THE NORTH-EAST FOREST ALLIANCE (NEFA)

A Compilation of Workshop Discussions from the Inaugural NEFA Meeting - (August 5th and 6th 1989), Grafton

Please note:

The resolutions presented here are still in the formulative stage.
They need to be evaluated (by NEFA members) in the NEFA context -
(i.e. what is relevant to the overall NEFA 'campaign').
The original resolutions (arrived at during the Forest Summit) are attached.
This document is based on the original but has been re-formatted (to distinguish between policies, objectives and initiatives), with a number of suggested additions.
Resolutions, in some cases, have been reworded or simplified and some re-directed to more relevant sections (so we aren't repeating ourselves over and over again).
When reading these please refer to the originals to ascertain any changes that have been made (remember - all changes are only suggestions at this stage).
The next stage is for each member group to evaluate what is presented here and make suggestions for change - i.e. additions, deletions, rewordings etc;).
It will be a big job to collate and review all these new suggestions, so please have yours returned to the Big Scrub by ..the..15th..of. September.

Thank You and Good Luck

30.61

The Major Forest Issues discussed were -:

WETLANDS (Mangroves and Coastal Forests)

Preamble

Policies and Objectives

- prohibit the destruction of mangrove forests;
- reafforestation of flood prone river flats and stream banks;
- any developments in, adjacent to, or altering the status of SEPP 14 or LEP wetlands to require full EIS. open to public participation and consideration;
- identification and protection of all wetlands under SEPP 14, to include freshwater wetlands, flood plains and wetlands beyond photo limits;
- any flood mitigation works by local councils on any type of land should only be allowed to proceed after preparation and consideration of an EIS, with full public participation;
- full assessment and identification of the effects of agricultural, industrial and urban run-off on wetlands and estuaries;
- restoration of wetlands damaged by flood mitigation works;
- assessment of the environmental impact on river / wetland systems of dams and the removal of water for irrigation and other uses;
- restriction / prohibition of developments (residential or educational) in midge areas;
- identification and assessment of swamp and melaleuca forests;
- establishment of management areas around SEPP 14 areas and other coastal vegetation.

Initiatives

- promote values of mangroves and wetlands;
- encourage some low key ecologically sensitive visitor facilities in some mangrove / paperbark forests - such as boardwalks, birdwatching spots and visitor interpretive signs.

FLORA and FAUNA

Preamble

Policies and Objectives

- undertake detailed flora and fauna inventories throughout NSW;
- institute a Flora and Fauna Guarantee based on the Victorian model;
- institute an eradication campaign to eliminate feral animals from natural areas;
- identify the habitat requirements, delineate populations and identify threats to rare and endangered flora and fauna;
- identify and provide protection for estuarine fish breeding areas and habitat for migratory birds;
- increase research into the effects of roading, logging, fire, grazing, mining and other human induced disturbance on native plants and animals, and the environment generally;
- compile and assess all available information on the impacts both direct and indirect, of human induced disturbance on natural ecosystems to be used in the assessment by all Government Departments of impacts of developments in natural areas.

Initiatives

OLD GROWTH FORESTS AND WOODLANDS

Preamble

The term old growth forests is herein used to delineate ecologically mature eucalypt forests that are unlogged or only lightly selectively logged. It has been roughly estimated that some 10% of economically loggable eucalypt (and Brushbox) forests and woodlands currently remain in their old growth phase is north-eastern NSW. Most of these will be completely cutout soon after the turn of the century. For the large numbers of wildlife dependent upon old-growth forests this is a looming environmental catastrophy.

Policies and Objectives

- call for a moratorium on logging, burning, grazing and other threats to old growth forests while an assessment of their distribution and extent, along with the conservation requirements of their dependent fauna, is undertaken;
- legal protection for old growth forests on private lands, with education and financial incentives provided to landholders;
- retention and promotion of adequate numbers of old growth trees, plus suitable recruitments, throughout forest areas (A minimum of 5 evenly distributed hollow bearing trees, plus suitable recruitments, per hectare should be maintained as an interim measure.

Initiatives

- ensure money allocated to old-growth inventory, under the directorship of the Department of Primary Industries, is not purely a resource inventory and is directed to an appropriate body;
- that the dynamic nature of the age class structure and change over time be recognized;
- initiate public education;
- encourage Governments to recognise that all remaining natural vegetation, tree covered land and old-growth forest / woodlands are an essential habitat and precious resource for maintenance of Australian flora and fauna. The protection of its ecological integrity must be the priority of the States Conservation Strategy. No clearing of Crown Lands and controls on private land clearance.

RAINFORESTS

Preamble

(Ultimately each section should have a Preamble. Some suggestions have been put forward here for discussion - most still need a lot of work. In areas you have an interest in please put forward some ideas- Thanks).

Worldwide, rainforests are disappearing at the rate of a football field a second. In NSW we have already cleared over three quarters of our rainforests and seriously degraded over half of that remaining. Only one third of NSW's remnant rainforests are in National Parks or Nature Reserves while over half are still controlled by the Forestry Commission. It is time to stop logging and clearing rainforests in NSW and assist the regeneration of degraded areas.

Policies and Objectives

- Stop logging in, and/or the clearing of, all remnant rainforests;
- all significant areas of rainforest on Crown Land to be transferred to the NPWS, along with funding;
- initiate research into, and evaluation of, the ecological status and classification of 'moist hardwood' secondary rainforests;
- review, and evaluate, the conservation status of all forms of rainforest, including small isolated remnants and littoral rainforests

Initiatives

- call for Governments to fully protect all inadequately conserved rainforests;
- reject the myth that 'all NSW's rainforests were saved - or that there has been some political trade off done;
- encourage assessment of regeneration on abandoned agricultural land (and evaluation of all data from trial plantings of rainforest species);
- for each Local Shire - undertake mapping and assessment of rainforests (and ensure their appropriate zoning in LEP's.

PLANTATIONS

Preamble

There is an urgent need to establish extensive plantations of hardwoods to help alleviate the pressure on native forests. Blah Blah Blah

Policies and Objectives

- no clearing of native vegetation for plantations;
- aim in the long term at deriving all timber from plantations;
- evaluate and promote share farming as a means of expanding the plantation estate;
- tax incentives and the rasing of timber royalties from Crown Lands should be introduced to encourage plantations;
- assess the appropriateness and weed potential of non-native plantation species (Pines, Paulownias etc);
- assessment and location of land available, or potentially available / suitable for plantation establishment. Particular emphasis on linking natural areas e.g; wildlife corridors;
- economic reassessment of the timber industry with relevance to plantations;
- plantations on Crown Lands to be controlled by State Government (Forestry Commission?) with public participation in management;
- wherever possible plantations of local species grown from seeds collected in the vicinity should be established;
- assess, evaluate and promote mixed rainforest plantations;
- promotion of mixed plantations rather than monocultures.

Initiatives

- call for the NSW Government to recognise mixed eucalypt plantations as an appropriate alternative to logging native forests;
- promote the non-timber values of plantations e.g; for wildlife and against land degradation, greenhouse effect;
- federal funding for plantations - the '1 billion trees plan' requires clarification.

THE GREENHOUSE EFFECT and OZONE DEPLETION

Preamble

The future of NSW's forests is irrevocably linked to the massive, complex, inexorable and unpredictable changes that the combined impacts of the Greenhouse Effect and Ozone Depletion will have. The Greenhouse Effect threatens mass extinction of plants and animals and elimination of vast tracts of forests. Increased ultraviolet radiation will cause a significant decline in ecosystem productivity and adversely effect the health of many plants and animals. It is vital that these impacts be assessed in the design of conservation strategies.

Policies and Objectives

- urgent investigation into and assessment of the predicted impact that atmospheric warming and increased ulltraviolet radiation will have on ecosystems;
- preservation and creation of corridors to allow for the migration of plants and animals resultant from climatic change;
- assessment of the future impact that the GE and OD will have upon plantations before they are established;
- development and implemenation of a strategy to ensure the survival of mangrove communities and coastal forests where threatened by sea level rises;
- development and implemntation of a strategy to ensure the survival of as comprehensive an array of native plants and animals as possible.

Initiatives

- lobby the Government to increase research into the combiuned impacts of the GE and OD on natural ecosystems;
- initiate a public education campaign.

PUBLIC PARTICIPATION IN MANAGEMENT PLANS

Preamble

Policies and Objectives

- full and effective public participation should be allowed into the preparation and regular reviews of management plans;
- all relevant information on the management of Public Lands should be freely and readily available to assist informed public participation;
- obligation for politicians from all levels of Government to openly discuss a matter in a public forum once a certain number (e.g 20,000) of signatures on a petition have been collected;
- propose a federal referendum to give citizens of local communities the constitutional mechanisms to petition their local or regional government for binding referendums on issues involving human habitat and the quality of life;
- Environmental Impact Statements to be prepared by independent bodies with allowance for public participation.

Initiatives

- initiate public education of the importance of public participation in management of all publicly owned lands;
- identify current infrastructure for public input. Question if they are of use. Make changes. Adopt EPA Act provisions which apply to LEP's and DA's;
- encourage the implementation of the Institute of Foresters of Australia's policy to have public participation in forestry management.

INDUSTRY ECONOMICS

Preamble

Policies and Objectives

- increase timber royalties to represent real costs - environmental, social and economic;
- no export of woodchips or pulp. Only value added wood products to be exported;
- assess and utilize non-timber sources for pulp and paper production. Include a total recycling strategy to lessen demand for raw materials;
- encourage the use of composite timbers manufactured from small regrowth and plantation timbers, particularly as substitutes for sawnwood;
- initiate research into the manufacture of new composite timber products;
- include all costs in decisions - environmental, social and economic;
- increase mill recovery rates and decrease mill wastage;
- increase funding to support local decentralised production of composite timbers, with subsidies to ecologically and economically sustainable industries.

Initiatives

- publicise that industries centralisation and resource depletion are responsible for (employment?) decline- publicise available material and facts;
- mobilise and educate youth, community service workers and unemployed workforce for forest activities by redesigning social wage / dole;
- initiate dialogue with forestry unions;
- evaluate and publicise the export of capital to purchase equipment;
- promote timber and paper recycling (deposit on paper?);
- Federal Government to exercise corporations / export powers to enforce / promote above policies and initiatives.

NATIONAL PARKS AND WILDLIFE SERVICE

Preamble

Policies and Objectives

- increase funding for the NPWS to an adequate level to enable them to acquire areas, rehabilitate areas, study / research natural areas and undertake off-park conservation activities;
- protection of habitat to be made a priority consideration in all aspects of park management;
- end privatisation of public facilities in National Parks;
- before any development is carried out - a detailed environmental impact assessment to be compiled and considered, with full public participation;
- a moratorium on all works in National Parks, Nature Reserves and State Recreation Reserves until a publically agreed Plan of Management has been prepared and adopted;
- amend the NPWS Act to require display and public participation in the preparation of Plans of Management, with detailed documentation of the geology, flora, fauna and environmental impact of proposed developments to be included;
- non-party political District Advisory Committees to be appointed and properly consulted (by the NPWS);
- establishment of management zones adjoining National Parks and Nature Reserves for adequate preservation of habitat within the parks and to restrict any detrimental activities;
- require local Government tourism authorities and private tourism operators to contribute to the maintenance / upkeep of National Parks, Nature Reserves and State Recreation Reserves;
- identify and rename National Parks and Nature Reserves by local Aboriginal names connecting natural areas with earlier natural use;
- make management costs publically available;
- undertake a thorough assessment and review of fire management, with public participation;
- identification and assessment of the significant threats posed by vehicular access and necessity of restricting active recreation to areas outside park boundaries.

Initiatives

- educate NPWS on wilderness and its management;
- ensure political independence of NPWS;
- request NPWS to clearly define between the National Parks, Nature Reserves and State Recreation Reserves objectives and compatible uses.

TENURES (other Crown Lands and Private Lands)

Preamble

Policies and Objectives

- halt the conversion of timber leasehold lands to freehold. With particular attention paid to land containing significant stands of rainforest and old growth forest, and/or lands of National Estate or Wilderness significance;
- extend the powers of the Soil Conservation Service (SCS) and Catchment Protection Board (CPB) to apply over all leasehold land and freehold land, so that broad scale clearing can be prohibited in all timbered lands;
- reinstate the former conservation policies of the Department of Lands, allowing reservation from sale;
- full and unrestricted assessment of Crown Land conversion and lease applications by the NPWS, with full public participation;
- extend the powers of the Department of Agriculture and the Soil Conservation Service to prohibit agricultural developments in areas of marginal or poor agricultural viability;
- regular reviews / assessments of leasehold lands should be undertaken by the SCS, NPWS and CPB to ensure the land is being managed in an environmentally sensitive and appropriate manner;
- records should be kept and significant fines imposed on leaseholders who despite warnings and advice do not obey environmental protection requirements. Repeated offenders should not be given any more leasehold or freehold land;
- catchment area provisions to bind the Crown;
- Crown Lands Office should be given adequate provisions to protect environmentally significant areas both within and adjoining permissive occupancies;
- service corridors (e.g. Elcom etc;) to include controls on the clearing of natural vegetation and to be directed away from environmentally sensitive areas;
- that the CPB include conservation representatives.

Initiatives

WILDERNESS AREAS

Preamble

Policies and Objectives

- protection of all wilderness areas in NSW and implementation of responsible management;
- implementation of the wilderness Act in NSW;
- amendment of the Wilderness Act to increase interim protection during assessment of nominatiuons. To include an immediate moratorium on development, change of tenure and other detrimental activities;
- provision of adequate resources to NPWS for Wilderness nominations assessment and management of designated wilderness areas;
- legislative power to protect wild and scenic rivers outside National Parks and Wilderness Areas;
- complete inventory of Wilderness quality areas in NSW.

Initiatives

- preparation of furhter nominations under the Wilderness Act, with prioritisation and preparation of strategy for timing of nominations;
- Government to provide money for education of public and politicians about the values of wilderness by NPWS, Department of Education and community groups.

NATIONAL ESTATE FORESTS

Preamble

Policies and Objectives

- increase legislative power under Federal National Estate Properties Act and ensure stronger implementation of current powers;
- increase AHC resources to enable adequate assessment and processing of nominations;
- moratorium on all detrimental activities in areas proposed or listed.

Initiatives

- syncronize wilderness (State) and National Estate (Federal) nominations;
- identification of, and prepartion of nominations for, National Estate areas in NSW;
- Governments to provide funds for education of the public and politicians about National Estate;
- encourage philosophy that National Estate areas have National, State and local significance;
- prioritize and prepare a strategy for timing of nominations;
- seek National Estate grants.

A. M. Gilmour
Dorlon

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MANAGEMENT OF NATIVE HARDWOOD FORESTS IN STATE FORESTS OF NORTH COAST NEW SOUTH WALES

R A Curtin, R H Squires and C M Mackowski

INTRODUCTION

The native forests have had an integral part in the history of European settlement and development of the north coast of N.S.W. They presently form a major landscape feature of the region, providing beauty and diverity, secure habitat for flora and fauna, and raw material for local industries. We intend to describe and discuss the current management of those hardwood (primarily eucalypt) forests of the north coast under the control of the Forestry Commission of N.S.W. There are also substantial areas of indigenous forest on the north coast which are in private ownership or are managed by other Government departments, principally the National Parks and Wildlife Service. The management of these areas is outside the scope of this paper.

To convey a picture of these State Forests, we will briefly describe the forests and their early history. The objects of management, management policy, and planning processes involved in current management planning will also be described. This is followed by a description of the management procedures adopted on these forests. Such procedures are standardised throughout the indigenous State Forest areas of NSW, and aspects of these procedures will be repeated or enlarged upon in other papers. Current and past silvicultural treatment, and the productivity of these forests are discussed, as well as current protection needs. Finally we look at the future prospects for the continued management of the north coast forests into the next century.

Description of the Forest Types

The north coast of New South Wales is the area north from Sydney about 120km wide lying between the east coast and the Great Dividing Range (Figure 1). Latitude varies from 28-34s and longitude form about 151-153E. The terrain varies from flat to steep with altitudes up to 1000 m a.s.l. and comprises a series of coastal rivers that drain the land east of the range to form a pattern of alluvial valleys separated by low coastal ranges. Climate is warm temperate to subtropical, with annual rainfall usually in excess of 1000 mm fairly uniformly distributed throughout the year but commonly with a spring dry season and a summer/autumn rainy season.

Forested areas are distributed throughout the north coast in four different land tenure categories:

- State Forests
- National Parks and similar reserves
- Various tenures specified in the Forestry Act (other Crown-timber lands)
- Private property and other tenures not covered by the Forestry Act.

This paper concentrates on the management of the first category of land of which there are about 1,200,000 hectares distrubuted as illustrated in Figure 1. There are a further 340,000 hectares of other Crown-timber on the north coast, but most such areas are not considered of potential and are not required for long-term production.

The State Forests of north coast New South Wales are a mosaic of many forest types. These can be grouped into six broad categories that are summarised by area and tenure in Table 1. Their general distribution is shown in Figure 2. Botanical names for common names used in this paper are given in Appendix 1. The contribution of individual species to current sawlog production is listed in Table 2. Brief descriptions of each category are:

(1987) Proc. 10th Biennial Conference, Institute of Foresters of Australia. Perth

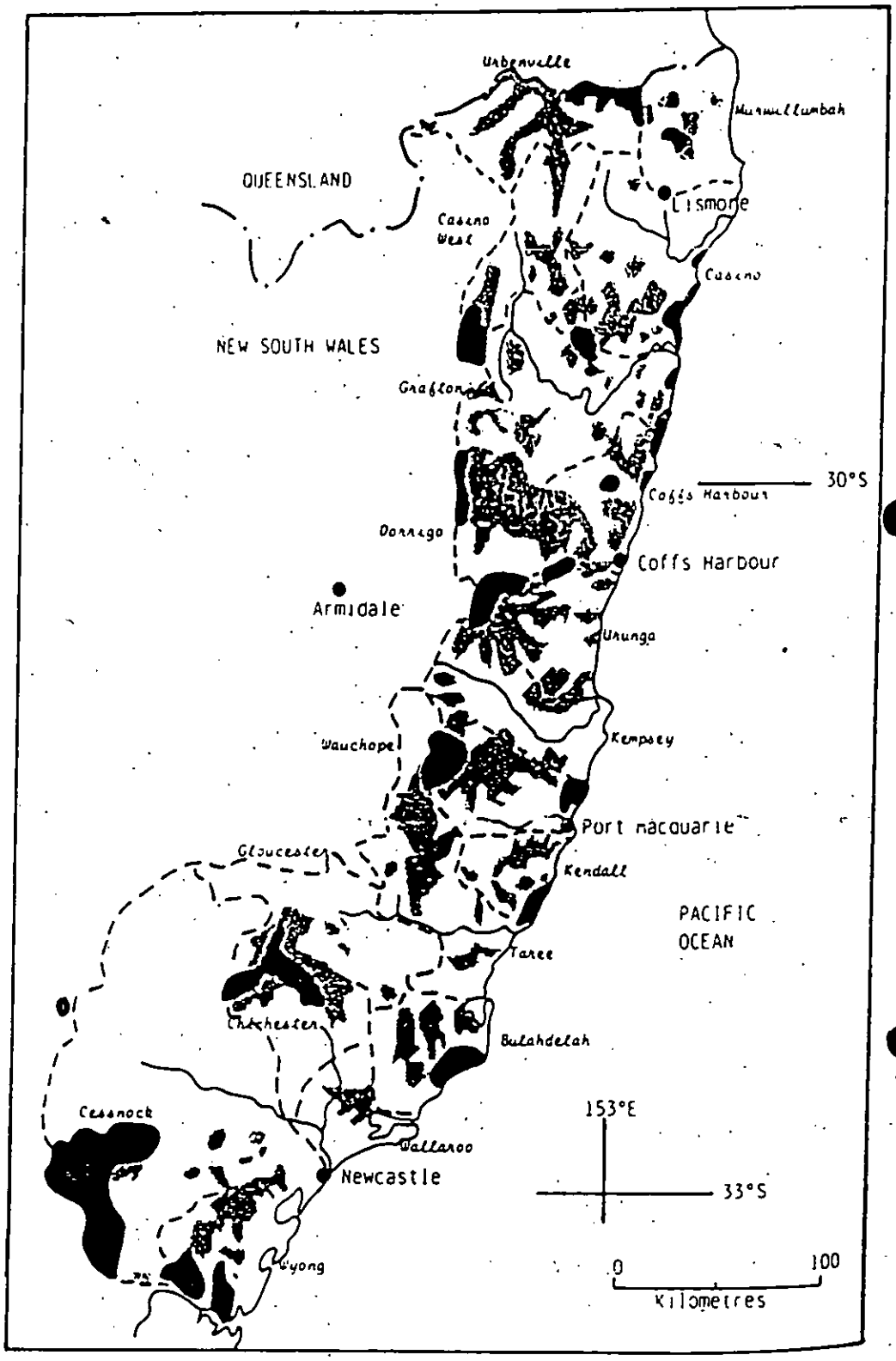

Figure 1: Management Areas. Broken line indicates management area boundaries. Solid shading - National Parks. Lighter shading - State Forests. Names in italics are names of management areas.

(a) Blackbutt

The blackbutt forest types are characterised by the occurrence, and usually the clear dominance of blackbutt. It is the single most important native timber tree in N.S.W., currently providing about 15 per cent of the tive hardwood log cut from Crown-timber lands in N.S.W. It is one of the more vigorous eucalypt species and its silvicultural attributes make it very well suited to intensive forest management.

Blackbutt types range in occurrence from relatively low site quality (20 m site height) dry sclerophyll to high site quality wet slcerophyll forest on soils of moderate fertility in areas of medium to high rainfall. This species tends to avoid soils derived from basalt, poorly drained soils and soils with a high bulk density. It is essentially a species which occupies the slopes and broader ridges, avoiding gully situations which are occupied by flooded gum or other moist hardwood types.

(b) Flooded Gum

Flooded gum occurs as a wet sclerophyll forest often in pure, even-aged stands which occupy moist gully sites of moderate fertility. Although it occurs on heavy clay soils, it does not tolerate water logged soils. The forest type has a limited area (about 20,000 ha) and has not been separated from moist hardwood in Table 1, but it is important because of its potentially very high productivity, on sites located close to markets.

(c) Moist Hardwood Forest

The moist hardwood forest is a wet sclerophyll forest usually dominated by tallowwood, brush box and blue gum, which are capable of attaining very large sizes. Typically it has an understory of mesic vines and shrubs, and in many situations the understory itself may be a well-developed rainforest.

The moist hardwood forest attains its best development on the steeper topography of the escarpment zone to the east of the ranges at elevations between 300 - 1000 m above sea level. However there are significant areas of these types on undulating topography of lower altitude. Soils are moderately fertile and rainfall is high. Although these types are relatively remote from the markets, they are highly productive of timber in the primary logging, often yielding between 30 and 100 m^3 of sawlogs per hectare. The moist hardwood forest is currently contributes nearly one third of the sawlog production in N.S.W. (Table 2)

TABLE 1. FOREST TYPES BY LAND TENURE

Forest Type	Land Tenure				
	State Forest	Other Crown	National Park	Private	Total
Rainforest	125	10	65	30	230
Blackbutt	220	30	30	90	370
Moist Hardwood	250	50	75	160	535
Dry Hardwood	320	510	230	760	1820
Spotted Gum	130	50	10	180	370
Tablelands & Other	105	70	50	100	325
Total Forest	1150	720	460	1320	3650
Non Forest	40	(380)	(45)	5055	5520

Values are thousands of hectares, approximately correct for June 1986 for land area comprising Newcastle, Port Macquarie and Coffs Harbour forest administration regions. (Values in brackets are approximately correct for 1976 and have changed significantly but to an unknown extent since.)

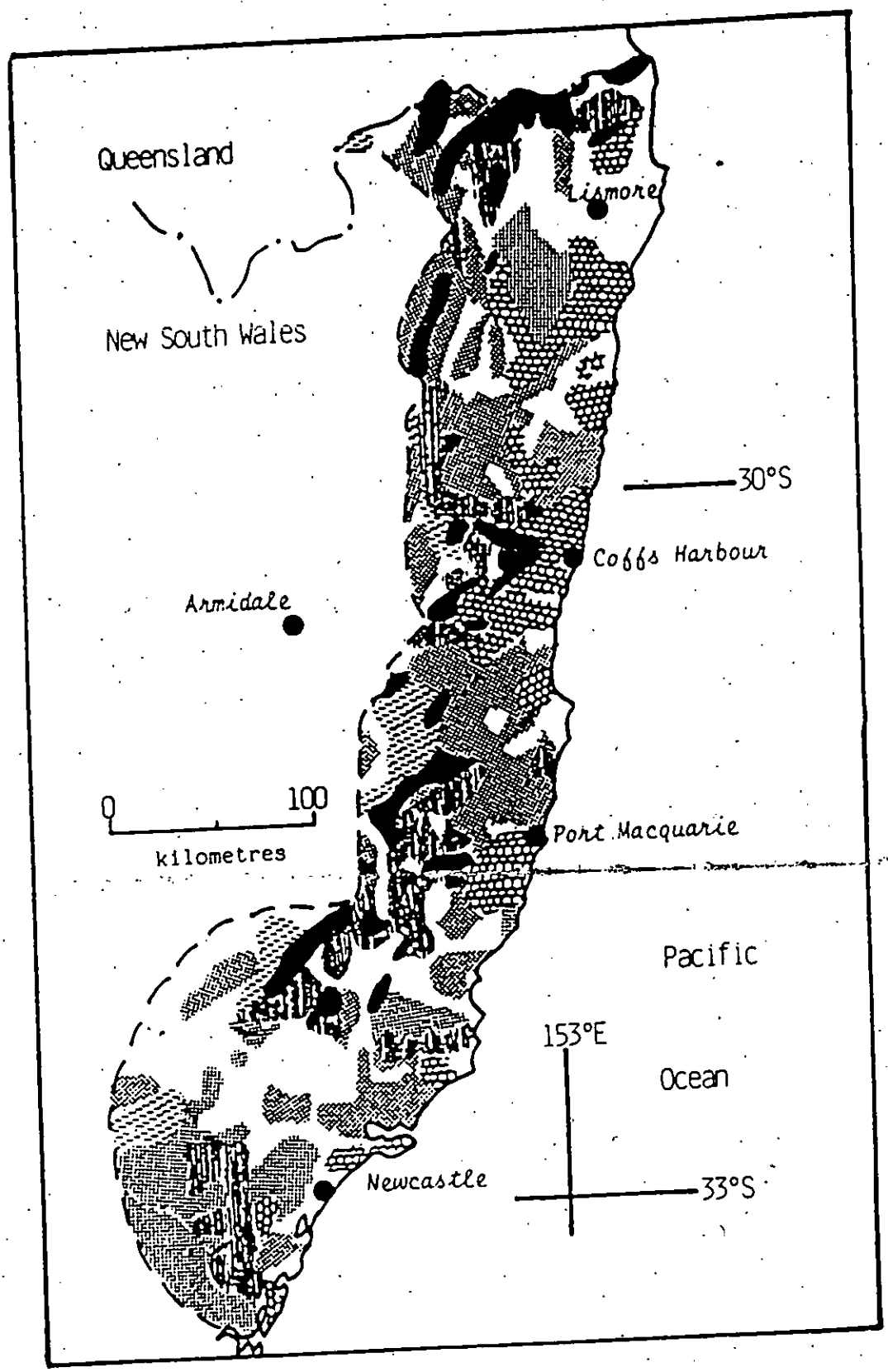

Figure 2: Forest Types. Solid shading - rainforest. Vertical shading - moist hardwood. Honeycomb shading - blackbutt. Spotted shading - dry hardwood. Broken horizontal shading - tablelands types.

TABLE 2. GROSS VOLUME (m^3) OF SWALOGS CUT DURING THE YEAR 1986 TO MAY 1987 FOR THE MAJOR HARDWOOD SPECIES OF THE NORTH COAST OF N.S.W.

Species	Volume cut (North coast)	%	Volume Cut (State)	%
Blackbutt	106,100	23.6	164,000	15.4
Flooded gum	40,000	5.9	40,100	3.8
Tallow wood	96,900	14.3	108,300	10.2
Blue gum	82,100	12.1	98,200	9.2
Brush box	79,500	11.7	84,600	8.0
Silvertop stringybark	20,500	3.0	42,000	4.0
Turpentine	18,300	2.7	21,900	2.1
Spotted gum	52,400	7.7	68,000	6.4
Ironbark	16,400	2.4	34,700	3.3
White mahogany	13,100	1.9	14,800	1.4
Grey gum	8,200	1.2	8,800	0.8
Red mahogany	6,500	1.0	7,700	0.7
Other species	83,100	12.3	370,000	34.7
Total	677,100	100.0	1,063,100	100.0

(d) Dry Coastal Hardwoods

These mixed eucalypt types are the most widely distributed forest communities on the north coast. They are dominated by a diversity of eucalypts but particularly include the white mahoganies, grey gums, ironbarks, bloodwood, grey box, red gums, and stringybarks. Included in these forest types are substantial areas of forest containing species, such as scribbly gum, rough-barked apple, needlebark, and orange gum, that are not important for timber production.

The dry coastal hardwoods have been the major source of durable, high strength species for girders, poles and piles. They have also provided the bulk of the pit props and other timber for the development of the Hunter valley coalfield.

The dry coastal hardwoods occur on a range of sites typically of lower rainfall and greater exposure on the upper slopes and ridges of moderate topography. Soils are variable, particularly with respect to fertility, but they tend to the heavier soils where rooting depth, soil aeration and permeability are restricted. Understory is characteristically xerophytic, as these forests have been exposed to frequent fire. However, on more protected sites, these forest types may develop a mesic understory.

(e) Spotted Gum

Spotted gum occurs widely, yet discontinuously, throughout the coastal forests and the species provides over 6 per cent of the current sawlog cut from State Forests in N.S.W. The spotted gum types vary from woodland stands to tall wet sclerophyll forest, often growing on heavy soils of moderate fertility in areas of relatively low rainfall, and often intermixed with species typical of dry coastal hardwood forest.

(f) Tableland Forest and Other Types

The forest types of the northern tablelands N.S.W occur at higher altitudes but extend eastwards into the north coast forests to below 600 m elevation in some localities. These forests typically contain New England blackbutt, messmate, brown barrel, silvertop stringybark, manna gum or peppermint and have a similarity to the foothill forests of Victoria. The management of similar forest types on the southern tablelands of N.S.W. will be discussed by Hamilton and Cowley (1987). Seperate areas for these types are not provided in Table 1.

(g) Rainforest

A number of rainforest types occur in areas with either high nutrient soils or with high rainfall, where the incidence of fire is very low. Rainforest is a distinctive mesic community and its management will be discussed by Baur (1987). However rainforest does occur as an understory component of moist hardwood forest where tallowwood, blue gum and brush box typically constitute the overstory. Alternatively these three species, plus other eucalypts, may occur as scattered nomads in the rainforest community (Smith and Guyer 1983).

Other types include, for the purposes of the table, both miscellaneous and generally non timber-producing forests, and non-forested lands. Examples include paperbark oak, and swamp mahogany types as well as cleared land, water surfaces, heathland, coastal swamps and similar non-forested sites.

Many of above forest types extend south of Sydney, and north into Queensland. Further detailed descriptions of these forest types can be found in Baur (1962) and Forestry Commission of N.S.W. (1965). The large number of species of eucalypts, and the mosaic of their communities, is broadly related to species adaptations to, and tolerance of, various edaphic and microsite factors (Florence 1963, 1964, Meakins 1976, Awang 1977). However it is stressed that the factors responsible for the natural distribution of species on the north coast require more study.

History of Exploitation and Treatment

To understand the development of forest management on the north coast, it is useful to examine the pattern of settlement and early exploitation of the forests.

Discovery of red cedar on the banks of the Hawkesbury River about 1790 created the colony's first export commodity. Subsequent exploration and exploitation of this valuable timber relied entirely on the use of river transport and then coastal shipping.

By 1842 the cutting of red cedar had already reached the Richmond and Tweed river systems on the far north coast of N.S.W. (Daley 1968). Permanent settlers invariably followed the cedar trade leading to the development of relatively isolated but growing communities located on the major river systems and coastal ports. These farming communities gave a major impetus to clearing the forest, first on the alluvial soils along the river, but later spreading into the adjacent hardwood forest.

As the properties of the local hardwood species became better known, markets developed for both local and export use. Much of the production was a by-product of clearing for agriculture and grazing, but the trade was completely reliant on river and ocean transport. Various regulations were introduced which required licences for the cutting and removal of timber. Although providing a small revenue, there was little direct control over the timber industry (Kessell 1934). The amount of indiscriminate clearing became a matter of concern to the Government and in 1871 the first timber reserves were set aside. Shortly afterwards a rudimentary forestry administration was in place, highlighted by the appointment in 1881 of the poet Henry Kendall as the first Inspector of Forests and his death the following year (Smith 1982).

Although the newly-established Forestry Branch saw the reservation of much of the important forested lands remaining in N.S.W, the form of tenure was insecure and continued alienation and uncontrolled cutting continued during the depression of the 1890s and beyond. A Royal Commission into forests was set up in 1907 which resulted in the first Forestry Act in 1909 and a second in 1916, which created the present Forestry Commission of N.S.W. The Forestry Commission acted quickly to dedicate the existing reserves as State Forests and by 1920 most of the present day forest estate on the north coast had been gazetted. Working Plans (often supported by forest inventories) were prepared for the major accessible forests on the coastal plain.

Logging of these accessible forests had commenced in the 1860s with hauling by bullocks to the nearby navigable lakes and streams. In a number of notable instances, expensive logging tramway systems

were constructed, powered initially by horses and later by steam engines, to harvest some of the better quality forest areas (Simmons, 1977; Brooker, 1982).

By the early 1900s, accessible Crown forest areas were regarded as heavily exploited, degraded, fire damaged, and urgently in need of silvicultural treatment. However, despite both fire and high-grading, which left an overstory of mainly useless trees, the eucalypt forest had shown that it was capable of regenerating naturally and forming groups of advance growth with future potential. Between 1917 and 1927 much of the cut-over forest had been given silvicultural treatment, consisting of the ringbarking of useless overmature trees in order to promote further regeneration and stimulate the development of advance growth. An intensified version of this treatment later became know as "Timber Stand Improvement" or TSI and Jacobs (1955) referred to it as "Advance Growth Salvage", the precursor of the Australian Group Selection System. While some of this treatment was spectacularly successful and gave rise to modern examples of highly productive forest, fire damage continued to be a serious problem and in some cases silvicultural treatment was suspended until fire protection could be improved.

In these early days, the most silviculturally desirable species were the high strength, durable species such as the ironbarks, tallowwood, the grey gums, and white mahogany. The fast growing, less durable species such as blackbutt, flooded gum and blue gum were actively discouraged. These species later became the most important ones, due to their vigorous growth rates.

The area of forest given silvicultural treatment increased greatly during the 1930s assisted by labour made available by the unemployment relief schemes of the Great Depression. Silvicultural treatment came to a halt at the commencement of World War II as all resources were then devoted to harvesting timber supplies for the war effort. During this period the Forestry Commission attempted to increase its basic control of the logging operations through such devices as cutting girth limits, orders of working, prescribed cutting cycles, and in some circumstances yield control. These efforts were not particularly effective until after the end of World War II.

The accessible forests of the coastal plain had by then been utilised virtually continuously over a period of time often dating back to the 1860s. They had been afforded a range of silvicultural treatments and reasonable fire protection. Consequently these forests had developed an irregular, unmanaged structure characterised by the following features:

(1) A more or less balanced size class distruction

(2) A relatively low absolute volume of merchantable growing stock

(3) A high level of internal defect

Because of these characteristics, the forest had become self regulating in that only a limited (but sustainable) volume of mature timber became available for utilisation during a short cutting cycle (Curtin, 1970a).

The increased demand for timber during and after World War II led to the rapid expansion of logging into the previously inaccessible overmature forests of the coastal escarpment. The harvesting of these more remote ("up river") forests has been intensively managed by the Forestry Commission as its staff became more professional and greater control of the operations was achieved. Prior to the 1950s sawmills obtained their supplies from allocated areas but the actual rate of cut was largely left to the discretion of the mill. This system was changed in 1954, with each mill being given an annual quota, usually based on the volume of timber cut over the previous three years (Baur, 1982). Although these quotas often exceeded the sustainable yield, the quota system has been the basis for the continuing efforts to bring the forests of the north coast onto a sustained yield basis.

The initial harvest of these overmature "up river" forests is now nearing completion, and overall yields are being progressively reduced to a level which should be capable of sustention in the near future. As the Forestry Commission further intensified its management of the forest estate during the 1960s

and 1970s, the increased level of public concern for the environment has encouraged and assisted a re-emphasis on multiple-use management, and the development of greater controls over logging practices.

Changes in land use over the years have had a significant impact on the total forested area, and on land tenure. It is likely that there is now a greater proportion of the region under forest cover than was present 50 years ago, primarily as a consequence of the regrowth of forest on abandoned dairy farms. The total area of publicly-reserved forest has increased over the past few decades with dedications of additional areas of National Parks and State Forests. More recently there have been major revocations of State Forests in favour of National Parks.

In broad terms, the State Forests are in a healthy condition with high levels of total tree cover of mostly younger aged (less than 100 years) stands. Veteran trees are less common in forests of the accessible areas, but are relatively abundant, mainly as defective individuals, in steeper country away from the coast. The thinned second growth stands of blackbutt and flooded gum beside the Pacific Highway at locations such as Bulahdelah, Herons Creek and Pine Creek are fine examples which are now roaded and accessible to the public.

Current Production of Timber

To place the importance of the production of crown timber from the north coast forests in context, table 3 gives the production statistics for 1986/87.

TABLE 3. CROWN TIMBER PRODUCTION STATISTICS FOR NORTH COAST FORESTS

Products	North Coast	% State Total
Hardwood sawlogs		
Net Volume (m^3)	505,800	60%
Total Value ($)	10,898,000	63%
Price/m^3 ($)	21.55	
Hardwood Veneer Logs		
Net Volume (m^3)	16,600	100%
Total Value ($)	540,000	100%
Price/m^3 ($)	32.54	
Poles, Piles, Girders		
Volume (m^3)	30,700	91%
Total Value ($)	2,012,000	94%
Price/m^3 ($)	52.70	
Sleepers		
True Volume (m^3)	18,000	49%
Total Value ($)	557,000	46%
Price/m^3 ($)	30.94	
Mining Timber		
Volume (m^3)	27,100	58%
Total Value ($)	312,000	59%
Price/m^3 ($)	11.51	

Note: Percentage defect for sawlogs cut on the north coast during the 12 month period from June 1986 to May 1987 was 18.2%.

CURRENT STATUS OF FOREST MANAGEMENT

The Management Framework

Management of the State Forests of the north coast of N.S.W. is carried out within the framework of a statewide system. This framework will be outlined first, before describing planning provisions more specific to the North Coast forests. Forest management in N.S.W is composed of five major levels:

- Statutory planning
- Forest policy
- Strategic planning
- Operational planning
- Performance reviews

These levels are illustrated in Figure 3.

Statutory Planning

Statutory planning is incorporated in the provisions of the Forestry Act, which defines the objectives and powers of the Forestry Commission, and hence the broad objectives to be pursued in the management of the forest estate. These objectives are :

(a) to conserve and utilise the timber on Crown-timber lands to the best advantage of the State;

(b) to provide adequate supplies of timber from Crown-timber lands 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;

(d) to encourage the use of timber derived from trees grown in the State; and

(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, "In the attainment of its objects and the exercise 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."

Forest Policy

The forest policy statement of particular relevance to the management of north coast forests in the "Indigenous Forest Policy", (Forestry Commission of N.S.W., 1976). This document provides an overview of the management situation for the whole of the State's indigenous forests, although its development was initiated to clarify questions of management and silviculture on the north coast. This policy expands upon legislative objectives embodied in the

Forestry Act. It provides direction and guidance for the implementation of the policy by forest managers, and informs the public as to the scope and requirements of forest management.In addition to the "Indigenous Forest Policy",specific policies for particular activities or forest values are issued covering such issues as recreation, wildlife, erosion mitigation and fire control.

The "Indigenous Forest Policy" is in general terms similar in layout and content to a conventional forest management plan: the statutory control and their values are described; the social context is ex-

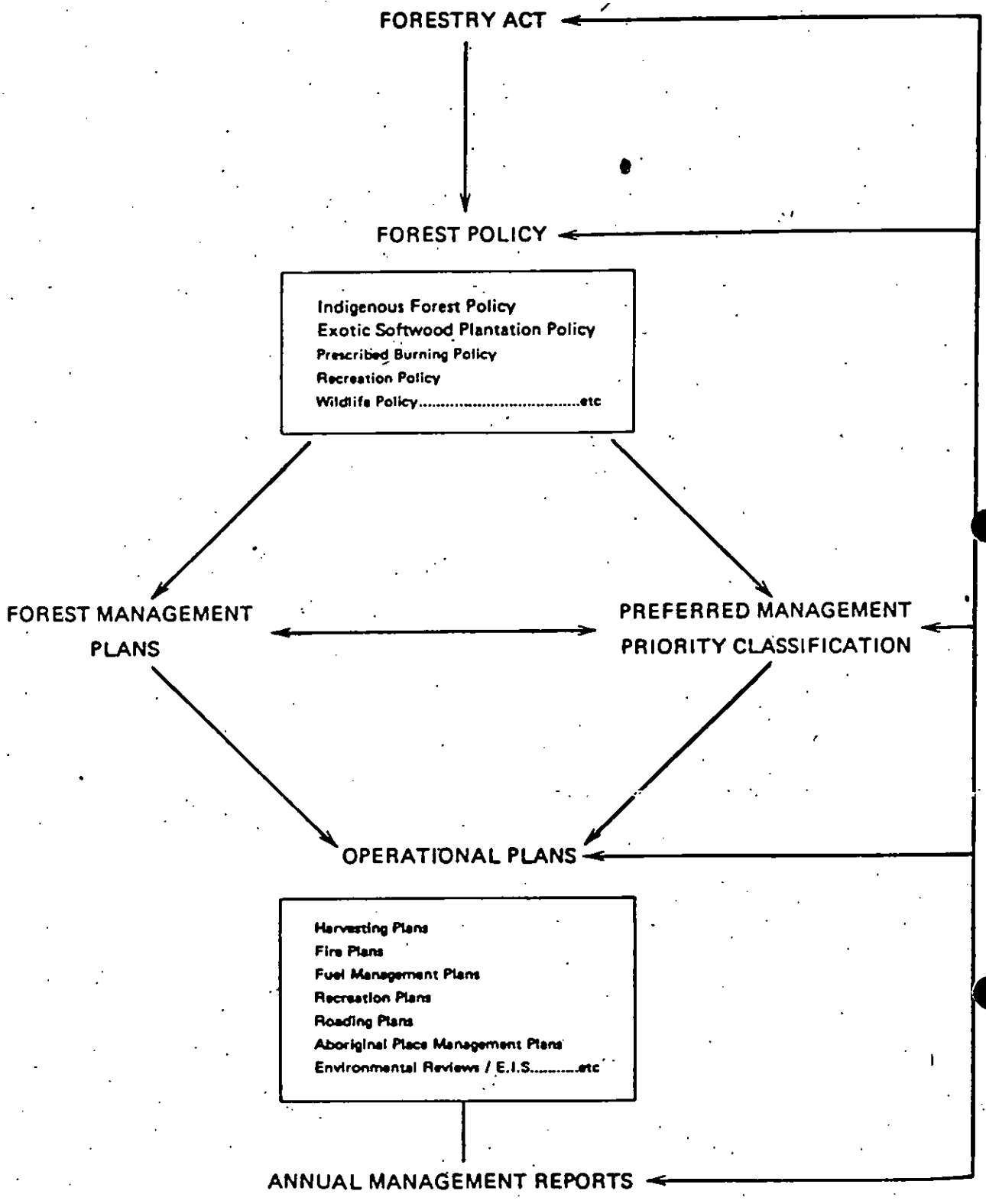

Figure 3: The Five Levels of Management Planning for NSW State Forests.

plored; and policies and their implementation are outlined. The "Indigenous Forest Policy" concluded in 1976 that:

- There will be a substantial deficit between demand for large sawlogs and the ability of native forests and softwood plantations to supply this demand for 20-30 years. After that time the increased production from softwood plantations will be expected to eliminate this deficit.
- Management should aim at maintaining sawlog yield from the native forest for the next 30 years at a high level subject to aintaining a suitable forest environment.
- This can be achieved by promoting growth on existing good quality growing stock. Less emphasis is needed on promoting regeneration.
- The substantial non wood benefits are important. These values need to be maintained by providing a diversity of species and age classes.
- Present management should ensure that the widest range of options for future management are retained.
- All opportunities should be taken to reduce the current overcut in order to achieve sustained yield in the long term.

The "Indigenous Forest Policy" prescribes for the more accessible forests that management should be directed to sawlog and round timber production, and for the maintenance of other forest values (wildlife,catchment values etc) but particularly for public recreation. Sawlog production is to be on a sustained yield basis, and during harvesting all thrifty stems should be retained in the stand for continued growth in order to alleviate the forecast deficit over the next few decades. Harvesting and silvicultural practices should aim to maintain species and forest types, with artificial regeneration techniques applied if and where necessary.

The forests of the steeper, or "up river" terrain are specified as extensive management areas, with sawlogs and other products harvested on a more complete utilisation basis of standing timber resources provided always that

- Sound vigorous advance growth is retained and
- A continued acceptable forest cover remains after harvesting.

An acceptable forest cover in these extensively managed forests may consist of some regeneration, secured without silvicultural treatment, and the retention of defective, residual trees from the original stand. These residuals need not necessarily have a future commercial value.

Circumstances vary between management areas but the general situation has been that the steeper and largely unlogged forests have supplied the bulk of sawlog resources in recent years. During the same period the coastal forests have been allowed to grow, with any harvesting operations designed for silvcultural advantage under a regime of long-term sustained yield.

Wherever the opportunity has arisen, and where necessary, sawlog commitments to industry are being reduced in conformity with the Indigenous Forest Policy, to match harvesting to the sustainable capacity of a particular management area.

Strategic planning

Strategic planning in N.S.W. is aided by two complementary items: the Forest Management Plan and the Preferred Management Priority (P.M.P.) Classification Map. It is at the strategic planning level that policies are integrated into specific objectives and a particular course of action is laid down for a particilar unit of land, called the Management Area. Each Management Area is a geographically defined management/administrative unit, and includes all State Forests, Timber Reserves, unleased and variously leased Crown lands, and other sundry publicly- owned lands (Figure 1).

Forest Management Plans lay down the objectives and strategy of long-term management for each Management Area, together with specific management requirements, or prescriptions, which are to be implemented. Plans are revised in periods ranging from 5 to 10 years. Each includes sufficient

background information to explain and support the adopted strategy and prescriptions. These Management Plans are of a classical structure that would be familiar to all professional foresters. They are public documents.

The Preferred Management Priority (P.M.P.) classification system is a form of forest zoning, which allocates all lands within State Forests into broad classes of long-term management intent and land use as a basis for appropriate priority or special emphasis in management. The 1:25 000 scale maps produced from such a classification for an individual Management Area are public documents and are in a standardised format. These maps give geographic meaning to Management Plan provisions and prescriptions, and are regularly reviewed and amended. The P.M.P. classification system will be fully described in a separate paper (Hamilton and Cowley, 1987).

A typical example of Management Objectives from a coastal Management Area is as follows.

1. To supply hardwood sawlogs to local industry at the maximum rate that can be sustained consistent with other objectives.

2. To supply poles, veneer logs, small wood and other timbers and products to the extent economically justifiable and consistent with other objectives.

3. To improve timber productivity to the extent that it is economically justified.

4. To provide for use for public recreation.

5. To maintain natural forest vegetation generally adequate to:

   Conserve soil resources and water catchment capabilities.
   Retain an aesthetic forest environment acceptable to the public.
   Maintain a diversity of habitat suitable to indigenous wildlife.
   Maintain the ecological viability of the various native forest types.

6. To maintain any unique or rare ecological, historical, floristic, faunal or other scientific or cultural values.

7. To provide for apiary sites, grazing, and other forest uses where compatible with other objectives.

8. To maximise net financial returns to the extent compatible with other objects of management.

The only major difference between objectives for the extensively managed "up river" forests, and the accessible coastal forests is in a reduced emphasis (in the former) on improving timber productivity by silvicultural investment. This reflects the unfavourable economics of silvicultural expenditure in sites remote from population centres. In other ways, management has identical objectives for the two forest categories.

Hardwood timber production objectives are designed to be achieved by the harvesting of mature, overmature and defective trees, and thinnings from immature stands to promote increment on potentially merchantable stems. Silvicultural removal of non-merchantable trees, subject to environmental contraints, is generally prescribed as a desirable practice in economically situated high site quality areas. While traditional sawlog harvesting has been the mainstay of forest production, attention is now being focussed on small wood production. Years of silvicultural work, especially by intensive regeneration establishment techniques, have given rise to stands that require thinning to promote continued growth. Thinning products are smaller than the traditional sawlog minimum size of 40 cm dbhob, but industry is developing techniques to successfully process these small sawlogs.

The production of timber other than sawlogs includes veneer logs, poles (durable and non durable species), piles, girders, sleepers, mining timber, pulpwood, fencing timber and firewood. The integration of forest operations is Forestry Commission policy and continues to develop offerring good prospects for efficient utilisation and orderly management of operations. Many of the markets for such products are highly variable, and supply continues to be on a demand and short-term availability basis.

Yields of individual products are set in Management Plans and separately regulated for the management plan period. An important aspect of the timber production strategy is the monitoring of yield on an annual basis, particularly against expected production.

Future timber production is aided by the encouragement of natural regeneration, supplemented where economically favourable, and silviculturally necessary, by site preparation and plantings of indigenous species following harvesting. This generally means that special silvicultural efforts are not applied to "up river" forests.

Public recreation objectives are pursued by efforts concentrated on maintaining and expanding established visitor facilities, according to monitored demand and usage.

Maintenance of natural vegetation cover and related objectives are met by the timber production strategy and by intensive fire protection. Other measures include:

- The application of "Standard Erosion Mitigation Conditions" for N.S.W Forests" to all forest operations.
- Exclusion from or modification of logging or other forest operations in preserved areas and areas of particular sensitivity designated for special emphasis under the Preferred Management priority (P.M.P) system.
- Planting to supplement natural regeneration in areas where existing tree cover may not be at an acceptable density, and were the timber production strategy does not prevent special regeneration effort, such as in low site quality areas.
- Selective retention of trees suitable for wildlife habitat.

Unique, rare or associated values are maintained by retaining existing reserves (Flora Reserves, Forest Preserves) or by sympathetic management of special emphasis P.M.P. areas. Additional sites are identified and set aside as investigations reveal their presence.

Miscellaneous forest uses are encouraged where such uses are compatible with other forest uses. Bee-keeping and grazing are the most common of these miscellaneous uses.

Objectives related to improving financial returns are pursued by continuing review of forest works, marketing strategies and operational procedures.

Operational Planning

Operational Planning involves the more detailed planning of individual operations or types of operations within the general strategy established by the Management Plan. Examples of these plans are roading and logging proposals, harvesting plans, fire plans, fuel management plans, recreation plans, and orders of working. Documents and reports produced in such exercises are usually regarded as internal working aids and are not designed for public information. In general terms operational plans are produaed to conform with guidelines as to their content applied on a statewide basis. Actual planning and implementation is the responsibility of the field forester in charge of an individual Management Area.

Performance Review

Performance reviews are presented in Annual Management Reports. They compare performance for the year at the operational level with the prescriptions of the Management Plan, and provide the feedback mechanism for overall review purposes. These reports provide the major opportunity to review management performance in a comprehensive and integrated way on a routine basis.

Multiple Use Management

Multiple use management is being pursued within the north coast forests of N.S.W. However, it is clear that wood production has priority. Timber production has long been an integral part of the socio-economic structure of the region, and its forests, nevertheless there has been a strong emphasis on continued management for the non-wood values and the methods being used are described below.

Recreation

The north coast seaboard is a major holidaying area in N.S.W, centred on areas such as the Central Coast south of Newcastle, the coast north of Lismore, and major towns such as, Port Macquarie and Coffs Harbour.. State Forests are within easy reach of all coastal recreation bases and are heavily used on a day visit basis. Use statistics for Coffs Harbour Management Area for 1985/86 indicate an eatimated 180 000 visitors, and for Kendall Management Area (about one third the size of Coffs Harbour, at the time) it was 50 000 visitors.

There are two types of visitor facilities provided: Forest Drives and specific stopping-places. Forest Drives have been developed in all Management Areas, and aim to show the visitor scenic features as well as educational aspects of forest management. Selected sites such as lookouts, attractive creek-side areas, waterfalls, outstanding trees or examples of special forest types are developed as picnic areas, and occasionally as camping sites. Forest access is good and usually of an all-weather standard. Vistors are warned of current forest operations and forests may be closed in fire danger periods, otherwise access is uncontrolled. Rangers are employed to perform special recreation monitoring and servicing functions including during weekends.

One recreational development of particular interest is the use of the Nymboida River in Dorrigo and Grafton Management Areas for white water rafting and canoeing. Commercial ventures are licensed to operate tours on this stream and activities are specially monitored.

Exclusive use forms of recreation, such as trail bike racing, and car rallying are catered for as special events when a demand arises.

Conservation of Flora

The multiple use management of northeastern N.S.W eucalypt forests aims at maintaining existing floral species diversity so as not to preclude any future forest land use options. This conservative approach to management is supplemented by an active program of native forest preservation, which sets aside examples of forest to be retained with minimal human disturbance (Baur 1981). Initially the selected sites are set aside as Forest Preserves with a P.M.P. classification of 1.3 Preserved Natural Forest. Ultimately these Forest Preserves are notified as Flora Reserves under the Forestry Act; and are managed under a formal working plan approved by the Minister. Flora Reserves can only be revoked by Act of Parliament.

This system of Flora Reserves and Forest Preserves on State Forest complements those forests preserved in the National Park system, especially be preserving forest types and naturally coexisting groups of types not sampled by National Parks. With a median area of about 100 hectares, Flora Reserves and Forest Preserves are smaller than National Parks but provide a more extensive sample of forest communities. Flora Reserves and Forest Preserves serve primarily as scientific reference areas for future research and understanding of ecosystem processes. Also they may be used to protect areas of particular aboriginal, historic, scenic, or recreational signigicance. At the beginning of 1984, the total area of Flora Reserves and Forest Preserves on the north coast was 18 200 ha in 87 reserves with a mean area of 209 ha. The reserves cover all forest types including rainforest.

Management of these reserves involves complete protection of flora and fauna (except for bona-fide scientific purposes) including exclusion of logging, soil removal, and mining operations and, as far as possible, the exclusion of grazing by domestic stock. Deliberate burning for fire hazard reduction purposes is excluded from most reserves but occasional fire is used as a deliberate management operation to maintain the character of some Flora Reserves.

addition to these Flora Reserves and Forest Preserves additional areas may be managed with special emphasis on maintaining or preserving the occurrence of particular flora through the use of F.M.P. classification of areas for that purpose. Specific efforts are made to ensure the adequate protection - preferably through formal reservation - of viable samples of recoginised rare or threatened species.

Conservation of Fauna

The hardwood forests of northeastern N.S.W. contain a notable diversity of arboreal fauna. All five Australian species of marsupial glider are widespread in forests of this region. North coast hardwood forest occupies a central part of the distribution, and provides core habitat for populations of koala (eucalypt forest's largest arboreal folivore), tiger quoll and powerful owl (Australia's largest arboreal carnivores). Notable terrestrial forest dependant wildlife of north coast hardwood forest include both species of lyre bird, swamp wallaby, parma wallaby, and potoroo.

Although the National Parks and Wildlife Service has the primary responsibility in N.S.W. for the conservation of flora and fauna, the Forestry Commission recognises the high conservation value of the State Forests in complementing the National Parks system. In terms of wildlife management, the main thrust of the Indigenous Forest Policy is to use logging and silvicultural treatments to maintain the diversity of the forest in terms of age, species, structure and condition classes. The Forestry Commission adopted a wildlife policy in 1980 which states that the forests will be managed so that the overall diversity of the existing native species of animals is maintained. This will be done by maintaining suitable habitat and viable populations of all species on a regional basis, giving particular attention to forest dependent animals, as well as rare and endangered species.

It also provides for setting aside undisturbed areas of forest. This wildlife policy is currently under review but it has been useful while research and wildlife inventory are undertaken to focus more clearly on the impacts of forest practices on wildlife and how they can be ameliorated. Rare or endangered fauna are subject to special management constraints. For example, on the north coast logging operations are excluded from 12.5 hectare areas surrounding all known singing sites of the rufous scrub bird. They are also excluded from all known habitat of the Hastings River mouse.

Wildlife species most influenced by forest harvesting and management for timber production are those species dependant on trees with nesting or den hollows (Recher *et al.* 1980). For this reason the retention of hollow trees is a common prescription in the management of multiple use eucalypt forest. About 500 individuals is the population size considered to be adequate to maintain genetic heterozgosity of wildlife species for continued evolution (Brown 1983). Many hollow dependant wildlife species can occur in population densities whereby adequate populations for continued evolution are retained in areas of forested land that are not harvested, such as connected filter strips, steep areas, uneconomic harvest areas, or other preserved forest. It is conventional belief that logged forest with retained hollow trees extends the utilisable habitat of hollow tree dependant wildlife species, beyond that of the area of habitat retained as non-logged refugia.

Although comparatively small areas of habitat may be adequate to conserve many hollow tree dependant wildlife species, such areas would not be adequate for conserving wildlife species dependant on extensively distributed resources (Johns 1985). In north coast hardwood forests such species include: various species of black cockatoo (hollow dependant: h.d.); nomadic fruit pigeons; exudate feeders such as lorikeets (h.d.), fruit bats, and yellow-bellied glider (h.d.); and top carnivores such as the larger owls (h.d.), dingo, and tiger quoll. Such wildlife can be adequately conserved by the maintenance of a scattered distribution of critical resources such as occurs under multiple cycle logging regimes (Johns 1985). By the retention of scattered hollow trees and their recruits and scattered groves of retained advanced growth and stands of mature understorey, following logging, multiple use forest contributes greatly to the maintenance of habitat for eucalypt forest wildlife species that depend on extensively distributed resources.

Catchment Protection

The Forestry Act and the Indigenous Forest Policy recognise the importance of forests generally for the protection of soils and catchment values. Most management plans have a major management objective of maintaining the area under a cover of natural vegetation to conserve the soil resources and water catchment values. One strategy for achieving this objective is preventing the occurrence of wildfire, although the use of prescribed burning may be an important technique in achieving this fire protection.

It is recognised that logging and road construction can cause soil erosion and lead to increased levels of suspended sediment and dissolved solids in stream water. Consequently the production of timber may need to be constrained on some parts of a catchment, and certain modifications may be needed to the harvesting techniques employed. By using this strategy, the production of timber and water can be compatible (Cornish and Mackay, 1981). These constraints are being imposed through the Preferred Management Priority classification (P.M.P. 1.1.5) and the adoption of the Standard Erosion Mitigation Conditions.

The north coast of N.S.W has a relatively high rainfall. The river systems have a high run off, of which very little is stored for irrigation or domestic use. Most small communities obtain their water supplies direct from the streams and many of the larger towns have only small storage systems which are supplemented by pumping from the river as needed. Under these circumstances, the quality of run off water is much more important than the amount of water produced, and the turbiditity of the water is the most important water quality variable. High turbidity is not acceptable in potable water supplies and can cause problems in the important fisheries of the lakes and rivers.

The forests of the coast and lower catchments make such a small percentage of the total catchment area. The run off from these forests is only locally important and has no appreciable impact on the overall quality of water, which tends to be influenced primarily by farm and grazing land. The Forests of the coastal escarpment however tend to dominate land use in the upper parts of catchments and are also more important because of generally higher rainfall and rapid run off from the steeper terrain.

The impact of logging on water quality has been the subject of considerable environmental debate, and in N.S.W the problem has been approached by research, by the introduction of general controls on harvesting known as the Standard Erosion Mitigation Conditions, and by making special management provisions in those forest areas locally important for domestic water supplies.

(a) Hydrology Research

A major hydrological research programme was commenced in the Chichester Management Area in 1975. The primary objective is to provide quantitative information on the effects of eucalypt plantation establishment, and two intensities of harvesting, on water quality and water yield in a steep moist hardwood forest. After calibration for 7 years, the catchments were logged and treated. Quantitative data is now being obtained on the apparently rapid recovery rate of these catchments.

A number of other studies were established to monitor the effects of routine forestry operations on the water quality of streams draining large areas of managed forest. In general it has been shown that forest operations do not have an excessive impact on stream turbidity levels (Cornish, 1980).

Most monitoring studies were undertaken prior to the general introduction of erosion mitigation conditions and represent more extreme situations than exist now. In general these studies were able to measure increased but temporary elevations of stream turbidities, often associated with bridge construction or road works in close proximity to permanent streams. Although mean turbidity levels were elevated relative to unlogged catchments they remained within acceptable standards on average. Turbidity levels in the forest were always lower than in agricultural and pastoral areas downstream.

Turbidity in undisturbed forest streams varies widely as a consequence of soil types, rainfall and catchment slopes. The natural range in turbidity values recorded in unlogged catchments over a period of time is often larger than the values recorded immediately after logging.

(b) Standard Erosion Mitigation Conditions

In the absence of definitive reseach results, the Forestry Commission and the Soil Conservation Service drew up a general set of conditions which in 1977 were applied to all harvesting operations under the control of the Forestry Commission and those provate forests which come under the jurisdiction of the Catchment Areas Protection Board. They cover all facets of the harvesting operation from the construction of the access roads through to revegetation of tracks and log dumps and will be described later in more detail.

(c) Domestic Water Supplies

When a catchment for a domestic water supply consists largely of forest which is also being used for timber production, additional protection is usually given by further modification of logging practices within areas designated as special emphasis under the Preferred Management Priority Classification.

For example in the catchment of the Rocky Creek Dam which supplies water for the city of Lismore, a 40 metre wide strip is excluded from logging along the dam foreshore and on both sides of the tributary streams. In addition to the Standard Erosion Mitigation Conditions the following measures also apply:

- The retention of filter strips on streams and drainage lines where the catchment area exceeds 30 ha.
- The use of buffer strips 5 metres wide along both sides of drainage lines extending to the boundary of the catchment.
- Drainage works specifications applicable to high erosion class soils.
- Automatic closure of roads and the cessation of harvesting when water commences to flow in the table drains of roads, or on the surface of snig tracks, during rain.

Additionally, in recognition of the importance of Rocky Creek Dam to the community, activities which would increase the risk of bacteriological contamination are excluded from the Dam catchment.

Such activities include temporary or other residential facilities, grazing, or recreational developments likely to lead to concentration of people on the ground, particularly close to streams.

Protection of Visual Resources

The north coast forests are a dominant part of the regional landscape and are valued for their variety and wide distribution. They have both "foreground" or close range attractions when the individual character of trees, forest structure, and varying forest types becomes important; and a general "background" role in enhancing landssscape appearance. There are many renowned examples of the beauty of the north coast forests, such as O'Sullivans Gap near Bulahdelah (flooded gum, moist hardwood and rainforest), Middle Brother (veteran blackbutt), Heron's Creek (second growth blackbutt, Bruxner Park (flooded gum and rainforest), and Whian Whian (blackbutt).

Management strategies recognise these visual attractions of the forests and require that special provisions be made for their protection and enhancement. Measures adopted include:

- P.M.P. classification for Special Emphasis for visual features protection.
- Recreational developments are accompanied by special provision for visual protection.

- Particular sites may be given statutory proctection (Flora Reserves).
- Harvesting plans cater for retention of visual attractions in the siting of loading ramps, snig tracks or haulage routes, and the organisation of harvesting operations.

MANAGEMENT PROCEDURES

Management Planning, Inventory and Yield Regulation

There are 19 indigenous forest Management Areas in 16 Districts within 3 Regions on the North Coast (Figure 1). Management Plans have been published for 17, with each plan operating from five to ten years before revision is required. A number are due for revision. These are conventional documents and provide a comprehensive understanding of the management regime currently in place. They are prepared by local foresters according to guidelines, and reviewed and amended by senior management and specialist staff of the Forestry Commission before formal approval by the Commission, and publication.

Most of the basic descriptive data for the various Management Areas already exist in one form or another. For example forest type maps have been available for some years, but certain categories of information require special efforts for their compliations. Comprehensive flora and fauna lists are examples.

Timber stand data availability is variable and depending upon prevailing circumstances, new projects may be undertaken as part of the management planning process. In the most complex situation, an investigation can consist of the following procedures:

- Acquisitions of new aerial photography, of 1:15 000 or 1: 25 000 scale.
- Air photo interpretation for stand tree size and canopy density stratificaction of areas identified for timber production, and subsequent map production.
- Stratified random sampling using variable radius field plots.
- Data analysis and sorting.
- Cutting cycle analysis (McGrath and Carron, 1966) for sustained yield sawlog production.

In the simplest situation (ie. unlogged, overmature forest), the collation of historical data is sufficient to provide an analysis of past performance, and map records indicate the distribution of current resources. As yet, no sophisticated geographic information systems (GIS) are employed in current forest resource recording or evaluating programs.

Forest increment data is available from a variety of sources such as research studies, Continuous Forest Inventory (C.F.I) plot series, and Permanent Growth Plots (P.G.P). The latter represent a comparatively new development in N.S.W. forests, and have the specific aim of collecting comprehensive and standardised growth data for the more important forest types throughout the State, for all native forests which are to be managed on a long term basis for wood production. The P.G.P. plots have been designed to replace the old C.F.I systems which proved to be expensive, limited in their coverage and usually inappropriate for the collection of both growth and inventory information.

Plots in the P.G.P series are located systematically at a pre-determined intensity. They are established and subsequently maintained only in areas that have been recently logged, and are permanently marked in the field. The plots are of variable radius, designed to include at least 5-10 trees per plot in each of the diameter class ranges of 10-30, 30-50, 50-70, and 70 + cm. Plots have a minimum area of 0.1 ha. Parameter measurement is comprehensive and standardised, with full tree and site characteristics recorded. The aim of the P.G.P. system is to overcome deficiences in knowledge of stand increment under modern management regimes, by providing an unbiassed and readily-maintained sampling method. Such plot series are now in place in north coast forests, but it will be some years yet before worthwhile increment data is available.

Yield is normally reulated on the basis of "quota-quality" logs, ie. sawlogs over 50cm cdub and above certain minimum defect percentages, and maximum or average yeilds are specified in each management plan. In some instances current allocations to industry are above the sustainable level and in

such situations a plan will outline a specific strategy for reduction or specify that opportunities shall be taken to reduce the volume harvested annually towards the level which can besustained. Cutting cycle analysis is often employed to determine allowable cut, and there are two basic approaches. One employs the notional harvesting of trees according to various efficiency classes (assessed from dominance, vigour, stem from and quality categories). The other approach is somewhat simpler and involves the classifying of trees in the field into harvesting categories for removal in the current or later cutting cycles. Both forms of cutting cycle analysis require estimates to be made of diameter increment, mortality, damage and tree defect. The most important attribute in this regard is the practical availability for harvesting of a tree or a stand.

Many trees may be classed as utilisable in inventory but are unavailable for harvest in practice because of

- Inaccessible terrain
- Uneconomic harvesting conditions
- Environmental sensitivity
- Damage from neatby harvesting.
- Incorrect merchantability classification

All five of these factors reduce the volume available for present or future harvest.

Both forms of cutting cycle analysis estimate allowable yield over one or two relatively short (usually 25 year) cycles, with an indication of recruitment for subsequent cycles. Monitoring of actual yields is regarded as a critical requirement in checking the forecasts derived from yield analysis. The yields of other timber products are most often regulated by demand and availability under the prescriptions for the harvesting of quota-quality sawlogs. Although sustainable yields may be determined for products such as poles or veneer logs in some management areas.

Of the 19 Management Areas on the North Coast, 12 are on estimated sustained yield for sawlog production, and 7 indicate that current levels of harvesting need to be reduced below existing commitments. These reductions are currently in process of being achieved through explicit strategies incorporated into management plans and negotiated with industry. With the majority of these Management Areas, there is a deficiency of advanced growth in madium size classes so that calculated sustained yields are in fact below long/term capacity for sawlog production. Indications are that over some 40-50 years, recruitment from the smaller size classes will permit an increase in sustainable yield generally throughout the accessible forests of the north coast.

Preferred Management Priority Zoning

P.M.P mapping has been completed or is well underway for all north coast management areas.

Orders of Working

Orders of working for commercial forest operations are of particular importance in north coast forests because of the highly variable condition of stands. Old growth trees suitable for, and requiring, removal are comparatively few in number. On the other hand, advanced growth and smaller regeneration need thinning to ensure tree growth is maintained. These aspects need to be addressed along with the necessity to provide industry with an even flow of sawlogs, and the practical requirements of orderly forest operations. Orders of Working are drawn up annually for the following two years and are approved by senior management.

A typical Order of Working (Coffs Harbour Management Plan 1984) contains the following provisions for harvesting in State Forests:

- Priorities to supply commitments shall be:
  - Thinning of overstocked regeneration stands
  - Harvesting of areas carrying large volumes per hectare of overmature and defective trees.

- Harvesting of areas carrying large volumes per hectare of mature trees not required for retention

- Areas suitable for wet weather logging should be set aside for that purpose.
- Logging areas should be allocated:
  - to avoid relative economic disadvantage to timber licescees to provide species mix and site conditions mix)
  - to avoid concentration of operations might prejudice aesthetic or wildlife values
- Operations should be integrated as far as practicable.

An Order of Working is normally provided also for silvicultural operations, based on preferred stands and sites.

Control of Harvesting Operations

Harvesting is the key process in manipulating the growing stock, securing the yield, and providing space for regeneration. It also involves disturbance to the site and must be controlled to minimise adverse environmental effects such as soil erosion. Poorly located logging roads or stream channel disturbance during harvesting operations can result in serious but unnecessary impacts on soil and water quality. The range of procedures used to control logging operations are outlined below.

Standard Erosion Mitigation Conditions

These conditions set down standards for the location, construction and drainage of roads, logging tracks and snig tracks. In particular, the roading pattern should be located on ridges, where practicable. Logging tracks should have cross fall drainage and are drained by cross banks as soon as logging ceases. Streams are crossed only with use of appropriate structures. 20 metre wide filter strip of existing vegetation are retained on both sides of streams having a maximum catchment of 100 ha, although there conditions are made more stringent when soil erodibility or stream conditions so warrant. Trees are not felled into watercourses and the movement of machinery is prohibited within a filter strip.

Snigging should be uphill, where practicable and all snig tracks must be drained by cross banks at a spacing depending on grade and reodibility class. As a general rule snig grades should not exceed 25. Log dumps should be located for an uphill extraction pattern, top soil is stackpiled for later recovery, of logging, the dumps are drained. The practice of "blading - off" on minor roads and tracks is restricted, as is traffic on these tracks when run off is occurring.

The erosion mitigation conditions are primarily concerned with preventing serious erosion during and after all stages of forest operations and are a major factor in ensuring that clean water and timber can both be produced from the forest. Other measures such as closures to logging and hauling during wet weather are also used. All logging operators and contractors are licensed under the Forestry Act and one of the conditions of that licence is the carrying out of erosion control work in accordance with the Standard Erosion Mitigation Conditions.

Environmental Review

An environmental review is undertaken and documented, by a forester, for operations on State Forest. It reviews the predicted environmental effects of imminent intended activities ranging from small areas (bridge construction) up to several thousand hectares (aerial ignition for fuel reduction).

An intended activity must conform to Management Plan objectives and constaints identified on P.M.P maps. The effects of an intended activity are formally assessed for the following environmental factors:

a) environmental and social effects on local communities.

b) physical transformation of the locality

c) impact on ecosystems of the locality

d) diminution of aesthetic, recreation, scientific, or other values

e) effect on structures or places with aesthetic, cultural historical scientific, archeological or special values

f) danger to species of flora and fauna

g) long term effects on the environment

h) degrade in quality of the environment

i) risk to the safety of the environment

k) air, water, or noise pollution

l) problems of waste disposal

m) increase in demand on scarce resources

n) cumulative effects with other exisiting or likely future activities

o) identification of departures from established policy.

The review should also identify constraints on activities, that can be applied to ameliorate the environmental effects of those activities.

In practice the review procedure is undertaken several months to several years before a major activity proceeds. A previously unlogged area will be inspected and will have a review written before there is expenditure on road survey; this reviews the effects of roading, logging, silvicultural treatment to follow logging, and the initial hazard reduction burning operations following logging.

The review necessarily incorporates both subjective and objective elements and is a professional forester's assessment of the situation. The Forestry Commission is the consent authority, under the N.S.W Environmental Planning and Assessment Act, for operations on State Forests. For the purpose of this laws, the review is used as an administrative internal procedure to help determine whether or not the environmental effect of a proposed activity is likely to be significant and hence whether an Environmental Impact Statement should be prepared before a decision is made to undertake that activity.

Roading

Virtually all major roading has been completed, in the north coast forests with primary and secondary networks established for a number of years. New roadworks tend to be confined to tertiary or "feeder" road contruction (these being required to tap single logging units). Road maintenance, including the "bedding-down" of access after current cutting cycle harvest operations, is now a major cost in the management of these forests.

Roading practices focus on aesthetic and environmental pretection requirements as well as efficient engineering design. Preference in read location is given to ridge top roading with minimal clearing width, and where possible to "non-seen" sites, to reduce the visual impact of new construction. Debris disposal, creek crossings, batter construction and revegetation, and earth works generally are undertaken with particular attention to minimising environmental and visual disturbance.

Gravel and borrow pits are located and planned with eventual restoration in mind.

Types of Harvesting Operation

Harvesting operations vary in their nature and intensity. These operations and particularly the residual stands which result from them are influenced principally by the:

(a) products being obtained

(b) structure of the forest stand

(c) quantity and quality of the growing stock making up the stand

(d) constraints which operate as a result of the Indigenous Forest Policy, and the high cost of silvicultural treatment.

Consequently harvesting in a forest with a high proportion of overmature trees with high defect will tend towards a clear falling operation. A well structures second growth forest, with a good proportion of growing stock in the larger size classes will be logged conservatively (Florence 1970), with a reduced emphasis on regeneration fellings, as a result of the desire to retain vigorous growing stock for further valuable sawlog increment. Alternatively a plantation or even-aged stand of young regeneration might be thinned heavily to promote the growth on the residual stand of potential sawlogs, providing a mrket for small timber is available. Finally a low site quality forest of dry hardwoods may only support a light, high grading selection logging for a few poles, sawlogs, or sleepers.

The ability to market a wide range of forest products from a variety of species will have a considerable impact on the type and intensity of harvesting operations. Because of the benefits which flow to both forest management and the timber industry, the Forestry Commission has adopted a policy which requires licensees to integrate the supply of products into the one harvesting operation. There are administrative problems in arranging a smooth flow of all products in the correct proportions, but the benefits are well worthwhile. There is provision for the payment of a reject tree allowance to the licencee to encourage the cutilisation of trees of doubtful merchantibility. The size of tree harvested ranges upward from as low as 10 cm dbhob and estimates of the number of trees sold in each size class are given in Table 4.

Mining timber has provided a large (but now declining) market for trees 10-20 cm dbhob. This market is concentrated in the Hunter Valley although supplies are also made to the coalfields to the west and south of Sydney. Supplies are drawn from forest thinning operations as far north as Coffs Harbour. There is a small demand for similar sized trees for oyster stakes, viticulture and for horticultural timber in those areas where markets exist. Small sawlogs from trees 30-50cm dbhob, of varying quality, are utilised mainly for pallet, case and fencing timber. Straight, sound, small to medium sized trees are utilised for high value products such as poles, piles or girders. Trees generally over 50 cm dbhob are mostly utilised for veneer and sawlogs. Short offcuts from poles or logs may be cut into railway sleepers.

Woodchip

A small but important pulpwood industry, is centred on the Hunter Valley. Some silvicultural and sawlog residue timber is chipped to make hardboard at Raymond Terrace. Chipped sawmill waste from many sawmills on the north coast, plus chipped sawlog and silvicultural residues from the Hunter Valley and nearby management areas are exported to Japan through the port of Newcastle. Market constraints exist due to selective species requirements, and relatively low royalties for export woodchip timber. Pulpwood is obtained from residue timber remaining in heads, butts or reject trees after routine harvesting for other forest products.

Chippable material is also produced from the thinning of young regrowth stands and from the harvesting of culls in areas programmed for regeneration treatment. These areas are limited in extent to the area which would have been culled to waste prior to the development of a market for pulpwood.

TABLE 4. ESTIMATE OF THE NUMBER OF TREES SOLD IN EACH SIZE CLASS — NORTH COAST CROWN TIMBER (June 1986 — May 1987)

DBHOB Class (cm)	Estimated No. of Trees Sold	%
0-20	200	0.1
20-30	7,300	2.7
30-40	23,800	8.6
40-50	39,600	14.3
50-60	54,700	19.8
60-70	51,400	18.6
70-80	35,600	12.9
80-90	22,300	8.1
90-100	14,600	5.3
100-110	9,600	3.5
110+	16,700	6.1
Total	275,700	100.00

The chainsaw is the most common method for timber felling in eucalypt forest. Most snigging is by wheeled skidder or crawler tractor depending on terrain. Several bullock teams still operate as small operations drawing small logs on relatively flat terrain less than one hour walk from suitable resting paddocks. Many harvesting operations are now integrated operations with product sorting at truck loading site. A recent development has been the use of excavators to debark, sort, stack and load products in integrated operations; they have the additional useful capability of spreading soil free waste bark tracks back into the forest for less refractory burning or decomposition and minimal fire hazard.

