NOTES ON THE SILVICULTURE OF MAJOR N.S.W. FOREST TYPES

1. MOIST COASTAL HARDWOOD TYPES

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Appendices:

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Notes On The Silviculture Of Major N.S.W. Forest Types

1. Moist Coastal Hardwood Types

1. INTRODUCTION

These notes summarise the existing recorded information relating to the silviculture of the Moist Coastal Hardwood (MCH) types in N.S.W. - types that since the 1970's have yielded about a quarter of the State's hardwood sawlog production.

As understood here the types are essentially those forming the Sydney Blue Gum/Bangalay **(For botanical names, see Appendix 1)** League, described in Forestry Commission Research Note No. 17 (Forestry Commission of N.S.W., 1965), but excluding the Flooded Gum type (no. 48), which is proposed for separate coverage, and types confined to the South and Central Coasts. Nonetheless the features described here probably apply equally well to the latter group of types.

These types are typically tall, high yielding, wet sclerophyll forest stands, usually with a dense, mesic understorey and with Tallowwood, Blue Gum and Brush Box well represented. Whilst often thought of as typical of the escarpment zone, between the coast and tablelands (a point rendering the "Coastal" in their name rather inappropriate), they also occur in more coastal districts and at lower altitudes.

The types are commonly considered difficult to regenerate, and in an effort to determine some of the factors influencing their regeneration patterns a substantial research programme into the types was carried out in the late 1950's and through the 1960's. A number of internal Forestry Commission reports resulted from this programme, and these provide the basis for much of the information in these notes: Floyd (1957? And 1959), Curtin (1960) and Van Loon (1965); the last of these was subsequently substantially published as For. Comm. Res. Note No. 19 (Van Loon, 1966).

2. FOREST ECOLOGY

2.1 The Types

From Res. Note 17, the types making up the Moist Coastal Hardwood types include:

46	Sydney Blue Gum
47	Tallowwood-Blue Gum
49	Turpentine
51	Dunns White Gum
53	(Inland) Brush Box
54	Whitetopped Box

Besides the species giving their names to these types, other hardwoods (eucalypts and related genera) that may be significantly present in the overstorey include Flooded Gum, Narrowleaved White Mahogany, Silvertop and Diehard Stringybarks and New England Blackbutt. Other species may also be present in local or marginal sites, though even a relatively low proportion of Blackbutt is usually regarded as sufficient to take the stand out of these types and into a Blackbutt community.

Forest Oak often occurs as an understorey tree, sometimes over 30m in height, and the less common Brush Cypress Pine has its main occurrence in these types, resembling Forest Oak in size.

Stands commonly exceed 40m in height and individual trees may exceed 60m. Virgin stands typically yield between 30 and 100 m^3 of timber per hectare, and on exceptional sites may exceed 300 m^3.

Rainforest species are commonly present in the understorey, and in the absence of fire or other disturbance they may gradually develop into a mature rainforest which assumes possession of the site when the hardwood overstorey trees finally die, though this full sequence probably only rarely reaches such a conclusion. Fire will alter or interfere with the sequence, and other understorey combinations usually indicate differing fire histories. These other understorey species include wattles, Tickbush and such vines as wild raspberries, native grapes, Soldier Vine and Hibbertia spp. Ferns may sometimes densely cover the ground, while grass may dominate the understorey in sites that are fairly regularly burnt.

Differences between and within individual types reflect in part changing physical conditions, but undoubtedly also are strongly influenced by historical accidents, such as the frequency, severity and timing of past fires. Tallowwood and Blue Gum can be regarded as the two key species, though either may be absent from particular areas (e.g. Tallowwood from Allyn River area of Chichester State Forest), and either can completely dominate whole stands. Of the two, Blue Gum probably has a greater need for sites with deeper soil and possibly moister and more sheltered conditions, though it commonly occurs on ridgetops in the moister areas.

Features of the occurrence of other major associates include:

- Brush Box - predominates in moister sites, often in more sheltered gullies adjacent to rainforest, but may occupy ridges where rainforest is widespread.
- Turpentine - again tends to favour moister sites.
- New England Blackbutt - usually on drier, ridge sites, sometimes with Diehard Stringybark.
- Narrowleaved White Mahogany - most common at lower altitudes and warmer parts of types' range.
- Silvertop Stringybark - higher altitudes.
- Whitetopped Box - rather spasmodic, usually on steep, escarpment sites on fertile soils; occasionally on less favourable sites.
- Flooded Gum - on broad alluvial flats and adjacent slopes; Dunns White Gum has rather similar occurrence in a few sites on far North Coast.

Indications of the broadacre composition of these types are given by the following figures, from Curtin (1960) and Forestry Commission of N.S.W. (1980a):

Type	**Bulga-Dingo Management Area**	**Washpool Study Area**	
		Very Moist Sites	**Drier Sites**
Tallowwood	39%	40%	40%
Blue Gum	21%	15%	20%
Brush Box	18%	40%	5%
Other spp.	22%	5%	35%

(Other species at Washpool includes New England Blackbutt).

The types support a rich and varied fauna. For the Washpool Study Area it is noted that 80 per cent of the mammals expected in the area (39 out of 49 species) would be associated with these moister hardwood types, and 62 per cent of the birds (100 out of 160 species), while in the Hastings district 35 out of the 38 mammals present (excluding bats) occur in the moist forests. Complexity and variety of forest structure, foliage height diversity, branch and stem hollows, nectar resources, berry-bearing plants, and the high nutrient status of the forests generally are among

the factors contributing to the high wildlife productivity. Appendices 4 and 5, taken from the Washpool environmental impact statement (Forestry Commission of N.S.W., 1980a) and based upon observations in a number of North Coast forests, indicate the range of mammal and bird species, respectively, occurring in the Moist Coastal Hardwood types.

2.2 Ecological Relationships

The Moist Coastal Hardwood types appear to show fairly close ecological relationships, and are usually associated with the occurrence of rainforest. Broadly, these types and rainforest could both equally occupy the same sites. In any locality, rainforest tends to be confined to the more sheltered and moister sites, with hardwood in the sites more prone to periodic burning: an environmental change that often also coincides with a fertility gradient. Probably there are no Moist Coastal Hardwood sites that would not support some type of rainforest under present conditions given indefinite protection from fire, though in some cases the combination of soil fertility and rapid drainage would result in rainforest of low site quality. These conditions, however, tend to ensure that such sites burn from time to time, thus perpetuating the hardwood.

Radiocarbon dating at Whian Whian S.F. has shown Brush Box trees in excess of 1 000 years old; Tallowwood probably has similar longevity. With such trees, one severe fire in a millennium is all that is needed to maintain the type. In fact, at Whian Whian several ages of trees (of overlapping size range) are present, suggesting fires at intervals of 300 to 400 years. Such fires allow the survival of the fairly fire-resistant hardwoods, and provide conditions for these intolerant species to regenerate. The virgin stands we see today are probably the end result of numbers of such fires, each helping to add to the stocking of trees present by providing conditions for regeneration in the gaps and openings that have occurred (by natural mortality, storm damage or the previous fire) since the area was previously burnt.

Besides rainforest, where two distinct types of forest vegetation are involved, the Moist Coastal Hardwood types also merge into a number of other hardwood forest types, of which the most important are the Moist Tableland Hardwoods, Blackbutt, and the moister phases of the Grey Gum - Grey Ironbark and Spotted Gum types.

2.3 Environment

Climatic averages for eight stations occurring in Moist Coastal Hardwood sites, with altitudes varying from 9 to over 1 000m, and latitudes from 28°36`S to 33°6'S, are given in Appendix 2. The major features of silvicultural significance are:

- High annual rainfalls (usually over 1 260 mm), with highest falls in late summer-early autumn.
- Dry late winter-spring, when rainfall over 3 months may average less than 200 mm.
- Cold winters.

All stations probably experience occasional summer days approaching 40°C, while frosts would be regularly experienced in suitable openings adjacent to all stations, and at the higher altitudes can be frequent and severe through the winter and early spring.

Soils are typically deep and of moderate to high fertility, usually well drained but with fair to good moisture-holding capacity. They can be derived from a wide range of parent materials. Basalt soils may sometimes be excessively drained in their surface layers, creating regeneration difficulties, though they can subsequently support high quality stands. Variations in soil characteristics are undoubtedly important factors influencing changes in productivity, composition and other features of these types, as demonstrated by Turner and Kelly (1981) in their study of soil/vegetation relationships in the Terania Creek basin, near Lismore.

The types can occur on a wide range of topographic situations, from gullies to plateau surfaces, and sometimes including steep slopes. The changes associated - from sheltered gully with deep enriched soil to drier ridgetop; from cool, moist, south-facing slope to fire-prone western slopes - influence the nature of the types and their relationship with other communities.

Fire has to be recognised as a major factor in the occurrence of these types, as discussed in Section 2.2. It is the basis for the regeneration of the hardwood overstorey in Nature. It also strongly influences the nature of the understorey. Frequent fire will result in a ground cover of grass or bracken; severe fire will often create dense wattle stands (e.g. *Acacia binervata, A. irrorata*), which can persist for 20 to 30 years before significant break up occurs. Elsewhere, fire may be followed by Tickbush thickets, while infrequent fire allows rainforest to develop. Fires also cause damage to the overstorey trees, leading to wood damage and sometimes to the death of the trees.

Seldom, if ever, will a fire burn evenly over a tract of Moist Coastal Hardwood forest. Some sites, such as the ridges, will burn regularly, but the fire will rarely penetrate into the more sheltered parts. Yet these typically develop very high fuel loadings that, on the fortuitous conjunction of drought conditions, extreme fire weather and an ignition source, can result in a severe fire. As previously noted, the incidence of such fires might only be once every few centuries, but usually ft seems to be much more frequent than this. Not all such fires result in tree death or the establishment of persisting regeneration, since the overstorey stems are usually quite fire resistant and may survive numbers of such fires with little long-term visible evidence.

As already discussed (Section 2.1), the Moist Coastal Hardwood types provide a rich wildlife habitat.

