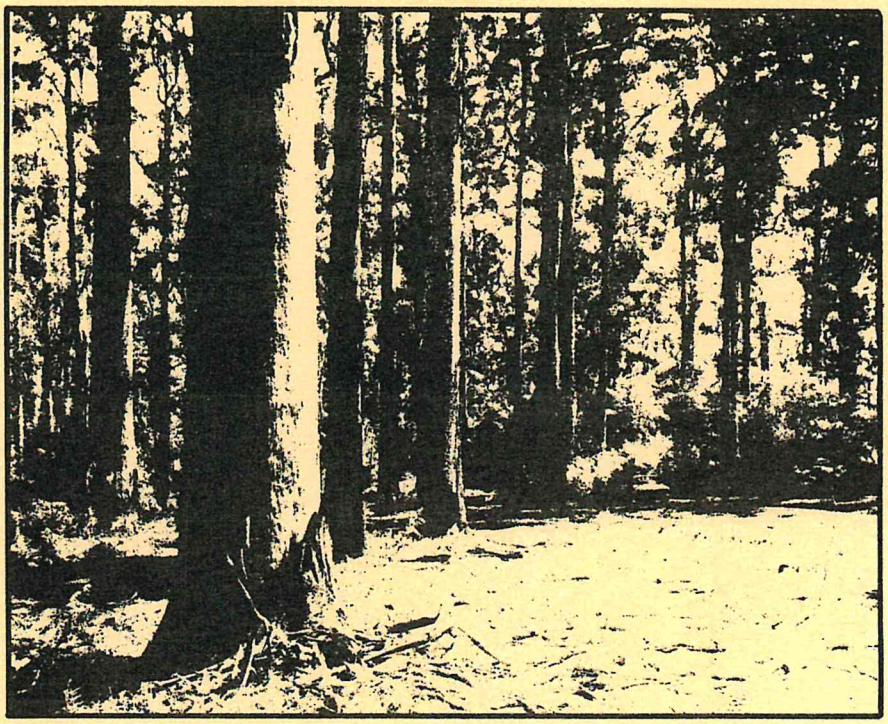
The Road, River and Stream Zone System in the Southern Forest of Western Australia



A Review

March 1988

Department of Conservation
and Land Management

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SUMMARY

A review of management experience and research results suggests that a re-distribution of zones and more flexibility in the allocation of these buffer zones to road, river and streams would improve conservation, amenity and hydrologic values of the forest.

An additional consideration is the requirement for sawlogs to be obtained by cutting within the zoned area. This requirement results from the decision to reserve the Shannon Basin as a National Park whilst at the same time maintaining projected levels of sawlog supplies.

In the existing road, river and stream zone system the road reserves are twice the width required by the Environmental Protection Authority. It was originally proposed that the sawlog deficit resulting from the creation of the Shannon River National Park would be made up by clearfelling the road reserves to within 200 metres either side of the road.

Following a careful examination of all timber resources during preparation of the State Timber Strategy, and with the availability of new data on amenity and conservation values, a new system which did not necessitate clearfelling was evaluated.

It is now proposed that the entire area which is presently allocated to road, river and stream zones be re-distributed to achieve the best possible conservation, amenity and hydrologic result. The sawlog requirement would be satisfied by selective cutting, primarily within the road zone, using modern landscaping principles to lessen the visual impact.

Conservation and hydrologic values will not be compromised by the system of selective cutting which is proposed. There may be some short term loss visually but it is expected that this will be balanced by the increased flexibility for landscaping which is a part of the proposed new system.

The new system will result in a more efficient distribution of the zoning system, and will provide for a significant improvement in the conservation, amenity and hydrological values of the system.

1. PREFACE Terms of reference, commitments and background to the review

In the Regional Management Plan, Southern Forests Region, December 1987, it was proposed that a review of road, river and stream zones in the region would be done during the first period of the Plan. This review would aim to improve the efficiency of the zoning system without reducing the overall area and to provide for amenity, wildlife habitat and stream protection. This was to be done within the framework set by the Management Plan and the accompanying Strategy for Timber Production in Western Australia. Furthermore, the plan provided that any changes must meet with the approval of the EPA.

The Government's commitment to reserve the Shannon Basin and still maintain the sawlog cut at projected levels means that timber resources have to be obtained from the road, river and stream zone system.

The declaration of the Shannon National Park has meant a loss of 1.3 million cubic metres of karri sawlog and about half a million cubic metres of jarrah sawlog. The Timber Strategy explored all avenues of overcoming this shortfall, and the deficit has been reduced to approximately half a million cubic metres karri sawlog.

A task force was appointed to undertake the review and consider these issues.

Its terms of reference were:

1. To review road, river and stream zones (including an analysis of research results from logging of trial areas) with the object of improving their efficiency in providing amenity, wildlife habitat and stream protection.

2. To investigate the extension of the system outside the Marri Chipwood Licence Area.

3. To take into account the existing fire protection strategy and its dependance on certain key road zones for protective burning.