Codes of Practice

All operators are required to comply with the provisions of a regional code of logging practice that covers all harvesting operations in State Forest and Crown-timber lands in a forest Region. The codes are similar between regions but details such as tree marking or log identification may vary. All operators receive a copy of the Code booklet. The booklet briefly explains the statutory controls on timber harvesting operations under the Forestry Act, Workers Compensation Act, Occupational Health and Safety Act, Motor Traffic Act, and Local Government Act. The booklet details the code of practice under operational sections dealing with:

i) Safety

ii) Planning of Harvesting Operations (including tree systems and product identification)

iii) Tree Felling Practice (including explanation of tree retention requirements)

iv) Extraction and Loading Practice (including load limits and road maintenance)

vi) Constraints on Wet Weather Logging Operations

vii) Fire Precautions

viii) Aboriginal Sites

xi) Control of Firearms

Harvesting Plans

A harvesting plan is a short term logging plan prepared and implemented at District level. Preparation of formal harvesting plans was introduced by the Forestry Commission in 1976 to improve the planning and administration of harvesting operations particularly with respect to the inter action of logging with aesthetic and environmental safegards. It is an operational plan designed to make sure

that all the requirements of the management plan and the policies of the Commission are in fact brought to consideration at the level of individual operations. Harvesting plans are distributed to the supervising foreman, the licencee and the logging contractor and thus provides for improved communication and feedback prior to the commencement of the operation.

While the format of these harvesting plans is flexible, it nomally consists os a sketch map of the area with attached conditions.

The sketch map will specify such items as compartment and coupe boundaries, and the location of logging tracks, stream crossings and log dumps. It will also show the location of filter strips, reserve areas and special prescription areas under the Preferred Management Priority classification. The plan will also define wet and dry weather logging areas, inaccessible (steep) areas, and the order of working, It will specify the colour codes used in tree marking for removal of logs or the retention as desirable growing stock, wildlife habitat or seed trees. The erodibility class for nominating the spacing of cross drains on snig tracks will also be given. A description of forest types and stand conditions may be included, indicating yields of various products. Often the harvesting plan will include a post logging check list which needs to be ticked off and signed by the supervising foreman to verify that the operation has been completed properly.

Field Implementation and Supervision:

Implementation of harvesting plans and field supervision begins at the environmental review stage of operations. Consultation of the P.M.P. map and field inspection for the review identifies critical areas requiring special management prescriptions.

For integrated harvesting operations the supervising forester predicts the product mix and arranges harvesting areas so that an even flow product mix can be obtained. Before the harvesting operation begins in an area there is an inspection by the supervising forester and other supervisory staff and the harvesting plan is explained on site. The harvesting contractor usually takes part in this inspection. Critical areas such as filter/protection strips or preserved areas are mapped on harvesting plans and their boundaries are usually marked (by bark blaze, paint or ribbon) in the field, before harvesting. If the boundaries are obvious or are easily interpretable they may not be marked.

The operation is inspected soon after it commences so that:

i) incorrect practice can be quickly identified and any necessary remedial action can be taken immediately, and

ii) timber quality of the area can be monitored and adjustments to harvest prescription can be readily made, if required.

Tree marking is done prior to harvesting. Follow up marking for removal may be done if there is inadequate utilisation in areas where trees were marked for retention only. On completion, the harvesting area is inspected for quality of utilisation, snig track drain age, and compliance with the harvesting plan and code of logging practice. Breaches of the conditions laid down in the code of procedure and incorporated in the licence can attract serious penalties such as fines or suspension of licence.

CONTROL OF PUBLIC USE

The use of State Forests in N.S.W. by the public is regulated in two ways. The first method involves the specific legal provision of permits, licences or leases. In essence, any person or organisation deriving economic or exclusive benefit from the forest estate must hold legal authorisation from the Forestry Commission following activities are authorised on north coast forests:

- Logging, with a licence covering general operations and separate licences for persons actually working within State Forests.
- Other timber products harvesting.

Bee & keeping (permit per apiary site)

Grazing (permit for number of stock).

- Occupation (long term lease, or annual permit). Miscellaneous products removals eg. native plants, gravel.
- Miscellaneous activities eg. hunting, conduct of research, car rallies.

The second type of public use of forests involves general recreation. In broad terms, the State Forests of N.S.W. are freely open to the public for non-exclusive use and visitation. Camping for short periods is permitted and is not regulated nor is a fee currently required.

Forests may be closed to the public in times of extreme weather such as flood, wind or fire danger, otherwise there are no general exclusions. Visitors are warned of harvesting operations by signposting. Rangers are employed for weekend patrol of busier recreation sites.

MANAGEMENT CONTROL

Annual Management Reports and Compartment Records

Annual Management Reports are required to be prepard each year of operation of the management plan for each Management Area.

Detailed records of the yield of each commercial product obtained from individual compartments are kept in a compartment history system. These records include details of silvicultural treatment, fire occurrence and other relevant information. A copy of the harvesting plan is also generally lodged in the compartment history. Maps of areas logged and treated are updated annually and include other records such as details of recreation usage.

Management Accounts

Since 1981/82, the Forestry Commission has been keeping accounts on an accrual basis according to both historical cost and replacement cost conventions. This is designed to permit a full measure of profitability and the extent of recovery of costs through royalty and other income. Commercial accounts are kept for accounting units which correspond with management area boundaries.

This accounting system involves three major variations from the traditional type of direct expenditure statement previously used. They are:

(1) Setting aside of costs not related to the revenue - producing functions of the Commission.

(2) The equitable distribution of all overheads across direct field expenditure.

(3) The amortisation of long term capital expendituve such as roading over an appropriate number of years.

Most of the management areas on the north coast have experienced a considerable investment in both new road construction and silvicultural treatment since the 1950s, and their current productivity is relatively low. Consequently many of these accounting units operate at a loss at present.

The management accounts are a valuable tool for the forest manager, not so much for the figures published in any one year, but for an appreciation of how and why the accounts change over time. The forest manager is able to take advantage of the knowledge that the road system will soon be fully depreciated; that the management area cannot currently afford a massive silvicultural treatment; or that other expenditure such as road maintenance needs to be controlled if the area is to regain profitability. In some instances the manager may decide that some timber resources, which are difficult of access, may need to be left in the forest unless a higher royalty can be obtained.

In summary, the new accounting system provides a more accurate picture of where the management area is headed financially. While some of the costs, including the high level of overheads, cannot be

directly controlled by the local forester, there are other direct costs which can. This provides the impetus for rationalisation of plant and man power. The present strategy in north coast forests has involved a major reduction in silvicultural treatment while attempting to maintain or eventually increase the productivity of the forest.

This strategy is based on the fact that much of the forest estate has had some form of silvicultural treatment at least once since dedication, utilisation standards should continue to improve (meaning that harvesting will increasingly do what culling did in the past), and there are substantial areas of vigorous regrowth yet to come into production. Time and the management accounts will tell whether this is a viable strategy or not. There exists an increasing reliance on the market to remove unthrifty and poor growing stock, but the forest manager will need to beware that the overall level of useful growing stock does not deteriorate excessively.

SILVICULTURAL CONSIDERATIONS

History of Silvicultural Treatment

The forests of the north coast fall into two broad groups. The first group consists of the accessible forests of the coastal plain which have been maintained primarily, (but certainly not without exception) in an unevenaged or irregular condition. The second group of forests are the hinterland forests which have been logged more recently and more intensively because of improved utilisation. Where regeneration has been successful, they have tended to form vigorous even-aged stands. In the wetter forests where regeneration may not have occurred readily, or utilisation was not intensive, because of poor timber quality, the forest still retains much of its original structure but with a dense understory beneath gaps in the canopy.

The coastal forests have experienced a relatively long and effective history of silvicultural treatment. In the 1920s this treatment consisted almost entirely of ringbarking culls and it was aimed primarily at releasing the advance growth which already occurred in the forest. Later this treatment was often extended to include enlarging existing groups of regeneration, removing useless growing stock, whether overmature or not, and occasionally non-commercial thinning within the group.

With renewed activity in the preparation of management plans during the 1950s, inventories were carried out on many of the coastal forests. The results of these inventories caused Henry (1955) to note that all of these forests were deficient in the 10 - 30 cm diameter size classes. Henry attributed this shortage to fire and the results of single tree selection and this conclusion led to an increase in group size. The working plans of the 1950s prescribed the Group Selection System for all species associations including flooded gum, and the moist hardwoods. It soon became clear that these types did not regenerate readily under the Group Selection System because of problems associated with the dense understory. Initially this understory was controlled by the use of hot slash burns following logging. In the 1950s the use of seed trees gave way to broadcast sowing and later spot sowing (Floyd 1960). When A.P.M. Forests Pty Ltd commenced planting purchased farm lands with flooded gum in the 1960s, development work by the company and the Forestry Commission led to the use of small pressed peat pots or "jiffy pots"(Pryor *et al* c. 1967). This technique in its current form has been described by Horne (1979). The establishment of jiffy pot plantings was not limited to flooded gum and in the 1960s and 1970s appreciable areas of flooded gum, blackbutt, blue-leaved stringybark and silvertop stringybark were planted (primarily on moist forest sites) as a basis for the integrated production of mining timber, pulpwood, poles and sawlogs.

Treatment of the hinterland forest has been recent and not very extensive. There has been some ringbarking and some use of fire to create a suitable seed bed. Floyd (1966) favoured the use of tractor clearing to expose the soil for regeneration because it reduced the amount of weed competition which could be very prolific on burnt sites. In some situations, a cheaper version of tractor clearing known as "snig track extension" was used, effectively increasing the area of exposed soil at a lower cost than full clearing. Research was initially concentrated on the regeneration of tallowwood, the prime species of the moist hardwood forest, but because of its poor early growth rate emphasis was also placed on the planting and sowing of faster "off-site" species such as blackbutt, flooded gum and silvertop stringybark (Van Loon 1966).

ny areas that were not silviculturally treated following primary logging were of low site quality d presently contain substantial populations of remnant trees that were too small, too defective or non-utilisable species at the time of logging. These stands are now fully stocked by the older and larger remnant trees plus regeneration resulting from the logging.

Silviculture and the Indigenous Forest Policy

The Indigenous Forest Policy was being formulated at a time when considerable funds were being invested in the silvicultural treatment of north coast forests. There had been a proliferation of jiffy pot nurseries to provide stock for the regeneration of the moist sites in the moist hardwood, flooded gum and blackbutt types. Even some of the drier sites, with significant quantities of advance growth were being felled in order to create plantations of the desirable species, often in "off-site" locations. Improving standards of utilisation, the availability of powerful machinery, disillusionment with the efficacy of the traditional T.S.I. methods, were all factors which influenced the north coast foresterto favour an emphasis on high yielding, uniform plantations, often involving the drastic alteration of natural vegetation and the sacrifice of existing advance growth of non-preferred species. In this rush to emulate the systems being used in the establishment of pine plantations, many north coast forests became victims of the behavioural disorder occasionally referred to as "pinus envy".

The architects of the Indigenous Forest Policy were conscious of the need to harness this new trend in silviculture. Analysis of supply and demand pinpointed the necessity to re-affirm a policy of advance growth salvage. Environmental considerations indicated that the diversity of the forest should maintained and there was concern over the ability of the forest to provide reasonable returns on the silvicultural investment being made. The Indigenous Forest Policy has been extremely valuable in focusing on these needs, and in providing guidelines for the implementation of responsible silvicultural treatment on the north coast.

The adoption of the Policy in 1976 resulted in much less emphasis on regeneration treatment and more emphasis on stimulating the growth of existing trees capable of yielding sawlogs in the 20-30 years. This has meant the retention of larger growing stock (of good timber quality) during logging, increased thinning operations in regrowth stands, and reduced investment in regeneration treatment.

The aim of most present day management is the freeing up of codominants in fully stocked even-aged or irregular stands resulting from past management. This freeing up is a crown thinning and requires the removal of trees in all size classes. Remnant defective and declining overmature trees are also removed, subject to constraints for retention of trees with wildlife hollows. Removals are of lesser size than in primary logging and can include further removal of large numbers of even smaller trees in thinning of regeneration cohorts. Whereas felling to waste was used in previous decades, the harvesting operation is now the main silvicultural tool. Harvesting aims at the removal of merchantable trees of all practicable sizes so as to both provide an economic yield and leave behind a forest of retained growing stock with room to grow. Variable size gaps in the forest canopy suitable for eucalypt regeneration are produced incidentally by such management.

Silvicultural Characteristics of the Forest Types

The species occurring in the different forest types have variable growth habits and vary in the way they respond to the type of harvesting system applied. Also the structure, composition and quality of the types vary depending on stand history such as logging, fire and silvicultural treatment.

Blackbutt is essentially an intolerant eucalypt and most forest dominated by blackbutt has been intensively logged and treated during the past 80 years. Such stands are well stocked and vigorous and are logged to release codominants. Many stands are typical irregular stands that are logged on a felling cycle of 10 to 30 years. In line with the concept of maximising increment on potential sawlogs, younger stands are thinned quite heavily for mining timber and poles and older stands are thinned conservatively. Blackbutt does not grow lignotubers, however seedlings often form a pool of knee high "advanced regeneration" under the forest canopy and individuals of this pool are capable of rapid response to the creation of openings in the canopy (Curtin & King 1979). Such canopy openings are incidentally created by present thinning and harvesting operations and approximate the group selection logging systems of earlier management (Jacobs 1955). The process of natural seedling regeneration in blackbutt forest has been reported by Floyd (1962).

Flooded gum is a very intolerant, fast growing, non-lignotuberous species that, especially at the southern end of its range, commonly occurs in evenaged single species stands with dense mesic understories. Current harvesting consists of regular thinning operations, but eventually clear felling will be necessary to maintain productivity from this highly productive forest type. Most flooded gum forest occurs on the coastal plain close to industry and will be regenerated by eliminating the understorey, exposing mineral soil, and either planting genetically improved stock or by the use of seed trees. Severe frost has caused the failure of some flooded gum plantings; this has been overcome by planting these areas with manna gum at high altitudes or white gum at low altitudes. In the past, flooded gum plantation was extended into sites where it grew in mixture with tall trees of the dry hardwood forest type. These now appear to be low quality sites and may eventually be converted back to other eucalypts or possibly may be suitable for *Araucaria* planting in northern areas.

The dry hardwood and spotted gum forest types are typically composed of straight growing species prized for durable or treated pole production but containing a large proportion of species unsuited to the manufacture of paper pulp. Harvesting operations in these forests are generally conservative and large populations of hardy lignotubers are usually present in the understory. These lignotubers are capable of growing into trees in response to opening up of the canopy. However this response can be severely restricted or delayed by low intensity fires and browsing by cattle. Both hazards are common in these forest types so that tree growth following release by logging may take a variable time to become established and regeneration cohorts should not be considered evenaged.

Regeneration problems may occur in moist hardwood types that have a dense mesic understory. Successful establishment of eucalypt seedlings, in these forest types, requires some forest operation that exposes mineral soil. Depending on the quality of the stand, harvesting alone may not disturb the understory sufficiently to give rise to dense regeneration. However, an acceptable level of regeneration is generally achieved if the logging area is burnt following logging and even in the absence of fire, an acceptable forest environment is eventually achieved (King 1985).

Current Silvicultural Treatment

Application of the Indigenous Forest Policy to the hardwood forests of the north coast has resulted in silvicultural emphasis being given to the more accessible and productive forest types of the coastal plain, particularly types containing blackbutt and flooded gum, although other types are being given some treatment. These forest types already have a long history of silvicultural treatment and have minimal need for regeneration treatment at present.

Although there is now less emphasis on regeneration treatment, some investment in obtaining desirable regeneration is still undertaken following logging in highly productive forest types, in areas of gentle topography and economic location. This investment is generally necessary only where mesic understory would severely restrict the regeneration of an adequate stocking of desirable species.

Culling of unmerchantable trees (in the absence of a market for pulpwood or similar product) is still undertaken on a regular basis in the forest types of the coastal forest. Typical Management Plan prescriptions for cultural operations would include:

"Cultural Operations

Following logging in State Forests, each logged compartment should be investigated to assess the needs for silvicultural treatment and action taken as follows:

1. Where available, overmature trees of potential arboreal wildlife habitat value as nest or den trees shall be retained at a frequency of about one per hectare, preferably in clumps of up to five trees and where possible near watercourses.

2. In Blackbutt and Grey Gum/Ironbark/White Mahogany (60,62a) types, unmerchantable trees not required for retention for future timber production or as arboreal wildlife habitat, shall be culled as necessary to:

- Promote increment on existing stems merchantable or potentially merchantable as sawlogs, poles or veneer
- Establish openings in the forest canopy of sufficient magnitude to allow for the establishment and development or release of regeneration, where regeneration to a full Stocking of commercial species would not otherwise be achieved.

3. In moist forest types, where natural regeneration to a full stocking of commercial species could not otherwise be expected, the following treatments should be undertaken:
   - In areas of moderate topography, carrying no potentially commercial advance growth and forming sufficiently large consolidated areas to enable effective site preparation and subsequent intensive protection - clearing and planting.
   - In other areas - planting of seedlings on tracks and other areas of disturbed soil, with, if necessary prior burning of debris.

   Plantings shall be generally with blackbutt or flooded gum, or other eucalypt species more suited to a particular site, at a spacing which will achieve a stocking of about 700 stems per hectare".

In less productive forest, or less accessible forest remote from markets, the cheapest method to obtain regeneration is used in order to rehabilitate the cut over forest to an environmentally and ecologically acceptable forest cover. These areas generally regenerate naturally. Failure to regenerate to preferred timber producing species is an acceptable consequence and silvicultural treatment, to promote desirable species, is not carried out. Better quality but less accessible forests, with a high proportion of large merchantable trees, are relatively heavily logged, with high soil disturbance leading to satisfactory regeneration. However cull trees and advance growth trees may remain in the stand even though their removal would increase stocking of desirable regeneration. In remote forests with a dense understory, that inhibits the establishment of regeneration, and containing none or few advance growth trees, an acceptable forest environment is maintained through the retention of a cover of defective trees and the relatively inexpensive promotion of regeneration through the use of fire.

Such a policy may not appeal to the silviculturist who prefers to see all areas fully stocked with regeneration of desirable species. However, this policy is seen to direct the management dollar into those forests that give the best return on investment, when examined in conjunction with management accounts, and existing operating constraints with respect to manpower and equipment.

Productivity of the North Coast Hardwood Forests

In 1970 Curtin examined the productivity of a number of N.S.W. forests, noting that:

- Current yields and prescribed yields were strongly related to the level of useful growing stock.
- There was a relationship between current yields and historic long term yields.
- The general level of these yields was low.

The data used by Curtin for specific State Forests on the north coast are given in Table 5.

Further information is given in Table 4 for a number of coastal management areas (which generally include the State Forests listed in Table 3 but do not necessarily refer to the same production units). Current growing stock information is not readily available.

The general level of current prescribed yields of between 0.4 m^3 nett/ha for the dry coastal hardwoods and 1.7m^3 nett/ha for a good blackbutt forest is still disappointingly low despite the silvicultural treatment given to these areas over a long period of time. This was one of the reasons for the sustained activity during the 1970s in establishing eucalypt plantations.

A wealth of measurement data ia available from experimental plots which demonstrate that mean annual increments (M.A.I.) in excess of 20 m3/ha are not uncommon for uniformly well stocked stands (Borough *et al.* 1978). Carter (1974) considered that eucalypt plantations could be managed on short rotation for yields of 21 m3/ha/annum. Yield tables based conservatively on sample plot data indicate

M.A.I's of between 8 m3/ha and 16 m3/ha for even-aged stands of blackbutt and flooded gum depending on rotation and markets (Curtin 1969, 1970a, Borough *et al.* 1978)

There is no a priori reason why uneven-aged stands should not be as productive as even-aged stands, and Curtin (1963) proposed an ideal or target stocking for a blackbutt forest with a theoretical M.A.I. of 5.9 m3/ha which has probably not yet been achieved in practice.

A series of continuous forest inventory systems (C.F.I.) were established in some of the better coastal forests in the 1950s. While most of these systems have now been discontinued and they have not yet been thoroughly analysed (but see Turner 1966), these systems have been capable of giving realistic estimates of forest growth. Estimates of total growth for some of the major forest types are listed in Table 7.

The growth estimates in Table 7 are not strictly comparable because some of them include ingrowth, and different volume equations have been used for the same species. However it is clear that the total growth of the blackbutt and flooded gum types is generally in the range 2-5 m3/ha, while the growth of dry coastal hardwoods type is in the range from 1-2 m3/ha. When these estimates of total gross growth are adjusted to allow for:

(a) unmerchantable growing stock,

(b) differences between volume estimated by equations and volumes actually sold (by Hubers method),

(c) changes from gross volume to net volume because of defect, it can be appreciated why the net production figures given in Table 6 are indeed low

Some size class distributions for the blackbutt and dry coastal hardwoods types are illustrated in Table 8.

TABLE 5. PAST YIELDS, CURRENT YIELDS AND CURRENT GROWING STOCKS FOR SOME FORESTS ON THE NORTH COAST (Curtin 1970a)

State Forest	Major Species Type	Mean net yield since 1920 $m^3/ha/ann$	Calculated gross yield in 1969 $m^3/ha/ann$	Useful growing stock 1969 m^3/ha
Coopernook	Blackbutt	2.4	2.7	104
Lansdowne	Blackbutt	0.9	1.0	48
Kendall	Blackbutt	0.8	1.6	80
Wyong	various	0.5	0.9	49
Kiwarrak	Dry Coastal Hardwoods	0.4	0.6	42
Yarratt	Dry Coastal Hardwoods	0.2	0.4	39

TABLE 6. COMPARISON OF PAST YIELDS (SINCE APPROX. 1920) WITH CURRENT PRESCRIBED YIELDS FOR A NUMBER OF MANAGEMENT AREAS (All yields are expressed as m^3 net/ha.)

Management Area	Net Production since 1920		Current Net Production	
	All products	Sawlogs	All products	Sawlogs
Coopernook	1.4	1.2	—	0.7
Kendall	1.2	1.0	1.7	1.5
Urunga	1.1	0.7	—	1.2
Coffs Harbour	—	0.6	0.8	0.4
Wyong	0.8	0.5	0.7	0.3
Taree	0.7	0.3	0.4	0.3
Grafton	0.4	—	—	—

TABLE 7. ESTIMATES OF TOTAL GROWTH (m^3/ha an) FOR SOME FORESTS WITH C.I.F. SYSTEMS

Forest	Type	Total Gross Growth in m^3/ha/annum	Reference
Coopernook	Blackbutt	4.6	Curtin (1963)
Kendall	Blackbutt	2.6-3.1	Forestry Commission (1982)
		2.5	Hoschke (1973)
Pine Creek	Dry Blackbutt	3.4	Valclay (1977)
	Moist Blackbutt	2.6	Valclay (1977)
	Flooded Gum	1.8	Valclay (1977)
Yarratt	Dry Hardwood	1.1	Curtin (1970b)

The features of these distributions are:

- Satisfactory stocking in the smaller size classes
- Low numbers of useful trees in the larger size classes
- Low total basal areas (and volumes), with a relatively high proportion of useless growing stock particularly in the dry hardwood types.
- The ideal distribution has a flatter decrease of numbers with increasing size class. There are fewer trees in the small classes and more trees in the large classes.

However these distributions do not give any information on the occurrence of unstocked areas, occurrences of poor site quality areas, and other unproductive areas. These forests are diverse with useful growing stock, and corresponding productivity, varying markedly over very short distances. Spectacular improvements in productivity would onluy be possible by

(a) a massive increase in the intensity of silvicultural treatment, and

(b) an expansion of the market for a variety of products which would allow the sale of previously useless trees (and useless species), across the range of available size classes.

Given the current Indigenous Forest Policy and a responsible attutude to management accounting, it is obviously unwise to invest large sums in silvicultural treatment for the time being, although continuing judicious investment should contribute to a gradual improvement in productivity. The real opportunity for increased productivity lies in the expansion of markets for all species and size classes.

In this way there is not only an immediate increase in productivity, but the increased flexibility will allow the removal of poor quality growing stock and the stimulation of the better growing stock, equivalent to the "radical" treatment schedules proposed by Florence (1970) and Florence and Phillis (1971).

There are indications that such potential markets are developing on the north coast and they need to be encouraged. For example, in the Coffs Harbour Management Area the current prescribed annual yield for quota sawlogs, veneer logs and poles amounts to 36 000 m^3 or 0.61 m^3/ha from the productive area of 59 200 ha. Recently tenders have been accepted for a furthur 23 000 m^3 of small sawlogs (under 40cm cdub and down to 25cm small end diameter). An additional volume of 13 000 m^3 is also available for sale as salvage logs and small roundwood. If this total combined yield of 72 000 m^3 can be sold on a regular basis, as anticipated, the productivity would have doubled to 1.22 m^3/ha/ann. However when the long history of silvicultural treatment and expanding markets is compared with current levels of productivity, spectacular economic results may not be achieved. In particular it will be necessary to be on the lookout for a declining level of productivity, if the markets do not develop and silvicultural investment is further restricted. It is also necessary to re-affirm the empirical result that high productivities are restricted to high levels of useful growing stock being retained in the forest.

TABLE 8. EXAMPLES OF SIZE CLASS DISTRIBUTIONS (number/ha), BASAL AREAS AND VOLUMES FOR THREE FORESTS NEAR TAREE, COMPARED WITH AN 'IDEAL' DISTRIBUTION FOR BLACKBUTT (Curtin 1963)

Forest Major Type	Coopernook Blackbutt		Kiwarrak Dry Hardwood		Yarrat Dry Hardwood		'Ideal' Blackbutt Stocking (Curtin) (1963)
Merchantability Class	Useful	Total	Useful	Total	Useful	Total	
Size Class (cm)							
10- 20	37.8	157.8	48.8	129.5	102.5	163.7	58.8
20- 30	23.5	36.2	37.9	70.0	42.8	63.3	40.0
30- 40	20.5	25.2	25.3	41.8	26.2	38.5	27.2
40- 50	10.0	11.2	13.1	18.3	11.4	16.6	18.5
50- 60	8.1	8.3	5.6	8.3	2.7	5.6	12.6
60- 70	5.1	5.3	2.0	3.5	1.0	2.5	8.6
70- 80	4.7	4.8	0.6	4.3	1.0	3.9	5.9
80- 90	1.9	1.9	0.4				4.0
90-100	0.4	0.4	0.2				2.7
100+			0.2				
	111.9	251.2	134.1	275.7	187.6	294.1	178.3
Basal area (m^3)	12.2	15.3	10.1	18.5	9.8	16.0	21.8
Gross Bole Vol. (m^3/ha)	96.5	106.6	55.4	107.0	41.6	71.7	168.7

PROTECTION REQUIREMENTS

Fire is the major cause of damage to north coast forests. While most species are fire tolerant, fire causes much damage in terms of injury to the stem or death and by providing entry points for termite attack and wood rots. The Forestry Commission Policy Statement on Fuel Management in Indigenous Forests (1986) calls for the planned use of low intensity fire to reduce fuel loads. Use of prescribed fore on a broad scale can present problems in terms of dynamics of the forest and particularly the recruitment of regeneration into the smaller size classes of uneven-aged stands. Such burning results in a mosaic of burnt and unburnt patches so that recruitment dynamics of these forests is complex and has not yet been studied in detail (King 1984). Large scale aerial ignition burning has not been extensively used on the north coast, and current practice includes top disposal burning, small area burning and the use of extensive strategic strip burning along the road systems now available for such operations.

All State Forests are covered by Fire Plans. These give operational guidelines and emergency data necessary for wildfire control, and also proffer a general strategy for fuel hazard reduction. Hazard reduction proposals are prepared usually during autumn, to cover burning off operations during winter, in preparation for the spring fire season. The proposal maps areas burnt for hazard reduction, or by wildfire, the previous year and shows proposed burning areas. The proposed operations are recorded on a pro forma that reviews predicted fire behaviour and monitoring at the time of fire. The lighting of fires is under direct responsibility of a forester and limited to certain times fulfilling meteorological or location criteria that limit the damage to the forest and minimise smoke pollution. The planning and recording paperwork associated with burning operations is legally sensible but some foresters feel that it undully reduces the flexibility of burning operations. However it has the advantage of making sure that the objectives of the operation are compared with the results.

Browsing by macropods is a problem in eucalypt plantations remote from urban and agricultural dog populations. Damage can be minimised by designing plantations to reduce boundary length of individual planting blocks, by the use of large seedlings for planting, and by planting (with starter fertiliser) as early as possible with the summer rains so that plants are more than 60 cm high by the first winter (Horne 1975).

Natural or silvicultural control systems are the only methods relied on for control of insect pests of foliage and living wood in north coast forests. Occasional salvage logging is carried out in areas where conspicuous foliage damage has been caused by Psyllids. Problems with wood quality also arise from attacks by Ambrosia beetles and similar defect caused by *Glyptotermes* termites. *Lyctus* attack occurs in the sapwood of some species during and after timber conversion - this is particularly notable with spotted gum. Chrysomelid and Scarabaeid attack has been a feature of young flooded gum plantations on former pasture land (Carne *et al.* 1974). Wood boring Lepidoptera sometimes give rise to mechanical failure as well as internal defect. Cerambycid larvae cause considerable defect in young flooded gum and spotted gum.

Damage by termites and wood rot fungi are probably the major causes of economic loss in north coast forests. Partial digestion of wood by pioneer fungi appears to be a precondition for attack by termites (Wood 1978). Termite infestation is low in trees in good physiological condition, irrespective of potential hazard for infestation (Greaves & Florence 1966). Control of termite and wood rot damage is only feasible through protection from fire and logging damage and by the timely harvest of less thrifty trees.

FUTURE PROSPECTS

A continuation of the management strategy described in this paper into the 21st Century will see the hardwood forests of the north coast in an environmentally satisfactory condition capable of providing a sustained level of timber production while maintaining and improving the non-wood values for which they will be increasingly appreciated.

The more accessible high quality forests will be in a reasonably productive condition. Most importantly the forests will encompass a wide range of sites and stand conditions and most options for further management will have been retained. These future options will vary from intensive wood production to nature conservation. Just what options will be exercised at that time will depend on the

social and economic pressures and demands of the day. We outlined our thoughts on some of these pressures below.

Production of Non-Wood Values

The management of the State Forests must continue to remain sensitive to the needs and desires of all sections of the community, but it is unlikely that the environmental conflicts of the last two decades will desappear.

Despite the emphasis on multiple use management there will be continued pressure for removal of significant areas of forest being managed for timber production to be converted to national parks. Hopefully a reasonable procedure for objectively making land use decisions will be in place by the. Nevertheless any removal of land for purely Conservation purposes will inevitably lead to a reduction in timber production.

In terms of water production, we expect that the residents of the smaller north coast communities will demand considerable improvement in their domestic water supplies. This improvement should be met primarily by the development of properly engineered storage, treatment and reticulation systems which will buffer the variable quality of natural run off water in these catchments. The compatible production of both water and timber should continue from forested catchments, although limited areas of key catchments could be either removed from timber production or, more sensibly, require additional constraints for timber production.

As tourism increases, recreational pressures on north coast forests will increase. This will necessitate the provision of extra facilities, more or less on a demand basis rather than as entrepreneurial development.

Management for wildlife conservation will continue and emphasis should become more species specific as the ecological requirements of individual species are better understood, and the Commission's wildlife policy (now under review) is professionally implemented. Increased emphasis on wildlife conservation will continue to have a direct cost by resulting in some reduction in timber production.

We expect that the existing management strategies are readily able to meet continuing demands for the use of the forest for education, scientific investigation, grazing, conservation of flora andand the protection of visual resource values.

Production of Timber

Australia, and N.S.W. in particular, is a large importer of forest products especially sawn timber. The main approach taken to reduce the deficit in sawn timber supply has been to increase the area of plantation conifers.

The Indigenous Forest Policy predicted that by about the year 2010 the production of sawlogs from the plantation resource in N.S.W. would virtually eliminate the deficit. In the meantime, the production of radiata pine in N.S.W. is being supplemented by imports from New Zealand. More recent estimates however cast some doubt as to whether New Zealand imports and the Australian production of conifers will have the predicted impact on the sawlog deficit, and if it does then it may be appreciably later than 2010 (Gentle 1986).

Nevertheless there is competition between hardwood and softwood in the market place despite the fact that the demand for hardwood sawlogs is not currently satisfied. As softwood becomes more readily available and expertly marketed it will continue to rplace hardwood in its traditional use for structural framing timber in house construction. Consequently the future for hardwood in the market place will depend on a change in utilisation practice from the production of green, rough sawn general construction material to the production of dried, stress graded material utilising the high strength properties of these species.

In addition to strength, increasing emphasis will be given to the beauty and variety of many of the north coast hardwoods. Such value-added products include veneers, panelling, furniture, flooring

and joinery. Movements in this direction are already well under way. It may well be that once again blackbutt will lose its pre-eminent position among the north coast hardwoods, as the decorative features of more highly coloured species become more appreciated. It is likely that the durability of many of the north coast species will continue to be emphasised where this property is important, and specialty uses can continue to be developed.

An important constraint on the utilisation of fast grown sawlogs from trees less than 40 cm dbhob are problems associated with growth stresses and the poor behaviour of the wood close to the pith. More technical research is needed in this area.

Problems of Utilisation

The discussion above on future timber production and utilisation has centred on the production of sawlogs or trees of similar size. There is no doubt that maintenance of the uneven-aged forest structure will contribute to the ability of these forests to grow some trees of large size. Nevertheless the maintenance and improvement of the productivity of these forests will depend on the ability to sell currently unwanted trees at a price at least sufficient to recover the marketing cost. In order to improve the productivity of these forests it will be necessary to market a high proportion of defective and small trees, as well as species which are not currently in high demand. The obvious market for this material will be as pulpwood. We see the development of a viable pulpwood market beyond the present limits just north of Newcastle, to be an essential future need, if the silvicultural requirements of the north coast forests are to be generally improved. Ideally such a market would include the use of small thinnings (preferably with bark on) as well as those highly coloured and dense species not yet utilised for pulpwood.

There are other markets for small sawlogs and roundwood which although not large will continue to be important at least on a local level. These products include small sawlogs for case material, dunnage, pallet timbers, mining timber and landscape timbers. Other products include durable and non-durable poles, round mining timber, railway sleepers and fuelwood. While not all of these markets can be expected to expand, local opportunities are being taken to improve both productivity and silvicultural condition of the forest.

Forest managers will need to be innovative and grasp marketing opportunities as they arise. The utilisation problem associated with small sawlogs (ie. low recovery, and knotty core defect) will be alleviated economically provided large quantities of residues can be utilised as woodchips for pulp, horticulture and fuel.

We look forward to the continued management of the hardwood forests of the north coast for both timber and other values. We believe that these forests will become more productive and retain their intrinsic natural value to the people of N.S.W.

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ATTACHMENT A

DRAFT

[For AHC use only]
FILE NO: _____
REGISTRATION NO: _____
NAME: _____

AUSTRALIAN HERITAGE COMMISSION

NOMINATION FORM FOR THE REGISTER OF THE NATIONAL ESTATE

THIS FORM SHOULD BE USED TO NOMINATE NATURAL AND NEAR-NATURAL PLACES ONLY. ALTERNATIVE FORMS ARE AVAILABLE FOR ABORIGINAL AND HISTORIC PLACES

The National Estate is defined under the Australian Heritage Commission Act 1975 as **"those places being components of the natural environment of Australia or the cultural environment of Australia, that have aesthetic, historic, scientific or social significance or other special value for future generations as well as the present community".**

Under the Act, a primary function of the Commission is to identify places which are part of the National Estate and to prepare a Register of those places. The purpose of this form is to provide nominations for the register and sufficient information on nominated places to allow the Commission to identify them and assess their National Estate significance. A paper on criteria for assessment of significance is available from the Commission on request.

A properly completed nomination form, supported by maps, plans and photographs, is the minimum requirement for the presentation of a nomination to the Commission. The nomination form should summarise the case to be presented. It must be supported by location and boundary maps, photographs and a site plan or sketch in the case of structures, including buildings. Additional photographs, reports or written notes should be included with the nomination where possible. (The requirement for a photograph may be waived in the case of places which are very remote and no feasible source of material is available).

The intention of the form is to elicit systematically as much information which relates to significance as is readily available. For a nomination to be valid, only the following questions are mandatory: 1, 2, 3, 16(d). However, it is desirable that all sections of the form relevant to the place are completed, since this will allow a thorough assessment to be carried out more quickly.

Notes to assist in completing each page of the form are provided opposite the page to be completed and in a separate background note. **IT IS IMPORTANT THAT THE RELEVANT NOTES BE READ CAREFULLY BEFORE COMPLETING ANY SECTION.** The nomination should be able to stand alone, as far as possible. Reference to other documents should be in addition to information on the form, or confined to the bibliography.

It should be noted that, in general, the Commission will retain maps, photographs or documents submitted with the nomination form. Any material to be returned to the nominator should be identified with the nomination.
The completed form should be sent to, and more information may be sought from:

THE DIRECTOR
AUSTRALIAN HERITAGE COMMISSION
GPO BOX 1567
CANBERRA ACT 2601
TELEPHONE: (062) 72 3966

30.63

1. IDENTIFICATION

(a) NAME OF PLACE WASHPOOL WILDERNESS

(b) OTHER (OR FORMER) NAMES

2. LOCATION

(a) If located in a city or town:

ADDRESS: Street

City/Town Postcode

(b) If located outside a city or town:

NAME OF NEAREST SETTLEMENT (Use any town, village or homestead marked on a standard 1:100,000 or 1:250,000 map series)

Name of settlement COLLUM COLLUM STATION Town ☐ Village ☐ Homestead ☑

Distance from nearest settlement (km) 8 Direction **from** nearest settlement South West.

(c) APPROXIMATE AREA OF THE PLACE (ha) 34,500

(d) PROPERTY DETAILS

(e.g. Block/Section,

or County/Portion)

(e) DESCRIPTION OF LOCATION AND BOUNDARIES (Please describe fully the boundary in words. Attach additional sheets, if necessary.)

(f) ADMINISTRATIVE LOCATION

State Local Government Area

State Local Government Area

State Local Government Area

(If the place falls into more than 3 LGA's, please supply a separate list)

3. NAME AND ADDRESS OF NOMINATOR

NAME DAVID CARR.

POSITION IN ORGANISATION

ORGANISATION NAME The Wilderness Society.

STREET OR P.O. BOX PO Box 1155

CITY OR TOWN ARMIDALE STATE NSW POSTCODE 2350.

TELEPHONE NO. (Include STD Code) (067) 711155.

I wish my name as nominator to remain confidential ☐

I wish the name of my organisation to remain confidential ☑

I agree that my name can be released on request ☑

I agree that the name of my organisation can be released on request ☐

SIGNATURE OF NOMINATOR DATE __/__/__

4. USE AND OWNERSHIP

(Please circle all relevant codes.)

(a) SIGNIFICANT USES - PAST AND PRESENT

9820 Residential
(9821) Social/recreational
(9822) Educational
(9823) Scientific
9824 Commercial
9825 Industrial/manufacturing
9826 Transport/communications
9827 Governmental
9828 Military
9829 Health
9830 Religious
9831 Monument/cemetery
(9832) Forestry
9833 Mining
9834 Farming/pastoral
(9835) Park/reserve
9837 Vacant/unused
(9838) Traditional Aboriginal land use
9836 Other .....

(b) OWNERSHIP

9957 Crown - Commonwealth
(9958) Crown - State/Territory
9951 Crown - leasehold
9952 Private - freehold
9955 Local government
9956 Aboriginal Land
9979 Department of Defence
9980 Department of Transport
9981 Telecom
9982 Australia Post
9953 Leased by the Commonwealth

5. OWNERS OR LESSEES OF PLACES (If more than three owners, please attach list)

HOLDING/SECTION/PORTION _____
NAME OF OWNER/LESSEE _____
STREET OR P.O. BOX _____
CITY OR TOWN _____ STATE _____ POSTCODE _____
TELEPHONE NO. (Include STD Code) _____

HOLDING/SECTION/PORTION _____
NAME OF OWNER/LESSEE _____
STREET OR P.O. BOX _____
CITY OR TOWN _____ STATE _____ POSTCODE _____
TELEPHONE NO. (Include STD Code) _____

HOLDING/SECTION/PORTION _____
NAME OF OWNER/LESSEE _____
STREET OR P.O. BOX _____
CITY OR TOWN _____ STATE _____ POSTCODE _____
TELEPHONE NO. (Include STD Code) _____

6. PREVIOUS ASSESSMENTS

NAME OF AGENCY, _____
STREET OR P.O. BOX _____
CITY OR TOWN _____ STATE _____ POSTCODE _____
RESULT OF ASSESSMENT _____ DATE __/__/__

NAME OF AGENCY _____
STREET OR P.O. BOX _____
CITY OR TOWN _____ STATE _____ POSTCODE _____
RESULT OF ASSESSMENT _____ DATE __/__/__

7. GENERAL CLASSIFICATION

(a) GENERAL CATEGORY OF PLACE
(Please circle the most appropriate category)

(6100) Natural areas (Scientific values)
6101 Natural landscapes (Aesthetic, Historic, Social values)
6102 Natural areas/ landscapes with Cultural elements
6103 Cultural sites/ landscapes with Natural (Scientific) values
6004 Cultural landscapes (Predominantly modified environment)
6005 Cultural sites/ areas

(b) SIGNIFICANT ASSOCIATIONS
(Please circle all significant associations)

(6160) Aesthetic values
6161 Historic associations
6162 Social values
(6163) Teaching/Educational site
6164 Research site
(6165) Type locality
6166 Reference/Benchmark site
(6167) Recreational/Tourist use
(6169) Other WILDERNESS

(c) BIOCLIMATIC ZONE
(Please indicate the most appropriate zone)

6070 Alpine
6071 Antarctic & sub-Antarctic
6072 Arid & semi-arid
(6073) Temperate
6074 Tropical
6075 Other .....

8. DETAILED DESCRIPTION CODES

(a) ALTITUDINAL RANGE Low 200 m High 1120 m

(b) TOPOGRAPHY

6100 Level	(<0° 35')	(6104) Steep	(18° - 30°)
6101 Very gently inclined	(0°35' - 1° 45')	6105 Very steep	(30° - 45°)
6102 Gently inclined	(1° 45' - 5° 45')	6106 Precipitous	(45° - 72°)
6103 Moderately inclined	(5° 45' - 18°)	6107 Cliffed	(>72°)

(c) GEOLOGY
(Please circle "p" (for "Present") or s (for "Significant") for all relevant attributes and specify details, if known)

(P) S (6110) Igneous rocks .....
P S 6111 Sedimentary rocks .....
P S 6112 Metamorphic rocks .....
P S 6114 Geological structures .....
P S 6115 Stratigraphic .....
P S 6116 Mineralogical .....
P S 6117
(P) S (6119) Other Volcanic

(d) PALAEONTOLOGICAL

Fauna		Flora	
P S 6340	Terrestrial vertebrates	P S 6340	Micro-fossil - Pollen
P S 6341	Marine vertebrates	P S 6341	Micro-fossil - Diatoms
P S 6342	Freshwater vertebrates	P S 6342	Micro-fossil - Phytoliths
P S 6343	Terrestrial invertebrates	P S 6343	Macro-fossil - Plant parts
P S 6344	Marine invertebrates	P S 6359	Other Palaeontological site .....
P S 6345	Freshwater invertebrates		.....

(e) PALAEOENVIRONMENTAL

P S 6360 Ancestral streams
P S 6361 Fossil or buried soils
P S 6362 Sea level changes
P S 6363 Relict coastline
P S 6364 Other relict landform .....
P S 6365 Charcoal deposits
P S 6366 Varve sediments
P S 6379 Other Palaeoenvironment feature .....
.....

(f) LANDFORMS
(Please circle "p" (for "Present") or s (for "Significant") for all relevant attributes)

P S 6130 Caves, incl. Limestone Caves
P S 6131 Cliffs/ Escarpments
P S 6132 Collapse structure
P S 6133 Coral reefs and atolls
P S 6134 Depositional fan
P S 6135 Inselberg
P S 6320 Islands
P S 6137 Karst
P S 6138 Landslides
P S 6139 Mesas and buttes
P S 6140 Meteorite impact sites
(P) S (6141) Mountains/ hills
P S 6142 Plain/ Peneplain
(P) S (6143) Plateaux/ Tablelands
P S 6144 Sandplain
P S 6145 Sinks/ Internal drainage basins
P S 6146 Springs/ soaks
P S 6160 Aeolian landforms
P S 6180 Coastal landforms
P S 6200 Fluvial landforms
P S 6220 Glacial landforms
P S 6240 Structural landforms
(P) S (6260) Volcanic landforms
P S 6280 Other .....

8. DETAILED DESCRIPTION CODES (cont.)

(Please circle "p" [for "Present"] or "s" [for "Significant") for all relevant attributes)

(j) COASTAL LANDFORMS

P S 6181 Bays
P S 6182 Beaches
P S 6183 Headlands & Rock platforms
P S 6184 Coastal dune systems
P S 6185 Sandbars and Sandbanks
P S 6186 Tidal cliffs
P S 6199 Other .....

(k) ISLANDS/MARINE

P S 6321 Continental islands
P S 6322 Coral reef
P S 6323 Sand islands
P S 6324 Oceanic islands
P S 6325 Volcanic islands
P S 6326 Sand/Mud islets
P S 6327 Inshore marine
P S 6328 Offshore marine
P S 6338 Other marine areas .....
P S 6339 Other island types .....

(l) FLUVIAL LANDFORMS

P S 6201 Anabranches, Billabongs and Oxbows
P S 6202 Channel country
P S 6203 Estuaries
P S 6204 Floodplains
P S 6205 Waterfalls/Rapids
P S 6219 Other .....

(m) WETLANDS

P S 6301 Lakes
P S 6302 Swamps
P S 6303 Land subject to inundation
P S 6304 River channels
P S 6305 Tidal flats, mud flats
P S 6306 Coastal Water Bodies
P S 6319 Other .....

P S 6307 Saline
P S 6308 Brackish
P S 6309 Freshwater
P S 6310 Seasonally variable water quality

P S 6311 Permanent/Near permanent water
P S 6312 Intermittent presence of water
P S 6313 Seasonal presence of water
P S 6314 Episodic presence of water

(n) GLACIAL LANDFORMS

P S 6221 Glacial pavements
P S 6222 Moraines
P S 6223 Tarns
P S 6224 Glacial valley (U-shaped, hanging, etc)
P S 6225 Perched bogs of glacial origin
P S 6239 Other .....

(o) VOLCANIC LANDFORMS

P S 6261 Calderas
P S 6262 Lava caves
P S 6263 Lava flows
P S 6264 Organ pipes
P S 6265 Volcanic ash, bombs, etc
P S 6266 Volcanic plugs
P S 6267 Crater lakes
P S 6268 Mud flows
P S 6279 Hot springs
P S 6279 Other volcanic landforms .....

(p) MAJOR/DOMINANT SOIL TYPES

P S 6400 Calcareous sand
P S 6401 Clay
P S 6402 Gibber Surface
P S 6403 Gravel
P S 6404 Gypseous soils
P S 6405 Impeded drainage soils, gleys
P S 6406 Lateritic soils
P S 6407 Lithosols
P S 6408 Loam
P S 6409 Marl
P S 6410 Organic (peats, etc)
P S 6411 Saline
P S 6412 Sand
P S 6413 Silt
P S 6414 Duplex
P S 6415 Gradational
P S 6416 Uniform
P S 6419 Other .....

(q) FLORA

Structural classification

P (S) (6420) Closed forest- rainforests
P S 6421 Closed forest- mangroves
P (S) 6422 Open forest
P (S) 6423 Woodland
(P) S 6424 Open woodland
(P) S 6425 Scrub heath
P S 6426 Open scrub heath
(P) S 6427 Shrubland
P S 6428 Open shrubland
P S 6429 Hummock grassland
P S 6430 Closed herbland
P S 6431 Herbland
P S 6432 Open herbland
P S 6439 Other .....

8. DETAILED DESCRIPTION CODES (cont.)

(n) FLORA (cont.) - Height classification

P	S	6440 0-0.25m	P	S	6443 1.01-3m	P	S	6446 12.01-20m
P	S	6441 0.26-0.5m	P	S	6444 3.01-6m	P	S	6447 20.01-35m
P	S	6442 0.51-1m	P	S	6445 6.01-12m	P	S	6448 35.01-50m
						P	S	6449 >50m

(o) FAUNA

- (S) 6460 Amphibians
- (S) 6461 Birds
- S 6462 Freshwater fish
- S 6463 Marine fish
- S 6464 Invertebrates
- (S) 6465 Terrestrial reptiles
- S 6466 Freshwater reptiles
- S 6467 Marine reptiles
- S 6468 Monotremes
- S 6469 Arboreal marsupials
- (S) 6470 Terrestrial marsupials
- S 6471 Aerial placental mammals
- S 6472 Terrestrial placental mammals
- S 6473 Marine placental mammals
- S 6479 Other .....

9. SUMMARY DESCRIPTION - Natural Elements

(Please enter description of place [or summary description for large, diverse or complex places])

10. DESCRIPTION OF THE PLACE - Natural Elements by sub areas (land units, catchments or similar)

UNIT	GEOLOGY	LANDFORM/TOPOGRAPHY	SOILS	VEGETATION

10. DESCRIPTION OF THE PLACE - Natural Elements (cont)

UNIT	GEOLOGY	LANDFORM/TOPOGRAPHY	SOILS	VEGETATION

11. SUMMARY DESCRIPTION - Landscape, visual and cultural elements

12. DESCRIPTION OF PLACE - Landscape, visual and cultural elements (See Notes opposite)

LANDSCAPE UNIT	F	M	B	LANDFORM	VEGETATION	AESTHETICS	CULTURAL ELEMENTS

13. PERIOD OF ESTABLISHMENT OF CULTURAL ELEMENTS

9601 Pre-1788 9602 1788-1850 9603 1851-1914 9604 1915-1945 9605 Post-1945

Principal dates (Year only): ....

14. DESCRIPTION OF PLACE - CODED INFORMATION - Landscape, visual and cultural elements

AESTHETICS

P S 6500 Colour/form/texture/etc .....

P (S) 6501 Unity/consistency of landscape character Unbroken Forest Canopy

P S 6502 Diversity of visual interest .....

P S 6503 Outstanding landscape feature .....

P S 6504 Inconsistent/jarring elements .....

P S 6509 Other .....

DESIGN

P S 6520 Important designer .....

P S 6521 Design style or tradition .....

P S 6522 Design features .....

P S 6529 Other design interest .....

HISTORIC

P S 6530 Historic elements in landscape .....

P S 6531 Historic associations .....

P S 6539 Other historic interest .....

HORTICULTURAL

P S 6540 Plantings .....

P S 6549 Other .....

LAND USE

P S 6550 Historic land use .....

P S 6551 Present land use .....

P S 6552 Pioneering technology / practice .....

P S 6559 Other land use interest .....

15. CONDITION AND INTEGRITY

CONDITION

(9715) Excellent
9716 Good
9717 Fair
9718 Degraded

INTEGRITY

(9725) Intact/pristine
9726 Values subject to degradation
9727 Modified - recovery likely
9728 Modified - recovery unlikely
9729 Significantly disturbed - recovery unlikely

16. SIGNIFICANCE OF THE PLACE

(a) SIGNIFICANT ATTRIBUTES
(Please circle all significant attributes)

6010 Landforms
6011 Geology
6012 Soils
(6013) Flora
(6014) Fauna
6015 Palaeontology
(6016) Natural systems or habitats
(6017) Landscape

(b) SIGNIFICANT HABITATS, SYSTEMS OR SITES
(Please circle all significant habitats, systems, sites or features)

6020 Coast
6021 Islands
6022 Marine
(6023) Remnant vegetation
(6024) Representative systems
(6025) Rivers and streams
6026 Wetlands
(6027) Wilderness
6039 Other natural .....
.....

6040 Arboretum/Plantation
6041 Botanic Garden
6042 Remnant urban bushland
6043 Urban park/garden
6044 Urban setting
6045 Cultural landscape
6046 Historic building
6047 Other historic structure
6048 Aboriginal site
6059 Other cultural .....

16. SIGNIFICANCE OF THE PLACE (cont.)

(c) SIGNIFICANCE AGAINST REGISTER CRITERIA

CRITERION	SIGNIFICANCE INFORMATION

(d) STATEMENT OF SIGNIFICANCE

(A concise statement about why the place is significant and why it should be entered in the Register is essential.)

(d) STATEMENT OF SIGNIFICANCE (CONT)

17. RATIONALE FOR THE PROPOSED BOUNDARIES OF THE PLACE

(a) In general, the boundary represents:

6060 Natural vegetation cover
6061 Natural ecological boundary
6062 Water catchment boundary
6063 Elements in a certain condition (eg: wilderness, or lands not grazed)
6064 Visual catchment boundary
6065 Historical catchment boundary
6066 Line to include diverse of elements
6067 View from line or point
6068 Cadastral units approximating 60E....
6069 Existing park or reserve boundary
6079 Other .....

(b) The boundary is drawn to:

6080 Include all significant areas
6081 Exclude all areas not significant
6082 Include all areas of high significance and minimise areas of little significance
6089 Other .....

(c) Any additional comments on boundaries (including options)

18. FURTHER SOURCES OF INFORMATION (Bibliography, personal contacts, etc. Please supply address and/or phone no)

19. ATTACHMENTS

(a) MANDATORY ATTACHMENTS

- ☐ Location map
- ☐ Boundary map
- ☐ Photographs/slides

(b) DESIRABLE ATTACHMENTS

- ☐ Sketch map of land units or landscape units
- ☐ Species list(s) - if readily available

(c) OTHER ATTACHMENTS (Please list. Use additional space below if more space is required)

ADDITIONAL SPACE FOR DESCRIPTION, SIGNIFICANCE OR BOUNDARIES

(Please use this space for continuation of response to one or more of the earlier questions. For any question continued here, please insert a side heading indicating which question)

. IDENTIFICATION

(a) Current Name: the name of the place in current use.

(b) Former or Other Names: any other names currently or formerly used for the place.

2. LOCATION

(a) Address: For a place in an urban area, please specify the street address.

(b) Otherwise, please provide the following
- Name of nearest settlement, whether town, village or homestead;
- Distance from the nearest settlement;
- Direction from that settlement to the place nominated, (not vice versa).

c) Approximate area of the place in hectares.

e) Property details: if available, please list the title information - block and section or parish and portion, or equivalent. For purposes of consultation and advice, it would be helpful to know of any other direct interest in the nominated lands e.g. easements, exploration or mining leases, grazing leases or other tenements

f) Description of boundary: the boundaries of places entered in the Register must be defined in words in sufficient detail to identify the place; please describe the boundary in terms of features occurring on a published map. Question 19 requests that copies of appropriate maps be provided.

g) Administrative location: please specify state and local government area; if a place overlaps boundaries, give all states and local government areas in which the place falls.

3. NAME AND ADDRESS OF NOMINATOR

This information is not normally made available on enquiry and is not entered into the Commission's computer system.

If you have no objection to your name or your organisation's name being released as the nominator, please indicate in the space provided. If, at any time, you wish to change your preference for confidentiality, please notify the Commission in writing.

4. USE AND OWNERSHIP OF THE PLACE

(a) PRESENT USE OF PLACE

Circle code for all relevant uses of the place or parts of the place.

(c) OWNERSHIP

Specify all relevant codes indicating tenure/ ownership.

5. OWNERS OR LESSEES OF PLACE

This information is extremely valuable in enabling the Commission to notify owners of properties proposed for the Register and it is highly desirable that this information be provided.

If the names and addresses are not known, it is nevertheless useful to provide other address details, such as Property Name or Holding Name.

6. PREVIOUS ASSESSMENTS

Has the conservation value of the place (or part of it) been assessed by another government or non-government agency, such as the National Parks and Wildlife Service or the National Trust? If so, please indicate what assessment, the date of the assessment and the result.

GENERAL CLASSIFICATION

(a) GENERAL CATEGORY OF PLACE

Identify the general category in which the place fits best. **PLEASE CHOOSE ONE ONLY.**

Natural area:

Any area, park or reserve nominated primarily for reasons associated with natural system or features (rather than constructed or modified by human activity); the significance of natural areas will rest very largely on scientific values, although there also may be aesthetic, historic or other values.

Natural landscape:

Any area, park or reserve nominated primarily for the significance of its (near-)natural landscape; the significance of such an area will rest primarily on aesthetic, historic or social values, although there also may be some elements of scientific significance.

Natural areas/landscapes with cultural elements

Natural area or landscape (as above) with significant cultural elements, whether constructed or by association.

Cultural sites/ landscapes with significant Natural (Scientific) values

If you wish to nominate a place primarily for its Aboriginal or Historic significance, then you should use the special nomination form for the relevant area. If you wish to nominate a natural feature, site or area within a cultural landscape in its own right and for its natural values, then you should use this form and concentrate on the values of the smaller site you wish to nominate. A second or subsequent nomination may be prepared for the larger cultural landscape.

Cultural landscapes

Cultural sites and areas

These classes include a wide range of Aboriginal or Historic places, including: rock art sites, Aboriginal occupation sites, sacred sites, Historic buildings, sites of historic events, cemeteries, industrial archaeological sites, historic landscapes, aesthetic modified landscapes, etc, etc. If you wish to nominate a place which falls into either of these classes, then you should use the Aboriginal or Historic nomination form.

(b) SIGNIFICANT ASSOCIATIONS

Please circle all relevant codes indicating which basic attributes of the place are regarded as significant.

(c) BIOCLIMATIC ZONE

Please select one zone only.

8. DETAILED DESCRIPTION CODES

Question 8 seeks to elicit detailed information in a structured way about which elements of the environment are present (p) and which are significant (s).

If a place or its significance is simple, Q8 should be completed for the area as a whole. If a place is complex or has a variety of reasons for its significance, it may be desirable for Q8 to be completed for a number of sub-areas or Types. For example, an area which includes lowlands, escarpment and tablelands may have diverse grounds for significance and it may be desirable for Q8 to be completed for each major land system.

(a) ALTITUDINAL RANGE

Please give the altitude of the lowest and highest points within the place (or sub-area).

(b) TOPOGRAPHY

Please identify which one or more slope classes lie within the place (or sub-area).

(c) GEOLOGY

(d) PALAEONTOLOGY

(e) PALAEO ENVIRONMENTS

(f) LANDFORMS

Please identify which environmental elements are Present and which are Significant, by circling p or s throughout.

DETAILED DESCRIPTION CODES (cont.)

estion 8 seeks to elicit detailed information in a structured way about which elements of the environment are present (p) and hich are significant (s).

a place or its significance is simple, Q8 should be completed for the area as a whole. If a place is complex or has a variety of asons for its significance, it may be desirable for Q8 to be completed for a number of sub-areas or Types. For example, an ea which includes lowlands, escarpment and tablelands may have diverse grounds for significance and it may be desirable for to be completed for each major land system.

COASTAL LANDFORMS
ISLANDS / MARINE
FLUVIAL LANDFORMS
WETLANDS
GLACIAL LANDFORMS
VOLCANIC LANDFORMS
) SOILS
FLORA

ase circ[illegible] or s, as appropriate.

DETAILED DESCRIPTION CODES (cont.)

Question 8 seeks to elicit detailed information in a structured way about which elements of the environment are present (p) and which are significant (s).

(n) FLORA (cont.)

Height classification: Please identify the height class for the dominant (or tallest) layer of vegetation, indicating whether the height is regarded as significant by circling s.

(o) FAUNA

Please circle p or s, as appropriate.

9. SUMMARY DESCRIPTION - NATURAL ELEMENTS (See also Q11/12 relating to aesthetic, historic and social values).

Please include a summary description for the place as a whole.

If the place is relatively simple (e.g. geological site, endangered species habitat), please provide a description of the place. For example: "The area is characterised by a mosaic of low dense Racosperma shrubland with small pockets (up to 0.5ha) of mid-height grasslands (generally about 0.6-0.8m high). Dominant shrubland species include Racosperma ....., and Hakea ....., with the occasional overtopping Eucalptus ..... The major grass species include Astrebla ..... and Triodia ..... This provides ideal habitat for the endangered Stippled Wren and for a variety of small mammal species, including ....."

If the area is more complex and/or its significance rests on more diverse grounds and adequate information exists, a detailed description of the various land units or sytems or catchments should be provided in response to Q10 below, and a summary should be provided in response to Q9. For example:

"The area includes: a) hilly granite country supporting a range of Eucalypt forest types; b) a fragmented occurrences of poorly drained swamps and heaths on sandstones at margins of the steep country; c) lower gently sloping Eucalypt open woodlands, and d) the meandering floodplain of the Strange River which forms the south-eastern boundary of the area."

10. DESCRIPTION - NATURAL ELEMENTS (See also Q11/12 relating to aesthetic, historic and social values)

If the place is complex and sufficient information is available identify the separate land units; name them A, B, C or 1, 2, 3 or similar. Complete, so far as possible, entries for GEOLOGY, LANDFORM/TOPOGRAPHY, SOILS AND VEGETATION for EACH land unit.

The more detailed description of the example above might read:

Unit	Geology	Landform/Topography	Soils	Vegetation
	Granite	Steep country with deep valleys and prominent granite tors and bluffs	Shallow, gravelly loams	Mature, intact forests of Eucalyptus sp. on the slopes, with various E. microcorys associations in the gullies
-i	Sandstones . conglomerates	Flattish swampy country - poorly drained sites	Waterlogged sandy clays	Swamp sedge communities
-ii	Sandstones, conglomerates	Flattish swampy country - better drained sites	Low nutrient sandy loams	Low open heath
	Basalts	Open gently sloping plains	Heavy black soils	Open to sparse Eucalypt woodland, with Poa grassland understorey
	Quarternary alluvium	Floodplain	Deep alluvial silts grading to very sandy channels	E. camaldulensis/E. microtheca/ E. ochrophloia complex

11. SUMMARY DESCRIPTION OF PLACE - Landscape, visual and cultural elements

Q11 corresponds exactly to Q9 in that it seeks a general or summary description of the place, but differs in that it seeks a description of those elements of the environment which have aesthetic, historic or social value. Such elements may include the aesthetic qualities of a natural landscape or of a cultural landscape or feature within the boundaries of a generally natural area, or the historic or social associations of the natural area or a cultural element within it. The detailed example in the notes to Q12 below indicate some typical cultural elements.

12. DESCRIPTION OF PLACE - Landscape, visual and cultural elements

The headings for Description are largely self explanatory, with the exception of F, M and B which stand for Foreground, Middleground and Background - an extensive or linear landscape element may fit more than one of these.

If the place is complex and sufficient information is available, identify the separate land units; name them (see below). Complete, so far as possible, entries for each of the major landscape units

For those elements (including humanly modified or constructed elements, such as pastoral landscape, township and setting, mining site and relics, cemetery) the significance of which rests on aesthetic, scientific or social significance, please complete Q12 as far as possible.

LANDSCAPE	F	M	B	LANDFORM	VEGETATION	AESTHETICS	CULTURAL ELEMENTS
Pastoral		X	X	Rolling open country	Improved pastures with dotted eucalypts	Pleasing vivid green fields, with eucalypts adding visual diversity	Setting for historic Tinytown and Bellevue Homestead
Tinytown	X			Prominent ridge above the floodplain	Grand street trees dating from the 1890's	Diverse urban elements (bldgs, park, street trees) with high unity and aesthetic quality	Church and Court House
Pioneer cemetery	X			On a rise behind the town	Drive and periphery planted with poplars	Well tended 19 cent. cemetery; popular plantings and siting make it a prominent landscape feature;	History of gold & establishment of pastoral periods reflected in the headstones grave of Sir Alphonse Lotterby
Mining site	X			At the creek bank below the town	Fringing Casuarinas	Little visual evidence of mining activity	Footings of crushing plant; site has considerable archaeological potential
Forested slopes			X	Steep valley sides with some granite outcrops	Moist eucalypt forest with rainforest pockets in the gullies	Strong colour and texture contrasts with open fields; experience of enclosure when in bottom of valley	History of cedar-getting in 1880-1890's; no known relics remain
Thingammy Creek environs	X	X	X	Steep incised creek in upper reaches; more open at lower altitude	Enclosing rf in headwaters; fringing Casuarinas at lower altitude	Unifying element, linking near and distant, and cultural elements; "whispering" Casuarinas add to experience of landscape	Two known Aboriginal natural campsites of unknown significance; potential for additional sites
Summary of whole valley	X	X	X	Steep valley sides enclosing open rolling valley floor	Forested slopes, Casuarina riverine woodland, open pastures and plantings of exotics	Diversity of colour, form, texture and depth; experience of enclosure from forested valley sides. Very high aesthetic values	Natural and cultural history reflected in interaction of diverse elements. Landscape of some historical interest.

13. PERIOD OF ESTABLISHMENT OF CULTURAL ELEMENTS

For cultural elements, please specify the period of establishment. For parks, gardens, structures, etc specify the date of construction/ establishment. For landscapes, specify the period in which the landscape took on the character for which it is being nominated.

If there is a specific year or date which is significant please give it in the space provided.

14. DESCRIPTION OF PLACE - CODED INFORMATION - Landscape Elements

Please circle p or s for each relevant data item if it is Present or Significant in the landscape or area. See notes on Q8 above for additional guidance.

In addition, please add any brief descriptive terms to designate the character of the place, unifying theme(s), key historic elements or associations, etc. For example:

- colour/texture contrasts between valley floor and walls;
- identify outstanding landscape feature;
- identify designer (e.g. landscape architect);
- specify design style(s) represented
- specify plantings of note - cemetery poplars

15. CONDITION AND INTEGRITY

(a) CODES

Condition: specify the current condition (state of repair, maintenance or management) of the place;
Integrity: specify the degree of viability or sustainability which you believe most accurately reflects the long-term prospects of the place

(b) NOTES ON CONDITION/INTEGRITY

Please add any qualitative comment on the condition (state of repair or management) or integrity (level of sustainability) of the place.

Condition: please specify the current condition (state of repair, maintenance or management) of the place;
Integrity: please specify the degree of long-term sustainability of those characteristics for which the place is significant.

16. SIGNIFICANCE OF THE PLACE

(a) SIGNIFICANT ATTRIBUTES

(b) SIGNIFICANT HABITATS, SYSTEMS OR SITES

Please circle all items which contribute to the significance of the place.

6. SIGNIFICANCE OF THE PLACE (cont.)

c) SIGNIFICANCE AGAINST CRITERIA

Information under this item is of critical importance in helping to determine whether the place merits inclusion in the Register.

The chart overleaf sets out in schematic form the criteria for the Register. This question seeks specific information items which establish whether the place nominated is significant against the criteria. Below, for guidance, are examples of where some common or indicative items might fit:

.1 Places indicative of landform processes e.g. volcanic sites, biogeographically significant species; relict or disjunct communities or populations; refugia;
.2 Gene pool preservation, ongoing evolutionary processes; pristine catchments
.3 Diverse flora or fauna assemblages, or landscape types
.4 Explorers gravesite; early land grant
.5 Sites associated with important discoveries
.1 Rare flora; rare fauna; uncommon community or association; uncommon landform;
.2 Evidence of early land management practice
.1 Representative flora, landforms - eg mulga, sandplains, etc
.2 Landscapes representative of various land use; example of design style
.1 Collecting localities of Banks, von Mueller, etc, etc
.2 Association with important settlers, community leaders
.1 Places which represent high design achievement e.g. in landscape design
.1 Sites of symbolic or sacred significance
.2 Places of high wilderness quality
.1 Important research sites, type localities, reference catchments;
.2 Archaeological sites

Entries should include specific item of significance eg

- occurrence of rare plant, Glycine latrobeana;
- uncommon Eucalyptus sp./ Casuarina sp. community;
- von Mueller collecting expedition of 1865;
- type locality for particular serpentinite,
- 1830's land grant reflected in holdings;
- land use reflects influence of German settlers, etc
- represents excellent example of late 19th century public gardens design - especially in layout and design of paths and ponds

d) STATEMENT OF SIGNIFICANCE

This should be a concise statement of why the place is thought sufficiently significant to merit registration. It should be based on the data elements listed in response to Q9-12. A Statement of Significance must be included for the nomination to be assessed.

Although considerable space is allowed for the statement it should be kept as concise possible, reflecting the relative merits of the the various significant elements. The full space allowed is likely to be required for a few places only.

6. SIGNIFICANCE

16 (d) Statement of Significance (cont.)

17. RATIONALE FOR THE PROPOSED BOUNDARY

(a) THE BOUNDARY REPRESENTS .....

Please indicate the major consideration(s) you had in mind in arriving at the boundary you propose to nominate. Circle the relevant code(s).

Natural vegetation cover : the present extent of natural vegetation.

Natural ecological boundary : the limit of a particular landscape type, geological formation, vegetation community, species habitat.

Water catchment boundary : the divide between river or stream catchments.

Elements in a certain condition : boundary based on assessment of condition of land
e.g.. includes those lands unlogged in the last 50 years, ... or in wilderness condition, ...or ungrazed.

Visual catchment boundary : the composite of what can be seen from various points in the landscape

Historical catchment boundary : a line around landscape (elements) unified by historical theme or period

Line to include diverse elements : if the nomination rests largely on its diversity or representativeness, its boundary should reflect this objective entirely or in some degree

View from line or point : similar to Visual catchment, but indicates a more specific viewing locality e.g from the main street or from a point which has particular historic or social significance

Cadastral (or Land tenure) portions approximating one of the above : please specify by completing the code
e.g. if a boundary is drawn use cadastral portions to give a reasonable representation of landform and vegetation types, then circle 6068 and complete the code to read 6066.

(b) THE BOUNDARY IS DRAWN TO .....

Please indicate the policy or criterion you adopted in relation to inclusions in and exclusions from the area.

ADDITIONAL COMMENTS

Any additional comments you wish to make about the boundary

18. FURTHER SOURCES OF INFORMATION

Please list :

- known publications about the place or which might assist in assessing significance
- research or survey work carried out in/on the place
- research or survey work in progress
- contacts who have researched the place or who know the area well, especially if they hold unpublished material
- any other possible sources of information.

19. ATTACHMENTS

All nominations MUST have:

- Location map
- Boundary map
- Photographs or slides

It is highly desirable that other information relevant to the significance of the place be provided if it is available. Such material would include:

- Species lists of flora and fauna
- Sketch map of major land units or landscape elements - for large, complex or diverse natural areas or landscapes.

For complex places, even very approximate sketch maps could be very helpful for documentation and evaluation purposes. Maps of the various units would be valuable in assessing the following examples:

- a natural area in an arid environment which might include such units as floodplain and channel country, Mitchell Grass plains, sandplain, sand dunes and playa lakes;
- a natural area in mountain country which might include such units as snow grass plains, sub-alpine woodland, montane forest communities and a lake system;
- a cultural landscape which might contain timbered ridges under natural vegetation cover, valley floors cleared for grazing, historic towns/villages, pioneer cemetery and a eucalyptus still.

Simil[illegible], assessment could be greatly assisted by a sketch map showing which areas have been grazed or burned or revegetated at particular times.

ADDITIONAL SPACE

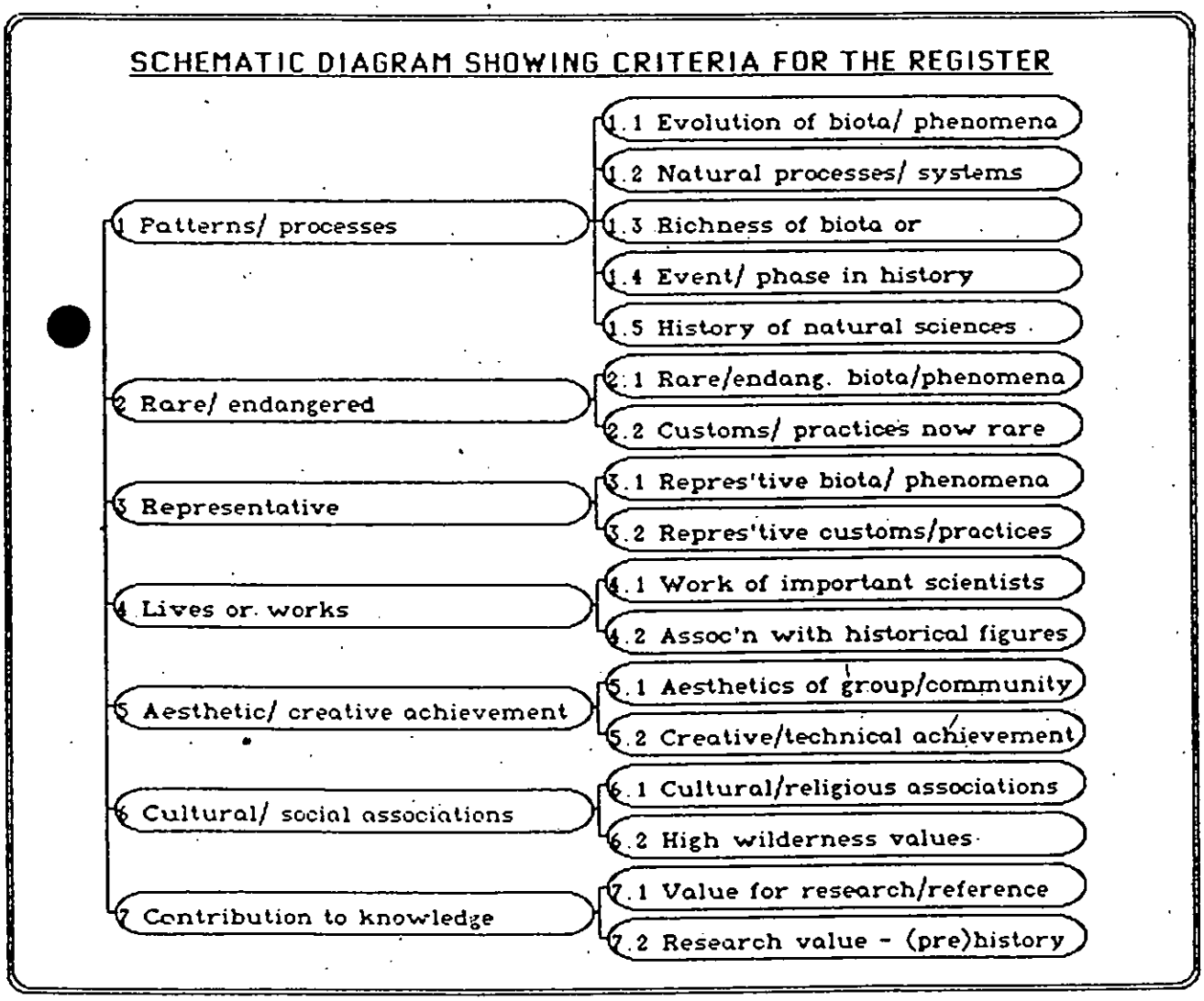
Additional space is include to cater for any overflow from Description, Boundaries, Bibliography or Significance. Please indicate at the beginning of any section of text what type of entry follows. For example:

Q9. Summary Description continued: .....

and/or

Q16(c) Significance against the Criteria continued: .....

SCHEMATIC DIAGRAM SHOWING CRITERIA FOR THE REGISTER



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REPORT TO THE AUSTRALIAN HERITAGE COMMISSION

REVIEW OF THE CONSERVATION STATUS OF VEGETATION COMMUNITIES IN NEW SOUTH WALES.

PART 3
ASSESSMENT OF THE CONSERVATION STATUS OF FOREST PLANT COMMUNITIES IN NORTH EASTERN NSW

FINAL REPORT
ASSESSMENT OF THE CONSERVATION STATUS OF FOREST PLANT COMMUNITIES IN NORTH EASTERN NSW

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** Plant Ecology Section
Royal Botanic Gardens

November 1991

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REVIEW OF THE CONSERVATION STATUS OF VEGETATION COMMUNITIES IN NEW SOUTH WALES.

PART 3
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SECTION 1
ASSESSMENT OF THE CONSERVATION STATUS OF FOREST PLANT COMMUNITIES

CONTENTS

1.0 Summary

The conservation status of plant communities in north east NSW has been assessed in terms of the adequacy of samples in reserves. One community, *Eucalyptus dunnii* was investigated in more detail.

A total of 65.9% of plant communities have fewer than five representations in reserves, including 11.0% with no representations. These are mainly communities of the tablelands, which reflects the inadequacy of reserves in this region. For example, *Eucalyptus nova-anglica* while widespread is not well representated in reserves.

40.5% of communities have less than 5% of their areal extent conserved, including 21.5% with less than 1% conserved. A higher proportion of these communities occur on the coastal foothills, indicating that the level of representation is inadequate in this area. For example, tall forests dominated by *Eucalyptus maculata* are poorly representated in reserves.

68.3% of plant communities have less than 5% conserved in a major part of their geographic range.

Of the plant communities occurring in old growth forest areas, 14 have less than 5% conserved with the Chaelundi, Dalmorton, Cells-Ralfes and Kumbatine areas housing most of these. Another 13 communities are inadequately conserved over part of their range.

6.2% of *Eucalyptus dunnii* communities are conserved, with inadequate representation over the western and southern part of their range. Most areas are disturbed by logging resulting in a younger age class and modification of the understorey.

A variety of plant classifications were employed in the sources used in this study. These were correlated with the adopted classification on the basis of similar floristic composition.

The data required by Professor Specht for the review of the conservation status of Australian vegetation has been collated and incorporated in a database. The data have been forwarded to Professor Specht for comment.

The study has highlighted the need for accessible and reliable information on the occurrence of plant communities.

The commonly quoted figure of 5% or less has been used to delineate inadequately conserved communities and these are listed. Recent studies suggest that this figure is likely to increase. Until additional information is available, the conservation status of communities with less than 10% conserved has been designated as indeterminate.

2.0 Introduction

In parts 1 and 2 of this project, two reports were produced. The first report (Hager and Benson J.S. 1990) includes a critical analysis of the plant community classification used by Professor Ray Specht in his current review of the conservation status of Australian plant communities. This report also contains a preliminary assessment of the fields and file structures required for a database to store and manipulate data on plant communities.