3. OCCURRENCE

While the individual major species have a wider range, the main occurrence of the Moist Coastal Hardwood types is in the hinterland escarpment zone of the North Coast, at elevations between about 300 and 1 000m - the area described in the Indigenous Forest Policy (Forestry Commission of N.S.W., 1976) as “the more mountainous and less accessible forests behind the coastal plain.” It extends discontinuously from the foothills of the Barrington Tops, north of Dungog, along the various ranges of the North Coast to the McPherson Range, and hence into Queensland. Lower altitude occurrences are found fairly widely along the North Coast, usually in association with other high site quality forest stands; one such major centre is in the Bulahdelah district. Related communities occur widely in the Watagans group of forests and elsewhere in more southern locations.

The general occurrence of these types is shown (as “Moist Coastal Forest”) on the N.S.W. forest type map (Forestry Commission of N.S.W., 1978). Management areas with significant areas of these types include Chichester, Gloucester, Wingham, Marsh, Wauchope, Kempsey, Bellinger, Dorrigo, Coffs Harbour, Grafton, Casino West, Urbenville and Kyogle, the eastern edge of most areas along the New England Tablelands, and, at lower altitudes, Wyong, Cessnock, Bulahdelah and Murwillumbah.

Two inventories providing estimates of forest type areas have been undertaken in N.S.W., in 1963 and 1971/72 (Hoschke, 1976). Neither used quite the same type definitions as are used here. The earlier inventory showed 67 000 ha of Tallowwood - Blue Gum type and 124 000 ha of “semi-moist hardwoods”, much of which would be attributable to the Moist Coastal Hardwood types, as would some of the “Flooded Gum and gully sites”. In all, probably 200 000 to 250 000 ha of Moist Coastal Hardwood types could be regarded as existing on State Forests. The latter study used type groupings from Res. Note 17: for the relevant types, two groupings were recognised, Tallowwood - Blue Gum (type no. 47) and "Moist Hardwood - Gully" (types 46, 48 - 54), the latter including some communities excluded here. Areas shown by the inventory were:

Type	Area on State Forest	Total Area
Tallowwood - Blue Gum	80 000 ha	126 000 ha
Moist Hardwood- Gully	211 000 ha	600 000 ha
Total	291 000 ha	726 000 ha

For the types considered here, these areas probably reduce to something in excess of 200 000 ha for State Forests, and to perhaps 500 000 ha for the State as a whole.

4. UTILISATION

The Moist Coastal Hardwood types have in recent years been of major importance as producers of hardwood sawlogs, with the three main species, Tallowwood, Blue Gum and Brush Box ranking second, third and fourth in gross volumes of sawlogs cut from Crown forest lands (not, however, all from these types) in 1979-80 (Forestry Commission of N.S.W., 1980b). The current high use reflects the types' often rather remote location: operations have progressively moved into these areas while the more accessible forests are allowed to accrue volume following long periods of earlier logging.

The properties of the main timber species in the types are summarised in Appendix 3, using data from Bootle (1971). The timbers of any species can vary considerably in quality from site to site, with termites, rot, gum veins and loose rings being the major defects.

The timbers are mainly used for sawing, sometimes with follow up operations for posts or sleepers. Girders may also be produced. Turpentine still yields some excellent piles, while some of the more accessible regeneration areas have been thinned for mining timber and poles. During the 1970's a small but continuing market for Forest Oak shingles has developed. Rainforest logs may be obtained from some understorey areas.

Little use is made of the types for other products, though Duboisia leaf has been harvested in the past. The sites are not normally highly regarded by apiarists, though Brush Box sites may be prized.

Grazing leases cover large areas carrying the types, but much of the types, with their dense undergrowth, are little used by stock. Frequently burnt areas are the exception.

The types' location in areas of high rainfall ensures their importance as stream catchments, while the combination of escarpment scenery and tall, moist forest gives them high recreational potential that is however limited by their usual remoteness and difficult access. These in turn are factors, which give some areas wilderness value. The types support a rich and varied fauna and flora.

5. HISTORY OF USE AND MANAGEMENT

Harvesting of timber in the Moist Coastal Hardwood types would almost certainly have first occurred last century in some of the lower altitude stands of relatively easy access on parts of the coastal plain (e.g. parts of Bulahdelah district).

This early timber harvesting, as opposed to clearing for agriculture, would have been highly selective with only scattered, large trees of outstanding form and quality being felled, to leave a scattering of relatively small openings and narrow tracks through the forest. Logging of this nature probably occurred over the same area on a number of occasions, and almost inevitably the stands were periodically burnt, either accidentally by wildfire or more deliberately by some form of burning off, though occasional sites may have escaped any burning.

Although such treatment would not conventionally be regarded as appropriate for the regeneration of these types, in fact it usually resulted in regeneration establishment in the openings - less generally, than the forester would have liked, but enough to maintain a productive stand over a period. In this it probably resembled, in somewhat accelerated form, the way Tallowwood and Brush Box often became established in Nature.

Some logging, from local bush mills, had taken place in the escarpment forests long prior to World War II, but following the war these areas gradually became increasingly important in meeting the States timber needs. Because of their usual remoteness and the high costs of access, logging normally aimed to recover as much timber as possible in the one operation; for exactly the same reasons, the standard of log acceptable to the sawmills was higher than in more accessible sites, so that often a considerable quantity of unmerchantable trees remained after logging. For a long period much of the Brush Box component was included as unmerchantable because of problems in seasoning this species.

As experience was gained with these types, a post-logging burn was usually given to the stands to aid regeneration establishment. Occasionally merchantable stems were left as seed trees and were salvaged a year or so later; sometimes the unmerchantable component was removed, by ringbarking or, after the introduction of chain-saws, by felling, either immediately, after logging or following the regeneration burn. Probably most usually the unmerchantable stems were retained to save the cost of removal or as a seed source insurance: more recently this retention has been further rationalised as providing *"a continued acceptable forest environment of defective and smaller trees"* (Forestry Commission of N.S.W., 1976) or as wildlife habitat.

When a large stocking of unmerchantable trees was retained, regeneration was usually substantially restricted; if no post-logging burn occurred, it was at times non-existent. On the other hand, often many of the retained trees subsequently became acceptable to the mills, so that many stands with retained stems now offer a useful supplementary source of timber to extend the first cutting cycle in the upland forests of these types. Where regeneration has established between the retained trees, this further logging will inevitably cause some loss of regrowth.

Usually natural sources were relied upon for regeneration, but in the 1960's artificial sowing was often used to supplement the natural regeneration, and subsequently jiffy pot seedlings (seedlings raised in small peat pots) have been used for enrichment planting on snig tracks and dump sites, or in a few localities for complete plantation establishment.

Whilst there were undoubted failures in regeneration establishment, particularly in some of the moister sites, heavy logging and burning usually resulted in adequate stockings of hardwood seedlings. However, at a time when Tallowwood was certainly the most favoured species, and was often regarded as the only worthwhile species in these types, difficulties in establishing this species and stockings less than were considered optimum led to the belief that these types were particularly difficult to regenerate, and resulted in the research programmes of the 1950's and 1960's.

6. REGENERATION REQUIREMENTS

6.1 Seeding Habits

Tallowwood can flower from early spring to early autumn, with a usual summer peak, which tends to be later at higher altitudes than at lower ones. The extent of flowering varies from year to year. Blue Gum has a more variable flowering period, but autumn is the most likely season for peak flowering.

Both species carry some viable seed throughout the year, and this can be shed when conditions are suitable. Maximum Tallowwood seedfall is usually about 12 months after peak flowering though the capsules are probably ripe after about 6 months, but tend to hold their seed until warm, sultry-weather occurs, usually in late spring and early summer. Empty capsules fall about 2 months later. With Blue Gum, peak seedfall is usually 2 years after flowering, though from

studies on the closely related Flooded Gum it seems that again the seed is probably ripe on the tree within about 6 months of flowering (Hodgson, 1975). Less is known about the associated species, but casual observation suggests that New England Blackbutt, Brush Box and Turpentine can also provide some seed throughout the year if conditions are suitable.

All species vary in seed production from year to year. Over five seasons (1960-64), Van Loon at Bulga S.F. *"recorded two high, one moderate and two medium-low production years for Tallowwood, and one high, two low and two poor years for Blue Gum."*

The hardwoods all possess the typical very small, granular seeds of the capsular-fruited Myrtacae, produced with much infertile "chaff"' (Tallowwood seed is somewhat flattened). Table 1, from Van Loon (1965) and Boland et al (1980), gives typical seed weight figures.

Tallowwood seed is slow to be released from the capsules: Floyd (1959) showed that after 17 days' exposure to warm, dry conditions, 19 per cent of the viable seed was still retained in the fruit; extraction was not complete until 29 days.

Tallowwood seed retains its viability for up to 6 years when stored at room temperature, but Blue Gum, New England Blackbutt and Brush Box are losing viability at this time. Tallowwood germination shows no advantage from stratification.

In seed trap studies over 3 to 4 years, Van Loon obtained annual seed productions of from 52 000 to 580 000 viable Tallowwood seeds per hectare and from 5 900 to 143 000 seeds per hectare for Blue Gum. The comparison is not strictly valid, since the traps averaged only 11m from Tallowwood trees, but 20m from Blue Gum.

The warm, dry conditions that promote capsule opening are often associated with winds that assist in disseminating the seed: Floyd (1959) records capsular-bearing Tallowwood branchlets up to 60m from the base of the nearest tree. Floyd, Curtin and Van Loon produce conflicting figures on effective seed spread for Tallowwood. Floyd suggested twice height of seed tree (say 60m from a 30m tree), Curtin two-thirds height (20m), and Van Loon reduced this to 17m. Figures for other species are not known, but in practice something close to Curtin's suggestion, say about 40m between 30m trees, should provide for adequate seed distribution over the whole logging area. This is equivalent to about 6 to 8 seed trees per hectare.

Table 1

NUMBERS OF VIABLE SEEDS PER KILOGRAM

Species	Average	Range	Source
New England Blackbutt	145 000	- 516 000	Boland (1980)
New England Blackbutt	160 000	98 000 - 189 000	Van Loon (1965)
Brush Box	273 000		Van Loon
Whitetopped Box	594 000	- 159 000	Boland
Flooded Gum	652 000	- 2 100 000	Boland
Sydney Blue Gum	538 000	- 1 540 000	Boland
Sydney Blue Gum	880 000	290 000 - 2 175 000	Van Loon
Narrowleaved White Mahogany	140 000	- 230 000	Boland
Silvertop Stringybark	51 000	- 96 000	Boland
Tallowwood	205 000	- 770 000	Boland
Tallowwood	165 000	105 000 - 245 000	Van Loon

6.2 Regeneration Establishment

The Moist Coastal Hardwood types can be among the most difficult in the State to regenerate successfully. The dense rainforest understorey precludes hardwood regeneration without major disturbance; some of the most important species are relatively slow growing in their younger stages; weed growth after disturbance can be prolific and vigorous.