4. The Timber Strategy commits CALM to supply a karri sawlog cut of 153,000 m^3/annum. A small proportion of this, approximately 20,000 m^3/annum, obtained over the 25 year period of the first rotation) will need to be obtained from within the zoned areas.

5. To take into account commitments made in the Regional Management Plan, Southern Forest Region, December 1987 and Timber Production Strategy.

In summary the Regional Management Plan commitments are:

1. To obtain the sanction of the EPA before any changes are made to the present road, river and stream zone system.

2. No clearfelling of any road, river and stream zones will take place.

3. There will be no decrease in the total area of road, river and stream zones in the region.

4. The existing practice of selective cutting will continue, providing this practice is compatible with amenity, conservation and catchment protection objectives.

Although this review was triggered by the Management Plan process, it is also a part of forest management to improve systems as new knowledge becomes available. This review is regarded as a routine forestry procedure.

2. INTRODUCTION

The multiple use concept practised in forestry in W.A. has led to three forms of conservation strategy in areas where timber production (i.e. harvest followed by regeneration) takes place:

1. Establishing large, representative areas of forest which are free from significant disturbance from logging or mining, e.g. national parks, conservation parks and nature reserves;
2. Linking these areas through a network of zones or strips along roads, rivers and streams; and
3. Managing other forest areas for multiple use, including timber production, catchment protection, landscape values and the protection of flora and fauna.

The present road, river and stream zone system was designed in the early 1970s to form a network of mature forest throughout the area where forest was being cut and regenerated by the clearfelling method. River and stream zones were established because they were known to be areas of high biological diversity and to protect watercourses. Road zones were established on roads to maintain a vista of undisturbed forest for travellers through the region.

The major features of the current road, river and stream zone system developed in the early 1970s and implemented since woodchipping began in 1975, are:

1. Approximately 20% of every forest block is reserved from clearfelling. The whole of State forest is subdivided into management units called blocks. These make a convenient unit of land upon which to base local levels of conservation planning.
2. Selected major roads forming a network throughout the area have zones of 400m either side, (i.e. total width 800m).*
3. Major rivers (Donnelly, Warren etc.) have zones of 200m either side, (i.e. 400m total width).
4. Most 3rd and 30% of 2nd order streams have zones 100m either side.
5. Zone are linked by connecting corridors to other zones. Stream zones are often extended to interconnect across ridges.

Footnote

* The 1973 EIS (Forests Dept. of W.A.) states that Major highways and tourist routes would have uncut reserves of a minimum of 200m on each side along them. This was accepted by the EPA at the time and in subsequent reviews by the EPA. The current road zones are therefore twice the required minimum width.

6. Some of the road zones are temporarily part of the fire protection system in the region.

7. 'Special care zones' are established in areas where there is no stream zone but where slopes exceed 15^{o} or features such as wetlands or rock outcrops exist. These amount to additional 'reserved' areas which are generally not mapped or counted in regional statistics.

3. REVIEW OF RECENT KNOWLEDGE

An extensive research program has been conducted since the development of the original zoning system. As a result, more information, particularly on wildlife management and water resources, has become available. This is summarized below.

a. Vertebrates

Research throughout Australia confirms that a reserve system of mature forest is vital to the regional conservation of a broad spectrum of vertebrate species (Loyn 1980, Loyn et al. 1980, Loyn 1985, Recher et al. 1980, Recher et al 1985, Recher et al 1987, Shields et al. 1986). Twenty-three per cent of Australia's vertebrates, or nearly 350 species, use hollows in trees in some way (Ambrose 1983), and therefore are dependent on older (> 80 yrs old) trees.

Wardell-Johnson (1984) found that 14 of 44 species (32%) of birds observed in the karri forest used hollows in trees as nest sites.

This trend is the same for mammals. Sixty-seven per cent (20 species) of mammals occurring in the Western Australian forests use hollows (this figure includes hollows in fallen logs as well as standing tree hollows). Mature trees are also used by animals for many other purposes besides nesting (Wardell-Johnson unpubl. data).

It is not known at what age karri trees develop hollows suitable for wildlife. Preliminary studies suggest that although hollows are found in individual trees over 80 years old, a stand needs to be 100 to 150 years old before numbers of hollows have developed.

There is also evidence that the most valuable areas for wildlife habitat are those lowest in the topography (Dobyns and Ryan 1983, Loyn 1980, Smith 1985, Recher et al. 1980, Recher et al. in press, Shields 1984). High nutrient status may also be an important consideration in certain forest types (Braithwaite et al. 1984). Sites lowest in the topography are most valuable for the full spectrum of bird species found in a particular habitat type (Loyn 1980, Recher et al. 1987, Watkins and Wardell-Johnson unpubl. data). Sites lowest in the topography are also most valuable for other vertebrate groups (Recher et al. 1987).

Small mammals reach greatest numbers in sites low in the topography in karri forest (Christensen and Kimber 1975).

Riparian (i.e. streamside) zones occupy a minor portion of the total forest area (see Churchward et al. in press) but are a critical factor contributing to diversity within any forest system.