The second report (Robinson and Benson J.S. 1990) contains a classification and assessment of the conservation status of seagrasses, saltmarsh and mangroves. It highlights the problems involved in classifying and assessing the conservation status of plant communities where there is an inconsistent information base. Nonetheless, it has demonstrated the type of results that can be achieved despite these constraints.

The current phase of this project has the following components:

2.1 Development of a classification of plant communities occurring in medium to high nutrient tall eucalypt forests occurring in north eastern NSW;

2.2 Preliminary assessment of the conservation status of forest plant communities within north eastern NSW (based on the most accurate available estimate of areal extent in reserves with approximate estimates for other occurrences);

2.3 Provision of data on the areal extent of floristic groups in reserves within north eastern NSW to Professor Specht;

2.4 The comprehensive assessment of the conservation status of *Eucalyptus dunnii* (based on estimated areal extent within reserves, state forests, crown lands and privately owned land, derived from field survey data);

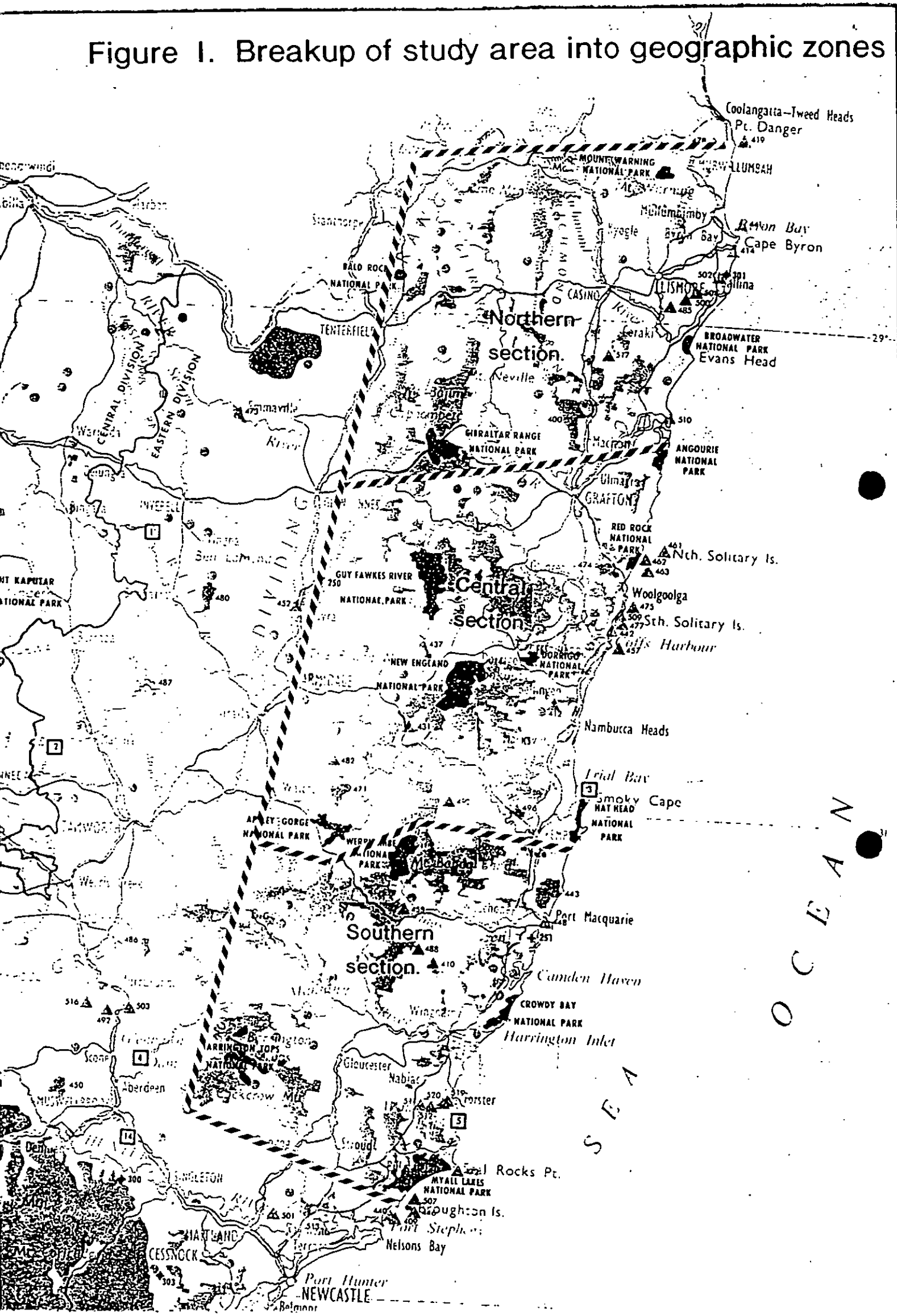
2.5 The assessment of the conservation significance of the forest types found in old growth forests (based on the conservation status as assessed in objective 2.2 and the importance of the sample in the old growth area based on size and location).

2.6 Finalisation of the specifications for a database to store and manipulate the data generated in this project;

2.7 Development of the above database;

The first section of this report considers objectives 2.1 to 2.5, while objectives 2.6 and 2.7 are considered in section 2.

Figure 1. Breakup of study area into geographic zones



All the data on occurrences of plant communities in reserves has been entered into an ADVANCED REVELATION database, including data derived from the digitising of available vegetation maps covering reserves in the region. The completed vegetation classification, final measurements for the areal extent of Specht's floristic groups and plant associations in each reserve and the final assessments of conservation status are presented. The discussion highlights priority plant communities for conservation. Major occurrences of those plant communities classified as poorly conserved are identified where possible.

An outline is given of a comprehensive assessment of the conservation status of *Eucalyptus dunnii* communities. The limitations of this project and suggestions for further work are discussed.

3.0 METHODS

3.1 Plant community classification

A literature review was carried out in order to identify the optimum classification for forested plant communities in NSW. Although this project concentrated on north eastern NSW, some plant communities extend to the central and southern parts of the state and classifications used in these areas also had to be considered. The following criteria were used in the selection of classifications:

1. Classifications applicable to a broader geographical area were preferred to more restricted ones, with attention being paid to classifications used interstate in the areas near the state borders.

2. Classifications where the units have been adequately mapped or those with a substantial amount of available resource information were preferred in order to facilitate areal extent measurements.

3. Classifications down to the association level (Beadle 1981) were preferred to broader classifications wherever this is an option.

4. Due to the variable relationship between structure and floristics in Australian vegetation (Keith and Sanders, 1990), structure was considered uniform if the association falls in two or less of the structural groups identified by Specht (1979) or Walker and Hopkins (1990).

5. Objective classifications would be preferred to intuitive ones but these are largely unavailable in the study area.

The classifications selected using these criteria have been synthesized into a single classification. Some localised plant

communities were amalgamated into more widespread communities in order to avoid the incorporation of a large number of communities with a limited areal extent into a statewide classification. This classification contains a combination of associations and alliances as defined by Beadle (1981). The vegetation units so described are referred to here as plant communities. These have a finer level of resolution the floristic group classification (Specht, in press).

The relationship between the units in the plant community classification and the floristic groups proposed by Specht (in press) has been established on the basis of subjective assessment of similar floristics between units in the two classifications. Although Specht has provided dichotomous keys to floristic groups, these were not used because a complete species list is required for each plant community and these were generally not available. Since floristic groups as defined by Specht (in press) are a coarser classification, several of plant communities were generally allocated to a particular floristic group in a hierarchical fashion.

A high proportion of the vegetation maps published in the study area use the forest type classification employed by the Forestry Commission for many years. The basic units of this classification are forest types which are more variable in composition than an association (Forestry Commission of NSW 1988). A relationship between this classification and the plant community classification has also been established in order to facilitate the use of this data. Details of the relationship are shown in Appendix 4.

The Forestry Commission have grouped related forest types into broader units called leagues (such as the Blackbutt league). A substantial amount of data from various sources (eg Forestry Commission management plans) contain information on the occurrence of forest types and leagues.

3.2 Assessing the conservation status of vegetation in north east NSW

The conservation status of each plant community within reserves was assessed using three criteria:

- the number of representations, regardless of size, within reserves (including flora reserves)
- the proportion of the community's areal extent conserved
- the spread of samples within reserves across the community's geographic range.

3.2.1 The number of representations within reserves.

Using digitised data or estimates from other sources, the occurrences of plant communities within NPWS reserves have been compiled and incorporated into the database. This information was

used to count the number of representations of each plant community in NPWS reserves. The number of representations in Flora Reserves were derived from data in Forestry Commission of NSW (1989), where the data are presented for forest types as defined by Forestry Commission of NSW (1988). These data have been expressed in terms of plant communities using the relationship established between plant communities and forest types.

This analysis was primarily useful to identify plant communities which are not conserved in any reserves. As the analysis of the number of representations within reserves does not distinguish between small and large samples, the analyses in sections 3.2.2 and 3.2.3 are considered in terms of the areal extent of plant communities within reserves.

3.2.2 Proportion of the community's areal extent conserved.

Measurements of the areal extent of plant communities within reserves were based on digitised vegetation maps where available. Areas in reserves without a reliable vegetation map (most of the smaller reserves and many large reserves are in this category) were estimated from qualitative surveys and the knowledge of specialists familiar with the reserve. The total areal extent was calculated by adding the areal extent in reserves, state forests, vacant crown land and privately owned land. The data on vacant crown land and privately owned land was obtained from Hoscke (1974). The data from state forests was obtained from various Forestry Commission management plans.

The data from both these sources were generally presented for leagues (as defined in section 3.1 above). In order to derive an estimate for individual forest types from such data, additional data on the relative abundance of each forest type comprising a league was gathered. Firstly, the forest types occurring in each management zone were listed and allocated to the corresponding league. Then, the abundance of each forest type within the management zone was estimated by counting occurrences on a representative sample of the forest type maps within each management zone. The abundance of each individual forest type was divided by the total abundance of all forest types within a league to derive a relative abundance. The relative abundance was then multiplied by areal extent of the league to give the areal extent of each forest type within the management zone. The data from each management zone were summed to give a total for each land tenure within the study area. The proportion conserved was calculated by dividing the areal extent within reserves by the total areal extent on all tenures. As in section 3.2.1, the forest types have been converted to the corresponding individual or group of plant communities.

Due to time constraints, the number of forest type maps counted was relatively small and may not be fully representative of the whole management zone. Hence, the calculated proportion conserved is expressed as a range corresponding to the calculated value plus or

minus 50% of that value. Then the proportion conserved estimates have been expressed in a semi-quantitative manner using five classes. The classes selected were less than 1% (LT1), 1% to less than 5% (LT5), 5% to less than 10% (LT10), 10% to less than 25% (LT25) and greater than or equal to 25% (GT25). If the calculated proportion conserved (plus or minus 50%) corresponds with more than one the above classes, then a range of classes are recorded for that community.

3.2.3 Spread of samples within reserves across the community's geographic range.

The adequacy of the geographic spread of samples of plant communities within reserves was determined by considering the proportion conserved in the northern, central and southern part of north eastern NSW. The estimates of the proportion conserved within these geographic zones were derived in course of the calculation for the whole study area, with the information on occurrences within and outside reserves being firstly compiled for the geographic zones and then amalgamated for the whole study area. The boundaries of these zones is shown in Figure 1. These zones correspond to the northern, central and southern part of the range of many of the plant communities considered in this project. Some communities only occurred in two of these zones and the analysis was accordingly restricted to these zones in these instances. The analysis was not carried out for communities with a distribution in one zone only.

A conservation code has been allocated to each plant community after consideration of all three indices. The numerical portion of this code is based on the code used by Benson J.S. (1989). Two additional class has been added to those proposed by Benson J.S. (1989), one for communities with adequate total representation but an inadequate sample in part of its range and one for communities whose conservation status is indeterminate. The codes adopted are:

1. Not/poorly conserved, because none or only minuscule areas located in reserves

2. Inadequately conserved, because relatively small areas are located in reserves and major parts of its geographical range remain unprotected

3. Inadequately conserved, because major parts of its geographic range remain poorly protected despite moderate areas being located in reserves.

4. Indeterminate, because moderate areas are located in reserves but additional information on the size of an adequate sample is required before conservation status can be reliably assessed.

5. Adequately conserved, because large areas and major parts

of its geographic range are located in reserves.

Unlike the analysis in section 3.2.1 which included NPWS and flora reserves, the analyses in sections 3.2.2 and 3.2.3 were restricted to NPWS reserves because the resources available to the project did not permit areal extent measurements to be made for plant communities in flora reserves. The data on rainforests have been supplemented by information contained in Floyd (1990), which includes occurrences in flora reserves.

3.3 Conservation significance of vegetation in old growth forests

The conservation significance of each plant community within old growth forests is assessed in terms of the size of the sample and its location within the community's geographic range. The size of each plant community within each old growth area was determined by measuring the areal extent using a planimeter or the dot grid method. The location of these samples was determined by allocating the individual old growth areas to one of the geographic zones previously discussed. The conservation significance of each occurrence of those communities which are identified as inadequately conserved using the method described in section 3.2 is considered in terms of its contribution to improving the overall proportion conserved and representation over the geographic range. The areal extent measurements were not completed for all old growth forests and in such instances, a list of the plant communities along with an approximate estimate of abundance is used instead. The other conservation values of old growth forests are beyond the scope of this project and are not considered in this report.

3.4 Conservation status of *Eucalyptus dunnii*

The assessment of the conservation status of *Eucalyptus dunnii* is made by using measurements of areal extent on NPWS reserves and flora reserves, state forests, crown lands and privately owned lands. Where these occurrences have been mapped, areal extent measurements were carried out by the dot grid method. The extent of the unmapped areas was determined by aerial photograph interpretation followed by translocation onto a 1:25,000 map and areal extent measurement. The locations of populations of *Eucalyptus dunnii* were identified from herbarium records, forest type maps, seed collectors, various vegetation surveys and management plans. Population numbers and age classes were estimated by counting all individual trees in thirty 50 by 50 meter quadrats. These counts were split into three age classes based on diameter at breast height (DBH). The relative abundance of trees in each category gave an indication of the age of the stand and hence logging history.

Plant species occurring with *Eucalyptus dunnii* were recorded along with their abundance in 20 by 20 meter quadrats. This data will be subjected to a multivariate analysis in order to determine whether

there are distinct plant communities involving *Eucalyptus dunnii*, but this step is beyond the scope of the current project.

The time since the last fire was estimated by the age of understorey shrubs which would have germinated following the last fire and the age of fire scars. The presence of understorey species favoured by frequent fire was also noted. Evidence of grazing was recorded by the presence or absence of signs such as fencing, animal droppings, management practices (eg regular fire) and weeds associated with grazing. These estimates of disturbance history and population counts were carried out at a representative sample of the known occurrences of *Eucalyptus dunnii*.

This information is used to provide a comprehensive assessment of the proportion of *Eucalyptus dunnii* conserved, the extent to which populations are adequately conserved over its geographic range and the degree of disturbance.

4.0 RESULTS AND DISCUSSION

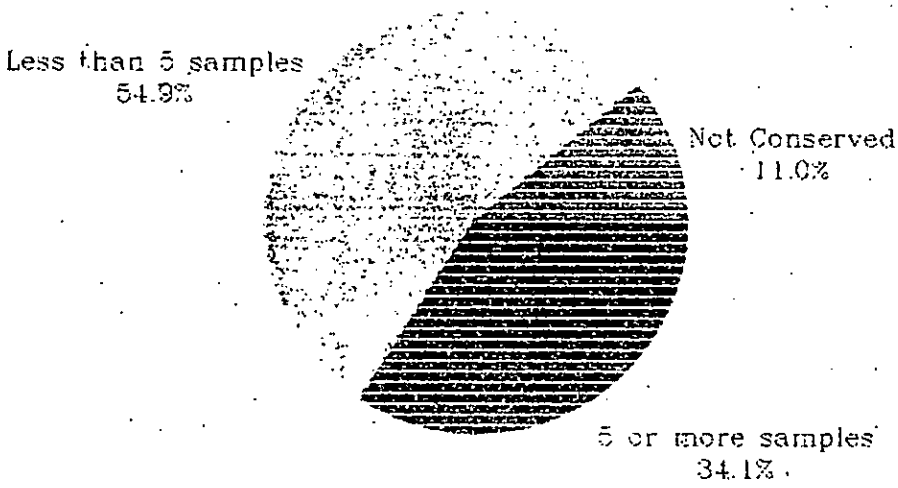
4.1 Classification

No consistent classification is used in plant surveys due to the different aims and methods employed. The end result is that classifications vary in their scale and in the attributes used to describe their structure and floristics. The classification used for this project is shown in Appendix 4. This is largely based on Benson J.S. (1989) and Floyd (1990). Several additional eucalypt plant communities have been added to the classification. Sources consulted in finalising the classification include Beadle (1981), Forestry Commission of NSW (1988), Keith and Sanders (1990), Baur (1968), Benson D.H. (1981), Benson D.H. (1984a), Benson D.H. (1984b), Benson D.H. (1986), Keith and Benson D.H. (1988) and McRae and Cooper (1981).

The relationship between Specht's floristic groups and the accepted classification is also shown in Appendix 4. As the major aim of Specht's conservation review is to establish the areal extent of each floristic group in each reserve in Australia, the correct assignment of plant communities to floristic groups has been an important component of this project. This approach will enable the information on floristic groups required by Specht for the review of the conservation status of Australian vegetation to be compiled from data which was almost exclusively presented at a finer scale of resolution. The details of this process are discussed in paragraph 4.0 of section 2 of this report.

The resolution of classifications also varies. This caused some problems in the presentation of data in Appendix 1. The data on flora reserves were expresssed in terms of the forest type classification. In general, the forest type classification has a coarser level of resolution than the plant community classification. Many forest types will therefore be equivalent to more than one plant community, preventing the establishment of a

Figure 2. Samples of plant communities in conservation reserves



NB Size of sample not taken into account

one to one relationship. In these instances, the number of representations within flora reserves is assigned to the group of equivalent plant communities. In these cases, no conclusions as to how the representations are divided between the constituent plant communities can be drawn.

This problem also extends to the estimates of areal extent for plant communities on the various Crown tenures and privately owned land, as much of the available information is presented under the forest type classification. This constraint meant that conclusions about the conservation status of some plant communities had to be generalised to the overall status of the group of communities equivalent to the forest type. This disguises any variability in conservation status within these groups.

As the plant community classification applies to the whole study area, some of the regional variability in the communities has been lost. Thus, even though a species may locally replace one of the dominant species or achieve local co-dominance, the names of the

plant communities have generally not been amended to incorporate such variations in community composition.

4.2 Conservation status of vegetation in north eastern NSW

The data on the number of reserves in which each plant community is represented and their conservation status have been included in Appendix 1. As this is a large body of data, subsets which highlight aspects of the data have been included in some of the other tables and appendices.

The inventory of the areal extent of floristic groups within conservation reserves appears to the main output from this project required by Professor Specht. Reports for all the reserves in north eastern New South Wales are contained in Appendix 5. The information contained in this appendix is in the format requested by Professor Specht and a copy of the data has been forwarded to him for comment. The unsurveyed area in several of these examples consists of non-forested plant associations, non-vegetated areas and that part of the reserve with no available resource information. The unsurveyed area will decrease when available data on the non-forested communities are entered into the database.

Consideration of the number of representations of each plant community in reserves has enabled plant communities with no or few representations in reserves to be identified. This information is displayed graphically in Figure 2 and it is evident that 65.9% of plant communities have fewer than 5 representations in reserves including 11.0% of plant communities which are not represented in any reserve. These communities, which are not represented in any reserve, are the most poorly conserved and they are identified in Table 1 along with known occurrences. These communities almost exclusively occur on the tablelands, indicative of the fact that there are relatively few reserves at higher altitudes and in the drier parts of the northern tablelands. Some of the more widespread communities include *Eucalyptus pauciflora ssp pauciflora-Eucalyptus viminalis*, *Eucalyptus williamsaiana-Eucalyptus radiata ssp sejuncta* and *Eucalyptus viminalis* from the higher areas and *Eucalyptus elliptica-Eucalyptus macrorhyncha-Eucalyptus dives-Eucalyptus rossii* and *Eucalyptus macrorhyncha-Eucalyptus prava* and from the drier areas. The only widespread coastal community not conserved is *Eucalyptus pilularis-Eucalyptus maculata*. All these communities will have a conservation code of 1 as defined in section 3.2.

Table 1 Plant communities not represented in conservation reserves

Community number	Community name	Conservation code	Location
EF107	EUCALYPTUS BRUNNEA-EUCALYPTUS CYPELLOCARPA	1	Dorrigo to Tenterfield area
EF140	EUCALYPTUS PILULARIS-EUCALYPTUS MACULATA		Kempsey to Grafton area

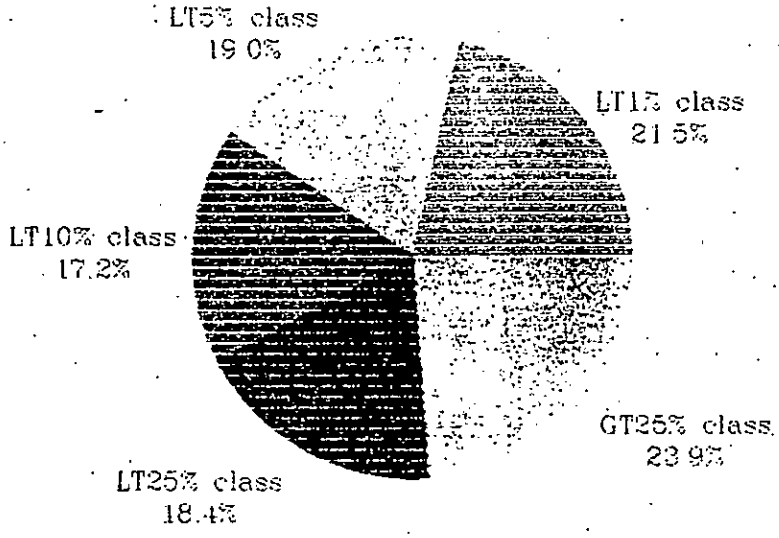
EF240	EUCALYPTUS NORTONII-EUCALYPTUS SERPENTINICOLA	1	Nundle area
EF309	EUCALYPTUS VIMINALIS*	1	Coolah Tops, Kempsey, Nundle to Glen Innes area
EF325	EUCALYPTUS RADIATA SSP SEJUNCTA-EUCALYPTUS SUBTILOR	1	Ebor, Glen Innes area
EF328	EUCALYPTUS ELLIPTICA	1	Tamworth, Armidale area
EF330	EUCALYPTUS ELLIPTICA-EUCALYPTUS MACRORHYNCHA-EUCALYPTUS DIVES-EUCALYPTUS ROSSII	1	Tamworth, Armidale area, drier areas
EF342	EUCALYPTUS MACRORHYNCHA-EUCALYPTUS PRAVA	1	Armidale area north, drier areas
EF350	EUCALYPTUS CALIGINOSA-EUCALYPTUS MELLIODORA	1	New England area, drier areas
EF351	EUCALYPTUS MCKIEANA-EUCALYPTUS NICHOLII-EUCALYPTUS CALIGINOSA	1	Tingha, Bundurra areas
EF352	EUCALYPTUS MCKIEANA	1	Bundurra area
EF354	EUCALYPTUS WILLIAMSIANA-EUCALYPTUS RADIATA SSP SEJUNCTA	1	Ebor, Glen Innes, Tenterfield area
EF364	EUCALYPTUS ANDREWSII-EUCALYPTUS BANKSII	1	Armidale area north, drier areas
EF365	EUCALYPTUS NOVA-ANGLICA	1	Armidale, Glen Innes area
EF367	EUCALYPTUS NOVA-ANGLICA-EUCALYPTUS BRIDGESIANA	1	Armidale, Glen Innes area
EF376	EUCALYPTUS STELLULATA-EUCALYPTUS NOVA-ANGLICA		Armidale, Glen Innes area
EF612	EUCALYPTUS MELANOPHLOIA	1	Upper Clarence River area
RF205	WATERHOUSEA FLORIBUNDA-TRISTANIOPSIS LAURINA	1	Gloucester to Casino area

* may occur in reserves outside north eastern NSW

For the communities represented in reserves, consideration of the areal extent conserved is more informative than the number of representations as small occurrences are given less weight than larger ones. The areal extent conserved as a proportion of the areal extent remaining in NSW has been presented in Appendix 1. A total of 40.5% of communities fall into either the less than 1% or less than 5% proportion conserved classes for their areal extent represented in reserves (Figure 3).

When using vegetation maps for conservation planning, it is generally assumed that conservation of a mapped unit will result in the conservation of the species associated with such units. This assumption has been rarely tested and recent studies have shown that it is questionable. Margules, Nicholls and Pressey (1986) have demonstrated that only 68% of species found in wetlands on the Macleay River floodplain would be conserved if all of the most species-rich example of each plant association was conserved. There is little data on the proportion of a community's occurrence needed to conserve all the species associated with the community but studies such as Pressey and Bedward (1991) have demonstrated

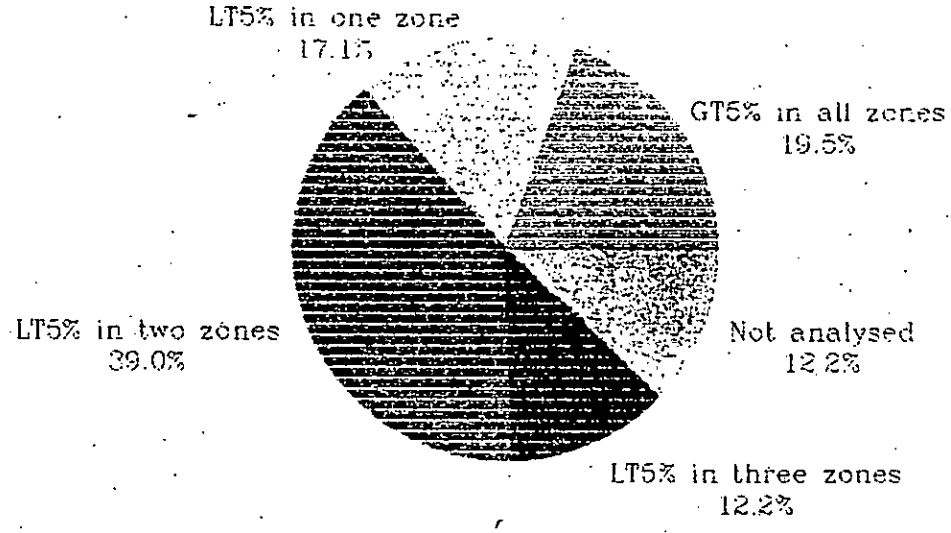
Figure 3. % of plant communities within proportion conserved classes



that this amount is likely to exceed the commonly quoted amount of 5%. Until additional information on this question is available, the conservative estimate of 5% will continue to be used. Since this figure is being questioned, its use here does not imply that communities with more than this amount in reserves are adequately conserved. Thus, the conservation status of communities with less than 10% in reserves has been designated as indeterminate at this stage. These communities have been assigned a conservation code of 4 in Appendix 1.

Those communities with less than 5% conserved are listed in Appendix 2. The communities already identified as not conserved in Table 1 have not been re-listed in Appendix 2. Some of the more widespread communities are Eucalyptus grandis, Eucalyptus acmenioides-Eucalyptus propinqua, Eucalyptus tereticornis, Eucalyptus maculata, Eucalyptus maculata-Eucalyptus siderophloia, Eucalyptus signata and Eucalyptus signata-Eucalyptus intermedia. These communities would require several additional samples to be conserved before their conservation status could be considered

Figure 4. % of communities with part of range inadequately conserved



LT/GT= Less/Greater than 5% conserved

adequate. A higher proportion of these communities occur in the coast and escarpment areas which indicates that while the reserve system samples most communities in these biogeographic units, the size of many of these samples is inadequate. These communities will have a conservation code of 1 or 2 as defined in section 3.2. The adequacy of the spread of samples across the geographic range of each community has also been assessed in Appendix 1. The data has been expressed graphically in Figure 4, which demonstrates that 68.3% of plant associations are inadequately conserved in part of their range. These communities are listed in Appendix 3 along with occurrences within that part of their range in which they are inadequately conserved, excluding those communities already listed in Table 1 and Appendix 2, which are inadequately conserved in all three zones.

Some of the communities listed in Appendix 3 were classed as adequately conserved under the criteria of number of representations and proportion conserved. This demonstrates that consideration of the adequacy of the spread of samples provides

additional information on conservation status. These communities will have a conservation code of 1, 2 or 3 as defined in section 3.2.

4.3 Conservation significance of plant communities in old growth forests

Estimates for the areal extent of plant associations in some of the old growth forests of the escarpment areas of northern NSW are contained in Appendix 6. The overall conservation status of these communities (as assessed in section 3.2) is also given in this appendix.

Fourteen of the plant communities in the old growth areas are inadequately conserved in terms of their total proportion conserved, and these are listed in Table 2 along with their occurrences.

Table 2 Plant communities with LT1 or LT5 proportion conserved class occurring in old growth areas within state forests

Community number	Community name	Name of old growth occurrence
EF100	EUCALYPTUS GRANDIS	Blackbutt Plateau, Duck Creek, Kumbatine
EF109	EUCALYPTUS ACMENIOIDES-EUCALYPTUS PROPINQUA	Cascade Creek, Kennedys Mountain, Banda Banda, Rocky Hip, Kindee, Tirrill, Kumbatine, Willi Willi
EF111	EUCALYPTUS TERETICORNIS	Dalmorton, Chaelundi, Kindee, Tirrill, Kumbatine
EF121	EUCALYPTUS MACULATA	Dalmorton, Chaelundi
EF123	EUCALYPTUS MACULATA-EUCALYPTUS SIDEROPHLOIA	Dalmorton, Chaelundi
EF138	SYNCARPIA GLOMULIFERA-EUCALYPTUS MICROCORYS	Blackbutt Plateau
EF205	EUCALYTUS MACULATA-EUCALYPTUS ACMENIOIDES-EUCALYPTUS GUMMIFERA-ANGOPHORA FLORIBUNDA	Chaelundi
EF207	EUCALYPTUS SIGNATA-EUCALYPTUS INTERMEDIA	Blackbutt Plateau
EF316	EUCALYPTUS OBLIQUA-EUCALYPTUS NOBILIS	South Seaview, Ben Halls Gap
EF349	EUCALYPTUS CALIGINOSA	Stokes, Cells-Ralfes
EF353	EUCALYPTUS WILLIAMSIANA	Stokes, Cells-Ralfes

EF354	EUCALYPTUS WILLIAMSIANA-EUCALYPTUS RADIATA SSP SEJUNCTA	Stokes, Cells-Ralfes
EF373	EUCALYPTUS LAEVOPINEA-EUCALYPTUS VIMINALIS	South Seaview
EF374	EUCALYPTUS LAEVOPINEA-EUCALYPTUS SALIGNA	Chaelundi, Rocky Hip, Homewoods,Stokes, Stewarts Brook, Kholwa, Whispering Gully, Davis Creek, Boonabilla, South Seaview

The more frequently occurring communities include *Eucalyptus maculata* and *Eucalyptus maculata-Eucalyptus siderophloia* (Dalmorton and Chaelundi areas), *Eucalyptus tereticornis* (Dalmorton, Chaelundi and Kumbatine areas), *Eucalyptus williamsiana-Eucalyptus radiata ssp sejuncta* (Stokes and Cells-Ralfes areas) and *Eucalyptus laevopinea-Eucalyptus saligna* (Chaelundi, Hastings and Barrington areas). Table 3 contains details of the 13 plant communities occurring within old growth areas which are inadequately conserved in the same part of their geographic range as the old growth area occurs.

Table 3 Plant communities in old growth areas within state forests which are inadequately conserved in that part of their geographic range in which the old growth area is located.

Community number	Community name	Name of old growth occurrence
EF101	EUCALYPTUS GRANDIS-LOPHOSTEMON CONFERTUS-EUCALYPTUS MICROCORYS	Cascade Creek, Kennedys Mountain,Banda Banda, Rocky Hip, Homewoods, Stokes, Kindee, Cells-Ralfes, Tirrill, Kumbatine, South Seaview
EF102	EUCALYPTUS SALIGNA	Dalmorton, Willi Willi, Duck Creek
EF110	EUCALYPTUS PROPINQUA-EUCALYPTUS SIDEROPHLOIA	Willi Willi, Kennedys Mountain, Banda Banda, Woorong, Bootumbarra, Rocky Hip, Homewoods, Comara Range, Kindee, Cells-Ralfes, Tirrill, Kumbatine
EF115	EUCALYPTUS PILULARIS	Cascade Creek, Banda Banda, South Seaview, Homewoods, Willi Willi
EF116	EUCALYPTUS PILULARIS-EUCALYPTUS RESINIFERA	Cascade Creek, Banda Banda, South Seaview, Homewoods, Willi Willi

EF117	EUCALYPTUS PILULARIS-EUCALYPTUS ACMENIOIDES	Cascade Creek, Banda Banda, South Seaview, Homewoods, Willi Willi
EF118	EUCALYPTUS PILULARIS-EUCALYPTUS INTERMEDIA-EUCALYPTUS SIDEROPHLOIA	Cascade Creek, Banda Banda, Homewoods, Kumbatine, Willi Willi
EF139	EUCALYPTUS PROPINQUA-EUCALYPTUS CAMERONII	Cells-Ralfes
EF146	EUCALYPTUS ACMENIOIDES-EUCALYPTUS TERETICORNIS-ALLOCASUARINA TORULOSA	Davis Creek, Boonabilla
EF615	EUCALYPTUS TERETICORNIS-EUCALYPTUS UMBRA+-EUCALYPTUS SIDEROPHLOIA	Homewoods, Kindee, Tirrill
RF110	CALDCLUVIA PANICULATA-CRYPTOCARYA ERYTHROXYLON-ORITES EXCELSA-MELICOPE OCTANDRA-ACMENA BRACHYANDRA	Dalmorton
RF113	DORYPHORA SASSAFRAS-DAPHNANDRA MICRANTHA-DENDROCNIDE EXCELSA-FICUS SPP-TOONA AUSTRALIS	Chaelundi
RF200	ARAUCARIA CUNNINGHAMII	Dalmorton, Chaelundi

The old growth areas also contain conservation values such as pristine condition, undisturbed age class, few exotic species, unaltered understorey, high fauna values, wilderness values, catchment values and scientific values, but these values have been documented elsewhere (eg Resource Assessment Commission, 1991) and their consideration of these aspects is beyond the scope of this project.

4.4 Conservation status of *Eucalyptus dunnii*

The estimates of the areal extent of *Eucalyptus dunnii* in reserves (mainly Flora Reserves), state forest, Crown land and privately owned land, along with the number of individual trees and the proportion conserved are shown in Table 4. Although estimates of the number of individuals which constitute a viable population vary, it is likely that the estimate of 6200 individuals in reserves constitutes a viable population. The absolute areal extent conserved (49 ha) is not large and some consideration should be given to the minimum areal extent to be conserved for communities with a limited distribution. The estimated proportion conserved is 6.2%. The question of what proportion of a community constitutes an adequate sample is the subject of ongoing research. Recent studies (eg Pressey and Bedward 1991) indicate that the commonly quoted figure of 5% is inadequate. Hence, it is unlikely that all the species associated with this plant community are currently conserved.

Table 4. Occurrence of *Eucalyptus dunnii* communities on various tenures

Location	Tenure	Area-ha	Number of trees
Koreelah Range, Wallaby Creek	State forest	195	22,900
	Flora reserve	35	5,190
	Private	18	2,190
Tooloom Range	State forest	82	8,770
	Private	5	530
Acacia Plateau, south	State forest	77	6,790*
	Private	8	710*
Acacia plateau, north	State forest	14	1,030
MacPherson Range	State forest	105	10,510
	Flora reserve	9	760
	Private	5	490
Richmond Range	State forest	38	1,580
Tooloom Range, Richmond Range	State forest	62	5,080
	Private	1	80
Urbenville showground	Crown land	5	200*
Acacia Creek	Private	18	1,590*
Tooloom Creek, Woodenbong	Private	5	710*
Border Ranges	National park	5	260
Gilgurry	State forest	8	690
Averys Creek, Moleton	State forest	8	840
Black Mountain road, Moleton	State forest	52	3,460
Clouds/Hortons Creek	Private	32	5,260
Total- ha	State forestx	649	61,650
	Reserves	49	6,210
	Crown land	5	200
	Private	92	11,560
	Total	795	78,890

Total- %	State forestx	81.6
	Reserves	6.2
	Crown land	0.6
	Private	11.6

x Excludes flora reserves
* Estimate

The community is not adequately conserved in the southern part of its range. An additional flora reserve is under consideration in Kangaroo River State Forest (E. Chiswell, pers. comm.). A nature reserve is proposed at Hortons Creek but the most extensive stands of *Eucalyptus dunnii* are outside the current proposal. So the proposal requires review in light of this information.

The western-most occurrence in Gilgurry State Forest is also unconserved and has been recently logged. If the two additional reserve proposals come to fruition and some protection is afforded to the western-most occurrence, the proportion conserved would increase to approximately 10% and the community would have an adequate spread of reserves over its geographic range. These steps would improve the representation of the species in this plant community within reserves.

The age class data are presented in Table 5. It is evident from the high proportion of young trees that most stands of *Eucalyptus dunnii* have been logged. While it appears to regenerate readily following logging, this disturbance has caused a shift to a younger age class in the community. *Eucalyptus dunnii* is found on fertile soils which are prone to invasion by weeds after a disturbance such as logging. Several sites carried a high abundance of *Aegeratina adenophora* (Crofton Weed). The practice of burning after logging also changed the understorey associated with *Eucalyptus dunnii* by discriminating against the fire sensitive shrubs.

Table 5 Disturbance history of *Eucalyptus dunnii* communities

Location	Proportion of trees within DBH classes (meters)			Years since most recent fire	Presence of grazing
	0-.5	.51-1.25	1.26-2		
Koreelah Range,	.97	.03	0	GT30	Y
Wallaby Creek	.92	0	.08	GT30	Y
	.96	.04	0	LT5	Y
	.88	.11	.01	GT30	N
	.90	.10	0	GT30	N
	.93	.07	0	LT5	N
Toolooa Range	.97	.03	0	GT30	N
	.67	.22	.11	GT30	N
	.94	.06	0	30	N
	.94	.04	.02	GT30	N

	.67	.22	.11	GT30	N
	.75	.25	0	GT30	N
Acacia Plateau, south	NR	NR	NR	NR	NR
Acacia plateau, north	.81	.10	.09	LT1	Y
	.88	.06	.06	LT1	N
MacPherson Range	1	0	0	LT5	N
	1	0	0	GT30	N
	.88	.12	0	GT30	N
	.83	.17	0	GT30	N
	.98	0	.02	GT30	N
Gilgurry	.74	.22	.04	GT30	N
Richmond Range	NR	NR	NR	GT20	Y
Border Ranges	.78	.14	.08	GT30	Y
Tooloom Range, Richmond Range	.96	.04	0	GT30	N
	1	0	0	GT30	N
	.94	.06	0	GT30	N
	.89	.11	0	GT30	N
Averys Creek, Moleton	.68	.25	.07	30	N
Black Mountain road, Moleton	.94	.06	0	10	Y
	.59	.29	.12	GT50	N
Clouds/Hortons Creek	.93	.05	.02	GT30	Y
	.54	.36	.10	GT50	Y
Urbanville showground	NR	NR	NR	GT50	Y
Acacia Creek	NR	NR	NR	NR	Y
Tooloom Creek, Woodenbong	NR	NR	NR	NR	Y

NR= Not recorded

Relatively few of the sites with a moist understorey showed evidence of grazing, presumably due to the absence of grasses (Table 5). Where weed species or management practices typical of grazing were observed, the *Eucalyptus dunnii* community was invariably drier with fewer rainforest species and more grasses. There was little regeneration in these sites. The presence of weed species and regular fire had often modified the understorey. Sites on generally cleared land have been substantially modified due to

replacement of the understorey and lack of regeneration of trees and shrubs.

The time since the last fire at each site is shown in Table 5. Fire is infrequent, apart from some sites where regular fire has been used to promote the growth of grasses. A low fire frequency is due to *Eucalyptus dunnii* occupying moist, fertile sites with an understorey which is not especially flammable. Under natural conditions, it is likely that *Eucalyptus dunnii* regenerates when infrequent disturbance such as fire or a cyclone occurs.

The locations of *Eucalyptus dunnii* records from herbarium specimens were not accurate and had to be verified in the field. In some instances, apparently separate populations identified from these records were in fact several kilometers from the location given on the record and were found to be identical with populations identified from more accurate sources.

The sites identified on forest type maps were generally accurately typed, particularly when road access was freely available. One area below Acacia Plateau and comprising approximately 70 hectares was found to be *Eucalyptus saligna* rather than *Eucalyptus dunnii*. So there is some value in field checking the more inaccessible sites identified by remote sensing.

The time required to carry out this survey of the conservation status of *Eucalyptus dunnii* was twelve weeks. Locating and mapping the locations of *Eucalyptus dunnii* took 7 weeks, verifying locations, estimating the number of individual trees, recording disturbance histories and surveying the species associated with *Eucalyptus dunnii* communities occupied 2 weeks and data processing and writing up of the report took 3 weeks. The two weeks allowed for verification of locations proved to be the bare minimum required and another week would have allowed a more comprehensive assessment of sites identified on privately owned lands.

As there are currently more than 400 recognised plant communities in the state, many of which have a wider distribution than *Eucalyptus dunnii*, it is clearly not possible to adopt this approach for each community. Nevertheless, the approach is suitable for comprehensive surveys of restricted communities.

4.5 Problems encountered in the study

4.5.1 Classification

The problem arising from the use of different classifications in most ecological studies have been discussed by Robinson and Benson J.S. (1990). In this study, classification units used in various ecological studies have been matched with the closest equivalent unit in the plant association classification (after Benson 1989). There will always be some instances where there is no clear equivalent. In this exercise, close matches were obtained for about 80% of plant communities. It is anticipated that this

problem will gradually decline in significance as the plant community classification is progressively supplemented with communities identified in regional vegetation surveys. It is anticipated that the problems associated with the varying resolution of classifications will similarly decline.

The number and hence diversity of plant communities occurring in the study area is likely to be underestimated. This results from the use of classifications which are intuitively derived or based on inadequate field sampling. If either of these factors are operable, then biodiversity can be simplified. This is typified by the broadness of some forest types (eg Type 117 Scribbly Gum or Type 1 Booyong) or the additional communities which can be delineated when an area mapped by remote sensing is subject to field survey (eg Floyd 1979). This situation will also decline in significance as additional vegetation surveys are completed.

4.5.2 Availability of data

Due to the time available for this study and the size of the study area, it was necessary to rely on published information. Since accurate data is not available for parts of the study area, qualitative surveys and professional estimates from individuals with sound local knowledge have been used. The data for plant communities in many reserves are based on professional estimates.

When a vegetation map does exist, the information is generally in hard copy form in which manipulations such as areal extent estimates are time consuming to perform. This constraint restricted the number of accurate areal extent measurements that could be performed to some reserves, the *Eucalyptus dunnii* locations and some old growth forests. It also restricted the number of measurements which could be made in estimating the relative abundance of the individual forest types within a management zone so that the data on leagues could be expressed in terms of forest types.

Due to the constraints on the form and availability of data, approximate areal extent estimations were widely used in this report. This restricted the analyses performed to a semi-quantitative basis but they are considered to be reasonably accurate.

4.5.3 Size of the sample conserved

The conservative nature of the estimate of 5% or less used to delineate inadequately conserved communities has been discussed in paragraph 4.2. However, the resolution of classification units also influences the question of the size of an adequate sample. Pressey and Bedward (1991) have shown that the amount required is scale dependent and that conservation of a relatively low proportion of species in a classification unit will occur if the scale of the classification is relatively coarse and/or its units are relatively heterogeneous.

Some of the units in the classification used in this study are coarse which further suggests that the 5% delineation is conservative. Additional information on this question such as testing the homogeneity of the intuitively derived classification against one derived from a survey with adequate sampling and data analysis as suggested by Bedward, Keith and Pressey (in press) would substantially assist with the assessment of the adequacy of the classification for the various assessments of conservation status carried out in this study.

4.6 Further work required

The major constraint encountered during this project was the inaccessibility, inaccuracy or lack of the data on the areal extent of plant communities as previously discussed. In the first instance, it is probably more efficient to concentrate resources on increasing the accessibility of the existing information by incorporation into databases and Geographic Information Systems. If such information could be accessed and manipulated, the estimates of areal extent of communities on the various land tenures would be substantially quicker and more accurate than was achieved for the majority of plant communities considered in this project. The ability to readily incorporate additional data was considered when designing the databases and methods used in the project as projects involving the databasing of such information are underway.

After the existing information has been incorporated into information systems, the next priority would be to fill the gaps in the information base which would necessitate additional survey work, air photo and LANDSAT interpretation followed by mapping to identify the plant communities within the study area and to accurately estimate their areal extent.

Improving the quality and availability of information would facilitate projects such as this more than any other factor.

The plant community classification can likewise be improved. The classifications used in regional vegetation surveys in the study area should be incorporated as they become available. Replacing the broad and intuitive classification units with those derived from field survey should make them more homogeneous and hence the units in the classification should be better surrogates for species diversity than is currently the case.

The question of the size of the sample which will adequately conserve a plant community is the subject of ongoing research. The conservation codes allocated to plant communities, in particular those having an indeterminate conservation status, will need to be reviewed as additional data on this question become available.

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REPORT TO THE AUSTRALIAN HERITAGE COMMISSION

REVIEW OF THE CONSERVATION STATUS OF VEGETATION COMMUNITIES IN NEW SOUTH WALES.

PART 3
ASSESSMENT OF THE CONSERVATION STATUS OF FOREST PLANT COMMUNITIES IN NORTH EASTERN NSW

SECTION 2
FINAL SPECIFICATIONS FOR A PLANT COMMUNITIES DATABASE

SECTION 2

1.0 SUMMARY

Different approaches have been adopted in the establishment of databases depending on whether the plant communities have been reliably mapped. Attributes which have been mapped have been digitised into E-RMS databases. The AREV database deals with numerical and text attributes which cannot or have not been mapped. Most information has been gleaned from references dealing with vegetation surveys and the data relating to each study area identified have been incorporated into individual records in the AREV database. Both E-RMS and AREV have the capacity to perform the calculations that are needed to derive the total areal extent of plant communities from individual records. The ability to handle two levels of resolution in the classification is a feature of both databases. The capacity for searching is needed for the generation of some reports in the AREV database.

2.0 Introduction

Objectives 2.1 to 2.5 have been considered in the first section of this report. Objectives 2.6 and 2.7 below are now considered in this section of the report.

2.6 Finalisation of the specifications for a database to store and manipulate the data generated in this project;

2.7 Development of the above database;

The database has been constructed and is close to its final form. The most commonly used standard reports have been incorporated into the database. All the data on occurrences of plant communities in reserves has been entered into an ADVANCED REVELATION database, including data derived from the digitising of available vegetation maps covering reserves in the region. The information in these databases was extensively used in the analyses carried out in section 1 of this report.

The development of these databases constituted a reasonable proportion of this stage of the project and their use will substantially facilitate future stages of the project.

3.0 Purpose of the database.

3.1 To allow the easy storage and retrieval of data about the location, areal extent, conservation status and threats to plant communities.

3.2 Manipulation and integration of the above data. Examples include area calculation, map rescaling, overlaying plant community maps with other attributes and the amalgamation of several plant communities to produce a broader classification.

3.3 Correlation of plant community maps with other mapped attributes to assist with the design, analysis and extrapolation of resource surveys to unsurveyed areas.

4.0 Need for the database

The Service requires information about the conservation status of plant communities in New South Wales in order to assist with the assessment of priorities for the establishment of new reserves, to assist in the management of presently reserved areas, to assist with the Service's off park conservation activities and to participate in the environmental assessment process in a more adequate manner. To date, the sources of such information have been based on qualitative information and have contained an large degree of subjectivity. The Service is increasingly requiring quantitative information concerning the area occupied by plant communities within and outside reserves as competition for and threats to the state's remaining natural resources become more intense. There are also increasing demands for information from external sources such as the Resources Assessment Commission, National Forest Inventory (DASETT and DPI) and the conservation status review of plant communities proposed by Professor Specht.

There are a substantial number of references dealing with vegetation surveys in NSW and these have been included in a bibliography using the Advanced Revelation (AREV) software as part of this project. However, there is a need to make the information contained in these references more accessible to allow the data to be more easily retrieved and manipulated. A substantial amount of this quantitative information concerning locations and the area occupied by plant communities has been generated during this project. This provides an ideal opportunity to input this information onto a database as it is collated.

5.0 General requirements

For plant surveys where individual plant communities have been reliably mapped, software which readily deals with mapped attributes is required. The best option in this instance is to digitise such maps into a GIS. The Service has already commenced the establishment of a GIS for northern NSW using Environmental Resources Mapping System (E-RMS) software. Some of the attributes previously digitised have been used for this project and E-RMS has been used to digitise additional attributes required for the project. Many ecological surveys have only general descriptions of plant communities and their areal extent. Therefore an approach involving mapping of attributes is not readily applicable and an AREV database has been developed to cater for references in this category.

The AREV database handles attributes of plant communities which have been gleaned from a number of individual references. It is proposed to have one record in the database for the data associated with each plant community in each study area identified in a reference. Although most references have only one study area, this approach will cover

the situation where several discrete areas are studied. Some of the attributes involve text entries but numerical information (eg estimates of the areal extent of plant communities) features prominently. The ability to perform some calculations is also required as the raw data from these individual references needs to be summed to give a total areal extent over the community's geographic range. These totals have assisted in developing a picture of the overall conservation status of each plant community.

The database has been designed to handle classifications which vary in their scale and in the attributes used to describe their structure and floristics. The question of scale is particularly relevant to this project because the classification proposed by Specht (in press) is broader than those used in the publications from which the primary data has been obtained. This problem has been dealt with by having the ability to amalgamate several plant communities into a broader group and to sum their individual numerical attributes giving a total figure for the broader group.

For the purposes of this database, only two levels of resolution (the plant communities and floristic groups as defined in paragraph 3.1 in section 1) have been considered. The attributes used to define the communities identified in individual references do not always exactly match the classification used in this project. Fields have been allocated in the database to enter the dominant species used by individual authors to describe communities and to assign an estimate of goodness of fit with the NPWS classification.

The primary data have been entered into a file dealing with plant communities and the total areal extent figures for plant communities and floristic groups have been derived in suitable reports.

The only reference to the source of data for each record in the plant communities database is the code in the key field of the AREV bibliography database of vegetation surveys. It is possible to relate the plant community and bibliography databases so that full details of the reference can be called up in a separate window.

The detailed specifications for databases capable of handling both mapped and descriptive data are now considered further.

6.0 Database structure.

6.1 E-RMS database for reliably mapped information

It is proposed to incorporate data which has been reliably mapped into E-RMS databases. E-RMS has been chosen from various GIS software packages as it is designed for use on microcomputers, does not require highly specialised training to use and has good capability for data integration, analysis and design in addition to the usual data storage, retrieval

and mapping capabilities. E-RMS has the following features (from Ferrier 1989).

* The software runs on IBM-PC XT/AT, PS/2 microcomputers and close compatibles. Supported hard copy devices include pen plotters, inkjet plotters and dot matrix printers.

* E-RMS is primarily a grid cell based system with a resolution of 1 hectare. However, vector data can be incorporated for cartographic purposes. Over 500,000 grid cells with up to 300 attributes can be stored in a single database. Analytical functions of the package include Boolean overlaying, proximity transformations, graphical and statistical analysis of relationships between features and predictive modelling.

* Maps are produced with full interactive control of scaling, windowing and colouring. The system generates a variety of reports including checklists, area/frequency tables and histograms.

* A digitising module is included in the package. Data can also be imported from other sources including ASCII data files and various GIS commercial packages including ARC/INFO and ERDAS.

The following attributes have already been included in the Service's GIS for northern NSW:

- Coastline and estuaries digitised at 1:25,000
- Major roads digitised at 1:100,000
- Land tenure classes digitised at 1:125,000
- National Parks and Nature Reserves digitised at 1:25,000
- Aboriginal sites
- SEPP coastal wetlands and littoral rainforest digitised at 1:25,000
- Elevation, slope and aspect digitised at 1;100,000

Attributes which are currently being added to the database or which are available for part of northern NSW include:

- Climate which is derived using CRES algorithms
- Local government, State and Federal electoral boundaries (from AUSLIG)
- Plant and animal location records from various sources
- Structural vegetation classes digitised from type maps produced by visual interpretation of georeferenced 1:100,000 Landsat TM images

- Plant communities from available maps, at varying scales but often 1:25,000

The digitising of vegetation at the structural level and existing maps at the floristic level has been largely completed for northern NSW. The ability to overlay other attributes over the plant community maps (eg tenure and clearing) will also be an essential component of future work . The capability of E-RMS to perform transformations has also been utilised in combining plant communities into the broader floristic groups required for the review of the conservation status of Australian major plant communities (Specht, in press). Other attributes such as fire and logging histories have also been added to the GIS as maps are digitised. These attributes have assisted with the assessment of the condition of plant communities.

6.2 AREV database for imprecise information

This database has been developed in Advanced Revelation and it operates in the runtime version. All the major databases either under development or completed by the Service use this software. Advantages of the AREV software include variable length fields which result in substantial savings in space, the ability to tightly specify the format of the input and output data, the ease of performing calculations using symbolic fields, the ability to share data by establishing relationships between separate files and the ease of amending the database.

The fields that are needed for the plant communities file are listed in Appendix 7. The notations in some fields refer to the proposed entries which are listed in Appendix 8.

The database has been designed to accept areal estimates of the extent and/or amount cleared for plant communities in study areas defined in individual references. There is the capacity to input data for plant communities occurring on various tenures. In the case where reserves occur in the study area defined in the reference, there is the capacity to identify each reserve and express the figures as occurrences in each reserve. Other information which can be included in the database includes data about the study area, condition and threats/conservation status for a particular plant community, key areas for the conservation of the community and the source of data.

Totals of all these areal estimates over the geographic range of each community are needed to assist in the assessment of the conservation status of an community. This aspect is dealt with in the reports which have been designed as part of the database. The inclusion of data from references with overlapping study areas would result in double counting of area figures. In order to avoid this possibility, provision has been made to identify whether the data for a study area is active or inactive. Only the data associated with active study areas are incorporated in the calculations used to

derive the reports. If study areas overlap completely, the more reliable reference is identified as active and the other inactive. Where overlap only affects part of a study area, it is necessary to divide one study area into active and inactive portions, to make areal estimates for each portion and then treat each portion as a separate study area.

In addition to the totals of the areal estimates, the text attributes such as threats, condition and conservation status for each individual record are compiled in the reports and this information also assists with the assessment of conservation status. The reports which have been commonly used are discussed in section 7.0.

Some of the information required for Specht's review of the conservation status of Australian vegetation concerns abiotic attributes of reserves (eg area, latitude/longitude, elevation and geology). Fields for this information have already been included in the Service's AREV database on national parks and nature reserves and this database has also been used in the course of this project.

The information about floristic groups required for Specht's review is also generated in the reporting process. Each plant community record is also flagged with a floristic group number and this allows the reports about floristic groups to be generated. This approach should make the most efficient use of computing time and space requirements.

7.0 REPORTS

7.1 Calculations

As mentioned previously, the areal extent figures for individual occurrences need to be summed to give total figures for plant communities and floristic groups over their geographic range in NSW. The following table shows the information required for this report:

TOTALS FOR PLANT COMMUNITIES AND FLORISTIC GROUPS DERIVED FROM SPECIFIC RECORDS

Plant community (or floristic group) number:

Plant community (or floristic group) name:

Total area in reserves (ha):

Reliability of estimates:

Total area in state forests (ha):

Reliability of estimates:

Total area in other Crown tenures (ha):

Reliability of estimates:

Total area in freehold and leasehold (ha):

Reliability of estimates:

Total area remaining: (Sum of previous four categories)

% conserved: (Area in reserves / area remaining * 100)

Total area cleared (ha):

Reliability of estimates:

Total original area (ha):

% of original area conserved: (Area reserved / original area * 100)

Conservation status/risk codes:

Key areas for conservation:

Causes for decline:

Threats:

7.2 Floristic groups

There is a need to view the compilations of plant community records into floristic groups for each reference. A report containing the following information would satisfy this need:

Floristic group number:

Floristic group name:

Biblio database reference:

Study Area description:

Reserve number:

Reserve name:

Reserve area:

Proportion of reserve area in study area:

Area per reserve (ha):

Area in state forests (ha):

Area in other Crown tenures (ha):

Area on freehold or leasehold (ha):

Area cleared (ha):

7.3 Reports involving searching

The following reports which largely involve searching for text attributes rather than calculation of totals from raw data are also required:

7.3.1 Which plant communities/floristic groups have a particular conservation status/risk code?

7.3.2 Which plant communities are represented in any reserve? (include area reserved in report)

7.3.3 Which plant communities/floristic groups with a particular conservation status/risk code are represented in any reserve? (include area reserved in the report)

7.3.4 Which plant communities are represented in a particular reserve? (include conservation status/risk code, area reserved and area of reserve in the report)

7.3.5 Which plant communities in a particular reserve have a particular disturbance history? (include conservation status/risk code in the report)

7.3.6 In which reserves is a particular plant community found? (include areas in each reserve in this report)

7.3.7 Which plant communities are not represented in any reserve?, have less than a specified number of hectares reserved? or have less than a specified percentage of their total areal extent reserved? (include total areal extent, conservation status/risk code, threats and key areas for conservation in the report)

7.3.8 Which plant communities have been assigned to a particular floristic group?

8.0 ACKNOWLEDGEMENTS

This project was undertaken using funds from a grant supplied by the Australian Heritage Commission and this assistance is gratefully acknowledged. Murray Ellis provided valuable advice on the database specifications and contributed his own time in converting the concept into a working database. Peter Bowen made a substantial contribution by digitising the vegetation maps and completing a substantial amount of data entry.

9.0 REFERENCES

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Specht, R.L. and Bolton, M.P. In press. Introduction. In: Specht R.L. (ed) Major plant communities in Australia: An objective assessment.

Appendix 1. Samples in reserves and conservation status of plant communities

Association number	Association name	Number of Samples in Reserves		Proportion conserved in NPWS reserves by Regions			Total Proportion Conserved	Conservation Code
		NPWS	FC	northern	central	south		
EF100	EUCALYPTUS GRANDIS	10	17	LT5-LT10	LT5	LT1	LT1-LT5	2
EF101	EUCALYPTUS GRANDIS-LOPHOSTEMON CONFERTUS-EUCALYPTUS MICROCORYS	28	41	LT25-GT25	LT10-LT25	LT5	LT10-LT25	3
EF102	EUCALYPTUS SALIGNA	3	19	LT5	LT1	LT10-LT25	LT5-LT10	3
EF145	EUCALYPTUS SALIGNA-ANGOPHORA FLORIBUNDA-EUCALYPTUS ACMENIOIDES-ALLOCASUARINA TORULOSA	1						
EF103	EUCALYPTUS SALIGNA-EUCALYPTUS MICROCORYS	15	28	LT25-GT25	LT5-LT10	LT5-LT25	LT10-LT25	5
EF10A	EUCALYPTUS SALIGNA-EUCALYPTUS QUADRANGULATA	1	2	N/A	LT1-LT5	LT25-GT25	LT10-LT25	3
EF105	EUCALYPTUS DUNNII	1	3	LT10*	LT1	N/A	LT10*	3
EF106	EUCALYPTUS BRUNNEA	1	1	LT1-LT5	LT1-LT5	N/A	LT1-LT5	2
EF1[illegible]	EUCALYPTUS BRUNNEA-EUCALYPTUS CALIGINOSA	2						
EF107	EUCALYPTUS BRUNNEA-EUCALYPTUS CYPELLOCARPA	0	0	N/A	LT1	N/A	LT1	1
EF109	EUCALYPTUS ACMENIOIDES-EUCALYPTUS PROPINQUA	5	12	LT5	LT1	LT1-LT5	LT1-LT5	2
EF203	EUCALYPTUS RESINIFERA-EUCALYPTUS ACMENIOIDES	3						
EF110	EUCALYPTUS PROPINQUA-EUCALYPTUS SIDEROPHLOIA	11	13	LT25-GT25	LT5	LT5	LT10-LT25	3
EF111	EUCALYPTUS TERETICORNIS	12	7	LT5-LT10	LT5	LT1	LT5-LT10	2
EF113	EUCALYPTUS TERETICORNIS-EUCALYPTUS HELLIODORA	2						
EF112	EUCALYPTUS AMPLIFOLIA-ANGOPHORA SUBVELUTINA-EUCALYPTUS TERETICORNIS	1	0	LT1	LT5	LT1	LT5	2
EF120	EUCALYPTUS AMPLIFOLIA	1						
EF115	EUCALYPTUS PILULARIS	21	17	LT10-LT25	LT25-GT25	LT5	LT10-LT25	3
EF116	EUCALYPTUS PILULARIS-EUCALYPTUS RESINIFERA	3						
	EUCALYPTUS PILULARIS-EUCALYPTUS ACMENIOIDES	3						
EF118	EUCALYPTUS PILULARIS-EUCALYPTUS INTERMEDIA-EUCALYPTUS SIDEROPHLOIA	4	17	LT1	LT5-LT10	LT1	LT5-LT10	3
EF121	EUCALYPTUS MACULATA	4	6	LT1-LT5	LT5-LT10	LT1	LT5	2
EF123	EUCALYPTUS MACULATA-EUCALYPTUS SIDEROPHLOIA	6	7	LT5-LT10	LT1	LT1-LT5	LT1-LT5	2
EF205	EUCALYPTUS MACULATA-EUCALYPTUS PROPINQUA-EUCALYPTUS GUMMIFERA-ANGOPHORA FLORIBUNDA	1						
EF124	EUCALYPTUS MACULATA-EUCALYPTUS RUMMERYI	0	2	LT1	LT1	N/A	LT1	1
EF125	EUCALYPTUS MACULATA-SYNCARPIA GLOMULIFERA-EUCALYPTUS SALIGNA	1	1	LT1	LT1	LT1	LT1	1
EF133	EUCALYPTUS AGGLOMERATA	0	1	N/A	N/A	LT5-LT10	LT5-LT10	4
EF134	EUCALYPTUS GLOBOIDEA-EUCALYPTUS AGGLOMERATA	1						
EF138	SYNCARPIA GLOMULIFERA-EUCALYPTUS MICROCORYS	3	0	LT1	LT1	LT1	LT1	1

LT1, LT5, LT10 or LT25= Less than 1%, 5%, 10% or 25% conserved respectively; GT25= Greater than 25% conserved.

Association number	Association name	Number of Samples in Reserves NPWS	FC	Proportion conserved in NPWS reserves by Regions northern	central	south	Total Proportion Conserved	Conservation Code
EF139	EUCALYPTUS PROPINQUA-EUCALYPTUS CAMERONII	1	2	LT1	LT10-LT25	LT1	LT10-LT25	3
EF140	EUCALYPTUS PILULARIS-EUCALYPTUS MACULATA	8	8	LT1	LT1	LT1	LT1	1
EF141	EUCALYPTUS MACULATA-EUCALYPTUS MOLUCCANA	8	3	LT1	LT1	LT1	LT1	1
EF142	EUCALYPTUS MACULATA-LOPHOSTEMON CONFERTUS	8	3	LT1	N/A	N/A	LT1	1
EF143	EUCALYPTUS MOLUCCANA-EUCALYPTUS SIDEROPHLOIA-EUCALYPTUS PROPINQUA	8	3	LT1	LT1	N/A	LT1	1
EF144	EUCALYPTUS LARGEANA-LOPHOSTEMON CONFERTUS	8	1	N/A	LT1	LT1	LT1	1
EF146	EUCALYPTUS ACMENIOIDES-EUCALYPTUS TERETICORNIS-ALLOCASUARINA TORULOSA	1	5	LT25-GT25	LT1-LT5	LT1	LT10-LT25	3
EF615	EUCALYPTUS SIDEROPHLOIA-EUCALYPTUS TERETICORNIS-EUCALYPTUS UMBRA	4						
EF201	EUCALYPTUS PILULARIS-ANGOPHORA COSTATA	8	2	LT5-LT25	LT25-GT25	GT25	LT25-GT25	5
EF202	EUCALYPTUS ROBUSTA	8	8	LT1	LT5	LT25-GT25	LT10-LT25	3
EF204	EUCALYPTUS INTERMEDIA	3	1	LT1-LT5	LT1	LT1	LT1	2
EF209	EUCALYPTUS TINDALIAE-EUCALYPTUS GUMMIFERA	2						
EF206	EUCALYPTUS SIGNATA	9	1	LT1-LT5	LT5-LT10	LT1-LT5	LT5	2
EF207	EUCALYPTUS SIGNATA-EUCALYPTUS INTERMEDIA	8						
EF208	EUCALYPTUS SIGNATA-CALLITRIS COLUMELLARIS	5	8	LT1-LT5	LT5-LT10	LT1	LT5	2
EF210	EUCALYPTUS UMBRA SSP UMBRA	8	3	LT1	LT1	LT5-LT10	LT5-LT10	3
EF251	EUCALYPTUS UMBRA SSP CARNEA-EUCALYPTUS PROPINQUA	1						
EF211	EUCALYPTUS PLANCHONIANA-EUCALYPTUS PILULARIS	6	1	LT25-GT25	LT25-GT25	LT5	LT10-LT25	3
EF212	EUCALYPTUS BAILEYANA	1	3	LT1	LT5-LT25	N/A	LT1-LT5	2
EF213	EUCALYPTUS BAILEYANA-EUCALYPTUS PLANCHONIANA-EUCALYPTUS BANCROFTII	3						
EF223	EUCALYPTUS GUMMIFERA-ANGOPHORA FLORIBUNDA	2	8	LT1	LT1	LT1	LT1	1
EF240	EUCALYPTUS MORTONII-EUCALYPTUS SERPENTINICOLA	8	8	N/A	N/A	LT1	LT1	1
EF247	EUCALYPTUS PYROCARPA-EUCALYPTUS ACMENIOIDES	1	5	LT10-LT25	LT1	LT1	LT10-LT25	3
EF372	EUCALYPTUS PYROCARPA-EUCALYPTUS CAMERONII	1						
EF248	EUCALYPTUS APPROXIMANS	3	8	LT25-GT25	GT25	N/A	LT25-GT25	5
EF250	ANGOPHORA COSTATA-EUCALYPTUS GLOBOIDEA	1	1	N/A	N/A	LT5-LT10	LT5-LT10	4
EF301	EUCALYPTUS PAUCIFLORA SSP PAUCIFLORA-EUCALYPTUS STELLULATA	1	1	LT1	LT1	LT25-GT25	LT25-GT25	3
EF302	EUCALYPTUS PAUCIFLORA SSP PAUCIFLORA-EUCALYPTUS DALRYMPLEANA	1	1	LT1	LT1-LT5	LT25-GT25	LT10-LT25	3
EF303	EUCALYPTUS PAUCIFLORA SSP PAUCIFLORA-EUCALYPTUS VIMINALIS	1						
EF304	EUCALYPTUS MOOREI	1	8	GT25	N/A	N/A	GT25	5
EF308	EUCALYPTUS DALRYMPLEANA SSP HEPTANTHA-EUCALYPTUS CALIGINOSA	1	2	LT1	LT1	N/A	LT1	1
EF309	EUCALYPTUS VIMINALIS	8						1

LT1, LT5, LT10 or LT25= Less than 1%, 5%, 10% or 25% conserved respectively; GT25= Greater than 25% conserved.

Association number	Association name	Number of Samples in Reserves NPWS	Number of Samples in Reserves FC	Proportion conserved in NPWS reserves by Regions northern	central	south	Total Proportion Conserved	Conservation Code
EF310	EUCALYPTUS VIMINALIS-EUCALYPTUS DORRIGOENSIS	0	1	LT1	LT1	N/A	LT1	1
EF312	EUCALYPTUS OBLIQUA-EUCALYPTUS PAUCIFLORA-EUCALYPTUS CAMPANULATA	1	2	LT1	LT1	LT1	LT1	1
EF313	EUCALYPTUS OBLIQUA-EUCALYPTUS FASTIGATA-EUCALYPTUS CYPELLOCARPA	1	2	N/A	LT5-LT10	LT25-GT25	LT10-LT25	5
EF314	EUCALYPTUS NITENS-EUCALYPTUS FASTIGATA-EUCALYPTUS CYPELLOCARPA	1	2	N/A	LT5-LT10	LT5-LT10	LT5-LT10	4
EF315	EUCALYPTUS NITENS	1						
EF343	EUCALYPTUS CYPELLOCARPA	0						
EF379	EUCALYPTUS FASTIGATA-EUCALYPTUS VIMINALIS	1						
EF316	EUCALYPTUS OBLIQUA-EUCALYPTUS [redacted] MOBILIS	2	3	LT1	LT1-LT5	LT1-LT5	LT1-LT5	2
EF[redacted]	EUCALYPTUS OBLIQUA-EUCALYPTUS CAMERONII	2	1	LT1	LT1-LT5	N/A	LT1-LT5	2
EF323	EUCALYPTUS RADIATA SPP SEJUNCTA	1	1	LT5-LT10	LT5-LT10	LT5	LT5-LT10	3
EF324	EUCALYPTUS RADIATA SPP SEJUNCTA-EUCALYPTUS-ACACIIFORMIS-EUCALYPTUS DALRYMPLEANA SSP HEPTANTHA	4						
EF325	EUCALYPTUS RADIATA SPP SEJUNCTA-EUCALYPTUS SUBTILOR	0	0	LT1	LT1	N/A	LT1	1
EF327	EUCALYPTUS RADIATA SPP SEJUNCTA-EUCALYPTUS DIVES-EUCALYPTUS DALRYMPLEANA	0	1	LT1	LT1	LT1	LT1	1
EF328	EUCALYPTUS ELLIPTICA	0	0	N/A	LT1	LT1	LT1	1
EF330	EUCALYPTUS ELLIPTICA-EUCALYPTUS MACRORHYNCHA-EUCALYPTUS DIVES-EUCALYPTUS RUSSII	0	0	N/A	LT1	LT1	LT1	1
EF335	EUCALYPTUS DIVES-EUCALYPTUS RUBIDA SSP BARBIGERORUM-EUCALYPTUS MACRORHYNCHA	0	0	LT1	LT1	LT1	LT1	1
EF341	EUCALYPTUS MACRORHYNCHA-EUCALYPTUS BRIDGESIANA-EUCALYPTUS MELLIODORA	1	0	LT5-LT10	LT1	LT1	LT5-LT10	3
EF342	EUCALYPTUS MACRORHYNCHA-EUCALYPTUS PRAUA	0	0	LT1	LT1	N/A	LT1	1
EF357	EUCALYPTUS STANNICOLA-EUCALYPTUS PRAUA	1						
EF345	EUCALYPTUS OREADES	1	1	LT1	LT1	LT1	LT1	1
EF346	EUCALYPTUS LAEVOPINEA	0	5	LT5-LT10	LT25-GT25	N/A	LT25-GT25	5
EF347	EUCALYPTUS LAEVOPINEA-EUCALYPTUS CAMERONII	0						
EF348	EUCALYPTUS LAEVOPINEA-EUCALYPTUS RETINENS-EUCALYPTUS BANKSII-EUCALYPTUS MELLIODORA	1						
EF349	EUCALYPTUS CALIGINOSA	3	0	LT5	LT1	N/A	LT1-LT5	2
EF350	EUCALYPTUS CALIGINOSA-EUCALYPTUS MELLIODORA	0						1
EF351	EUCALYPTUS MCKIERAMA-EUCALYPTUS NICHOLII-EUCALYPTUS CALIGINOSA	0						1
EF352	EUCALYPTUS MCKIERAMA	0						1
EF353	EUCALYPTUS WILLIAMSIANA	1						2
EF354	EUCALYPTUS WILLIAMSIANA-EUCALYPTUS RADIATA SPP SEJUNCTA	0						1
EF355	EUCALYPTUS STANNICOLA-EUCALYPTUS ANDREWSII	1						2
EF356	EUCALYPTUS SUBTILIOR-EUCALYPTUS LIGUSTRINA-EUCALYPTUS CAMPANULATA	1						2

[illegible] 10% or 25% conserved respectively; GT25= Greater than 25% conserved.

Association number	Association name	Number of Samples in Reserves		Proportion conserved in MPWS reserves by Regions			Total Proportion Conserved	Conservation Code
		MPWS	FC	northern	central	south		
EF358	EUCALYPTUS CAMPANULATA	12	23	LT25-GT25	GT25	LT10-LT25	LT25-GT25	5
EF359	EUCALYPTUS CAMPANULATA-EUCALYPTUS CAMERONII	9						
EF360	EUCALYPTUS CAMPANULATA-EUCALYPTUS CALIGINOSA	6						
EF361	EUCALYPTUS CAMPANULATA-EUCALYPTUS RADIATA SPP SEJUNCTA	1						
EF364	EUCALYPTUS ANDREWSII-EUCALYPTUS BANKSII	0	0	LT1	LT1	N/A	LT1	1
EF365	EUCALYPTUS NOVA-ANGLICA	0	0	LT1	LT1	N/A	LT1	1
EF366	EUCALYPTUS NOVA-ANGLICA-EUCALYPTUS RADIATA SPP SEJUNCTA-EUCALYPTUS ACACIIFORMIS	1						
EF367	EUCALYPTUS NOVA-ANGLICA-EUCALYPTUS BRIDGESIANA	0						
EF368	EUCALYPTUS BICOSTATA	1	1	N/A	LT1	LT1	LT1	1
EF373	EUCALYPTUS LAEVOPINEA-EUCALYPTUS VIMINALIS	1	3	LT5-LT10	LT1-LT5	LT1	LT5	2
EF374	EUCALYPTUS LAEVOPINEA-EUCALYPTUS SALIGNA	0						
EF375	EUCALYPTUS OBLIQUA-EUCALYPTUS LAEVOPINEA	0	2	LT1	LT1	LT5-LT10	LT5-LT10	3
EF376	EUCALYPTUS STELLULATA-EUCALYPTUS NOVA-ANGLICA	0	0	LT1	LT1	N/A	LT1	1
EF609	EUCALYPTUS FIBROSA-EUCALYPTUS SIDEROPHLOIA-EUCALYPTUS TETRPLEURA	0	3	LT1	N/A	N/A	LT1	1
EF612	EUCALYPTUS MELANOPHLOIA	0	0	LT1	N/A	N/A	LT1	1
CF188	CASUARINA CUNNINGHAMIANA	2	1	-	-	-	-	3
RF100	HERITIERA TRIFOLIATA	10	26	GT25	LT10-LT25	LT10-LT25	GT25	5
RF106	HERITIERA ACTINOPHYLLA	5						3
RF107	HERITIERA ACTINOPHYLLA-ARAUCARIA CUNNINGHAMII	1						3
RF108	HERITIERA ACTINOPHYLLA-DYSOXYLUM MUELLERI-SYZYGIUM FRANCISII	0						3
RF109	HERITIERA ACTINOPHYLLA-DENDROCNIDE EXCELSA-FICUS SPP	3						3
RF101	TOONA AUSTRALIS-FLINDERSIA SPP	1						2
RF102	CRYPTOCARYA OBOVATA-DENDROCNIDE EXCELSA-FICUS SPP-ARAUCARIA CUNNINGHAMII	4						3
RF103	ELAEOCARPUS GRANDIS	2						3
RF104	CASTANOSPERMUM AUSTRALE-DYSOXYLUM MUELLERI	3	3	LT5	N/A	N/A	LT5	2
RF203	CASTANOSPERMUM AUSTRALE-GREVILLEA ROBUSTA	1						2
RF105	ARCHONTOPHOENIX CUNNINGHAMIANA-LIVISTONA AUSTRALIS	14	5	GT25	LT5-LT10	LT5	LT25-GT25	3
RF110	CALOCLUVIA PANICULATA-CRYPTOCARYA-ERYTHROXYLON-ORITES EXCELSA-HELICOPE OCTANDRA-ACMENA BRACHYANDRA	3	11	GT25	LT1-LT5	LT25-GT25	GT25	3
RF111	SLOANEA WOOLSII-DYSOXYLUM FRASERIANUM-HERITIERA ACTINOPHYLLA-CALOCLUVIA PANICULATA	7						5
RF112	SCHIZOMERIA OVATA-DORYPHORA SASSAFRAS-CALOCLUVIA PANICULATA-CRYPTOCARYA GLAUCESCENS	5	11	LT5-LT10	LT25-GT25	LT25-GT25	LT25-GT25	4

LT1, LT5, LT10 or LT25= Less than 1%, 5%, 10% or 25% conserved respectively; GT25= Greater than 25% conserved.

