’ opinion such information was not required and identifying problems and developing solutions was not something the Project or the community should be involved in. The evaluation report was released to the Project proponents in late 2004 and it indicates no maps were produced.

The pre-logging surveys in Cpt. 2035 (SFNSW 1995) did not locate Bell-miners, yet now they occupy the coupes logged at that time and other bird species are excluded from these areas, further reducing forest cover and species diversity. Other Bell-miner colonies are located in areas logged in the early eighties and based on the frequency of ‘pings’ are now, 20 years after logging, ‘low density’ populations.

Pre-logging surveys for Bell-miners (pers. obs) in Cpt 2032 did not locate the species in a gully to the south of log dump D, but only ten days after the start of logging, Bell-miners had occupied the area. Newly established Bell-miner colonies are highly vocal, as they actively evict the resident, and repel any visiting, bird species, although given the low density and diversity of bird species observed in the compartments, this may not have taken much time.

It seems likely that changes to natural hydrology, as a result of logging, is the one process that could cause trees to become stressed in such a short period. The difference between suitable and unsuitable conditions for eucalyptus is likely to be reflected in the species they sustain, although not all forests can sustain Bell-miners or Koalas.

Perhaps coincidentally the 10 records for Koalas match the number of Yellow-bellied Glider records. However, Yellow-bellied Gliders have a much more varied diet, consuming psyllids and tapping tree sap in areas occupied by Bell-miners, at least, that is, while the trees are alive.

**Table 8 : Fauna Records for 2032, 2035 and surrounding compartments**

COMMON NAME	1979 to 1990	1993	1994	1995	1996	2005	Total
King Parrot	1						1
Australian Raven	1						1
Bell Miner	2			1			3
Black-faced Cuckoo Shrike	1						1
Boobook Owl				2			2
Brown Goshawk	1						1
Brown Thornbill	2						2
Brush Cuckoo	2						2
Common Bronzewing				1			1
Crimson Rosella	1						1
Dingo and Dog	1						1
Eastern Spinebill	2						2
Eastern Whipbird	2			2			4
Eastern Yellow Robin	2			1			3
Fan-tailed Cuckoo	1						1
Glossy Black Cockatoo		1	1	2			4
Golden Whistler	2			2			4
Greater Glider				1			1
Grey Butcher Bird				1			1
Grey Fantail	2				2		4
Gang Gang Cockatoo				1			1
Grey Shrike-Thrush	2			1			3
Koala	1			7	2		10
Laughing Kookaburra				1			1
Lewin's Honeyeater	2			1			3
Long-nosed Bandicoot				1			1
Masked Owl				1			1
Mistletoebird	1						1
New Holland Honeyeater	1			1			2
Olive-backed Oriole	1						1
Pied Currawong				1			1
Pilotbird	1						1
Powerful Owl			2	1			3
Rednecked Wallaby				1			1
Red-browed Finch	2						2
Red Wattle Bird				2			2
Red-browed Tree Creeper	1						1
Ringtail Possum				2			2

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Rose Robin	2						2
Rufous Fantail	1						1
Satin Bowerbird	1						1
Shining Bronzewing	1						1
Silvereye	1			11			12
Sooty Owl			1	3			4
Spotted Pardalote	2			1			3
Striated Thornbill	2						2
Sugar Glider				3			1
Superb Blue Wren	2			1			3
Superb Lyrebird	1			3			4
Swamp Wallaby				1			1
Unidentified	1						1
Varied Sittella	1						1
Weebil				1			1
Welcome Swallow	1						1
White-browed Scrub Wren	2			1			3
White throated Tree Creeper				1			1
White-eared Honeyeater	1			1			2
White-naped honeyeater	2			1			3
White-throated Nightjar	2			1			3
Wallaroo				1			1
Wombat				1			1
Wonga Pigeon	1			11			12
Yellow-bellied Glider			3	2	4	1	10
Yellow-faced Honeyeater	2						2
Yellow-rumped Thornbill					1		1
Total	61	1	7	78	9	1	155

Data from: NPWS Wildlife Atlas (2000) for Compartments 2034,2030, 2035, 2036, 2051, Logging Plan 2035 (SFNSW1995) and surrounding compartments (2050, 2030,2029)

**Estimates of remaining timber volumes in Five Forests catchments**

“ . . . the harvesting Crew has been moved to another area better suited to meeting the product requirements of customers’. Bill Frew, DOPI spokesperson (Narooma News 8 June 2005)

Estimates of remaining standing timber in the Five Forests come from several sources; the original Bega District Resource Register (BDRR) provides the volume of sawlogs and pulplogs cut in the in the first coupes (1.1 cut) (NSW Forestry Commission 1991).