Recher et al. (1987) recommend wide zones and movement corridors based on the theory of central place. This is based largely on the requirements of gliders (which do not occur in W.A.), though many birds may have similar requirements. These authors also found that the trees left in buffers of 40m total width were subject to crown decline and general degradation.

b. Aquatic fauna

With the exception of some work on fish by Christensen (1982) and Pusey (1981) little work has been conducted into the aquatic fauna of the karri forest or the impact on it of timber cutting and regeneration. Detailed research is required before definitive statements can be made about the aquatic fauna, the impact of timber cutting and regeneration, and the need for buffer strips beside watercourses.

However, all rivers and most permanent streams in the region are already protected by wide buffers from any potential adverse effects of timber cutting, and nearly half the forest has been set aside in reserves or zones where clearfelling and regeneration is not planned, so it can be inferred that no serious threat to aquatic fauna exists.

Furthermore, the aquatic fauna is obviously adapted to natural fluctuations in stream parameters. The need for buffers to protect it from any potential adverse impacts of clear-felling and regeneration is a question of the extent to which these operations push stream parameters (e.g. sediment concentration, temperature etc.) outside the normal range, and the length of time before the fauna recovers from this perturbation.

Logging may cause a small and temporary increase in sediment concentrations if buffers are not used (Borg et al. 1988). This is insufficient to affect water quality from the point of view of WAWA but may affect the aquatic fauna (Graynoth 1979).

Temporary loss of streamside vegetation following clearfelling may cause a rise in water temperature (Brown and Krygier 1970), and this could affect aquatic fauna. Natural wildfires would have the same effect. A rise in temperature causes nutrient release from the streambed and reduces oxygen levels, which can lead to eutrophication and algal blooms. These have been observed in an experimental area where no stream buffers were retained (Borg et al. in prep.).

Cutting to the edge of streams can also lead to debris (tree branches etc.) falling into the water. If not removed by loggers, this could change the pattern of water flow and the stream profile (Borg et al. in prep.).

Much of the aquatic fauna in streams rely on allochthonous production (i.e. leaf and litter input) (Bunn 1986). This is reduced temporarily by clearfelling (although a scrub buffer can probably fulfill most of these functions). Natural wildfires also interrupt the allochthonous production cycle, so it may be assumed the fauna is adapted to this process.

c. Flora

No complete study of the flora of the karri region has been undertaken. Collection of vascular plants and survey work over the last 15 years suggests that there are few plants which are confined exclusively to the karri forest. The numbers of rare and endangered flora in the karri forest are low (Christensen et al. 1985).

The effect of tree felling and timber extraction may have a temporary and localised effect, mostly by creating temporary bare areas (For. Dept. unpubl. data), but the floristic composition of clearfelled and regenerated areas is basically a function of fire regime.

The effect of fire on the understorey plants of forests in W.A., including the karri forest, has been well-documented (see Christensen and Abbott, in prep). The effect of fire may vary according to its frequency, intensity and season. Changes are

greatest immediately following fire but the effects are mostly short-lived and burnt areas are soon re-colonised and quickly return to the pre-fire condition. No fuel reduction burning occurs for at least 18-20 years after a regeneration burn.

In karri forest almost all recruitment following fire is from soil-stored seed, or resprouting from rootstocks and other underground organs such as bulbs and tubers. Very few species of vascular plants re-colonise burnt areas from outside, (i.e. plants with windborne seeds) therefore road, river and stream zones have only a very limited value in providing propagules for re-colonisation of clearfelled areas. More important are the 'de facto' reserves (see later), especially granitic outcrops, which often contain unique and specialised flora and fauna. These may be more sensitive to disturbance (Christensen et al. 1985) and are set aside from clearfelling and regeneration burning.

d. Hydrology

In a report by the Steering Committee for Research on Land Use and Water Supply (Anon 1987), changes to the current road, river and stream zone system are recommended. The report states; "Clearfelling in karri forest and heavy selection cutting in jarrah forest cause small, temporary increases in stream salinity and sediment concentration in local streams in the

intermediate and high rainfall zones. These effects pose no threat on a regional water resources scale. However, brief seasonal peaks in salinity and/or sediment concentrations on a local scale should be moderated by some refinement of management practices". In the low rainfall zone the report recommends stream buffers be matched in size to the risk of saline ground water discharge. Special care also needs to be taken in the medium rainfall zone where stream buffers are also recommended.

Research has confirmed that salinity control in south-west forest areas is achieved best by phased logging and modification of silvicultural prescriptions, and not by permanent stream and river zones. Salinity control will thus not be considered in this report.

Stream sediment levels are best controlled by having zones of undisturbed vegetation around the stream. It has been known for a very long time (Hornbeck and Reinhart 1964) that prohibiting machine access to streams was a major factor in preventing unnecessary turbidity levels.

In a review of stream zones Clinnick (1985) concluded that a width of 30m on either side of the stream was generally required. In some situations, e.g. highly permeable soils and slopes $<30^{\circ}$, 20m was considered acceptable, and in other situations widths >30m may be required.