Part of the problem is one of time-scale. We are faced with stands containing trees sometimes up to 1 000 years of age. They have resulted from a number of waves of regeneration, each in the wake of a fire. Sites unregenerated after one fire are likely to respond to subsequent fires, possibly 50 or 100 or more years later: after some centuries, the differences in age are hard to pick. The stands are then logged, and the forester is upset if he cannot fully regenerate the site immediately. Our expectations tend to be too high for the time available.

Nonetheless certain actions can be taken to increase the levels of regeneration establishment, and these involve satisfying three main requirements.

- adequate source of viable seed,
- receptive seed bed,
- appropriate protection after establishment.

Although most species are lignotuberous, in these moist forest types regeneration usually develops from newly germinated seedlings, not from a pool of suppressed lignotuberous advance growth. Similarly coppice growth is usually unimportant in these types. Direct seeding (spot sowing) and planting have been used to supplement (and sometimes replace) natural seed sources.

Spot sowing was widely used in the late 1950's and early 1960s, Using large pepper shakers calibrated to yield a given quantity of seed per shake. Sowing rates for Tallowwood were usually in the range of 200-300 g/ha, to deliver about 30 000 to 50 000 viable seeds per hectare. Sowing was usually carried out immediately after seedbed preparation, shortly before, or during the wet season (January to March). Some good results were obtained, but the technique was subsequently abandoned in favour of planting eucalypt seedlings raised in jiffy pots, which gave consistently, more reliable results.

Some plantings in Moist Coastal Hardwood sites date from the 1940's, but the techniques was not extensively used until a cheap technique for raising eucalypts in small peat pots (Jiffy pots) was developed in the late 1950's. This technique, in its current form, has been described by Horne (1979). Coupled with mechanical clearing, jiffy pots have been used for routine scale plantation at Watagan (main species Blueleaved Stringybark), Dungog (Silvertop Stringybark) and Murwillumbah (Flooded Gum and Blackbutt), and in other areas for enrichment planting on log dumps and snig tracks (sometimes deliberately extended to provide more planting space). Because of its slower early growth, Tallowwood has been little used for planting.

The resultant plantations are mostly very impressive, with average volume MAI's of 14 m^3/ha/an estimated for Silvertop Stringybark at Dungog at age 20 years. These are often established on sites where adequate natural regeneration will in any case appear. In such cases their effect is to alter species composition or to ensure high early yields of small timber for particular industries, with the remaining stems progressing to sawlogs. Elsewhere, they can ensure hardwood regeneration in sites that might otherwise be difficult to establish with an adequate stocking of commercial species.

6.3 Germination

From either natural seedfall or artificial sowing the seed must be able to germinate and then survive for establishment to occur. For all hardwood species involved, germination will occur rapidly from viable seed in contact with moist mineral soil. It will not occur if the seedbed is dry, and is likely to be inhibited by very low or high temperatures (Table 2). Thus the best season for germination is usually summer and autumn; an unusually moist spring is also suitable, but such occurrences are rare.

Table 2

GERMINATION TABLES

Temperature Range	Day of Maximum Germination			
	Tallowwood	New England Blackbutt	Blue Gum	Brush Box
13 - 17°C	13	12	13	21
20 - 21°C	7	6	7	10
28 - 31°C	5	4	7	7
34 - 36°C	5	5	9	11
40 - 41°C	0	0	-	18

Ungerminated seed is lost rapidly from the site by removal by ants and other insects. Van Loon reports tree percents of from 3.4 to 12.7% for dieldrin-treated spot-sown seed, compared with 0.6 to 0.9% for untreated seed. Seed that has to lie on the seedbed for a period before conditions suitable for germination occur runs a high risk of heavy loss.

6.4 Seedbed

While germination is possible on virtually any forest seedbed, a suitable receptive bed is necessary if the germinates are to become established. In the Moist Coastal Hardwood types with their dense understorey, this particularly means some form of fairly massive disturbance, in Nature normally provided by fire opening up the understorey and exposing the mineral soil. This need for disturbance is greater in some sites than others, and is particularly needed in the moister sites.

The earlier regeneration successes after logging these types usually were associated with wildfires that burnt the logging debris and understorey, to expose the soil to seedfall. Particularly in the earlier days, with lighter logging intensities and lighter logging equipment, logging without fire usually resulted in little or no regeneration; the success that did occur with what was often virtually selection logging (e.g. Myall River 5.7.) was probably usually attributable to occasional fires, accidental or deliberate.

Deliberate post-logging burns started to be applied to these types in the late 1940's and led on to substantial field trials (many supervised by M.T. Gatenby at Wingham) and routine practice in the 1950's. For these burns some felling of the woody understorey was often carried out.

The regeneration resulting from burning was usually successful when followed by good rains. Thus summer burns were usually successful, and winter burns followed by a wet spring. There were some failures:

- At Clouds Creek, clearfelling and burning allowed subsequent severe frosts to convert former high forest to frost-maintained grassland, similar to some of the local high altitude "plains".

- At Ellis, failure of regeneration from a January burn was apparently due to the seed trees shedding their seed prior to the fire.

- At Mt. Boss, fire burning into a moist gully only singed the understorey trees; subsequent leaf drop blanketed the ground and precluded establishment.

Nonetheless success was usual with summer or late spring burns, whereas on unburnt blocks regeneration was confined to snig tracks and similar disturbed sites. Curtin refers to 4 burnt blocks with an average of 55% of milliacre ($4m^2$) plots stocked with Tallowwood or Blue Gum regeneration; by comparison on an unburnt block, 46% of plots on snig tracks were stocked, but only 5% of those away from snig tracks. In these blocks the average height of regeneration on

burnt plots was 1.4m, on the unburnt block only 0.2m. Sometimes, of course, reasonable results have been obtained even on undisturbed sites. G.C. King, from Bulga State Forest, has recorded regeneration on three areas logged between 1977 and 1979, and assessed in 1981; none of the areas was burnt:

PLOTS STOCKED

Compartment	% Plots Disturbed	% Disturbed Sites	% Undisturbed Sites
173	72	97	46
121A	61	71	35
121B	65	87	55

However, the superiority of the disturbed sites is still most evident.

Prelogging burns were also tried. While good regeneration was often obtained, this was largely destroyed in the subsequent logging, while the moister sites were almost impossible to burn both successfully and safely. The pros and cons of prelogging burning have been well summarised in some notes by R.R. Richmond, and these are attached as Appendix 6.

The difficulty of the safe regeneration burn is in fact a major problem in the Moist Coastal Hardwood types. Prolonged summer rains mean prepared sites may have to be abandoned, while the conditions suitable for burning the moister sites are those associated with moderately severe wildfires. Escapes from the regeneration burn are a real risk, while the heat of the fire may kill trees retained for seed and sometimes even the seed capsules consumed on the trees. This occurred in a site on Wild Cattle Creek S.F, where only a dense wattle crop was produced.

Dense wattle is not unusual after a hot fire, though the faster hardwoods can usually keep pace with it initially, and then outgrow it, while the slower but more tolerant species, such as Brush Box and to some extent Tallowwood, can persist below the canopy and then assume more active growth when the wattle stand finally starts to break up, usually after 20 to 30 years. Other weeds may also be promoted by burning.

Top disposal is sometimes used after logging, but more as a fuel reduction measure than to obtain regeneration. The burning is often done in winter, but may produce regeneration if a wet spring follows; its value for regeneration is probably greatest on the drier, ridge sites. With heavy logging, and hence heavy slash, top disposal is synonymous with broadcast post-logging burning. Top disposal depends upon logging slash, and on these Moist Coastal Hardwood sites this slash deteriorates as fuel after about 12 months unless burning in a fire-dangerous period is contemplated. Thus there is normally a period of only one year available after logging in order to obtain an effective burn.

Because of the problems with fire and the success of regeneration an snig tracks in unburnt areas, the development of more powerful tractors, capable of clearing the understorey, led to wide use or tractor-clearing for seed bed preparation in the Moist Coastal Hardwood types. Early efforts to clear the whole site were followed by more limited clearing (“snig track extension”) which cold still expose the soil of up to 70% of the total area at relatively low cost, while the network of tracks meant that the remaining debris could often now be more safely burnt. Subsequently, higher standards of utilisation and consequent heavier logging have often produced similar levels of site disturbance without further snig track extension, as is shown by G.C. King’s assessments from Bulga State Forest, referred to above.

The mechanically cleared sites are usually satisfactory for regeneration establishment, though some unsuitable, compacted sites are often present. Germination is somewhat slower than on burnt sites, possibly due to less favourable moisture conditions, but the sites tend to remain receptive for much longer, sometimes up to 18 months. This is due in part at least to less aggressive weed growth: Floyd reports the production of 3 300 kg/ha of plant dry matter in a year on a burnt site, compared with only 390 kg on a tractor-cleared site.

Somewhat lower, but still adequate, regeneration stockings occur on the tractor-cleared sites. Van Loon reports comparable blocks where 45% of milliacre plots were stocked on burnt sites and 33% on tractor-cleared sites. Early growth on the tractor-cleared sites tends also to be slow: average regeneration heights quoted by, Curtin for natural regeneration at Bulga S.F. at age 6 to 7 months are:

Treatment	Tallowwood	Blue Gum
Burnt	94 mm	63 mm
Tractor cleared	38 mm	56 mm

Because of the lesser weed growth, this slower early growth was regarded as of little consequence.

Van Loon suggested that tractor clearing should be carried out from August to December, with a view to direct sowing in January or February. This timing should also be suitable for natural seedfall.

Apart from the preparation techniques, steeper slopes may be difficult to regenerate because of soil washing from the roots of the young germinates, while excessive drainage in some gravely or excessively porous soils (including some basalt soils) may cause difficulties in regeneration establishment.

6.5 Canopy

Even where complete clearfelling is intended, logging will rarely remove all trees. A scattering of excessively faulty trees, occasional clumps of younger, “growthy” stems, and odd individuals with good form and the capacity for further worthwhile growth will remain. The extent to which these are present depends on the economic location of the forest, the nature of the stand itself and the intensity of supervision by the forester.