During the Comprehensive Regional Assessment Process in the Eden Region, SFNSW modified these 'actual' timber volumes to produce the information found in the FRAMES database. The table below (Table 9) indicates there was significant increase, nearly 3 fold, in the estimated remaining sawlog volumes in the Five Forests as a result of the recalculation of the BDRR.

Most of the increase in sawlog volumes is in compartments in Bermagui State Forest that includes areas of Barragoot, Bermagui-Nutleys and Narira, Dignams & Wallaga. Catchments. These compartments are described in the NSW Forestry Commission's Environmental Impact Statement for Forestry Operations in Eden (1994) as 'Totally Logged' and were attributed with the highest level of fragmentation (Attachment 2, Environmental Criteria, Volume C).

**Table 9. Standing Timber volume estimates for the Five Forests**

Catchment	Type	FRAMES	BDRR	DISCREPANCY
Barragoot	Sum of Sawlog	1480	0	+1480
	Sum of Pulp	740	0	+740
Bermagui-Nutleys	Sum of Sawlog	8682	0	+8682
	Sum of Pulp	4982	0	+4982
Cuttagee	Sum of Sawlog	1320	976	+344
	Sum of Pulp	23755	23571	+184
Murrah	Sum of Sawlog	8736	7093	+743
	Sum of Pulp	60231	53307	+6924
Narira Dignams Wallaga	Sum of Sawlog	16166	0	+16166
	Sum of Pulp	5182	0	+5182
Wapengo	Sum of Sawlog	6935	7499	-564
	Sum of Pulp	38710	52361	-13651
Total of Sawlog		43318	15568	+27750
Total of Pulp		133600	129239	+4361

Data from Eden FRAMES (1997) and Bega District Resource Register (1991)

Note: Sawlog volumes: cubic metres, pulp-log volumes: tonnes. Pulp only coupes not included.

These discrepancies have not been explained, the methods employed to modify the original BDRR have not been produced, and the estimates in the logging plan are not from the original FRAMES database.

Forests NSW (M. Linehan) stated, after logging ceased in Cpt 2032 that the operations were 'economically marginal', suggesting a poor understanding of forest condition before logging.

Part of the confusion could be attributed to the various tables in the FRAMES database that provide conflicting information on sawlog species and volumes. Two of these are provided below (Table 10), indicating estimated diameter classes and species mix for Cpt 2032. The significant discrepancy between the sawlog estimates (78 m<sup>3</sup>) is one concern but, according to the first table, the total 'high quality quota sawlog' volume of 8.5 m<sup>3</sup> for the compartment (SFNSW 1997) could represent one tree.

**Table 10 Sawlog Species and Volumes Cpt 2032**

DiaClass	MKG	Other	SBK	STA	Grand Total
40-49cm	0.5	0.7	33.9	4.3	39.4
-40cm	0.3	0.4	18.6	2.4	21.6
50-69cm	0.5	0.7	30.6	3.9	35.6
70+cm	0.1	0.2	7.3	0.9	8.5
Grand Total	1.3	1.9	90.3	11.5	105.2

CPT	SppCode	SPECIES	Sawlog
2032	2	STA	20.002
2032	3	WS	3.27
2032	7	PEP	3.38
2032	9	MKG	2.315
2032	3	YS	153.437
			182.404

Estimates of standing timber volume for Cpt 2032 (Table 11) come from the aforementioned sources and Logging Plans produced in 1995 and 2005. The Logging Plan (2005) suggests “ . . . *Field estimates for pulpwood have been adjusted to reflect changed specifications in 2002*”. These changes apparently entailed dropping the minimum pulp-log volume from 50 to 30 tonnes per hectare as a consequence of increased mechanisation. The reduction to 30 tonnes per hectare assumedly provides for operations aimed at removing trees retained for seed, habitat etc. during the first cycle of ‘integrated logging’. This reduction allegedly led to trees greater than 80cm DBH being retained, although trees this size in these forests are quite rare and frequently have hollow trunks. In this condition they are readily split into ‘billets’ able to fit into the wood-chipper.