Filter strips, i.e. where trees have been harvested but understorey is undisturbed except at log extraction points, are recommended by Clinnick (1985) in addition to stream zones where no logging has taken place. Harvesting logs from these filter strips can create channels leading towards the stream, although the operation can be planned to minimise the problem, or to rehabilitate and block snig tracks after logging.

These factors are well-known and are currently accounted for in logging prescriptions.

e. Amenity

The allocation of zones along roads where clearfelling would not take place was originally based simply on local knowledge of the most popular tourist drives. A standard width (800m) was applied.

During the last five years visual assessment procedures have been developed to assess and allocate landscape priorities for all operations in the karri region.

For example, roads are classified according to levels of landscape sensitivity (Level 1 - high, Level 2 - moderate, Level 3 - low). The levels are based on a set of criteria including factors such as usage, scenic value, cultural or landscape

significance, proximity to residential area, etc. All or part of each of the roads within these road sensitivity levels are then allocated to visual landscape zones (Zone A, Zone B and Zone C). For each of these zones there is a specified acceptable degree of alteration or disturbance ranging from very low in areas zoned A to higher levels in zones B and C.

This new system provides a basis for re-assessing the road zones laid down in the 1970s.

f. Logging Trials

In 1984 the Government directed CALM to begin a series of operational trials to examine the feasibility and consequences of extending cutting and regeneration coupes into selected road, river and stream zones. The results of the river and stream zone cutting trials are reported in Hordacre and Batini (1987) and Borg et al (1988). These authors conclude that reducing the width of stream buffers from 100m to 50m had no effect on the watercourse or water quality. The complete removal of a stream buffer introduced logging debris to the stream channel and led to algal blooms and changes in stream profile. Additional sand and organic matter were observed in the stream bed, but only adjacent to a major road. The effects of logging, with or without a buffer, on stream sediment concentration and turbidity were negligible. Most values were below the currently accepted standard for domestic water supply of 25 NTUs.

Results of the road zone cutting trials have not yet been published. Several of the trials involved clearfelling the 'back half' of the 400m zone adjacent to a road. The general consensus of people who have viewed these trials is that a 200m strip along roads retains a mature forest vista; however, this may vary depending on visual management objectives. These results are not conclusive but they are supported by general observations and experience over a long period of time.

4. ALTERNATIVE APPROACHES

There are a number of approaches to conservation that could be used in areas subject to clearfelling and regeneration operations. Six of them were considered when reviewing the road, river and stream zone system in case a new approach to conservation would be more effective than fine-tuning the existing system. The six approaches are:

1. Manage for selected components of the habitat that are known to be or suspected of being limiting, for example tree hollows. Trees with hollows suitable as nesting sites for those species requiring them may be limiting in regenerated forest after clearfelling, and hollows take a long time to form (Mackowski 1984, Inions 1985). The option of leaving selected trees with hollows has the problem that such trees significantly reduce productivity in the new forest by suppressing young regrowth (Rotheram 1982). Neither does this system provide for optimal development of the landscape character and dead and stag headed trees pose problems in fire control. In addition to these problems the long term viability of a system dependent on single mature trees is fragile.
2. Extend rotations so that there is time for suitable habitat to develop and be re-colonised by breeding populations from other suitable habitat before logging is carried out again.

This is a very real option for the future management of regrowth stands in the karri forest. On present indications, timber supplies will improve in W.A. after about the year 2050 and it would then be possible to manage second growth forests on very long rotations. However, it is not an option for the present generation.

3. Change the cutting regime from clearfelling to selective felling. Selective felling involves the progressive harvest and regeneration of a forest over a given cycle (e.g. 30 yrs) rather than one or two years as in clearfelling. This still leads to the completion of cutting of mature forest within a given block in the same time frame as clearfelling does. Unless there was a massive reduction in the allocation of timber resources, a change to selection cutting would not provide for hollows in second rotation trees before the end of the cut. This option also has silvicultural and management problems.

4. Reduce coupe size or alter coupe boundaries to increase diversity in each forest block. This option has considerable advantages to amenity and conservation in the short term but, like option 3, still leads to a completion of cutting within a forest block during the same time scale as occurs under the present system. Smaller coupes greatly increase the cost of regeneration and difficulty of subsequent fire protection.

5. Retain strips or patches of mature forest within the clearfelled and regenerated areas. This option is widely practised throughout Australia, and is the system currently in use in the southern jarrah forests. It is particularly useful where important areas of sensitive wildlife occur in patches. Riparian zones and areas of high nutrient status are examples of this. Buffer strips in stream headwaters and along streams and rivers prevent sedimentation following logging. In addition, leaving undisturbed forest along roads and major rivers and around places of special interest (e.g. rock outcrops or large trees) is the most practical way of maintaining forest amenity in localised sites.

6. Convert multiple use forest into conservation reserves. This option would not allow continuation of timber production levels and, by necessity, would quickly lead to the cessation of the timber industry in the region. This option was rejected as being outside prescribed Government policy.

Of the alternatives, the fifth option was chosen when planning began for the introduction of woodchipping in the karri forest in 1975. Twenty per cent in each forest block in the wood production zone was allocated to conservation reserves and as road, river or stream zones. After 13 years experience and research, this approach still appears superior: it is the most valuable for wildlife conservation and the only option that addresses amenity and hydrological requirements. Fine tuning is needed however, in the light of new knowledge, to ensure the best possible pattern of retained vegetation within intensively managed stands in the karri forest.