For the Washpool Study Area (Forestry Commission of N.S.W., 1980a) it was estimated that logging in the moister phases (about 40% Brush Box) could be expected to remove up to 60% of the overstorey canopy, while in the more extensive drier sites (more New England Blackbutt) only about 40% would be removed. Because of economic location most other forests would be more accessible and therefore logging would tend to remove more overstorey.

Such remaining trees serve as a seed source. Trees with growth potential will grow on to a later cutting cycle. However most retained trees will be those currently considered unmerchantable:

- Despite their unmerchantability, these trees are usually acceptable as a seed source. Faultiness in these old hardwoods usually appears to be more due to fire and other historical events than to genetic weakness.

- Merchantability is a reflection of current markets. Trees unacceptable to mills 30 years ago may be sought after today, while new markets (e.g. pulpwood) may develop for wood unsuitable for the sawmills.

- Large, standing trees will severely interfere with regeneration development over a considerable area; a stocking of such trees will sterilise a substantial part of a logging area.

- However in particularly frost-prone areas the retention of adequate canopy may be needed to prevent local frost-hollow creation.

Studies by Van Loon, supported by general observation, confirm that in most sites, the less the remnant canopy, the better the regeneration stocking and growth.

The unmerchantable stems have often been removed by ringbarking or felling in a silvicultural "timber stand improvement" (TSI) operation carried out about the time of any regeneration treatment. Sometimes also stems can be salvaged for use for sleepers, fence posts or other products. Culling has often removed many trees that would subsequently have been considered saleable, while ringbarking produces standing dead trees that can damage regrowth as they break up and that can be a severe hazard during fire. Because of improved utilisation standards, fewer such trees are left today than in the past. These are sometimes culled, but probably more usually are retained - chiefly to save expense, but often rationalised as retaining "wildlife habitat" or "possum trees" or as contributing to the vegetation cover. These rationalisations should not be accepted too uncritically: their objectives are desirable enough, but sometimes the means used to achieve them are opportunist rather than effective.

6.6 Regeneration Damage

As noted, frost can damage regeneration and, in extreme cases, convert forest to grassland once opened up. Its risk is greatest on higher altitude sites with impeded air drainage. Tallowwood tends to be more susceptible than Blue Gum to frosting. Weeds, particularly annuals, can sometimes offer useful protection to the young eucalypts from frost.

Weed competition in one of the most distinctive features of the Moist Coastal Hardwood types, particularly after fire. On burnt sites, seedbed receptivity may be lost after a few weeks because of weed growth, and weeds may completely blanket the site within 6 months. Weed species include annuals (e.g. Cobblers Peg, Inkweed, Stinking Roger), ground cover (Soldier Vine, Wandering Jew), shrubs (Tickbush, Wild Tobacco), scramblers (Lantana, Wild Raspberries), pioneer rainforest species (Poison Peach, Giant Stinger), wattles, and coppice from some rainforest species. Some are frost susceptible and last only till the first winter; most are longer lived and can offer severe completion to the young hardwoods.

The faster eucalypts can usually keep pace, and ultimately outgrow the weed crop. Tallowwood, with its slower growth, is at a disadvantage here, but because of its greater tolerance often survives in the weed layer, to win through as the weeds die off. Brush Box is even more tolerant.

Besides their competitiveness, the presence of dense and often prickly weed crops makes very difficult the task of assessing regeneration and makes it hard to estimate visually the extent of desirable regeneration present.

The vigorous growth in regeneration areas is attractive to many animals, leading to browsing damage. Domestic stock can cause damage where present, but native mammals (wallabies and possibly some possums) appear a more common cause, and can produce high levels of damage: Curtin recorded 57% of milliacre plots with signs of browsing damage at Bulga and 43% at Myall River, but only low levels of damage at Mt. Boss S.F., where wallabies were regarded as scarce. Whilst browsing need not destroy seedlings, it certainly retards their growth, with Tallowwood's slower early growth making it susceptible for longer periods. At times, however, the mortality from browsing can be highly significant.

Insects also cause damage, both through seed removal, as noted, and by attack on established regeneration: severe infestations of the Gum Tree Scale, *Eriococcus coriaceus*, in particular, can at times occur on, and affect the growth of, both Tallowwood and Blue Gum.

6.7. Early Development

Initial establishment of seedlings is usually followed by a gradual diminution in stocking over the next few years, though on tractor-cleared sites stocking may increase for a period because of continuing germination on beds that remain receptive for longer periods: figures showing these effects, from work by Van Loon, are given in Table 3a.

More recently G.C. King has assessed regeneration on a range of sites in the Port Macquarie Region, logged from 2 to over 20 years previously. All carried reasonable hardwood

regrowth stockings, though local sites (usually moister areas with a significant rainforest component) were often deficient. Stocking in sites with no treatment other than logging was in the range 175 to 265 stems per hectare; on burnt sites, 300 to 2 000 stems per ha. In all cases spots on disturbed soil were well stocked (71 to 100% stocking rate), whereas those on undisturbed soil were less satisfactory (18 to 55%). Species composition varied considerably (see Table 3b):

Table 3a
EARLY ESTABLISHMENT AND GROWTH

	Burnt	Tractor cleared sites
Number of blocks	6	5
% Milliacres Stocked-Tallowwood		
6 month	40	33
15 - 18 month	36	46
27 - 30 month	31	39
Height at 30 months		
Mean	1.4m	0.7m
Range	0.9 - 2.7m	0.3 - 1.4m

Table 3b

Species	Regeneration Composition	
	Average %	Range %
Tallowwood	37	17 - 63
Blue Gum	28	3 - 64
Brush Box	24	6 - 62
Other spp.	11	0 - 40

Whilst stockings on unburnt sites are in some cases marginal, King's results support the visual impression that the Moist Coastal Hardwood types in fact usually regenerate successfully, except for some of the very moist sites.

Height growth in the regenerating stands varies greatly. The following figures, from a variety of sources, indicate the trends to be expected over the first 5 years:

Age	Tallowwood		Sydney Blue Gum	
	Average (m)	Top Range (m)	Average (m)	Top Range (m)
1 yr	0.3	1.3	0.8	1.8
3 yr	1.6	4.5	3.4	5.0
5 yr	3.0	6.0	5.0	7.2

The "top range" values are those to be expected under most favourable conditions. The slower early growth of Tallowwood is typical; Brush Box would be slower again.

Because of weed growth, regeneration assessments in the early years following logging are hard to organise and carry out, while visual examination can be misleading (failures tend to be in the less accessible, moister sites). Thus, recognition in advance of sites likely to have problems in regenerating is often more important than being able to take subsequent corrective action.

7. GROWTH AND YIELD

A number of growth plots have been maintained in regrowth stands of the Moist Coastal Hardwood types for periods of up to 30 years. They include some series of plots where different thinning regimes have been applied. These plots are listed in Table 4.

The plots were selected in part because they carried well-stocked stands, and they almost certainly represent better than average growing conditions. Any growth trends from them

should be regarded as indicative of the upper range of growth expected in these types, rather than of average conditions. More representative information should ultimately result from the permanent growth plots that are currently being established in some districts.

Table 4
GROWTH PLOTS MAINTAINED IN REGROWTH STANDS

Identifier	Plot Number	State Forest	Date of Regeneration	Details	Measured Since
H6/2.1	1-9	Styx River	1946	Thinning-Blue Gum, New England Hwds	1956
H6/2.2	1A 3F (18 plots)	Clouds Creek	1935	Thinning-Blue Gum	1960
H6/2.3	1 - 4	Moonpar	1937	Thinning-Tallowwood, other spp.	1955
H6/3.1	1	Brooklana	c-1930	Growth-Tallowwood, Brush Box	1953
H6/3.2	A,B,C	Doyles River	1947	Growth and early spacing, Tallowwood and others.	1951
H6/3.3	1,2	Bulga	1942	Growth and early spacing, Tallowwood and others.	1956
H6/3.3	3	Bulga	c.1928	Growth, Tallowwood and others	1956

While measured regularly, there have been no recent efforts to analyse the growth data held. However a brief, graphical review of the periodic summaries gives the trends summarised in Table 5.

Table 5
GROWTH TRENDS SHOWN IN PLOTS

AgeYears	**10**	**20**	**30**	**40**	**50**	**60**	**70**
D.B.H. Selected Stems [1]							
Average (cm)	19.4	27.6	33.6	38.4	42.4	46.0	49.4
Best Plots [2] (cm)	29.4	41.0	49.0	54.2	58.5	62.0	65.0
Mean Dom. Height [3] (m)	12.5	21.4	27.0	31.2	34.0	36.4	38.6
Volume/Ha [4]							
Average (m3)	-	50	114	190	256	306	
Best Plots [2] (m3)	32	132	236	328	390		
Mean D.B.H.							
Tallowwood-Blue Gum (cm)	13.8	19.0	23.2	26.6	30.0	33.1	35.9
Brush Box (cm)	6.0	9.6	13.0	16.2	19.2	21.4	23.6

Notes: 1 Selected Stems: about 100 best stems per ha, selected in field, regardless of species.
2 Best Plots: upper range of plot data and their likely future trends.
3 Mean Dom. Ht: Mean height of selected dominant stems in plot, regardless of species.
4 Volume: calculated from appropriate stem BA/Mean Dom. Ht. equation.

There are some interesting points about this data:

1. The material represents a pooling of growth information from plots of varying species composition, stocking and history.

2. Despite the slower early growth of Tallowwood, in these older plots there was no evident difference in the rates of diameter growth between Tallowwood and Blue Gum. Tallowwood in fact provided the rate of diameter growth (H6/2.3, plot 3) and Blue Gum the slowest (H6/2.1, several plots), but the overlap of values was such that the two species can be regarded as having similar rates of diameter growth over the range of ages, sizes and sites covered.

3. By contrast, Brush Box shows much slower rates, though these are probably further depressed because, in all plots where it occurs, the Box is growing beneath a taller overstorey of faster eucalypts.

4. The selected stems can be regarded as constituting the future sawlog component of the stand.

5. Volume estimates show MAI's peaking at about 5 m^3/ha at age 50-60 years on average, and at about 8 m^3 on the best plots. Eucalypt plantations on similar sites show MAI's of about 14 m^3/ha at age 20 years. For widespread areas or natural regeneration, volume increments of 2-2.5 m^3/ha would appear reasonable.