**Table 11 Timber Volume Estimates over time Cpt 2032**

Year	Sawlog	Pulplog	Area	SI/ha	Pulp/ha
1990	117	4797	117	1	41
1995	436	4905	109.3	4	45
1997	105	5258	103	1	51
2005	208	7287	104.1	2	70

SEFE (Vince Phillips BDN '**Extreme Greens tell lies**' Friday, 17 June 2005) indicates SEFE buy pulp logs for \$60 per tonne and sell woodchips for \$70 to \$90, dependent on grade. According to the Logging Plan ‘low grade’ pulplogs will be removed, although it is unclear whether ‘grade’ alters the \$60 per tonne figure at the Chipmill.

Forests NSW (2004) suggest the following revenue from timber sales in the Eden and Southern Regions.

**Table 12 Revenue from Saw and Pulplog sales, Southern and Eden Regions**

Eden	Volume	% of Total Revenue	Unit price
Sawlog	35915	19	\$36.50 m <sup>3</sup>
Pulplog	280720	72	\$17.75 tonne
Southern			
Sawlog	90580	56.7	\$42.56 m <sup>3</sup>
Pulplog	71563	6.3	\$6.50 tonne

A cost –benefit analysis of logging operations in the Eden Region suggested forest management costs of \$4 and log harvesting and haulage costs of \$30 per cubic metre of timber cut, based on costs in 1991(DUAP 1995).

Haulage rates (SFNSW 1997) for timber from the Five Forests to Eden ranged from \$14.50 to \$16.20 per tonne, the average haul to Eden being around \$8. Since that time and apart from the price of pulplogs, most other prices have increased considerably, suggesting that the upper cost per tonne for fuel is probably >\$25 a tonne. The reduced revenue (Table 12) for pulplogs from Southern Region Compartments in the Five Forests (\$6.50 per tonne) is thought to account for some of the fuel costs. Other costs for the logging crews have also increased considerably over the past 14 years.

Logging operations continued over the five days in Cpt. 2032, and in that time an area of approximately 15 hectares was logged. Based on estimates from the BDRR, the logging crew cut 3 m<sup>3</sup> of sawlog and 123 tonnes of pulplogs per day.

Based on the aforementioned figures an estimate of logging costs of \$ 33 per tonne, freight at \$25 per tonne and a royalty of \$18 per tonne, the total cost to SEFE is \$76 per tonne. The economic benefits of these operations would appear to be less than marginal.

Based on the estimates in the BDRR and the revenue indicated in the ESFM Plans (Forests NSW 2004), the return for logging all that remains in the Five Forests would be a maximum of \$2.8 million. Based on a notional \$25 per tonne, the fuel cost to freight the timber to Eden is \$3.6 million.

A load of ironbark ‘sawlogs’ did apparently go to the Eden Sawmill from Cpt. 2032, although rumour has it the logs were found to be ‘unmillable’ and presumably were cut up for firewood. Pulplog-only operations are not permitted under the IFOA.

Thinning operations have been undertaken twice in the Cuttagee catchment; in 1995 when 8.5 hectares was thinned in Cpt. 2057 (Smith 2000) and this year, (2005) when another 35 ha was thinned in Cpt. 2057 and an unknown area in 2056. These operations are being undertaken in tress that are claimed to have originated from a wildfire in 1952, making them very old trees for a first thinning. Unlike the rest of Cuttagee Catchment, where short, steep sub-catchments prevail, the topography in these compartments is generally flat to undulating. Pulplog yields for the thinning

operation were estimated to be 73 m<sup>3</sup> per hectare, somewhat more than that estimated in Cpt. 2032 (62 m<sup>3</sup>) and twice the pulplog yield (33m<sup>3</sup>) estimated for Cpt. 2035 (Forests NSW 2005).

While these operations that employ 'walkover' techniques and are constrained to moderate (<15°) slopes, cause much less disturbance than 'integrated' operations, any benefit is lost with the 'post-logging burn'. No attempt was made during the thinning to retain preferred Koala feed trees and several secondary and supplementary Koala feed tree species were seen that had been pushed over or otherwise damaged during the operations (pers.obs).

Even if it is assumed that a similar timeframe (50+ years) will be required for logging regrowth to reach thinning size, that machines are developed for the steep slopes and that public subsidies for such operations are still available, it will be another 30 years before the first alternate coupes are thinned.