5. OBJECTIVES OF THE ROAD, RIVER AND STREAM ZONE SYSTEM

In considering the objectives of the road, river and stream zone system, it is essential to regard the zones as a system that complements the broad-area conservation reserves. Both systems together enhance and extend the conservation values of the forest as a whole, including areas clearfelled and regenerated.

The road and stream zones, together with the conservation reserves, will meet three major requirements to ensure multiple use values are maintained: conservation, amenity and hydrology.

a. Conservation

The aim is to conserve viable populations of existing species at the local level. It is important to realise that there is no danger of species extinction as a result of current harvesting and regeneration operations. What is being addressed is the continued maintenance of viable populations at the local level, (and the level chosen is that of the forest block of 2500-7500 ha) (N.B. This depends to some extent on the species). In view of the importance of stream zones for fauna, zones on streams must be considered the most important for conservation.

b. Amenity

The aim is to maintain the visual character of the forest and therefore the amenity along selected public roads. Areas of high visual impact may require specific attention. At the same time, the visual impacts of timber harvest and forest regeneration will be minimised and alterations integrated into the general forest landscape.

The amenity of the overall landscape should be considered although the high exposure viewsheds from public roads are of greatest importance.

c. Hydrology

The aim is to maintain water quality within its natural range. Events that go outside the natural range and lead to permanent or prolonged degradation of the stream environment are not acceptable.

Relatively narrow strips of vegetation only are needed along streams to maintain water quality. Such strips need not have trees in them to be effective in sediment control, provided the dense streamside understorey vegetation is relatively undisturbed.

6. CRITERIA BY WHICH THE SUCCESS OF THE SYSTEM MAY BE JUDGED

a. Conservation of flora and fauna

All present species should remain in a forest block at all times. It is the opinion of zoologists on Research Working group 12 (Forest Fauna) that it should be the aim of forest authorities to conserve fauna at the local level. We endorse this concept in W.A. and use the forest block as a convenient managment unit to achieve this.

Monitoring and survey work will be required to determine whether this objective is being met. A quantitative and statistically sound monitoring program needs to address the question of whether populations of wildlife species are being maintained at the forest block level. This can be done by combining existing research projects with an additional program of research on selected components of the biota in representative areas. The freshwater biota of the streams in the high rainfall zone is one component where inadequate work has been done.

b. Amenity

A visual resource management system has been developed with clearly defined visual quality objectives for the categorised and mapped landscape character types. All activities will be done in accordance with the visual quality objectives, and changes may be monitored using the system.

c. Hydrology

Mean annual stream sediment concentration should be less than 5mg/l. On a regional basis, the research to date indicates this is being achieved. However, further studies by WAWA should help to clarify the position. This program needs to be expanded.

7. AREAS OF POSSIBLE IMPROVEMENT

Features of the present zoning system which could be improved upon in the light of recent knowledge include:

1. Stands of retained mature trees within road, river and stream zones can be some distance apart under the current system. Minimising this distance will have fauna conservation benefits, particularly for species dependent on mature trees.*

2 The distribution of road zones is not optimal for amenity. Better information on visitor patterns suggest that some roads which have zones do not need them and others which do not have them need them.

3. Recent information on the hydrology and ecology of the forest suggests that there needs to be better coverage of rivers and streams. There is also a need for more flexibility so that advice from landscape architects may be taken.

* N.B. There is little quantitative evidence on this point, it represents the general feeling of the zoologists on the task force.

4. Trial cutting in road zones suggest that the width of road reserves may be reduced by one half without appreciably affecting landscape and amenity.

5. Trial cutting in stream and river zones support other studies which demonstrate that a buffer of 50m is sufficient protection on streams and rivers for water quality purposes (i.e. minimising sedimentation).

The area gained by reducing the width of road and stream zones would be available to increase the length of roads and streams covered by the zoning.

8. RECOMMENDATIONS

1. **Re-allocations of existing zoned area to incorporate a greater proportion of streams.** The principle of retaining uncut forest at the local level (forest blocks) should be continued. However, the system of road, river and stream zones should be modified to provide a more effective pattern to meet the three objectives of conservation, hydrology and amenity within the karri forest. It is therefore recommended that the existing area of road, river and stream zones be re-allocated to favour streams to a greater degree.

2. **Flexibility in zoning.** More flexibility in the percentage of zoned forest left in each block should be allowed in order to cater for special circumstances (e.g. where additional areas of road zone are required for special protection or amenity. The percentage of forest allocated to road, river and stream zones per forest block should be allowed to vary from 10 to 20% but overall it should average the same percentage of the production forest area at present.

3. **Clearfelling.** Clearfelling all or a portion of the extra width on the road reserves is not recommended. A better option would be retaining this extra area within the zone system and obtaining the required volume of sawlogs by selective cutting over a portion of the zoned area.