Other estimates of Tallowwood diameter growth have been provided by Curtin from trees present in primarily Blackbutt growth plots, and by Fisher, (1978), from open forests in the Blackbutt Range, Qld. Both sources tend to represent poorer conditions for the species than the sites considered here. These estimates compared with those from Table 5 are shown in Table 6.

Table 6

COMPARISON OF TALLOWWOOD DIAMETER INCREMENT

Fisher (1978)		**Diam. Range** (cm)	**Diam. P.A.I** (cm)	
Diam. Range (cm)	**Diam. P.A.I** (cm)		**Curtin (1960)**	**Table 5**
15 - 20	0.20	10 - 20	0.51	1.10
20 - 25	0.24	20 - 30	0.58	0.70
25 - 30	0.46	30 - 40	0.71	0.51
30 - 35	0.42	40 - 50	0.38	0.38
35 - 40	0.72	50 - 60	-	0.34
40 - 45	0.39			

Whilst the growth plots show responses to thinning particularly in diameter growth, analysis is inadequate to indicate the order of such response. However the tolerance of Tallowwood suggests that this species will probably show satisfactory growth in rather denser stands than, say, Blackbutt.

All three of the major species can reach massive size: figures provided by Forestry Commission of N.S.W. (1981 - Appendix 6) indicate the following upper limits:

	Height (m)	DBH (m)
Tallowwood	74	3.4
Blue Gum	65	2.5
Brush Box	54	3.0

Volumes of individual trees can exceed 100 cubic metres. As discussed, Brush Box may exceed 1 000 years in age, and Tallowwood probably has similar longevity, whereas Blue Gum is usually assumed to have a much shorter life span, possibly in the order of 400 years, though this may not be correct.

8. DAMAGE TO OLDER STANDS

The damage agencies affecting the Moist Coastal Hardwood types are essentially those characteristic of the moister eucalypt forests in N.S.W. generally. Snowfalls occasionally damage younger stands, up to about 10m in height, through breakage and bending. It is most likely at the higher altitudes. Wind squalls may sometimes produce similar damage.

As discussed, fire is a major factor in the occurrence of these types; it is also a major source of damage. Most hardwoods are fairly resistant to fire damage (Brush Box is probably least resistant of the major species), but may be killed in severe fires. Secondary insect and fungal attack may follow fire damage.

The response of the types to fire varies considerably. Whereas the drier phases will often burn under prescribed conditions, in the moister sites fire may only occur under fairly extreme, and uncontrollable conditions. Hazard reduction burning is normally confined to the drier sites.

Blue gum is probably more susceptible than other major species to insect attack in regrowth stands. Psyllids (lerp insects) are a common pest, and while outbreaks usually follow the normal course of insect build-up and then collapse as natural control mechanisms come into play, sometimes the attack becomes almost permanent: apparently this is due to bell-bird populations preferentially feeding on predators of the psyllids. A leaf-miner attack on Blue Gum at Cumberland S.F. seems to follow a similar pattern. Such attacks will reduce growth rates and lead to the death of weaker, and at times, even dominant trees. All species suffer from internal defect, associated with termites, wood rot, borers, gum veins or other causes.

9. PRESERVATION

Many examples of Moist Coastal Hardwood types have been set aside in Preserves on the North Coast, and the preservation record is probably better than for any other major commercial forest type in N.S.W., except rainforest. One reason for this is that many stands have remained inaccessible until recent times, so that better opportunities to preserve undisturbed areas have existed than for most other communities. Another reason is the undoubted magnificence of many of the stands.

National Parks containing significant stands of these types include:

National Park/Nature Reserve	Area (ha)
Barrington Tops	16 300
Dorrigo	3 900
Gibraltar Range	17 300
Limpinwood	2 400
New England	23 600
Werrikimbe	14 300

The Forestry Commission's Native Forest Preservation program (Forestry Commission of N.S.W., 1981) includes 26 Flora Reserves, with a total area of 4 100 ha, and 24 Forest Preserves, with a total area of 3 800 ha, containing one or more of the types included here. Between them they sample most of the variation present in these communities. These preserved areas are listed in Appendix 7.

As previously noted, the types contain many trees of outstanding size. A number of these, listed in Appendix 6 of Forestry Commission of N.S.W. (1981), have been specifically recorded and preserved; they include:

Tallowwood	8 specimens
Brush Box	6 specimens
Forest Oak	5 specimens
Sydney Blue Gum	2 specimens
Brush Cypress Pine	2 specimens

and one each of New England Blackbutt, Dunns White Gum and Turpentine.

10. MANAGEMENT ASPECTS

10.1 Objectives

The manner in which any forest area is managed depends greatly on the local objectives of management. Most forests containing significant areas of Moist Coastal Hardwood types have their objectives expressed in fairly similar terms. A typical management plan (for Chichester Management Area; Forestry Commission of N.S.W. 1980 c) lists these objectives as:

1. To supply sawlogs at commitment level for as long as possible, subject to periodic review in the light of resource data and progressive adjustment, if possible under suitable industry conditions, to a level that can be sustained in perpetuity.

2. To supply part of the pulpwood requirements for a possible future paper pulp industry.

3. To supply poles, piles, mining timber and other timber products in accordance with availability and demand.

4. To maintain the State Forests generally under natural forest vegetation adequate to:

   - Conserve the soil resources and water catchment capabilities
   - Maintain a diversity of habitat suitable for wildlife indigenous to the area
   - Retain an aesthetic forest environment acceptable to the public generally.

5. To minimise, to the extent practicable, damage to the State forests by wildfire and prevent the escape of fire to adjoining lands

6. To maintain any unique or rare, ecological, historical, flora, faunal or other scientific values occurring within the State Forests.

7 To provide for use of the forests for public recreation, in accordance with the Forestry Commission's general policy on recreation in State forests, and also for educational purposes.

8. To provide for grazing and other forest uses where compatible with other management objectives.

9. To maximise net financial returns to the extent possible under the other management objectives.

Timber production is given a predominant position in this list, but this use is then restricted by other objectives (especially 4 and 6), by the broader provisions of the Indigenous Forest Policy (Forestry Commission of N.S.W., 1976), and by other policy statements and prescription e.g. Standard Erosion Mitigation Conditions for Logging.

In the case of the more remote forest areas, the Indigenous Forest Policy carries constraints that represent a restriction on investment in future wood production and that have been interpreted by some as a policy of regarding these areas essentially as a source of timber for the present, rather than as a continuing wood production unit. Emphasis is given to creating a green vegetation cover of any tree type after logging, not necessarily regeneration of commercial species:

> *"In types such as moist hardwood where regeneration establishment is difficult, a continued acceptable forest environment should be sought, either through promotion of regeneration by burning techniques or the retention of an adequate forest cover of defective and smaller trees of the original stand. The essential feature of post-logging management of these areas is to obtain an acceptable forest cover preferably of commercial quality. Where this would require additional investment, any forest cover should be accepted as an alternative".*

While this provision does not apply to the more accessible areas, it is the less accessible ones that probably represent the greater proportion of the area of Moist Coastal Hardwood types under forest management. However the provision may be modified by more specific prescriptions appearing in individual management plans.

10.2 Management Problems and Practices

The main problems relating to the management of these types have been previously noted:

- Often remote location and difficult topography, so that standards of utilisation are poor. Many stems that would be sold in other sites are rendered unmerchantable.

- Difficulties in regeneration relating to need for site disturbance and opening, dense weed growth, and short period of seedbed receptivity.

- Relatively slow early growth of the major species, Tallowwood.

- Related to their location, the low priority accorded to much of these types for treatment, compared with other forest areas of similar productivity on more economic sites.

Added to this is the often close and intimate association with rainforest. Any restrictions on harvesting rainforest trees must inevitably affect the management of the Moist Coastal Hardwood types where rainforest trees are frequently present in the understorey, or where undoubted stands of rainforest adjoin the hardwood stands or have to be traversed to gain access to the hardwood.

Management of these types has to be carried out within the context of these constraints.

The detailed interpretation of the management objectives vary from area to area, but in broad terms it involves the harvesting and sale of all merchantable stems in a logging coupe, except for:

- those retained in creek side strips; steep slopes or other nominated sites;
- stems judged capable of making useful growth over the period of a further cutting cycle (usually the occasional younger, healthy stems);
- stems deliberately retained as a seed source or for aesthetic or wildlife purposes or, as stated in some management plans, *"to maintain an adequate forest cover".*

Burning may follow logging, and some enrichment planting may be carried out. In some areas, complete clearing and planting may occur. Regenerated stands may subsequently be thinned to provide small timber for a variety of purposes.

As seen, this practice usually results in satisfactory regeneration and development, but some more specific guidance points, for implementation as appropriate, can be noted.

10.3 Guidance Points

Based on the information reviewed here, the following points are made:

1. The Moist Coastal Hardwood types can be managed in some areas by a selection or group selection system. Such a system will usually produce good clumps of regeneration on the drier sites, but the moister and more sheltered sites may be slow to regenerate and require a series of fires (often very difficult to arrange) if local seedbed receptivity is to be restored on a number of occasions. Alternatively, tractors may be used to develop a patchwork of small, disturbed seedbed areas. In these moister sites the slower growing and more tolerant hardwoods are likely to appear, and there is a risk that the lower value species, Brush Box and Turpentine, may dominate the regrowth.

2. More usually, a more concentrated logging operation is desirable to open up the canopy and expose the mineral soil.

3. The major species appear to carry at least some seed at all times. It seems desirable to maintain a stock of seed or these species, and regularly to-cheek on the status of the seed crop during logging operations. In the event of a seed crop failure of a general nature in any area (i.e. not just one species), arrangements should be set in hand for the subsequent use or artificial regeneration either by spot sowing or, preferably, by planting.

4. Sufficient seed trees should be retained to disseminate their seed over the area logged. If burning of the slash is not intended, and seed is to come primarily from the heads or logged trees, then four or five stems per hectare should be retained as insurance. However, if the slash is to be burnt so that seed must then come from the retained trees, six to eight well-spaced trees, per hectare tare should be kept. Unmerchantable stems of desirable species are normally acceptable as seed trees, provided they have healthy crowns.