Association number	Association name	Number of Samples in Reserves		Proportion conserved in NPWS reserves by Regions			Total Proportion Conserved	Conservation Code
		NPWS	FC	northern	central	south		
RF113	DORYPHORA SASSAFRAS-DAPHNANDRA MICRANTHA-DENDROCNIDE EXCELSA-FICUS SPP-TOONA AUSTRALIS	1	1	N/A	N/A	LT25-GT25	LT25-GT25	5
RF114	FICUS SPP-DYSOXYLUM FRASERIANUM-TOONA AUSTRALIS-DENDROCNIDE EXCELSA	1	1	LT1	N/A	LT5	LT5	2
RF115	SYZYGIUM LUEHMANNII-ACMENA HEMILAMPRA	4	1	LT25-GT25	LT5-LT10	LT25-GT25	LT10-LT25	2
RF118	DRYPETES AUSTRALIS-SARCOMELICOPE SP-CASSINE AUSTRALIS-PODOCARPUS ELATUS	3						5
RF116	CUPANIOPSIS ANACARDIOIDES	15						5
RF117	LOPHOSTEMON CONFERTUS	4	1	LT10-LT25	LT1-LT5	LT1	LT5-LT10	3
RF200	ARAUCARIA CUNNINGHAMII	5	16	LT25-GT25	LT5	N/A	LT25-GT25	3
RF201	FLINDERSIA SPP-ARAUCARIA CUNNINGHAMII	1						3
RF202	[illegible]S SPP-STREBLUS BRUNONIANUS-CASSINE AUSTRALIS	3	4	LT25-GT25	LT1	LT5	LT10-LT25	3
RF204	STREBLUS BRUNONIANUS-AUSTROMYRTUS SP	2	9	LT5-LT10	LT25-GT25	LT25-GT25	LT25-GT25	2
RF205	WATERHOUSEA FLORIBUNDA-TRISTANIOPSIS LAURINA	0						1
RF206	CHORICARPA LEPTOPETALA	0						3
RF207	BACKHOUSIA SCIADOPHORA-DENDROCNIDE EXCELSA-DRYPETES AUSTRALIS	9						2
RF208	BACKHOUSIA MYRTIFOLIA-LOPHOSTEMON CONFERTUS-TRISTANIOPSIS LAURINA	5						2
RF210	ALECTRYON FORSYTHII-ALECTRYON SUBDENTATUS-NOTELAEA MICROCARPA	4	8	LT1	LT10-LT25	LT1	LT10-LT25	3
RF313	LEPTOSPERMUM SPP-NOTELAEA VENOSA-PROSTANTHERA SPP	0						5
RF300	CERATOPETALUM APETALUM-SCHIZOMERIA QUATA-HERITIERA ACTINOPHYLLA-SLOANEA WOOLSII	7	5	GT25	GT25	LT25-GT25	LT25-GT25	5
RF302	[illegible]TOPETALUM APETALUM-SCHIZOMERIA QUATA-CALDCLUVIA PANICULATA	8	9	GT25	LT25-GT25	LT25-GT25	LT25-GT25	5
RF303	CERATOPETALUM APETALUM-DORYPHORA SASSAFRAS	3	8	LT25-GT25	LT25-GT25	LT25-GT25	LT25-GT25	5
RF306	SCHIZOMERIA QUATA-DORYPHORA SASSAFRAS-CALDCLUVIA PANICULATA-ORITES EXCELSA	3						3
RF307	DORYPHORA SASSAFRAS-QUINTINIA SIEBERI	0						3
RF308	DORYPHORA SASSAFRAS-SCHIZOMERIA QUATA	8						5
RF309	ACMENA SMITHII-DORYPHORA SASSAFRAS-DAPHNANDRA MICRANTHA-DENDROCNIDE EXCELSA-FICUS SPP	1	0	N/A	N/A	GT25	GT25	5
RF312	TRISTANIOPSIS COLLINA-CERATOPETALUM APETALUM-SCHIZOMERIA QUATA	5	0	LT25-GT25	LT25-GT25	LT1	LT25-GT25	5
RF400	NOTHOFAGUS MOOREI-QUINTINIA SIEBERI-DORYPHORA SASSAFRAS	5	4	LT5-LT10	LT5-LT10	GT25	LT25-GT25	5
RF403	NOTHOFAGUS MOOREI-DORYPHORA SASSAFRAS-ORITES EXCELSA-CALDCLUVIA PANICULATA	0						5
RF404	NOTHOFAGUS MOOREI-ELAEOCARPUS HOLOPETALUS	1						5

LT1, LT5, LT10 or LT25= Less than 1%, 5%, 10% or 25% conserved respectively; GT25= Greater than 25% conserved.

Association number	Association name	Number of Samples in Reserves		Proportion conserved in NPWS reserves by Regions			Total Proportion Conserved	Conservation Code
		NPWS	FC	northern	central	south		
RF401	NOTHOFAGUS MOOREI-CERATOPETALUM APETALUM	4	1	LT1-LT5	LT5-LT10	LT25-GT25	LT10-LT25	4
RF402	NOTHOFAGUS MOOREI-CALLICOMA SERRATIFOLIA-TRISTANIOPSIS SP	1						2
RF410	ELAEOCARPUS HOLOPETALUS	1	0	N/A	GT25	N/A	GT25	5
RF411	CRYPTOCARYA FOVEOLATA-DORYPHORA SASSAFRAS-ORITES EXCELSA-QUINTINIA SIEBERI	1	0	LT1	LT25-GT25	LT1	LT25-GT25	3
WL115	EUCALYPTUS MOLUCCANA	1	3	LT1	LT1	LT1	LT1	1
WL116	EUCALYPTUS MOLUCCANA-EUCALYPTUS TERETICORNIS	4	1	LT1	LT25-GT25	LT5	LT5-LT10	3
WT100	ALLOCASUARINA GLAUCA-JUNCUS SPP	12	1	LT1-LT5	LT1-LT5	LT5	LT5-LT10	3
WT400	JUNCUS KRAUSII-ALLOCASUARINA GLAUCA	1						
WT101	MELALEUCA QUINQUENERVIA-ALLOCASUARINA GLAUCA	17	2	LT10-LT25	LT5-LT10	LT10-LT25	LT10-LT25	4
WT102	MELALEUCA SYPHELIOIDES-MELALEUCA LINARIIFOLIA	4						
WT300	BRUGUIERA GYMNORRHIZA-AVICENNIA MARINA	3	0	LT5-LT10	LT1	LT1	LT5-LT10	3
WT301	RHIZOPHORA STYLOSA	1						
WT302	EXCOECARIA AGALLACHA-EXCOECARIA DALLACHIANA	1						
WT303	AEGICERAS CORNICULATUM-AVICENNIA MARINA	6						
WT304	AVICENNIA MARINA	9						

The conservation codes are defined as:

1. Not/poorly conserved, because none or only minuscule areas located in reserves

2. Inadequately conserved, because relatively small areas are located in reserves and major parts of its geographical range remain unprotected

3. Inadequately conserved, because major parts of its geographic range remain poorly protected despite moderate areas being located in reserves.

4. Indeterminate, because moderate areas are located in reserves but additional information on the size of an adequate sample is required before conservation status can be reliably assessed.

5. Adequately conserved, because large areas and major parts of its geographic range are located in reserves.

* Includes occurrences in flora reserves.

... are conserved respectively: GT25= Greater than 25% conserved.

Appendix 2 Plant communities within less than 1% or less than 5% proportion conserved classes for NPWS reserves

Community number	Community name	Conservation code[X]	Occurrence
EF100	EUCALYPTUS GRANDIS	2	Buladelah to Murwillumbah area, widespread
EF106	EUCALYPTUS BRUNNEA	3	Dorrigo to Tenterfield area
EF108	EUCALYPTUS BRUNNEA-EUCALYPTUS CALIGINOSA	3	Dorrigo to Tenterfield area
EF109	EUCALYPTUS ACMENIOIDES-EUCALYPTUS PROPINQUA	2	Buladelah to Murwillumbah area, widespread
EF111	EUCALYPTUS TERETICORNIS	2	Buladelah to Murwillumbah area, widespread
EF112	EUCALYPTUS AMPLIFOLIA-ANGOPHORA SUBVELUTINA-EUCALYPTUS TERETICORNIS	2	Taree to Murwillumbah area, localised
EF113	EUCALYPTUS TERETICORNIS-EUCALYPTUS MELLIODORA	2	Taree to Murwillumbah area, localised
EF120	EUCALYPTUS AMPLIFOLIA	2	Taree to Murwillumbah area, localised
EF121	EUCALYPTUS MACULATA	2	Buladelah, Coffs Harbour to Casino area
EF123	EUCALYPTUS MACULATA-EUCALYPTUS SIDEROPHLOIA	2	Buladelah, Coffs Harbour to Casino area
EF124	EUCALYPTUS MACULATA-EUCALYPTUS RUMMERYI	1	Grafton, Casino areas
EF138	SYNCARPIA GLOMULIFERA-EUCALYPTUS MICROCORYS	1	Taree to Murwillumbah area
EF141	EUCALYPTUS MACULATA-EUCALYPTUS MOLUCCANA	1	Coffs Harbour to Casino area
EF142	EUCALYPTUS MACULATA-LOPHOSTEMON CONFERTUS	1	Urbenville area
EF143	EUCALYPTUS MOLUCCANA-EUCALYPTUS SIDEROPHLOIA-EUCALYPTUS PROPINQUA	1	Coffs Harbour to Urbenville area
EF144	EUCALYPTUS LARGEANA-LOPHOSTEMON CONFERTUS	1	Gloucester to Kempsey area
EF203	EUCALYPTUS RESINIFERA-EUCALYPTUS ACMENIOIDES	2	Port Macquarie to Coffs Harbour area
EF204	EUCALYPTUS INTERMEDIA	2	Port Macquarie to Murwillumbah area
EF205	EUCALYPTUS INTERMEDIA-EUCALYPTUS MACULATA-EUCALYPTUS CREBRA	2	Coffs Harbour to Murwillumbah area
EF206	EUCALYPTUS SIGNATA	2	Buladelah to Murwillumbah area
EF207	EUCALYPTUS SIGNATA-EUCALYPTUS INTERMEDIA	2	Port Macquarie to Murwillumbah area
EF208	EUCALYPTUS SIGNATA-CALLITRIS COLUMELLARIS	2	Maclean to Murwillumbah area, localised

EF209	EUCALYPTUS TINDALIAE-EUCALYPTUS GUMMIFERA	2	Grafton to Murwillumbah area
EF212	EUCALYPTUS BAILEYANA	2	Grafton to Murwillumbah area
EF213	EUCALYPTUS BAILEYANA-EUCALYPTUS PLANCHONIANA-EUCALYPTUS BANCROFTII	2	Grafton to Murwillumbah area
EF223	EUCALYPTUS GUMMIFERA-ANGOPHORA FLORIBUNDA	1	Buladelah to Murwillumbah area
EF308	EUCALYPTUS DALRYMPLEANA SSP HEPTANTHA-EUCALYPTUS CALIGINOSA	1	Walcha to Tenterfield area
EF310	EUCALYPTUS VIMINALIS-EUCALYPTUS DORRIGOENSIS	1	Dorrigo to Tenterfield area
EF312	EUCALYPTUS OBLIQUA-EUCALYPTUS PAUCIFLORA-EUCALYPTUS CAMPANULATA	1	Armidale to Tenterfield area
EF316	EUCALYPTUS OBLIQUA-EUCALYPTUS NOBILIS	2	Tamworth to Tenterfield area
EF317	EUCALYPTUS OBLIQUA-EUCALYPTUS CAMERONII	2	New England area
EF327	EUCALYPTUS RADIATA SSP SEJUNCTA-EUCALYPTUS DIVES-EUCALYPTUS DALRYMPLEANA	1	Barrington Tops to Nundle area
EF343	EUCALYPTUS CYPELLOCARPA	1	Ebor, Armidale area
EF345	EUCALYPTUS OREADES	1	Comboyne, Glen Innes, Urbenville area
EF349	EUCALYPTUS CALIGINOSA	2	Walcha to Tenterfield area
EF353	EUCALYPTUS WILLIAMSIANA	2	Walcha to Tenterfield area
EF355	EUCALYPTUS STANNICOLA-EUCALYPTUS ANDREWSII	2	Walcha to Tenterfield area
EF356	EUCALYPTUS SUBTILOR-EUCALYPTUS LIGUSTRINA-EUCALYPTUS CAMPANULATA	2	Walcha to Tenterfield area
EF357	EUCALYPTUS STANNICOLA-EUCALYPTUS PRAVA	1	Armidale to Tenterfield area
EF366	EUCALYPTUS NOVA-ANGLICA-EUCALYPTUS RADIATA SSP SEJUNCTA-EUCALYPTUS ACACIIFORMIS	1	
EF368	EUCALYPTUS BICOSTATA	1	Nundle, Walcha, Armidale area
EF373	EUCALYPTUS LAEVOPINEA-EUCALYPTUS VIMINALIS	2	Gloucester, Dorrigo to Tenterfield area
EF374	EUCALYPTUS LAEVOPINEA-EUCALYPTUS SALIGNA	2	Gloucester, Dorrigo to Tenterfield area
EF605	EUCALYPTUS CALEYI SSP CALEYI-EUCALYPTUS DEALBATA	2	Murrurundi to Tenterfield area, drier areas
EF609	EUCALYPTUS FIBROSA-EUCALYPTUS SIDEROPHLOIA-EUCALYPTUS TETRPLEURA	1	Grafton to Casino area
RF101	TOONA AUSTRALIS-FLINDERSIA SPP	2	Murwillumbah, Nymboida area
RF104	CASTANOSPERMUM AUSTRALE-DYSOXYLUM MUELLERI	2	Border Ranges, Wollongbar, Maclean area
RF114	FICUS SPP-DYSOXYLUM FRASERIANUM-TOONA AUSTRALIS-DENDROCNIDE EXCELSA	2	Gibralter Range, Wauchope, Dungog area

RF115	SYZYGIUM LUEHMANNII-ACMENA HEMILAMPRA	3	Kempsey, Coffs Harbour, Iluka, Tweed Heads area
RF203	CASTANOSPERMUM AUSTRALE-GREVILLEA ROBUSTA	2	Border Ranges, Casino area
RF204	STREBLUS BRUNONIANUS-AUSTROMYRTUS SP		Richmond River area
RF402	NOTHOFAGUS MOOREI-CALLICOMA SERRATIFOLIA-TRISTANIOPSIS SP	2	Border Ranges, Dorrigo area
WL115	EUCALYPTUS MOLUCCANA	2	Dungog, Stroud, Grafton, Bundarra area

x The conservation codes are defined as:

1. Not/poorly conserved, because none or only minuscule areas located in reserves

2. Inadequately conserved, because relatively small areas are located in reserves and major parts of its geographical range remain unprotected

3. Inadequately conserved, because major parts of its geographic range remain poorly protected despite moderate areas being located in reserves.

4. Indeterminate, because moderate areas are located in reserves but additional information on the size of an adequate sample is required before conservation status can be reliably assessed.

5. Adequately conserved, because large areas and major parts of its geographic range are located in reserves.

Appendix 3 Plant communities in within less than 1% or less than 5% proportion conserved classes for part of their geographic range.

Community number	Community name	Conservation code	Zone	Occurrence within inadequately conserved portion of range
EF100	EUCALYPTUS GRANDIS	2	C,S	Buladelah to Grafton area, widespread
EF101	EUCALYPTUS GRANDIS-LOPHOSTEMON CONFERTUS-EUCALYPTUS MICROCORYS	3	S	Buladelah to Kempsey area, widespread
EF102	EUCALYPTUS SALIGNA	3	N,C	Buladelah to Kempsey area, Grafton to Murwillumbah area
EF145	EUCALYPTUS SALIGNA-ANGOPHORA FLORIBUNDA-EUCALYPTUS ACMENIOIDES-ALLOCASUARINA TORULOSA	3	"	Grafton to Murwillumbah area
EF104	EUCALYPTUS SALIGNA-EUCALYPTUS QUADRANGULATA	3	C	Kempsey, Armidale area
EF105	EUCALYPTUS DUNNII	3	C	Coffs Harbour, Glenreagh area
EF110	EUCALYPTUS PROPINQUA-EUCALYPTUS SIDEROPHLOIA	3	C,S	Buladelah to Grafton area, widespread
EF111	EUCALYPTUS TERETICORNIS	2	C,S	Coffs Harbour to Urbenville area, widespread
EF113	EUCALYPTUS TERETICORNIS-EUCALYPTUS MELLIODORA	2	"	Coffs Harbour to Urbenville area, localised
EF115	EUCALYPTUS PILULARIS	3	S	Buladelah to Kempsey area
EF116	EUCALYPTUS PILULARIS-EUCALYPTUS RESINIFERA	3	"	Buladelah to Kempsey area
EF117	EUCALYPTUS PILULARIS-EUCALYPTUS ACMENIOIDES	3	"	Buladelah to Kempsey area
EF118	EUCALYPTUS PILULARIS-EUCALYPTUS INTERMEDIA-EUCALYPTUS SIDEROPHLOIA	3	N,S	Taree, Grafton area
EF121	EUCALYPTUS MACULATA	2	N,S	Buladelah, Grafton, Casino area
EF123	EUCALYPTUS MACULATA-EUCALYPTUS SIDEROPHLOIA	2	C,S	Bulladelah to Taree area, Coffs Harbour to Grafton area
EF205	EUCALYPTUS INTERMEDIA-EUCALYPTUS MACULATA-EUCALYPTUS CREBRA	2	"	Taree area, Coffs Harbour to Grafton area
EF139	EUCALYPTUS PROPINQUA-EUCALYPTUS CAMERONII	3	C	Coffs Harbour, Grafton area
EF146	EUCALYPTUS ACMENIOIDES-EUCALYPTUS TERETICORNIS-ALLOCASUARINA TORULOSA	3	C,S	Gloucester, Kempsey to Grafton area
EF615	EUCALYPTUS SIDEROPHLOIA-EUCALYPTUS TERETICORNIS-EUCALYPTUS UMBRA	3	"	Gloucester, Kempsey to Grafton area
EF202	EUCALYPTUS ROBUSTA	3	N,C	Kempsey to Coffs Harbour area
EF206	EUCALYPTUS SIGNATA	2	N,S	Buladelah to Kempsey area, Grafton to Murwillumbah area

EF207	EUCALYPTUS SIGNATA-EUCALYPTUS INTERMEDIA	2	"	Buladelah to Kempsey area, Grafton to Murwillumbah area
EF208	EUCALYPTUS SIGNATA-CALLITRIS COLUMELLARIS	2	N,S	Kempsey area, Grafton to Murwillumbah area
EF210	EUCALYPTUS UMBRA SSP UMBRA	3	N,C	Coffs Harbour area
EF251	EUCALYPTUS UMBRA SSP CARNEA-EUCALYPTUS PROPINQUA	3	"	Kempsey to Casino area
EF211	EUCALYPTUS PLANCHONIANA-EUCALYPTUS PILULARIS	3	S	Taree area
EF212	EUCALYPTUS BAILEYANA	2	N	Grafton to Murwillumbah area
EF213	EUCALYPTUS BAILEYANA-EUCALYPTUS PLANCHONIANA-EUCALYPTUS BANCROFTII	2	"	Grafton to Murwillumbah area
EF247	EUCALYPTUS PYROCARPA-EUCALYPTUS ACMENIOIDES	3	C,S	Taree, Dorrigo, Coffs Harbour area
EF372	EUCALYPTUS PYROCARPA-EUCALYPTUS CAMERONII	3	"	Taree, Dorrigo, Coffs Harbour area
EF301	EUCALYPTUS PAUCIFLORA SSP PAUCIFLORA-EUCALYPTUS STELLULATA	3	N,C	Armidale to Tenterfield area
EF302	EUCALYPTUS PAUCIFLORA SSP PAUCIFLORA-EUCALYPTUS DALRYMPLEANA	3	N,C	Armidale to Tenterfield area
EF323	EUCALYPTUS RADIATA SSP SEJUNCTA	3	S	Murrurundi, Nundle area
EF324	EUCALYPTUS RADIATA SSP SEJUNCTA-EUCALYPTUS ACACIIFORMIS-EUCALYPTUS DALRYMPLEANA SSP HEPTANTHA	3	"	Murrurundi, Nundle area
EF341	EUCALYPTUS MACRORHYNCHA-EUCALYPTUS BRIDGESIANA-EUCALYPTUS MELLIODORA	3	C,S	Tamworth, Bundurra area
EF375	EUCALYPTUS OBLIQUA-EUCALYPTUS LAEVOPINEA	3	N,C	Walcha to Tenterfield area
RF101	TOONA AUSTRALIS-FLINDERSIA SPP	2		
RF102	CRYPTOCARYA OBOVATA-DENDROCNIDE EXCELSA-FICUS SPP-ARAUCARIA CUNNINGHAMII	3	C,S	Bellingen, Wingham area
RF105	ARCHONTOPHOENIX CUNNINGHAMIANA-LIVISTONA AUSTRALIS	3	C	Brooms Head, Bellingen area
RF108	HERITIERA ACTINOPHYLLA-DYSOXYLUM MUELLERI-SYZYGIUM FRANCISII	3	N	Upper Clarence River
RF117	LOPHOSTEMON CONFERTUS	2	C	Coffs Harbour area
RF200	ARAUCARIA CUNNINGHAMII	3	C	Nymboida area
RF202	FICUS SPP-STREBLUS BRUNONIANUS-CASSINE AUSTRALIS	2	S	Dungog area
RF206	CHORICARPA LEPTOPETALA	3	C	Coffs Harbour area
RF207	BACKHOUSIA SCIADOPHORA-DENDROCNIDE EXCELSA-DRYPETES AUSTRALIS	2	S	Dungog, Gloucester area

RF208	BACKHOUSIA MYRTIFOLIA-LOPHOSTEMON CONFERTUS-TRISTANIOPSIS LAURINA	2	N	Evans Head area
RF306	SCHIZOMERIA OVATA-DORYPHORA SASSAFRAS-CALDCLUVIA PANICULATA-ORITES EXCELSA	3	N	East of Tenterfield
RF402	NOTHOFAGUS MOOREI-CALLICOMA SERRATIFOLIA-TRISTANIOPSIS SP	2	C	East of Dorrigo
RF411	CRYPTOCARYA FOVEOLATA-DORYPHORA SASSAFRAS-ORITES EXCELSA-QUINTINIA SIEBERI		S	Barrington Tops area
WL116	EUCALYPTUS MOLUCCANA-EUCALYPTUS TERETICORNIS	1	N,S	Gloucester, Casino, Urbenville area
WT100	ALLOCASUARINA-GLAUCA-JUNCUS SPPJUNCUS KRAUSII-ALLOCASUARINA GLAUCA	3	S	Buladelah to Kempsey
WT303	AEGICERAS CORNICULATUM-AVICENNIA MARINA	3	S,C	Buladelah to Coffs Harbour
WT304	AVICENNIA MARINA	2	"	Buladelah to Coffs Harbour

Appendix 4. Plant community classification (after Benson 1989) used in this project.

Community number	Community name	Floristic Group code	Forest type number
EF100	EUCALYPTUS GRANDIS	TR710	48
EF101	EUCALYPTUS GRANDIS-LOPHOSTEMON CONFERTUS-EUCALYPTUS MICROCORYS	TR710	53
EF102	EUCALYPTUS SALIGNA	TR346	46
EF103	EUCALYPTUS SALIGNA-EUCALYPTUS MICROCORYS	TR710	47
EF104	EUCALYPTUS SALIGNA-EUCALYPTUS QUADRANGULATA	TR346	54
EF105	EUCALYPTUS DUNNII	TR710	51
EF106	EUCALYPTUS BRUNNEA	TR710	161
EF107	EUCALYPTUS BRUNNEA-EUCALYPTUS CYPELLOCARPA	TR710	161
EF108	EUCALYPTUS BRUNNEA-EUCALYPTUS CALIGINOSA	TR168	161
EF109	EUCALYPTUS ACMENIOIDES-EUCALYPTUS PROPINQUA	TR707	60
EF110	EUCALYPTUS PROPINQUA-EUCALYPTUS SIDEROPHLOIA	TR707	62
EF111	EUCALYPTUS TERETICORNIS	TR707	92
EF112	EUCALYPTUS AMPLIFOLIA-ANGOPHORA SUBVELUTINA-EUCALYPTUS TERETICORNIS	TR352	93
EF113	EUCALYPTUS TERETICORNIS-EUCALYPTUS MELLIODORA	TR716	92
EF115	EUCALYPTUS PILULARIS	TR707	36
EF116	EUCALYPTUS PILULARIS-EUCALYPTUS RESINIFERA	TR707	36
EF117	EUCALYPTUS PILULARIS-EUCALYPTUS ACMENIOIDES	TR707	36
EF118	EUCALYPTUS PILULARIS-EUCALYPTUS INTERMEDIA-EUCALYPTUS SIDEROPHLOIA	TR707	37
EF120	EUCALYPTUS AMPLIFOLIA	TR352	93
EF121	EUCALYPTUS MACULATA	TR707	70
EF123	EUCALYPTUS MACULATA-EUCALYPTUS SIDEROPHLOIA	TR717	74
EF124	EUCALYPTUS MACULATA-EUCALYPTUS RUMMERYI	TR707	87

Community number	Community name	Floristic group code	Forest type number
EF125	EUCALYPTUS MACULATA-SYNCARPIA GLOMULIFERA-EUCALYPTUS SALIGNA	TR710	73
EF133	EUCALYPTUS AGGLOMERATA	TR349	121
EF134	EUCALYPTUS GLOBOIDEA-EUCALYPTUS AGGLOMERATA	TR349	121 123
EF138	SYNCARPIA GLOMULIFERA-EUCALYPTUS MICROCORYS	TR707	45 49
EF139	EUCALYPTUS PROPINQUA-EUCALYPTUS CAMERONII	TR139	64
EF140	EUCALYPTUS PILULARIS-EUCALYPTUS MACULATA	TR707	39 76
EF141	EUCALYPTUS MACULATA-EUCALYPTUS MOLUCCANA	TR716	72
EF142	EUCALYPTUS MACULATA-LOPHOSTEMON CONFERTUS	TR707	71
EF143	EUCALYPTUS MOLUCCANA-EUCALYPTUS SIDEROPHLOIA-EUCALYPTUS PROPINQUA	TR716	80 81
EF144	EUCALYPTUS LARGEANA-LOPHOSTEMON CONFERTUS	TR707	87
EF145	EUCALYPTUS SALIGNA-ANGOPHORA FLORIBUNDA-EUCALYPTUS TERETICORNIS-ALLOCASUARINA TORULOSA	TR346	46
EF146	EUCALYPTUS ACMENIOIDES-EUCALYPTUS TERETICORNIS-ALLOCASUARINA TORULOSA	TR707	65
EF201	EUCALYPTUS PILULARIS-ANGOPHORA COSTATA	TR706	41
EF202	EUCALYPTUS ROBUSTA	HW008 TR354	30
EF203	EUCALYPTUS RESINIFERA-EUCALYPTUS ACMENIOIDES	TR707	60 68
EF204	EUCALYPTUS INTERMEDIA	TR711	126
EF205	EUCALYPTUS INTERMEDIA-EUCALYPTUS MACULATA-EUCALYPTUS CREBRA	TR717	74
EF206	EUCALYPTUS SIGNATA	TR711	117
EF207	EUCALYPTUS SIGNATA-EUCALYPTUS INTERMEDIA	TR711	117
EF208	EUCALYPTUS SIGNATA-CALLITRIS COLUMELLARIS	TR711	215
EF209	EUCALYPTUS TINDALIAE-EUCALYPTUS GUMMIFERA	TR349	126
EF210	EUCALYPTUS UMBRA SSP UMBRA	TR711	61

Community number	Community name	Floristic code	roup	Forest type number
EF211	EUCALYPTUS PLANCHONIANA-EUCALYPTUS PILULARIS	TR711		40
EF212	EUCALYPTUS BAILEYANA	TR711		97
EF213	EUCALYPTUS BAILEYANA-EUCALYPTUS PLANCHONIANA-EUCALYPTUS BANCROFTII	TR711		97
EF222	EUCALYPTUS GUMMIFERA-ANGOPHORA COSTATA-EUCALYPTUS HAEMASTOMA	TR350		119
EF223	EUCALYPTUS GUMMIFERA-ANGOPHORA FLORIBUNDA	TR349		130
EF228	EUCALYPTUS PIPERITA-ANGOPHORA COSTATA	TR350		106
				115
EF240	EUCALYPTUS NORTONII-EUCALYPTUS SERPENTINICOLA			225
EF247	EUCALYPTUS PYROCARPA-EUCALYPTUS ACMENIOIDES	TR707		38
EF248	EUCALYPTUS APPROXIMANS			225
EF249	EUCALYPTUS PIPERITA-SYNCARPIA GLOMULIFERA	TR350		116
				128
EF250	ANGOPHORA COSTATA-EUCALYPTUS GLOBOIDEA	TR350		127
				105
EF251	EUCALYPTUS UMBRA SSP CARNEA-EUCALYPTUS PROPINQUA	TR707		61
EF301	EUCALYPTUS PAUCIFLORA SSP PAUCIFLORA-EUCALYPTUS STELLULATA	TR335		136
EF302	EUCALYPTUS PAUCIFLORA SSP PAUCIFLORA-EUCALYPTUS DALRYMPLEANA	TR334		140
EF303	EUCALYPTUS PAUCIFLORA SSP PAUCIFLORA-EUCALYPTUS VIMINALIS	TR334		140
EF304	EUCALYPTUS MOOREI			225
EF308	EUCALYPTUS DALRYMPLEANA SSP HEPTANTHA-EUCALYPTUS CALIGINOSA	TR347		159
EF309	EUCALYPTUS VIMINALIS	TR347		159
EF310	EUCALYPTUS VIMINALIS-EUCALYPTUS DORRIGOENSIS	TR346		159
				98
EF312	EUCALYPTUS OBLIQUA-EUCALYPTUS PAUCIFLORA-EUCALYPTUS CAMPANULATA	TR346		138
EF313	EUCALYPTUS OBLIQUA-EUCALYPTUS FASTIGATA-EUCALYPTUS CYPELLOCARPA	TR346		151

Community number	Community name	Floristic group code	Forest type number
EF314	EUCALYPTUS NITENS-EUCALYPTUS FASTIGATA-EUCALYPTUS CYPELLOCARPA	TR347	155
			154
EF315	EUCALYPTUS NITENS	TR347	158
EF316	EUCALYPTUS OBLIQUA-EUCALYPTUS NOBILIS	TR347	152
EF317	EUCALYPTUS OBLIQUA-EUCALYPTUS CAMERONII		160
			153
EF323	EUCALYPTUS RADIATA SSP SEJUNCTA	TR347	111
EF324	EUCALYPTUS RADIATA SSP SEJUNCTA-EUCALYPTUS ACACIIFORMIS-EUCALYPTUS DALRYMPLEANA SSP HEPTANTHA	TR347	111
EF325	EUCALYPTUS RADIATA SSP SEJUNCTA-EUCALYPTUS SUBTILOR		111
EF327	EUCALYPTUS RADIATA SSP SEJUNCTA-EUCALYPTUS DIVES-EUCALYPTUS DALRYMPLEANA	TR347	131
EF328	EUCALYPTUS MANNIFERA SSP ELLIPTICA		109
EF330	EUCALYPTUS MANNIFERA-EUCALYPTUS MACRORHYNCHA-EUCALYPTUS DIVES-EUCALYPTUS ROSSII	TR342	110
EF335	EUCALYPTUS DIVES-EUCALYPTUS RUBIDA-EUCALYPTUS MACRORHYNCHA	TR342	141
EF340	EUCALYPTUS MACRORHYNCHA-EUCALYPTUS ANDREWSII	TR339	177
EF341	EUCALYPTUS MACRORHYNCHA-EUCALYPTUS BRIDGESIANA-EUCALYPTUS MELLIODORA	TR341	124
EF342	EUCALYPTUS MACRORHYNCHA-EUCALYPTUS PRAVA	TR342	129
EF343	EUCALYPTUS CYPELLOCARPA	TR347	158
EF345	EUCALYPTUS OREADES	TR350	101
EF346	EUCALYPTUS LAEVOPINEA	TR666	167
EF347	EUCALYPTUS LAEVOPINEA-EUCALYPTUS CAMERONII	TR168	167
EF348	EUCALYPTUS LAEVOPINEA-EUCALYPTUS RETINENS-EUCALYPTUS BANKSII-EUCALYPTUS MELLIODORA	TR666	167
EF349	EUCALYPTUS CALIGINOSA	TR168	122

Community number	Community name	Floristic group code	Forest type number
EF350	EUCALYPTUS CALIGINOSA-EUCALYPTUS MELLIODORA	TR338	172
EF351	EUCALYPTUS MCKIEANA-EUCALYPTUS NICHOLII-EUCALYPTUS CALIGINOSA	TR168	122
EF352	EUCALYPTUS MCKIEANA	TR168	122
EF353	EUCALYPTUS WILLIAMSIANA	TR168	122
EF354	EUCALYPTUS WILLIAMSIANA-EUCALYPTUS RADIATA SSP SEJUNCTA	TR168	122
EF355	EUCALYPTUS STANNICOLA-EUCALYPTUS ANDREWSII	TR168	122
EF356	EUCALYPTUS SUBTILOR-EUCALYPTUS LIGUSTRINA-EUCALYPTUS CAMPANULATA	TR168	122
EF357	EUCALYPTUS STANNICOLA-EUCALYPTUS PRAVA	TR168	129
EF358	EUCALYPTUS CAMPANULATA	TR346	163
EF359	EUCALYPTUS CAMPANULATA-EUCALYPTUS CAMERONII	TR168	163
EF360	EUCALYPTUS CAMPANULATA-EUCALYPTUS CALIGINOSA	TR168	122
EF361	EUCALYPTUS CAMPANULATA-EUCALYPTUS RADIATA SSP SEJUNCTA	TR168	163 163
EF362	EUCALYPTUS ANDREWSII	TR168	176
EF364	EUCALYPTUS ANDREWSII-EUCALYPTUS BANKSII	TR168	NIL
EF365	EUCALYPTUS NOVA-ANGLICA	TR335	142
EF366	EUCALYPTUS NOVA-ANGLICA-EUCALYPTUS RADIATA SSP SEJUNCTA-EUCALYPTUS ACACIIFORMIS	TR342	142
EF367	EUCALYPTUS NOVA-ANGLICA-EUCALYPTUS BRIDGESIANA	TR335	142
EF368	EUCALYPTUS BICOSTATA	TR666	164
EF371	EUCALYPTUS DEALBATA-CALLITRIS ENDLICHERI	TR717	183

Community number	Community name	Floristic group code	Forest type number
EF372	EUCALYPTUS PYROCARPA-EUCALYPTUS CAMERONII	TR168	38
EF373	EUCALYPTUS LAEVOPINEA-EUCALYPTUS VIMINALIS	TR666	168
EF374	EUCALYPTUS LAEVOPINEA-EUCALYPTUS SALIGNA	TR666	168
EF375	EUCALYPTUS OBLIQUA-EUCALYPTUS LAEVOPINEA	TR346	153
EF376	EUCALYPTUS STELLULATA-EUCALYPTUS NOVA-ANGLICA	TR335	137
EF377	EUCALYPTUS DEALBATA-EUCALYPTUS ALBENS	TR717	177
EF378	EUCALYPTUS PRAVA-EUCALYPTUS LAEVOPINEA/EUCALYPTUS EUGENIOIDES-EUCALYPTUS MELLIODORA	TR707	NIL
EF379	EUCALYPTUS FASTIGATA-EUCALYPTUS VIMINALIS	TR347	155
EF605	EUCALYPTUS CALEYI SSP CALEYI-EUCALYPTUS DEALBATA	TR361	205
EF606	EUCALYPTUS CALEYI SSP CALEYI-CALLITRIS ENDLICHERI	TR716	181
EF608	EUCALYPTUS FIBROSA-EUCALYPTUS MOLUCCANA	TR716B	83 84
EF609	EUCALYPTUS FIBROSA-EUCALYPTUS SIDEROPHLOIA-EUCALYPTUS TETRPLEURA	TR716	84
EF612	EUCALYPTUS MELANOPHLOIA	TR364	207
EF615	EUCALYPTUS SIDEROPHLOIA-EUCALYPTUS TERETICORNIS-EUCALYPTUS UMBRA	TR707	65
OF100	CASUARINA CUNNINGHAMIANA	TR352	211
RF100	HERITIERA TRIPOLIATA	RF040	1
RF101	TOONA AUSTRALIS-FLINDERSIA SPP	RF040	1
RF102	CRYPTOCARYA OBOVATA-DENDROCNIDE EXCELSA-FICUS SPP-ARAUCARIA CUNNINGHAMII	RF040	1
RF103	ELAEOCARPUS GRANDIS	RF040	1
RF104	CASTANOSPERMUM AUSTRALE-DYSOXYLUM MUELLERI	RF040	4
RF105	ARCHONTOPHOENIX CUNNINGHAMIANA-LIVISTONA AUSTRALIS	RF040	7
RF106	HERITIERA ACTINOPHYLLA	RF040	1
RF107	HERITIERA ACTINOPHYLLA-ARAUCARIA CUNNINGHAMII	RF040	1

Community number	Community name	Floristic group code	Forest type number
RF108	HERITIERA ACTINOPHYLLA-DYSOXYLUM MUELLERI-SYZYGIUM FRANCISII	RF040	1
RF109	HERITIERA ACTINOPHYLLA-DENDROCNIDE EXCELSA-FICUS SPP	RF040	1
RF110	CALDCLUVIA PANICULATA-CRYPTOCARYA ERYTHROXYLON-ORITES EXCELSA-MELICOPE	RF040	2
RF111	OCTANDRA-ACMENA BRACHYANDRA SLOANEA WOOLSII-DYSOXYLUM FRASERIANUM-HERITIERA ACTINOPHYLLA-CALDCLUVIA	RF040	2
RF112	PANICULATA SCHIZOMERIA OVATA-DORYPHORA SASSAFRAS-CALDCLUVIA	RF040	3
RF113	PANICULATA-CRYPTOCARYA GLAUCESCENS DORYPHORA SASSAFRAS-DAPHNANDRA MICRANTHA-DENDROCNIDE	RF040	6
RF114	EXCELSA-FICUS SPP-TOONA AUSTRALIS FICUS SPP-DYSOXYLUM FRASERIANUM-TOONA	RF040	6
RF115	AUSTRALIS-DENDROCNIDE EXCELSA SYZYGIUM LUEHMANNII-ACMENA	RF041	24
RF116	HEMILAMPRA	RF041	24
RF117	CUPANIOPSIS ANACARDIOIDES	RF041	25
RF118	LOPHOSTEMON CONFERTUS DRYPETES AUSTRALIS-SARCOMELICOPE SP-CASSINE	RF041	24
RF200	AUSTRALIS-PODOCARPUS ELATUS	RF044	21
RF201	ARAUCARIA CUNNINGHAMII FLINDERSIA SPP-ARAUCARIA CUNNINGHAMII	RF044	21
RF202	FICUS SPP-STREBLUS BRUNONIANUS-CASSINE AUSTRALIS	RF044	22
RF203	CASTANOSPERMUM AUSTRALE-GREVILLEA ROBUSTA	RF044	4
RF204	STREBLUS BRUNONIANUS-AUSTROMYRTUS SP	RF044	1
RF205	WATERHOUSEA FLORIBUNDA-TRISTANIOPSIS LAURINA	RF044	1
RF206	CHORICARPA LEPTOPETALA	RF044	23
RF207	BACKHOUSIA SCIADOPHORA-DENDROCNIDE EXCELSA-DRYPETES AUSTRALIS	RF044	23
RF208	BACKHOUSIA MYRTIFOLIA-LOPHOSTEMON CONFERTUS-TRISTANIOPSIS LAUR	RF044	23
RF209	BACKHOUSIA MYRTIFOLIA-ACMENA SMITHII	RF044	23

Community number	Community name	Floristic group code	Forest type number
RF210	ALECTRYON FORSYTHII-ALECTRYON SUBDENTATUS-NOTELAEA MICROCARPA	DS040	26
RF300	CERATOPETALUM APETALUM-SCHIZOMERIA OVATA-HERITIERA ACTINOPHYLLA-SLOANEA WOOLSII	RF041	5
RF302	CERATOPETALUM APETALUM-SCHIZOMERIA OVATA-CALDCLUVIA PANICULATA	RF041	11
RF303	CERATOPETALUM APETALUM-DORYPHORA SASSAFRAS	RF041	12
RF306	SCHIZOMERIA OVATA-DORYPHORA SASSAFRAS-CALDCLUVIA PANICULATA-ORITES EXCELSA	RF041	12 15
RF307	DORYPHORA SASSAFRAS-QUINTINIA SIEBERI	RF041	12
RF308	DORYPHORA SASSAFRAS-SCHIZOMERIA OVATA	RF041	12
RF309	ACMENA SMITHII-DORYPHORA SASSAFRAS-DAPHNANDRA MICRANTHA-DENDROCNIDE	RF041	NIL
RF312	EXCELSA-FICUS SPP TRISTANIOPSIS COLLINA-CERATOPETALUM APETALUM-SCHIZOMERIA OVATA	RF041	13
RF313	LEPTOSPERMUM SPP-NOTELAEA VENOSA-PROSTANTHERA SPP	RF041	26
RF400	NOTHOFAGUS MOOREI-QUINTINIA SIEBERI-DORYPHORA SASSAFRAS	RF169	16
RF401	NOTHOFAGUS MOOREI-CERATOPETALUM APETALUM	RF169	17
RF402	NOTHOFAGUS MOOREI-CALLICOMA SERRATIFOLIA-TRISTANIOPSIS SP	RF169	17
RF403	NOTHOFAGUS MOOREI-DORYPHORA SASSAFRAS-ORITES EXCELSA-CALDCLUVIA PANICULATA	RF169	16
RF404	NOTHOFAGUS MOOREI-ELAEOCARPUS HOLOPETALUS	RF169	16
RF410	ELAEOCARPUS HOLOPETALUS	RF087	NIL
RF411	CRYPTOCARYA FOVEOLATA-DORYPHORA SASSAFRAS-ORITES EXCELSA-QUINTINIA SIEBERI	RF169	20
WL115	EUCALYPTUS MOLUCCANA	TR707	82
WL116	EUCALYPTUS MOLUCCANA-EUCALYPTUS TERETICORNIS	TR716B	85
WL118	EUCALYPTUS CONICA	TR363	203
WL124	EUCALYPTUS MELLIODORA-EUCALYPTUS BRIDGESIANA-EUCALYPTUS BLAKELYI	TR338	172

Community number	Community name	Floristic group code	Forest type number
WT100	ALLOCASUARINA GLAUCA-JUNCUS SPP	CW005 CW019 CW037	32
WT101	MELALEUCA QUINQUENERVIA-ALLOCASUARINA GLAUCA	CW005 CW019 CW037	31
WT102	MELALEUCA STYPHELIOIDES-MELALEUCA LINARIIFOLIA	HW008	31
WT300	BRUGUIERA GYMNORRHIZA-AVICENNIA MARINA	CW005	33
WT301	RHIZOPHORA STYLOSA	CW005	33
WT302	EXCOECARIA AGALLACHA-EXCOECARIA DALLACHIANA	CW005	33
WT303	AEGICERAS CORNICULATUM-AVICENNIA MARINA	CW005 CW019 CW037	33
WT304	AVICENNIA MARINA	CW005 CW019 CW037	33
WT400	JUNCUS KRAUSII-ALLOCASUARINA GLAUCA	CW005 CW019 CW037	32

Appendix 5 Floristic groups (after Specht, in press) within North-eastern NSW NPWS reserves

IDENTIFICATION CODE N0214
RESERVE - Clybucca HS
AREA - 416

CW005 ESTUARINE WETLAND GROUP005	49 ha
RF041 RAINFOREST TREE GROUP041	8 ha
TR354 EUCALYPT TREE GROUP354	8 ha
TR706 EUCALYPT TREE GROUP706	41 ha

Total area = 106 ha

Unsurveyed area = 310

IDENTIFICATION CODE N0001
RESERVE - Bald Rock NP
AREA - 5451.362

TR168 EUCALYPT TREE GROUP168	5000 ha
TR342 EUCALYPT TREE GROUP342	50 ha
TR346/351 EUCALYPT TREE GROUP346/351	50 ha

Total area = 5100 ha

Unsurveyed area = 351

IDENTIFICATION CODE N0002
RESERVE - Barrington Tops NP
AREA - 39120.721

RF040 RAINFOREST TREE GROUP040	6600 ha
RF041 RAINFOREST TREE GROUP041	2000 ha
RF044 RAINFOREST TREE GROUP044	2200 ha
RF169 RAINFOREST TREE GROUP169	4200 ha
TR334 EUCALYPT TREE GROUP334	3000 ha
TR335 EUCALYPT TREE GROUP335	3000 ha
TR346 EUCALYPT TREE GROUP346	10500 ha
TR666 EUCALYPT TREE GROUP666	3100 ha
TR707 EUCALYPT TREE GROUP707	1500 ha

Total area = 36100 ha

Unsurveyed area = 3020.721

IDENTIFICATION CODE N0056
RESERVE - Boonoo Boonoo NP
AREA - 2692

TR168 EUCALYPT TREE GROUP168	1200 ha
TR347 EUCALYPT TREE GROUP347	300 ha
TR666 EUCALYPT TREE GROUP666	1200 ha

Total area = 2700 ha

Unsurveyed area = -8

IDENTIFICATION CODE N0050
RESERVE - Border Ranges NP
AREA - 31508.1

RF040 RAINFOREST TREE GROUP040	12458 ha

RF041 RAINFOREST TREE GROUP041	614 ha
RF044 RAINFOREST TREE GROUP044	6160 ha
RF169 RAINFOREST TREE GROUP169	128 ha
TR339 EUCALYPT TREE GROUP339	43 ha
TR346/351 EUCALYPT TREE GROUP346/351	900 ha
TR707 EUCALYPT TREE GROUP707	4193 ha
TR710 EUCALYPT TREE GROUP710	5654 ha
TR716 EUCALYPT TREE GROUP716	5 ha

Total area = 30155 ha

Unsurveyed area = 1353.1

IDENTIFICATION CODE N0007
RESERVE - Broadwater NP
AREA - 3737.13

CW005 ESTUARINE WETLAND GROUP005	195 ha
HW008 HUMID FORESTED WETLAND GROUP008	1 ha
RF041 RAINFOREST TREE GROUP041	1 ha
TR354 EUCALYPT TREE GROUP354	10 ha
TR706 EUCALYPT TREE GROUP706	15 ha
TR707 EUCALYPT TREE GROUP707	8 ha
TR710 EUCALYPT TREE GROUP710	3 ha
TR711 EUCALYPT TREE GROUP711	8 ha

Total area = 241 ha

Unsurveyed area = 3496.13

IDENTIFICATION CODE N0041
RESERVE - Bundjalung NP
AREA - 17678.915

CW005 ESTUARINE WETLAND GROUP005	206 ha
HW008 HUMID FORESTED WETLAND GROUP008	40 ha
RF040 RAINFOREST TREE GROUP040	25 ha
RF041 RAINFOREST TREE GROUP041	30 ha
TR349 EUCALYPT TREE GROUP349	400 ha
TR354 EUCALYPT TREE GROUP354	35 ha
TR706 EUCALYPT TREE GROUP706	1100 ha
TR707 EUCALYPT TREE GROUP707	3100 ha
TR710 EUCALYPT TREE GROUP710	510 ha
TR711 EUCALYPT TREE GROUP711	415 ha
TR717 EUCALYPT TREE GROUP717	500 ha

Total area = 6361 ha

Unsurveyed area = 11317.915

IDENTIFICATION CODE N0046
RESERVE - Cathedral Rock NP, Serpentine NR
AREA - 7252

TR168 EUCALYPT TREE GROUP168	1000 ha
TR347 EUCALYPT TREE GROUP347	5800 ha

Total area = 6800 ha

Unsurveyed area = 452

IDENTIFICATION CODE N0009
RESERVE - Crowdy Bay NP
AREA - 8005.2422

CW005 ESTUARINE WETLAND GROUP005	1100 ha
HW008 HUMID FORESTED WETLAND GROUP008	40 ha
RF041 RAINFOREST TREE GROUP041	35.5 ha
TR350 EUCALYPT TREE GROUP350	1 ha
TR354 EUCALYPT TREE GROUP354	150 ha
TR706 EUCALYPT TREE GROUP706	400 ha
TR707 EUCALYPT TREE GROUP707	131 ha
TR710 EUCALYPT TREE GROUP710	6.2 ha
TR711 EUCALYPT TREE GROUP711	110.2 ha

Total area = 1973.9 ha

Unsurveyed area = 6031.3422

IDENTIFICATION CODE N0011
RESERVE - Dorrigo NP
AREA - 7885.464

RF040 RAINFOREST TREE GROUP040	675 ha
RF041 RAINFOREST TREE GROUP041	1900 ha
RF044 RAINFOREST TREE GROUP044	1000 ha
RF169 RAINFOREST TREE GROUP169	60 ha
TR346/351 EUCALYPT TREE GROUP346/351	360 ha
TR707 EUCALYPT TREE GROUP707	1720 ha
TR710 EUCALYPT TREE GROUP710	2150 ha

Total area = 7865 ha

Unsurveyed area = 20.464

IDENTIFICATION CODE N0012
RESERVE - Gibraltar Range NP
AREA - 17273.271

RF040 RAINFOREST TREE GROUP040	100 ha
RF041 RAINFOREST TREE GROUP041	900 ha
TR168 EUCALYPT TREE GROUP168	8800 ha
TR347 EUCALYPT TREE GROUP347	1100 ha
TR350 EUCALYPT TREE GROUP350	10 ha
TR707 EUCALYPT TREE GROUP707	3000 ha
TR710 EUCALYPT TREE GROUP710	400 ha

Total area = 17310 ha

Unsurveyed area = 2963

IDENTIFICATION CODE N0013, N0437
RESERVE - Guy Fawkes River NP, Guy Fawkes NR
AREA - 37163.59

DS040 DRY SEMI-DECIDUOUS CLOSED FOREST040	1000 ha
TR168 EUCALYPT TREE GROUP168	21500 ha
TR710 EUCALYPT TREE GROUP710	300 ha
TR716 EUCALYPT TREE GROUP716	13800 ha
TR716B EUCALYPT TREE GROUP716B	300 ha

Total area = 36900 ha

Unsurveyed area = 264.59

IDENTIFICATION CODE N0014
RESERVE - Hat Head NP
AREA - 6444.873

CW005	ESTUARINE WETLAND GROUP005	791 ha
RF040	RAINFOREST TREE GROUP040	10 ha
RF041	RAINFOREST TREE GROUP041	40 ha
TR354	EUCALYPT TREE GROUP354	30 ha
TR706	EUCALYPT TREE GROUP706	800 ha
TR707	EUCALYPT TREE GROUP707	340 ha
TR710	EUCALYPT TREE GROUP710	35 ha
TR711	EUCALYPT TREE GROUP711	250 ha
TR716B	EUCALYPT TREE GROUP716B	5 ha

Total area = 2301 ha

Unsurveyed area = 4143.873

IDENTIFICATION CODE N0067
RESERVE - Kings Plains NP
AREA - 3713

TR339	EUCALYPT TREE GROUP339	200 ha
TR361	EUCALYPT TREE GROUP361	2700 ha
TR717	EUCALYPT TREE GROUP717	300 ha

Total area = 3200 ha

Unsurveyed area = 513

IDENTIFICATION CODE N0024
RESERVE - Mount Warning NP
AREA - 2380.355

RF040	RAINFOREST TREE GROUP040	1243 ha
TR346/351	EUCALYPT TREE GROUP346/351	67 ha
TR707	EUCALYPT TREE GROUP707	443 ha
TR710	EUCALYPT TREE GROUP710	251 ha

Total area = 2004 ha

Unsurveyed area = 376.645

IDENTIFICATION CODE N0026
RESERVE - Myall Lakes NP
AREA - 31501.411

CW019	ESTUARINE WETLAND GROUP019	1610 ha
RF041	RAINFOREST TREE GROUP041	70 ha
TR348	EUCALYPT TREE GROUP348	820 ha
TR350	EUCALYPT TREE GROUP350	2550 ha
TR354	EUCALYPT TREE GROUP354	2550 ha
TR706	EUCALYPT TREE GROUP706	8160 ha
TR710	EUCALYPT TREE GROUP710	5 ha
TR717	EUCALYPT TREE GROUP717	240 ha

Total area = 16005 ha

Unsurveyed area = 15496.411

IDENTIFICATION CODE N0028
RESERVE - New England NP
AREA - 29985.197

RF040	RAINFOREST TREE GROUP040	3767 ha

RF041 RAINFOREST TREE GROUP041 3756 ha
RF044 RAINFOREST TREE GROUP044 1520 ha
RF169 RAINFOREST TREE GROUP169 280 ha
TR334 EUCALYPT TREE GROUP334 295 ha
TR346 EUCALYPT TREE GROUP346 2462 ha
TR346/351 EUCALYPT TREE GROUP346/351 590 ha
TR707 EUCALYPT TREE GROUP707 10316 ha
TR710 EUCALYPT TREE GROUP710 6259 ha
Total area = 470 ha

Unsurveyed area = 740.197

IDENTIFICATION CODE N0062
RESERVE - Nightcap NP
AREA - 4945

RF040 RAINFOREST TREE GROUP040 1744 ha
RF041 RAINFOREST TREE GROUP041 45 ha
RF044 RAINFOREST TREE GROUP044 331 ha
RF169 RAINFOREST TREE GROUP169 3 ha
TR346/351 EUCALYPT TREE GROUP346/351 114 ha
TR707 EUCALYPT TREE GROUP707 1018 ha
TR710 EUCALYPT TREE GROUP710 1180 ha
TR711 EUCALYPT TREE GROUP711 13 ha
Total area = 4418 ha

Unsurveyed area = 527

IDENTIFICATION CODE N0055
RESERVE - Nymboida NP
AREA - 18998

RF040 RAINFOREST TREE GROUP040 400 ha
RF041 RAINFOREST TREE GROUP041 60 ha
RF044 RAINFOREST TREE GROUP044 692 ha
TR346 EUCALYPT TREE GROUP346 1596 ha
TR707 EUCALYPT TREE GROUP707 12668 ha
TR710 EUCALYPT TREE GROUP710 3620 ha
TR717 EUCALYPT TREE GROUP717 532 ha
Total area = 19568 ha

Unsurveyed area = -570

IDENTIFICATION CODE N0043
RESERVE - Oxley Wild Rivers NP
AREA - 90216.31

DS040 DRY SEMI-DECIDUOUS CLOSED FOREST040 4375 ha
RF044 RAINFOREST TREE GROUP044 4375 ha
TR168 EUCALYPT TREE GROUP168 40000 ha
TR339 EUCALYPT TREE GROUP339 500 ha
TR346/351 EUCALYPT TREE GROUP346/351 50 ha
TR347 EUCALYPT TREE GROUP347 400 ha
TR352 EUCALYPT TREE GROUP352 2200 ha
TR363 EUCALYPT TREE GROUP363 300 ha
TR666 EUCALYPT TREE GROUP666 1200 ha
TR716 EUCALYPT TREE GROUP716 33000 ha
TR717 EUCALYPT TREE GROUP717 100 ha
Total area = 86500 ha

Unsurveyed area = 3716.31

IDENTIFICATION CODE N0064
RESERVE - Warrabah NP
AREA - 3470.675

TR361 EUCALYPT TREE GROUP361	2000 ha
TR716 EUCALYPT TREE GROUP716	500 ha
TR717 EUCALYPT TREE GROUP717	1000 ha

Total area = 3500 ha

Unsurveyed area = -29.325

IDENTIFICATION CODE N0061
RESERVE - Washpool NP
AREA - 27715

RF040 RAINFOREST TREE GROUP040	1833 ha
RF041 RAINFOREST TREE GROUP041	5935 ha
TR168 EUCALYPT TREE GROUP168	4221 ha
TR707 EUCALYPT TREE GROUP707	4716 ha
TR710 EUCALYPT TREE GROUP710	9376 ha
TR717 EUCALYPT TREE GROUP717	269 ha

Total area = 26350 ha

Unsurveyed area = 1365

IDENTIFICATION CODE N0042
RESERVE - Werrikimbe NP
AREA - 35178

RF040 RAINFOREST TREE GROUP040	50 ha
RF041 RAINFOREST TREE GROUP041	2400 ha
RF044 RAINFOREST TREE GROUP044	1300 ha
RF169 RAINFOREST TREE GROUP169	1500 ha
TR168 EUCALYPT TREE GROUP168	16200 ha
TR335 EUCALYPT TREE GROUP335	400 ha
TR346/351 EUCALYPT TREE GROUP346/351	550 ha
TR347 EUCALYPT TREE GROUP347	700 ha
TR707 EUCALYPT TREE GROUP707	2960 ha
TR710 EUCALYPT TREE GROUP710	2650 ha

Total area = 28710 ha

Unsurveyed area = 6468

IDENTIFICATION CODE N0057
RESERVE - Woko NP
AREA - 8265.14

RF040 RAINFOREST TREE GROUP040	885 ha
RF044 RAINFOREST TREE GROUP044	4200 ha
TR346 EUCALYPT TREE GROUP346	1750 ha
TR349 EUCALYPT TREE GROUP349	350 ha
TR710 EUCALYPT TREE GROUP710	350 ha

Total area = 8235 ha

Unsurveyed area = 30.14

IDENTIFICATION CODE N0040
RESERVE - Yuraygir NP
AREA - 18284.887

CW005 ESTUARINE WETLAND GROUP005	18 ha
CW019 ESTUARINE WETLAND GROUP019	1930 ha
RF041 RAINFOREST TREE GROUP041	4 ha
RF044 RAINFOREST TREE GROUP044	1 ha
TR349 EUCALYPT TREE GROUP349	200 ha
TR354 EUCALYPT TREE GROUP354	150 ha
TR706 EUCALYPT TREE GROUP706	1850 ha
TR707 EUCALYPT TREE GROUP707	2520 ha
TR710 EUCALYPT TREE GROUP710	30 ha
TR711 EUCALYPT TREE GROUP711	2645 ha
TR717 EUCALYPT TREE GROUP717	15 ha

Total area = 9363 ha

Unsurveyed area = 8921.887

IDENTIFICATION CODE N0502
RESERVE - Ballina NR
AREA - 721

CW005 ESTUARINE WETLAND GROUP005	692 ha
TR363 EUCALYPT TREE GROUP363	60 ha

Total area = 752 ha

Unsurveyed area = -31

IDENTIFICATION CODE N0400
RESERVE - Banyabba NR
AREA - 12559.601

RF044 RAINFOREST TREE GROUP044	627 ha
TR707 EUCALYPT TREE GROUP707	5649 ha
TR711 EUCALYPT TREE GROUP711	6277 ha

Total area = 12553 ha

Unsurveyed area = 6.601

IDENTIFICATION CODE N0580
RESERVE - Boatharbour NR
AREA - 24.237

RF040 RAINFOREST TREE GROUP040	13 ha
RF044 RAINFOREST TREE GROUP044	4 ha

Total area = 17 ha

Unsurveyed area = 7.237

IDENTIFICATION CODE N0410
RESERVE - Boorganna NR
AREA - 390.027

RF040 RAINFOREST TREE GROUP040	50 ha
RF041 RAINFOREST TREE GROUP041	30 ha
RF044 RAINFOREST TREE GROUP044	69 ha
TR346/351 EUCALYPT TREE GROUP346/351	180 ha
TR710 EUCALYPT TREE GROUP710	60 ha

Total area = 389 ha

Unsurveyed area = 1.027

IDENTIFICATION CODE N0412
RESERVE - Bowraville NR
AREA - 60.908

RF040 RAINFOREST TREE GROUP040 15 ha
TR707 EUCALYPT TREE GROUP707 30 ha
TR710 EUCALYPT TREE GROUP710 15 ha
Total area = 60 ha

Unsurveyed area = .908

IDENTIFICATION CODE N0414
RESERVE - Broken Head NR
AREA - 97.6351

RF040 RAINFOREST TREE GROUP040 25 ha
RF041 RAINFOREST TREE GROUP041 73 ha
Total area = 98 ha

Unsurveyed area = -.3649

IDENTIFICATION CODE N0523
RESERVE - Brunswick Heads NR
AREA - 84

RF040 RAINFOREST TREE GROUP040 15 ha
RF041 RAINFOREST TREE GROUP041 39 ha
Total area = 54 ha

Unsurveyed area = 30

IDENTIFICATION CODE N0516
RESERVE - Bungawalbin NR
AREA - 467.2

CW005 ESTUARINE WETLAND GROUP005 267 ha
TR707 EUCALYPT TREE GROUP707 200 ha
Total area = 467 ha

Unsurveyed area = .2

IDENTIFICATION CODE N0538
RESERVE - Camels Hump NR
AREA - 545

RF040 RAINFOREST TREE GROUP040 100 ha
RF044 RAINFOREST TREE GROUP044 300 ha
TR707 EUCALYPT TREE GROUP707 145 ha
Total area = 545 ha

Unsurveyed area = 0

IDENTIFICATION CODE N0542
RESERVE - Coocumbac Island NR
AREA - 5.058

CW005 ESTUARINE WETLAND GROUP005 0.5 ha
RF040 RAINFOREST TREE GROUP040 3 ha
Total area = 3.5 ha

Unsurveyed area = 1.558

IDENTIFICATION CODE N0550
RESERVE - Coramba NR
AREA - 8

RF040 RAINFOREST TREE GROUP040 8 ha
Total area = 8 ha

Unsurveyed area = 0

IDENTIFICATION CODE N0533
RESERVE - Davis Scrub NR
AREA - 13.86

RF040 RAINFOREST TREE GROUP040 13 ha
Total area = 13 ha

Unsurveyed area = .86

IDENTIFICATION CODE N0570
RESERVE - Deer Vale NR
AREA - 181.2

RF040 RAINFOREST TREE GROUP040 30 ha
RF041 RAINFOREST TREE GROUP041 130 ha
RF169 RAINFOREST TREE GROUP169 20 ha
Total area = 180 ha

Unsurveyed area = 1.2

IDENTIFICATION CODE N0431
RESERVE - Georges Creek NR
AREA - 1189.774

RF040 RAINFOREST TREE GROUP040 127 ha
TR346 EUCALYPT TREE GROUP346 99 ha
TR707 EUCALYPT TREE GROUP707 937 ha
TR710 EUCALYPT TREE GROUP710 32 ha
Total area = 1195 ha

Unsurveyed area = -5.226

IDENTIFICATION CODE N0582
RESERVE - Hayters Hill NR
AREA - 8

RF044 RAINFOREST TREE GROUP044 8 ha
Total area = 8 ha

Unsurveyed area = 0

IDENTIFICATION CODE N0510
RESERVE - Iluka NR
AREA - 135.92

RF041 RAINFOREST TREE GROUP041 68 ha
TR707 EUCALYPT TREE GROUP707 34 ha
Total area = 102 ha

Unsurveyed area = 33.92

IDENTIFICATION CODE N0592
RESERVE - Inner Pocket NR
AREA - 236

RF040 RAINFOREST TREE GROUP040 60 ha
RF041 RAINFOREST TREE GROUP041 25 ha
RF044 RAINFOREST TREE GROUP044 40 ha
TR707 EUCALYPT TREE GROUP707 60 ha
TR710 EUCALYPT TREE GROUP710 50 ha
Total area = 235 ha

Unsurveyed area = 1

IDENTIFICATION CODE N0568
RESERVE - Ironbark NR
AREA - 1603.7

TR361 EUCALYPT TREE GROUP361 1200 ha
TR716 EUCALYPT TREE GROUP716 400 ha
Total area = 1600 ha

Unsurveyed area = 3.7

IDENTIFICATION CODE N0557
RESERVE - Jasper NR
AREA - 354.5

RF044 RAINFOREST TREE GROUP044 124 ha
TR710 EUCALYPT TREE GROUP710 53 ha
TR716B EUCALYPT TREE GROUP716B 36 ha
Total area = 213 ha

Unsurveyed area = 141.5

IDENTIFICATION CODE N0561
RESERVE - Kattang NR
AREA - 58

CW005 ESTUARINE WETLAND GROUP005 2.025 ha
RF041 RAINFOREST TREE GROUP041 1 ha
TR349 EUCALYPT TREE GROUP349 10 ha
TR710 EUCALYPT TREE GROUP710 0.05 ha
Total area = 13.075 ha

Unsurveyed area = 44.925

IDENTIFICATION CODE N0442
RESERVE - Kororo NR
AREA - 10.926

TR710 EUCALYPT TREE GROUP710 11 ha
Total area = 11 ha

Unsurveyed area = -.074

IDENTIFICATION CODE N0559
RESERVE - Lake Innes NR
AREA - 3508.801

CW019 ESTUARINE WETLAND GROUP019	650 ha
TR706 EUCALYPT TREE GROUP706	55 ha
TR710 EUCALYPT TREE GROUP710	5 ha
TR711 EUCALYPT TREE GROUP711	40 ha

Total area = 750 ha

Unsurveyed area = 2758.801

IDENTIFICATION CODE N0443
RESERVE - Limeburners Creek NR
AREA - 9082.858

CW005 ESTUARINE WETLAND GROUP005	25 ha
CW019 ESTUARINE WETLAND GROUP019	1180 ha
RF040 RAINFOREST TREE GROUP040	1 ha
RF041 RAINFOREST TREE GROUP041	17 ha
TR354 EUCALYPT TREE GROUP354	60 ha
TR706 EUCALYPT TREE GROUP706	650 ha
TR707 EUCALYPT TREE GROUP707	85 ha
TR710 EUCALYPT TREE GROUP710	15 ha
TR711 EUCALYPT TREE GROUP711	605 ha

Total area = 2638 ha

Unsurveyed area = 6444.858

IDENTIFICATION CODE N0444
RESERVE - Limpinwood NR
AREA - 2646.679

RF040 RAINFOREST TREE GROUP040	2292 ha
RF044 RAINFOREST TREE GROUP044	281 ha
RF169 RAINFOREST TREE GROUP169	25 ha
TR707 EUCALYPT TREE GROUP707	224 ha
TR710 EUCALYPT TREE GROUP710	464 ha

Total area = 3286 ha

Unsurveyed area = -639.321

IDENTIFICATION CODE N0526
RESERVE - Linton NR
AREA - 640

TR341 EUCALYPT TREE GROUP341	640 ha

Total area = 640 ha

Unsurveyed area = 0

IDENTIFICATION CODE N0594
RESERVE - Little Pimlico Island NR
AREA - 16

RF041 RAINFOREST TREE GROUP041	8 ha

Total area = 8 ha

Unsurveyed area = 8

IDENTIFICATION CODE N0448
RESERVE - Macquarie NR
AREA - 12.1646

TR707 EUCALYPT TREE GROUP707 3 ha
TR710 EUCALYPT TREE GROUP710 3 ha
Total area = 6 ha

Unsurveyed area = 6.1646

IDENTIFICATION CODE N0569
RESERVE - Mann River NR
AREA - 5640

TR168 EUCALYPT TREE GROUP168 1000 ha
TR707 EUCALYPT TREE GROUP707 4600 ha
Total area = 5600 ha

Unsurveyed area = 40

IDENTIFICATION CODE N0509
RESERVE - Moonee Beach NR
AREA - 240

CW005 ESTUARINE WETLAND GROUP005 24 ha
RF041 RAINFOREST TREE GROUP041 12 ha
TR354 EUCALYPT TREE GROUP354 24 ha
TR707 EUCALYPT TREE GROUP707 12 ha
Total area = 72 ha

Unsurveyed area = 168

IDENTIFICATION CODE N0583
RESERVE - Moore Park NR
AREA - 8.979

RF044 RAINFOREST TREE GROUP044 6 ha
TR352 EUCALYPT TREE GROUP352 2 ha
Total area = 8 ha

Unsurveyed area = .979

IDENTIFICATION CODE N0566
RESERVE - Mount Hyland NR
AREA - 1636.2

DS040 DRY SEMI-DECIDUOUS CLOSED FOREST040 169 ha
RF040 RAINFOREST TREE GROUP040 51 ha
RF041 RAINFOREST TREE GROUP041 790 ha
RF087 RAINFOREST TREE GROUP087 150 ha
TR346 EUCALYPT TREE GROUP346 480 ha
TR710 EUCALYPT TREE GROUP710 28 ha
Total area = 1668 ha

Unsurveyed area = -31.8

IDENTIFICATION CODE N0578
RESERVE - Mount Neville NR
AREA - 2666

RF040 RAINFOREST TREE GROUP040 2 ha

TR707 EUCALYPT TREE GROUP707 560 ha
TR710 EUCALYPT TREE GROUP710 58 ha
TR711 EUCALYPT TREE GROUP711 1537 ha
TR717 EUCALYPT TREE GROUP717 414 ha
Total area = 2571 ha

Unsurveyed area = 95

IDENTIFICATION CODE N0453
RESERVE - Mount Seaview NR
AREA - 1703.749

RF040 RAINFOREST TREE GROUP040 98 ha
RF041 RAINFOREST TREE GROUP041 7 ha
RF044 RAINFOREST TREE GROUP044 245 ha
TR168 EUCALYPT TREE GROUP168 636 ha
TR346 EUCALYPT TREE GROUP346 35 ha
TR707 EUCALYPT TREE GROUP707 240 ha
TR710 EUCALYPT TREE GROUP710 149 ha
Total area = 1410 ha

Unsurveyed area = 293.749

IDENTIFICATION CODE N0555
RESERVE - Mount Yarrowyck NR
AREA - 170.2

TR168 EUCALYPT TREE GROUP168 170 ha
Total area = 170 ha

Unsurveyed area = .2

IDENTIFICATION CODE N0539
RESERVE - Muldiva NR
AREA - 10.42

RF040 RAINFOREST TREE GROUP040 10 ha
Total area = 10 ha

Unsurveyed area = .42

IDENTIFICATION CODE N0545
RESERVE - Numinbah NR
AREA - 858

RF040 RAINFOREST TREE GROUP040 568 ha
RF041 RAINFOREST TREE GROUP041 152 ha
RF169 RAINFOREST TREE GROUP169 5 ha
TR710 EUCALYPT TREE GROUP710 131 ha
Total area = 856 ha

Unsurveyed area = 2

IDENTIFICATION CODE N0572
RESERVE - Richmond River NR
AREA - 108.448

CW005 ESTUARINE WETLAND GROUP005 79 ha
Total area = 79 ha

Unsurveyed area = 29.448

IDENTIFICATION CODE N0577
RESERVE - Sea Acres NR
AREA - 76

RF040 RAINFOREST TREE GROUP040 28 ha
RF041 RAINFOREST TREE GROUP041 40 ha
TR707 EUCALYPT TREE GROUP707 5 ha
Total area = 73 ha

Unsurveyed area = 3

IDENTIFICATION CODE N0473
RESERVE - Severn River NR
AREA - 1946.535

TR717 EUCALYPT TREE GROUP717 1500 ha
Total area = 1500 ha

Unsurveyed area = 446.535

IDENTIFICATION CODE N0474
RESERVE - Sherwood NR
AREA - 2444.297

RF044 RAINFOREST TREE GROUP044 244 ha
TR707 EUCALYPT TREE GROUP707 1832 ha
Total area = 2076 ha

Unsurveyed area = 368.297

IDENTIFICATION CODE N0478
RESERVE - Stotts Island NR
AREA - 141.64

CW005 ESTUARINE WETLAND GROUP005 75 ha
RF040 RAINFOREST TREE GROUP040 70 ha
Total area = 145 ha

Unsurveyed area = -3.36

IDENTIFICATION CODE N0544
RESERVE - Susan Island NR
AREA - 23

RF040 RAINFOREST TREE GROUP040 23 ha
Total area = 23 ha

Unsurveyed area = 0

IDENTIFICATION CODE N0480
RESERVE - The Basin NR
AREA - 2317.711

TR168 EUCALYPT TREE GROUP168 600 ha
TR716 EUCALYPT TREE GROUP716 1700 ha
Total area = 2300 ha

Unsurveyed area = 17.711

IDENTIFICATION CODE N0549
RESERVE - Tuckean NR
AREA - 550.5

CW005 ESTUARINE WETLAND GROUP005 540 ha
Total area = 540 ha

Unsurveyed area = 10.5

IDENTIFICATION CODE N0575
RESERVE - Tyagarah NR
AREA - 750

CW005 ESTUARINE WETLAND GROUP005 79 ha
Total area = 79 ha

Unsurveyed area = 671

IDENTIFICATION CODE N0536
RESERVE - Ukerabagh NR
AREA - 150

CW005 ESTUARINE WETLAND GROUP005 65 ha
RF041 RAINFOREST TREE GROUP041 5 ha
TR707 EUCALYPT TREE GROUP707 20 ha
Total area = 90 ha

Unsurveyed area = 60

IDENTIFICATION CODE N0504
RESERVE - Uralba NR
AREA - 288

RF041 RAINFOREST TREE GROUP041 25 ha
TR707 EUCALYPT TREE GROUP707 260 ha
Total area = 285 ha

Unsurveyed area = 3

IDENTIFICATION CODE N0500
RESERVE - Victoria Park NR
AREA - 17.5

RF040 RAINFOREST TREE GROUP040 8 ha
Total area = 8 ha

Unsurveyed area = 9.5

IDENTIFICATION CODE N0534
RESERVE - Watsons Creek NR
AREA - 1260

TR168 EUCALYPT TREE GROUP168 400 ha
TR717 EUCALYPT TREE GROUP717 800 ha
Total area = 1200 ha

Unsurveyed area = 60

IDENTIFICATION CODE N0488
RESERVE - Weelah NR
AREA - 37.474

RF040 RAINFOREST TREE GROUP040	7 ha
TR346/351 EUCALYPT TREE GROUP346/351	15 ha
TR710 EUCALYPT TREE GROUP710	15 ha

Total area = 37 ha

Unsurveyed area = .474

IDENTIFICATION CODE N0490
RESERVE - Willi Willi Caves NR
AREA - 8.094

RF044 RAINFOREST TREE GROUP044	8 ha

Total area = 8 ha

Unsurveyed area = .094

IDENTIFICATION CODE N0496
RESERVE - Yarravel NR
AREA - 28.328

TR710 EUCALYPT TREE GROUP710	14 ha
TR711 EUCALYPT TREE GROUP711	14 ha

Total area = 28 ha

Unsurveyed area = .328

IDENTIFICATION CODE N0601
RESERVE - Arakoon SRA
AREA - 471.937

CW005 ESTUARINE WETLAND GROUP005	15 ha
RF040 RAINFOREST TREE GROUP040	15 ha
RF041 RAINFOREST TREE GROUP041	10 ha
TR707 EUCALYPT TREE GROUP707	250 ha
TR710 EUCALYPT TREE GROUP710	40 ha

Total area = 330 ha

Unsurveyed area = 141.937

Appendix 6 Plant communities in old growth forests

Dalmorton State Forest
Location: Central zone

Plant association	Area (ha)	Conservation Code
RF110 Caldcluvia paniculata- Cryptocarya erythroxylon- Orites excelsa- Melicope octandra- Acmena brachyandra/RF111 Sloanea woolsii- Dysoxylum fraseranum- Heriteria actinophylla- Caldcluvia paniculata	71	3x/5
RF200 Araucaria cunninghamii	365	3x
EF101 Eucalyptus grandis- Lophostemon confertus- Eucalyptus microcorys	329	3
EF102 Eucalyptus saligna	28	3x
EF103 Eucalyptus saligna- Eucalyptus microcorys	218	5
EF111 Eucalyptus tereticornis	128	2x
EF121 Eucalyptus maculata	1184	2
EF123 Eucalyptus maculata- Eucalyptus siderophloia	5177	2x
EF358 Eucalyptus campanulata	408	5
EF359 Eucalyptus campanulata- Eucalyptus cameronii	100	5
Non forest	422	

Chaelundi State Forest- Chandlers Creek section
Location: Central zone

Plant association	Area (ha)	Conservation Code
RF111 Sloanea woolsii- Dysoxylum fraseranum- Heriteria actinophylla- Caldcluvia paniculata/RF112 Schizomeria ovata- Doryphora sassafras- Caldcluvia paniculata- Cryptocarya glaucescens	37	5/4
RF113 Doryphora sassafras- Daphandra micrantha- Dendrocnide excelsa- Ficus spp- Toona australis/RF114 Ficus spp- Dysoxylum fraseranum- Toona australis- Dendrocnide excelsa	43	3x/2x
RF200 Araucaria cunninghamii	151	3x
RF302 Ceratopetalum apetalum- Schizomeria ovata- Caldcluvia paniculata	3	5
EF101 Eucalyptus grandis- Lophostemon confertus- Eucalyptus microcorys	78	3
EF103 Eucalyptus saligna- Eucalyptus microcorys	33	5
EF111 Eucalyptus tereticornis	22	2x
EF115 Eucalyptus pilularis	351	3
EF117 Eucalyptus pilularis- Eucalyptus acmenioides	119	3
EF121 Eucalyptus maculata	43	2
EF123 Eucalyptus maculata- Eucalyptus paniculata	3552	2x
EF205 Eucalyptus maculata- Eucalyptus propinqua- Eucalyptus gummifera- Angophora floribunda	3798	2x
EF358 Eucalyptus campanulata	14	5
EF359 Eucalyptus campanulata- Eucalyptus cameronii	571	5
EF361 Eucalyptus campanulata- Eucalyptus radiata ssp sejuncta	339	5
EF374 Eucalyptus laevopinea- Eucalyptus saligna	465	2x
Non forest	216	

Chaelundi State Forest- Marara Creek section
Location: Central zone

Plant association	Area (ha)	Conservation Code
RF111 Sloanea woolsii- Dysoxylum fraseranum- Heritiera actinophylla- Caldcluvia paniculata	2	5
RF114 Ficus spp- Dysoxylum fraseranum- Toona australis- Dendrocnide excelsa	4	2x
EF101 Eucalyptus grandis- Lophostemon confertus- Eucalyptus microcorys	11	3
EF121 Eucalyptus maculata	20	2
EF123 Eucalyptus maculata- Eucalyptus paniculata	316	2x
EF359 Eucalyptus campanulata- Eucalyptus cameronii	30	5
EF361 Eucalyptus campanulata- Eucalyptus radiata ssp sejuncta	19	5