4. **Selection cutting.** Clearfelling trials in the road and stream zones have demonstrated that cutting can be carried out without detrimental effects on water quality. In view of this and the timber commitments made in the Regional Plan and in the Timber Strategy, selective cutting is regarded as being acceptable within some zones providing certain constraints are adhered to:

(i) Cutting levels should not exceed 50% of the sawlog volume in the area being cut. (This level of cutting would retain more than 50% of the trees. See Fig. 1). N.B. The 50% level of cut proposed is a mean figure, some variation either side should be accepted in practice. This flexibility is necessary to allow for reduced levels of cut, including no cutting in certain sensitive areas, e.g. areas of exceptional scenic value etc.

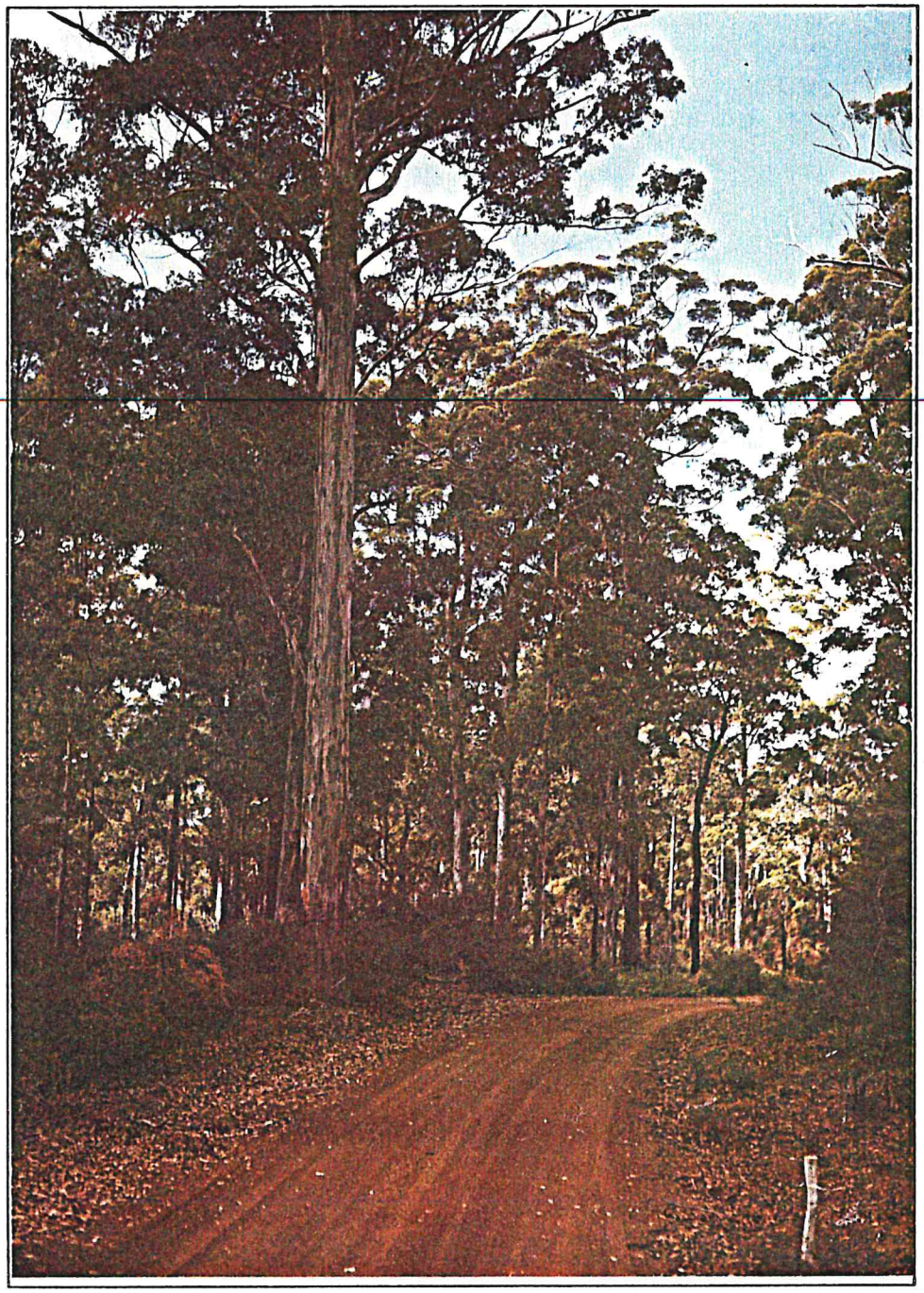


Figure 1
Selective cut karri forest in Pine Creek, a tributary of the Donnelly River

(ii) No cutting should be allowed in zones within 50m of a river or stream.

(iii) The area cut is to be regenerated.

N.B. In fire protection buffers it may be necessary to delay regeneration for a time.

5. **Thinning in areas of even-aged regrowth karri, produced by clearfelling some 50 years ago, such as those in Treen Brook, should continue.** Thinning young stands simulates the natural process and enhances amenity and conservation values.