After the arrests of protestors at the blockade in Cuttagee, the loggers decided not to continue with logging operations and were permitted to remove the logs they had cut and their machinery. Most of the pulp logs were straight pole size trees that used to be Koala habitat and according to the Logging Plan (Forests NSW 2005) were supposed to have been retained for future sawlogs.

On the same day, several utes with tandem trailers arrived to get fire wood from Biamanga NP, although some claimed they had a permit from Forests NSW to cut firewood on the J3 Road. According to the publicly-available map, this road is in Biamanga National Park. Currently firewood sells for between \$90 and \$120 per tonne in the Bega Shire, representing a more profitable use of public timber resources. There is a significant discrepancy between the volumes of firewood recorded as removed from the Southern Forestry Region compared to the Eden Region (Forests NSW ESFM Plan 2004).

Estimates of timber resource in the Southern Region were intended to come from the methodology developed by the Forest Resource and Management Systems Technical Committee (FRAMES). However the Manager of Southern Region, Mr. S. Dodds, made a unilateral decision to exclude areas of non-commercial forest from the initial forest inventory. The outcome was a timber inventory giving the impression that there may be more 'commercial' forest than is actually the case (ie. State Forests' Harvesting Plan for compartments 587 and 588, Wandera State Forest).

More recently, Forest NSW has apparently dropped the \$15 million plus FRAMES system in favour of an 'off the shelf' single species forest growth model, developed in Canada. According to Forests NSW Website ". . . *Examples of wood supply issues which the sophisticated program helps with is the removal of wood supply spikes (over-supply) such as those from large-scale areas of regrowth forest following wildfires.*" The term 'wood supply spikes' apparently relates to large areas of dead trees that can occur as a result of wildfire or DAD.

Under these conditions, both small and large trees die (Jurskis 2004a) and the revelations that the logging crew report only 10 tonnes of pulp per hectare in Cpt.

2032 suggest many large 'wood spikes'. SEFE only takes green timber, dead trees are uprooted or pushed over during logging operations.

## **Roads**

Access for logging equipment to Compartments 2032 and 2035 is from Quaama along Field-buckets Road and Murrah River Road through Biamanga National Park. A log bridge across Pipeclay Creek (Murrah Catchment) in Biamanga NP was damaged during the last logging operations and was repaired by the NPWS and Forests NSW earlier this year (2005).

The NPWS are managing Biamanga National Park on behalf of the traditional Aboriginal owners, pending the outcomes of mediation regarding the transfer of ownership. Bega Valley Council manages the eastern end of Murrah River Road adjacent to Compartments 2044 and 2045. Council maintenance for the Bermagui Shotgun Club extends up to another unmapped road in Cpt 2045 in Murrah State Forest.

On the first day of community action on Murrah River Road in what was thought to be Biamanga NP (30 May 2005), an attempt was made to find out, first from the logging crew, and then from Forests NSW (J.Jaggers), where the operations were being undertaken, this being an important consideration in terms of the likely negative impacts on Koalas. Forests NSW (J.Jaggers) would not respond to this request.

An employee of the NPWS happened to be passing and informed the gathering that the 'road' is considered to be 'outside' of National Park tenure and 'ownership' was vested with the Minister. However on the next day, and before the arrests, Forests NSW (J. Jaggers) claimed that they 'own' out to the centre of Murrah River Road and another 20 metres into the National Park. This claim is consistent with the maps found in Forests NSW Harvesting Plan (2005), however, the publicly-available Brogo 1:25000 map (LIC 1999) indicates the National Park boundary is on the eastern side of Murrah River Road.

There are approximately 115 kilometres of mapped, unsealed roads in and around the Cuttagee Catchment. Within and adjacent to Cpts. 2032 and 2035 there are in excess of 12 km of permanent roads with more constructed for these operations. Based on a notional area of one hectare per log dump and one hectare per kilometre of road including major and minor snig tracks, over 20% of the area logged is rendered permanently non-productive and a long-term source of water pollution, as a direct result of logging operations. Of course, this figure does not account for the permanent degradation of forests downstream, and assumes trees will germinate and continue to grow in the logged and burned area.

According to information the NSW Forestry Commission (SFNSW 1999) provided to the former South East Catchment Management Board (SECMB), there are ten unsealed steam crossings in public forest of Cuttagee, with six in National Park and four in State Forests.