Chaelundi State Forest- Broadmeadows section
Location: Central zone

Plant association	Area (ha)	Conservation Code
RF111 Sloanea woolsii- Dysoxylum fraseranum- Heriteria actinophylla- Caldcluvia paniculata/RF112 Schizomeria ovata- Doryphora sassafras- Caldcluvia paniculata- Cryptocarya glaucescens	157	5/4
RF113 Doryphora sassafras- Daphandra micrantha- Dendrocnide excelsa- Ficus spp- Toona australis/RF114 Ficus spp- Dysoxylum fraseranum- Toona australis- Dendrocnide excelsa	43	3x/2x
RF200 Araucaria cunninghamii	12	3x
EF101 Eucalyptus grandis- Lophostemon confertus- Eucalyptus microcorys	177	3
EF103 Eucalyptus saligna- Eucalyptus microcorys	384	5
EF121 Eucalyptus maculata	20	2
EF123 Eucalyptus maculata- Eucalyptus paniculata	1719	2x
EF358 Eucalyptus campanulata	488	5
EF359 Eucalyptus campanulata- Eucalyptus cameronii	1393	5
EF361 Eucalyptus campanulata- Eucalyptus radiata ssp sejuncta	742	5
EF374 Eucalyptus laevopinea- Eucalyptus saligna	402	2x

Willi Willi VCL and leasehold*
Location: Central zone

Plant association	Area (ha)	Conservation Code
RF112 Schizomeria ovata- Doryphora sassafras- Caldcluvia paniculata- Cryptocarya glaucescens	110	4
RF Myrtle	1107	
EF101 Eucalyptus grandis- Lophostemon confertus- Eucalyptus microcorys	1212	3
EF102 Eucalyptus saligna	15	3x
EF103 Eucalyptus saligna- Eucalyptus microcorys	457	5
EF109 Eucalyptus acmenioides- Eucalyptus propinqua	397	2x
EF110 Eucalyptus propinqua- Eucalyptus siderophloia	2952	3x
EF115 Eucalyptus pilularis/EF116 Eucalyptus pilularis- Eucalyptus resinifera/EF117 Eucalyptus pilularis- Eucalyptus acmenioides	99	3x/3x/3x
EF118 Eucalyptus pilularis- Eucalyptus intermedia- Eucalyptus siderophloia	74	3x
EF358 Eucalyptus campanulata	464	5
EF359 Eucalyptus campanulata- Eucalyptus cameronii	1181	5

Non forest		

Richmond Range/Yabbra State Forest- Duck Creek section
Location: North zone

Plant association	Area	Conservation Code
RF100 Heritiera trifoliata	E	5
RF105 Archontophoenix cunninghamiana- Livistona australis	C	3
RF200 Araucaria cunninghamii	O	3
RF Myrtle	R	
EF100 Eucalyptus grandis	E	2
EF101 Eucalyptus grandis- Lophostemon confertus- Eucalyptus microcorys	C	3
EF102 Eucalyptus saligna	C	3x
EF103 Eucalyptus saligna- Eucalyptus microcorys	E	5
EF110 Eucalyptus propinqua- Eucalyptus siderophloia	C	3
Non forest	R	
Total area	2900 ha	

Mount Boss State Forest- Cascade Creek section
Location: South zone

Plant association	Area	Conservation Code
RF110 Caldcluvia paniculata- Cryptocarya erythroxylon- Orites excelsa- Melicope octandra- Acmena brachyandra/RF111 Sloanea woolsii- Dysoxylum fraseranum- Heriteria actinophylla- Caldcluvia paniculata	C	3/5
RF Myrtle	C	
RF401 Nothofagus moorei- Ceratopetalum apetalum	O	4
EF101 Eucalyptus grandis- Lophostemon confertus- Eucalyptus microcorys	C	3x
EF103 Eucalyptus saligna- Eucalyptus microcorys	C	5
EF109 Eucalyptus acmenioides- Eucalyptus propinqua	C	2x
EF115 Eucalyptus pilularis/EF116 Eucalyptus pilularis- Eucalyptus resinifera/EF117 Eucalyptus pilularis- Eucalyptus acmenioides	E	3x/3x/3x
EF118 Eucalyptus pilularis- Eucalyptus intermedia- Eucalyptus siderophloia	C	3x
EF251 Eucalyptus umbra ssp carnea- Eucalyptus propinqua	C	3
EF358 Eucalyptus campanulata	E	5
Non forest	R	
Total area	1100 ha	

Mount Boss State Forest- Kennedy's Mountain section
Location: South zone

Plant association	Area	Conservation Code
RF106 Heritiera actinophylla/RF109 Heritiera actinophylla- Dendrocnide excelsa- Ficus spp	C	3/3

RF110 Caldcluvia paniculata- Cryptocarya erythroxylon- Orites excelsa- Melicope octandra- Acmena brachyandra/RF111 Sloanea woolsii- Dysoxylum fraseranum- Heriteria actinophylla- Caldcluvia paniculata	C	3/3
RF Myrtle	C	
EF101 Eucalyptus grandis- Lophostemon confertus- Eucalyptus microcorys	O	3x
EF103 Eucalyptus saligna- Eucalyptus microcorys	C	5
EF109 Eucalyptus acmenioides- Eucalyptus propinqua	C	2x
EF110 Eucalyptus propinqua- Eucalyptus siderophloia	C	3x
EF251 Eucalyptus umbra ssp carnea- Eucalyptus propinqua	C	3
EF358 Eucalyptus campanulata	C	5
Non forest	O	
Total	2400 ha	

Mount Boss/Yessabah State Forest- Banda Banda section
Location: South zone

Plant association	Area	Conservation Code
RF110 Caldcluvia paniculata- Cryptocarya erythroxylon- Orites excelsa- Melicope octandra- Acmena brachyandra/RF111 Sloanea woolsii- Dysoxylum fraseranum- Heriteria actinophylla- Caldcluvia paniculata	R	3/5
RF Myrtle	O	
EF101 Eucalyptus grandis- Lophostemon confertus- Eucalyptus microcorys	C	3x
EF103 Eucalyptus saligna- Eucalyptus microcorys	C	5
EF109 Eucalyptus acmenioides- Eucalyptus propinqua	C	2x
EF110 Eucalyptus propinqua- Eucalyptus siderophloia	E	3x
EF115 Eucalyptus pilularis/EF116 Eucalyptus pilularis- Eucalyptus resinifera/EF117 Eucalyptus pilularis- Eucalyptus acmenioides	E	3x/3x/3x
EF118 Eucalyptus pilularis- Eucalyptus intermedia- Eucalyptus siderophloia	C	3x
EF251 Eucalyptus umbra ssp carnea- Eucalyptus propinqua	C	3
EF358 Eucalyptus campanulata	C	5
Total area	5500 ha	

Nulla-Five Day/Pee Dee State Forest- Woorong section
Location: Central zone

Plant association	Area	Conservation Code
RF112 Schizoneria ovata- Doryphora sassafras- Caldcluvia paniculata- Cryptocarya glaucescens	C	4
RF Myrtle	C	
EF101 Eucalyptus grandis- Lophostemon confertus- Eucalyptus microcorys	C	3
EF103 Eucalyptus saligna- Eucalyptus microcorys	C	5
EF110 Eucalyptus propinqua- Eucalyptus siderophloia	C	3x
EF358 Eucalyptus campanulata	O	5
Total area	2300 ha	

Styx River/Nulla-Five Day/Lower Creek State Forest- Bootumbarra section*
Location: Central zone

Plant association	Area	Conservation Code
RF112 Schizomeria ovata- Doryphora sassafras- Caldcluvia paniculata- Cryptocarya glaucescens	C	4
RF401 Nothofagus moorei- Ceratopetalum apetalum	C	4
RF Myrtle	C	
EF101 Eucalyptus grandis- Lophostemon confertus- Eucalyptus microcorys	C	3
EF103 Eucalyptus saligna- Eucalyptus microcorys	C	5
EF110 Eucalyptus propinqua- Eucalyptus siderophloia	E	3x
EF118 Eucalyptus pilularis- Eucalyptus intermedia- Eucalyptus siderophloia	C	3
EF358 Eucalyptus campanulata	E	5
Total area	11500 ha	

Dingo State Forest- Rocky Hip section
Location: South zone

Plant association	Area	Conservation Code
RF Myrtle	R	
EF101 Eucalyptus grandis- Lophostemon confertus- Eucalyptus microcorys	R	3x
EF103 Eucalyptus saligna- Eucalyptus microcorys	C	5
EF109 Eucalyptus acmenioides- Eucalyptus propinqua	C	2x
EF110 Eucalyptus propinqua- Eucalyptus siderophloia	E	3x
EF115 Eucalyptus pilularis/EF116 Eucalyptus pilularis- Eucalyptus resinifera/EF117 Eucalyptus pilularis- Eucalyptus acmenioides	C	3/3/3
EF118 Eucalyptus pilularis- Eucalyptus intermedia- Eucalyptus siderophloia	C	3
EF358 Eucalyptus campanulata	O	5
EF374 Eucalyptus laevopinea- Eucalyptus saligna	C	2x
Non forest	O	
Total area	1200 ha	

Bulga State Forest-Homewoods section
Location: South zone

Plant association	Area	Conservation Code
RF106 Heritiera actinophylla/RF109 Heritiera actinophylla- Dendrocnide excelsa- Ficus spp/RF112 Schizomeria ovata- Doryphora sassafras- Caldcluvia paniculata- Cryptocarya glaucescens	E	3/3/4
RF Myrtle	O	
EF101 Eucalyptus grandis- Lophostemon confertus- Eucalyptus microcorys	C	3x
EF102 Eucalyptus saligna	O	3
EF103 Eucalyptus saligna- Eucalyptus microcorys	E	5
EF110 Eucalyptus propinqua- Eucalyptus siderophloia	C	3x
EF115 Eucalyptus pilularis/EF116 Eucalyptus pilularis- Eucalyptus resinifera/EF117 Eucalyptus pilularis- Eucalyptus acmenioides	C	3x/3x/3x

EF118 Eucalyptus pilularis- Eucalyptus intermedia- Eucalyptus siderophloia	C	3x
EF358 Eucalyptus campanulata	O	5
EF374 Eucalyptus laevopinea- Eucalyptus saligna	C	2x
EF615 Eucalyptus siderophloia- Eucalyptus tereticornis- Eucalyptus umbra	C	3x
Total area	1500 ha	

Nulla-Five Day State Forest- Comara Range section
Location: Central zone

Plant association	Area	Conservation Code
RF Myrtle	C	
EF101 Eucalyptus grandis- Lophostemon confertus- Eucalyptus microcorys	C	3
EF103 Eucalyptus saligna- Eucalyptus microcorys	C	5
EF110 Eucalyptus propinqua- Eucalyptus siderophloia	E	3x
EF358 Eucalyptus campanulata	E	5
Total area	2000 ha	

Enfield State Forest- Stokes section
Location: South zone

Plant association	Area	Conservation Code
RF106 Heritiera actinophylla/RF109 Heritiera actinophylla-Dendrocnide excelsa- Ficus spp	C	3/3
RF111 Sloanea woolsii- Dysoxylum fraseranum- Heriteria actinophylla-Caldcluvia paniculata/RF112 Schizomeria ovata- Doryphora sassafras-Caldcluvia paniculata- Cryptocarya glaucescens	C	5/4
RF303 Ceratopetalum apetalum- Doryphora sassafras/RF306 Schizomeria ovata-Doryphora sassafras- Caldcluvia paniculata- Orites excelsa/RF307 Doryphora sassafras- Quintinia sieberi/RF308 Doryphora sassafras- Schizomeria ovata	C	5/3/3/5
RF Myrtle	C	
EF101 Eucalyptus grandis- Lophostemon confertus- Eucalyptus microcorys	C	3x
EF102 Eucalyptus saligna	C	3
EF103 Eucalyptus saligna- Eucalyptus microcorys	C	5
EF349 Eucalyptus caliginosa/EF353 Eucalyptus williamsiana/EF354 Eucalyptus williamsiana- Eucalyptus radiata ssp sejuncta	C	2x/2x/2x
EF358 Eucalyptus campanulata	E	5
EF374 Eucalyptus laevopinea- Eucalyptus saligna	C	2x
Non forest	R	
Total area	3500 ha	

Mount Boss State Forest-Kindee section
Location: South zone

Plant association	Area	Conservation Code
RF106 Heritiera actinophylla/RF109 Heritiera actinophylla-Dendrocnide excelsa- Ficus spp	O	3/3
	E	
RF Myrtle	C	3x
EF101 Eucalyptus grandis- Lophostemon confertus- Eucalyptus microcorys	O	3
EF102 Eucalyptus saligna	E	5
EF103 Eucalyptus saligna- Eucalyptus microcorys	E	2x
EF109 Eucalyptus acmenioides- Eucalyptus propinqua	C	3x
EF110 Eucalyptus propinqua- Eucalyptus siderophloia	C	2x
EF111 Eucalyptus tereticornis	C	3
EF251 Eucalyptus umbra ssp carnea- Eucalyptus propinqua	O	3x
EF615 Eucalyptus siderophloia- Eucalyptus tereticornis- Eucalyptus umbra	R	
Non forest		

Doyles River/Bulga State Forest- Cells-Ralfes section
Location: South zone

Plant association	Area	Conservation Code
RF114 Ficus spp- Dysoxylum fraseranum- Toona australis- Dendrocnide excelsa	R	2
RF106 Heritiera actinophylla/RF109 Heritiera actinophylla-Dendrocnide excelsa- Ficus spp	C	3/3
RF110 Caldcluvia paniculata- Cryptocarya erythroxylon- Orites excelsa-Melicope octandra- Acmena brachyandra/RF111 Sloanea woolsii- Dysoxylum fraseranum- Heriteria actinophylla- Caldcluvia paniculata	R	3/5
RF111 Sloanea woolsii- Dysoxylum fraseranum- Heriteria actinophylla-Caldcluvia paniculata/RF112 Schizomeria ovata- Doryphora sassafras-Caldcluvia paniculata- Cryptocarya glaucescens	C	5/4
	C	
RF Myrtle	C	3x
EF101 Eucalyptus grandis- Lophostemon confertus- Eucalyptus microcorys	C	3
EF102 Eucalyptus saligna	C	5
EF103 Eucalyptus saligna- Eucalyptus microcorys	C	3x
EF110 Eucalyptus propinqua- Eucalyptus siderophloia	O	3x
EF139 Eucalyptus propinqua- Eucalyptus cameronii	C	2x/2x/2x
EF349 Eucalyptus caliginosa/EF353 Eucalyptus williamsiana/EF354 Eucalyptus williamsiana- Eucalyptus radiata ssp sejuncta	C	5
EF358 Eucalyptus campanulata	O	2x
EF374 Eucalyptus laevopinea- Eucalyptus saligna	O	
Non forest		
Total area	8100 ha	

Doyles River State Forest- Tirrill section
Location: South zone

Plant association	Area	Conservation Code
RF106 Heritiera actinophylla/RF109 Heritiera actinophylla- Dendrocnide excelsa- Ficus spp	C	3/3
RF Myrtle	E	
EF101 Eucalyptus grandis- Lophostemon confertus- Eucalyptus microcorys	C	3x
EF102 Eucalyptus saligna	R	3
EF103 Eucalyptus saligna- Eucalyptus microcorys	E	5
EF109 Eucalyptus acmenioides- Eucalyptus propinqua	E	2x
EF110 Eucalyptus propinqua- Eucalyptus siderophloia	C	3x
EF111 Eucalyptus tereticornis	C	2x
EF251 Eucalyptus umbra ssp carnea- Eucalyptus propinqua	C	3
EF615 Eucalyptus siderophloia- Eucalyptus tereticornis- Eucalyptus umbra	R	3x
Non forest	R	
Total area	600 ha	

Stewarts Brook State Forest
Location: South zone

Plant association	Area	Conservation Code
RF403 Nothofagus moorei- Doryphora sassafras- Orites excelsa- Caldcluvia paniculata/RF404 Nothofagus moorei- Elaeocarpus holopetalus	C	5/5
EF301 Eucalyptus pauciflora ssp pauciflora- Eucalyptus stellulata	C	3
EF313 Eucalyptus obliqua- Eucalyptus fastigata	E	5
EF358 Eucalyptus campanulata	C	5
EF374 Eucalyptus laevopinea- Eucalyptus saligna	C	2x
RF379 Eucalyptus fastigata- Eucalyptus viminalis	O	4
Non forest	O	
Total area	3900 ha	

Chichester State Forest- Whispering Gully section
Location: South zone

Plant association	Area	Conservation Code
RF111 Sloanea woolsii- Dysoxylum fraseranum- Heriteria actinophylla- Caldcluvia paniculata/RF112 Schizomeria ovata- Doryphora sassafras- Caldcluvia paniculata- Cryptocarya glaucescens/RF113 Doryphora sassafras- Daphandra micrantha- Dendrocnide excelsa- Ficus spp- Toona australis/RF208 Backhousia myrtifolia- Lophostemon confertus- Acmena smithii/RF306 Schizomeria ovata- Doryphora sassafras- Caldcluvia paniculata- Orites excelsa	C	5/4/3/2/3
RF403 Nothofagus moorei- Doryphora sassafras- Orites excelsa- Caldcluvia paniculata/RF404 Nothofagus moorei- Elaeocarpus holopetalus	C	5/5
EF102 Eucalyptus saligna	O	3

EF346 Eucalyptus laevopinea	C	5
EF374 Eucalyptus laevopinea- Eucalyptus saligna	C	2x
Total area	5500 ha	

Barrington Tops State Forest- Kholwa section
Location: South zone

Plant association	Area	Conservation Code
RF111 Sloanea woolsii- Dysoxylum fraseranum- Heriteria actinophylla- Caldcluvia paniculata/RF112 Schizomeria ovata- Doryphora sassafras- Caldcluvia paniculata- Cryptocarya glaucescens/RF113 Doryphora sassafras- Daphandra micrantha- Dendrocnide excelsa- Ficus spp- Toona australis/RF208 Backhousia myrtifolia- Lophostemon confertus- Acmena smithii/RF306 Schizomeria ovata- Doryphora sassafras- Caldcluvia paniculata- Orites excelsa	C	5/4/3/2/3
RF403 Nothofagus moorei- Doryphora sassafras- Orites excelsa- Caldcluvia paniculata/RF404 Nothofagus moorei- Elaeocarpus holopetalus	C	5/5
EF102 Eucalyptus saligna	R	3
EF102 Eucalyptus saligna/EF104 Eucalyptus saligna- Eucalyptus quadrangulata	O	3/3
EF145 Eucalyptus saligna- Angophora floribunda- Eucalyptus acmenioides- Allocasuarina torulosa	O	3
EF301 Eucalyptus pauciflora ssp pauciflora- Eucalyptus stellulata	O	3
EF302 Eucalyptus pauciflora ssp pauciflora- Eucalyptus dalrympleana	C	3
EF313 Eucalyptus obliqua- Eucalyptus fastigata	E	5
EF374 Eucalyptus laevopinea- Eucalyptus saligna	E	2x
EF379 Eucalyptus fastigata- Eucalyptus viminalis	C	4
Non forest	O	
Total area	8900 ha	

Mullum State Forest- Blackbutt Plateau section
Location: North zone

Plant association	Area	Conservation Code
RF100 Heritiera trifoliata	C	5
RF Myrtle	R	
EF101 Eucalyptus grandis- Lophostemon confertus- Eucalyptus microcorys	R	3
EF115 Eucalyptus pilularis/EF116 Eucalyptus pilularis- Eucalyptus resinifera/EF117 Eucalyptus pilularis- Eucalyptus acmenioides	E	3/3/3
EF138 Syncarpia glomulifera- Eucalyptus microcorys	C	1x
EF207 Eucalyptus signata- Eucalyptus intermedia	C	2x
EF358 Eucalyptus campanulata	O	5
Total area	200 ha	

Chichester/Mount Royal State Forest- Boonabilla section
Location: South zone

Plant association	Area	Conservation Code
RF302 Ceratopetalum apetalum- Schizomeria ovata- Caldcluvia paniculata	C	5
RF Myrtle	C	
EF102 Eucalyptus saligna	C	3
EF145 Eucalyptus saligna- Angophora floribunda- Eucalyptus acmenioides- Allocasuarina torulosa	C	3
EF146 Eucalyptus acmenioides- Eucalyptus tereticornis- Allocasuarina torulosa	C	3x
EF358 Eucalyptus campanulata	C	5
EF374 Eucalyptus laevopinea- Eucalyptus saligna	C	2x
Total area	2500 ha	

Mount Royal State Forest- Davis Creek section
Location: South zone

Plant association	Area	Conservation Code
RF302 Ceratopetalum apetalum- Schizomeria ovata- Caldcluvia paniculata	0	5
RF Myrtle	0	
EF145 Eucalyptus saligna- Angophora floribunda- Eucalyptus acmenioides- Allocasuarina torulosa	C	3
EF146 Eucalyptus acmenioides- Eucalyptus tereticornis- Allocasuarina torulosa	C	3x
EF313 Eucalyptus obliqua- Eucalyptus fastigata	C	5
EF374 Eucalyptus laevopinea- Eucalyptus saligna	C	2x
Total area	1900 ha	

Ballengarra State Forest- Kumbatine section
Location: South zone

Plant association	Area	Conservation Code
RF113 Doryphora sassafras- Daphandra micrantha- Dendrocnide excelsa- Ficus spp- Toona australis/RF114 Ficus spp- Dysoxylum fraseranum- Toona australis- Dendrocnide excelsa	12	3/2
EF100 Eucalyptus grandis	15	2x
EF101 Eucalyptus grandis- Lophostemon confertus- Eucalyptus microcorys	613	3x
EF102 Eucalyptus saligna	31	3
EF103 Eucalyptus saligna- Eucalyptus microcorys	49	5
EF109 Eucalyptus acmenioides- Eucalyptus propinqua	352	2x
EF110 Eucalyptus propinqua- Eucalyptus siderophloia	2357	3x
EF111 Eucalyptus tereticornis	2	2x
EF118 Eucalyptus pilularis- Eucalyptus intermedia- Eucalyptus siderophloia	57	3x
Non forest	18	
Total area	3434 ha	

Doyles River/Mount Seaview State Forest- South Seaview section
Location: South zone

Plant association	Area	Conservation Code
RF106 Heritiera actinophylla/RF109 Heritiera actinophylla-Dendrocnide excelsa- Ficus spp	1	3/3
RF112 Schizoneria ovata- Doryphora sassafras- Caldcluvia paniculata-Cryptocarya glaucescens	283	4
RF303 Ceratopetalum apetalum- Doryphora sassafras/RF306 Schizoneria ovata-Doryphora sassafras- Caldcluvia paniculata- Orites excelsa/RF307 Doryphora sassafras- Quintinia sieberi/RF308 Doryphora sassafras- Schizoneria ovata	20	5/3/3/5
RF Myrtle	263	
EF101 Eucalyptus grandis- Lophostemon confertus- Eucalyptus microcorys	400	3x
EF102 Eucalyptus saligna	128	3
EF103 Eucalyptus saligna- Eucalyptus microcorys	849	5
EF115 Eucalyptus pilularis/EF116 Eucalyptus pilularis- Eucalyptus resinifera/EF117 Eucalyptus pilularis- Eucalyptus acmenioides	156	3x/3x/3x
EF316 Eucalyptus obliqua- Eucalyptus nobilis/EF358 Eucalyptus campanulata/EF373 Eucalyptus laevopinea- Eucalyptus viminalis/EF374 Eucalyptus laevopinea- Eucalyptus saligna	719	2x/5/2x/2x
EF358 Eucalyptus campanulata	8	5
EF359 Eucalyptus campanulata- Eucalyptus cameronii/EF360 Eucalyptus campanulata- Eucalyptus caliginosa	1029	5/5
Non forest	70	
Total area	3924 ha	

* Measurement completed for part of the area only
x Inadequately conserved in this part of its geographic range
1= Poorly conserved
2= Inadequately conserved
3= Adequately conserved over part of range only
4= Conservation status indeterminate
5= Adequately conserved
E= Extensive
C= Common
O= Occasional
R= Rare

APPENDIX 7

FIELDS FOR A FILE ON INDIVIDUAL RECORDS FOR PLANT COMMUNITIES

Key: FS

Community number: FS (8.1)

Community name: SS

Classification level: FS (8.12)

Related floristic group number: FS (8.2)

Biblio database reference for source of data: FS

Community name used in reference: FS

Goodness of fit with NPWS classification: FS (8.13)

Study Area description: FS

Study area status: FS (Active or inactive)

Biblio reference for overlapping surveys: FM

OCCURRENCES WITHIN RESERVES IN STUDY AREA

Map number: FM (8.10)

Map name: SM

Reserve number: FA1 (8.11)

Reserve name: SA1

Reserve area (ha): FA1

Proportion of reserve within study area: FA1 (8.4)

Area of community per reserve (ha): FA1

Logging history: FA1 (8.5)

Fire history: FA1 (8.6)

Other disturbance history: FA1 (8.7)

Reliability: FS (8.3)

OCCURRENCES OUTSIDE RESERVES

Area in state forests (ha): FS

Reliability: FS (8.3)

Area in other Crown tenures (ha): FS

Reliability: FS (8.3)

Area on freehold or leasehold (ha): FS

Reliability: FS (8.3)

Area cleared on all tenures (ha): FS

Reliability: FS (8.3)

Conservation status/risk code in study area: FS (8.8)

Key areas for conservation in study area: FM

Causes for decline in study area: FM (8.9)

Threats in study area: FM (8.9)

Comments: FS

Appendix 8

FIELD ENTRIES FOR PLANT COMMUNITY DATABASE

8.1 Plant communities

Community number STR1
Community name: Argyrodendron actinophyllum - Araucaria cunninghamii
Conservation status/risk code: E1 (as defined in 8.8 below)
Causes for decline: BURN (as defined in 8.9)
Evidence for decline: UNDER (as defined in 8.14)
Threats: CROP (as defined in 8.9)

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Community number n
Community name n
Conservation status/risk code n
Causes for decline n
Evidence for decline n
Threats n

8.2 Floristic group

Floristic group number TOF706
Floristic group name Tree group 706

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.

Floristic group number n
Floristic group name n

8.3 Reliability of data

DET Actual determination based on quantitative survey
EST Reliable estimate based on qualitative survey
GEST Poor estimate based on general resource information
GUES Professional estimate based on personal knowledge

8.4 Proportion of reserve in study area

LT25 Less than 25%
LT50 25% to 49%
LT75 50% to 74%
LT99 75% to 99%
ALL 100%

8.5 Logging history

CF1 More than 50% heavily logged once.
CF2 More than 50% heavily logged more than once.
S1 More than 50% selectively logged once.

S2 More than 50% selectively logged more than once.
NL Unlogged or no information and no evidence of logging.
LH No information but evidence of past logging.

8.6 Fire history

B10 More than 50% burned in the past 10 years.
B20 More than 50% burned in the last 20 years.
B50 More than 50% burned in the last 50 years.
U50 More than 50% unburned in the last 50 years.
NF No information on fire history

8.7 Other disturbances

G More than 50% grazed by introduced livestock.
NG No information on grazing history.
W More than 50% damaged by cyclone in the last 10 years.
R Evidence of ringbarking or thinning by other treatments.

8.8 Conservation/risk status over range

This is a binary code (eg E1)

E Endangered: Likely to become extinct within a few decades
V Vulnerable: Likely to become endangered within a few decades
N Not threatened in the foreseeable future
1 Not conserved or only minuscule area conserved
2 Inadequately conserved (small areas and/or exclusion of major part of geographic range)
3 Adequately conserved (large areas and/or large proportion of its geographic range)

8.9 Causes for decline/Threats

BURN Detrimental burning regimes
CROP Cropping
DIS Disease
DAM Dam construction
DRAIN Drainage or reclamation
FOR Forestry
GRAZ Grazing
HERB Herbicides or fertilisers
IRRI Irrigation
MINE Mining or quarrying
NOXA Overgrazing by noxious animals
PATH Pathogens or pests
POLL Habitat pollution
RECR Recreation developments
RESTR Restricted occurrences over all or part of distribution
ROAD Road construction

URB	Urban or industrial expansion
VECT	Loss of pollination or dispersal vector
WEED	Competition from weeds

8.10 Maps

This gives the number, name and scale for each map in the following format. All 1:100,000 maps have been entered.

9130-1-N Broken Bay 1:25,000

8.11 NPWS areas

This large file already exists and gives the number and name of each reserve (including flora reserves) in the format:

N0006 Brisbane Water National Park

8.12 Classification level

SRT	Structure
SUP	Superalliance
ALL	Alliance
SUB	Suballiance
ASS	Association

8.13 Goodness of fit of classification

EXACT	Dominant species match exactly
GOOD	Exact match only if associated species considered
FAIR	One dominant species does not match
POOR	More than one dominant species does not match

8.14 Evidence for decline

EXT	Extinct
REDN	Major reduction in range and/or populations
SLREDN	Minor reduction in range and/or populations
INCR	Increased distribution
UNDER	Major alteration of understorey
DELAY	Delayed response
YOUNG	Younger age class over much of its distribution
OLD	Older age class over much of its distribution

THE FUTURE OF HARDWOOD PLANTATIONS IN NSW

A Discussion Paper

30.65

by Dr. John I. Cameron
Consulting Resource Economist
Australian Conservation Foundation

June, 1989

EXECUTIVE SUMMARY

A hardwood plantation strategy has been proposed by the conservation movement as a long term means for protecting conservation values in the native forest and providing a secure source of supply to industry. The strategy involves the declaration of the remaining unprotected high conservation value forests as national parks or reserves, the establishment of sufficient eucalypt plantations on already cleared land to provide the bulk needs of hardwood, the provision of timber for industry from lower conservation value forests while the plantations are maturing, and the transition to low-intensity selective logging to produce high-valued timber in the lower conservation value forests in the longer term.

The major uses of hardwood currently harvested from the native forest and the proposed sources under the conservation strategy are set out below.

	Pulplog	Lower Quality Sawlogs	High Quality Sawlogs
Use	Paper & paper products	House framing and general construction	Furniture veneer, mouldings, etc.
Consumption in Australia 1986/87	5,700,000m3	4,200,000m3 (estimated)	250-350,000m3 (estimated)
Current Source	Intensive logging in native forest + sawmill residues + thinnings	Selective logging in native forest + some logs from intensive logging	Selective logging in native forest
Interim under Conservation Strategy (next 20 - 30 years)	Intensive logging in low conservation value native forest + thinnings + sawmill residues	Selective logging in native forest + pine logs + some logs from intensive logging	Selective logging in native forest
Long term under Conservation Strategy	Eucalypt plantations + thinnings + sawmill residue	Pine logs + selective logging in native forest + Eucalypt plantations (if necessary)	Long rotation selective logging in native forest

The principal benefits of the strategy are as follows:

- It provides a way to reduce the conflict occurring between conservationists and industry over some forests.
- It provides an industry-dedicated supply of pulplogs and possibly sawlogs to industry that is more secure than native forest supply.
- Eucalypts grow much more rapidly on plantations than in the native forest.
- It provides a superior quality feed to pulpmills.
- There is great potential to improve plantation stock to reduce pulping costs further and increase pulplog and sawlog quality.
- In the long term there is the possibility of producing high-valued logs on mixed native species plantations.
- It conserves the few remaining unprotected high conservation value native forests.
- It expands the area of tree cover in the state.

Drawbacks of the strategy include:

- There is a high initial capital cost to implementing the strategy relative to continued sole dependence on native forests.
- Large scale fast-growing hardwood plantations do not have a proven track record in NSW and therefore involve an element of risk, although success in other states and overseas reduces the risk.
- It increases the competition for cleared high rainfall land.

A study by the Australian Conservation Foundation (ACF) found that the strategy was likely to yield a net economic benefit to the nation as well as being practicable on ecological grounds.

While the Federal Government and some state governments have endorsed elements of the strategy in principle and are planting several thousand hectares of eucalypt plantation each year, the NSW Forestry Commission (NSWFC) has prepared a critique of the strategy for NSW. The primary differences between the NSWFC and the ACF are:

Item	ACF	NSWFC	Comment
Area of Plantation Required	50,000-80,000 ha (mainly pulplog)	250,000 ha (sawlog/pulplog)	NSWFC misunderstands plantation strategy; assumes complete replacement of native forest logging

Item	ACF	NSWFC	Comment
Rotation period of plantations	20 yrs (pulplog)	60 yrs (high quality sawlogs)	NSWFC erroneously assumes produce high quality sawlogs on plantations
Availability of land	150,000-300,000 ha suitable	60,000 ha available	Differing rainfall cut-off. Difference between suitability and availability. Ignores contribution by sharefarming
Land purchase price ($/ha)	1,200	1,700	Differing rainfall cut-off
Cost of establishment ($/ha)	1,038	1,337	
Marketing ($/ha)	0	384	Marketing costs should not be included
Plantation growth rates (m3/ha/yr)	16-20	7-12	FC very conservative due to past unrepresentative experience
Log prices: pulpwood ($/m3): sawlog	15 27	10 11-35	ACF closer to actual ACF higher than FC on average
% of current broadleaf) State Forest converted) to National Park)	About 10%	100%	FC misunderstands plantation strategy

Thus, differences over the plantation strategy are a mixture of the Forestry Commission misunderstanding the strategy and genuine differences of opinion over technical parameters. A further fundamental difference is that the NSWFC maintains that there is no significant ecological effect of intensive forestry, whereas the conservation movement maintains that there is a significant loss of conservation values which can be avoided with the plantation strategy. A general point of difference between industry and conservationists concerns forecasts of sawn timber demand, which conservationists project at current low rates of increase, while industry envisages much more rapid growth than has historically been the case.

It is recommended that the NSW Government agree in principle to the plantation strategy and fund a number of technical studies aimed at providing a feasible timetable for hardwood plantations in the state. The Government should also convene a panel to suggest areas for implementing a plantation sharefarming scheme in NSW. Finally, it is recommended that the Government commission two economic studies, one to investigate the market for sawn timber in NSW to 2030, and the other to investigate log pricing mechanisms and the possibility of underpricing.

The hardwood plantation strategy, though not without its contentious aspects, has much to recommend it. It is understandable that the Forestry Commission, with poor results from some previous eucalypt plantations and facing capital budgeting constraints, would be unenthusiastic about hardwood plantations. However, the great increase in eucalypt plantings by industry and government in other states, modern techniques, and the willingness of the Federal Government to provide financial assistance indicate that these constraints can be overcome.

It is time for the NSW Government to pay serious attention to the issue of hardwood plantations.

'RAINFOREST REFORESTATION TECHNIQUES'

RAINFOREST REGENERATION, RESTORATION & MAINTENANCE

- Recommendations for the Far North Coast of NSW

30.66

PREPARED BY: ROBERT M. KOOYMAN
FOREST RANGER

FORESTRY COMMISSION OF NSW

FOR: RAINFOREST REMNANTS

' A RAINFOREST REHABILITATION WORKSHOP'

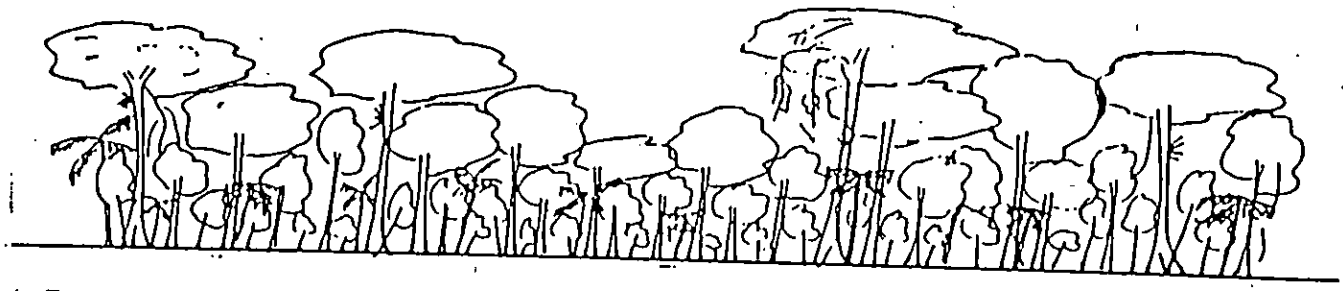
NPWS OF NSW

NOVEMBER, 1988

TABLE OF CONTENTS

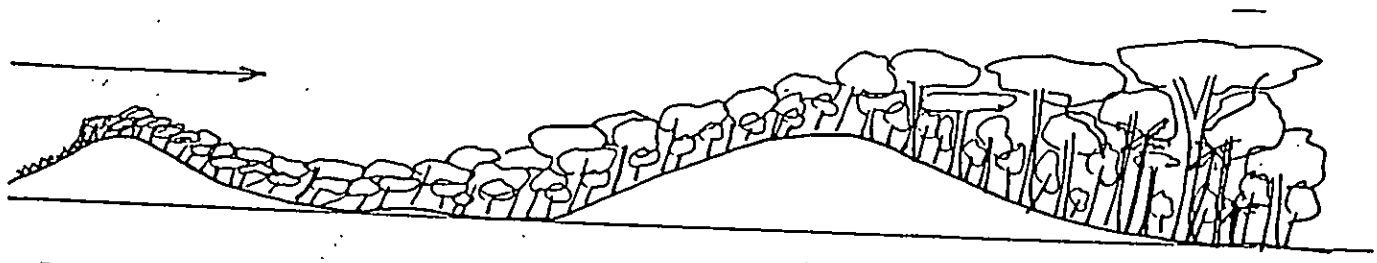
"RAINFOREST TYPE DEFINITIONS:"

SUB-TROPICAL RAINFOREST : STRF



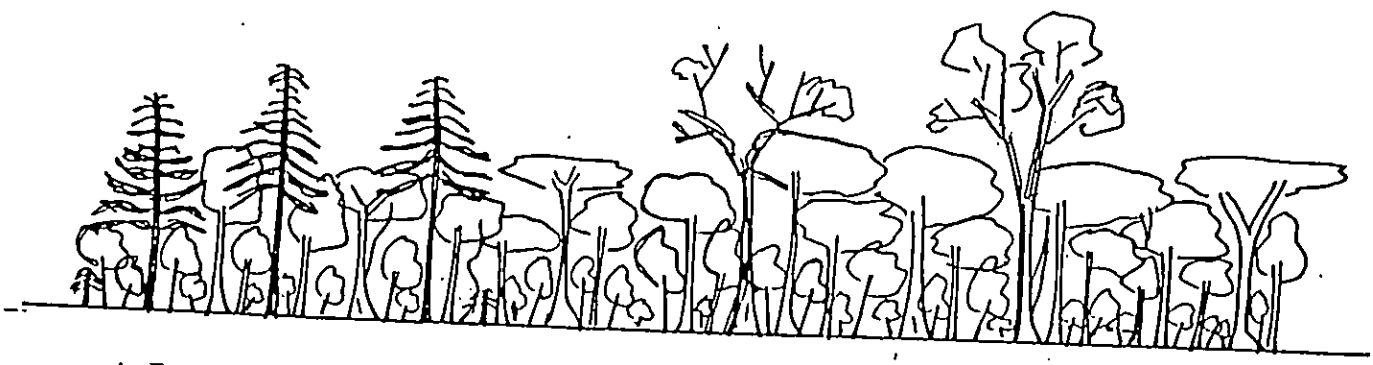
A Forest with a 'species rich' mixture of trees which form a variable, layered, evergreen closed canopy. Characteristic features are palms, strangling figs, epiphytes, vines, woody climbers and stem buttressing (in trees). STRF occurs on fertile soils such as alluvium or basalt with a seasonally well distributed high rainfall (over 1300mm).

LITTORAL RAINFOREST : LRF



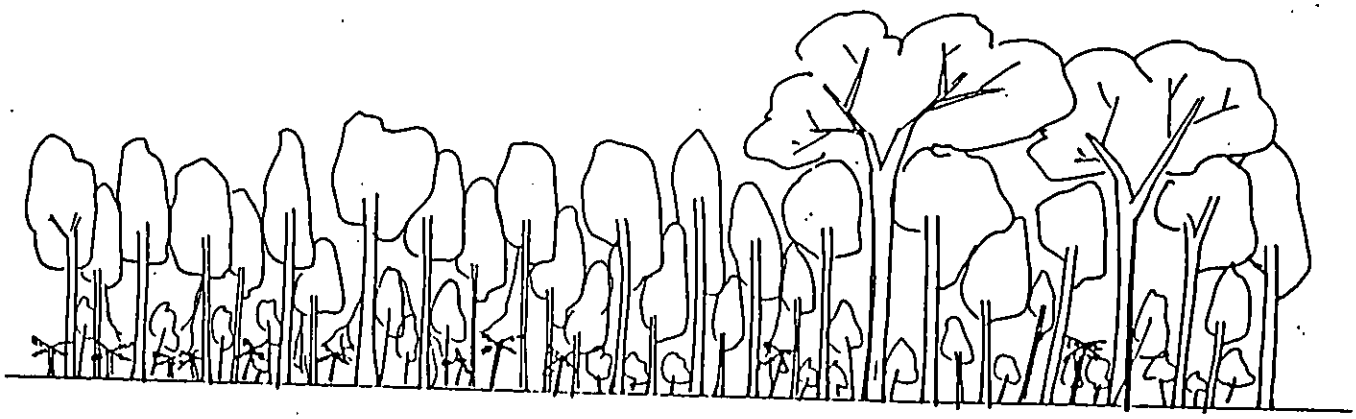
- Is a maritime variant of STRF adapted to high airborne salt levels (Refer A. Floyd) and in exposed situations the forests' form is affected by prevailing 'on-shore' winds. An increase in species diversity and structural complexity occurs with a corresponding increase in protection from the salt laden winds.
Species are recruited largely from STRF and DSTRF types (with some strictly coastal species).

DRY RAINFOREST : DSTRF



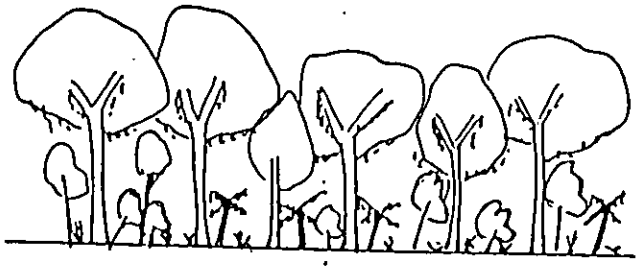
A Forest adapted to seasonally (spring) drier conditions (annual rainfall 600mm-1100mm) on fertile soils. Tall emergents (Hoop-Pine and some deciduous and semi-deciduous species), an irregular canopy and prominent woody vines are significant features. Strangler figs, buttresses and epiphytes become rare, as do palms and tree ferns.

WARM TEMPERATE RAINFOREST : WTRF



These Forests occur on the poorer soils derived from rhyolite (acid volcanics), and sedimentary rock at altitudes (generally) from 300-1200m with a well distributed rainfall exceeding 1300mm (per annum). Less diverse than STRF the even canopy is dominated by only a few species and features such as strangler-figs, woody vines and buttressing are rare. ± larger, emergent trees. (lophostemon confertus).

COOL TEMPERATE RAINFOREST : CTRF



- Growing under cooler conditions at higher altitudes (900-1500m) on fertile or moderately fertile soils with a well distributed rainfall (over 1750mm annually) these forests are often dominated by one tree species (nothofagus moorei) in the even canopy. Ground ferns and tree ferns are often common as are mossy epiphytes and lichens. Vines are thin and wiry and features such as palms and plank buttresses are generally absent.

INTRODUCTION:

Natural rainforest regeneration generally passes through a number of phases or stages of succession.

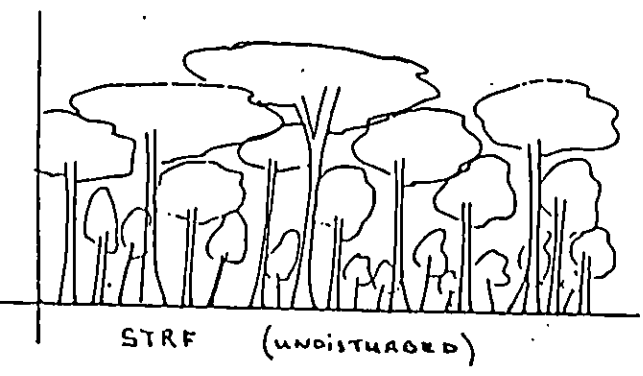
In the (normally) 'closed canopy', largely evergreen rainforest very little light (as low as 1% daylight) penetrates to the forest floor.

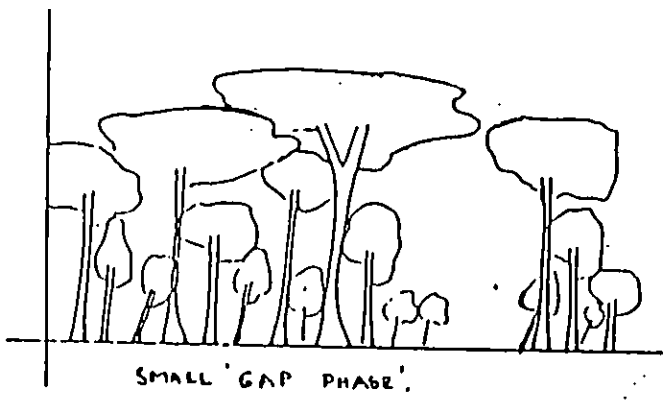
This situation can be dramatically altered when a large, old tree falls or areas of trees are randomly 'blown-out' by storms or cyclones. The sudden increase in light to the forest floor prompts an immediate response in seed germination, suppressed seedling and small tree growth.

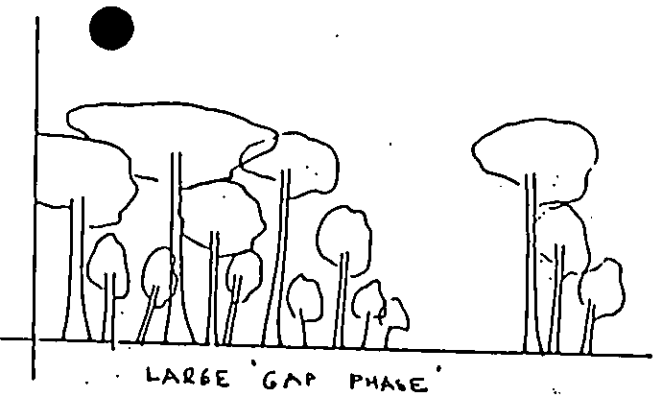
The size of the canopy opening or 'gap' regulates the amount of light and thereby the stage in succession – large gaps with sunlight penetrating to ground level can result in prolific growth of short lived weeds, woody shrubs and vines, followed by fast growing/light demanding rainforest trees, with slower growing/shade tolerant tree species moving in under the protection of the faster growing trees.

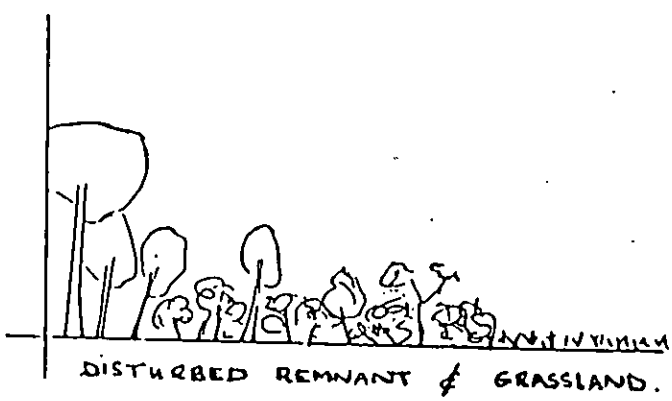
Succession in smaller gaps is often confined to a growth response, (due to the increase of light), by existing mid-storey trees and suppressed seedling trees in the under storey.

'GAP PHASES'









'STAGES OF SUCCESSION'

A cleared STRF site, without weed competition, would (according to Floyd and others) be colonised initially by:-

STAGE I - species such as the wild raspberry (Rubus rosifolius), scrub nettle (Urtica incisa), prickly nightshade (Solanum prinophyllum). These plants establish quickly and rapidly produce prolific quantities of seed. The seeds have a long viability and are effectively dispersed. These species are intolerant of shading and soon intermix with and give way to -

STAGE II - species such as the bleeding heart (Omalanthus populifolius), soft corkwood (Duboisia myoporoides), native peach (Trema aspera) and elephant's ear (Macaranga tanarius). These are generally short lived shrubs and small trees which quickly produce large quantities of seed with long viability. They do not regenerate in their own shade and are thus replaced by species of -

STAGE III - the Nomads

These are fast growing/light demanding trees with many (but not all) having seeds of long viability and effective wind and animal dispersal mechanisms.

Examples are the pencil cedar (Polyscias murrayi), red ash (Alphitonia excelsa), red kamala (Mallotus phillipenensis), brown kurrajong (Commersonia bartramia), bumpy-ash (Flindersia schottiana) and stinging tree (Dendrocnide excelsa).

These species do not persist under shaded conditions and ultimately are replaced by the shade tolerant trees established in the understorey and belonging to -

STAGE IV - Nature/Climax Species

These final stage trees are generally slow growing, long lived and shade tolerant. They can seed irregularly and the seed is often of short viability.

Examples include - white booyong (Argyrodendron trifoliolatum), black booyong (Argyrodendron actinophyllum), rosewood (Dysoxylum fraserianum), teak (Flindersia australis), yellow carabeen (Sloanea woollsii), and various species of genera such as Cryptocarya, Endiandra, Syzygium etc.

(These four 'nominated' stages are part of a dynamic succession and naturally 'overlap'. Each regeneration 'site' provides a different set of environmental factors which will influence the subsequent intermixing of some or all of the various stages and species in the succession and consequently the 'make-up' of the mature stand, depending, of course, on seed availability).

Webb et. al (1972) concluded that following the pioneer stage culminating in a temporary canopy, rainforest succession is not unidirectional and is probabilistic rather than determinate.

That is, the number of seedlings of a particular species that germinate depends on the number of seeds produced per hectare, the species' mode of dispersal, the time of year it fruits, the period of time over which the seed remains viable, and the time of year during which the canopy 'break' was created.

Rainforest regeneration projects on the far north coast vary from bare land regeneration to enrichment planting and 'accelerating' natural succession and restoration on disturbed or weed infested rainforest sites.

STRF is the main rainforest type being regenerated and subsequently it is highlighted in this paper. (Reference is made to the 'other' types in later notes). - excluding CTRF.

STRF is the most complex (structurally and floristically) rainforest type in NSW with approx.300 tree and shrub species, over 100 vines and many other vascular plants eg. ferns, epiphytes etc.

Hopkins et. al. (1976) points out that any hectare of subtropical rainforest in the Border Ranges could be expected to contain 12 to 20 thousand vascular plants taller than 0.5 metres. More than 100 species would be represented in such a sample; 300 or so would be canopy trees of about 60 species.

The distribution of each species varies according to its requirements of temperature, rainfall, soil nutrients and many other factors. Any one particular area or site will only possess a subset of the total number of species available.

The wide variety of sites and variations in soils, rainfall, altitude, coastal influence, aspect and topography together with the diversity of species and their individual responses to the abovementioned factors can, at first, make the prospect of successfully regenerating rainforest and choosing the correct species difficult, to say the least.

However, if a few basic principles are followed and the techniques outlined later in the paper are used effectively (with adequate site preparation and maintenance) the task is made quite simple.

Advice should be sought regarding site suitability, species selection and appropriate techniques.

Information is avilable from some local officers of the Forestry Commission of NSW, Soil Conservation Service of NSW, NPWS of NSW, Local Reforestation Organisations etc.

Existing vegetation (on site) or adjacent remnant forest patches and individual trees can indicate site and species suitability.

REGENERATION TECHNIQUES

Fortunately for the rainforest 'grower' the early stages of succession (characterised by prolific growth of weeds, woody shrubs and vines), can generally be by-passed or greatly accelerated.

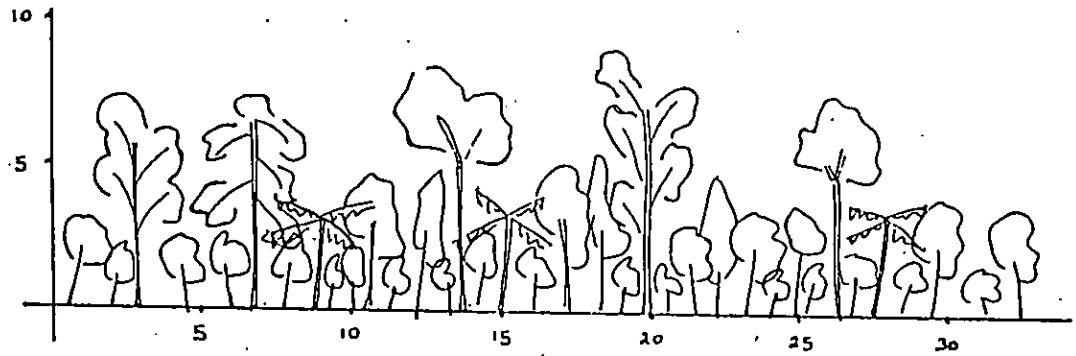
On cleared land this 'accelerated' regeneration means planting a combination of predominantly fast growing/light demanding species with many of the slower growing/shade tolerant species of the mature rainforest.

The greatest mix of species possible should be used.

- The following diagrams show 'profiles' of 3-4 year old STRF plantings on basalt derived soils. (approximate sizes)

Four methods of rainforest regeneration are shown here:-

A



STANDARD PLANTOUT WITH SHRUBS AND PALMS. (3000+ TREES PER. HECTARE)

A. A combination of fast growing/light demanding species such as:- Flindersia schottiana, Elaeocarpus grandis, Grevillea robusta, Alphitonia excelsa, Polyscias murrayi, Macaranga tanarius, Commersonia bartramia, Diploglottis australis, is mixed with slower growing/shade tolerant species such as:-

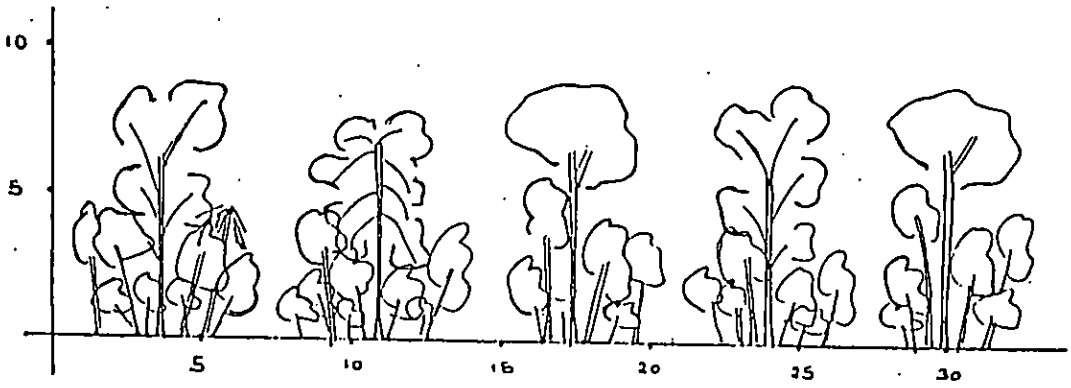
Dysoxylum muelleri, Dysoxylum fraseranum, Argyrodendron trifoliolatum,
(Red Bean) (Rosewood) (White Booyong)

Argyrodendron actinophyllum, Cryptocarya spp., Endiandra spp.,
(Black Booyong) (Laurels)

Acmena spp., Syzygium spp., etc. etc.
(Lilly Pilly) (Cherry etc.)

Interplanting can then be carried out using palms and rainforest shrubs.

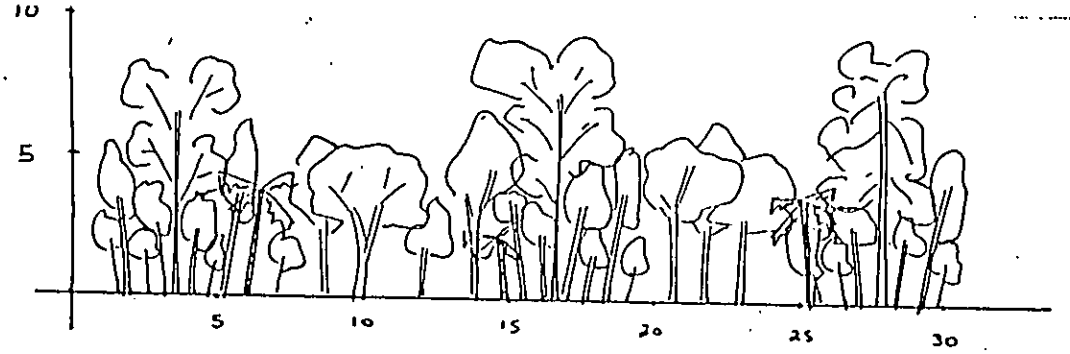
B



'CLUMP' PLANTING (4000+ TREES PER. HECTARE)

B. CLUMP PLANTING - uses the same combination of light demanding/fast growers with a quite dense planting of the more shade tolerant/slower growers (with shrubs, and palms to form the 'clump').

C

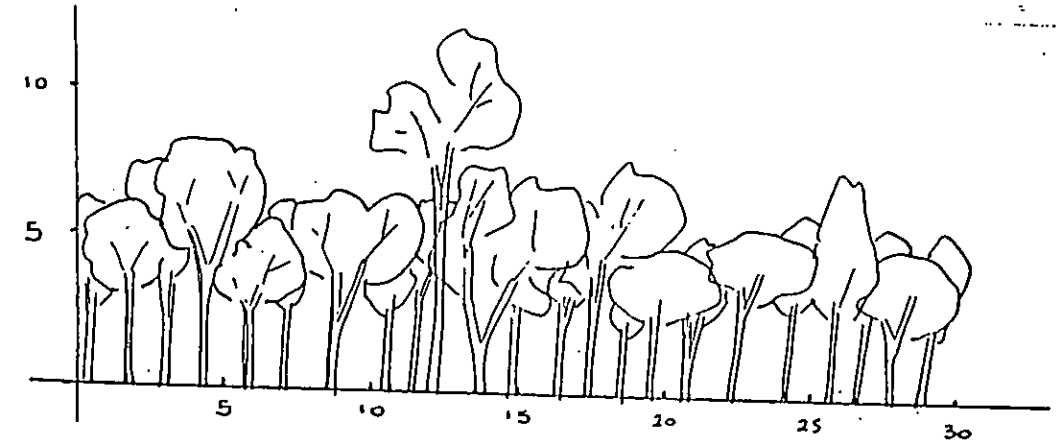


INTERSPERSED 'CLUMP' PLANTING. (combination 'clump' and early succession plantings).
[4-5,000 TREES PER HECTARE.]

C. Clumps can be interspersed with 'gap filling' plantings or planted quite close together. (See diagram Page 8).

This method seems to offer the advantages of rapid canopy closure around the central clump stem(s), better site domination and quicker re-establishment of the rainforest environment, micro-climate, structure and pattern (mosaic) of species distribution.

D



EARLY SUCCESSION PLANTING (4,500 per. hectare).

D. Species such as elephant's ear (Macaranga tanarius), brown kurrajong (Commersonia bartramia), pencil cedar (Polyscias murrayi), red ash (Alphitonia excelsa), guioa (Guioa semiglauca), bumpy-ash (Flindersia schottiana) and blue fig (Elaeocarpus grandis) are planted at approximately 4,500 trees per hectare (1½m. spacings).

These trees are all fast growing/light demanders which will quickly establish a canopy.

Once canopy closure (site domination) is achieved natural forces take over. The forest begins to guide its own destiny.

Factors such as microclimate, re-distribution of nutrients and the particular fauna species utilizing the area all change and influence the composition and structure of the regenerating forest.

Individual rainforest plantings are never reproductively independent of nearby forests or remnant seed trees via their wind, and animal, seed dispersal mechanisms.

- Animals are an integral part of the rainforest ecosystem in that they pollinate, disperse seeds and eat seeds and foliage. If not for frugivorous birds and flying foxes carrying seeds, only seedlings and regeneration from reproductively mature trees nearby would occur in any patch of regeneration.

SAMPLE :

* STRF PLANTING

GAP | CLUMP PLANTING | GAP | CLUMP PLANTING. | GAP

GAP SPECIES

Commersonia bartramia
(Broun kurrajong)

Macaranga tanarius
(Macaranga)

Alphitonia excelsa
(Red-ash)

Guioa semiglauca
(Guioa)

Pittosporum undulatum
(sweet pittosporum)

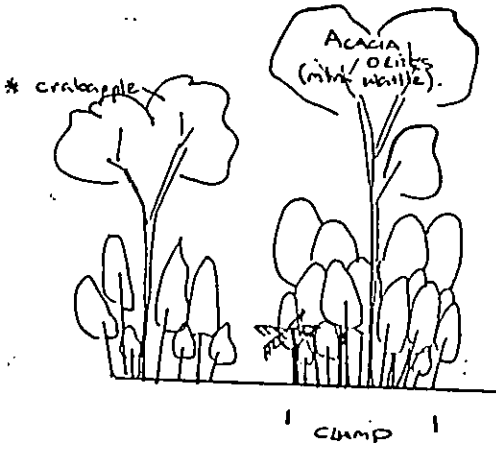
Arcopterix stipitata
(steelwood) etc.

A. Elaeocarpus grandis
(Blue Fig.)
- with species such as
Dysoxylum fraserianum
(Rosewood)
Syzygium crebrinerve
(Purple cherry)
Endiandra pubens
(Hairy walnut)
Antharocarpa nitidula
(Bog-onion)
Neolitsea dealbata
(White bolly-gum)
Archontophoenix cunninghamiana
(Bangalow palm)
etc. etc. etc.

A. Flindersia schottiana
(Bumpy-ash)
- With species such as :
Harpullia pendula
(tulipwood)
Cryptocarya obovata
(white walnut)
Geissois benthami
(red carabeen)
Argyrodendron trifoliolatum
(white booyong)
Acmena smithii
(lilly pilly). etc. etc. etc.

* 20 to 50 trees per. clump.
include shrubs and palms.

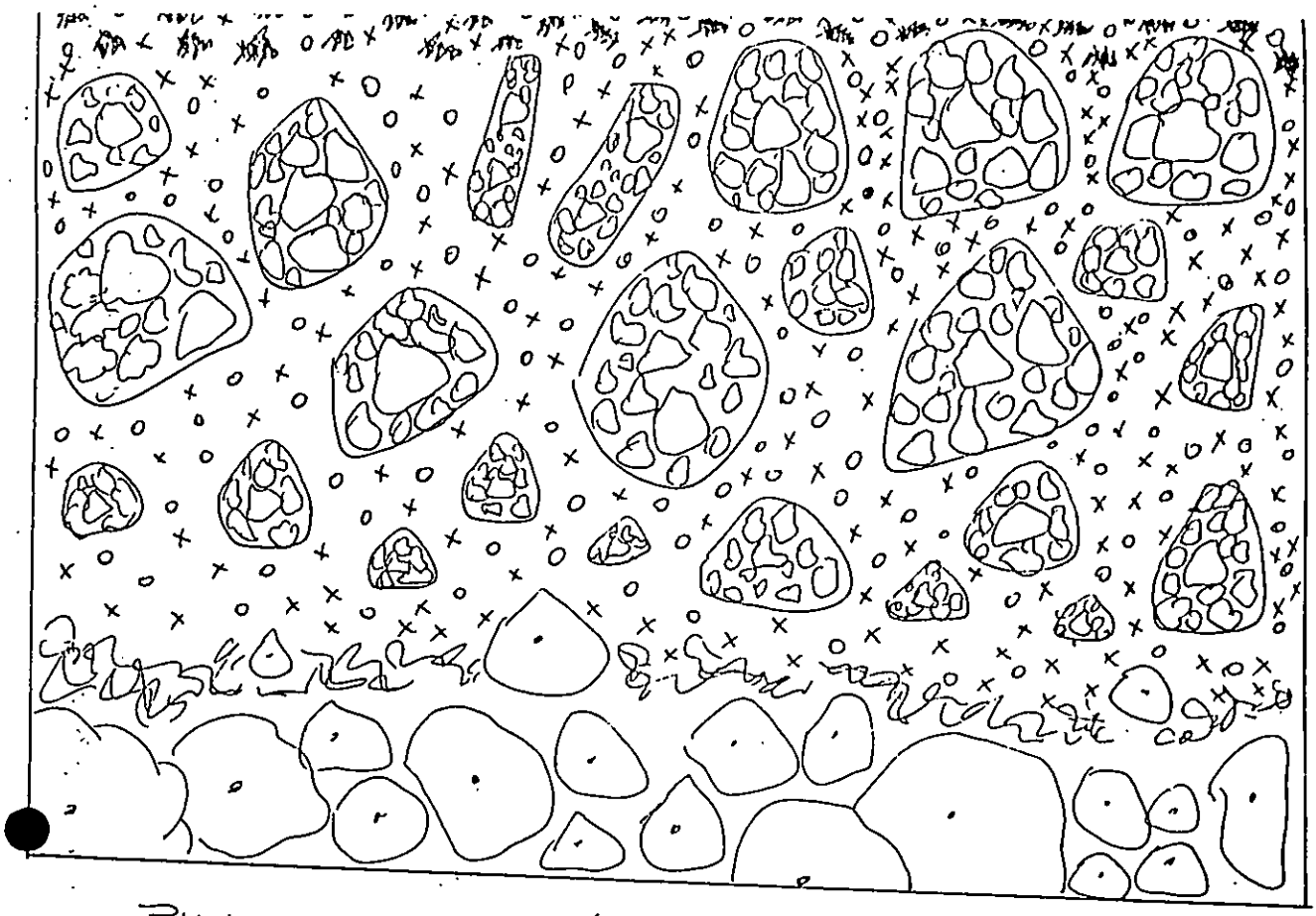
● * WTRF PLANTING



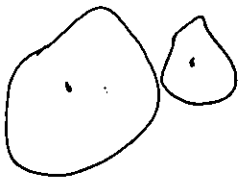
— suitable species include —

Ceratopetalum apetalum
(coachwood)
Schizomeria ovata
* (crabapple)
Austrobuxus swainii
(Pink cherry)
Daphnandra micrantha
(Socketwood)
Elaeocarpus kirtonii
(white quondong)
Cinnamomum oliveri
(yellow sassafras).

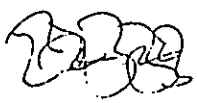
Acradenia euodoformis
(nthn. acradenia)
Cyathea leichhardtiana
(prickly tree fern)
Helicia ferruginea
(rusty helicia)
Syncarpia glandulosum
(scentless rosewood)
Caldcluvia paniculosa
(corkwood)
Callicoma serratifolia
(callicoma).
etc. etc.



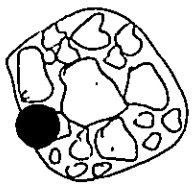
PLANT-OUT DESIGN (ADJACENT TO EXISTING REMNANT)
[AERIAL VIEW].



REMNANT RAINFOREST (EXISTING TREES)



RETAINED WEED EDGE.



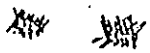
CLUMP PLANTINGS.

X X

O O

GAP PLANTINGS

(COMBINATION PLANTING OF PREDOMINANTLY EARLY SUCCESSION TREES WITH SOME OF THE LATER SUCCESSION TREES MIXED IN.)



WINDBREAK PLANTINGS

(COMBINATION RAINFOREST SPECIES

ADD EUCALYPTUS SPP., LOPHOSTEMON CONFERTUS, etc

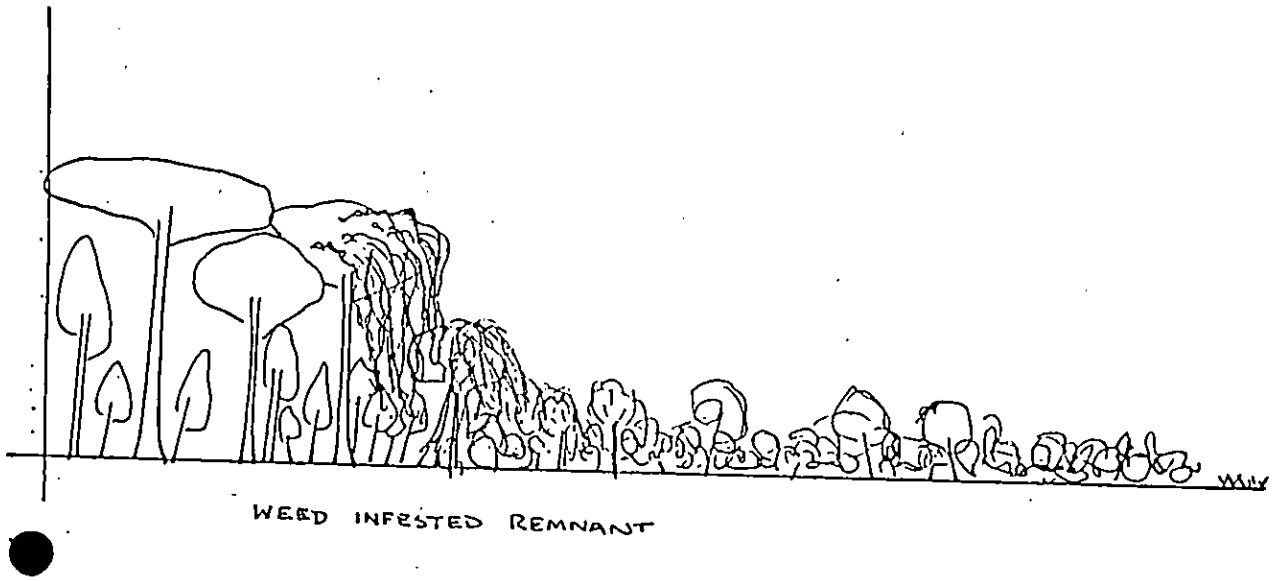
- ON EXPOSED SITES.

* EDGE RESTORATION AND EXPANSION OF RAINFOREST REMNANTS

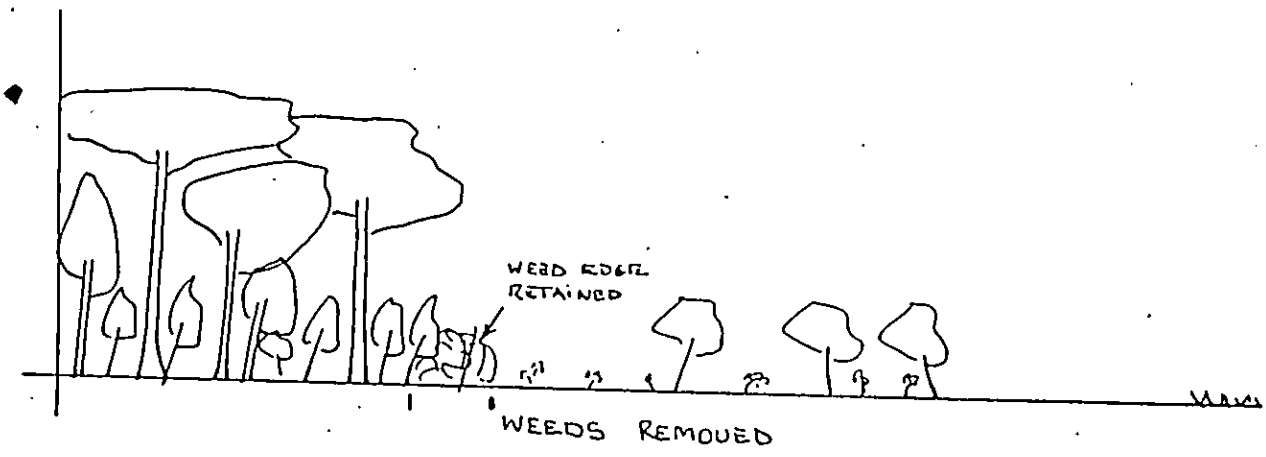
The outer edges of rainforest 'remnants' are often weed infested with just a few relict or regenerating rainforest trees existing with the exotic species.

Diagram B illustrates the need to retain a protective edge of weed species to maintain, as much as possible, the micro climatic features of the remnant. The aim being to exclude strong, cold or hot winds and angled sunlight, all of which can/will effect the remnant significantly through micro-climate alteration and/or further weed infestation.

The following diagram D illustrates the technique utilized to stimulate natural regeneration from the rainforest edge using the combination of plantings and the principles of 'gap phase' succession to expand the remnant.

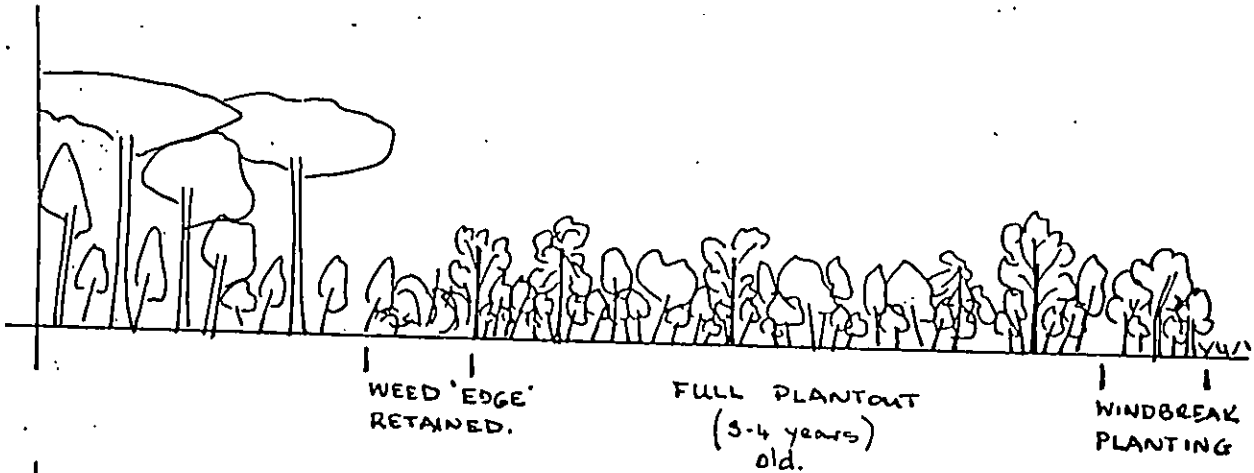


A.

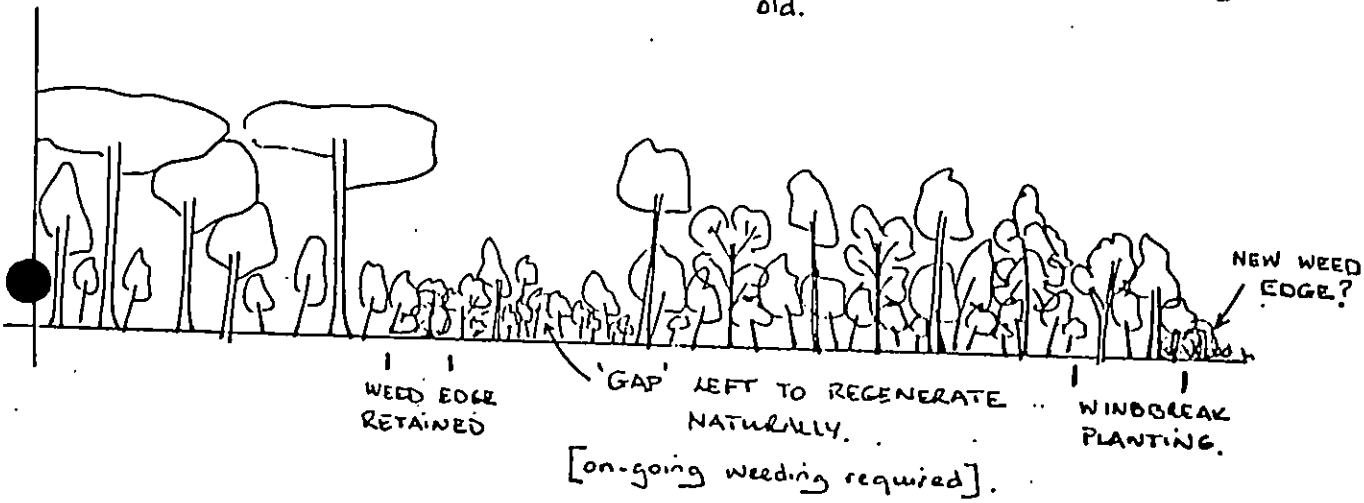


B.

C.



D.



SITES WITH EXISTING REGENERATION - or weed infested regeneration may require a series of operations prior and subsequent to planting.

Operations could include:-

a. Removal of undesirable trees eg. camphor laurel (Cinnamonum camphora), coral trees (Erythrina spp.) by tractor or poisoning.

b. Removal of woody weeds eg. lantana (Lantana camara), large leaved privet (Liguostrum incidium), small leaved privet (Liguostrum sinense), tobacco bush (Solanum mauritianum), groundsel bush (Baccharis halamifolia) etc. by tractor, grubbing and/or poisoning.

c. Vine cutting and/or grubbing. Problem vines include the introduced jalap vine (Anredera cordifolia), balloon vine (Cardiospermum grandiflorum) and Cat's claw creeper (Macfadyena unguis-cati).

Native vines which can also be a problem are

Cissus antarctica and Cissus hypoglauca (the native grapes), Passiflora spp. etc.

d. Removal of dense ground cover eg. crofton weed (Ageratina adenophora), mistflower (Ageratina riparia), and various grasses, by hand grubbing, poisoning, or tractor clearing.

The technique that most successfully facilitates the regeneration and restoration of weed infested remnants involves the removal of all weed species from all levels of the rainforest remnant - from ground level and below (root competition) to the canopy.

Restoration of the canopy, (the number one priority) together with the elimination of all weed competition will rapidly restore the dynamics and vigour of the treated remnant.

Lack of vigour in the remnant is compounded by further weed infestation which competes directly with existing growth and prevents germination or survival of native seedlings.

Climatic events (such as cyclones, floods, storms, etc.) may physically damage the remnant. Grazing and wandering stock may damage/destroy existing plants and germinating seed stock, compact the soil, damage surface roots and introduce weeds. A lack of wildlife may compromise (at least in part) pollination and seed dispersal.

These, and other factors, may combine (in various ways) to degrade the rainforest remnant by impairing some of the ecological processes which sustain species diversity and stand vigour.