6. **Extension of the system.** The possibility of extending the zoning system to wood production areas outside the marri woodchip licence area should be examined. It is likely that some modification will be needed: forest types and logging systems are different from the karri forest, and there are complicating factors such as Alcoa's mining leases.

9. IMPLEMENTING THE RECOMMENDATIONS

a. General Considerations

All relevant data were computerised to be able to examine ways in which the zoning system might be modified to accommodate the requirements of conservation and meet the obligations in the Timber Strategy and the Regional Plan.

All the streams within the chipwood licence area, classified from 1st order streams through to 5th order rivers were mapped on computer. All major roads were classified according to sensitivity levels and portions were assigned to different visual landscape zones A to C. Current and projected fire buffers were also mapped. The total length of each of the categories of roads, rivers and streams was then calculated.

These maps were then overlaid by maps of forest blocks and data on sawlog volumes were included for eight sawmill permits and 12 different forest types, i.e. a total of 96 possible combinations.

These data allowed all possible combinations and permutations of area length and width of road, river and stream zones to be examined. The effect of re-allocating

area from roads to streams and vice versa were evaluated for their impact on conservation, amenity, timber and fire protection.

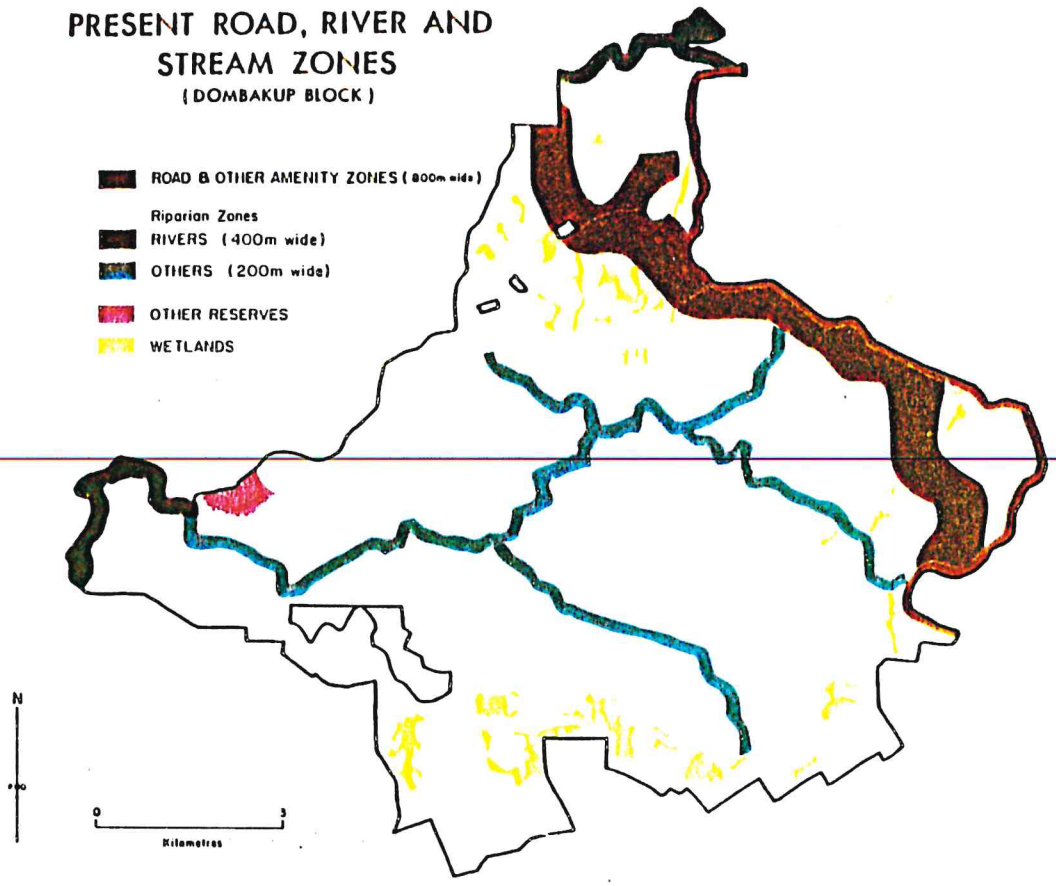
As a result of this analysis some major changes to the present system are recommended which will result in a better system and one which will accommodate all the objectives outlined the the Southern Regional Plan and associated Timber Strategy.

b. The proposed new zoning system

Retain zones of reduced width (200m total width) on all rivers (5th-4th order streams) and 100m total width on 3rd and 2nd order streams. The approximate area needed is 22,700 ha.

Retain zones of reduced width, 400m total width on Level 1 roads, most Level 2 roads and designated essential fire buffers. Total area required is 36,250 ha.

A comparison between the present system and the proposed system is in Fig. 2.