Not indicated in the Logging Plan, which uses the road layer found in publicly-available maps, one of these stream crossings joins No. One Road in Cpt. 2032 (aka Nutleys Link Road) with Nutleys Creek Road in Biamanga National Park. There has been recent maintenance to this road in Biamanga National Park and some 'burning-off'. This maintenance coincided with bulldozer work on Siltstone Road also in Biamanga NP and tree-felling in Bermagone Nature Reserve. The logging crew used Nutleys Link Road to gain access to the logging operations on the Monday afternoon (30 May 2005).

The stream crossing on No. One Road is indicated as being on National Parks tenure, although the Harvesting Plan places the Compartment boundary on the eastern side of Cuttagee Creek in Biamanga NP, raising uncertainty about which agency manages this road and crossing. Either way, no gravel has been placed on approaches to the crossing.

This crossing does appear on another map produced by Forests NSW and nailed to trees along Murrah River Rd, indicating Cpt 2032 is a much larger (920 hectare) 'reserved forest area' for the period from 22 May til 22 August. According to Forests NSW (J. Jagers), the green lines on the map are not compartment boundaries, but he could not explain what the lines signify. The red lines are apparently roads but are not consistent with either the Logging Plan map or the publicly-available maps.

The map illustrating the 'restricted area' appears to demonstrate that Forests NSW has a least two different Geographic Information System road layers, one in publicly-available maps and one for foresters. On 30 May 2005 a Forests NSW employee removed the map descriptions, replacing them with a description indicating the 'North Western Section of Murrah State Forest' as the area 'reserved' exclusively for logging until 31 August.

Another stream crossing, an old log bridge covered with clay, traverses the creek between Cpts 3032 and Biamanga NP some 120 metres west of the aforementioned crossing. The presence of this bridge, like several other crossings in the Five Forests, is not recorded in any of the official sets of information. A combination of rotting timber and stream bank scouring under the bridge, suggests it is starting to collapse into the creek. Increased water runoff from cleared areas is likely to speed this process, and the resulting 'dam' in the creek will significantly increase water pollution and stream bank erosion.

Further upstream, where the poorly maintained Nutleys Creek Road crosses Cuttagee Creek in Biamanga NP, eroded materials from the deeply rilled road surface flow straight into the creek. Clearly, a poor impression is gained when the NPWS spend public funds maintaining logging access roads and do not follow the licence conditions stipulated in the IFOA for stream crossings where soils are dispersible.

Another map, provided by Forests NSW (M. Linehan) to local residents, shows another stream crossing on the Murrah River in Biamanga NP. This crossing is similarly not to be found on publicly-available maps or in the information Forests NSW provided to the SECMB.

Surveys undertaken in Cpt 2032 on 17 June 2005, (pers. obs.) found cross-banks placed on roads had been reduced in height and, in some instances, pieces of wood placed either side to facilitate vehicular access. Evidence of other, presumably Forests NSW, post-logging surveys in 2032, was noted, although the purpose of these surveys is unclear. They were apparently not directed at establishing the gross area logged.

The extent and management of roads are important considerations in terms of reduced forest productivity, erosion, sedimentation, weeds and feral predator access. A full assessment and rationalisation of the road network and an objective appraisal of maintenance and restoration priorities is required.

## **Burning**

Fire is part of the natural disturbance forests have evolved with over millions of years, although on the 'hilly east coast', under normal conditions, ridges, gullies and waterways will reduce the spread of fire (Flannery 1994).

According to the manager of the NPWS Far South Coast Region, Mr. Tim Shepard, the NPWS, Forests NSW and the Rural Fire Service '*. . . have a commitment to hazard reduction burning in the belief that it will assist in fire-fighting efforts during an actual bushfire.*' (Bega District News 20 May 2005).

This 'belief' results in tens of thousands of hectares burned annually for no apparent benefit, apart from justifying agency claims that the area burned reflects the efficiency of their operations.

Post-logging burning involves the use of a high intensity fire, claimed to promote the release of seed from the retained seed trees, sterilise soil pathogens and provide a nutrient rich seed bed to promote regeneration of seedlings (Smith 2000).

The difference between these burning practises and an actual wildfire is that the latter is invariably a fire in the tree crowns. There is no human force that can stop such a fire, whether the area has been subject to 'fuel reduction' burning, or not.