- Hopkins (1981) has described how in Northern NSW in what was once the 'BIG SCRUB', vast areas of lowland rainforests were cleared in the early part of this century. The forest regeneration on many of the abandoned areas and roadsides now appears to be arrested at an early secondary stage. In some cases, this can be attributed to changed site conditions brought about by past land use. In others, the redevelopment of the forest has been delayed apparently by a lack of mature phase species.

The techniques employed in the restoration and regeneration of degraded rainforest stands should aim at retaining all the existing desirable growth (trees and understorey) in an undamaged condition.

In some cases the 'so called' weed species - tobacco bush, bleeding heart, dogwood etc. may be present. These species are part of the natural regeneration processes and should be retained. Some thinning out and form pruning may be necessary to avoid them dominating other planted or regenerating tree species.

A certain amount of controversy surrounds the current technique of 'Bush Regeneration' with its dependence on the application of herbicides (by tree injection, frilling or cut and swab techniques) to facilitate the removal of 'woody' weeds. Although some people may wish to physically dig out such weeds rather than use herbicides, this may not be feasible in dense weed-infested areas with the human resources available and the unacceptable damage which may eventuate.

The Nutrient Cycle of the rainforest is often referred to as a 'closed cycle'. This term refers to the fact that apart from some 'take up' of nutrients from soil parent material, the available plant nutrients are mainly locked up in the living vegetation and the humus layer, between which a very nearly closed cycle is set up.

The resources of the parent rock are only necessary in order to make good the small losses due to drainage. (Heavy average annual rainfalls).

The majority of the roots, including nearly all the 'feeding' roots, are in the upper layers of the soil to facilitate the rapid 'take up' of those available nutrients, (released by the decomposition of the humus layer).

These surface feeding roots are particularly vulnerable to mechanical site preparation or excessive disturbance created by 'grubbing' weed roots etc.

Careful and selective use of herbicides can greatly accelerate the processes of natural regeneration whilst keeping damage to an absolute minimum.

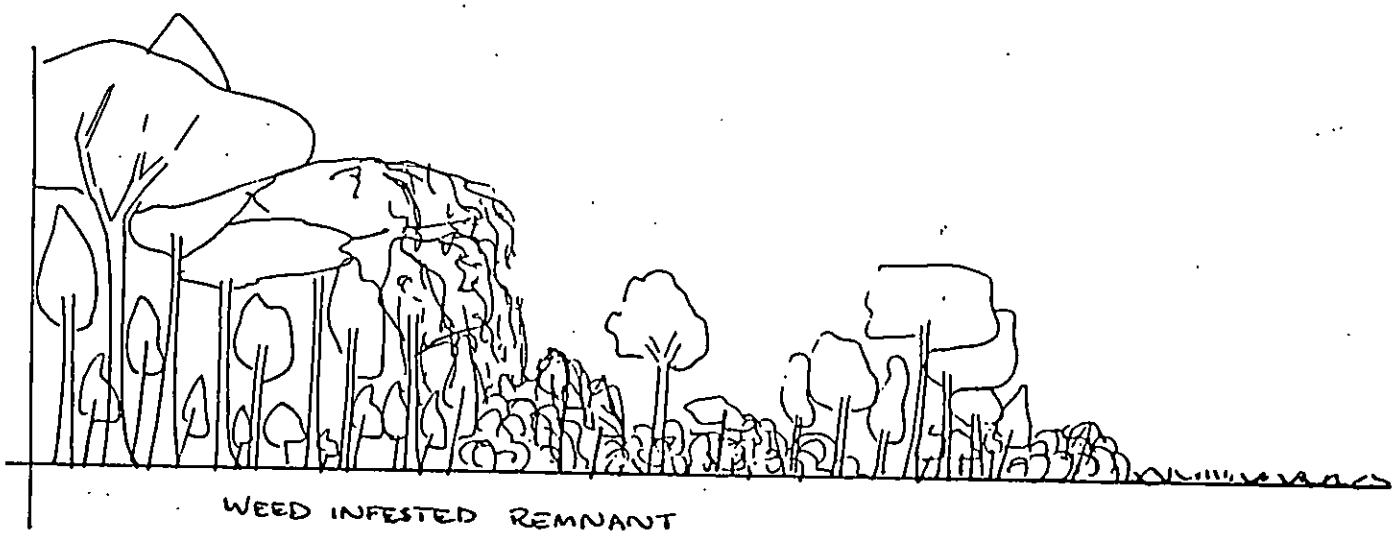
It often comes down to a choice of using these chemicals to promote natural regeneration (in a remnant rainforest stand), or doing nothing because of labour or cost restraints.

This is not an argument of 'advocacy', rather it is a statement of pragmatic reality.

Ultimately it comes down to individual values and choice.

* Always use the minimum amount of chemical necessary to complete the job and select the chemical which is the least residual and most effective.

Information is available from pamphlets distributed by the Ag. Dept. & Forestry Commission.

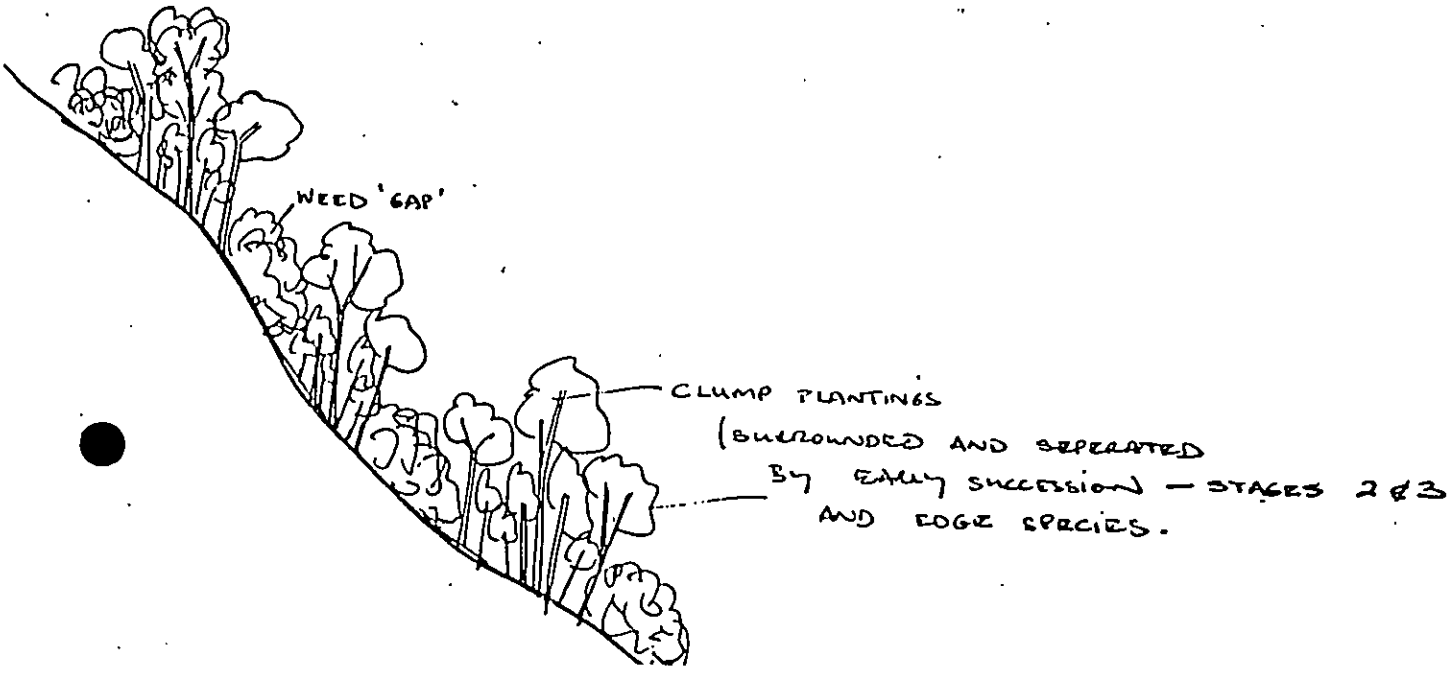


REMNANT MANAGEMENT

At this point, with all the weed species removed one can either allow the natural forces (with on-going weeding) to take over or 'enrichment' planting could be used to 'accelerate' the natural processes: SEE EARLIER NOTES.

(Wherever possible 'local' seed(ling) stock should be used).

STEEP LAND REGENERATION TECHNIQUES



DIAGRAM

* Interspersed 'Clump" Planting on steep slopes, (using line clearing on the contours).

* In areas where machinery is restricted or it is not environmentally 'sound' to totally clear the site or where economics dictate minimal use of machinery (or maximisation of available machine time) the technique of grid or contour line clearing, and replanting, using the combination of 'clumps' and early succession species will allow rapid regeneration of the planted lines with subsequent 'shading' of the weed gaps promoting natural regeneration.
  - On-going maintenance will be necessary.

  (This is offered as an alternative to a complete clear and plant technique).

  On very steep slopes machinery (Crawler tractor) is forced to work up and down the slope. Cleared lines should be carefully worked and 'mitre' drained to prevent erosion.

* CONTACT SOIL CONSERVATION SERVICE OF N.S.W FOR ADVICE.

'PADDOCK' TREE MANAGEMENT

A feature of the now cleared Big Scrub area is the occurrence of isolated, individual 'paddock' trees. (Ficus spp., Flindersia spp., Dysoxylum spp., etc.)

These individual trees, together with the small remnant patches and 'roadside' regeneration form an important landscape and nature conservation resource.

They act as refugia areas for rare and endangered species.

They are an invaluable resource to the wildlife of the area and provide 'stepping stones' across an ocean of grass. The importance of even individual trees should not be underestimated.

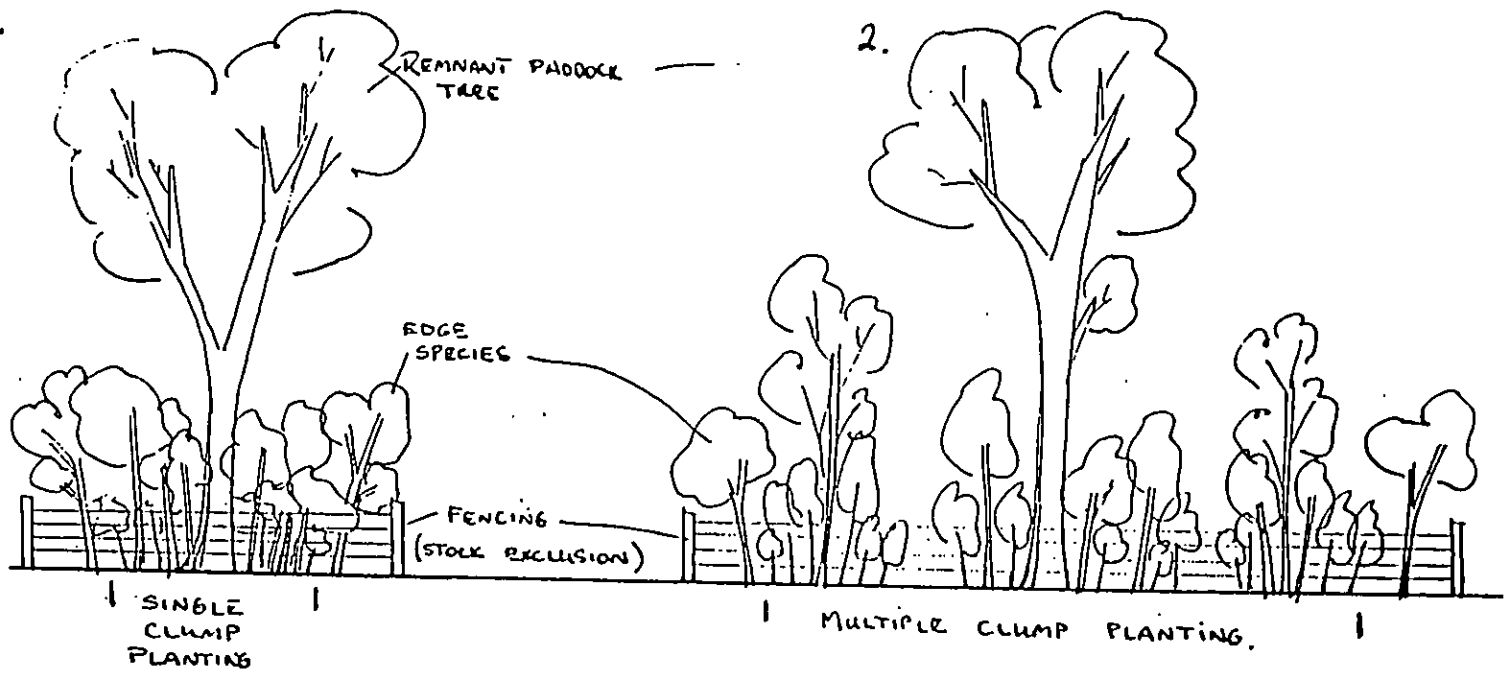
Care should be taken to protect these trees (and small remnants) from the ravages of weed infestation (camphor laurel etc.), stock damage, fire etc.

The following diagrams illustrate techniques for 'paddock' tree management.

The natural regeneration processes and the important role of 'wildlife' is demonstrated in the following 'field trial'.

A single, large fig tree (Ficus macrophylla) in a paddock situation was chosen. Stock were excluded from the site. All weed species and the few rainforest plants present were removed. Regeneration was monitored over a three year period with all species recorded.

22 Rainforest trees and shrubs
6 Rainforest vines
8 Weed species (regularly removed)



PLANTING GUIDELINES

The most successful plantings and recorded growth rates occur (as might be expected) on the better basalt and alluvially derived soils.

STRF Plantings on poorer soils generally show much slower establishment and growth rates, with a tendency to leaf discoloration, due to nutrient deficiency.

It is often said that rainforest indicates a fertile soil, however, this is not strictly true as rainforest occurs on the impoverished dune sands of Brunswick Heads NR, Illuka NR, Cooloola, Fraser Island and various coastal pockets.

The occurrence of rainforest on these dune sands (equal to the poorest soils in the world) is accomplished by the efficient recycling of nutrients in leaf litter and the storage of small amounts of nutrient carried in by wind and rain, in the new growth.

Thus, most of the nutrients are stored in the trees and not in the soil.

As little experimental work has been carried out on these poorer soil types information is limited, but some general observations can be provided. (See Littoral rainforest notes and coastal sites notes for suitable 'dune sand' species).

On other poor sites - a smaller range of rainforest species will be found suitable and a case may exist on these sites to use a mixed planting of eg. brush-box, Sydney blue-gum, tallowood etc. interspersed with rainforest trees, (shrubs and palms).

On the far north coast warm temperate rainforest generally grows on the poorer/rhyolite and sedimentary derived soils at higher altitudes. The principal species of coachwood (Ceratopetalum apetalum) and crabapple (Schizomeria ovata) often occur in association with brush-box (Lophostemon confertus). Regeneration of this rainforest type (on these poorer soils) would be slow. Brush-box planted as an overstorey with interplantings of -

Callicoma serratifolia, Doryphora sassafras, Schizomeria ovata
(Callicoma) (Sassafras) (crabapple)

Orites excelsa, Stenocarpus salignus, Synoum glandulosum,
(prickly ash) (beefwood) (scentless rosewood)

Ceratopetalum apetalum, Caldcluvia paniculosa, Cryptocarya spp.
(coachwood) (soft corkwood) (laurels)

Endiandra spp., Quintinia spp. etc.
(laurels) (possumwood)

may provide reasonable growth rates and subsquent canopy closure.

* See 'clump' planting technique diagram.

Drier Rainforest Sites

require careful species selection and some extra work at planting eg. use of water retentive compounds or follow up watering. Mulching is essential on these sites.

* See - 'Clump' planting technique (Advantages - rapid canopy closure, slows moisture loss etc.)

- Planting techniques as for STRF.

..... Suitable tree species include:- Araucaria Cunninghamii (hoop pine), Owenia Cepiodora (onion cedar), Hodkinsonia Ovatiflora (golden ash), Dysoxylum Meulleri (red bean), Flindersia australis (teak), Brachychiton discolor (lace bark), Podocarpus elatus (plum pine), Rhodasphaera rhodanthema (deep yellow-wood), Scolopia braunii (flintwood), etc.

POORLY DRAINED SITES

Swampy sites are often dominated by Melaleuca spp. (paper bark) swamp-forest and palms. (Livistona australis- cabbage palm, and Archontophoenix cunninghamiana (bangalow palm). Semi-swampy (or poorly drained) sites may have palm/rainforest with bangalow and/or cabbage palms and rainforest trees such as:-

Syzygium francisii (giant water gum) Acmena smithii (lilly pilly), Sloanea woolsii (yellow carabeen), Sloanea australis (maiden's blush) etc.

The elegant tree Elaeocarpus grandis - (blue fig or silver quondong) occurs (with rainforest species mentioned above) along many north coast creeks.

EXPOSED SITES may require the planting of windbreaks to restrict the effects of destructive or dessicating winds. Protection from wind is essential to the survival of seedling rainforest trees. Suitable edge species could include:-

sweet pittosporum (Pittosporum undulatum), scrub turpentine (Rhodamnia rubescens), guioa (Guioa semiglauca), black wattle (Acacia melanoxylon), hollywood (Pittosporum rhombifolium), steelwood (Sarscopterix stipitata), bennet's-ash (Flindersia bennettiana), etc.

FROST PRONE SITES may require the planting of a nurse crop of fast growing/short lived species such as brown kurrajong, macaranga etc. to protect the slower growing/frost sensitive species of the final planting. Thinning and limb pruning of the fast growers will be necessary to avoid suppressing the growth of desirable stems.

COASTAL SITES

Successful regeneration of rainforest on Coastal Sites under the influence of prevailing 'on-shore' salt laden winds requires the 'physical' protection of the frontal dunes and planting of species of the seaward edge eg. Cupaniopsis anacardioides and Banksia integrifolia (dominants) interspersed with Alectryon coriaceus, Mischocarpus pyriformis, Cassine australe etc.
Coastal tuckeroo, banksia, with beach alectryon, pear fruit, red oliveberry etc.

Away from the 'seaward' edge species such as .....
Acmena hemilampra, Syzygium leuhmannii, Euroschinus falcata, Mischocarpus pyriformis, Diospyros pentamera, Cassine australe, Halfordia kendack dominate with a shrub layer including .....

Pittosporum revolutum, Eupomatia laurina, Breynia oblongifolia etc.

Broad leaved lilly-pilly, riberry, ribbonwood, pear fruit, myrtle ebony, red olive-berry, saffron-heart, with the shrubs - hairy pittosporum, large bolwarra, breynia, etc.

Cattle and Grazing Stock should be excluded from the site. Stock should be permanently excluded from rainforest plantings, restoration areas and remnants.

Fire should be permanently excluded from all rainforest plantings. Rainforest trees are often thin barked and very vulnerable to damage and death from fire and the subsequent invasion of damaged parts of the trees by fungi and insects.

PLANTING should be carried out from late Spring to late Summer to capitalize on usually reliable rain in spring storms and the summer/autumn wet.

Grassed areas require preparatory removal of the grass sward by chemical (Roundup) 'Glyphosate' or mechanical means.

Spot spraying of 2m. diameter circles and 'clump' areas at least two weeks prior to planting seems most effective. Follow up spraying will be necessary for around three to five years with two or three sprayings the first year and gradually less until the trees dominate the competing grass.

Spraying can be greatly reduced or eliminated by the use of an initial 'newspaper' and 'bagasse' mulch.

Mulching is generally recommended. It helps retain soil moisture levels, keeps soil temp. more even, protects the surface feeding roots of the establishing rainforest trees, and suppressses weed invasion .

A variety of materials are suitable as mulch - slashed grass, spoiled hay, straw, soya bean straw, bagasse (sugar cane waste). Mulch a circular area surrounding the seedling (approx. 1½ metre diam.) making sure the mulch is not in contact or packed around the seedling stem. (This prevents rot and fungal attack in wet conditions).

SEEDLINGS are generally provided as 'container' plants in plastic pots or bags. The seedlings are usually around 20-40cm. high and should be sun hardened.

A small hole is dug, using spade and bar, deep enough to contain the full root depth of the seedling tree plus 5cm to 10cm.

A mud slurry is generally prepared in the hole and the tree planted directly into this.

FERTILIZING improves the vigour of the seedlings and accelerates site domination (via increased growth) reducing maintenance.

Fertilizers will only be required during establishment (approx. 5 years).

Do not put fertilizer into planting holes, or in 'touch' with tree stem.

Recommend:- Q7, Dynamic Lifter (chicken manure), Maxi-Crop foliar spray (sea weed), and slow release pellets.

ACKNOWLEDGEMENTS –:

REFERENCES –:

1. Trees & Shrubs in Rainforests of NSW and S.E. Qld.
   J. Williams, G. Harden, W. McDonald.

2. NSW Rainforest Trees by A.G. Floyd (and other publications).

3. Moreton Region Vegetation Map Series – Dowling & McDonald
   Qld. DPI.

4. The Tropical Rainforest – Richards.

5. L.J. Webb (et al) various papers.
   (ideas, information)

6. Hopkins (et al) various papers.

7. G. Baur (Various papers).

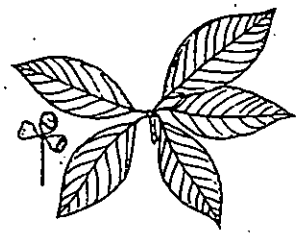
My thanks to–: a. Sandy Gilmore, David Milledge, John Hunter,
Bruce Chick, Keith King, Russ Maslen for ideas and information.

b. Madeleine – for her assistance.

c. Typing – by Mullumbimby 'Confidential Secretarial Services'.

* "The Vegetation and Flora of Brunswick Heads, NSW"
J.B. Williams & G.J. Harden, Dept. Botany, U.N.E. ISBN 0 85834 26S 5.
(For Coastal recommendations).

Steedy



BRUSH BOX
Lophostemon confertus

N.E.F.A.
NORTH EAST FOREST ALLIANCE

SYDNEY: NSW Environment Centre, 39 George St, The Rocks. 2000. Ph. 02 2474 206, Fx 02 2475 945
LISMORE: The Big Scrub Environment Centre Inc, 88A Keen St, Lismore. 2480. Ph 066 213 278, Fx 066 219 420

SCHEDULE OF RESEARCH AND REVIEW REQUIRED FOR 'OLD GROWTH FORESTS'

1. Existing information for Chaelundi SF is inadequate; the EIS needs to generate information for the following spatial scales:

i) within the area proposed to be logged, i.e. whole of area subject to Class 4 action;

ii) within the unit of forest that encompasses those forests types;

iii) within the forest or management area existing as an entity isolated from other forest areas by cleared lands;

iv) within the region;

on the following issues:

1.1 Stand and condition and history of perturbation of all forest types;

1.2 Populations of species dependent on 'old growth' and/or high productivity forests, or as components of their habitats present in areas with old trees and on productive sites with wet sclerophyll forest;

1.3 As pointed out by Mackowski (1984);

"The retention of scattered hollow bearing veterans in heavily logged forest, when first logged, serves to ameliorate the impact of logging on hollow dependent fauna - but this is of only short term benefit."

"To maintain hollow trees in perpetuity requires the management of the forest so that new hollow trees are recruited as old hollow trees die."

To accommodate the requirements for hollow dependent fauna species the following information will need to be gathered or simulated for each forest type;

i) The density and crown dimensions and number of hollows of the dominant individuals through to the period of their natural lifespans.

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ii) The degree to which these hollows are utilised by various species including arboreal mammals, bats, cockatoos, parrots, lorikeets, tree-creepers, kingfishers, pardalotes and other species. Predictions of the populations of each species within these groups needs to be made.

1.4 Changes to the soil moisture regime in gullies with the conversion of 'old growth' forests to regrowth forests, with the consequent increase in transpiration and reduced dry season soil moisture for a long period of the regrowth stands' life span, and the consequences for vertebrate consumers of detritus based food chains, such as potoroos, bandicoots, lyrebirds, bush rats, antechinus etc.

Predictions of the total populations of the species involved need to be made for the situation of no logging taking place and for ten years intervals for a period of two tree lifespans following a specific harvest, or series of harvests.

1.5 Effects on the species composition and densities of aquatic invertebrates, and other species reliant upon streams, in streams whose catchments will receive suspended particles and solutes from roads and tracks and disturbed soil associated with the logging activities, over the short term, under various intensities and frequencies of rainfall and how they vary over the lifespan of the longest lived forest components.

1.6 Changes to the reptile populations induced by long term alterations to the size of canopy gaps and the influence on the periodicity of solar radiation at and near the forest floor.

Associated with changes to the structure of the forest is the quantities of dead and down material, its dimensions and rates of decomposition, all variables that influence the equilibrium quantities of various size/decomposition combinations.

Information on the reptiles utilizing different logs for basking, egg laying or hibernation sites needs to be determined to derive predictions of populations, at intervals of a decade, for a period of two tree lifespans.

1.7 Changes in the incidence of utilization by non-native species and/or predatory species as a consequence of road construction and habitat modification need to be identified.

This will entail looking at the increase in populations of rabbits, hares, foxes and cats and their impacts on potential competitors or prey such as potoroos, other small macropods, bandicoots, rodents and carnivorous

marsupials.

The accumulated impact of these feral species plus native carnivores, which colonize fragmented habitats (including Dingoes, Kookaburras, Tawny Frogmouths, Black snakes, Pied Currawongs), and the consequences for nesting success and mortality of potential prey species or species subject to competition needs assessment. In this regard, the Tiger Quoll is of particular significance.

1.8 The importance of the forest to be logged for migratory fauna and the effect of forestry activities on populations of intra-regional, intra-state and inter-state migrants should be evaluated.

Predictions of the changes in populations of migratory species including birds and flying foxes, need to be accomplished, and the consequences for both the forest and the complementary areas the species seasonally occupy must be made.

1.9 The damage to fruit bearing rainforest trees and understorey mesomorphic shrubs and vines will have consequences for fruiteating fauna; of particular concern in this regard are fruit pigeons. A simulation of successional changes in growth rates, densities and fruit production, for all species utilized by fruit pigeons, needs to be conducted.

1.10 As well as predictions of populations for the maintenance of regional and local populations, the essential ecological processes they are involved in facilitating need to be predicted. These include:

i) Any alterations to the pollination success and degree of outcrossing of plants;

ii) The degree to which mycorrhizal fungus spores have their dispersal patterns and germinations rates changed.

iii) Changes to the quantities and spatial distribution of seed dissemination;

iv) Changes to the rate of litter decomposition, nutrient cycling and humification of organic matter;

v) Any changes to the rates of herbivory consequent on changes in insectivore populations.

1.11 The influence on microclimate and availability of growing substrates for vascular epiphytes and biophytes, and their projections of occurrence through time under different management options, including subsequent logging cycles needs to be made.

1.12 In view of the degradation to the seral status of rainforests, induced by roads and other permanent canopy gaps, plus the facilitation of weed colonization, quantitative predictions of the species composition, soil seed store and structure of vegetation for a period of time following harvest, equal to the longest lived components of the habitat, need to be made.

What the impacts of repeated harvests on the composition, soil seed store and structure of the forest are also need evaluation.

1.13 The compilation an energy and materials budget for the forest if left unlogged and comparison and contrasting of this to where the materials removed from the site in wood, smoke, solutes or other particles are redistributed should be undertaken. This should focus on nutrient elements and Carbon, and should include time estimates for the Carbon compounds to be oxidised to carbon dioxide.

The energy budget should include the energy content of the timber harvested, the energy consumed during harvesting, transporting and milling logs, that consumed distributing the product and a proportion of the lifespan of the machinery times the energy used in its construction and maintenance.

1.14 Other impacts that warrant consideration are:

i) impacts on soil structure;

ii) effectiveness of erosion mitigation works and rehabilitation of disturbed soils;

iii) short and long term impacts of prescribed burning;

iv) effects of truck movements on road safety, road conditions and the anxiety caused to affected people;

v) archaeological sites and other sites of significance to Aboriginal people;

2.0 There needs to be a thorough assessment of the economics of all aspects of the proposed logging operations including:

i) Management - Head Office and District Office costs, planning, field costs, EIS costs, legal costs etc.;

ii) Costs of constructing and maintaining existing and proposed roads used to service the logging operation. the impact of laden trucks on the council and state road system is significant and needs to be assessed;

iii) The losses of nutrients in the timber harvested, to the atmosphere on burning and by increased transport in overland flow and by leaching needs to be assessed, and the monetary costs of replacing these lost nutrients should be determined;

iv) The loss in productivity caused by compaction and other soil disturbances needs to be determined along with the costs of replacing eroded soil and soil restructuring, to return the site to its natural condition;

v) The full costs of establishing and maintaining replacement trees of the same species through their achieving the same size as those proposed to be removed;

vi) Royalties for all classes of timber to be taken need to be detailed, along with all forms of rebates and any other subsidies obtained by the falling contractors, sawmillers or their employees directly or indirectly from the Government;

vii) The proposed end uses of all timber taken, along with their state/country of destination, and the direct benefits this provides to the people of NSW should be detailed. Company profits from the use of such timber need to be separately detailed.

Meeting the Environmental Challenge

A Forestry Strategy

June 1990

Introduction

Forestry in New South Wales is facing an increasingly difficult legal and political environment.

Forests, especially native forests, are a valuable resource to be carefully managed to provide a range of benefits, now and for the future, on a sustainable basis.

We need to demonstrate to the community that our forests are in good hands and that they are being managed in a way that will maintain both their ecological integrity and the survival of the industries and jobs which depend on them.

The challenge is to review forest management strategies in the light of new Government policy directions and community attitudes, and to adopt policies and strategies that will ensure sustainable and balanced use of resources.

Forests considered to be substantially undisturbed - often referred to as "old growth forests" - merit special attention.

Forestry and Timber in an Environmental Future

There are sound reasons why forestry should proudly take its place as a central plank in any responsible environmental policy. Forests are renewable provided that their ecosystems and processes are not irreversibly altered. Timber, the major material product of forests, is a very environmentally friendly product.Timber:-

- is renewable
- is environmentally benign and non-polluting
- is recyclable, biodegradable
- requires low energy input for processing
- has high energy conservation attributes when in service in buildings
- stores CO_2 from the atmosphere and therefore works against global warming
- involves processes in its production which have much lower environmental impacts than agriculture or mining
- has outstanding aesthetic qualities.

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The forest products industry also plays a vital role in Australia's economy. It is the second largest manufacturing industry and the most significant in rural areas. Yet Australia currently imports $2.3 billion worth of forest products each year, leaving a net trade deficit of $1.7 billion.

Sustainable forest management including timber production must play an important role in any environmentally and economically responsible future for this State. The Government is committed to achieving and maintaining a proper balance in the use of the forest resource for the production of both timber and other values, including water quality, wildlife and flora conservation.

The New Environmentalism

In his recent major statement on the environment, the Premier defined the Government's broad policy direction and philosophical approach to the environment and provided the basis for developing more detailed policies for natural resource management. Philosophically the approach can be restated as follows:

- Nature is neither sacrosanct nor something to be pillaged. Rather, nature contains resources which we must use sensibly and rationally, but use nevertheless, if we are to maintain the quality of our lifestyles. This is a view shared by the great majority of Australians.
- While we may embrace many of the concerns of the hard-core environmental movement, we are not bound to embrace the ideological and sometimes silly nostrums they offer as solutions to our problems. Wider community concerns are not centred around a simplistic "green" agenda, but recognise the need to balance legitimate and sometimes competing interests. We must be willing to respond to the concerns of the majority.
- It is not ideology that matters, but solutions; solutions which work in the real world. These solutions lie in an economically rationalist approach and in better management. There must be a deliberate choice of achievable reform over "deep green" ideology.
- There is a need for stability and predictability in long term government policy.

Principles for Public Forest Management

The NSW Government accepts the following principles as a necessary and practical foundation for management of our State Forests:

- Decision-making must be based on a comprehensive information base covering relevant ecological, social and economic attributes of particular forest areas.
- Forests must be managed on an ecologically sustainable basis which maintains the ecosystem and provides for the interests of future generations in respect of both wood supply and environmental benefits.
- Forest management must be economically viable and efficient and must provide for a viable and efficient forest products industry.
- Decision-making must be balanced and open, and provide for public participation in the planning process.
- Forest management must be publicly accountable in ecological, social and economic terms, and responsive to evolving community concerns.

While a great deal has been achieved already in putting these principles into practice in NSW forests, the community now reasonably expects a higher level of visible commitment to their implementation.

The challenge is to develop strategies for fully applying these principles within the constraints of available funds, commercial viability, and rapidly evolving legal and political imperatives. In particular "old growth" forest has emerged as an issue requiring immediate attention.

A Strategic Direction

It is entirely appropriate that one of the practical expressions of the "New Environmentalism" should be directed to the conflict surrounding the management of native forests.

The central dispute in this conflict is a question of land use rather than forest management. There is no right or wrong answer in this land use dispute. The "Deep Green" lobby is calling for an end to all native forest logging. The timber industry and its employees are understandably anxious and want assurances that they can look forward to a sustainable and stable future in this important industry. An acceptable balance must be achieved.

Both the Government and some of the major conservation groups acknowledge that there must be some logging of old growth forests to maintain the viability of industry over the next 20-30 years. After that time current yields can be sustained entirely from previously logged areas. However, it is important to examine these forests and their values in considerable detail, evaluate the options for land use, and determine those areas where logging can be undertaken using sensitive management practices in order to lessen and ameliorate the environmental impact.

It is recognised that there is wide community concern about our environment. Government decisions will reflect that concern by increasing significantly the openness and accountability of the natural resource management of public authorities, such as The Forestry Commission.

The new forest strategy represents a real step forward in a number of respects:

- It recognises community concern about forestry issues and the need for more public involvement in forest management decisions.
- It provides for that involvement through the provisions of The Environment Planning and Assessment Act. In fact it will go beyond those legal requirements.
- The Forestry commission will not conduct these EISs behind closed doors. It will hire independent consultants to carry out some of the more sensitive EISs. In addition, the Commission will go to the community and seek their assistance in derermining the scope of the EISs, and the issues that will be addressed in them.
- There will be a moratorium on harvesting in these areas until the EISs have been completed. This will occur progressively over a five-year period.
- An order of priority will be established for the sequential preparation of EISs. Priority will be given to management areas having substantial areas of "old growth" forming part of the sustained yield resource base, and for which EISs have not yet been completed.

- In establishing priorities, an assessment of the whole state has identified the following key areas of unlogged old growth forest within State Forests, for which EISs have not already been completed.

Management Area	State Forests	Key Areas
Urbenville	Richmond Range, Yabbra	Duck Creek
Murwillumbah	Nullum	Blackbutt Plateau
Tenterfield	Boorook, Spirabo, Forestland	
Glen Innes	London Bridge, Glen Nevis, Oakwood,	London Bridge
Casino West	Mount Marsh	Mount Marsh
Grafton	Dalmorton	Cunglebung
Dorrigo	Chaelundi	Chaelundi
Walcha-Nundle	Ben Halls Gap, Tomalla, Giro	Ben Halls Gap,
Kempsey	Nulla Five Day, Styx River,	
Wauchope	Doyles River, Mount Boss, Yessabah, Kippara	
Wingham	Dingo, Bulga, Doyles River, Enfield	
Gloucester	Stewarts Brook, Barrington Tops	Barrington Tops
Chichester	Chichester, Boonabilla	Whispering Gully, Boonabilla
Mount Royal	Mount Royal	Davis Creek

These identified areas comprise some 180 000 ha within 14 separate forest management areas.

Old Growth Forest

Old-growth forests, have attracted considerable attention. There are practical problems in defining just what is meant by "old growth" forest. At one extreme, it may include any forest with old trees, and this definition covers practically all State Forest where selective logging has been practised for decades. A more meaningful definition would include only natural forest with few or no signs of human disturbance.

Using a definition of "old growth" based broadly on "forest with little or no disturbance", there are about 5 million ha of such forest in the State, distributed throughout different land tenures as follows (areas in millions of ha):

National Park	2.0
State Forest	1.6
Various Crown Lands	1.1
Privately-owned Lands	0.3
	5.0

Major areas of old growth are already reserved within the State's National Park system. Many of these Parks resulted from the revocation of extensive areas of State forest, particularly in recent years.

Of the 1.6 million ha within State Forests, 1.3 million ha are deliberately excluded from logging (eg in Flora Reserves or for catchment protection) or are unsuitable (eg excessively steep terrain and economically inaccessible areas). Together with the 2.0 million hectares protected with National Parks, this represents 92% of the total "old

growth" conserved within either National Parks or State Forests.

The debate about the harvesting of old growth forest therefore revolves around approximately 0.3 million ha of State Forest or about 8% of the total old growth permanently conserved within National Parks and State Forests. This 0.3 million ha, together with the 1.5 million ha of previously logged (and regenerated) State Forest currently provides our resource base for long term sustained yield of the State's hardwood timber needs.

The EIS process will determine the most appropriate use of these forests in line with sound, economic, social and environmental principles.

The "Rainforest" Decision of 1982

The current dispute in the North coast forests should also be seen in the context of decisions made in 1982.

The "Rainforest" decision of the former State Government in 1982 removed from production some 100 000 ha of old growth, formerly part of the north coast's sustained yield resource. Impacts on industry viability and jobs were significant, but industry concern was tempered by a firm Government guarantee that the remaining resource base would not be eroded.

Industry was given a written undertaking by the Government that alternative (i.e. remaining) timber resources would be identified, "the availability of which will be assured by Government." It also guaranteed the "maintenance of employment levels consistent with those existing and predicted from the current management proposals of the Forestry Commission of NSW," (NSW Government Rainforest Policy 1982). Thus both industry and the Forestry Commission were able to make adjustments to the reduced resource base, secure in the knowledge that it was guaranteed by Government.

Environmental lobby groups now have made further demands for the exclusion of harvesting from what remains of the north coast hardwood resource, specifically in those State Forests identified in 1982 by the former government as the "alternative" resource for industry.

Industry, having adjusted to the trauma of 1982 and having received firm undertakings from the Wran and Unsworth governments, has good reason to expect the maintenance of its resource base.

The Legal Challenge

The Environmental Planning and Assessment Act, enacted in 1979, requires an Environmental Impact Statement (EIS) for any activity likely to significantly affect the environment. It does not require an EIS for logging per se. It was not envisaged at the time, nor did the then Minister or the Department of Planning suggest, that an EIS would be required for all logging activities. In fact consultations with the Department led to the development of a system of internal environmental review designed to meet the requirements of the Act and identify those cases where EIS preparation might be required.

Since the Act came into force in 1980, the Forestry Commission has completed five EISs for operations within areas seen to have particular sensitivity. However, interpretation of a Land and Environment Court ruling in 1989 suggests that EISs could be required for a considerably broader range of logging operations than previously thought, and particularly in respect of "old growth" forest. In fact there is considerable doubt as to when an EIS might be held not to be required. This ruling, which has been successfully exploited by anti-logging groups, is the cause of the current crisis facing the Forestry Commission and the timber industry, particularly

on the North Coast.

This situation, coupled with perceived community concerns, gives additional impetus to the need to implement a strategy for the management of old growth forest.

Other Related Initiatives

The above strategy is complemented by a number of additional initiatives.

The Forestry Commission is reviewing its policy on hardwood plantations and identifying options for pursuing a more positive program consistent with broader timber supply objectives and economic efficiency.

The Government is exploring the feasibility of plantation share-farming schemes within NSW through a working party composed of representatives of the Forestry Commission, Nature Conservation Council, Land Conservation Council and Soil Conservation Service.

The Government will continue to pursue Commonwealth financial assistance for hardwood plantation schemes.

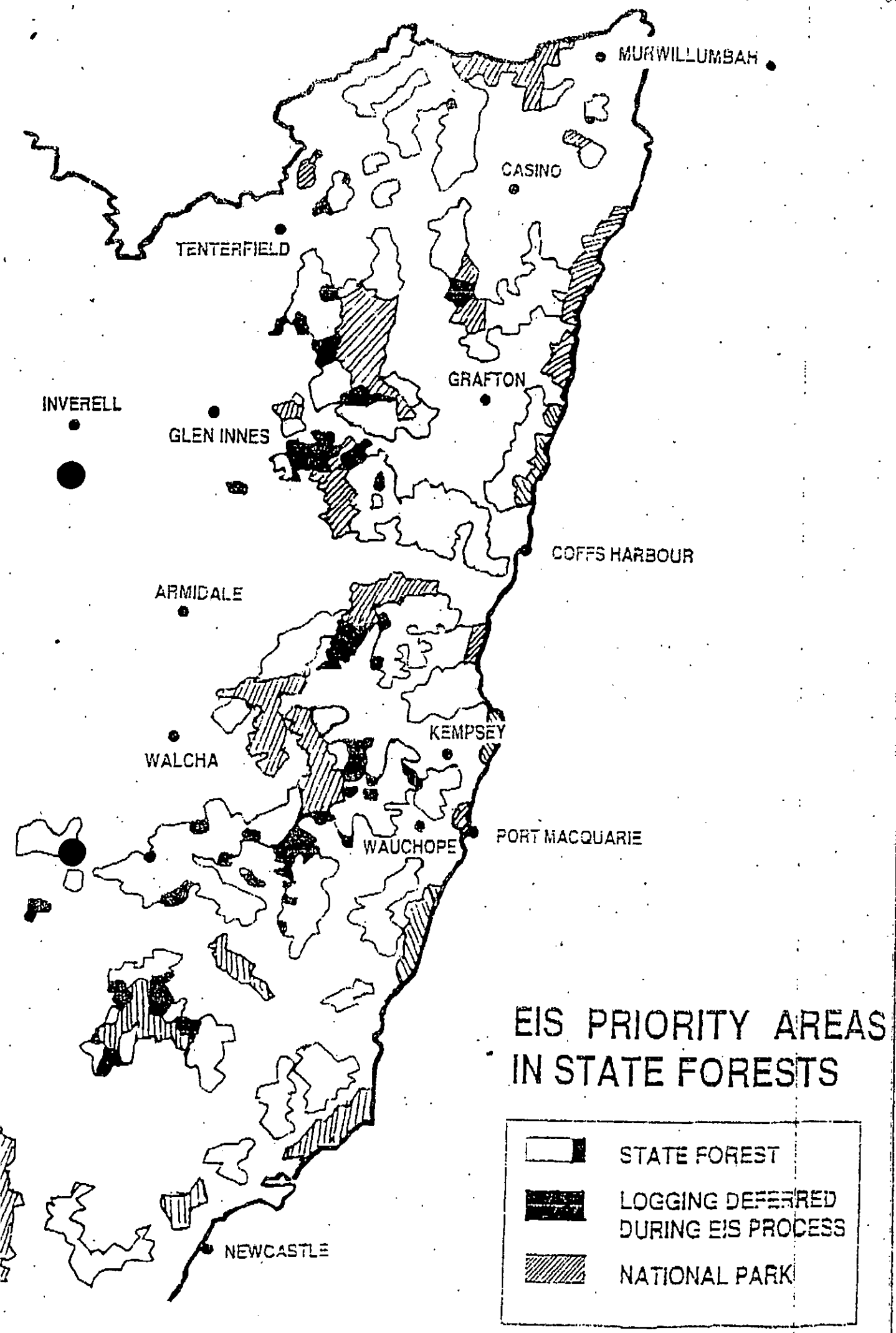
The Forestry Commission is currently establishing hardwood plantations at a rate of about about 200 hectares per annum.

The Forestry Commission will develop a more pro-active and adequately resourced communications program so as to increase the community's access to information about its policies and activities, particularly their environmental significance. The program will also provide avenues for feedback from the community.

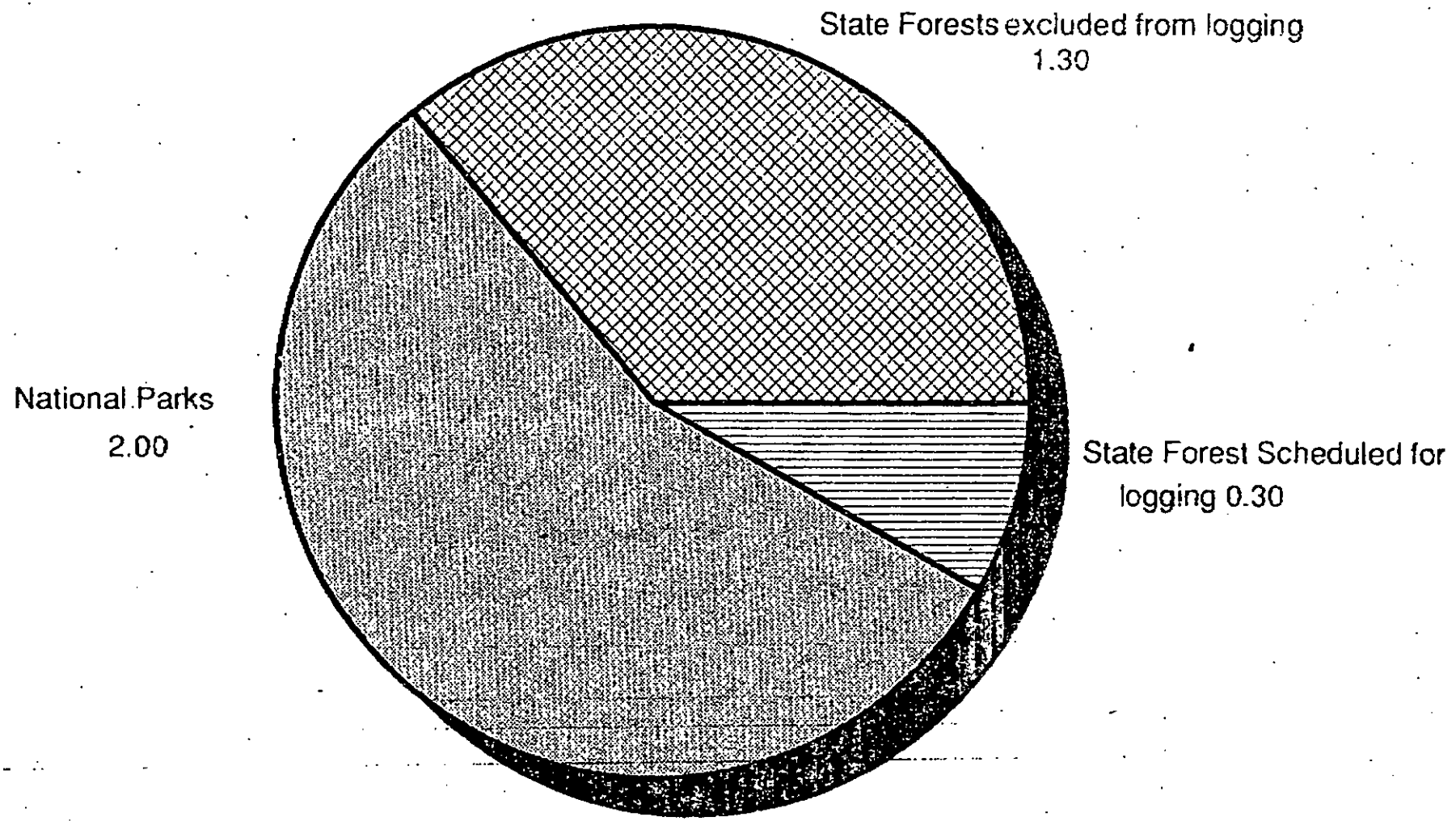
The Forestry Commission is developing a computer based Geographic Information System as a basis for improving its resource data bases and analytic capabilities. This system will greatly enhance community access to forest resource information and the ability to formulate management plans and evaluate environmental impacts.

Summary

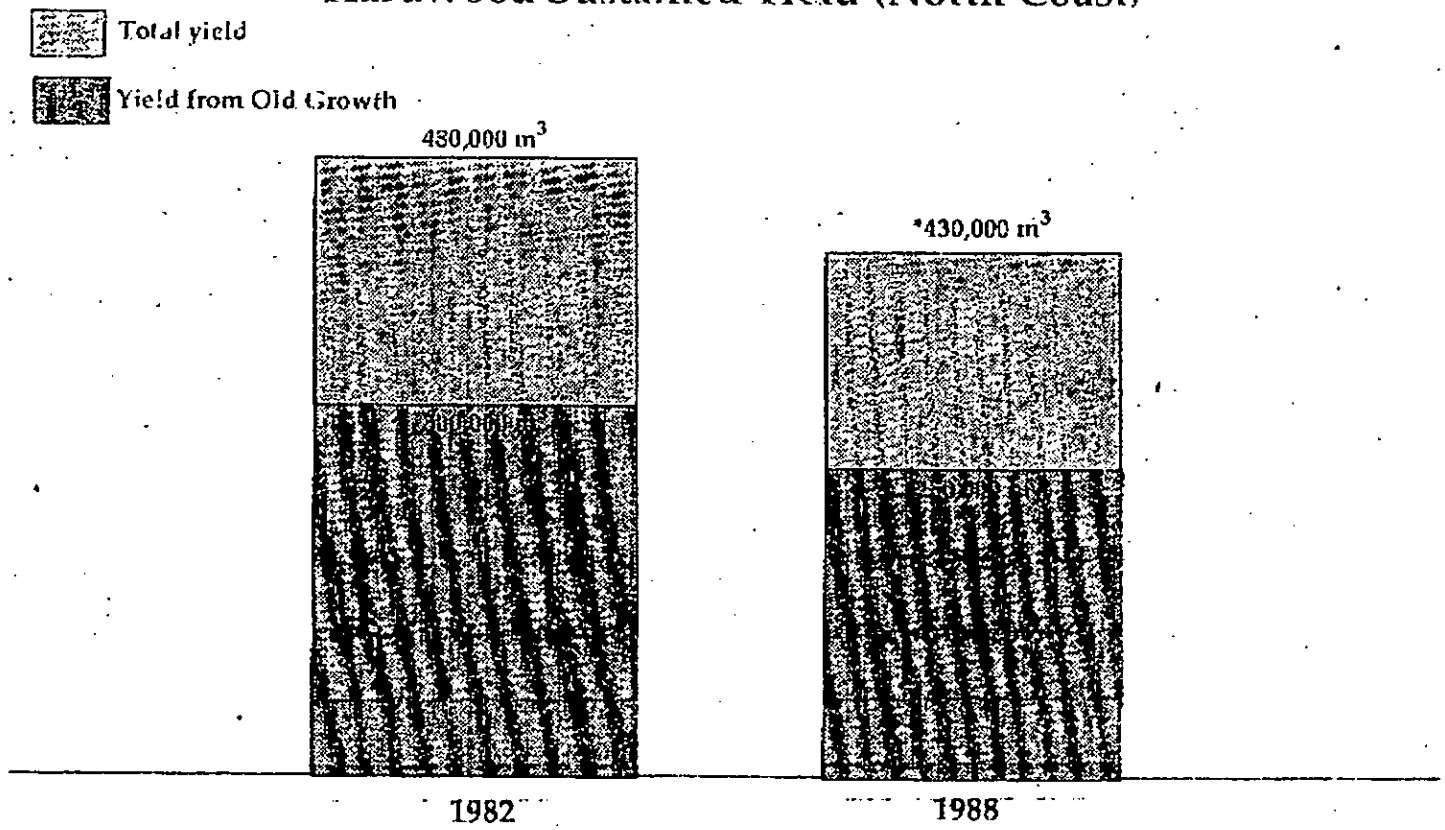
The strategy outlined above, provides a responsible and workable basis for a new approach to the legal, ecological and economic requirements for the management of "old growth" within State Forest. It will allow greater public participation in decision making processes and a higher degree of accountability to the community for the management of what it rightly regards as a precious natural resource.


MURWILLUMBAH
CASINO
TENTERFIELD
GRAFTON
INVERELL
GLEN INNES
COFFS HARBOUR
ARMIDALE
KEMPSEY
WALCHA
WAUCHOPE
PORT MACQUARIE
NEWCASTLE
EIS PRIORITY AREAS IN STATE FORESTS
STATE FOREST
LOGGING DEFERRED DURING EIS PROCESS
NATIONAL PARK

OLD GROWTH FOREST IN NATIONAL PARKS & STATE FORESTS - 3.6 Million Hectares



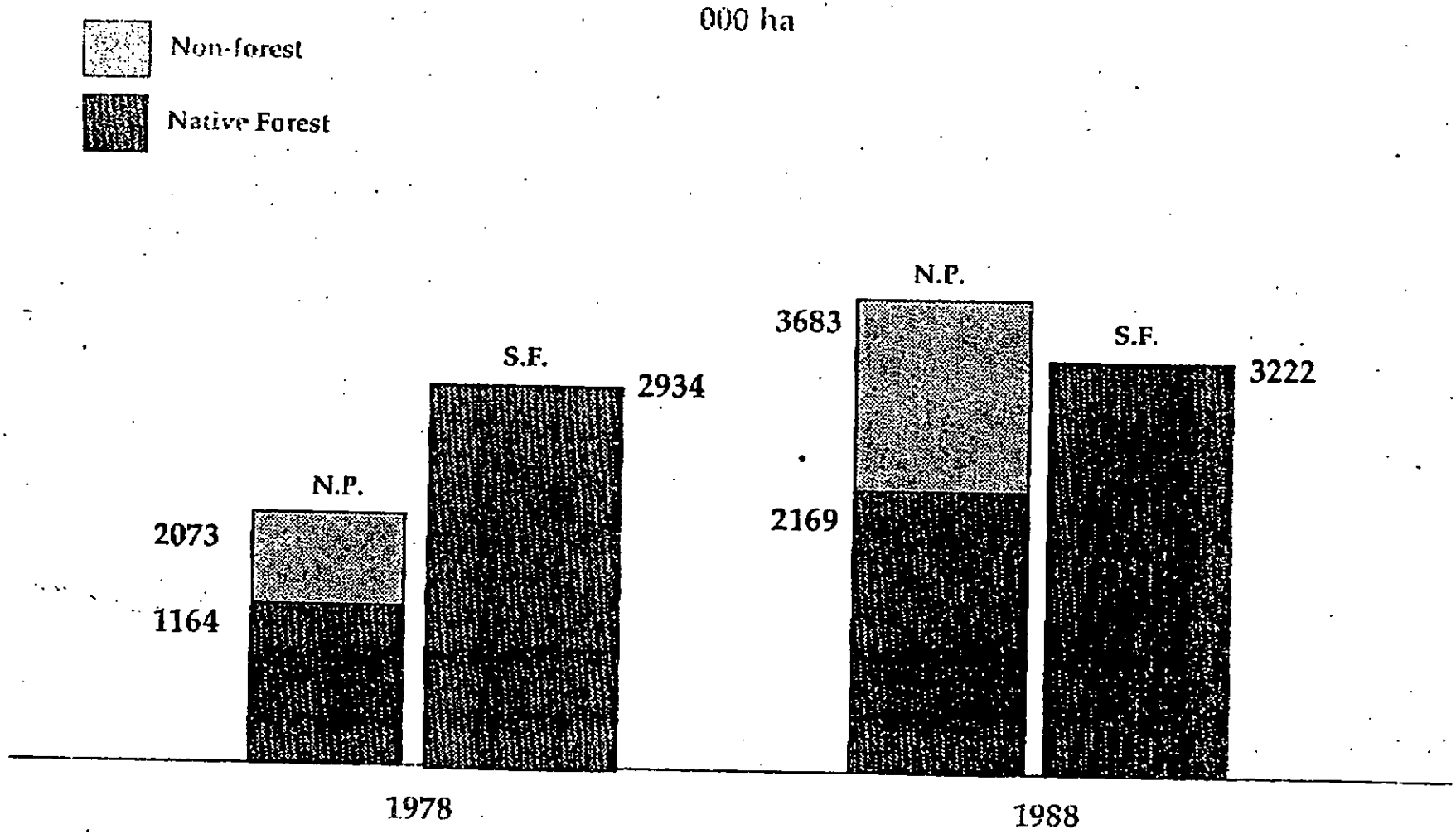
Hardwood Sustained Yield (North Coast)



* Reduction of 50,000 m^3/p.a. due to "Rainforest" Decision of 1982–83

National Parks and State Forests, N.S.W.

000 ha



June 1990

ENVIRONMENTAL STRATEGY
KEY AREAS FOR PREPARATION OF ENVIRONMENTAL IMPACT STATEMENTS

Management Area	Key Area	Compartments Numbers	Gross Area (ha)
Pt. Urbenville	Duck Creek	135,136,201-208	2 900
Pt. Walcha-Nundle	Ben Halls Gap	Whole of SF	1 800
Mount Royal	Davis Creek Section	200-204,175-178	1 900
Dorrigo	Chaelundi	Att. list (1)	14 200
Wingham		Att. list (2)	19 900
Pt. Murwillumbah	Blackbutt Plateau	Whole plateau	200
Glen Innes	-	Att. list (3)	23 500
Casino West	Mount Marsh	428-434 (possible small area for logging in 430,431)	3 300
Kempsey		Att. list (4)	27 800
Tenterfield		Att. list (5)	15 300
Grafton	Dalmorton	508-545,552, 555-559,588	8 500
Gloucester	Barrington Tops	Att. list (6)	15 900
Walcha-Nundle	-	Att. list (7)	11 200
Wauchope	-	Att. list (8)	17 700
Chichester	Whispering Gully	60-68,99, 167-171,141-143 145	5 500

169,300

30.70

ADDITIONAL COMPARTMENT LISTINGS

(1) DORRIGO MANAGEMENT AREA

Compartment numbers: Eastern block: 155-165, 225-227, 238-256, 273-284
Western block: 193, 199, 201-204, 207, 209-219, 221-224, 302-306

Area 14 200 ha

Note: Cpts 180, 198, 200 are in injunction area, but are nominated for logging during EIS preparation.

(2) WINGHAM MANAGEMENT AREA

STOKES

Pts Enfield and Doylee River SFs
Compartments: 278-283, 285-287, 289, 290, 293-296, 302-307

Area 3 500 ha gross

CELLS-RALFES

Pts Doyles River and Bulga SFs
Compartments: 176 pt, 174, 186, 204, 207, 208 pt, 223-233, 235 pt, 236, 239-248, 251-255, 258, 259, 260, 262, 264-275

Area 8 100 ha gross

TIRRILL

Pt Doyles River SF
Compartments: 209 pt, 212, 213, 216

Area 600 ha gross

HOMEWOODS

Pt Bulga SF
Compartments: 117, 118, 157, 183, 184, 185

Area 1 500 ha gross

ROCKY HIP

Pt Dingo SF
Compartments: 142-147

Area 1 200 ha gross

MISCELLANEOUS

Isolated part compartments in Knorrit, Dingo and Bulga SF
Within compartments: 10, 11, 12, 14, 20, 28, 29, 34, 35, 37, 38, 40, 41, 43, 46, 49, 50, 54, 55, 56, 63, 65, 72, 74, 75, 77, 79, 81, 83, 84, 148, 149, 151, 163, 180, 181, 182

Area 5 000 ha gross

WINGHAM MA TOTAL: 19900 ha

(3) GLEN INNES MANAGEMENT AREA

Warra SF

CPT. NO.	AREA	CPT. NO.	AREA	CPT. NO.	AREA
A	474 ha	C	251 ha	E	251 ha
B	658 ha	D	276 ha		

Area 1 910 ha

Oakwood SF

CPT. NO.	AREA	CPT. NO.	AREA	CPT. NO.	AREA
Pt. 99	120 ha	Pt.139	65 ha	Pt.115	260 ha
Pt.100	75 ha	138	539 ha	117	208 ha
144	320 ha	Pt.137	580 ha	118	430 ha
Pt.102	310 ha	Pt.136	250 ha	116	360 ha

Area 3 517 ha

Glen Nevis SF

CPT. NO.	AREA	CPT. NO.	AREA	CPT. NO.	AREA
116	449 ha	122	408 ha	140	486 ha
119	715 ha	123	336 ha	141	391 ha
120	475 ha	124	381 ha	142	642 ha
121	299 ha	125	772 ha	143	564 ha

Area 5 918 ha

London Bridge SF

CPT. NO.	AREA	CPT. NO.	AREA	CPT. NO.	AREA
Pt.126	310 ha	Pt.134	75 ha	130	442 ha
Pt.129	212 ha	Pt.135	160 ha	131	472 ha
Pt.128	20 ha	133	325 ha	132	643 ha

Area 2 659 ha

Curramore SF

CPT. NO.	AREA	CPT. NO.	AREA	CPT. NO.	AREA
154	269 ha	164	401 ha	174	431 ha
155	256 ha	165	156 ha	175	363 ha
156	270 ha	166	231 ha	176	456 ha
157	186 ha	167	289 ha	177	269 ha
158	170 ha	168	410 ha	178	350 ha
159	126 ha	169	278 ha	179	494 ha
160	381 ha	170	194 ha	180	419 ha
161	383 ha	171	144 ha	181	513 ha
162	234 ha	172	253 ha	182	325 ha
163	266 ha	173	465 ha	183	250 ha

Area 9 464 ha

GLEN INNES MA TOTAL: 23 468 ha

(4) KEMPSEY MANAGEMENT AREA

BOTUMBURRA

Nulla-Five Day SF - Cpts 104 (Pt excluding Por 15, Ph Comara), Cpts 105-122

Styx River SF - Cpts 12, 14-23 (16-23)

Lower Creek SF - Cpts 1, 6, 7, 27

Area 11 500 ha gross

14 404
15 264
1 378 ha
6
7 402 ha
27

COMARA RANGE

Nulla-Five Day SF Pt Cpt 102, Cpt 101, Pt 123, Cpt 124, 125, 143, Pt 144, 145

Area 2000 ha gross

WOORONG

Pee Dee SF - Cpts 91 and 92

Nulla-Five Day SF - Cpts 88, 89, Pt 90, 93, 94, Pt 95

Area 2 300 ha gross

WILLI WILLI

VCL and associated Leasehold

Parishes of Willi Willi, Dudley, Panton and Warbro excluding NW of Warbro Brook.

Area 12 000 ha gross

TOTAL KEMPSEY MA: 27 800 ha

Nulla 5 day 4,281

122	229
121	199
104	293
105	134
106	261
107	220
108	290
109	314
110	160
111	299
112	170
113	195
114	265
185	179
186	321
117	162
118	217
119	145
120	238

Styx R 4316

12	476
14	246
15	336
16	433
17	388
18	474
19	571
20	372
21	398
22	282
23	340

8,597

(5) TENTERFIELD MANAGEMENT AREA

Spirabo/Forestland SFs

CPT. NO.	AREA	CPT. NO.	AREA	CPT. NO.	AREA
153	225 ha	293	142 ha	312	184 ha
154	263 ha	294	144 ha	313	159 ha
229	85 ha	295	153 ha	314	123 ha
230	224 ha	296	158 ha	315	221 ha
231	198 ha	297	155 ha	316	132 ha
232	229 ha	298	137 ha	317	192 ha
236	193 ha	299	137 ha	318	133 ha
238	156 ha	300	221 ha	320	210 ha
239	234 ha	301	131 ha	321	133 ha
240	212 ha	302	171 ha	322	155 ha
247	201 ha	303	198 ha	323	126 ha
263	219 ha	304	140 ha	324	153 ha
264	189 ha	305	226 ha	325	150 ha
265	226 ha	306	127 ha	326	166 ha
266	154 ha	307	167 ha	327	186 ha
287	124 ha	308	241 ha	328	282 ha
289	202 ha	309	242 ha	329	207 ha
291	110 ha	310	143 ha	330	210 ha
292	184 ha	311	244ha		

Area 10 027 ha

Girard SF

CPT. NO.	AREA	CPT. NO.	AREA	CPT. NO.	AREA
78	279 ha	79	200 ha	80	235 ha

Area 714 ha

Boonoo SF

CPT. NO.	AREA	CPT. NO.	AREA	CPT. NO.	AREA
96	129 ha	105	181 ha	116	168 ha
125	244 ha	106	120 ha	117	346 ha
126	457 ha	107	197 ha	120	219 ha
102	163 ha	109	201 ha	113	126 ha
103	286 ha	114	200 ha	112	154 ha
104	186 ha	115	129 ha		

Area 3 506 ha

Boorook SF

CPT. NO.	AREA	CPT. NO.	AREA	CPT. NO.	AREA
81	161 ha	83	185 ha	Pt. 85	160 ha
82	178 ha	84	203 ha	135	163 ha

Area 1 050 ha

TENTERFIELD MA TOTAL: 13 009 ha → wrong

15,297

(6) GLOUCESTER MANAGEMENT AREA

Compartment numbers 44-68, 107, 111-113, 116-117, 123, 126-155, 168-171,

Area 15 900 ha gross

(7) WALCHA-NUNDLE MANAGEMENT AREA (excluding Ben Halls Gap SF)

Riamukka SF (Mt. Carrington)

CPT. NO.	AREA	CPT. NO.	AREA	CPT. NO.	AREA
Pt. 84	136 ha	73	232 ha	69	222 ha
75	216 ha	72	216 ha	68	257 ha
74	151 ha				

Area 1 430 ha

Giro SF

Includes Cpts. 242 - 253 inclusive and Extn. No. 14 (previously VCL) 900 ha - not yet compartmented.

Area 3 370 ha

Nowendoc SF

Includes Pt. Cpt. 205, Cpts. 206-210 inclusive, Pt. Cpt. 211, Pt. Cpt. 217, Pt. Cpt. 218, Cpt. 219.

Area 1 970 ha

Tuggolo SF

Includes Cpts. 260-266 inclusive, Cpt. 268, Cpt. 269, Cpt. 273 and Cpts. 318-325 inclusive.

Area 4 440 ha

WALCHA-NUNDLE MA TOTAL: 11 210 ha

(8) WAUCHOPE MANAGEMENT AREA

SOUTH SEAVIEW

Doyles River SF No. 911 and
Mount Seaview SF No. 877

Compartments: 154 part, 155, 156-158, 159, 168-195, 201-203, 205, 206

Area 4 200 ha gross

KENNEDY'S MOUNTAIN

Pt Mount Boss SF No. 910

Compartments: 264-272, 304

Area 2 400 ha gross

BANDA BANDA

Yessabah SF No. 602

Compartments: 76, 77, 82, 84, 159, 160, 299, 306-312, 314-322, 325, 327-332

Area 5 500 ha gross

CASCADE CREEK

Mount Boss SF No. 910

Compartments: 94-98, 116, 117

Area 1 100 ha gross

KUMBATINE

Ballangarra SF No. 474

Compartments: 39, 40, 43-53

Area 3 000 ha gross

KINDEE

Mount Boss SF No. 910

Compartments: 123, 125-132, 334

Area 1 500 ha gross

TOTAL WAUCHOPE MA: 17 700 ha

RAINFOREST INFORMATION CENTRE
BOX 368 LISMORE 2480
PHONE (066)218505. EMAIL: "RAINFAUS

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FACT SHEET ON OLD GROWTH FORESTS

Old growth trees are being eliminated at an alarming rate throughout Australia. Trees retained in farming areas are rapidly disappearing as consequences of natural forces, salinity, unnatual dieback (as on the NSW Tablelands), human desires and generally because they are not in a forest habitat.

The timber industry is rapaciously concentrating their activities into the few remaining old growth forests, while they pick out surviving old growth trees and pockets of old growth left scattered in regrowth forests.

There is no doubt that the rapid loss of old growth forests and individual trees is a major environmental catastrophe. The full diversity and complexity that characterises old growth forest may never be reattained once the surviving stands are felled. If we are to avert complete disaster we must save all the more productive old growth forests as soon as possible and initiate a return of old growth trees throughout the forest estate.

An old growth forest is one that is unlogged or only selectively logged. They contain a high proportion of old growth trees, though this is variable depending on forest type.

Old growth forests are characterised by a high diversity of structural features, complex ecological relationships, and outstanding aesthetic value.

An old growth tree can be defined as one which has attained its maximum height and crown width, and begun to shed major branches. Such trees are also variously described as mature, over-mature, veterans and senescent.

Mountain Ash generally attain maturity and enter their old growth phase at 130 years old. Blackbutt reach it at around 150 years (Mackowski 1987), while some other species take considerably longer.

Old growth trees provide numerous benefits for wildlife not adequately provided by regrowth: hollows; abundant flowers, fruits and seeds; stable and high nest sites; large trunks and branches for foraging; large logs; and regulation of stream flow.

Tree hollows, of use to wildlife, generally only form in old growth trees. From maturity there is a general increase in both the numbers and size of hollows with age. The large hollows required by many animals not being readily available until later in development - at around 225 years of age (1.4 metres in diameter) in the case of Blackbutt (Mackowski 1987), and 200 years for Mountain Ash.

Some 399 species (25%) of Australian terrestrial vertebrates utilize tree hollws (Ambrose 1982). A high proportion of forest vertebrates are hollow dependent including most possums gliders, bats, cockatoos, parrots, lorikeets, rosellas, owls, kingfishers, treecreepers, and a large variety of other mammals, birds,

reptiles and frogs.

Similarly large logs are necessary habitat components for many ground dwelling animals, including most reptiles and a number of frogs, mammals and invertebrates.

Old growth trees produce more abundant flowers and fruits than do immature trees (Ashton 1975), while immature trees transpire more water and thus cause decilnes in stream flows, particularly in dry periods (e.g. Langford and O'Shaughnessy 1977).

The fauna in turn provide numerous benefits to the plants, such as: pest control; pollination; disperal of seeds and beneficial fungi; and accelerated nutrient cycling. Old growth forest ecosystems are not simply the sum of the individuals which comprise them, but are complex environments in which the individuals interrelate to form the whole.

Old growth forests attain their best development on gentler slopes, in better soils and with higher rainfalls. These forests of high productivity are of the most value to forest dependent wildlife and to the timber industry. They are the least conserved forests and the most threatened.

The author's current estimate is that stands of eucalypt dominated old growth forest, over 100 hectares in size, represent some 3% of all eucalypt dominated forests on slopes of less than thirty degrees in the Coffs Harbour Forestry Region, and probably a similar proportion of all north east N.S.W.'s forests.

Under the present scenario, most of the old growth stands identified to date will be roaded, with logging well underway, within three years. Only the few fragmented stands left within National Parks will survive past the turn of the century.

The same scenario is currently occuring throughout Australia. While it may take over a decade before the last stands are finally plundered, we must stop this abuse now. The full ramifications of what we have already done may take many decades to become manifest as retained old growth trees are burnt out, blown over, or die without replacements being available. It may already be too late to ensure the survival of many species into our uncertain future.

--- Prepared by Dailan Pugh for
The Rainforest Information Centre

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3. Ashton, E.H. (1975) Studies of Flowering Behaviour in Eucalyptus Regnans. F. Muell..Aust.J.Bot 23:399-411.
4. Langford, K.J. and O'Shaughnessy, P.J. (1977) Some Effects of Forest Change on Water Values. Aust.For. 40(3): 192-218.

The costs of conservation must be analysed

We can't see the myths for the trees

By the Richmond-Tweed-Clarence branch of the NSW Forest Products Association

It is hardly surprising that Australians, confronted by daily news reports about acid rain, deforestation and the greenhouse effect, are anxious to find and support solutions to global and local environmental problems.

What is surprising is that we, as a nation, don't make the obvious connection between the environment and the other great issue of national concern — the economy and particularly our spiraling trade deficit.

There is a widespread illusion that environmental protection is free, or at least that any cost will be spread over the whole community and won't fall on us individually.

Nowhere is this more apparent, or more demonstrably false, than in debate over our forests.

Last year we imported $1.3 billion worth of forest products. This year, imports are running at $1.8 billion, and wood and paper products are the third-largest item on our burgeoning import bill.

They therefore make a significant contribution to our trade deficit and the flow-on effects, including soaring interest rates.

When we live beyond our means as a nation it is not just today's new home buyers but the future generations who suffer the consequences. The cost to each of us of importing forest products we could produce is very great indeed.

The forest industry has a growth plan which would eliminate the trade deficit in forest products by 2015.

□ □ □

Since the early 1970s vast areas of forest have been removed from production in the name of environmental protection. Only seven million hectares of Australia's 41 million hectares of forest land are available for wood production and, of that, only 340,000 hectares is of the quality needed to support high value-adding processing and manufacturing industries.

This figure is being eroded almost daily as new rates are set aside for conservation.

Many reasons advanced for locking away forests are based on simplistic assumptions which do not stand up to analysis.

For example, we are constantly told — and most people believe — that the number of trees in Australia is decreasing. This is the increase, and they have been for some time.

The major clearing of Australia's forests occurred last century, mostly as a result of the development of our great agricultural industries.

Since the 1920s our major forest areas have been stabilised and are now on the increase. In 1921, for example, about 2.7 million hectares of forest in NSW was reserved in State forests and timber reserves.

Today this figure is 3.8 million hectares.

This is not due to the efforts of environmental groups or tree planting by community-minded farmers. It is the result of increasingly effective management by the State forest services and, more recently, the forest industry, both of which have a vested interest in seeing Australia's forests expand.

In recent years the industry has been planting 40 to 50 million trees a year and the Prime Minister's promise to plant one billion trees by the year 2000 is relatively modest, compared with the 1.5 billion the industry will grow as part of its normal operations over the next decade.

A second popular misconception behind the push of locking up more of Australia's forests is the idea that they have been mismanaged in the past and are still being pillaged by a rapacious industry interested only in short-term profits. The popular image, reinforced by superficial media reporting, is that public forests are still being cleared and the land left denuded of trees.

In fact our forests, particularly those on crown land, are among the best managed in a world where forest management is the exception rather than the rule.

Unlike the forests in Africa — still being cleared for fuel and subsistence agriculture — ours are managed to maintain a sustainable yield. This means that harvesting does not exceed the capacity of the forest to grow and renew itself.

Where old growth forests are clearfelled the initial scene, often highlighted in the media, is one of apparent devastation. However, all clearfelled crown forests are regenerated and the regrowth is usually much healthier than the forest it has replaced.

□ □ □

For example, environmentalists claim the Eden export woodchip operation will "ruin the area's forest on 20 and 30 years". In fact the NSW Forestry Commission estimates the regrowth forests will carry more timber after 40 years than the present forest now aged between 80 and 100 years and repeated wildfires.

Another popular misconception is that we can contribute to environmental protection by reducing the consumption of wood-based products.

If we want to conserve the earth's resources and combat the build-up of carbon dioxide in the atmosphere there are good reasons why we should be using more wood rather than less.

First, trees are a renewable resource unlike oil, coal and iron ore used to produce alternatives to wood and paper, such as plastic, and steel.

Second, trees and wood products made from trees store carbon dioxide. In contrast, relatively large amounts of carbon dioxide are released in the production of wood alternatives. To provide the energy to produce a tonne of timber an average of 0.13 tonnes of steel, 1.15 tonnes of coal is required and a further 0.5 tonnes of carbon is released directly in the production of iron.

Taking into account the amount of carbon dioxide released in the production of various building materials and the carbon stored in sawn timber products, a steel-framed brick veneer house on a concrete slab has a much higher impact on atmospheric carbon dioxide than a house framed, floored and clad in wood.

When environmental groups encourage architects to specify non-wood materials, or the Federal Minister for Administrative Services directs that steel rather than timber be used to counter the greenhouse effect, they are reflecting community confusion about the problem of global warming due to the build-up of carbon dioxide in our atmosphere.

If they are serious about combating the greenhouse effect, they should encourage us to use less steel, aluminium, plastic, glass, bricks, and substitute wood for these materials where possible.

A related greenhouse misconception is the idea that old growth forests — like the famous "tall trees" in southern Tasmania — somehow act as the "lungs of the earth", absorbing harmful carbon dioxide. This idea is not supported by the scientific facts.

Carbon accumulation is a function of growth and because old forests are no longer growing much, they absorb only about the same amount of carbon dioxide as they emit through decay.

Recent research has confirmed, for example, that for mature *Eucalyptus sieberi* in the Eden area, the net carbon accumulation is zero. Six-year-old regrowth in the same area, however, accumulates almost nine tonnes of carbon a hectare in a year.

Thus, when the NSW Opposition leader, Mr Bob Carr, said that woodchipping and sawmilling at Eden was contributing to the greenhouse effect he was wrong. The new vigorous regrowth forests will absorb much more carbon dioxide than the degraded old growth they replace.

Protection of our natural environment and conservation of our forests are essential national goals. However, many of the conservation measures proposed are based on myth and misinformation.

We need to analyse them carefully, both in terms of

Move on

A new phase of campaign activity protect old-growth forests was nounced by the North East Forest A ance after a two-day meeting in Bel gen this week.

Spokesman John Corkill said the gr would broaden its area of interest to clude crown leasehold land being conv ed into freehold title, as well as st forests.

Also discussed was further non-viol action to pressure the NSW Fores Commission into complying with NSW Environmental Planning and sessment Act, Mr Corkill said.

He said the aim was to secure prot tion for all old-growth forests in nor eastern New South Wales.

"We recognise that our campaign affect the North Coast logging indus

NEW SOUTH WALES' RAINFORESTS

Rainforests cover less than 7% of the earth's land surface and yet support over half the world's life forms. They represent the greatest complexity and diversity that life is capable of attaining. It is variously estimated that we humans are destroying 7.4 to 20 million hectares of rainforest each year. N.S.W. over 75% of our rainforests have been obliterated since the arrival of Europeans, while most of the remaining stands have been seriously degraded by grazing, logging and fire.

A propaganda campaign by the State Government in 1982 duped most people into believing that N.S.W.'s rainforests had been saved. Of the 253,000 ha. of primary rainforest estimated by the Forestry Commission to remain in N.S.W. only 32% is under the control of the National Parks and Wildlife Service (this is less than 8% of what was here 200 years ago), while the Forestry Commission retains 56% to use and abuse.

Of the 142,000 ha of primary rainforest that the Commission controls some 8,000 ha. is within areas reserved (at present) from logging, 'maximum economic utilization' logging is continuing in the Washpool area, while the balance is retained for 'special purpose' logging. Roads are still being indiscriminately pushed through virgin stands, fire is destroying smaller stands, weeds and feral animals are invading along logging roads and numerous other agencies are contributing to the degradation of our public rainforests.