5. During the logging operation, as much mineral soil should be exposed and, subject to the need for retaining seed trees and young, growthy stems, as much of the canopy should be opened up and removed, as possible. If practicable, areas where additional clearing is needed should be identified in advance and efforts made to have these disturbed during the logging operation. Soil exposure, however, should not be to the extent that soil loss may occur.

6. In general, efforts should be made to burn the logging debris, after logging. This may be in the form of isolated top disposal or may be by a fire of more general extent. Subject to fire safety, the most appropriate time for the burn appears to be late spring or early summer, when fairly reliable follow up rains can be expected; earlier burns risk seed shed and germination into a dry period, when the young germinates will die; an autumn burn is a more acceptable alternative, but may occur when most seed on the trees has already been shed during the preceding summer, so that little remains to germinate after the fire. However, if logging has resulted in a high level of disturbance and exposed soil, burning might be omitted. (Against this, heavy disturbance usually means heavy fuel levels, which it may be desirable to remove as a protection measure, and often also a fuel body broken into discrete units, allowing for their more ready removal by fire). The comments on prelogging burning (Appendix 6) should also be considered in this context.

7. Where logging results in the retention of an appreciable cover of currently unmerchantable trees, the future of these needs to be carefully considered. These unmerchantable trees will severely inhibit the establishment and growth of subsequent regeneration, but on the other hand their unmerchantability may be a temporary affair that will alter in few years with a change in economic or market conditions. If the defect is such that a significant improvement in merchantability seems unlikely (e.g. heavy rot or termite infestations), then a culling treatment should, if possible, be applied immediately following logging, by felling or, less desirably, by ringbarking. However if a change in merchantability seems possible, then retention of the currently unwanted trees is to be preferred: in this case management will approach a selection system as outlined in (1), above. If the guess was wrong, and merchantability does not improve to the extent needed to warrant a further harvesting, then the choice of culling and burning will remain for the future if it is still desirable to improve the productive capacity of the site.

8. Justifying the retention of unmerchantable trees on the grounds of wildlife habitat or aesthetics needs to be looked at carefully. It would seem that greater contributions in both directions would often be made by increasing the retention of trees close to watercourses or along the moist rainforest margins, and by seeking a more even and vigorous establishment of regeneration over the bulk of the logging area.

9. The treatment, outlined in (4), (5) and (6), above, will usually result in the establishment of an adequate stocking of regeneration of desirable species. Planting should rarely be needed, except possibly on dump sites, to ensure their speedy recovery, or where plantation programmes have previously been approved and supply commitments made based on the higher yields to be expected from plantation crops.

10. Other exceptions may be the general failure of a seed crop, (see 3) or the existence of particularly moist sites, often close to rainforest stands and with a well developed rainforest component in the understorey, where natural regeneration establishment is difficult to achieve. Local experience will often indicate site of this type, and in these cases logging (and burning, if feasible, though this is often difficult in these moist sites) should be followed by low-density enrichment planting of suitable eucalypts in appropriate openings. It should however be recognised that such potential failure sites are much less frequent than is commonly believed. These moist sites art often very high yielding, and potentially highly productive if successfully regenerated to hardwood, but their management involves positive decisions on the relative values of different forest benefits, some of a rather intangible nature.

11. Every opportunity should be taken to check, visually or by assessment, on the regeneration present in logged areas, particularly in the moister sites away from the usual ridgetop access. Because of the often almost impenetrable

weed growth that follows logging and burning, post-logging regeneration is undoubtedly difficult and unpleasant. Nonetheless it should, if at all possible, be carried out on a regular basis on these Moist Coastal Hardwood types. Most districts would only need to assess a couple of areas in any year. If significant areas (say over 2 hectares) lacking regeneration are located, consideration should he given to applying some special regeneration treatment to these sites, e.g. planting scattered advanced seedlings; limited bulldozer clearing of track lines, followed by enrichment planting. Such treatments may in fact rarely be practicable, and the real value of regeneration assessment or other cheeks lies in building up a factual body of information about the development of regeneration under various conditions, as a guide to modifying future treatment.

12. As the regrowth develops, opportunities for the commercial thinning of the stand should be watched for. Thinning should aim to promote the growth of the, best stems for sawlog production.

Finally, it should be stressed that, with suitable treatment associated with logging and involving adequate canopy opening and soil disturbance, regeneration is usually far more reliably obtained, in these types than has often been stated or imagined.

10.4 Further Research

Much, of the material in this review is based on the results of a substantial silvicultural research programme carried out during the.1950s and 1960s, and supplemented by limited more recent studies and by considerable field experience on the part of many field foresters. The information available, however, is or course never enough for reviews of this type. One positive result of the review is to identify some areas where further work is needed. These include:

1. seeding characteristics of species other than Tallowwood and Sydney Blue Gum, Silvertop Stringybark, New England Blackbutt and Brush Box should receive highest priority.

2. analysis of existing growth data, and establishment of further growth plots covering a greater range of conditions.

3. efforts to identify in advance sites with the greatest problems in regeneration establishment and to develop techniques to minimise or overcome these problems.

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Appendix 1

PLANT SPECIES MENTIONED IN TEXT

Common Name	Botanical Name
Bangalay	Eucalyptus botryoides
Blackbutt	E. pilularis
Blackbutt, New England	E. andrewsii ssp. campanulata
Box, Brush	Tristania conferta
Box, Whitetopped	Eucalyptus quadrangulata
Bracken	Pteridium esculentum
Coachwood	Ceratopetalum apetalum
Cobbler's Peg	Erigeron sp.
Cypress Pine, Brush	Callitris macleayana
Duboisia	Duboisia myoporoides
Grapes, Native	Cissus spp.
Gum, Blue	Eucalyptus saligna
Gum, Dunns White	E. dunnii
Gum, Flooded	E. grandis
Gum, Sydney Blue	E. saligna
Inkweed	Phytolacca octandra
Lantana	Lantana camara
Mahogany, Narrowleaved White	Eucalyptus acmenoides
Oak, Forest	Casuarina torulosa
Peach, Poison	Trema aspera
Raspberry, Wild	Rubus spp.
Soldier Vine	Kennedia rubicunda
Stinger, Giant	Dendrocnide excelsa
Stinging Roger	Tagetes minuta
Stringybark, Blueleaved	Eucalyptus agglomerata
Stringybark, Diehard	E. cameroni
Stringybark, Silvertop	E. laevopinea
Tallowwood	E. microcorys
Tickbush	Helichrysum diosmifolium
Tobacco, Wild	Solanum mauritianum
Turpentine	Syncarpia glomulifera
Wandering Jew	Tradescantia albiflora
Wattle	Acacia spp.

Appendix 2

CLIMATIC AVERAGES: MOIST COASTAL HARDWOOD SITES

Station Localities

Altitude			**Latitude**			
	33°	32°	31°	30°	29°	28°
700m+			Styx R.			
					Girard	
600						
			Clouds Ck.			
500						
400						
						Whian Whian
300						
200						
	Olney		Bellangry			
100						
0		Coolongolook			Lismore	

OLNEY S.F. **Latitude** 33°6'S **Longitude** 151°15'E **Elevation** 152m

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**Year**
Daily Maximum Temperature (C°)													
Mean	26.5	26.3	23.5	22.7	17.2	15.4	14.2	15.4	19.1	20.1	23.2	23.6	20.6
Daily Minimum Temperature (C°)													
Mean	14.0	16.4	13.4	11.5	8.1	7.1	5.0	6.3	8.5	11.5	12.7	15.1	10.8
Rainfall (mm)													
Mean	152	197	177	152	129	214	71	103	74	104	111	130	1614
Raindays (No)													
Mean	12	12	12	10	7	9	8	7	8	9	8	10	112

COOLONGOLOOK S.F. Latitude 32°12'S **Longitude** 152°19'E **Elevation** 38m

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**Year**
Daily Maximum Temperature (C°)													
Mean	26.7	27.3	26.5	24.6	20.6	18.4	17.3	18.6	22.2	22.9	26.0	26.3	23.1
Daily Minimum Temperature (C°)													
Mean	15.3	16.4	13.9	11.8	6.7	3.4	3.1	4.3	8.0	10.1	12.3	14.6	10.0
Rainfall (mm)													
Mean	122	159	174	100	85	121	60	78	55	82	73	96	1205

BELLANGRY S.F. **Latitude** 31°20'S **Longitude** 152° 35'E **Elevation** 152m

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**Year**
Daily Maximum Temperature (C°)													
Mean	26.7	27.3	25.6	23.5	19.8	17.3	17.1	18.1	21.6	23.4	25.6	25.6	22.6
Daily Minimum Temperature (C°)													
Mean	16.4	17.2	15.8	13.8	10.8	9.6	7.7	8.8	11.1	12.7	14.2	15.9	12.8
Rainfall (mm)													
Mean	168	255	181	129	78	114	51	89	58	112	96	129	1460
Raindays (No)													
Mean	16	17	12	5	7	7	6	7	6	6	8	11	108

STYX RIVER S.F. **Latitude** 30°37'S **Longitude** 152°11'E **Elevation** 1036m

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**Year**
Daily Maximum Temperature (C°)													
Mean	25.4	21.4	20.9	19.3	13.5	11.8	11.9	13.7	13.4	17.2	21.9	22.9	17.8
Daily Minimum Temperature (C°)													
Mean	14.6	13.2	11.9	9.2	5.7	3.4	2.8	4.9	3.0	8.8	11.2	11.6	8.4
Rainfall (mm)													
Mean	204	208	207	106	81	120	81	81	62	105	112	149	1516
Raindays (No)													
Mean	15	14	15	11	9	10	7	8	7	10	11	13	130

CLOUDS CREEK S.F. **Latitude** 30°6'S **Longitude** 152°36'E **Elevation** 550m

Month	Jan	Feb	Mar	Apr	My	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**Year**
Daily Maximum Temperature (C°)													
Mean	26.9	26.4	25.4	23.6	19.8	17.5	16.4	17.3	20.5	23.8	26.2	26.7	22.5
Daily Minimum Temperature (C°)													
Mean	14.8	15.2	11.8	8.7	5.0	2.3	-0.3	2.7	4.8	9.0	11.0	12.9	8.2
Rainfall (mm)													
Mean	228	188	172	83	62	89	62	68	49	109	122	165	1397
Raindays (No)													
Mean	15	16	18	13	7	9	6	8	8	13	11	14	138