Many forested areas in Cuttagee Catchment are dominated by non-eucalyptus regrowth, particularly Forest Oak (*Allocasuarina littoralis*) and, consistent with most forest regrowth, there is no distinct separation between 'understorey' and 'overstorey', which makes controlling a fire, under even the most benign weather conditions, largely impossible. The density of Forest Oak is a concern due to the potential impact on retained eucalyptus trees in the event of fire. Like Silver-top Ash, Forest Oak is likely to die during a wildfire, and the proximity of the crowns of these trees is likely to increase fire damage to the trunks of eucalyptus species.

Burning operations have been employed for many years on the assumption that the level of moisture in ground fuels in gullies and streams would be sufficient to put out the fire. However, in some years, as during the very dry winter in 2004, many 'controlled' burns went out of control, because these usually moist areas were dry enough to support a fire.

Forest management that excludes deliberate fire, provides the most suitable conditions for the macro- and micro-biological activity required to maintain soil fertility and soil creation. Yet all forest management is aimed at implementing 'minimum' intervals between fires while neglecting to consider the apparent Bioregional decline of eucalyptus forests. There has been no research on long-term post-logging eucalyptus regeneration, where burning has not been undertaken. Similarly, attempts to implement forest management practices, aimed at increasing species density and diversity to aid forest fuel reduction, have not received agency support.

## **Conclusion**

In their paper "Options Forestry: Acting on Uncertainty (Bormann and Kiester 2004), the authors pose the question, "*But what if the uncertainty surrounding the outcome of major forest policies is actually much larger than has been apparent - or admitted to?*"

Forest management has been a contentious issue for many years both locally and abroad. Australians are encouraged to ponder world events, while woodchips, like the war in Iraq, the treatment of refugees and global warming, are Commonwealth Government concerns. At a Bioregional level, the management of public forests is similarly a Commonwealth matter and the knowable uncertainty surrounding temporal aspects of DAD would seem to be the greatest concern. Reducing soil Water Holding Capacity enables a situation where only a few months of dry weather are required to initiate DAD. In many instances surviving trees have not recovered from the DAD event in 2002-3.

Each subsequent DAD event will increase tree mortality across the Bioregion, affecting commercial and non-commercial forests across tenures by changing their structure.

At a catchment level, in forests also affected by BMAD, the evidence points to changes in forest structure and associated changes to natural hydrology, inducing changes in soil conditions, making them almost immediately unsuitable for most indigenous eucalyptus species. These changes have led to extensive and growing areas being subject to BMAD over the past two decades across all tenures in the Five Forests.

Whether the eventual decline and demise of Bell-miner colonies results from diminished resources, a return to pre-disturbance conditions or a combination of both, is unclear. However, there is certainty that current forest management will increase areas affected by BMAD, and DAD is likely to assist. The decline of Koalas, the spread of BMAD and the first manifestations of DAD in forested environments, are all consistent with reducing soil fertility, the most critical factor in forest management, yet such matters are not considered in the IFOA.

With the IFOAs, a 'one-size-fits-all' non-adaptive approach to forest management has been imposed on the environment and the community, based on science that, at least for the Five Forests, was outdated in 1994. This approach has led to the situation where the land management agencies are not encouraged to develop an

improved understanding of ecological processes. As a consequence the uncertainties are not acknowledged, because 'one-off' timber values are paramount, and there is no requirement to incorporate science into management or admit to what is apparent.

The IFOA was supposed to be reviewed every five years, with the public given notice of the review by September 2003 at the latest, although no notice was given. The outcome of the review, undertaken by the DIPNR, DEC and DOPI was to be tabled in both Houses of Parliament by March 2005, but this too has not occurred.

The NSW Scientific Committee is supposed to make a determination on any nomination within six months of receiving the nomination, yet more than four years on, this 'independent' committee cannot reach a determination and cannot find the information provided inadequate. Instead they claim there are 'other' Koalas in an area not subject to eucalyptus decline in the Bioregion, and they are aiming for a 'consistent approach' to all Koalas in NSW.

The NSW Scientific Committee has been unable to say the information provided for the Five Forests Koalas is inadequate, yet on the North Coast they claim that the cause of BMAD has not been identified. It is apparent that none of these actions are supported by any science, local knowledge or logically consistent thought.

It seems regrettable that the process, available to the general community to protect endangered populations and the environment, is determined by Government policy instead of scientific rigor. Similarly, the process for reviewing forestry activities and the mechanisms for community input into Catchment and Land management, has also not lived up to expectations.