Using the Commission's definition of rainforest timbers ('brushwoods') there has been a welcome decline in logging volumes since 1982, but when Brush Box is included with the other rainforest species there has been a consistent average of over 70,000 cubic meters of rainforest timbers removed annually in N.S.W. (Table 1). As the cut of other rainforest timbers has declined the cut of Brush Box has correspondingly increased.

The Commission classes Brush Box dominated forest as being 'moist hardwood' or 'wet sclerophyll' as distinct from 'brush' or 'rainforest'. Such a classification is ecologically unsound because most rainforest species are hardwoods and many have sclerophyll leaves (particularly in seasonally dry forms). As is evident by Brush Box's name it has historically been regarded as a rainforest species. It is included as such in rainforest botanical texts and is regarded by most rainforest ecologists as a true rainforest species.

Brush Box and a variety of specialized eucalypts, particularly Flooded Gum, Dunn's White Gum, Turpentine, Tallowwood, White-topped Box and Sydney Blue Gum, form a dynamic transitional zone between open forest and primary rainforest. Following wildfire an understorey of the hardiest rainforest plants develops, over hundreds of years the understorey passes through a series of successional stages -accumulating nutrients

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and creating a protected microclimate- until the eucalypts die out and a primary rainforest is created.

These transitional forests can be broadly separated into three forms: regenerating primary rainforest -after fire (Flooded Gum and Brush Box typical dominants); developing rainforest -capable of becoming primary rainforest; and mixed forest -expected to be regularily enough disturbed to maintain an overstorey of eucalypts. Ecologically these forests often function as rainforest and are utilized by most rainforest animals, providing vital winter food sources for some. The mature eucalypts provide homes for hollow dependent animals and food sources for animals from open forests, often giving these mixed forests a more diverse fauna than other forests.

The Commission controls some 250,000 ha. of these types, which they are currently logging to their "economic limit" at a rate "greater than their current sustained yield capacity"(1). They practice clearfelling "in appropriate circumstances as in virgin areas of [shade] into[plant species which contain only mature and overmature stems"(1). As they remove 75-95% of the overstorey trees they deliberately maximize damage to the rainforest understorey and then set fire to it to finish it off Regeneration is often poor and Sydney Blue Gum is being encouraged at the expense of the slower growing Tallowwood and Brush Box.

It is time that N.S.W. stopped contributing to the worldwide obliteration of rainforests and started acting responsibly to, retain the little that we have left, for the sake of both its inhabitants and our future descendants. Logging of primary rainforest should cease immediately and all large or significant stands should be transferred to the protective custody of the N.P.W.S. This would cost only a few [illegible]s and is in line with the Commissions own beliefs:

> "Where timber production is of minor use of a substantial forest area, and dominant use lies in the fields of scenic and nature conservation plus recreation, or catchment protection, then management control and land title may be more appropriate to the National Parks and Wildlife Service."(1)

The so called 'moist hardwood' forests present a greater problem as the Commission still regards them as a major resource. Research into the ecology of these forms needs to be instigated and an inquiry held to determine their status, conservation requirements, and a management strategy. Meanwhile the few surviving old growth stands should be left inviolate, and clearfelling should be replaced with a "50% canopy retention" logging prescription.

The Forestry Commission's primary objective is:

> "To manage the forests of New South Wales for the benefit of the people of New South Wales"(1)

If you don't believe that you (or the rainforests) are benefiting from the Commission's form of management then please don't condone the continual degradation of our rainforests. Write to the premier and the minister for forests requesting that:

*All logging and roading of primary rainforests stop.

*An inquiry be instigated into the Commission's management of rainforests and `moist hardwood' forests.

*Logging of old growth forests cease immediately.

*Clearfelling of `moist hardwood' forests be replaced by 50% canopy retention logging.

*The National Parks system be expanded to include most stands of rainforest.

D.Pugh
Rainforest Information Centre

REFERENCE:
(1) Forestry Commission of N.S.W. Indigenous Forest Policy 1976, reprinted 1984.

TABLE 1. Rainforest timbers (m^3) removed from public lands and private property in N.S.W. 1982-87. (source:Forestry Commission Annual Reports)

FINANCIAL YEARS	PUBLIC LANDS		PRIVATE P.	TOTAL
	RAINFOREST	BRUSH BOX	RAINFOREST	
1982-83	17,400	52,300	3,300	73,000
83-84	13,300	50,300	4,000	67,600
84-85	13,500	54,500	3,800	71,800
85-86	5.000	63,300	1,800	70,100
86-87	3,600	64,600	2,500	70,700
TOTALS	52,800	285,000	15,400	353,200

NEW SOUTH WALES RAINFORESTS

by Dailan Pugh

THE LOGGING GOES ON

Rainforests display the peak of variety and complexity that life on earth can achieve. They cover less than 7% of the land and yet are home to nearly half the world's plants and animals. They supply a growing number of our medicines and bestow many other benefits upon mankind. They were our creator and we are their destroyer.

Rainforests are being devastated at the rate of a football field a second, an area the size of N.S.W. every four years. Unless there is a dramatic turn around now, then by early next century nearly all the accessible rainforests will be gone, and along with them up to a third of the world's species.

Australia, as the only developed nation to contain substantial areas of rainforest, has the ability - and thus the responsibility - to preserve those few stands we have not already destroyed. In 1982 the people of N.S.W. were duped into believing that the Wran Government saved their rainforests. Since then over 70,000 cubic meters of rainforest timbers have been removed annually from New South Wales' rainforests as they continue to be clearfelled and degraded.

IN THE BEGINNING

Once upon a time long, long ago (about 50 million years), the lost continent of Gondwana was a warm and wet land on which the rainforests so flourished that they covered most of the land. For millions of years Gondwana had been breaking up as various parts drifted away to form our present continents. By then only South America, Antarctica, Australia and New Zealand remained united, though rifts were developing.

As Australia and Antarctica separated a cold current developed between them. This led to the rainforests on Antarctica being overwhelmed by ice, whilst on Australia droughts forced the rainforests to retreat towards coastal refuges. As they retreated, many of their inhabitants stayed behind and adapted to the drying environment, thereby giving rise to our typically Australian kangaroos, wattles and eucalypts. By a similar process people were evolving from the rainforests on another fragment of Gondwana.

As Australia approached Asia, plants and animals found their way across the sea and began to find niches for themselves, often restricting or forcing out native species in the process. The first placental mammals arrived over 20 million years ago, though it wasn't until relatively recently (at least 50,000 years ago) that people made it.

Because of the Aborigines' basic technology and respect for the land, they had a comparatively low impact on the environment, though through their use of fire to manage the country they

further restricted the fire-sensitive rainforests and aided the expansion of grassy woodlands. Their hunting also played a part in the extinction of the giant marsupials that once dwelt here. Certainly the most dramatic and destructive period since the extinction of the dinosaurs began a mere 200 years ago with the arrival of predominantly European settlers. With no respect for the natural order, they began clearing the forests and introducing numerous plants and animals from their homelands to replace the native species. They soon began to attack the rainforests in the refuges, felling the giants whose lifespans were measured in hundreds and thousands of years. By their bicentennial they had managed to destroy over 75% of Australia's rainforests and variously degraded most of the surviving stands.

THE AWAKENING

By early this century vast tracts of New South Wales' rainforests had been cleared for agriculture and sawmills established throughout the forests. Increasing mechanization in the 30's paralleled increasing devastation of the rainforests. Mountain strongholds, where the rainforests had survived the, were being searched out and plundered.In northern New South Wales the Forestry Commission began clearing the rainforests' large plateau refuges and planting pines, though thanks to the actions of native animals in raiding the plantations and attacking the pines, their aims were only partially achieved. Following logging, large tracts of rainforests were destroyed in wildfires, while in most areas fire was (and is) used to force the rainforests to retreat further. The Forestry Commission was, in effect, subsidizing the loggers to degrade the forests which are owned by the Australian people. There was no incentive to manage the forests properly or for the loggers to establish their own plantations. As a consequence the rainforests were becoming exhausted of millable timber. More uses were found for the remaining trees, such as formboard used in concrete pours and then discarded. New South Wales' rainforests were being plundered unmercifully, as they still are today.

Fortunately, there was an increasing awareness amongst the general population of the rainforest's plight in the late 70's. Demonstrations begun at Terania Creek in 1979 drew people's attention to the plight of a number of rainforests in N.S.W. As a consequence, the politicians were forced to do something. In October 1982 the N.S.W. Government announced plans to increase the area of rainforest in national parks and nature reserves from some 29,000 ha. to around 80,000 ha., thus giving 32% of New South Wales' remaining rainforests some form of protection. This is less than 8% of the rainforests that were here 200 years ago.

THE SILENT MAJORITY

The Forestry Commission was left with over 140,000 hectares to use and abuse. The government, aided by some conservation groups, then began a campaign to dupe the people of N.S.W. into believing that the rainforests had been saved. While Bob Carr may claim that "...in 1982 the Wran Government stopped [rainforest] logging"1, the facts speak for themselves:

Rainforest timbers removed from public lands and private property in N.S.W (82-87)
[Source: Forestry Commission Annual Reports]

FINANCIAL YEARS	PUBLIC LANDS Rainforest cu.m.	PUBLIC LANDS Brush Box cu.m.	PRIVATE PROPERTY Rainforest cu.m.	TOTAL cu.m.
1980-81	60,739	72,800	4,426	137,965
81-82	50,491	113,900	6,571	170,962
82-83	17,400	52,300	3,300	73,000
83-84	13,300	50,300	4,000	67,600
84-85	13,500	54,500	3,800	71,800
85-86	5,000	63,300	1,800	70,100
86-87	3,600	64,600	2,500	70,700
TOTALS	164,030	471,700	26,397	662,127

Using the Forestry Commission's definition of rainforest timbers ("brushwoods"), there has been a welcome decline in volumes since 1982. But when Brush Box is included with the other rainforest species there has been a consistent average of over 70,000 cubic meters of rainforest timbers removed annually in N.S.W. As the cut of other rainforest timbers has declined, the cut of Brush Box has correspondingly increased. Brush Box is one of the hardier rainforest species, growing on the drier sites within the rainforest and more commonly around the margins. Structurally its stands can vary from a simple form with a scattered understorey of other hardy rainforest species to a complex form where a variety of other rainforest giants are co-dominants over a diverse understorey. In one form their massive pink trunks tower above a dense understorey of feathery palms. The Brush Box rainforests merge into the wet (eucalypt dominated) forests and are important both as a nursery and a buffer zone for the less hardy rainforest plants.

The Forestry Commission's denial that Brush Box is a rainforest species was tested at Terania Creek when their attempts to log Brush Box, some carbon dated at over 1700 years old, were thwarted by hundreds of demonstrators. The protesters argued that Brush Box was a rainforest species and that the Commission was therefore logging rainforest. At the consequent enquiry, three of Australia's foremost authorities on rainforest (including Professor Len Webb, then head of the CSIRO's Rainforest Ecology Unit) agreed with the protesters; only the Commission's employees disagreed.

The Commission's policy is to log Brush Box to their "economic

limit" at a rate "greater than their current sustained yield capacity".2 They practice clearfelling "in appropriate circumstances as in virgin areas of intolerant species which contain only mature and overmature stems".3 'Intolerant' species are trees, such as Brush Box, which don't regenerate well beneath a dense rainforest understorey. To encourage regrowth they often deliberately maximize damage to the rainforest and maybe set fire to it. Despite these measures, Brush Box regeneration is often poor, and the once stately forests are left as a mess of weeds and tangled regrowth.

Warm-temperate rainforests are also being virtually clearfelled. This is despite the Commission finding that "a much lighter selection seems to be necessary to retain healthy stands".4 Because the Commission regards lighter selection as uneconomic, they take every tree of monetary value and often plant eucalypts in their place. As for the rest of the 140,000 ha. of rainforest (by their definition) the Forestry Commission controls, some 8,000 ha. is within areas reserved from logging and the balance retained for unspecified "speciality purpose" logging. It is open to the vagary of whoever holds power in N.S.W. to decide what constitutes a special purpose.

Logging and roading of rainforest has numerous associated impacts. The destruction of the canopy allows sun, wind and cold into the forest, changing the microclimate unfavourably. Roads are a major cause of erosion, the soil muddying and silting up once clear mountain streams. For each tree taken hundreds of other plants may be mortally damaged, while animals loose both food sources and homes. The numerous logging tracks which now crisscross the rainforest are used by weeds, feral cats, wild dogs, cane toads, diseases and the like to penetrate and spread throughout the disturbed forests, displacing or killing many natives in the process.

A forest is the sum of the numerous interactions and complex interdependencies that plants and animals have developed over millions of years of co-evolution. The destruction of each link starts a new chain reaction that spreads through the forest. The more vulnerable species, and thus the rarest, lose out in the forest's struggle to regain equilibrium.

Despite the obviously detrimental effects that logging has on wildlife, the Forestry Commission refuses to undertake detailed plant and animal surveys before they log an area, even when it is known that endangered species may be present. Growing numbers of species are in danger of extinction because of human activities. In southern N.S.W. the rainforests are mostly small stands amongst drier bush. Their most serious threat is the high incidence of fires and the logging of their buffer zones. Stands are being reduced in size and eliminated at an alarming rate.

In northern N.S.W. the rainforests are being reduced by fire, destruction of buffer zones, heavy logging and roading. They are also being degraded by mismanagement. The Forestry districts of

Coffs Harbour-Casino and Port Macquarie incorporate the majority of New South Wales' unprotected rainforests and have hence borne the brunt of rainforest logging in recent years.

Within the Port Macquarie District "general purpose" rainforest logging officially ended in 1986 and has been replaced by "speciality purpose" logging. The mixed stands of Brush Box and other rainforest species are currently being logged to their "economic limit". The species other than Brush Box are supplying some 100 cubic meters of rainforest timber a month to a veneer mill. These rainforests are being virtually clearfelled under the guise that they are not really rainforest.

In the Coff's Harbour District "general purpose" rainforest logging is still occurring on a "maximum economic utilization" system. The warm-temperate rainforests adjacent to the Washpool National Park are being heavily logged and as a consequence are suffering from severe dieback and poor regeneration. They are being destroyed and replaced with eucalypts. Stands containing Brush Box are also being destroyed.

North of Washpool, adjacent to the Queensland border, some 10% of N.S.W.s' rainforests grow on the remnants of the Focal Peak volcano. It is one of the most biologically diverse regions in Australia and central to the distribution of many of the species endemic to sub-tropical rainforests. For N.S.W.s' most vulnerable bird, Coxen's Fig Parrot, and a large number of other endangered animals, the Focal Peak region is their major refuge. The Commission refuses to do faunal surveys before logging or to take effective measures to limit the impact on endangered species. The government refuses to consider any of the park proposals put forward for the region.

Instead of being continually degraded by the Forestry Commission, the rainforests need time to heal so that they can more effectively resist the increasing pressures being put upon them by our society. As noted by Neville Wran, "Rainforests are too sensitive to be entrusted to foresters."5

WHAT NEXT

The N.S.W. Government feels secure because most people have accepted their claims that rainforest logging ceased in 1982. As there is insufficient public pressure to force the Government to reassess the rainforest issue, they ignore the plight of New South Wales' dwindling rainforests. Bob Carr, the Minister for Planning and Environment, is "...largely satisfied that the Government's rainforest conservation aims have been achieved and that we are now in a consolidation phase."6

The Federal Rainforest Fund provides millions of dollars each year to the N.S.W. Government for the conservation of rainforest. The money is spent on developing the rainforests already in national parks for tourism and on acquiring some privately owned rainforests. Only one or two token gestures have been made to

assess the conservation requirements of the rainforests the Commission controls.

The Commission recognizes that "Where timber production is only a minor use of a substantial forest area, and the dominant use lies in the fields of scenic and nature conservation plus recreation, or catchment protection, then management control and land title may be more appropriate to the National Parks and Wildlife Service."7

If future rainforest logging is going to be limited to truly speciality timbers then the dominant uses of substantial rainforest areas will be for purposes other than timber production. A significant proportion of the federal funds should be spent on assessing the conservation requirements of these areas, and where desirable their management transferred to the National Parks and Wildlife Service.

1 Letter to the Editor, Sydney Morning Herald, 13 Oct. 1987.
2 Forestry Commission of N.S.W. 'Indigenous Forest Policy', 1976, reprinted 1984.
3 Ibid.
4 Ibid.
5 Neville Wran's keynote address to Seminar on Exploring Alternatives to Rainforest Timbers, Univ. of Sydney, 5 September, 1987.
6 Bob Carr, 30 September, 1987, personal communication.
7 Ibid, Forestry Commission of N.S.W.

FIRST DRAFT

MEASURES THAT NEED TO BE TAKEN TO CONSERVE VERTEBRATE FAUNA IN FORESTS.

Dailan Pugh, North East Forest Alliance

INTRODUCTION

1.0 **CONSERVATION OF FOREST VERTEBRATE FAUNA IN NSW**
- .1 THE BENEFITS OF MAINTAINING THE DIVERSITY OF FAUNA
  - .1 Invertebrate control
  - .2 Pollination and seed dispersal
  - .3 Other benefits
- .2 STRATEGIES FOR MAINTAINING FAUNA DIVERSITY
- .3 THE URGENT NEED FOR RESEARCH
  - .1 Fauna surveys

2.0 **HABITAT RETENTION**
- .1 RESERVING SUITABLE AREAS
  - .1 Will existing reserves and steep unloggable country do?
    - .1 What is good wildlife habitat?
    - .2 Wildlife priority areas
  - .2 The necessity for retaining old growth attributes.
  - .3 Habitat fragmentation
  - .4 Edge effects
  - .5 Global warming and increasing ultra-violet radiation.
  - .6 Designing adequate reserves.
    - .1 Minimum viable populations
    - .2 Migratory species

- .2 FAUNA CORRIDORS
  - .1 The need for fauna corridors
  - .2 Adequacy of fauna corridors
  - .3 Design of fauna corridors

3.0 **MANAGEMENT FOR WILDLIFE AND OTHER PURPOSES**
- .1 TIMBER
  - .1 Does multiple purpose management work?
  - .2 Habitat tree retention prescriptions
    - .1 Occurrence of hollows
    - .2 Utilisation of hollows
    - .3 Determining habitat tree retention prescriptions
  - .3 Logging on long rotations
  - .4 Logging at lower intensities
    - .1 25% canopy retention
    - .2 33% canopy retention
    - .3 50% canopy retention
    - .4 66% canopy retention
- .2 FIRE MANAGEMENT
  - .1 Birds
  - .2 Mammals
  - .3 Reptiles
- .3 ROADING AND DISTURBANCE CORRIDORS

30.73

MEASURES THAT NEED TO BE TAKEN TO CONSERVE VERTEBRATE FAUNA IN FORESTS.

FIRST DRAFT

INTRODUCTION

The Forestry Act 1916, National Parks and Wildlife Act 1974 and Environmental Planning and Assessment Act 1979 have all conferred a statutory duty upon the responsible government departments to ensure the conservation of fauna in N.S.W. In the main these departments have abrogated this duty and it has been up to concerned citizens to apply the law where possible. Because of the Forestry Commission's refusal to manage the fauna on the lands it controls in a responsible manner, and the Department of Planning's refusal to ensure the Forestry Commission complied with the Environmental Planning and Assessment Act's requirements to adequately assess the environment before commencement of an activity and prepare an Environmental Impact Statement if their proposed activities were likely to have a significant impact, the Forestry Commission has seriously degraded the faunal values of vast tracts of forests, fostered division in the community and been dragged before the Land and Environment Court on numerous occasions since 1980.

The Land and Environment Court ruling on Corkill vs. Forestry Commission (1991) over three compartments in Chaelundi State Forest, the subsequent ruling of the Court of Appeal and the Endangered Fauna (Interim Protection) Act have clearly established the National Parks and Wildlife Service's responsibility to ensure the conservation and survival of native vertebrate fauna throughout N.S.W. There is thus an unprecedented opportunity for the National Parks and Wildlife Service to develop a comprehensive strategy to protect fauna across all land tenures through both ensuring an adequate reserve system and designing mitigation measures to lessen the impact of developments and activities upon fauna.

It remains to be seen as to whether the National Parks and Wildlife Service will adequately implement their duty to ensure the conservation of fauna throughout the state or whether political interference, lack of resources, lack of resolve and inadequate knowledge of fauna will combine to allow the destruction of our unique fauna to continue unabated. It is hoped that it will not be again necessary for concerned citizens to drag a government department through the courts in order to get them to fulfil their legal responsibilities. Unfortunately history has a way of repeating itself.

It is evident that because of the abysmal lack of knowledge of Australian fauna and the impact of habitat modification upon

apparently sensitive species, any conservation strategy can only be based on the best available information at this time and must be modified as more information becomes available. Given that habitat alteration is exponentially worsening and the fact that yet more species are undoubtedly doomed to extinction as changes already wrought upon their habitats become fully manifest it is imperative that a cautious and conservative approach be adopted.

While it is essential that fauna be conserved across the whole of N.S.W. throughout all habitats, this report focuses on forest dependent vertebrate fauna. Many of the principles and recommendations contained herein are applicable to other habitats.

At this stage this report is incomplete as many more references are yet to be incorporated. Many sections, including the list of target species, are still incomplete. It is being circulated to facilitate a more rational approach to fauna conservation at this early stage of the Endangered Fauna (Interim Protection) Act's implementation. Any comments and additional information will be appreciated. Please note that it is a draft and still contains a number of errors.

Dailan Pugh
North East Forest Alliance

1.0 CONSERVATION OF FOREST VERTEBRATE FAUNA IN NSW

Tyndale-Biscoe and Calaby (1975) state "The *Eucalyptus* forests of southeastern Australia and Tasmania support a rich and varied fauna of mammals and birds and together form the single most important refuge for wildlife in Australia. A greater number of mammal species are found in these forests than in any other broad category of habitat..."

McIlroy (1978) notes that within Australia 16% of birds and 17% of mammals are confined to rainforest and 16% of birds and 35% of mammals are confined to sclerophyll forest.

Neave and Norton (1990) state "The major threat to forest fauna arises through the fragmentation and loss of their habitat... The species at greatest risk of extinction are those which appear least resilient to habitat modification... The long-term viability of now disjunct populations of fauna may be compromised further by many factors including predation by introduced carnivores such as foxes... and episodic extreme events like fire, drought and outbreaks of disease... Additional problems include the inadequacy of the existing nature conservation reserves within forests... and the inconsistent regimes of forest management across State borders and land tenures".

Recher (1986) considers that to guarantee the rehabilitation and survival of forest wildlife there is a need to implement practices designed specifically to manage wildlife. He states "It is not enough to set aside samples of forest for nature conservation and expect these, by themselves, to ensure the survival of Australia's forest biota."

Recher (1986) emphasises the need to integrate wildlife conservation and management on private lands with those on Crown Lands and states "The lack of regional and national planning for forest wildlife planning can not be allowed to continue."

Bennett (1990) states "Reserved areas are vitally important for nature conservation, and it is essential that a representative set of natural ecosystems be protected with nature conservation as the primary objective. Nevertheless, this intensive approach is by itself is insufficient. We cannot rely on nature conservation reserves alone for the long-term protection and preservation of wildlife communities. We must develop a broader perspective and manage fauna at a regional, statewide and national scale, that includes lands used for a range of other purposes."

Norton and Lindenmayer (1990) state "Australia needs a coherent strategy to integrate the management of wildlife across all forested lands. The destruction and degradation of forested lands on the Australian continent since European settlement can be attributed to a variety of factors including the need for

settlements to survive, ignorance, poor planning and lack of concern for the environment. But these reasons will become lame if used any longer."

Davey and Norton (1990) state "It is clear that historical patterns of forest-use have had a significant, often detrimental, impact on the population status of many native, forest wildlife. At the same time, knowledge of the effect of these practices on most wildlife is not available. Many more species may have become extinct than is recognized."

Davey and Norton (1990) state "decision-making on the allocation of forest resources (wood, non-wood) appears to favour a perspective that is subjective and political rather than scientific. Political decision-makers have not, in general, adopted an approach in the allocation of these resources based on ecological and environmental principles."

Shaw (1983) states the general goals of wildlife conservation in state forests of Victoria are to: manage in order to maintain the diversity of species which are indigenous to that state's forests, and; manage for featured species (i.e. species of special social or ecological significance).

Loyn (1985) considers the primary objective of wildlife conservation is to ensure that no species becomes extinct or reduced in range. He states it is desirable "to conserve all species in major forest blocks and to do this populations must be maintained above critical levels needed for long-term survival."

1.1 THE BENEFITS OF MAINTAINING THE DIVERSITY OF FAUNA.

Gilmore (1990) states "There is increasing evidence that vertebrate wildlife are essential components of forest ecosystems and contribute to their long term stability and productivity. Vertebrate roles include: facilitating long distance pollen dispersal and outcrossing compared to Honey bees (*Apis mellifera*) and other insects...; consumers of herbivorous arthropods...; dispersers of fungal and higher plant spores and seeds... Passage through an animal's alimentary canal facilitates the germination of mycorrhizal fungal spores ... and the germination of seeds."

1.1.1 INVERTEBRATE CONTROL

Cowley (1971) notes that the majority of land birds are insect eaters, and each occupies an ecological niche relatively free from the competition of other species, stating "The combined effect of these birds on the insect population must be tremendous." He cites the beneficial effects of Pied Currawongs feeding on phasmatids, Yellow-tailed Black Cockatoos on wood boring insect larvae and cockatoos on the larvae of cerambyoid beetles and cossid moths. He notes that forests are the breeding areas for many species that spend most of their time in surrounding farm and pasture land.

A major problem associated with severe disturbance (particularly logging) of forests is the proliferation of the aggressive and territorial Bell Miners *Manorina melanophrys*. They exclude other birds while undertaking "farming" of psyllids, this results in the consequent death of regrowth trees.

Loyn (1985) found that when Bell Miners were removed from a psyllid-infested stand of mixed eucalypts there was an immediate influx of other birds which controlled the psyllids. He notes that the invading species were birds that are more abundant in mature forest than regrowth.

1.1.2 POLLINATION AND SEED DISPERSAL

Cowley (1971) notes the honeyeaters and lorikeets are important agents in the cross pollination of eucalypts, melaleucas, banksias and grevilleas.

Cowley (1971) notes the Mistletoe Bird is well known for its role in the spread of mistletoe.

Richards and Tidemann (1988) state "There is definitely a close relationship between fruit bats and the reproduction of many of their food trees, primarily through the pollination of flowers as nectar is consumed, and the dispersal of seeds in fruits that are eaten. These processes are vital to rainforest for the continued survival of some tree species and to the general cycle of rainforest regeneration."

1.1.3 OTHER BENEFITS

Cowley (1971) notes "The Superb Lyrebird is thought by some ecologists to play an important part in aerating the soil in mountain forests. It has been estimated that their scratchings in certain areas are equivalent to digging the entire forest floor once every two years."

1.2 STRATEGIES FOR MAINTAINING FAUNA DIVERSITY

Cowley (1971) stated "Our immediate objective should be to recognise, classify and conserve the widest possible variety of habitats, and by so doing conserve the greatest possible diversity of species." and "Single purpose reserves can readily be justified in certain cases, for example where there are rare or endangered species..."

Shaw (1983) suggests a number of measures that can be adopted until research provides the information needed to develop more specific guidelines: planning to provide appropriate reserves and corridors of old growth timber; providing a range of uncut vegetation reserves which includes at least some that are 2 000 to 20 000 ha in size; considering and planning the arrangement of corridors and reserves in a regional, state and national context; providing buffer strips to corridors that are harvested on a selective cut rather than clear cut; and, focusing wildlife conservation on species of special significance.

Loyn (1985) considers three strategies to provide for species that require old trees or patches of old forest: leave enough trees for them on individual harvested areas; extend the rotation so that there is time for regrowth to develop suitable habitat and be recolonised by breeding populations before it is harvested again; and retain strips and patches of old forest within a mosaic of harvested areas. He considers the later strategy to be most effective.

Recher (1986) cites a number of positive management initiatives: establishment of fauna priority areas; lessening the impact of logging on forest types with a restricted distribution or which are rich in species: establishment of corridors to link drainages and allow movement between nature conservation areas; harvesting forests with high wildlife values on a longer cutting cycle; and, retention of known habitat trees and suitable developing habitat trees.

Davey (1989) considers that within production forest viability of strategic areas will relate to availability of habitat trees, movement corridors and the maintenance of reserves managed for the conservation of wildlife species. He emphasises the value of disturbed forests for conservation of many species and, where required, the manipulation of reserves to meet prescribed wildlife objectives.

Davey (1989) considers that it is necessary for a manager to work within a defined region covering all land tenures (which may extend across State or other boundaries) within which areas of wildlife priority or significance can be identified and managed accordingly.

Dunning and Smith (1986) consider "There are three approaches to conserving arboreal mammals in logged forest; (i) preservation in unlogged reserves or corridor systems; (ii) preservation within logged areas by appropriate rotation and spatial organisation of logging coupes; and (iii) conservation within logged compartments by modification of logging practice and reduction of logging intensity to maintain species and their essential resources at a lower but stable density."

Dunning and Smith (1986) state "The first approach is useful for disturbance intolerant species with broad habitat requirements, the second for species with good dispersal capability dependent on particular successional stages after disturbance and the third for disturbance tolerant species dependent on mature forest."

Dunning and Smith (1986) recommend that the conservation of arboreal mammals and reptiles in their study area may best be achieved by designation of three zones of management: (i) an unlogged rainforest gully corridor system and unlogged moist hardwood ridgetop corridor system; (ii) a moist hardwood zone where logging intensity is low (33% canopy retention); and (iii) a logged moist hardwood zone with the retention of 4-5 hollow nest trees per hectare."

Lunney, Cullis and Eby (1987) recommend a number of options for conserving small mammals, (i) minimizing fire, including control burning, (ii) retaining unlogged forest with dense ground cover, (iii) extending the time over which alternate coupes are logged, to avoid creating a forest of uniform regrowth, and (iv) minimizing disturbance to the ground cover by heavy machinery in the retrieval of logs.

Norton and Lindemayer (1990) propose "the following set of ideal and minimum goals for forest wildlife management:

1. identify the full range of forest ecosystems remaining within the forest estate;

2. determine precisely the size and spatial arrangement of the remaining forest ecosystems;

3. assess the degree to which each forest ecosystem has been, or is being, modified by human practices;

4. establish the current land tenure of these forest ecosystems;

5. quantitatively evaluate the representativeness and viability (in terms of the identified range, size, spatial configuration and degree of modification of forest ecosystems) of the present conservation reserve network within native forests;

6. identify all forest species and determine their geographic range within the remaining native forests. This will need to be undertaken sequentially with perhaps an initial focus on key vertebrate and invertebrate groups...;

7. characterise the variation in genetic diversity exhibited by populations of all species across their geographic range;

8. determine the minimum habitat requirements (i.e. shelter, breeding, food) for the conservation of all forest species;

9. develop and implement a conservation strategy (e.g. revise the existing conservation reserve network, promote a conservation ethic for the use of lands outside the reserve network...) to accommodate all the needs identified in points 5. to 8.; and

10. establish a reliable, scientifically-based infrastructure which permits the strategy in point 9. to be monitored and updated regularly."

Norton and Lindemayer (1990) consider that: (i) the first two management goals could be addressed by the establishment of a geographic information system containing both environmental (e.g. climate, terrain, substrate) and biological data (e.g. location of remaining forest cover, reliable records of plant and animal distributions, forest floristics and structure), (ii) the third

goal requires the development of a generally-accepted classification, (iii) the forth goal is readily achievable, (iv) the fifth goal relies on the success of other goals, and (v) goals 6, 7 and 8 depend upon identifying all forest species, their habitat requirements and degree of genetic variability within and between populations. They consider that because the geographic distribution, habitat requirements and genetic variability of almost all forest fauna are not well known, it is necessary to evaluate the possibility of using key species (indicator, keystone and mobile link species) or groups of species that may be indicative of the well-being of ecosystems *in toto* or known important components of ecosystems.

Norton and Lindenmayer (1990) state "While knowledge of forest ecosystems and wildlife is limited, a number of practical steps can be readily adopted to facilitate more integrated conservation and management. These include a conservative use of forests and the need for more strategic and systematic research and planning. Current forest uses that are not, or do not appear to be, sustainable in the long term should be minimised or stopped. These include extensive forest clearing and the logging of old growth forests on fertile soils. At the same time, it is essential to quantitatively evaluate and upgrade the existing conservation reserve system within forests and to encourage more conservative land-use practices in forests outside of parks and reserves. Without the adoption of these steps in the short-term, it is unlikely that the ecological integrity of many forest ecosystems will be maintained in the long-term. As a consequence, considerable genetic diversity within species will be lost and the probability that forest wildlife will become extinct will continue to increase."

Davey and Norton (1990) consider "that both drought and fire needed to be considered within a wildlife planning framework, particularly in forests subject to logging."

1.3 THE URGENT NEED FOR RESEARCH

Tyndale-Biscoe and Calaby (1975) state "However, it is by no means a simple matter to ascribe a status to a particular species without a thorough study of its life history and ecology. Very few species of the forests we are considering have been so studied. Indeed it is still not possible to say with any precision what species occur in a given forest, how many of each species, nor what the minimum requirements of space and habitat are for long term survival of any species. To do this, inventories of species need to be prepared for selected areas throughout the range of forests and the requirements of each species determined. These later include short term or continuous requisites for individual survival, such as food, shelter and space, and long term requisites for the species' survival. The latter include special breeding grounds, refuges from drought or fire and space for a population of sufficient size to ensure genetic diversity and gene flow. Factors involved in this are

density, mobility, fecundity, longevity and social organisation of the species."

Shaw (1983) considers the task of integrating wildlife considerations into forest management practices should be approached at two levels; research to answer basic biological questions concerning forest animals and the effects of forestry on wildlife, and management to translate research findings into actual forest management policies.

Richards and Tidemann (1988) emphasise that although bats constitute one-quartre of Australia's mammal fauna they have received the least attention from scientists, stating "we are still learning the basic biology of our bats, and have not yet even established the full complement of species inhabiting Australia."

Davey (1989) notes "Whilst some information is becoming available, the knowledge necessary to make a sound prediction on the consequences of forest operations upon wildlife does not yet exist."

Davey (1989) outlines some of the research required to enable rational fauna management: an adequate vegetation classification which can be used to delineate faunal habitat across Australian forests; information about the temporal resources of species; differentation/discrimination/identification of critical limiting factors to which a species responds; an understanding of the effects of habitat manipulation on target species; information on behavioural traits associated with physiological requirements; demographic studies of species; and information to enable accurate prediction of the sizes of populations of forest wildlife.

Davey and Norton (1990) note the paucity of information available on wildlife and outline in some detail the research and planning systems they consider required to achieve scientific and rational forest planning and management for wildlife. They note "Few studies have addressed satisfactorily the meshing of an ecological understanding of wildlife into a forest planning framework. Such an approach, while considered necessary..., is still in its infancy."

Davey and Norton (1990) note "To understand population dynamics, data are required on the life histories (e.g. fecundity, mortality, dispersal) of, at least in the first instance, forest-dependent taxa or species considered to be indicators of biological diversity, guilds or ecosystem stability (e.g. owls, native marsupial carnivores). These types of information are critical for the viable management of functional forest ecosystems and wildlife in fragmented habitats or those subject to recurrent disturbance... Such data are a prerequisite for the determination of minimum viable population size or the planning and management of wildlife corridors."

Norton and Lindenmayer (1990) consider the central requirement to establish a coherent approach to wildlife conservation "is the need to establish a systematic research and management framework to identify important gaps in knowledge and to help set priorities for funding." They identify a number of issues that need to be addressed, including: (i) the feasibility and rationale for using indicators, keystone species and mobile link species, (ii) the effects of fragmentation, including edge effects, (iii) the role of forest corridors and the creation of new habitat in linking and enhancing viability of forest fragments, and (iv) establishing benchmark sites for monitoring ecosystem and population fluxes through time.

There are two major deficiencies with the majority of research into the effects of logging on fauna, (i) very few are comparisons of the same sites pre-logging and post-logging, most comparisons are between sites selected for their similar attributes with no certainty of the variables, and (ii) many sites are within close proximity to unlogged areas.

Gilmore (1990) states "Clearly we need to be able to specify the composition and structure of future stands under all potential management options, and to know what a particular part of the mosaic represents in terms of its suitability as habitat. A long term modelling and simulation capability must be developed, before it can be claimed that our planning and management is based more on science than faith.", and "How forest resources and dependent populations of wildlife are going to fluctuate in space and time, over timespans of several hundred years, needs to be determined. A planning period of this length is needed, as critical wildlife resources may take that long to develop".

Shields and Kavanagh (1985) state "enlightened wildlife management will rely on assessments of the impact of continued operational cycles of forest management on forest fauna."(p.26).

Tyndale-Biscoe and Calaby (1975) conclude "Reliable and worthwhile information cannot be collected in a short time and the deplorable thing is that changes to the forests are going on at such a rate that society may not be able to exercise its rightful choice between eucalypt forests as a timber resource and eucalypt forests as a refuge for wildlife."

1.3.1 FAUNA SURVEYS

Davey and Norton (1990) state "Clearly, forest surveys remain a fundamental component of any viable strategy for wildlife management but, at the same time, they need to be made cost effective. This can be achieved by moving, whenever possible, from one-off inventories towards surveys which record, at least, parameters readily adapted to Geographic Information Systems (GIS) and process models."

Davey (1990) states "Efficient planning for environment and wildlife management in our native forests now requires adequate ecological data bases collected by standardised methods to enable

comparison between habitats, regions and years... A standard survey system should provide estimates, in a standardised unit, of relative abundance of the population detected. Techniques should be usable by individuals (an increasing requirement for forest wildlife surveys), should minimise variability between individuals, be both time and cost effective and be compatible with an integrated faunal survey. To be effective, the influence environmental factors have upon detectability and abundance must be known."

Shields and Kavanagh (1985) state "to investigate or conserve animals, it must first be determined whether or not they are present in the areas under consideration."(p.10)

2.0 HABITAT RETENTION

Norton and Lindenmayer (1990) consider "that a reserve network stratified, in part, on regional environmental gradients might help capture the greatest range of forest wildlife... and be a useful basis for managing wildlife in light of climate change... Therefore, a practical approach to maintaining the present diversity of wildlife in native forests needs to aim at ensuring the linking or networking of areas managed primarily for nature conservation across major latitudinal and elevational gradients. This approach would attempt to maximise the long term options available for managing forest wildlife and maintaining ecosystem integrity... and be amenable to modification as new scientific data became available."

Davey and Norton (1990) state "Planning for the conservation of forest wildlife presently centres around the principles of island biogeography, minimum viable population and optimal habitat. ... In general, present design involves the linking of reserves, drainage lines (filter strips) and areas unable to be logged for logistic or economic reasons (refuge areas) with unlogged forest through which wildlife can disperse (wildlife corridors). All these features within the design area remain unlogged."

Bennett (1990) states "in forests used for timber harvesting, corridors must form part of a linked system of retained habitat that will sustain, throughout the forest landscape, populations of species that are sensitive to harvesting. The system of retained habitats will include nature reserves and other existing reserves...; areas exempted from harvesting because of steep slopes, or because they are uneconomic for production; filter strips and buffer strips retained to protect water quality; designated sites of floral or faunal significance; rainforests and their associated buffer strips; and, a hierarchy of wildlife corridors. Initial planning and location of corridors may be most appropriately carried out on a forest block basis, but it is important that the system of retained habitat be co-ordinated and developed from a broader regional perspective."

2.1 RESERVING SUITABLE AREAS

2.1.1 Will existing reserves and steep unloggable country do?

Recher (1986) states "Generally, the forests reserved for nature conservation have been those in the wildest and most remote places or those on poor soils with limited commercial potential. Preservation has seldom been preceded by any form of inventory or biological assessment and has been largely a political exercise in response to pressure from the conservation lobby."

Neave and Norton (1990) note "reserves have often been established only where other land use-options have not been considered economically-viable... As a consequence, representative samples of the remaining range of Australia's forest biodiversity are yet to be adequately protected... The size of existing reserves is also of concern as many may not be viable in the long-term without active management... Most reserves in forests are less than 15,000 hectares in size and few are larger than 50,000 hectares".

Kavanagh (1985b) considers that areas reserved because they are steep unloggable country "are likely to contain poor habitat for animals and may therefore be a poor source for the recolonisation of adjacent more favourable, but unlogged areas."

2.1.1.1 WHAT IS GOOD WILDLIFE HABITAT.

Binns (1981) reporting on Braithwaite's research in the Eden Region notes that arboreal mammals were concentrated in areas of favourable habitat rather than randomly or uniformly distributed (60% of animals were in about 5% of the forest area). More were found in tablelands wet sclerophyll types than drier coastal types, on more fertile soils and in areas from which severe fires had been excluded for at least 20-25 years.

Mackowski (1983) states that Braithwaite's findings that high concentrations of arboreal mammals occur only in high site quality forest is supported by preliminary analysis for north east NSW.

Shields and Kavanagh (1985 pp.81-82) state "the conservation of all possum - glider species depends not only on substantial areas of uncut, unburnt forest but also on retention of tree species diversity."

Gilmore (1990) states "Important determinants of the carrying capacity of a particular stand of forest for vertebrate fauna are, firstly *forest type*, which reflects a limited range of climate, soil and other site variables, as well as the quantity and quality of herbage, nectar and even insect populations available to consumers... Secondly, the *history of the stand* with respect to fire, silvicultural treatments, harvesting etc. The *size and context of the stand*, with respect to adjacent stands and potential sources of plant and animal propagules or colonists, microclimate and edge to area ratio can all influence

fauna populations, such that a particular population is prevented from reaching the carrying capacity defined by summing the innate, resource based carrying capacity of a series of stands."

Recher *et al.* (1991) note "The structual and biological diversity of these forests is an indication of the greater availability of water and richer soils (i.e. nutrient status) along creeks and gullies on ridges. Overall biological productivity is probably greater under these circumstances and greater population densities and richer faunas can be sustained.", and "The lowest population densities occurred in dry open-forests on ridges... These forests were characterized by low plant species diversity, a low, open canopy, poorly developed shrub and sub-canopy vegetation and often had skeletal soils."

Lunney, Cullis and Eby (1987) found that Bush Rat and Dusky Antechinus displayed a significant preference for south-east aspects over north-west aspects.

Neave and Norton (1990) consider the most favoured habitat of Greater Glider can be defined best by forest site productivity (fertile soils and a slope < 15 degrees) within its specific bioclimatic envelope.

Mackowski (1984) found "Blackbutt forest less than about 35 metres site height contains very low possum and glider populations".

Davey (1989) states "Habitat units encompassing optimum habitats for a number of 'target' species should where possible form the core areas as they will be viable sources of population from which a species can disperse."

2.1.1.2 WILDLIFE PRIORITY AREAS

Kavanagh and Webb (1989) state "Wildlife priority areas can be defined as those areas with particular significance to wildlife, either in terms of their richness of species or, in terms of their populations of sensitive and/or rare species."

Kavanagh and Webb (1989) considered that vegetation communities important for the most sensitive (to logging) species - Greater Glider, Yellow-bellied Glider and Feathertail Glider - should be designated Wildlife Priority Areas, particularly where all three species are present. Kavanagh (1990) further notes that the Sooty Owl and Powerful Owl also need to be considered priority species.

Davey and Norton (1990) consider that significance of areas can be determined in a number of ways, including "(i) high value of optimal habitat reflecting high population density of a select species; (ii) high habitat-unit value (habitat-unit equates with a high diversity of habitats in a geographic area...); and/or (iii) high diversity or population density of select species. Select species are those that are rare, endangered or sensitive (detrimentally) to forest operations."

Davey (1989) considers the significance of an area for fauna can be determined in terms of either (i) habitat values approaching optimum, reflecting high population numbers of a target species, (ii) providing habitat for a lot of target species and/or (iii) high importance values of target species.

Recher *et al.* (1991) state "Those planning the conservation and management of the avifauna in southeastern [NSW] forests must recognise that species may have a restricted elevational range and/or specific habitat requirements. This includes species dependent upon mature forest, but others may have equally precise and particular requirements. Species with narrow habitat requirements (e.g. brown warbler, Lewin's honeyeater, glossy black cockatoo, spotted quail thrush, red-browed treecreeper) and those with special resource needs (e.g. hole-nesting birds such as cockatoos, treecreepers and owls, and bark-foraging species such as treecreepers and shrike-tits) justify the greatest concern from forest managers. Few of these species have shown the ability to adapt to the effects of logging".

Shields and Kavanagh (1985, p.15) state that "at present, conservation by reservation of the preferred forest types (eg. managing for habitat) is the safest option because it is not known what level of logging can be undertaken and still retain viable populations of animals, nor is the rate of recolonisation known for those areas which are rendered temporarily uninhabitable by logging."

2.1.1.3 MIGRATORY SPECIES

Birds and flying-foxes undertake significant seasonal migrations. Conservation of migratory species requires consideration of various species latitudinal migrations (mostly northwards winter movements), altitudinal migrations (mostly species that breed at higher elevations in summer and descend to lower elevations in winter) and nomadic wandering (mostly species following flowering sources).

2.1.2 **The necessity for retaining old growth attributes.**

Mackowski (1987) interpreted the structure of natural unlogged (old growth) forest "as being an irregular unevenaged forest made up of an overlapping mosaic of even though different aged cohorts." He subjectively determined that two unlogged Blackbutt stands each contained 5 cohorts of trees in various size classes. The cohorts were assumed to have resulted from periodic regeneration events, notably fire induced.

Loyn (1985) considers that the species which need specific attention are those reliant upon old trees or old growth forest, particularly uncommon or rare species which are sensitive to harvesting.

Old trees provide a variety of resources which are either not provided, or provided in significantly lesser quantities, by young trees:

-hollows (e.g. Dunning and Smith 1986, Mackowski 1987)
-large logs (e.g. Mackowski 1987)
-nectar (Loyn 1985,)
-some insects in the bark and foliage (Loyn 1985,)
-regular and abundant supply of insect food (Loyn 1985)
-nectar and fruit of mistletoe (Loyn 1985,)

Loyn (1985) considers species most reliant upon old growth to be those utilising old trees for feeding, such as some honeyeaters and mistletoebirds which feed on mistletoe nectar or fruit, some insectivorous birds which feed from old eucalypt bark or among canopy foliage and some arboreal mammals which feed on sap and invertebrates from large eucalypt trunks and branches or on canopy foliage in tall eucalypts.

Richards and Tidemann (1988) note that most of the 20 or so species of bats that inhabit Australia's southern forests use tree hollows as refuges in which to roost during the day, and to rear their young, and as 'safe houses' during several months of inactivity or hibernation each winter.

Mackowski (1984) states "Hollows in eucalypt trees are an essential resource for most possums and gliders. Five of the ten possums and gliders occurring in central eastern Australia require tree hollows for denning - arguably nine species require tree hollows for nesting."

Bennett (1990) states "Species that have been identified as being sensitive to forest changes resulting from timber harvesting are primarily those that are dependent upon some aspect of a mature, or old-growth, forest environment... Animals that use tree hollows, such as forest owls, parrots, cockatoos, gliders, possums and bats, are prominent examples. Of particular importance are those forest-dependent species that naturally occur in low densities; predators (e.g. Masked Owls, Powerful Owl), species with large body size (e.g. Yellow-tailed Black Cockatoo), and those that are social, or have have specialised foraging or habitat requirements (e.g. Leadbeater's Possum, Yellow-bellied Glider). For these species, the effect of broad-scale habitat changes are compounded by the need for larger areas to sustain viable populations."

Recher *et al.* (1991) cite research that suggests "the importance of both forest maturity (approximated by total biomass) and productivity in determining the number of bird species which can co-exist at a site".

Davey (1989) considers sensitive species of fauna dependent upon mature forest need consideration as the lengths of time involved make it difficult to appreciate the long-term effects of forestry practice on these species.

Bennett (1990) notes "it is not uncommon for canopy trees to pre-date European settlement, particularly those trees in small remnants or scattered through farmland. However, there is often an obvious lack of successful regeneration, due to grazing by stock, to replace these ageing individuals. As remnant stands age and senesce we can expect even further depletion of forests and woodlands in the rural landscape, unless active measures are taken to promote regeneration."

2.1.3 Habitat fragmentation

Bennett (1990) considers habitat fragmentation "one of the major issues confronting wildlife conservation on a global scale. In Australia, clearing and fragmentation of natural vegetation is also of major importance, and it is having a profound effect on our native fauna." He notes that documented examples of species' extinctions have frequently shown an initial pattern of major range reduction and fragmentation followed by successive extinctions of local populations.

Neave and Norton (1990) state "The major threat to forest fauna arises through the fragmentation and loss of their habitat... The species at greatest risk of extinction are those which appear least resilient to habitat modification... The long-term viability of now disjunct populations of fauna may be compromised further by many factors including predation by introduced carnivores such as foxes... and episodic extreme events like fire, drought and outbreaks of disease..."

Bennett (1990) states "Fragmentation of wildlife habitats can also occur in large, seemingly intact, tracts of vegetation. Timber harvesting, for example, leaves isolated or loosley-connected patches of mature forest (old-growth forest) amid stands of regenerating forest. With the increasing intensity and scope of forestry activities in south-eastern Australia, areas of mature forest outside reserves are becoming fewer in number, smaller in size, and more and more isolated. For the fauna that is dependent upon mature forests, the degree of isolation of populations in these patches is related to their ability to pass through or utilise forests of earlier successional stage. Fires, both natural and of human origin, can also create patches of differing successional stages within extensive natural areas, and so isolate faunal populations that may depend upon a particular seral stage."

Bennett (1990) considers there are three main consequences of habitat loss and fragmentation:

(i) changes in the number of species in fragments - there is a highly significant relationship between the area of a fragment and the number of species that are present, with larger fragments likely to have sampled a greater diversity of fauna habitats and fauna, and larger more viable populations;

(ii) changes in the composition of faunal assemblages - smaller patches support the most widespread and 'edge' species and larger fragments the more uncommon and 'forest-interior' species; and

(iii)changes in the ecological processes - the loss of native species and invasion by exotic species disrupts or modifies ecological processes such as food chains, predator-prey interactions, plant-animal pollination and dispersal associations, and nutrient cycling pathways.

Saunders (1990) in his study of Carnaby's Cockatoo (in remnants in Western Australia) found that nesting attempts at one fragmented site declined from 23 in 1970 to none in 1977, and they have not been recorded in the area since. He observed that at least one nestling was killed by a cat and at least seven nest hollows were invaded and taken over by Galahs. He notes that the galah was not found in the south-west of Western Australia prior to European settlement but has quickly expanded into agricultural areas with clearing of native vegetation, this, coupled with the cockatoo's need to forage widely and consequent inability to adequately defend its nest, has left the cockatoo vulnerable to competition with galahs.

Gilmore (1990) notes that "many small remnant populations will continue to disappear, as time since isolation is one of the independent variables influencing extinctions in remnants."

2.1.4 Edge effects

Andrews (1990) states "The edge is a human artefact where two contrasting habitats suddenly converge without the natural graduations. The human made edge is usually inimical to most wildlife, and species from the natural interior do not inhabit edges. Species with excellent dispersal abilities, capable of invading and colonizing disturbed habitats, are attracted to edges, and move into the core of natural habitats if a road or utility corridor carries the edge into a previously undisturbed area. The edge experiences a different wind and radiation effect, leading to a different microclimate. If habitats are fragmented too much, and the ratio of edge to interior favours edges, the habitat will no longer be suitable for the interior species we most need to conserve. The core of areas important for conservation should ideally not be dissected with roads and utility corridors which create edge effects."

Bennett (1990) outlines some of the effects of edges:

(i) micro-climate changes - including changes in solar radiation, incident light, humidity, temperature, and windspeed.

(ii) changes in the composition and structure of plant communities - species from adjacent habitats, including weeds, can invade and compete with forest plants,

(iii) wildlife species that are edge specialists and those typical of adjacent developed habitats can invade the edge and become predators, competitors, or parasites of interior species,

(iv) edges are prone to a range of disturbances - including the drift of fertilizers and chemicals from farmland, trampling and grazing by farm animals, fires escaping into forest edges or riparian buffer zones, the placement of access tracks and control burns along edges, and recreational disturbance and littering.

Gilmore (1990) cites research that suggested "that forest-edge and farmland bird species exclude certain forest dependent bird species from smaller forest fragments more than area-dependent changes in habitat or degree of isolation." He notes that a variety of researchers "have all differentiated bird species by the degree to which their populations increase or decline with different degrees of habitat fragmentation."

Bennett (1990) cites various overseas research that found; (i) in terms of vegetation structure the width of the edge was less than 13 m. but based upon the distribution of birds nests the functional width of the edge ranged from 9-64 m., (ii) elevated levels of predation on birds nests at the forest-farmland edge declined with increasing distance into the forest, and were still higher at 100 m than 200-500 m. into the forest, and (iii) changes in the microclimate of forest patches adjacent to farmland extended from 30 m to more than 100 m. depending on aspect.

Gilmore (1990) notes "The creation of a large ratio of edge per unit area between stands of different age will benefit non forest-dependent species. Recent studies overseas indicate that edges and roads are utilized to a greater degree by predators and nest parasites."

2.1.5 Global warming and increasing ultra-violet radiation.

Page (1989) discusses the impact of rising sea levels and shifting climatic zones on ecosystems. He notes that the life zones that circle mountains in tiers would move up vertically and that the higher a life zone moves the smaller it becomes. He states "As an ecosystem becomes smaller, it supports fewer individuals. At some point, an increasingly small population becomes inbred - usually with lethal effects."

2.1.6 Designing adequate reserves

Davey (1989) outlines the five principles that have been applied to the survival of populations on marine islands:

i) as the size of a reserve increases, the probability of any one species becoming extinct diminishes;

ii) a single composite area is preferable to several smaller reserves of equal total size;

iii) if fragmented, reserves should be connected by corridor systems;

iv) if fragmented, reserves are better where equidistant; and

v) if fragmented, reserves are better where close together.

Davey (1989) considers that the forest analogy to 'islands' results from the planting of exotics, clearing for agriculture and intensive logging of native forests on short rotations, which break up the continuity of mature forests.

2.1.6.1 MINIMUM VIABLE POPULATIONS

Tyndale-Biscoe and Calaby (1975) note that an "Effective population number is the population size that will retain the original genetic diversity of the species, or a large fraction of it, in perpetuity and provide the genetic means for continued evolution. It must take account of natural fluctuations and be large enough to withstand the vicissitudes of fire, disease and drought; it is the lowest number that the population can fall to under these circumstances."

Tyndale-Biscoe and Calaby (1975) adopt an effective population of 1,000 individuals as near to the minimum to ensure the continuance of genetic variability and took 5,000 as an effective population size above the minimum for dependent residents of Tall Open forest. Using this they calculated that the area required to support an effective population of Greater Gliders in the area (near Tumut) they studied to be 6,656 - 10,870 hectares.

Tyndale-Biscoe and Calaby (1975) note the futility of setting aside small blocks of land of a few hundred hectares or less as wildlife refuges because (i) species with high attachment to their homesites do not move to other areas because these are already occupied, and (ii) the number of animals that the small reserve can support in isolation is quite inadequate for the species long term survival.

Davey (1989) considers that emphasis in forest planning and management needs to be placed upon maintaining a minimum viable population that will safeguard against genetic degradation and determining the habitat units that will support this population.

Davey (1989) notes that to derive the theoretical breeding population size required to ensure that the population, genetically, does not deteriorate the effective minimum population level (50+) must be adjusted for (i) variance in progeny of females, (ii) sex ratio, (iii) over-lapping generations and (iv) population fluctuations. A multiplication

factor of 10 is then applied to allow for long term evolutionary fitness.

Using this formula Davey (1989) calculates that the theoretical long-term breeding population size of Greater Gliders would be 2375 animals, but notes that as the estimate was derived from a poor data base the long-term viable population size of 5 000 suggested by Tyndale-Biscoe and Calaby may well be realistic.

Dunning and Smith (1986) adopt "the minimum population size of 500 proposed by Franklin (1980)", and state "This value increases to an effective population number of 521 for P. volans [Greater Glider] ...when the uneven sex ratios are taken into account.... Examination of the spatial distribution of logged and unlogged moist hardwood ... indicates that this total population [of Greater Gliders] is split into 3 major groups separated by rainforest. An effort should be made to maintain 521 individuals within each of these isolated areas. At present these isolated patches contain approximately 721 P. volans in the west patch, 285 in the central patch and 764 in the east patch. This central patch is the most vulnerable to the effects of inbreeding and loss of genetic variability."

Mackowski (1987) states "The planning process should consider the absolute size of wildlife populations to ensure the genetic viability of contiguous wildlife populations in refuge zones and temporally contiguous populations in logged zones."

Clark, Backhouse and Lacy (1991) report on Population Viability Analysis using the computer program VORTEX for six species, including Long-footed Potoroo and Mountain Pygmy-Possum. They note that most species and populations were highly susceptible to local extinction, stating "Any further habitat loss or fragmentation or reduction in population size or density would result in rapid extinction. ...Options included strict habitat protection, enhancement of existing habitat or restoration of lost habitat, captive breeding, and reintroduction of animals to existing habitat patches in which the species has become extinct in recent decades or to newly created habitat. ...the stimulations demonstrated that if proactive conservation management had been undertaken even five or ten years ago when populations and habitats were considerably larger, the task of present day managers would be much more tractable."

Davey and Norton (1990) note "The crux of the problem for wildlife management is that the habitat needs to be made available to support viable populations of taxa. Currently, there are only a very few species of Australian vertebrates for which there is adequate information to enable an estimate of a minimum viable population. Few studies have attempted estimates for other taxa."

2.2 FAUNA CORRIDORS

Bennett (1990) states "Essentially, corridors are linear habitats that differ from a more extensive, surrounding matrix. Frequently, they link one or more patches of habitat in the landscape and may be a pathway for animal movement, but they may occur as isolated lines of habitat."

Bennett (1990) notes that there are a variety of fauna corridors; riparian habitats, hedges, shelterbelts and plantations, fencerows, roadsides, tunnels and underpasses

Bennett (1990) notes that streamside riparian habitats are natural corridors comprised of a band of vegetation that usually is structurally and floristically distinct from adjacent habitats, with which it intergrades. Frequently they support species that do not occur in adjacent habitats or provide necessary habitat components for more widespread species.

Bennett (1990) considers that the structual connectivity of corridors is influenced by the (i) distance they extend, (ii) number and length of gaps, (iii) number of junctions with other corridors, and (iv) presence of 'nodes' of habitat along the corridor.

Bennett (1990) considers that the functional conectivity of corridors depends on (i) the behaviour of the species utilising the corridor, (ii) the scale of the species movements, and (iii) the species response to the width and quality of habitat in the corridor.

2.2.1 The need for Fauna Corridors.

Bennett (1990) considers "Habitat corridors have the potential to make a major contribution to regional conservation strategies by ameliorating the detrimental effects that habitat fragmentation and isolation have on wildlife populations."

Bennett (1990) notes that the island biogeographic theory predicts that corridors will increase the conservation status of habitat isolates by maintaining a higher level of species richness at equilibrium. This is achieved by (i) increasing the rate of colonisation of species to the isolate, and (ii) supplementing declining populations, and reducing the rate of species' extinctions.

Bennett (1990) considers that animals living in remnants can be viewed as 'metapopulations' when there is some level of interchange between them, so as to enable recolonization of populations that have become locally extinct and supplementation of declining local populations. The fragmented populations can thus be considered as one larger population.

Bennett (1990) considers that corridors can fulfil three main beneficial functions in the landscape, (i) habitat for certain species, (ii) facilitate the movement of plants and animals

between fragments, and (iii) provide habitat components for species utilizing surrounding habitat.

Bennett (1990) cites various research that has conclusively established the benefits (and often necessity) of streamside habitats, hedges, shelterbelts, plantations, fencerows and roadsides for fauna utilizing them for refuge, foraging, dispersal, migration or as a resident habitat.

In the south east of NSW Kavanagh (1985a) undertook a series of logging trials at Waratah Creek, in which 100 metre buffer strips were left along streams, giving a total width of 200 metres of unlogged forest. He noted that before logging most animals were clustered in or around the 100 metre wildlife corridors and that after logging these corridors appeared to contain most animals within them. Kavanagh (1985b) states "most animals which were found well away from creek reserves before logging were not found in these areas after logging". Kavanagh (1985a) states that "the provision of wildlife corridors appeared to play a major role in retaining populations of arboreal marsupials throughout the areas which were logged." Kavanagh and Webb (1989) note that approximately 50% of the original populations of arboreal marsupials remained after logging, partly because they were most abundant in creek reserves prior to logging.

Saunders (1990) considers the lack of connecting corridors of native vegetation hampered Carnaby's Cockatoo's ability to locate patches of remnant vegetation suitable for feeding, stating "When patches are visually isolated, finding a suitable patch may be a chance event." He cites a previous paper where he "pointed out that avian species will continue to be lost in some locations because very small populations of many species have been isolated on remnants and because many Australian bird species have poor colonizing abilities ...There is a need to provide corridors of native vegetation to link isolated remnants and allow movement between them."

Mansergh (1984) states "as no comprehensive system of corridors between reserves has been incorporated into the reserve system there is a possibility that the Victorian populations of [Tiger Quoll] will be further fragmented."

Moon (1990) notes "Koalas disappear from their usual feeding area from time to time, leading to the conclusion that both corridors and alternate feeding areas are essential to the conservation of a koala population."

Page (1989) notes that there is a need to consider migration of species at higher latitudes and higher altitudes of their range in response to global warming. He notes the vital necessity of corridors as pathways that creatures might take to remain in a familiar climate.

2.2.2. Adequacy of Fauna Corridors.

Bennett (1990) notes that gaps in a corridor can severely disrupt animal movements along the corridor, or the continuity of a resident population within the corridor. He states "For a forest animal, a gap in a forested corridor could be a stream, a road, a strip of grassy vegetation, a burned patch of forest, a break in the canopy, or even a different forest community."

Bennett (1990) considers the length of a corridor can influence its effectiveness in several ways; (i) with increasing length there is a reduced likelihood of single animals (particularly small terrestrial animals) traversing the length of the corridor, and an increased reliance on self-sustaining populations in the corridor to provide habitat continuity, (ii) greater cumulative impact of edge effects (e.g. risk of predation) from adjacent habitats, and (iii) greater vulnerability to sudden disturbance or catastrophe that can cut the corridor (e.g. fire, grazing by stock).

Bennett (1990) notes that the linear shape of corridors means that the ratio of edge to area is very high, which makes them very vulnerable to edge effects. He considers that narrow corridors within farmland may effectively be entirely edge habitat while in contrast, a mature forest corridor surrounded by earlier successional stages of the same forest type is more likely to have an interior habitat and support interior species.

Gilmore (1990) notes "If remnant habitat is long and narrow, such as many retained wildlife corridors and filter strips along gullies, the mean distance between the centre and a series of random points within that home range increases as the home range deviates from circular. Thus species with large home ranges may be excluded theoretically from occurring not by absolute area, but by the shape of the remnant habitat... Obviously the width of wildlife corridors should be adequate to accommodate the diameter of the home range of the vertebrates inhabiting the area, rather than arbitrarily determined values." and because of the edge effect "many wildlife corridors and other linear reserves are probably a suboptimal habitat and inhabitants have lower reproductive success compared to those in continuous habitat."

Kavanagh and Webb (1989) note some deficiencies with the corridor system applied by the Forestry Commission: uncertainty that the creek reserve system contains habitat suitable for the conservation of all sensitive species; uncertainty regarding the minimum number of individuals needed to comprise a "viable" population when the animals are confined to a reserve; low probability of success in maintaining populations of some species in narrow (<100m) linear corridors of mature forest; and, lack of knowledge about the rate of recolonisation of forest regenerating after logging by species initially confined to adjacent corridors and reserves, and whether this can be accomplished within the duration of the logging cycle.

Kavanagh (1985b) notes that Yellow-bellied Gliders "are not easily managed in creek reserves" and populations "apparently can not be maintained unless creek reserves are very large." That is

well in excess of the 100 metre each side of streams prescription.

Shields and Kavanagh (1985) note that "the preferred habitats of many species do not include narrow riparian strips or steep unloggable country. Consequently, it is often necessary to take other measures to reserve suitable areas of preferred habitats to ensure conservation of some species."

Recher *et al.* (1991) in their study of birds in the Eden woodchip area conclude "Attention has therefore focused on moist forests along creeks or in gullies where narrow strips (20 m to either side of the drainage) of undisturbed vegetation are normally retained as filtration strips to control erosion and protect water quality. These recommendations, which have been substantially implemented, offer a measure of protection to species at lower elevations that have been shown to have the most restricted habitat requirements. These areas also reserve habitat for a large number of more widely distributed and abundant birds. Reserves along creeks and gullies in tableland forests, although effective, are likely to conserve a smaller proportion of the local avifauna because of the greater area of wet sclerophyll forest in escarpment areas. A problem with implementing these recommendations in forests affected by integrated logging can also occur where catchments for gullies are small and filtration strips are not required". and, "Birds restricted to dry sclerophyll forests or woodlands are not necessarily protected by reserves or corridors along creeks and gullies. A conservative interpretation of the requirements of the forest avifauna in southeastern New South Wales suggests that it is also necessary to retain areas of mature forest along ridges and on slopes."

Recher *et al.* (1991) note that where narrow creekside reserves (< 80 m. total width, and > 100 m. total width) were retained in areas being converted to pines, they suffered a drop in forest-dependent species and an influx of open-country or non-forest birds within a few years.

Mackowski (1984) notes that "Corridor retention strategy in gullies on a regional basis at Eden (southeastern N.S.W.) is teleologically evident because, at Eden, possums and gliders concentrate in gully areas... However, there are many situations in north coastal N.S.W. where large scale corridor retention in gullies will not preserve the type of habitat that is utilised by the possum and glider community of adjacent logged areas.", and "A drawback of the corridor strategy is that the recruit regeneration event (fire or other disturbance) may have to be specifically allocated to retention corridors as it may be excluded from adjacent forest management."

Shields and Kavanagh (1985) note that "the effect of the Bombala fire on the avifauna of retention strips was drastic - in effect, complete removal of birds."

Andrews (1990) cites a survey of 7 fauna tunnels constructed under a 35 km length of new railway line by the New South Wales

Rail Authority which raised the problem that feral predatory mammals could focus their activities on the tunnels which acted as funnels for prey. A comparison with the use of existing culverts showed small mammals used these more, as vegetation cover was well established, and they were too small to allow entrance of some predators.

2.2.3 Design of Fauna Corridors.

Bennett (1990) states "Much of the evidence for the use of corridors by wildlife is observational and concerns remnant corridors that have survived by default rather than by good management (e.g. roadsides, fencerows). There are few planned systems of corridors, and there is little empirical data that addresses practical questions to which wildlife managers and planners require answers in order for ecologically sound corridors to be established. ...Clearly there is an urgent need for quantative, process-orientated research to provide a more satisfactory basis for such planning." He outlines in some detail recommendations for research and management.

Bennett (1990) states "Identification of the species or species assemblage for which a corridor is required, and a basic knowledge of their ecology is a first requirement for corridor design. Knowledge of the spatial scale of a species movements is of particular value. ...Information concerning the habitat requirements, diet and other necessary resources, will assist in optimizing the habitat within the corridor. Other behavioural and ecological attributes, such as the ability to cross gaps, the role of dispersal in the life history, the age of dispersing individuals, social organisation, and behavioural spacing mechanisms within the population, will also influence the ability of species to effectively utilise corridors. ...Design of corridors to provide habitat and effective population continuity for those species with the largest movement patterns and more-specialized habitat and foraging requirements should also encompass the requirements of many other species."

Bennett (1990) considers population continuity between patches of habitat can be achieved by three types of movement along corridors; (i) direct movement by single individuals, (ii) movement by a single individual, punctuated by pauses of hours or even months in the corridor, or (iii) most effectively by genetic flow through resident populations of target species within the corridor.

Bennett (1990) states "Corridor length is obviously determined by distance between habitat isolates, but several measures that may reduce the risks associated with corridor length include: duplication of the corridor; creating a network of corridors; and increasing the width of the corridor to reduce edge effects."

Bennett (1990) states "Incorporation of nodes of habitat along the corridor can increase its effectiveness by providing additional habitat in which animals can pause during lengthy

movements, or maintain a larger breeding population, thus introducing more dispersers into the system."

Recher *et al.* (1991) cite previous researchers who "recommended modifications to the creek reserve and corridor system to include the reservation of larger areas (e.g. entire coupes) of forest at periodic intervals along drainages on which creek reserves were established." They note that intent of proposals to add such nodes and retain mature forest along ridges and on slopes "was to include within the corridor system a complete sample of the fauna and their resource requirements along a topographical gradient from gully to ridge as well as providing larger areas of old growth forest for species requiring large, non-linear habitats."

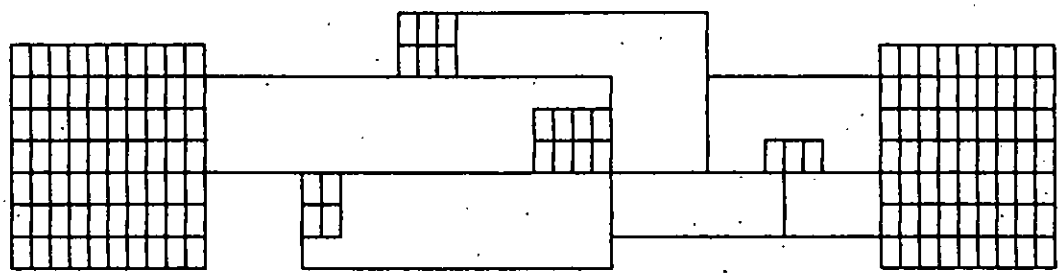

Fig. 1.
A corridor system that provides continuity, multiple pathways and nodes of habitats along the way is likely to be the most effective way of linking animal populations in remnant habitats (adapted from Bennett, 1990)

Bennett (1990) states "The width of a corridor is a particularly important consideration in corridor design as it influences most aspects of corridor function. Maximising the width of corridors is one of the most effective options that wildlife managers can exercise to increase the effectiveness of corridors for wildlife conservation." He notes that increasing width increases species richness and can make corridors more suitable for sensitive species with greater spatial requirements or specialized feeding and habitat requirements.

Bennett (1990) states "The retention of existing natural vegetation to create a corridor is more effective than attempting to reconstruct or revegetate a corridor. A high quality habitat for wildlife requires the full diversity of natural vegetation, and it is maintained by the functioning of natural ecological processes. Resources such as litter, tree hollows, dead trees, hypogeal fungi, and diverse invertebrate communities cannot be created simply by planting trees and shrubs in rows. They require the operation of natural ecosystem processes. There is an urgency, therefore, to retain and protect corridors and natural links that are still present in the landscape before they are lost."

Bennett (1990) states "When corridors link large tracts that include several contrasting habitats (e.g. ridges and gullies in

mountainous forest, dunes and swales in arid environments), the corridor must be suitable for species that occur in all habitats. This can be achieved by a broad corridor that encompasses the range of habitats, by duplication of corridors, or by placement of the corridor in a habitat that all species can utilise."

Bennett (1990) envisages a hierarchy of corridors;

(i) Regional corridors to restore natural links between formerly continuous large blocks that are isolated by developed land - because they are generally surrounded by farmland or other developed land, they are likely to experience greater levels of disturbance and consequently a broad swathe of forest will be required to maintain the integrity of the corridor habitat,

(ii) Major wildlife corridors within production forests to provide links between important reserved areas - they could follow the larger river systems,

(iii)Wildlife corridors forming common linkages in the system of retained habitat in a co-ordinated network throughout the forests - research is needed to determine optimum width but in the interim a minimum width of 100 m., with no logging, should be adopted.

Kavanagh (1989b) recommends the retention of 100m wide wildlife corridors for a radius of 2.5km around known localities of the Powerful Owl and Masked Owl. For Sooty Owls he recommends 200m wide wildlife corridors for a distance of 1km.

Saunders (1990) states "The optimum width of the connecting strip is not known and would be expected to vary for different species, but several general principles must be borne in mind by planners. Roads and railway lines should be placed to one side of the corridor, not in the middle as is presently standard practice in Western Australia. A road or railway line may act as a barrier to movement from one side to the other (in some species), doubles the amount of edge of the remnant vegetation and increases the chances of highway fatalities. In addition, linear reserves should be wide enough to retain their integrity and to resist the degrading physical and biotic influences of edge effects. ... In the agricultural areas of Western Australia these connecting corridors should be at least 200 m wide and any road or railway line should be located on one side. Such reserves should not be restricted to road and railway reserves, as these pose dangers to animals through collision with transport. Linkages are, where possible, better placed along paddock boundaries and drainage lines."

Dunning and Smith (1986) state "Results of this study suggest that two corridor systems are necessary for the conservation of arboreal mammals. One continuous gully system should incorporate the unlogged rainforest gullies throughout the study region. This corridor system would preserve rainforest inhabiting species, principally [Rufous Ringtail Possum, Mountain Brushtail Possum and Fawn-footed Melomys]. A second interconnected ridgetop

corridor system of unlogged or lightly logged moist hardwood forest will be necessary for conservation of mature hardwood dependent species such as [Greater Glider]. [Greater Glider] cannot be conserved within a rainforest gully corridor system ... The ridgetop corridors may only need to be relatively narrow (approximately 100 m) if they are sited adjacent to or continuous with ...low intensity logging and tree hollow retention zones".

Dunning and Smith (1986) consider "The unlogged ridgetop moist hardwood corridor system should have side branches that link up with the rainforest corridors to provide an avenue for movement of species that utilise both habitat types, and to increase the area of contact between logged forest and unlogged source areas for species that can recolonise after logging.", and "The proposed corridor system may possibly prevent the isolation of [Greater Glider] populations and allow genetic exchange through juvenile dispersal."

Mackowski (1984) states "Strip/corridor management needs the managerial control input of knowing what possum and glider communities occur in all forest types. This is so that a particular community is not missed in the strip retention system without justification."

Davey (1989) recommends that corridors may be improved by maximising diversity of stream side reserves through not stipulating constant width and enabling boundaries to maximise the structual and species diversity, and designing movement corridors through forest where it can be shown movement actually occurs.

3.0 MANAGEMENT FOR WILDLIFE AND OTHER PURPOSES

Tyndale-Biscoe and Calaby (1975) state "it is by no means easy to determine how much alteration the wildlife can tolerate when the forests are used as a resource for other commodities. This is due to our great ignorance about the majority of forest species."

McIlroy (1978) stated "There is general public support in Australia for policies of multiple use management of forests including, in particular, the conservation of wildlife. The problem is that in any single forest area it is impossible to satisfy the requirements of every animal species. A choice must be made between various management plans."

Mackowski (1987) states "The strategy of multiple use can be criticised because management is incapable of rigourously valuing options... Therefore multiple usage tends to default to the single use that is most conveniently valued".

Mackowski (1987) notes "Wildlife and other environmental objectives are often considered as constraints when discussing commercial forest management."

3.1 TIMBER

3.1.1 Does Multiple Purpose management work?

Dunning and Smith (1986) state "Under the Forestry Act, the Forestry Commission of New South Wales is obligated to conserve native wildlife in State Forests, but when this objective conflicts with that of timber production, as it clearly does in many regions, timber production has generally achieved management priority over wildlife conservation. Wildlife conservation has largely been achieved inadvertently in unlogged, erosion control streamside corridors, areas of inaccessible or excessively steep terrain, or low site quality forests with a high proportion of 'defective' trees."

Mackowski (1987) states "Historically, the general approach to Australian wildlife management has been exterminate then deify - or, don't bother at all.", "Incidental management of wildlife is the management (of wildlife populations) that occurs due to natural resource management that does not consider wildlife and has non-wildlife objectives. The management of arboreal wildlife in Australia has been subject to a long tradition of incidental management.", "Natural resource managers often cannot rely on continued consensus following compromise advice from disciplines with opposed goals..., and may consider co-operation between such disciplines as unnatural acts... As well as immiscibly compromised advice, management organisations have to deal with inertia of established personnel to the acceptance of novel management goals... This inertia has occurred in north American commercial forests, where there has been a lack of implementation of hollow tree management policies... The potential for similar lack of implementation in Australia's commercial eucalypt forest should not be overlooked."

Davey and Norton (1990) state "Despite the creation of seemingly appropriate legislation and formal structures relatively early in the development of the forestry industry to oversee the wise management of resources , it is clear that wise management has not been achieved. Several \ commentators have concluded that, in practice, forestry in Australia has been conducted within a philosophical framework, albeit unwritten, of wood primacy... That is, its practitioners believed that the principle function of forestry was wood production. Multiple-use management was considered to be wood production plus other uses." and, "...this history of resource management has had a significant impact on, at least, the past and current status of forest wildlife. Most State Forests have been cut over and few old-growth stands remain. Wildlife habitats have been removed, modified, fragmented and created."

Dunning and Smith (1986) describe the "normal logging" of "moist hardwood" forest in northern N.S.W.; "This generally involves 75%-95% of canopy removal, depending on the timber quality in the stand, followed by a post logging burn and minimal stand improvement. Large defective trees may be removed by ringbarking

or felling and regeneration may be aided by planting with seedlings during logging operations in what is referred to as 'timber stand improvement" (TSI) operations. Current practice in the study region now favours defective tree retention and regeneration by natural means, a policy of 'minimal stand improvement'."

Kavanagh and Webb (1989) describe "normal logging" in southern N.S.W.; "Integrated logging as normally practised in the region results in the retention of about 10% of the original tall canopy cover in the forest, although this may vary depending upon the nature of the terrain and the proportion of commercially acceptable tree species. This cover is comprised mainly by the 4-5 evenly spaced mature trees retained per ha to act as a source of eucalypt seed, the 5 'overmature' hollow-bearing trees per 15 ha left specifically to enhance the requirements of wildlife for habitat, and other trees which may provide good sawlogs in the future". Their normally logged coupe retained 28% of the original canopy cover, 21% of the original basal area (m2/ha), and 6 trees > 80 cm. dbhob.