GIRARD S.F. **Latitude** 28°54'S **Longitude** 152°18'E **Elevation** 671m

Month	Jan	Feb	Mar	Apr	My	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**Year**
Daily Maximum Temperature (C°)													
Mean	26.0	26.1	24.5	23.1	18.2	15.8	15.0	16.2	20.3	22.6	26.0	24.7	21.5
Daily Minimum Temperature (C°)													
Mean	14.0	13.4	12.4	10.1	5.8	4.5	1.5	3.5	5.5	9.3	10.0	12.7	8.6
Rainfall (mm)													
Mean	206	211	210	92	73	96	85	52	52	94	98	162	1431
Raindays (No)													
Mean	14	15	17	12	8	8	8	6	7	10	9	12	126

LISMORE P.O. **Latitude** 28°48'S **Longitude** 153°17'E **Elevation** 9m

Month	Jan	Feb	Mar	Apr	My	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Daily Maximum Temperature (C°)													
Mean	29.6	29.4	28.1	26.2	22.6	20.4	19.9	21.4	24.1	26.6	28.2	29.4	25.5
Daily Minimum Temperature (C°)													
Mean	18.9	19.0	17.3	14.4	10.5	8.3	6.0	7.6	9.8	13.3	15.8	17.6	13.2
Rainfall (mm)													
Mean	166	183	184	122	110	98	86	60	54	75	93	118	1349
Raindays (No)													
Mean	13	13	16	12	11	9	8	7	8	9	9	11	126

WHIAN WHIAN S.F. **Latitude** 28°36'S **Longitude** 152°23'E **Elevation** 381m

Month	Jan	Feb	Mar	Apr	My	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**Year**
Daily Maximum Temperature (C°)													
Mean	25.7	25.3	23.8	22.1	18.5	16.5	15.5	17.0	20.5	22.7	26.0	24.1	21.5
Daily Minimum Temperature (C°)													
Mean	16.7	16.3	14.9	13.0	9.5	8.2	5.8	6.8	8.8	12.1	13.4	15.5	11.8
Rainfall (mm)													
Mean	352	382	318	189	155	194	146	103	74	149	135	191	2388
Raindays (No)													
Mean	15	18	18	14	11	11	8	8	11	10	10	13	147

Appendix 3

PROPERTIES OF MAJOR TIMBER SPECIES: MOIST COASTAL HARDWOOD TYPE

(Derived from K. R. Bootle: "Commercial Timbers of N.S.W. and Their Use")
Abbreviations: L-S, Lyctid susceptible; G, green; S, seasoned; B, basic (re density)

Common Name	Blackbutt, New England	Box, Brush	Box, Whitetopped	Cypress Pine, Brush
Botanical Name	Eucalyptus andrewsii ssp. campanulata	Tristania conferta	Eucalyptus quadrangulata	Callitris macleayeana
General Properties	Light brown. Moderately fine texture. Gum veins common.	Pinkish brown. Fine texture. Interlocked grain common. Dresses well. Very good wearing qualities	Light yellow-brown. Fine texture. Very hard.	Light yellow-brown. Typical cypress pine odour. Fine texture. Less knotty than inland pine.
Density kg/m³	G: 1150 S: 900 B: 690	G:1170 S:900 B:690	G:1230 S:1020 B:800	S:580
Durability	2-3 L-S	3 (1- 2 for termites). Little lyctid attack	1- 2. Seldom lyctid attacked	2
Strength	BS3	B/S3	A/S3	D/S6
Sawlog Group	B	D	A	(Bwd) B
Uses	General building construction.	Flooring, panelling. Cladding, general building. Decking, bearings, industrial flooring, wharfage.	Heavy engineering construction. Poles, sleepers.	Cladding, flooring, panelling, building framework.
Other Notes	Prone to surface checking on back-cut surfaces. Some collapse.	Slow in drying; some distorts badly. Not suitable for bent work.		Dries quickly

Appendix 3 (cont.)

PROPERTIES OF MAJOR TIMBER SPECIES: MOIST COASTAL HARDWOOD TYPE
(Derived from K. R. Bootle: "Commercial Timbers of N.S.W. and Their Use")

Abbreviations: L-S, Lyctid susceptible; G, green; S, seasoned; B, basic (re density)

Common Name	Gum, Sydney Blue	Mahogany, Narrowleaved White (White Mahogany)	Oak, Forest (Rose Sheoak)	Stringybark, Silvertop
Botanical Name	Eucalyptus saligna	Eucalyptus acmenioides	Casuarina torulosa	Eucalyptus laevopinea
General Properties	Pink to red. Grain straight. Moderately coarse texture. Gum veins common. Easy to work, fix, dress and finish.	Light yellow-brown. Gum veins. Fine texture. Grain often interlocked. Not difficult to work.	Dark red with large, coloured rays. Relatively fine texture.	Light brown; sapwood not clearly distinguishable. Moderately fine texture. Grain sometimes interlocked.
Density kg/m³	G:1150 S:910 B:690	G:1180 S:990 B:780	G:1200 S:930 B:770	G:1040 S:690 B:530
Durability	3 L-S	1 Seldom lyctid attacked	2-3	2-3 L-S (but sapwood narrow)
Strength	B/S3	B/S2	A	C/S4
Sawlog Group	B	C	D	B
Uses	General construction. Cladding, flooring, panelling.	Heavy engineering construction. Poles, sleepers, crossarms, cladding, flooring.	Flooring, roofing, shingles and shakes. Decorative turnery and woodware	General building construction
Other Notes	Rather slow to dry; may check on back-cut surface. Only fair for bent work.	Dries slowly	Slow to dry. Prone to check on back-sawn surface.	Slow drying. Some collapse.

Appendix 3 (cont.)

PROPERTIES OF MAJOR TIMBER SPECIES: MOIST COASTAL HARDWOOD TYPE
(Derived from K. R. Bootle: "Commercial Timbers of N.S.W. and Their Use")

Abbreviations: L-S, Lyctid susceptible; G, green; S, seasoned; B, basic (re density)

Common Name	Tallowwood	Turpentine
Botanical Name	Eucalyptus microcorys	Syncarpia glomulifera
General Properties	Yellow-brown, greenish tinge. Moderately coarse texture. Grain interlocked. Greasy nature. No gum veins.	Red-brown. Fine, uniform texture. Grain interlocked. Turns well. Takes high finish. Resistant to wear. Does not splinter readily. Dulls cutting tools. Does not readily burn.
Density kg/m³	G:1230 S:990 B:800	G:1140 S:910 B:670
Durability	1 L-S	1 Seldom lyctid attacked. Very resistant to marine borers.
Strength	A/S2	B/S3
Sawlog Group	A	D
Uses	Heavy engineering construction. Poles, sleepers, crossarms. Sills, cladding, flooring.	Marine piling, shipbuilding, wharf decking, flooring, bearings, mallets. General building construction.
Other Notes	Dries slowly. Some surface checking and warping. Not recommended for bent work.	Slow drying. Some collapse.

Appendix 4

MAMMALS TO BE EXPECTED IN MOIST COAST HARDWOOD TYPES

(from Forestry Commission of N.S.W., 1980a)

ORDER	FAMILY	SPECIES NAME	COMMON NAME
MONOTREMATA			
		Tachyglosaus aculeatus	Echidna
MARSUPALIA			
	Dasyuridae	Antechinus flavipes	Yellow-footed marsupial mouse
		A. maculatus	Pygmy marsupial mouse
		A. stuartii	Brown marsupial mouse
		A. swainsonii	Dusky marsupial mouse
		Dasyurus maculatus	Tiger cat
		Phascogale tapoatafa	Brush-tailed phascogale
		Sminthopsis murina	
	Peramelidae	Isoodon macrourus	Brindled bandicoot
		Perameles nasuta	Long-nosed bandicoot
	Phalangeridae	Trichosurus caninus	Mountain possum
		T. vulpecula	Brush-tailed possum
	Burramydae	Acrobates pygmaeus	Feather-tailed glider
	Petauridae	Petaurus australis	Yellow-bellied glider
		P. norfolcensis	Squirrel glider
		P. breviceps	Sugar glider
		Pseudocheirus peregrinus	Ring~tailed possum
		Schoinobates volans	Greater glider
	Macropodidae	Macropus dorsalis	Black-striped wallaby
		M. giganteus	Grey kangaroo
		M. parma	Parma wallaby
		Potorous tridactylus	Potoroo
		Thylogale stigmatica	Red-legged pademelon
		T. thetis	Red-necked pademelon
		Wallabia bicolor	Swamp wallaby
	Phascolaretidae	Phascolaretos cinereus	Koala
CHIROPTERA			
	Pteropodidae	Pteropus poliocephalus	Grey-headed flying fox
		P. scapulatus	Little-red flying fox
	Molossidae	Tadarida norfolkensis	Eastern little mastiff-bat
	Vespertilionidae	Miniopterus schreibersii	Bentwinged bat
		Epesticus pumilus	Little bat
		Chalinolobus gouldii	Gould's wattled bat
		Nycticeius rueppellii	Greater broad-nosed bat
RODENTIA			
	Muridae	Rattus fuscipes	Bush rat
		R. lutreolus	Swamp rat
		R. rattus (#)	Black rat
		Mus musculus (#)	House mouse
		Melomys cervinipes	Fawn-footed melomys
CARNIVORA			
	Canidae	Canis familiaris (#)	Dingo
	Felidae	Felis catus (#)	Feral cat

(#) – Introduced

Appendix 5

BIRDS TO BE EXPECTED IN MOIST COASTAL HARDWOOD TYPES
(from Forestry Commission of N.S.W., 1980a)