*What if over confidence in decisions has led to unintended consequences, in what Gunderwson (1999a) called 'spurious certitude'? (Bormann and Kiester 2004)*

There are significant concerns held by the local community and by the public generally, regarding the management of public forests and the impact of that management on flora, fauna, water catchments and estuaries. Yet, in the case of Cuttagee Catchment, Forests NSW states there are 'nil' cultural or any other values worth protecting.

Forests NSW recently released their generic ESFM Plans for Eden and Southern Regions but have been slow to respond to reasonable comments like '*. . . totally unscientific in approach and full of unverifiable, untestable "motherhood" statements.*'<sup>1</sup>

Despite the fact that DEC has two representatives on the NSW Scientific Committee, the Editorial in the Bega District News notes that on Koalas "*. . . Unfortunately, it doesn't seem to take any view at all.*"

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<sup>1</sup> Comments on Forests NSW ESFM Plan, (2004) W.A. Douglas (2005) Bsc Hons. Msc. Dip Ed. Dip Ed Stud. Eurobodalla Greens.

The decline of forested environments is a local, national and global problem. In the Bateman Bioregion, BMAD and DAD have significant implications for Australia's contribution to global warming and dire implications for the environment, the community and the economy. Yet at regional, State and Commonwealth levels, there is no uncertainty about current management, even though the IFOA means agencies do not need to learn, so they do not need to change course to avoid irreversible damage.

World's best forestry practice does not employ misleading information that has no scientific basis, while ignoring the comprehensive soils data and other information from reputable sources, including that freely provided by the local community.

Under the IFOA the DIPNR provide 'alternative' soils information that contrasts with their own laboratory results. The DEC approves this 'alternative' soils information without challenge and DOPI and DEC incorporate this 'science' into their management of public, forested lands.

There is no consideration of whether the quality and quantity of habitat is sufficient for a Koala, let alone a viable Koala population; whether remaining soil fertility provides for forests to survive and grow back after roading, logging and burning; changing tree species distribution and abundance; the downstream impacts on riparian forests, streams, estuaries, or other reasonable community concerns.

The fact that there has been no post-logging research directed at BMAD or Koalas demonstrates a lax approach and a lack of accountability. It is not adequate for the DIPNR, DEC or DOPI to believe that the adverse impacts on the Endangered Koala population from logging, will be minimized, as a result of the IFOA. Nor can they rely on spurious claims that broad-acre burning across tenures will improve forest health.

Public forest management in the Bateman Bioregion has been an ongoing experiment based on 'one-off' observations and opinions that have little or no basis in science.

*Unknowable uncertainties arise when things change faster than they can be measured: Collecting more data does not help. . . . the large uncertainty associated with taking general principles from research and applying them to specific local areas can be reduced if the specialists are given responsibility training and rewards to be rigorous testers of the general theory, not appliers of cookbooks. (Bormann and Kiester 2004)*

The Objects of the NSW Forestry Act state that the Forestry Commission is “ . . . (a) to conserve and utilise the timber on Crown-timber lands and land owned by the commission or otherwise under its control or management to the best advantage of the State”

There is no provision in the Forestry Act (1916) for Forests NSW to push species to extinction or degrade the immediate and downstream environment beyond repair, be that State Forest, National Park or private land, in exercising their powers to exploit timber resources. Irrespective of the IFOA review, the capacity of Forests NSW to

unilaterally turn part of the area occupied by a nominated Endangered Population into an area exclusively for logging, does not appear to have a legislative basis in the IFOA or the Forestry Act.

The Objects of the NSW Forestry Act also state that the Forestry Commission is, *'...to preserve and improve, in accordance with good forestry practice, the soil resources and water catchment capabilities of Crown-timber lands and land owned by the commission or otherwise under its control or management.*

And that *" . . . In the attainment of its objects and the exercise and performance of its powers, authorities, duties and functions under this Act, the commission shall take all practicable steps that it considers necessary or desirable to ensure the preservation and enhancement of the quality of the environment.*

It is clear that Forests NSW does not consider credible science to be 'necessary or desirable' and aided by the other State land management agencies (DEC and DIPNR) and the Commonwealth, have taken all practical steps to suppress, minimize or dismiss credible science, while claiming to preserve and enhance the quality of the environment.

Forests NSW retains this stance despite the fact that their publicly-funded research on forest dieback has been demonstrated to have no scientific credibility and virtually all information they produce either contradicts itself or conflicts with credible publicly-available information.