Dunning and Smith (1986) state "In general, the effects of logging on arboreal mammals were consistent with each species food and general habitat requirements. Clearfelling (5% canopy retention) caused a significant decline in populations of [Greater Glider, Rufous Ringtail Possum and Brown Antechinus] and an apparent decline in numbers of [Mountain Brushtail Possum]. This result presumably reflects loss of food and foraging substrate for all these species and is consistent with the results of previous studies."

Dunning and Smith (1986) state "The conservation of arboreal mammals in logged forests is a function of individual species preference for particular seral stages after logging, dispersal ability and proximity to recolonisation source populations and the availability of nest sites."

Dunning and Smith (1986) found that the abundance of Ringtail Possum, Greater Glider and Brown Antechinus declined significantly following normal logging, with no Ringtail Possums found 2 months after logging and no Mountain Brushtail Possums 5 months after logging (they note that numbers of these later two species increased in unlogged areas and areas logged to a lesser intensity - suggesting movement out of 'normally' logged areas). They state that the Greater Gliders observed following normal logging "were on the borders with the 66% retention and the control II zones and it is assumed that their territories may have overlapped this area prior to logging. No animals were observed away from boundaries."

Tyndale-Biscoe and Calaby (1975) "predict that about ten species of mammal resident in Eucalyptus forests will probably disappear altogether from areas clear-felled. For these species, reserves of indigenous forests are the only means for their long term survival."

Kavanagh (1985a) stated that "the 10% and 25% canopy retention treatments clearly form no part of the management strategy designed to maintain populations of arboreal marsupials where these animals are to be given priority. The value to arboreal marsupials of the 50% canopy retention is also doubtful."

Kavanagh and Webb (1989) found "Species which remained more abundant in unlogged forest compared with all logging treatments were the Greater Glider, Yellow-bellied Glider, Feathertail Glider, and the lizards *H.maccoyi, S.tympanum* and *L.coventryi*."

Shields and Kavanagh (1985 p.78) cite research that found the greatest effects of logging on birds fell among the hollow nesters, eucalypt canopy feeders, the moist ground litter feeders and the non-passerines in general. They also note that regenerating forests lose some 20% of the bird species found in mature forest (pp. 18,43,67).

Mackowski (1987) notes the importance of downed timber to wildlife, stating "The harvest of timber from cohorts in a rotation < 40 y.o. would leave a minimal volume of down timber behind in the forest. This down timber would be of smaller piece size, and contain proportionately more sapwood, than that left following similar logging of older forest cohorts. This timber would be less in volume than what falls to the forest floor in natural forest and would also be less resistant to decomposition by decay and fire. This may have significant effects on carbon flow through the forest ecosystem to soil organic matter, and on energy flow to decomposer organisms and organisms at higher trophic levels that provide food for ground dwelling vertebrate wildlife and for tree nesting but ground foraging carnivores..."

Gilmore (1990) states "Lowered soil moisture in dry seasons and reduced stream flows consequent on the establishment of densely stocked plantations, beyond the stage of crown closure, has the potential to influence the suitability of gully habitats and streams for amphibians, and possibly other vertebrates. Clearly these effects will depend on the temporal and spatial mosaic of plantation types and age and treatment of stands and of other land cover within the catchment. Effects are likely to be greater for species dependent on gullies and low order streams within smaller catchments, but the extent of the impacts on fauna has not been investigated so far."

3.1.2 Habitat tree retention prescriptions

Mackowski (1984) notes "Management for adequate, uniformly distributed hollow trees and recruits does reduce problems of fragmentation and adequacy of reserve size suggested by biogeographic island theory".

Mackowski (1987) states "The occurrence of arboreal wildlife in eucalypt forest is dependant on a suite of critical resources that differ for different species... Tree hollows are resources

that are measurably separate to other resources, and are critical to a large number of arboreal wildlife in eucalypt forest".

Mackowski (1987) considers "The tree hollow resource in eucalypt forest may vary as to: (i) number of trees with hollows, (ii) number of hollows in each tree, (iii) size and disposition of hollows, and (iv) suitability of hollows for various species of wildlife."

McIlroy (1978) emphasises that to define how many trees and logs containing appropriate hollows should be retained, and at what stage the remaining or regenerating trees and logs will become useful to certain animals, further research is needed on (i) the types or characteristics of hollows required by different species, (ii) the specific number and distribution of hollow-containing trees and logs and the density of the surrounding canopy and understorey that each species requires, (iii) the relationship between the number of such nesting, roosting or homesites and population levels, and (iv) the competition between different species for their use.

Loyn (1985) states "The number of trees that need to be retained to provide breeding habitat for individual species of forest animal is not known." He considers that the highest densities of old trees are needed by species which use them for feeding, whether or not they also need them for nesting.

Mackowski (1983) states "Presently the Forestry Commission logs its eucalypt forests without measuring impact on, and with minimal regard for, arboreal wildlife populations, although in clearfelling/clearing situations occasional possum trees are left behind, these have no more prescription than 'it looks good to the eye'. This is incidental wildlife management..."

Kavanagh (1985b) states "The results of this study should be taken as an early warning of the probable inadequacy of current 'habitat tree' retention specifications for wildlife (arboreal marsupials) in forests subject to integrated logging. Management for wood production will inevitably take precedence over management for wildlife in most areas. However, it should be recognized that in other areas a strong commitment must be given to managing wildlife and that normal tree retention specifications (and creek reserves) are likely to be inadequate. The appropriate specifications for such areas are still unclear."

Kavanagh and Webb (1989) note that the present approach is deficient because of lack of knowledge about the number of mature and hollow-bearing trees that should be retained in logged areas to provide for the present or future requirements of mature forest-dependant wildlife.

Davey (1989) outlines a number of requirements for the management of fauna requiring hollows: knowledge of the rate at which hollows develop in a suite of species over a range of site qualities; identification of characteristics of hollows for all species utilising them; and determination of seasonal use of

hollows. He advocates the development of models predicting development of hollows in tree species in relation to size class of trees.

Loyn (1985) notes "The problem with the retention of large numbers of scattered old trees is that regrowth is suppressed by these trees ...and wood production is accordingly reduced. This increases the pressure to extend harvesting operations into mature forest which might be better reserved as habitat for the most sensitive plant and animal communities that could be damaged even by intermediate levels of selective logging."

Mackowski (1987) notes that where forests abut non-forest habitats (e.g. estuarine, mangrove, billabong, swamp, heath, pasture) the hollow trees in the forest "are significant resources for the hollow tree dependant wildlife that forage in adjacent non-forest habitats."

3.1.2.1 OCCURRENCE OF HOLLOWS

Mackowski (1987) considers "Hollows used by arboreal wildlife occur in trees that have attained a dbhob greater than the dbhob at which crown size increment declines reflecting a culmination of growth and the shedding of major branches."

Dunning and Smith (1986) found "The number of hollow bearing trees (>96 cm d.b.h.), in the Mt. Boss study, varied from 0.5 per hectare on some logged sites to on average 16 (8-30) per hectare in mature unlogged forest sites. Factors other than hollows would appear to limit arboreal mammal populations in mature moist hardwood, while in heavily logged forest the lack of hollows almost certainly limits population density."

Mackowski (1984) found that two stands of unlogged blackbutt forest had stockings of 6.7 and 13.4 hollow bearing trees per hectare. Kavanagh and Webb (1989) found their unlogged areas had averages of 26.9-40.8 trees > 80 cm. per hectare.

Mackowski (1987) found that in 40 m site height forest "although hollows occurred in blackbutt older than about 40 y.o. these hollows were not suitable for wildlife unless the blackbutt was > 144 y.o. [> 100 cm dbhob] and also, these hollows were not suitable for large hollow dependant wildlife unless the blackbutt was > 224 y.o. [> 140 cm dbhob]." and "Blackbutt longevity is about 300 years old, when blackbutt is about 180 cm dbhob in 40 m site height forest."

Mackowski (1987) notes "there is a mortality of about 1 tree/ha every 8 years during the 80 years the cohort takes to grow from 100 to 140 cm average dbhob, and about 1 tree/ha every 18 years during the 80 years the cohort grows from 140 - 180 cm average dbhob."

Mackowski (1987) notes "The average age of blackbutt with wildlife hollows is 185 years... Thus they have an average life

of about 120 years left... Trees with large hollows have an average life of only about 50 years left... If primary logging in blackbutt forest leaves existing hollow blackbutt as wildlife habitat, and relies on regeneration to provide tree hollows when existing hollow trees die, then it is probable that there will be a temporal gap in the availability of hollow trees for arboreal wildlife. It is almost certain that there will be a period without trees with large hollows in forest managed in this manner."

Mackowski (1983) notes that previously logged areas often have low stockings of hollow trees and states that "salvage logging in these areas will remove more hollow habitat, and continued management for timber will remove recruits to the hollow tree class."

Mackowski (1987) notes that habitat trees are lost or damaged by fires, lightning or windstorms.

3.1.2.2 UTILISATION OF HOLLOWS

Mackowski (1987) lists 13 species of marsupial, 13 species of bat, and 49 species of bird that use tree hollows and occur in northeastern NSW. He also found 3 species of lizards in tree hollows he dissected.

Mackowski (1987) states "The characteristics of tree hollows that may influence their use by wildlife include: hollow orientation (vertical, horizontal, aspect); the type of entry (smooth, jagged); the type of surrounding wood (green, wet, dry, cracked); entry size; hollow volume; drainage; ventilation; availability of water; biotic agents (predators, competition, parasites); hollow numbers; and availability of non hollow resources".

Mackowski (1987) states "Only trees > 100 cm dbhob were utilised by wildlife... Larger trees (> 140 cm dbhob) were utilised by more wildlife than were trees 100 -140 cm dbhob. Larger hollow utilising birds such as ducks, cockatoos and owls... are probably restricted to nesting in blackbutt >140 cm dbhob as larger hollows mainly occurred in these trees".

Mackowski (1987) notes "Arboreal marsupials the size of yellow-bellied glider and larger appear to require hollows > 100 cm^2 entrance size, these hollows only occur in blackbutt > 100 cm dbhob and are most abundant in blackbutt > 140 cm dbhob".

Lindenmayer *et al.* (1991) found that of the 823 trees they stagwatched only seven (0.9%) were occupied by more than one species, noting "Where co-occupancy did occur, nest trees were typically inhabited by a large and small species".

Mackowski (1987) identified three forms of wildlife hollows: branch, main stem and top. He found that 83% of hollows were branch hollows, and "Most of the wildlife occurrence in hollows... was in branch hollows." He also found that about half of the branch hollows were not seen by ground level observers.

Mackowski (1987) found that the two thirds of hollows which had jagged wood entries were utilised by Feathertail Gliders and lizards, while "All the non feathertail glider/reptile arboreal wildlife in blackbutt forest is restricted to choosing suitable hollows from the one third of blackbutt hollows that are smooth overgrown hollows."

Mackowski (1987) considers "that parrots (and large cockatoos?) may require deep vertical hollows to reduce egg and chick predation". He found evidence of use by parrots in three large hollows, all greater than 3 m deep.

Lindenmayer *et al.* (1991) state "Our results indicate that small species... prefer nest sites with a small entrance cavity, particularly holes. The dens of larger species... had a large entrance, such as a hollow-branch or spout. Medium-sized species... showed no particular preference for any type of nest entrance although holes were the most commonly used."

Lindenmayer *et al.* (1991) found that the dens of gliding marsupials were usually higher than those of non-volant species. They noted "Differences in the type and height of the entrance to the nest, together with the time of emergence from the den, indicate partitioning of the nest tree resource between the various species..."

Mackowski (1984) notes that "low numbers of hollow trees means more interspecific competition for hollows'

3.1.2.3 DETERMINING HABITAT TREE RETENTION PRESCRIPTIONS

Dunning and Smith (1986) for the area they studied recommend "The number of hollow bearing trees to be retained in the zones managed primarily for timber would be a minimum of 3 evenly spaced or 5 randomly spaced self sustaining potential nest tree clusters in each hectare of logged forest."

Mackowski (1984) found "that low possum and glider populations occur in blackbutt forest of 40 metres site height with less than 3 hollow bearing trees per hectare." He presents results from 10 spotlighting transect estimates of Greater Glider and Brushtail Possum densities in blackbutt forest of 35 - 45 m site height which show that on the seven sites with some 3 or less hollow trees per hectare there were less than 0.09 animals per hectare, while on the 3 transects with more than 3 hollow trees per hectare the densities were greater than 0.27 per hectare.

Loyn (1985) found that at Boola Boola retention of about 14 mature trees per hectare apparently failed to provide habitat for a significant small group of arboreal birds and mammals, even up to 70 years after harvesting.

Kavanagh (1990) suggests minimum numbers of habitat trees for four groups of forest types: from one per hectare on the poorest sites, through three and five to 10 on the richer sites.

Kavanagh and Webb (1989) in their study found that populations of Greater Glider, Yellow-bellied Glider and Feathertail Glider "were markedly reduced when less than 10 large (> 100 cm dbh) trees were retained per hectare."

Mackowski (1984) states "The retention of scattered hollow bearing veterans in heavily logged forest, when first logged, serves to ameliorate the impact of logging on hollow dependent fauna - but this is only of short term benefit.", "The retained veteran in first logged, heavily logged blackbutt forest will average 250 years of age at the time of logging. With a longevity of 300 years this means an average length of service as possum and glider habitat of only fifty years (30 years with adequate foraging substrate). The regeneration cohort will be 200 years old before it can provide hollows - there will be a period of 150 years during which there will be no hollows. Obviously larger sized trees need to be retained as recruits to the hollow tree class.", and "When managing a forest for possums, gliders, and timber, it is not a question of how many hollow trees to leave when logging - rather how many hollow trees to manage for. To maintain hollow trees in perpetuity requires the management of the forest so that new hollow trees are recruited as old hollow trees die."

Mackowski (1987) states "If the provision of wildlife hollows is to be continuous then there is a need, both in natural forest and in managed forest, for an unevenaged forest structure with regeneration events less than about 120 years apart for small hollow dwellers, and probably a 50 year periodicity of regeneration events for large hollow dependant wildlife."

Mackowski (1987) states "A continuous flow of 3 hollow trees/ha can be achieved, on a broadacre basis in 40 m site height blackbutt forest, by retaining 4 sound trees/ha as recruits of variable size between 60 and 100 cm dbhob, plus 2 hollow trees/ha of variable size between 100 and 140 cm dbhob, plus one hollow tree/ha >140 cm dbhob, at the primary logging and by managing the forest so as to maintain this distribution of tree sizes into the future. In a commercial forest where multiple use is the current management system, but where adequate hollow trees have not been retained in the past, a greater proportion of larger recruits should be selected (rather than evenly distributed between 60 & 100 cm dbhob) to facilitate the early return of hollow trees and the immigration of hollow dependant wildlife if it occurs nearby."

Mackowski (1984) states "Management for hollows on a small area basis requires a uniform distribution of hollow trees and their recruits. It requires the managerial control input of knowing hollow and food removal responses of possum and glider communities in different forest types."

Mackowski (1987) notes "The retention of trees across species is meant to be on a pro-rata basis so that the existing tree species mix is maintained in the hollow bearing tree community. However some species appear to have different hollow bearing characteristics to blackbutt and should not be relied on to produce wildlife hollows similar to blackbutt."

Mackowski (1987) suggests a "rapid method of predicting hollows, in forest of unknown producing character, is to determine dbhob/crown width curves and assume wildlife hollows occur in trees of dbhob greater than at which crown width levels off."

Mackowski (1987) states "The planning stage needs to look at hollow tree values of adjacent land use and land tenure. Adjacent retained/refuge areas may contain plenty of hollow trees but may be of a forest type that does not carry the same wildlife species as blackbutt forest (eg: low site quality forest of poor nutrient status, or riparian rainforest, both contain different suites of hollow dependant wildlife than occurs in blackbutt forest unpub. data)."

Mackowski (1987) recommends permanent marking of all habitat trees and identified potential replacements with stainless steel ribbon.

3.1.3 Logging on long rotations

Davey and Norton (1990) state "Equally important is to realize the length of time... for habitat to become optimal for most arboreal marsupials after major disturbance (clearfell, intense wildfire). Such a length of time has to be considered in the determination of the rotation length of a particular forest stand."

Loyn (1985) notes "The age which evenaged regrowth begins to support those species most sensitive to harvesting is not yet known." He considers that a rotation of 100 years or less would eventually exclude a small group of species from cutover areas, and a rotation of 150 years would be needed to maintain about a third of the forest in a condition suitable for these species.

Dunning and Smith (1986) consider that appropriate rotation and spatial organisation of logging coupes is useful for arboreal mammals with good dispersal capability dependent on particular successional stages after disturbance.

3.1.4 Logging at lower intensities

Dunning and Smith (1986) consider that conservation within logged compartments by modification of logging practice and reduction of logging intensity to maintain species and their essential resources at a lower but stable density is useful for disturbance tolerant species dependent on mature forest.

3.1.4.1 25% CANOPY RETENTION

Kavanagh and Webb (1989) note that their 25% canopy retention plot retained 57% of its canopy, 52% of its original basal area and 54% of trees > 80 cm. dbh. It can thus be considered to more accurately represent 50% canopy retention. There was no post logging burn.

Kavanagh (1985b) found that it was clearly apparent that few or no arboreal mammals were retained in logging areas outside of creekside reserves in the area logged to this prescription, with neither the Greater Glider or Yellow-bellied Glider persisting in logged areas.

3.1.4.2 33% CANOPY RETENTION

Dunning and Smith (1986) found that the numbers of Greater Gliders decreased by a half, Fawn-footed Melomys and Rufous Ringtail Possum declined by two thirds and Mountain Brushtail Possum and Brown Antechinus increased (the later apparently due to juveniles and the former immigrations from more intensively logged areas). They also note that Challengers Skink declined significantly in numbers (even without a post logging burn).

3.1.4.3 50% CANOPY RETENTION

Kavanagh and Webb (1989) note that their 50% canopy retention plot retained 57% of its original canopy cover, 51% of its original basal area and 54% of trees > 80 cm dbh. The method utilized was a 'chessboard' method where alternate patches were clearfelled. There was no post logging burn.

Kavanagh (1985b) states "Surprisingly, Greater Gliders were not observed in the small (0.5 ha) retained patches in the 50% treatment." Prior to logging he recorded 19 Greater Gliders in the area subsequently subject to logging, after logging he recorded 7 in the same area (6 of which were in unlogged patches adjoining unlogged corridors). Kavanagh (1985a) notes that Yellow-bellied Gliders were observed on occasions feeding just inside the logged areas (< 30 m from logging boundary) "but these wide ranging animals were normally encountered only in creek reserves or on the unlogged plots."

Kavanagh and Webb (1989) note that "This pattern of logging approaches the 'Australian group-selection' logging system ... which, silviculturally and ecologically, is the more traditional and widely accepted form of logging elsewhere in Australia."

3.1.4.4 66% CANOPY RETENTION

Dunning and Smith (1986) found that the numbers of Rufous Ringtail Possum decreased by one half, Greater Gliders and Brown Antechinus by one third, and Fawn-footed Melomys by four fifths.

3.2 FIRE MANAGEMENT

3.1.4.1 25% CANOPY RETENTION

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3.2 FIRE MANAGEMENT

McIlroy (1978) notes "As yet there has been little research on the effects of fire on wildlife, especially fires of different frequencies, intensities and seasons of Occurrence.", and "Studies of the effects of fire on wildlife in Australian forests have been limited to the first four years after the fires. ...Hence any conclusions made from the Australian studies to date must be regarded tentatively."

Recher, Allen and Gowing (1985) state "there is remarkably little information about the effects of fire on fauna or the long-term consequences of burning on forest ecosystems."

McIlroy (1978) states "Frequent low intensity fires (prescribed burning) also tend to produce a uniform habitat by gradually eliminating the shrub layer and allowing the monocotyledons and ferns to dominate the forest floor. As a consequence there is a gradual disappearance of animals dependent on the shrubs, litter or old logs for food and shelter."

Leigh and Holgate (1979) consider that "Possibly the current procedure of dropping aerial incendiaries on a grid basis as part of the burning programme in various areas especially for forestry and national park use may lead progressively to a substantial change in understorey structure and composition because of the localized selective grazing [by native species] of those small areas which have been burnt. ...it would lead most likely to a progressive increase in unpalatable plant species. This would alter, probably irreversibly the suitability of those areas for conservation of all parts of the flora and as a suitable habitat for the endemic fauna, both as shelter and feed."

Dunning and Smith (1986) found that post logging burning of moist hardwood forest was significantly deleterious for a variety of species and so advocated tractor clearing, rather than burning, to create disturbance for regeneration.

Mackowski (1987) found that "butt hollows" in the blackbutt forest he studied were lined with charcoal and "were probably 'excavated' by fire. He found that there was an average of 0.33 "butt hollows" in each tree 80 - 99.9 cm dbhob, 0.14 in trees 100 - 119.9 cm dbhob, 0.33 in trees 120 - 139.9 cm dbhob, 0.0 in trees 140 - 159.9 cm dbhob, and 1.17 in trees > 160 cm dbhob.

Mackowski (1987) notes "Interconnected hollows act as chimneys and, if connected through to the basal fire box, the result of even a moderately intense fire means either the burning down of the tree, the death of the standing tree, or, if it survives, the virtual sterilisation of the wildlife hollow complex of the tree mainstem and branches."

Mackowski (1987) notes that the frequent Occurrence of fire in 40 m site height blackbutt forest precludes a 100% chance of survival for habitat trees, as a proportion will be damaged, or weakened, or burnt down by each fire.

Bennett (1990) states "Fires, both natural and of human origin, can also create patches of differing successional stages within extensive natural areas, and so isolate faunal populations that may depend upon a particular seral stage."

3.2.1 BIRDS

Cowley (1971) notes "The birds most affected by fire are those which feed and nest close to the ground... Many other species which spend much of their time feeding at or near ground level but which nest in the higher levels of the forest would be affected to a lesser extent."

Cowley (1971) notes that the frequency with which fire burns an area can have a marked effect on the habitat by changing the plant species composition of the understorey and that this will in turn effect the bird species composition.

Rohan-Jones (1981) notes "the effects on birds of logging will be compounded by slash burning and the broad area hazard reduction programme. These together will serve to maintain more of the forest in a relatively simplified structural condition and overall there will be more 'effectively dry' habitat conditions. As well as resulting in a much more open understorey condition with few hollow and over mature trees, soil moisture will also be significantly reduced. The resultant loss of invertebrate faunal prey and decreased humidity will make unsuitable conditions for a number of bird species that would otherwise be present."

Recher, Allen and Gowing (1985) found that "There was a significant effect of fire and logging on the number of birds. Burnt and logged plots had lower numbers and fewer species of birds than unburnt or unlogged plots. The combined effect of logging and fire was greater than either treatment alone."

Recher, Allen and Gowing (1985) note that "The species of bird affected by any given burn varies according to the intensity of the fire and amount and layers of vegetation burnt. It is probable that changes in the abundance of birds after a fire occur in response to changes in the structure of the vegetation. In most instances the impact will be greatest on birds which forage or nest in ground and shrub vegetation while those favouring more open vegetation may benefit. ...recolonization and an increase in the abundance of birds probably proceeds in parallel with the rate of post-fire revegetation."

3.2.2 MAMMALS

Shields and Kavanagh (1985 p.21) note that fire regimes "have been shown to have a greater effect on small mammal populations than logging, and current policy in some regions prescribe fuel reduction burning at very short intervals."

Fox and McKay (1981) found a replacement sequence in time for species of small ground mammals to reach their maximum abundance following a fire: New Holland Mouse and/or House Mouse -> Common Dunnart -> Brown Antechinus -> Bush Rat. They interpreted this as

species occupying stages in the succession when their optimal habitat requirements were fulfilled, with New Holland Mouse and House Mouse populations peaking around one year post fire, Common Dunnart peaking at 4yr, Brown Antechinus reappearing after 2yr and peaking at 5yr and Bush Rat establishing populations after 3yr and plateauing at 8yr.

Wilson *et al.* (1990) studied small mammal succession following a wildfire, the impact of which few animals apparently survived. They found that "Populations of native small mammals at our burnt sites remained at extremely low levels for three years after the fire. They survived and recovered at a greater rate at partially burnt sites." They found that House Mouse populations peaked in the second to third years post fire on both the burnt and partially burnt sites. New Holland Mouse disappeared from one site after the fire and its population peaked 3 years after the fire at another site. Brown Antechinus populations peaked in burnt sites five years after the fire and continued to recolonise new sites up to the sixth year. Bush Rat achieved maximum abundance and colonization of sites in the fifth year. Swamp Rat was absent from a site it previously occupied for 3.5 years and was still increasing both in abundance and number of sites occupied in the sixth year. Southern Brown Bandicoot was present in low numbers until years 4 to 6 and was slow to colonise new sites.

Wilson *et al.* (1990) consider that Swamp Antechinus, Dusky Antechinus and Long-nosed Potoroo "may now have disappeared from the study area as they have not been captured for two to three years." They note that these species and New Holland Mouse "are vulnerable to the combined effects of disturbance factors due to their low population numbers and restricted distributions."

Fox and McKay (1981) cite reported greatly increased numbers of Yellow-footed Antechinus in forest unburnt for 40 years as opposed to stands unburnt for 30 years.

Dunning and Smith (1986) state that declines in numbers of Mountain Brushtail Possum and Fawn-footed Melomys "in the control plot accidently subject to burning suggests that the post logging burn commonly used in regenerating moist hardwood may be as disadvantageous as canopy removal to species that utilise the ground stratum."

Lunney, Cullis and Eby (1987) found that populations of Bush Rat, Brown Antechinus and Dusky Antechinus were drastically reduced following wildfire, with no Dusky Antechinus trapped for the three years sampled after the fire.

Moon (1990) states "For koalas, the effect of fires is to suppress eucalypt regeneration resulting in a simplified forest age structure, and to promote a dense ground stratum which inhibits koala movements." He recommends the formulation of alternative strategies to regular hazard reduction burning, to permit regeneration of koala food trees.

Wilson *et al.* (1990) state "Fuel reduction burning practices should be well planned and take into account ecological factors such as the frequency, area burnt, timing and intensity. It is recommended that 1) burning should not be at frequencies of less than four years, 2) patch burning be undertaken to produce a mosaic of successional ages within vegetation types, 3) burning not be carried out in spring when small mammals are breeding." For New Holland Mouse habitat they consider "It is essential that burning within these communities is not carried out on a large scale. It is recommended that burning be done in small patches (1-3 ha) within the preferred communities to maintain a variety of successional ages from 2-8 years."

3.2.3 REPTILES

Dunning and Smith (1986) found that post logging burning, "unlike logging, destroys litter and logs and increases the area of bare soil and rock. Since all three species of common reptiles were found to require logs and two were found to require litter, post logging burning probably has a more detrimental long term effect than logging on reptile numbers." and "Normal logging had an immediate effect on population numbers resulting in a shift from dominance by [Murray's Skink and Challenger's Skink] to dominance by [Delicate Skink]." They conclude "results suggest that elimination of slash burning after logging may be sufficient to sustain the fallen log microhabitat requirements of [Murray's Skink and Challenger's Skink] in logged forests."

3.3 ROADING AND DISTURBANCE CORRIDORS

Bennett (1990) notes that streams and naturally burnt areas can act as natural barriers but is most concerned that disturbance corridors of human origin (highways, canals, pipelines, railway lines, transmission clearings) are imposing an ever-growing network of partial or complete barriers to animal movement throughout the landscape.

Andrews (1990) undertook a literature review which revealed a variety of harmful effects of roads; (i) habitat loss and modification with accompanying effect on populations, (ii) intrusion of the edge effect into the core of natural areas, (iii) subdivision and isolation of populations by acting as a barrier, (iv) a source of disturbance to wildlife, (v) increased roadkills, and (vi) increased human access with undesirable impacts on disturbed areas.

Richards and Tidemann (1988) in relation to tropical rainforests state "The process of selective logging requires the construction of access roads for large trucks and machinery, smaller tracks for bulldozers to extract logs, and large open areas for loading logs onto semi-trailers. When a tree is felled it leaves a large gap in the normally closed canopy. All this activity results in a network of connected clearings. Other disturbance or modification practices such as rainforest real estate developments produce the

same result. These disturbed areas are unsuitable for most of the rainforest (specialist) bats to forage in, but are ideal for the open forest (opportunist) bats that invade within just a few weeks of their creation. There are, however, a few rainforest species (generalists) that seem to be unaffected."

Andrews (1990) cites a variety of overseas studies which have identified numbers of species which avoid roads, with specific species keeping particular distances away, some as far as 1.8-2.1 km away. In some instances breeding areas have been rendered unsuitable for a variety species by the construction of nearby roads. In others fragmentation by roads has significantly reduced suitable breeding areas.

Andrews (1990) notes that some species can be disturbed by roads so that they have less feeding and lying time, and expend more energy in flight. She also cites a study that established hearing loss in some species for weeks after less than 10 minutes exposure to a tape of a dune buggy, this caused inability to respond to recordings of predator sounds.

Andrews (1990) cites a variety of overseas studies that have found that roads (as narrow as 3 metres), powerline corridors, fences and even 10-15 metre wide mown grass strips, can act as total or partial barriers to the dispersal of a variety of vertebrates and invertebrates. She states "A barrier to dispersal of species can disrupt social organization. It can lead to local extinctions if an area is affected by fire or drought, can reduce the immigration of species to areas which may need replenishment, and also limit gene-flow, with subsequent 'bottle-neck' effects."

Barnett, How and Humphreys (1978) found "Road crossing by small mammals was inversely related to road width; roads severely restricted or stopped the movement of small mammals even when the road consisted of a long-unused and partly overgrown track."

Barnett, How and Humphreys (1978) cite overseas research that found that roads have impeded bird dispersal and small mammal dispersal, the most striking example being a population of *Rattus rattus diardi* (in Singapore) infested with the vector mites for scrub typhus which was contained within an area of 40ha. surrounded by roads; the adjacent populations across roads in all directions never carried the vector.

Andrews (1990) notes the most obvious effect of roads is the mortality caused by collisions with vehicles. She cites animals crossing roads, insects being attracted to shiny surfaces, birds alighting to feed on insects or collect grit, scavengers attracted to other road kills and animals attracted by grassy road verges as being contributing factors. She cites one estimation that one bird is lost every 13 km. and one mammal every 30km. In Australia in 1976 there were 866 000 km of roads.

Moon (1990) found vehicles to be the most significant cause of koala mortality (aside from habitat loss), in a single year at

least six koalas were killed by vehicles in the Iluka area, leaving a population of some 20-25 animals.

Bennett (1990) notes that road systems "are a source of chemical and physical pollutants and they may introduce invasive plants and animals into environments that the road corridor passes through."

Bennett (1990) states "Lightly trafficked roads are commonly used by predatory mammals as a clear pathway for movement and hunting, unimpeded by vegetation and other obstructions... In south-western Tasmania, the marsupial predators Tiger Quoll, Eastern Quoll and Tasmanian Devil were recorded only along forest tracks despite a greater survey effort away from tracks... The introduced predators, Fox and Cat, also use roads extensively as movement pathways through forests. The proliferation of roads and tracks in forests facilitate their spread."

Andrews (1990) notes "Plants and feral animals are easily introduced into the core of an area along a road, partly because the edge effect favours species with generalized requirements. Roads provide easy travelling conditions for animals, and are used by hunters such as foxes."

Gilmore (1990) notes "Many Australian predators exhibit a distinct bias to using tracks and roads through densely forested vegetation, suggesting that these areas may be subject to increased mortality of prey species."

Dunning and Smith (1986) state that Delicate Skink, "which is a widespread less habitat specific species, could survive along roadsides from where it could invade newly logged areas."

Andrews (1990) notes "Pollutants are emitted by vehicles, including oil residues and heavy metals such as lead, zinc, copper, nickel and chromium... Alongside heavily used roads the pollutants have potential biological significance if plants in which they concentrate form a large part of the diet of fauna, or if fauna living there breathe airborne pollutants. Pesticides and herbicides may be sprayed along roadsides and other utility corridors."

Andrews (1990) considers roads allow easy access to humans, which has been noted to lead to deliberate lighting of illegal fires and illegal hunting.

Andrews (1990) notes that "No Australian study documents the horrific injuries and mass mortalities documented in the USA" from powerlines, and cites American analyses which reveal that poor visibility, bad weather, mass migrations, dispersal by juveniles and the fragmentation by powerlines of the area flown resting and feeding create the situations in which the greatest numbers of deaths occur.

Andrews (1990) notes that increases in traffic flow and/or speed lead to increases in road deaths of fauna. She notes that the speed of vehicles is not decreased by animal warning signs.

3.4 GRAZING

Bennett (1990) states "Grazing by domestic stock in remnant vegetation has marked effects on the composition and structure of wildlife habitats through selective browsing of plants, an overall decline in understorey biomass, trampling and soil compaction, and altered soil nutrient levels."

Andrews (1990) cites the detrimental effects of fences on wildlife including entanglement, the cutting off of important natural factors such as water supplies, prevention of movement into suitable habitat areas, disruption of seasonal movement, overpopulation through limitations on dispersal and increased human access through use of fence maintenance roads.

Yellow-bellied Gliders, Greater Gliders (pers. obs.) and Queensland Blossum-Bat (D. Milledge pers. comm.) have been noted to become inextricably entangled on barbed-wire fences.

3.5 CHEMICAL USAGE

3.5.1 PESTICIDES

Cowley (1971) considers "every species of land bird in Australia is a potential victim of chemical pesticides. Most of these species are at least partly insectivorous and could therefore be seriously affected by insecticides, birds which eat fruit or seed can fall victim to poisoned baits intended for mammal pests, and owls and hawks can receive toxic amounts of pesticides indirectly by preying on animals which have come into direct contact with pesticides."

Cowley (1971) cites an American example of the progressive concentration of chemical pesticides in a food chain which resulted in an overall 80,000 fold increase in concentration and widespread mortality of predaceous fish and birds; (i) apparently safe application of T.D.E. (trichloro-dichlorophenzlethane) applied to lake, (ii) 0.02ppm T.D.E. recorded in water, (iii) 5.3ppm in plankton, (iv) 10.0ppm in small fish, (v) 1700ppm in the predaceous fish, and (vi) 1600ppm in the predaceous birds.

Cowley (1971) considers that T.D.E. and other organo-chlorines act on the central-nervous system and sub-lethal amounts may affect an animal's behaviour in such a way that it becomes more susceptible to predation. He notes that in Australia there is circumstantial evidence that the application of pesticides is causing the unintentional death of many birds and lowering the reproductive capacity of other birds receiving sub-lethal doses. He also notes that significant quantities of dieldren and DDT

have been found in birds eggs and the bodies of honeyeaters, kestrels, falcons and kookaburras.

Richards and Tidemann (1988) consider that the accumulation of insecticide toxins via the food chain is adversely impacting bats, stating "As insect pests become more and more tolerant to agricultural chemicals, and higher strengths are required for their demise, bats and other animals that eat sprayed insects are at an ever increasing risk. The annual cycle of most insectivorous bats ...is to store fat when prey is abundant which they can draw upon later. In areas where ground crops are grown and sprayed from the air, insect-eating bats that forage on crop pests gradually accumulate these poisons (microgram by microgram) into their fat reserves. At this stage the input dose of the chemicals isn't toxic, but is much higher when accumulated in their fat reserves and metabolised during winter hibernation."

3.5.2 1080 (SODIUM MONOFLUOROACETATE)

Cowley (1971) states "Losses of birds and mammals have been recorded following the use of '1080' for rabbit control. In one incident over 75 brush-tail possums were killed and examination revealed large amounts of bait material in their stomachs. Possums form part of the diet of the powerful owl."

Eason and Frampton (1991) found that at doses of 0.4 and 0.6 mg of 1080 per bait only one of six cats died, at a dose of 0.8 mg seven of 13 died, at 1.2 mg 6 of 8 died and at 1.4 and 1.6 mg all 10 cats died. They recommended a dose of 2 mg of 1080 per bait to kill all cats eating it within 24 hours.

3.5.3 FERTILIZERS

Gilmore (1990) notes "Changes to water quality, associated with leaching of fertilizer from some soils has the potential to influence aquatic-dependent fauna downstream of a plantation. This has obvious implications for species such as the 'acid frogs' which are restricted to breeding in low pH waters, in the sandy coastal lowlands of subtropical Australia".

3.6 **MINING**

Wilson *et al.* (1990) found that the House Mouse was the only small mammal resident on revegetated mine areas up to five years after the revegetation. They note the adjacent unmined area supported populations of White-footed Dunnart, Swamp Rat and New Holland Mouse, stating "The study indicates that the vegetation on the regenerating mined areas had not developed to a suitable successional stage for permanent occupation by these native small mammals." They concluded that "The major factors contributing to this were sub-optimal rehabilitation procedures and the absence of suitable corridors for animal movements."

Wilson *et al.* (1990) for post-mining rehabilitation recommend techniques including "burning before clearing, reducing soil stockpiling and seed burial to optimize seed germination rates,

using organic mulch and indigenous species. Mapping and maintenance of corridors for small mammals around the mine area should also be carried out."

Richards and Tidemann (1988) note that some old derelict mine tunnels have become vitally important sites for bats to raise young. They note that many of these old sites are now being reworked by open cut methods, particularly for gold, "consequently, several important bat colonies inhabiting abandoned mine tunnels are now under threat, and presumably others will follow."

3.7 FERAL ANIMALS

Eason and Frampton (1991) note that feral cats have altered ecosystems and depleted populations of indigenous lizards and birds on the mainland of both Australia and New Zealand and on numerous island habitats throughout the world.

Bennett (1990) notes "Foxes, efficient introduced predators in Australia, have been associated with the declining status of medium-sized marsupials (e.g. Brush-tailed Bettong, Parma Wallaby, rock wallabies)."

Saunders (1990) notes that in his eight years observing the nests of Carnaby's Cockatoo nest hollows were taken over by swarming honey bees on three occasions while there were eggs or nestlings in them.

Moon (1990) notes that feral pigs "cause widespread ground disturbance, which may inhibit regeneration of vegetation, and they may inhibit koala movements."

3.8 Disease

Wilson *et al.* (1990) found that the presence of *Phytophthora cinnamomi* was "a major factor affecting small mammal abundance." They consider consequences of infection such as the reduction of plant species diversity, elimination of specific species, reduction in cover and a decrease in plant productivity would be expected to ultimately affect small mammals. They cite a study that found that the soil and litter fauna in infected areas is markedly reduced.

4.0 TARGET SPECIES

NOTE: H - denotes a species which utilises tree hollows,
L - denotes a species which utilises large logs,
P - denotes a species particularly vulnerable to predation by dingos, foxes and/or cats.

4.1 MAMMALS

Eastern Quoll

While generally considered extinct in NSW there have been visual sightings in recent years by reputable wildlife researchers on the Petroi Plateau and Carrai Plateau in the head of the Macleay valley.

Tiger Quoll *Dasyurus maculatus* H
Mansergh (1984) notes that the Tiger Quoll is considered to have a patchy distribution and be common to uncommon in Tasmania, very rare or extinct in South Australia, to occupy about half its pre-European range and considered rare in Victoria, to have a limited disjunct range and be uncommon in Queensland and to be generally uncommon (but more common in the north) in New South Wales. He cites the obtaining of only one locality record in a five year study of the Eden woodchipping region, where it was previously described as possibly endangered.

Mansergh (1984) notes infestations by the parasitic larvae of the native flea *Uropsylla tasmanica* may have a debilitative affect on Tiger Quolls and that feral cats and foxes may compete with them for food resources, but considers a combination of habitat destruction and the widespread trapping and poisoning in and around forest areas were probably responsible for the extinction of Tiger Quolls in many areas. He notes there is considerable concern over the impact of clearfelling practices, and while there has been no study of these impacts he cites concerns about adverse effects on potential food sources and reduced availability of breeding hollows.

Brushtailed Phascogale *Phascogale tapoatafa* H

Dusky Antechinus *Antechinus swainsonii*
Lunney, Cullis and Eby (1987) found that this species showed a negative relationship to canopy cover, significant preference for regenerating forest, dependence on a high percentage of ground cover and was absent from three successive post-fire censuses.

Koala P
Kavanagh (1987) notes that "no studies have been reported on the effects of logging, prescribed burning or other forest management practices on Koalas. Being an arboreal species and one dependent on eucalypt leaves for food, it could be predicted that below a certain threshold the intensity of logging would seriously affect Koala populations. This threshold level is unknown."

Kavanagh (1989a) reiterates these concerns following a Koala Summit (7-8 November 1988) by stating "the lack of information which is of any use to forest managers on Koala habitats and their ecology in forests was one aspect highlighted by this summit. The Commission should redress this situation by initiating a research programme to address the questions: 1) What is good Koala habitat? 2) What are the movements and home ranges of Koalas in forest?" He considered that such research would help decide further questions: Are Koalas conserved by gully corridor reservation?; Do they require mature forest on ridges? and, To what extent do Koalas use regenerating forest?

Watts (1989) also advocates ongoing surveys and a specific research project on the Koala. He emphasises that in the short-term, in each area where Koalas are known to occur the preferred forest types/species should be noted and provision made for retention of undisturbed areas.

Moon (1990) notes that "the north coast has been identified as the remaining stronghold of koalas in NSW, these populations are known to be declining." In his study area he estimated that the koala population had been reduced to 20-25 animals and were still declining - "due mainly to an increased mortality caused by (in order of impact) habitat loss, road deaths, stress-related disease, dogs and fire." He considers "In the absence of action to redress the problems this population will cease to function as a breeding unit within a decade."

Fanning (1990) recommended adoption of an interim protocol to be applied when a Koala is found: immediate cessation of logging; record all relevant details and search area for other animals, and; initiate a research programme.

Greater Glider *Petaurus volans* H
Mackowski (1987) cites findings that the Greater Glider favours the use of two primary dens in each territory and use other hollows less frequently, and that their home ranges are 1.5 to 2.5 ha. Kavanagh (1985b) found the home range of Greater Gliders varied between about 0.75 and 2.0 ha (typically about 1.0 to 1.25 ha).

Lindenmayer *et al.*(1991) found that in their study area Greater Gliders predominately utilized branch hollows at a height of 40 m +/- 3 m.

Dunning and Smith (1986) found that the abundance of Greater Gliders "was positively associated with the number of trees >96 cm d.b.h., which is consistent with its apparent height preference of 30-36 m". They state that the Greater Gliders observed following normal logging "were on the borders with the 66% retention and the control II zones and it is assumed that their territories may have overlapped this area prior to logging. No animals were observed away from boundaries."

Kavanagh (1985a) found that all Greater Gliders were observed in unlogged patches of forest and nearly always in unlogged creek reserves in his study area.

Yellow-bellied Glider *Petaurus australis* H
Mackowski (1984) found one of his study areas (logged 1920) had 57 Yellow-bellied Glider den trees/km^2 in Blackbutt forest (which averaged out to 12/km^2 when adjacent forest types were included). Kavanagh (1985b) considered that the Yellow-bellied Glider has an elongated range amounting to about 60 ha.

Mackowski (1987) notes "Arboreal marsupials the size of yellow-bellied glider and larger appear to require hollows > 100 cm^2

entrance size, these hollows only occur in blackbutt > 100 cm dbhob and are most abundant in blackbutt > 140 cm dbhob".

Binns (1981) notes that the Yellow-bellied Glider is though to be very sensitive to disturbance, often apparently vacating a coupe when logging first begins. Kavanagh (1985a) found that Yellow-bellied Gliders were occasionally seen foraging just inside logged areas but were normally only encountered in creek reserves or unlogged areas. Kavanagh and Webb (1989) found that following logging they continued to use their den trees in the unlogged wildlife corridor but moved up to 1 km away to forage in unlogged forest.

Loyn (1985) notes that Yellow-bellied Gliders regularly feed in the mid-slope region and move between ridges and gullies in a single night.

Squirrel Glider *Petaurus norfolcensis* H

Eastern Pygmy Possum *Cercartetus nanus* H
Rohan-Jones (1981) considers that from known habitat preferences Eastern Pygmy Possums will decline as the result of logging, primarily due to the reduction of suitable dense shrub patches by the practice of slash burning. Kavanagh and Webb (1989) note that the four Eastern Pygmy Possums they caught were all in unlogged forest. Dunning and Smith (1986) note that the Eastern Pygmy Possums they found "were only trapped in mature unlogged moist hardwood forest."

Feathertail Glider *Acrobates pygmaeus* H
Mackowski (1987) notes that Feathertail Glider nests, within hollows, contained 3 - 5 gliders when occupied.

Mackowski (1987) notes "Feathertail gliders were the most abundant arboreal wildlife found in blackbutt hollows... but they were not sensed by spotlight or aural means... This suggests that they are also common in other forests where they are not sensed." He found that Feathertail Gliders occupied an average of 0.86 hollows in each tree 100 - 119.9 cm dbhob, 0.17 hollows in trees 120 - 139.9 cm dbhob, 1.00 hollows in trees 140 - 159.9 cm dbhob, and 1.17 hollows in trees > 160 cm dbhob.

Kavanagh (1985a) notes that no Feathertail Gliders were seen on plots after they were logged. Dunning and Smith (1986) note that most captures of Feathertail Gliders were in mature moist hardwood, though two were found two years after heavy logging.

Long-footed Potoroo *Potorous longipes* P
Clark, Backhouse and Lacy (1991) note that only 32 individuals of this species have been trapped and it has been detected in 63 canid scats, with 23 scattered colonies detected. They note the main perceived threats to its survival are predation from introduced predators, and habitat disturbance from logging and unsuitable fire regimes.

Long-nosed Potoroo P

Kavanagh (1982) notes that controlling the use of fire and reducing the number of foxes (and dingoes) is recommended in areas where the potoroo is known to occur.

Rufous Bettong P
Kavanagh (1982) notes that management to favour Rufous Bettongs could best be achieved by controlling competitors (mainly rabbits), predators (foxes and dingoes) and beef cattle stocking rates,

Parma Wallaby *Macropus Parma* P
Read and Fox (1991) note that due to its restricted range and continuing pressures on its forest habitat the Parma Wallaby is a species that is especially vulnerable to extinction. They note that since European settlement its range has declined, though consider with the paucity of information about population size, distribution and ecology its status must be treated with some reservation until more data is available.

Read and Fox (1991) consider that optimum habitat for the Parma Wallaby appears to be wet sclerophyll forest (often with Sydney Blue Gum and Tallowwood present) with a moist or rainforest understorey. They found Parma Wallabies in areas subject to past logging disturbance and noted that Parma Wallaby occurred in 4.6% of Dingo scats collected in the Petroi-Five Day Creek area.

Black-striped Wallaby

Fawn-footed Melomys *Melomys cervinipes*,
Dunning and Smith (1986) found "The abundance of [Fawn-footed Melomys] was positively correlated with the basal area of rainforest species in the overstorey and in the understorey and negatively associated with the basal area of overstorey eucalypts and Brush Box.", "The abundance of [Fawn-footed Melomys] on experimentally logged sites (33% and 66% canopy retention) declined in greater proportion than the amount of forest biomass removed (66% and 80% respectively)." and "this species appeared the most sensitive to logging disturbance." They found that Fawn-footed Melomys also declined on unlogged control sites, one area was attributed to the affect of an escaped post logging burn though in another area for no apparent reason "unless it was caused by the general disturbance created by logging of adjacent areas as [Fawn-footed Melomys] population numbers declined more than those of any other species in response to logging."

Hastings River Mouse *Pseudomys oralis*

New Holland Mouse

4.2 BIRDS

Yellow-tailed Black Cockatoo

Red-tailed Black Cockatoo

Glossy Black Cockatoo *Calyptorhynchus lathami* H
Turner and Kavanagh (1990) consider that of the large cockatoos the Glossy Black Cockatoo is potentially the most threatened by logging. They note that this species "feeds exclusively on *Casuarina* fruits which although not scarce, appear to be selected from only certain trees. The effect of logging and prescribed burning on the availability of these preferred trees is unknown." They also note that the Glossy Black Cockatoo "appears to prefer the lower slopes of dry sclerophyll ridges, a habitat that is not usually protected by wildlife corridors."

Coxen's Fig Parrot *Psittaculirostris diophthalma coxenii* H

Powerful Owl *Ninox strenua* H
Kavanagh (1989b) notes that "our knowledge of the ecology and habitat requirements of large owls, including the use, if any, of regenerating forest is largely unknown." He recommends that there is a need to determine the requirements and the reliance of the large owls for old growth forest as habitat.

Kavanagh and Webb (1989) note that intense predation by Powerful Owls significantly reduced arboreal mammals within unlogged forest in the vicinity of logged forest and that they were more frequently detected in the unlogged forest.

Kavanagh (1989b) recommends that for Powerful Owls the general locality (ie 2.5km radius or 2000ha) around each site where they were detected be well served by a network of reserved old growth forest along gullies as wildlife corridors (>100m width). He also recommends the employment of a specialist "nest finder".

Sooty Owl *Tyto tenebricosa* H
Rohan-Jones (1981) notes that this owl is a predator of arboreal mammals together with which it forms a closely dependent subsystem, and recommends that where this combination is located should preferably be left unlogged.

Kavanagh (1989b) recommends "that old growth forest be reserved in gullies in wide (>200m) corridors for distance of up to 1km in either direction at all locations where Sooty Owls were detected." He also notes the need for a specialist "nest finder".

Masked Owl *Tyto novaehollandiae* H
Kavanagh (1989b) recommends that for Masked Owls the general locality (ie 2.5km radius or 2000ha) around each site where they were detected be well served by a network of reserved old growth forest along gullies as wildlife corridors (>100m width). He also recommends the employment of a specialist "nest finder".

Barking Owl

Marbled Frogmouth

Bush Stone Curlew

Black-breasted Button Quail

4.3 REPTILES

Beech Skink *Cautula zia*

Skink *Hemiergis maccoyi* L
Hemiergis maccoyi is a burrowing skink found under rocks and fallen timber in southern NSW. Kavanagh and Webb (1989) found that there was a significant reduction in populations of *H. maccoyi* on three logged compartments compared with the unlogged control, with effects still significant three years after logging.

Challengers Skink *Lampropholis challengeri* L
Dunning and Smith (1986) found that the highest densities of Challenger's Skink were associated with a closed forest canopy and abundant litter and logs in the ground cover. They found that numbers of Challenger's Skink declined significantly following logging in moist hardwood, even where there was 33% canopy retention and no post logging burn.

Skink *Leiolopisma coventryi* L
McIlroy (1978) cites research that found that prescribed burning during winter destroyed the hibernation sites (logs and litter) of this species.

Murray's Skink *Sphenomorphus murrayi*,
Dunning and Smith (1986) found that the highest densities of Murray's Skink were associated with a ground cover of abundant logs and litter. They found that its numbers decreased significantly following logging and burning.

Southern Angle-headed (Rainforest) Dragon

Stephen's Banded Snake

4.4 AMPHIBIANS

5.0 STATUTORY RESPONSIBILITY

The Forestry Act 1916 obliges the Forestry Commission to conserve native wildlife in State Forests, but in practice timber production has achieved primacy over wildlife conservation (Dunning and Smith 1986, Mackowski 1987, Davey and Norton 1990). The Forestry Commission has consistently ignored research undertaken by their own personnel and other institutions on the impact of their operations on wildlife and failed to adopt adequate mitigation measures.

The Environmental Planning and Assessment Act 1979 gives the Department of Planning responsibility to protect and enhance the environment. They too have consistently failed their responsibility to ensure that developments or activities likely

to have a significant impact on wildlife are controlled or adequate mitigation measures adopted.

The National Parks and Wildlife Act 1974 gave the National Parks and Wildlife Service a clear statutory responsibility for the protection of protected and endangered fauna. This responsibility has only been partially applied for individual animals where direct methods of capture or killing were utilised, habitat destruction or indirect killing (e.g by felling of a tree) of protected fauna has been ignored.

The amendments to the National Parks and Wildlife Act 1974 and Environmental Planning and Assessment Act 1979 resulting from the Endangered Fauna (Interim Protection) Act 1991 specify in greater detail the National Parks and Wildlife Service's and Department of Planning's responsibilities to ensure the survival of protected fauna in N.S.W. Most importantly the amendments clearly establish the National Parks and Wildlife Service's over-riding responsibility to ensure the protection of endangered fauna.

The opportunity to implement planned regional systems of retained habitat and wildlife corridors across all land tenures, along with the adoption of adequate mitigation measures to lessen the impact of developments and activities upon fauna now clearly resides with the N.P.W.S. and Department of Planning. The question is; will these departments now fulfil their statutory duties or will it continue to be conservationists who uphold the law through repeated court actions?

5.1 PROTECTED FAUNA

Protected fauna are all fauna in N.S.W. not named in Schedule 11 of the N.P.W. Act 1974. Endangered fauna are included as Protected Fauna.

Any action which is likely to significantly affect the environment of protected fauna is required to be either covered by a licence obtained from the National Parks and Wildlife Service, be in pursuance of a duty imposed by or under any Act, or be <u>essential</u> for the carrying out of an activity or development in compliance with the Environmental Planning and Assessment Act 1979.

The Environmental Planning and Assessment Act 1979 requires that a Fauna Impact Statement is prepared if a proposed development (under part 4) or activity (under part 5) is likely to significantly affect the environment of protected fauna. An amendment made to the E.P.A. Act by the Endangered Fauna (Interim Protection) Act 1991 states:

"4A. ...in deciding whether there is likely to be a significant effect on the environment of protected fauna the following factors shall be taken into account -

(a) the extent of modification or removal of habitat, in relation to the same habitat type in the locality and region;

(b) the sensitivity of the species of fauna to removal or modification of its habitat;

(c) the time required to regenerate critical habitat;

(d) the effect on the ability of the fauna population to recover including interactions between the subject land and adjacent habitat that may influence the population beyond the area proposed for development or activities;

(e) any proposal to ameliorate the impact;

(f) whether the land is currently being assessed for wilderness by the National Parks and Wildlife Service under the Wilderness Act 1987;

(g) any adverse effect on the survival of that species of protected fauna or of populations of that fauna.

Under amendments made to the National Parks and Wildlife Act 1974 by the Endangered Fauna Interim Protection Act 1991, a fauna impact statement is required to:

92D(1) "(c) include, to the fullest extent reasonably practical, the following:

(i) a full description of the fauna to be affected by the actions and the habitat used by the fauna;

(ii) an assessment of the regional and statewide distribution of the species and the habitat to be affected by the actions and any environmental pressures upon them;

(iii) a description of the actions and how they will modify the environment and effect the essential behavioural patterns of the fauna in the short and long term where long term encompasses the time required to regenerate essential habitat components;

(iv) details of the measures to be taken to ameliorate the impacts;

(v) details of the qualifications and experience in biological science and fauna management of the person preparing the statement and of any other person who has conducted research or investigations relied upon."

The director is enabled to issue director's requirements for the preparation of Fauna Impact Statements. This provides opportunities for the standardisation of survey methodology. The methodology employed should be compatible with the Geographic

Information System utilised by the N.P.W.S. to facilitate assessment of applications and enhance the knowledge of N.S.W.'s fauna. It is also possible to request the collection of detailed data on rare and endangered species to facilitate a better understanding of their demography and habitat requirements.

5.2 ENDANGERED FAUNA

Endangered fauna are protected fauna of a species named in Schedule 12 of the N.P.W. Act 1974 as threatened, as vulnerable and rare, or as a marine mammal.

The director of the N.P.W.S has the responsibility for licensing any activity which will take or kill endangered fauna. On the receipt of such a licence application the director must advertise the application in a statewide newspaper and invite public submissions for at least 28 days. In considering the application the director must take into account any fauna impact statement or environmental impact statement, submissions, the status of the species and proposed mitigation measures. The director must then notify the applicant and people who made submissions of the director's decision and reasons for it, and make all information concerning fauna supplied to the director in support of the application freely available to the public.

The applicant or people who made submissions may, within 28 days of notification of the director's decision, appeal to the Land and Environment Court if dissatisfied with the director's decision.

The Minister for the Environment or the Director are able to issue stop work orders where they consider that an action is likely to significantly affect the environment of any protected fauna. Stop work orders last for 40 days and are able to be renewed.

6.0 DISCUSSION AND RECOMMENDATIONS

The key factors affecting the ability of a range of native fauna to persist in New South Wales are habitat loss, habitat fragmentation and habitat degradation. Logging, prescribed burning, road construction, stock grazing, mining and chemical usage have all been found to significantly affect a variety of native fauna. Overshadowing and compounding these impacts are global warming, increasing ultra-violet radiation, the buildup of toxic chemicals in foodchains, and displacement of native species by introduced species.

Habitat can be lost by clearing or by being rendered unsuitable by the loss of habitat components upon which a species relies. Habitat is degraded when components upon which a species depends are diminished but still sufficient to allow a species to persist (even if only temporarily). When considering the persistence of species in degraded habitats it is essential to consider whether the habitat has been rendered sub-optimal or marginal. If the

later is the case then individuals encountered in that area may be non-breeding colonists from optimal habitat elsewhere.

As habitat suitable for a species becomes fragmented or degraded other species from more open habitats, or introduced from other countries, may invade to compete with or prey upon resident species. These effects can penetrate well into intact habitat due to the edge effect (Andrews 1990, Bennett 1990, Gilmore 1990).

Fragmentation of populations of a species by unsuitable habitats can disrupt or stop gene flow between remnant populations. Entire populations of some species may have already been reduced to such an extent that they are suffering inbreeding and their long-term viability can only be assured by active management (Clark, Backhouse and Lacy 1991). Many isolated populations may also be suffering the same fate (e.g. Dunning and Smith 1986)

The full ramifications of changes already wrought upon the environment have yet to become fully manifest (e.g. declining numbers of habitat trees and large logs, global warming) and populations of many species can be expected to continue declining for many decades even after activities contributing to their demise cease.

Disturbance to an ecosystem makes it more vulnerable to invasion by other species and susceptible to climatic changes. Population declines in, or loss of species from, an ecosystem can disrupt the ecosystem's functioning and cause inbalances which may take many years to become fully manifest (e.g. Bell Miners killing regrowth, Currawongs decimating small bird populations, Dingo control leading to increases in foxes and subsequent declines in medium sized mammals).

The frequency at which disturbances recur is a major determinant of ecosystem potential and the ability of species to persist. If the frequency of disturbance is such that the structual components a species is dependent upon are unable to fully recover before the next disturbance then the impacts will compound the effects upon that species, with each disturbance lessening its ability to persist.

6.1 REGIONAL SYSTEM OF RETAINED HABITAT

The state needs to be separated into definable regions within which the aim should be to preserve the existing biodiversity. Given our ignorance of species requirements, ecosystem functioning and impacts of habitat modification it is essential that the highest priority be given to establishing a regional system of retained habitat which ensures the provision of adequate, and suitably linked, habitat to support viable populations of all target species.

A regional system of retained habitat should be comprised of adequate areas reserved from exploitation as legislated reserves, sites of significance and wildlife corridors. Such a system can

be complemented by enhanced retention of habitat components and specific fauna prescriptions in unreserved areas.

Where feasible (ie State Forests) reserves should be buffered by habitat subject to a lesser degree of disturbance than normal (e.g. forest logged to a reduced intensity). This is particularly important for small reserves and wildlife corridors.

6.1.1 Legislated Reserves

Some thousands of individuals may be required to maintain genetically isolated populations over time (Tyndale-Biscoe and Calaby 1975, Davey 1990). It is imperative that within each region adequate habitat, or potential habitat, be retained free from detrimental activities to ensure the maintenance of viable populations of target species over time.

The emphasis should be upon reserving major source areas (e.g. areas with high population densities of target species), refuge areas (areas species are already restricted to, become periodically restricted to, or are predicted to become restricted to as the result of global warming or other factors) and areas with a high diversity of target species.

The requirements of migratory and wide ranging species need to be considered in reserve design.

Where possible reserves should be as large as feasible (Tyndale-Biscoe and Calaby 1975, Davey 1989, Bennett 1990) and have a minimum edge to area ratio (Bennett 1990, Gilmore 1990).

6.1.2 Sites of significance

Sites of particular botanical and zoological significance outside major legislated reserves need to be identified and given appropriate protection. Sites of zoological significance should be those with outstanding faunal values or containing populations of nominated threatened, vulnerable and rare fauna. These sites should be identified in the Fauna Impact Statement process.

Sites of significance could be designated as Flora Reserves or protected under the Preferred Management Priority system if on State Forests. On private lands they could be designated as Environmentally Sensitive under the Protected Lands mapping system or a Conservation Agreement could be entered into with the landholder.

6.1.3 Wildlife Corridors

Corridors of forest need to be retained or established to provide multiple pathways for the dispersal of fauna throughout forests to allow: (i) genetic exchange between isolated populations (Dunning and Smith 1986, Bennett 1990, Saunders 1990), (ii) dispersal to required resources (Saunders 1990, Moon 1990), (iii) preservation of populations of some species in otherwise unsuitable habitat (Kavanagh 1985a, 1985b, Dunning and Smith

1986, Kavanagh and Webb 1989, Bennett 1990), (iv) for required resources for species utilizing adjacent habitats (Bennett 1990), and (v) for migration of species in response to predicted global warming (Page 1989).

Wildlife corridors should be as wide as possible and where possible established in natural forest which has preferably not been subject to severe pertabation.

In general the Forestry Commission relies upon modified streamside retention strips (implemented for erosion mitigation purposes) for wildlife corridors. These may be strips of vegetation 20 metres each side of streams with catchments in excess of 30 or 100 hectares, which may or may not be subject to logging (but not entered by machinery), or "wildlife corridors" comprised of strips 40 metres wide with the outer 20 m subject to modified harvesting. In some instances (e.g. Eden region) 100 m + strips may be retained.

Narrow riparian strips do not provide habitat suitable or adequate for a variety of species (Mackowski 1984, Kavanagh 1985b, Shields and Kavanagh 1985, Dunning and Smith 1986, Bennett 1990, Gilmore 1990, Recher *et al.* 1991). Even where suitable habitat is encompassed corridors with a total width of 200 m have been found inadequate for some species (Kavanagh 1985b).

When designing wildlife corridors it is essential to consider: (i) the species being targeted, their ecology, habitat requirements, and dispersal ability (Bennett 1990), (ii) the edge effect and its impact on suitability of the corridor for target species (Bennett 1990, Saunders 1990, Recher *et al.* 1991), (iii) the pathways actually utilized by species for movement (Davey 1989) and (iv) the necessity of species to migrate in response to global warming (Page 1989).

An adequate wildlife corridor system should encompass: (i) multiple pathways linking retained habitat (Bennett 1990), (ii) reservation of larger areas of suitable habitat at periodic intervals along corridors (Bennett 1990, Recher *et al.* 1991), (iii) linked riparian and ridge corridors sampling suitable habitat for a full range of target species (Dunning and Smith 1986, Bennett 1990, Recher *et al.* 1991) and (iv) a hierarchy of corridors comprised of broad regional corridors established to restore links between isolated forests, major wildlife corridors within production forests to link important reserved areas and a network of smaller wildlife corridors forming common linkages in the system of retained habitat (Bennett 1990).

While it is essential that wildlife corridor design be based on the actual requirements of target species, as interim measures the minimum width of regional corridors should be at least 200 m wide (Saunders 1990), or preferably wider, major wildlife corridors a similar width and smaller wildlife corridors at least 100 m wide (Dunning and Smith 1986, Kavanagh 1989b, Bennett 1990). Davey (1989) recommends not stipulating constant width and

enabling boundaries to maximise the structual and species diversity. Wildlife corridors should not be subject to logging.

In designing wildlife corridors it is essential to consider the effects of barriers to movement and strategies to facilitate movement across potential barriers (Andrews 1990, Bennett 1990, Saunders 1990). For example it is essential that movement of fauna be taken into account in highway and railway design by the provision of fauna underpasses (Andrews 1990). Forest roads should have fauna underpasses incorporated as well as ensuring that at strategic locations tree crowns can touch across roads to facilitate movement of arboreal species. Measures need to be identified to ensure that underpasses don't act as funnels to concentrate prey for predators (Andrews 1990).

6.2 **MULTIPLE USE MANAGEMENT**

The Forestry Commission has managed its forests predominately for wood production with wildlife considered a constraint and wildlife management at best incidental (Dunning and Smith 1986, Mackowski 1987, Davey and Norton 1990). Recommendations and research findings by research foresters have been regularly ignored by the Commission where they are considered to interfere with timber production. In attempts to justify their approach the Commission has resorted to propaganda which has been found to often contradict the results of their own research or have no scientific credibility.

Normal logging practices have been found to have a significant impact on wildlife, causing elimination or severe reductions of a variety of species in logged areas (Tyndale-Biscoe and Calaby 1975, Kavanagh 1985a, 1985b, Shields and Kavanagh 1985, Loyn 1985, Dunning and Smith 1986, Kavanagh and Webb 1989). Species most effected are variously considered to be those requiring tree-hollows for denning, roosting and/or nesting, eucalypt canopy feeders, moist ground litter feeders, trunk and bark foraging species, species dependent upon large logs, species reliant upon reliable moisture regimes in gullies and low order streams, and species with narrow habitat requirements (Loyn 1985, Shields and Kavanagh 1985, Mackowski 1987, Gilmore 1990, Recher *et al.* 1991). Logging impacts have also been found to extend into nearby unlogged areas for some species (Dunning and Smith 1986, Kavanagh and Webb 1989).

The impact of logging has been found to be significantly compounded by the common practices of post-logging burning (McIlroy 1978, Rohan-Jones 1981, Recher, Allen and Gowing 1985, Dunning and Smith 1986) and other prescribed burning (Cowley 1971, Rhonan-Jones 1981, Shields and Kavanagh 1985, Wilson *et al.* 1990, Moon 1990). Associated roading is also considered to be a major impact (Barnett, How and Humphreys 1978, Andrews 1990, Bennett 1990, Gilmore 1990). Other forestry practices such as application of herbicides and fertilizers, grazing, 1080 baiting and, conversion of native forest to plantations all contribute to the very significant impact of forestry operations on wildlife.

There is a dearth of research on the long term consequences of such disturbances upon fauna. Research to attempt to identify longer term consequences have compared different sites where site variables can not be adequately accounted for. It is evident that most species detrimentally affected, but not eliminated, by habitat disturbance will recover their populations as the structual components and food sources they rely upon are restored. For species reliant upon habitat components that rapidly regenerate recovery may occur in a matter of years, while species reliant upon habitat components that take a long time to develop (e.g. large hollows, large logs) population recovery (where possible) can be expected to take hundreds or thousands of years.

6.2.1. **Habitat tree retention prescriptions**

Hollow-bearing trees, and with them hollow-dependent species, have already been decimated within vast tracts of forests. The problems such fauna are facing is expected to exponentially worsen as the few remaining tall old-growth forests continue to be felled and currently retained trees (in both forests and pastoral lands) die-out without potential replacement trees being available. The full ramifications of changes already wrought will take a century or more to become fully manifest.

To mitigate the impact of logging operations upon some hollow-dependent fauna it is necessary to manage for provision of habitat (hollow-bearing) trees in perpetuity (Mackowski 1984, 1987). While this requirement was clearly identified by Mackowski to the Forestry Commission his concern that there would be a lack of implementation (Mackowski 1987) has been fully justified. Current blanket prescriptions in NSW vary from clumps of 5 habitat trees per 15 ha to 5 per 5 ha, though in individual cases foresters are being forced to retain higher numbers and distribute them more evenly through the logging area. It is reprehensible that there are no provisions to retain potential replacement trees for the future.

Current prescriptions are a farce because (i) a clump of habitat trees may effectively only be equivalent to one tree for territorial species, (ii) retained trees are more vulnerable to windthrow and there is no provision for replacements as retained trees drop out of the system, (iii) some retained trees have been observed to be already dead or burnt out at the base and unlikely to remain standing for long, (iv) there is no attempt to asses the usage of trees before delineation, and (v) there is generally no attempt to asses species densities and requirements prior to determining prescriptions for an area.

To determine habitat tree retention prescriptions for an area it is necessary to consider: (i) the habitat requirements and demography of the target species (including various species interactions), (ii) that only one large species may occupy a given tree (Lindenmayer *et al.* 1991), (iii) the type and position

of hollows and their suitability for target species (Lindenmayer *et al.* 1991, Mackowski 1987), (iv) the species of trees involved and their hollow-development characteristics (Mackowski 1987), (v) the need for a uniform distribution of habitat trees (Dunning and Smith 1986, Mackowski 1987), (vi) the area in a regional context (Mackowski 1984), and (vii) the retention of sufficient potential replacement trees to maintain the prescribed number of habitat trees in perpetuity (Mackowski 1984, 1987).

It is feasible that management aimed at providing hollows in perpetuity should only need to focus on species requiring larger hollows and endangered species. Some such species would be Greater Glider, Yellow-bellied Glider, Squirrel Glider, Powerful Owl, Sooty Owl, Masked Owl, Yellow-tailed Black Cockatoo, Red-tailed Black Cockatoo, Gang-gang Cockatoo, Glossy Black Cockatoo and possibly some bats. Kavanagh (1989b) recommends the employment of a specialist nest finder for owls, such a concept could be expanded to identify habitat trees for most of these species before trees are felled.

In old-growth forests hollow-availability is not generally considered to be a limiting factor for most species of hollow dependent species but rather other resources that are limiting populations (Dunning and Smith 1986, Mackowski 1984, 1987). It is in logged forests that hollows do become a limiting factor. As well as managing for provision of hollow-bearing trees in perpetuity it is crucial to determine other limiting resources for target species, the recovery time of such resources and when population recovery can be expected.

Many forests have been denuded of habitat trees. To enhance such forests for nature conservation and maintenance of ecosystem functioning they need to be managed for the return of adequate stockings of habitat trees. To determine adequate stockings for already disturbed areas it will be necessary to extrapolate from 'undisturbed' forests of similar type and productivity.

The concept of habitat tree needs to be expanded to include trees offering other critical resources for target species. For example trees tapped for sap or relied upon for abundant nectar at critical times by Yellow-bellied Gliders or the preferred individual food trees of Koalas or Glossy Black Cockatoos. Importantly the supply of large logs in perpetuity needs to be evaluated, target species dependent upon large logs for critical resources identified, their habitat requirements delineated, and the findings incorporated into habitat-tree retention prescriptions.

Habitat trees and their successors should be clearly marked in the field and monitored over time to determine their effectiveness (Mackowski 1987).

A suggested procedure to be adopted is:

1) Undertake surveys to determine target species' presence, habitat requirements and densities. Where possible identify

particular trees used by select target species (e.g. Kavanagh 1989b). Use actual findings as a basis for prescriptions with allowance made for predicted and potential occurrences and requirements,

2) Develop models predicting development of hollows in tree species and their use by target species, in relation to size class of trees (Mackowski 1984, 1987, Davey 1989). Combine this with models of stand dynamics and proposed silvicultural practices to determine prescriptions for habitat tree provision in perpetuity (e.g. Mackowski 1984, 1987).

3) Permanently mark habitat trees, and their replacements (Mackowski 1987). Monitor their effectiveness and accuracy of predictions at selected sites over time.

6.2.2 Prescribed burning

A single fire event has been found to have a significant effect upon fauna that inhabit or utilize the ground and shrub stratum (Cowley 1971, Fox and McKay 1981, Recher, Allen and Gowing 1985, Dunning and Smith 1986, Lunney, Cullis and Eby 1987, Wilson *et al.* 1990).

Species of small ground mammals exhibit a replacement sequence in reaching maximum abundance following fire, variously species may reach maximum abundance after one to eight years, with populations of some species found to be still increasing after six to eight years or even after 30 years (Fox and McKay 1981, Wilson *et al.* 1990). Populations of some species may be eliminated by fire (Wilson *et al.* 1990) and others may not establish populations in burnt areas for many years (Fox and McKay 1981, Lunney, Cullis and Eby 1987, Wilson *et al.* 1990).

Post-logging burns are commonly utilized to dispose of logging debris and encourage eucalypt regeneration. Such burning has been found to greatly compound the impact of logging operations on fauna (Recher, Allen and Gowing 1985, Dunning and Smith 1986), and is considered to have a greater impact on some small ground mammals and reptiles than logging (Shields and Kavanagh 1985, Dunning and Smith 1986). Post-logging burning leaves many large logs but due to their often being elevated by branches and other debris they commonly are severely charred, which can render them unsuitable for many invertebrates and consequently vertebrates.

Post-logging burns are of questionable silvicultural value and tractor clearing has been advocated to create the desired disturbance for regeneration (Dunning and Smith 1986), though this can have other undesirable consequences on soils (e.g. compaction). Kavanagh and Webb (1989) found that without burning the clearfelling of patches in their 50% canopy retention treatment resulted in better regeneration than the 'normally logged' treatment.

While populations of some species may recover in parallel with the rate of post-fire revegetation (Recher, Allen and Gowing 1985) it is considered that frequent burning (e.g. control burning) can result in degraded habitat and the loss of habitat components upon which species rely (Cowley 1971, McIlroy 1978, Leigh and Holgate 1979, Rohan-Jones 1981, Moon 1990, Wilson et al. 1990), such as understorey structure and plant species (Cowley 1971, McIlroy 1978, Leigh and Holgate 1979), habitat trees (Rohan-Jones 1981, Mackowski 1987), large logs and litter (McIlroy 1978, Dunning and Smith 1986). It is apparent that many of these habitat components will take many decades or centuries to be replaced.

The Forestry Commission prescribe burns some areas of forest every year (near plantations), every second year (high-risk areas near some roads or tourist facilities) or on frequencies of up to 5-7 years. Their ideal frequency is often not achieved due to labour and funding constraints. The greatest source of non-prescribed burns are graziers with forest-leases who burn vast tracts of forest (often in spring when peak flowering and breeding occurs) as frequently as every year. Grazier's fires must be stopped as a matter of urgency, if necessary their leases should be revoked.

Fuel reduction burns should be well planned, taking into account the frequency, area burnt, timing and intensity of fires (Wilson *et al.* 1990), and the demography, habitat requirements and responses to burning of target species. It is essential that a proper evaluation of burning and its impact on wildlife be undertaken and mitigation measures devised.

6.2.3 Roading

Roads (and other disturbance corridors) create avenues for the introduction and dispersal of non-forest and introduced species into forests (Richards and Tidemann 1988, Andrews 1990, Bennett 1990, Gilmore 1990), isolate or restrict movement between populations of some species (Barnett, How and Humphreys 1978, Andrews 1990, Bennett 1990), are significant causes of mortality (Andrews 1990, Bennett 1990, Moon 1990), and have many other deleterious impacts on fauna (Andrews 1990, Bennett 1990).

There is an obvious need to consider wildlife in road planning. Fauna underpasses and overpasses must be incorporated into road design to facilitate genetic exchange between isolated populations and minimise disruption to social organization, access to required resources, and migration. Road clearances through natural areas should be minimised. Effective means of reducing road fatalities need to be identified.

6.2.4 Other prescriptions

The Forestry Commission is still phasing out 'general purpose' rainforest logging and replacing it with unspecified 'speciality

purpose' logging. Their restrictive definition of rainforest is based on aerial photograph interpretation where 20% canopy cover (or in practice even less) by eucalypts or Brush Box is considered sufficient to classify a forest as non-rainforest. This, coupled with often inaccurate typing, is not an acceptable ecological basis upon which to classify rainforest. As a consequence rainforest is still being logged on a 'maximum economic utilization' basis, and surviving rainforest species killed in post-logging burns..

The Forestry Commission is allowing logging to occur up to rainforest margins (by their definition) and is regularly constructing roads through rainforest. Such activities have a significant impact upon the rainforest and the fauna which depend upon rainforest and must be considered in this respect. As well as applying an ecological definition to rainforest, proper and effective buffers around rainforest should be left during logging operations.

1080 baiting is extensively utilized in State Forests, National Parks and on private lands for control of Dingos and/or grazing pests (e.g. rabbits, wallabies). There has never been an Environmental Impact Statement prepared for 1080 baiting, even though it is an activity likely to have a significant impact upon the environment and thus an E.I.S. is required by the Environmental Planning and Assessment Act 1979. No further 1080 baiting should be allowed until the E.P.A. Act has been complied with and a Fauna Impact Statement prepared.

Grazing, chemical usage, mining and introduced diseases all have significant environmental impacts and their impacts on wildlife need to be fully considered and assessed for planned developments and activities.

7.0 GLOSSARY

dbh: diameter of a tree at breast height (1.3 m above ground), under bark - often used in general sense to include dbhob.

dbhob: diameter of a tree at breast height, measured over bark.

Cohort: a group of trees originating from the one regeneration event, often following a fire.

Endangered fauna: protected fauna of a species named in Schedule 12 of the N.P.W. Act 1974 as threatened, as vulnerable and rare, or as a marine mammal.

Habitat tree: trees containing hollows suitable for denning or nesting.

Indicator species: species that represents a particular use, ecosystem, or management concern.

Keystone species: a species, that if lost from a system, leads directly or indirectly to the disappearance of several other species.

Marginal habitat: habitat where a species can exist but not reproduce.

Minimum viable population: population size of a species that will ensure genetic viability over time.

Mobile link species: species which are important functional components of more than one food chain, plant-animal association, or ecosystem.

Optimum habitat: habitat that is of a quality that enables fecundity and/or population density of a species to be maximised.

Protected fauna: all fauna in N.S.W. not named in Schedule 11 of the N.P.W. Act 1974.

Sensitive species: species affected detrimentally by forest operations - logging, fire management, silvicultural treatments, grazing, roading and 1080 baiting.

Sub-optimal habitat: habitat of a lower quality than optimal habitat, but where a species can still reproduce.

Target species: species that are rare, endangered or sensitive to the effects of proposed activities and/or global warming.

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