Crested Hawk
Whistling Kite
Collared Sparrow Hawk
Grey Goshawk
Brown Goshawk
Wedge-tailed Eagle
Little Falcon
Brush Turkey
Black-breasted Button Quail
Red-crowned Pigeon
Wompoo Pigeon
Topknot Pigeon
White-headed Pigeon
Spotted Turtledove
Brown Pigeon
Peaceful Dove
Bar-shouldered Dove
Emerald Dove
Common Bronzewing
Wonga Pigeon
Glossy Black Cockatoo
Yellow-tailed Black Cockatoo
Galah
Sulphur-crested Cockatoo
Rainbow Lorikeet
Scaly-breasted Lorikeet
Musk Lorikeet
Little Lorikeet
Double-eyed Fig Parrot
Swift Parrot
Crimson Rosella
Eastern Rosella
Brush Cuckoo
Fantailed Cuckoo
Rufous-tailed Bronze Cuckoo
Golden Bronze Cuckoo
Indian Koel
Channel-billed Cuckoo
Pheasant Coucal
Powerful Owl
Boobook Owl
Barking Owl
Masked Owl
Sooty Owl
Marbled Frogmouth
Tawny Frogmouth
Azure Kingfisher
Laughing Kookaburra
Forest Kingfisher
Sacred Kingfisher
Dollar Bird
Noisy Pitta
Superb Lyrebird
Albert Lyrebird
White-winged Triller
Varied Triller
Scaly Thrush
Rose Robin
Eastern Yellow Robin
Pale Yellow Robin
Crested Shrike Tit
Olive Whistler
Rufous Whistler
Golden Whistler
Rufous Shrike Thrush
Grey Shrike Thrush
Black-faced Monarch
Spectacled Monarch
Leaden Flycatcher
Rufous Fantail
Grey Fantail
Spine-tailed Chowehilla
Eastern Whipbird
Superb Blue Wren
Variegated Wren
Large-billed Scrub Wren
Yellow-throated Scrub Wren
White-browed Scrub Wren
Brown Thornbill
Striated Thornbill
Brown Warbler
White-throated Warbler
Varied Sitella
White-throated Tree Creeper
Red-browned Tree Creeper
Red Wattlebird
Noisy Friar Bird
Blue-faced Honeyeater
Bell Miner
Lewin Honeyeater
Yellow-faced Honeyeater
Yellow-tufted Honeyeater
White-eared Honeyeater
White-naped Honeyeater
Brown Honeyeater
Eastern Spinebill
Scarlet Honeyeater
Mistletoe Bird
Spotted Pardalote
Striated Pardalote
Silvereye
Red-browed Firetail
Figbird
Olive-backed.Oriole
Spangled Drongo
Satin Bower Bird
Australian Regent Bird
Green Catbird
Rufous Scrub Bird
Paradise Riflebird
Thrush Tree Martin
Australian Magpie
Black-faced Cuckoo Shrike
Pied Currawong
Cicada Bird
Australian Raven
Forest Raven
Yellow-eyed Cuckoo Shrike
White-bellied Cuckoo Shrike

Appendix 6

NOTES ON PRELOGGING BURNING IN MOIST COASTAL HARDWOOD TYPES

by R.R. Richmond (Fire Control Officer)

Prelogging burning has always had some appeal although the difficulties in moist sites may well be insurmountable. The potential benefits, however, even if it remains confined to the drier and more exposed sites and aspects, are:

- It breaks the area up, fuel-wise, rendering postlogging burning much easier to manage without the need for costly control lines. It also allows postlog burns to be conducted in more severe conditions resulting presumably in a better seedbed.

- Advance growth, seed trees, possum trees and other retained stems have a much better chance of surviving.

- The incidence of fire weeds following postlogging burning, being confined to the patches occupied by tree heads, ought to be somewhat less.

- Removal or at least desiccation of mesophytic understorey by prelogging burning can probably be accomplished while a canopy remains to inhibit weed growth.

On the other band premature seedfall and damage to regeneration by logging are risks; organising the whole enterprise so as to phase it in with licensed logging operations is difficult and finally the problems in carrying out a safe prelogging burn under conditions when moist understorey will burn cannot be easily overstated, although two-stage burns (ridges from the top down early in spring and lower levels from the bottom up a little later) offer a partial solution. This is the sort of thing that a knowledgeable forester might have a go at.

Postlogging burning then becomes top disposal.

The implication is of course that all these burns must take place in the same season. Coupling this with an overriding fire safety proviso and that in both respects there is a long learning curve to be negotiated, it would certainly be necessary to avoid the suggestion that the practice has immediate widespread application, but there nevertheless seems room for it.

Appendix 7

PRESERVED AREAS CARRYING STANDS OF MOIST COASTAL HARDWOOD TYPES

Flora Reserves

Tooloom Scrub F.R. No. 652253. Beaury S.F. 705 ha. Includes Tallowwood - Blue Gum, Brush Box and Dunns White Gum types.

Bruxner Park F.R. No. 73036. Orara East S.F. 57 ha. Includes Brush Box.

Kerripit Beech F.R. No. 79931. Barrington Tops S.F. 243 ha. Includes Blue Gum and Whitetopped Box.

Sheepstation Creek F.R. No. 79945. Wiangaree S.F. 162 ha. Small areas of Brush Box and Tallowwood - Blue Gum types, with rainforest.

Mt. Lindsay F.R. No. 79950. Mt. Lindsay S.F. 117 ha. Includes Tallowwood - Blue Gum type.

Sugar Creek F.R. No. 79958. Wallingat S.F. 85 ha. Includes Blue Gum type.

Jerewarrah F.R. No. 79964. Ewingar S.F. 243 ha. Good example of Tallowwood - Blue Gum type.

O'Sullivans Gap F.R. No. 79966. Bulahdelah and Wang Wauk S.F.'s. 320 ha. -Includes Tallowwood - Blue Gum type.

Rowleys Rock F.R. No. 79971. Bulga and Dingo S.F.1s. 146 ha. Includes Tallowwood - Blue Gum and New England Blackbutt types.

Mines Road F.R. No. 79974. Bellangry S.F. 20 ha. Includes Tallowwood - Blue Gum type.

Blue Gum F.R. No. 79975. Stewarts Brook S.F. 292 ha. Fine stand of Blue Gum; also Whitetopped Box.

Edwards Plain F.R. No. 79976. Wild Cattle Creek S.F. 35 ha. Blue Gum regeneration fringing grassland "plain".

Mobong Creek F.R. No. 79978. Wild Cattle Creek S.F. 14 ha. Tallowwood Blue Gum and Brush Box types present.

Mount Nothofagus F.R. No. 79981. Donaldson S.F. 650 ha. Includes Brush Box and Tallowwood - Blue Gum types.

Black Bull F.R. No. 79982. Wild Cattle Creek S.F. 47 ha. Turpentine in sheltered parts.

Chapmans Plain F.R. 79984. Clouds Creek S.F.'25 ha. Blue Gum fringe to grassland "plain", then subsequent invasion by rainforest.

Teak Tree F.R. 79985. Wild Cattle Creek S.F. 20 ha. Some Tallowwood Blue Gum type with much Narrowleaved White Mahogany.

Lorne F.R. 79986. Lorne S.F. 54 ha. Some Brush Box type on lower slopes.

Minyon Falls F.R. 79986. Whian Whian S.F. 110 ha. Extensive Brush Box, also Turpentine, in gully.

Nightcap Track F.R. No. 79990. Whian Whian S.F. 375 ha. Some Brush Box and Turpentine types.

Big Scrub F.R. No. 79991. Whian Whian S.F. 196 ha. Includes some Brush Box and Turpentine types.

Brysons Camp F.R. No. 79992. Myall River S.F. 18 ha. Some Tall Blue Gum and Brush Box types.

Norman W. Jolly Memorial Grove F.R. No. 79998. Moonpar S.F. 52 ha. Excellent stand of very large Tallowwood, with some Blue Gum and Brush Box, over rainforest.

Boomerang Falls F.R. No. 79999. Whian Whian S.F. 24 ha. Some Brush Box type.

Madmans Creek F.R. No. 80001. Conglomerate S.F. 92 ha. Includes Brush Box and Turpentine types.

Wonga Wanga F.R. No. 80002. Orara West S.F. 25 ha. Includes Brush Box type.

Forest Preserves

19. Tinebank F.P. Kippara S.F. 132 ha. Good examples of Tallowwood - Blue Gum and Brush Box types.

38. Forty Spur F.P. Mebbin S.F. 8 ha. Brush Box and Turpentine types present.

41. Mt. Clunie F.P. Koreelah S.F. 375 ha. Includes Dunns White Gum type.

49. Cambridge Plateau F.R. Richmond Range S.F. 11 ha. Some Brush Box type.

85. Grange F.P. Grange S.F. 24 ha. Some Brush Box type.

107. Middle Creek F.P. Marengo S.F. 154 ha. Includes Tallowwood - Blue Gum types.

117. Killiecrankie F.P. Oakes S.F. 126 ha. Some Brush Box type.

120. Leagues Scrub F.P. Oakes S.F. 36 ha. Includes Tallowwood - Blue Gum and Brush Box types.

123. Kingsgate F.P. The Brothers S.F. 53 ha. Blue Gum, Tallowwood and Brush Box present.

124. London Bridge F.P. London Bridge S.F. 45 ha. Blue Gum type present.

126. Fenwicks F.P. Doyles River S.F. 80 ha. Brush Box type present.

129. Waterfall F.P. Mt. Boss S.F. 45 ha. Excellent example of Tallowwood - Blue Gum type.

130. Red Cedar F.P. Wild Cattle Creek S.F. 30 ha. Includes Tallowwood Blue Gum and Blue Gum types.

135. White Beech F.P. Girard S.F. 37 ha. Brush Box and Tallowwood - Blue Gum types present.

148. Tirril Creek F.P. Bulga S.F. 156 ha. Tallowwood - Blue Gum, Brush Box and New England Blackbutt types; includes very large Blue Gum.

156. Felton's F.P. Carrai S.F. 27 ha. Almost pure Whitetopped Box.

160. Cedar Pit F.P. Styx River S.F. 91 ha. Includes Tallowwood - Blue Gum type.

165. Shannon Creek F.P. Boundary Creek S.F. 240 ha. Includes Brush Box type.

171. Redbank F.P. Washpool S.F. 120 ha. Includes Tallowwood - Blue Gum and Brush Box types.

173. Daisy Patch F.P. Enfield S.F. 560 ha. Includes Blue Gum type.

174. Twelve Sixty F.P. Bagawa S.F. 305 ha. Includes Tallowwood - Blue Gum and Brush Box types.

175. Filmy King Fern F.P. Mt. Boss S.F. 149 ha. Some Tallowwood - Blue Gum and New England Blackbutt types.

177. Careys F.P. Doyles River S.F. 110 ha. Includes Tallowwood - Blue Gum type.

179. Lynchs Creek F.P. Wiangaree S.F. 900 ha. Brush Box and Tallowwood types present.