According to Forests NSW Chief Executive Officer Mr. Peter Duncan (Forest NSW 2004) *" . . . The principles of ESFM hold that the forest values across all tenures, not just on public lands, contribute to meeting goals and that forest management needs to be guided by public and stakeholder participation, openness to ideas and transparency in decision making. I commend this approach to you."*

Regrettably, such rhetoric has a hollow ring for those who have been assaulted, arrested, charged, harassed, victimized and bankrupted by Forests NSW while attempting to open the organization to ideas like ESFM, transparency when making decisions, community consultation and being guided by the public.

*" . . . Choosing to diversify is likely to result in partial success and failure (through multiple approaches tried simultaneously); choosing not to diversify leads to more complete success – if the right practice was chosen – or more complete failure. (Bormann and Kiester 2004)*

The lack of diversity in forest management has led to a complete failure. The knowable spatial and temporal uncertainties associated with forested areas in the Bioregion like the Five Forests that are subject to obvious 'mesic and/or xeric eucalyptus dieback' (BMAD &DAD) are sufficient for the NSW Forestry Commission to notify the relevant Ministers regarding the need to immediately implement the 'Force Majeure" provisions in their wood-supply contracts.

There is no certainty that implementing 'active' Adaptive Forest Management will stop or reverse forest decline, however, it would be irresponsible in the extreme were

the agencies, particularly Forests NSW, to continue to thwart proven scientifically-based remedial actions aimed at Koala survival and Catchment restoration, while they destroy critical Koala habitat and further degrade the environment. This is particularly the case when these remedial actions are proposed by the local community, supported by the Commonwealth and State Governments and implemented by the local community.

It is beyond time for the management of public land in the Five Forests to be accountable to the community. Koala extinction may be averted and the massive environmental, economic and social problems public forest managers have created in the Five Forests and all other coastal forests and catchments in the Bateman Bioregion, can begin to be addressed.

Robert Bertram  
Forest Ecologist

July 2005

### **Restoration Priorities Cpt 2032**

1. Collect seed from secondary and supplementary Koala feed trees felled or uprooted during logging (*E. longifolia*, *E. bosistoana*, *E. cypellocarpa*, *E. globoidea*, *E. muellerana*) and record their location.
2. Using a rubber-tired tractor, fill channels made for roads running toward Cuttagee Creek with displaced soil.
3. Cover replaced soil with a minimum 50mm of shredded or chipped tree leaves and branches from logging waste
4. Place logs and/or branches from logging operation at 5 metre intervals along roads on top of shredded material.
5. Remove logging debris for use from logged areas in the above operations in a pattern that allows access for replanting collected seed.
6. Spread bark and displaced soil on log dumps and other areas of completely exposed soils.
7. Plant seed in logged areas and along restored roads and operating log dumps (A, B, C, D, E), leaving the main (ridgetop) road open west of Log dump D for access to monitor Bell-miner activity.
8. Road running north from Log Dump D to be rehabilitated after bridge is removed.
9. Maintain post-logging ground cover levels in logged and surrounding areas. Post-logging burning is not undertaken.

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## **Objects of the Commission**

- (1) The objects of the commission shall be:
  - (a) to conserve and utilise the timber on Crown-timber lands and land owned by the commission or otherwise under its control or management to the best advantage of the State,
  - (b) to provide adequate supplies of timber from Crown-timber lands and land owned by the commission or otherwise under its control or management for building, commercial, industrial, agricultural, mining and domestic purposes,
  - (c) to preserve and improve, in accordance with good forestry practice, the soil resources and water catchment capabilities of Crown-timber lands and land owned by the commission or otherwise under its control or management,
  - (d) to encourage the use of timber derived from trees grown in the State,
  - (e) consistent with the use of State forests for the purposes of forestry and of flora reserves for the preservation of the native flora thereon:
    - (i) to promote and encourage their use as a recreation, and
    - (ii) to conserve birds and animals thereon, and
  - (f) to provide natural resource environmental services (whether within or outside of New South Wales).
- (2) In the attainment of its objects and the exercise and performance of its powers, authorities, duties and functions under this Act, the commission shall take all practicable steps that it considers necessary or desirable to ensure the preservation and enhancement of the quality of the environment.
- (3) The commission may make recommendations to the Minister with respect to any of its objects, powers, authorities, duties or functions and shall, when requested by the Minister to do so, make recommendations to the Minister with respect to any matter relating to its objects, powers, authorities, duties or functions.