PRESENT ROAD, RIVER AND STREAM ZONES
(DOMBAKUP BLOCK)
ROAD & OTHER AMENITY ZONES (800m wide)
Riparian Zones
RIVERS (400m wide)
OTHERS (200m wide)
OTHER RESERVES
WETLANDS
N
0
3
Kilometres

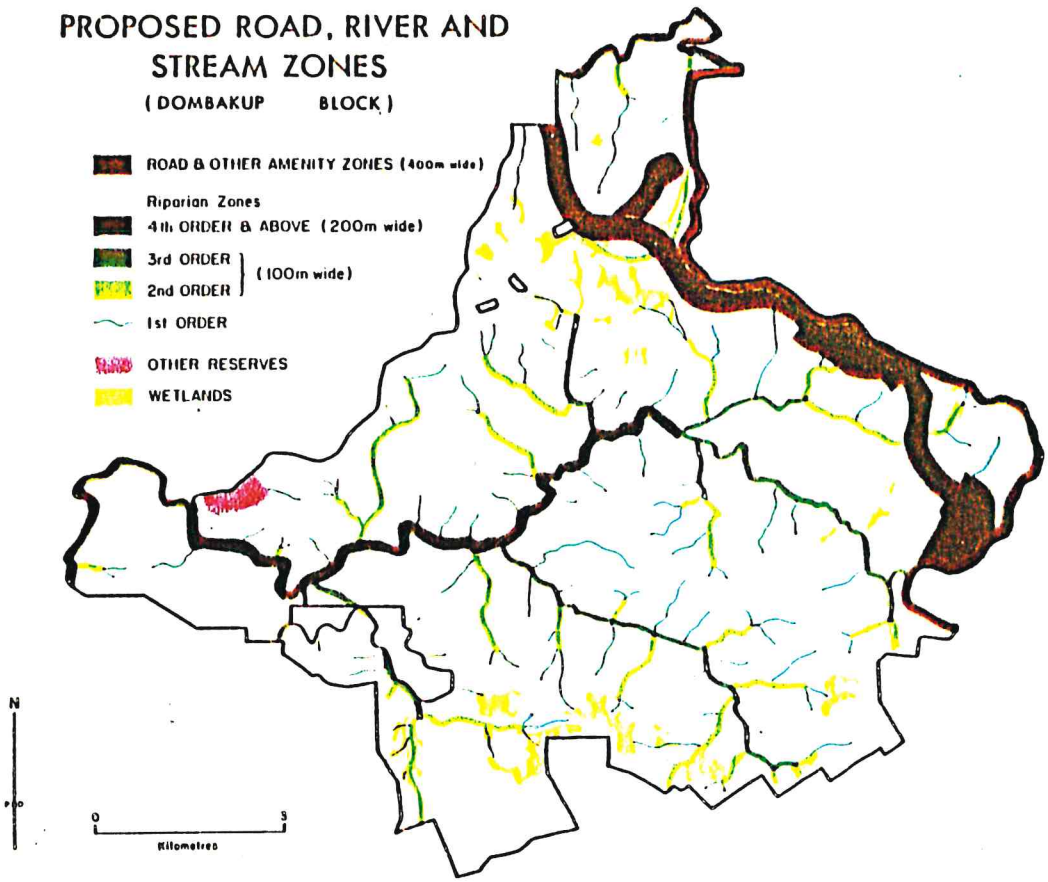

PROPOSED ROAD, RIVER AND STREAM ZONES
(DOMBAKUP BLOCK)
ROAD & OTHER AMENITY ZONES (400m wide)
Riparian Zones
4th ORDER & ABOVE (200m wide)
3rd ORDER
2nd ORDER
(100m wide)
1st ORDER
OTHER RESERVES
WETLANDS
N
0
3
Kilometres

Figure 2

It should be noted that 400m total width is a mean figure used to calculate the area needed to ensure adequate coverage. In practice the width may vary from 200m to 800m depending on the scenic value and other attributes of a particular section of road.

This flexibility is essential for landscape architects to gain the best effect from the available resource.

This allocation of the available zone resource (total 76,100 ha) leaves an uncommitted amount totalling some 17,150 ha.

The most effective use of this remaining area is to allocate it to selected 1st order streams and to boost the amenity total.

First order streams to receive zone allocation should be selected using the following criteria:

a. First order streams which are permanent or seasonal (many are not, especially in the lower rainfall zone).
b. First order streams which are likely to flow, albeit for only a short while, following clearfelling.
c. First order streams where valley slopes exceed 15^{o}. (These are currently treated in this way).

It is anticipated that some 20-30% of 1st order streams may require zoning using the above criteria. For this, some 7,500 ha of the 17,150 ha will need to be kept in abeyance for distribution to 1st order streams which fit the criteria above, as these are located. First order streams without zones should have scrub buffers. (N.B. It is not possible from maps to enumerate 1st order streams which fit the above criteria for zoning. This must be done in the field when the felling coupes are demarcated.

The balance of approximately 9,650 ha should be available for amenity purposes, distribution on Level 2 roads and scenic areas which warrant zoning.

A selection cut, averaging 50% of sawlog volume should be allowed in road and amenity zones and the outer 50m either side of rivers. No cutting should take place in stream zones.

The proposed level of cut will result in less than 50% of the trees being taken out. The cut can be done in different ways; 'feathering', for example, is one recognized method used by landscape architects to soften the visual impact of cutting (see Fig. 3).

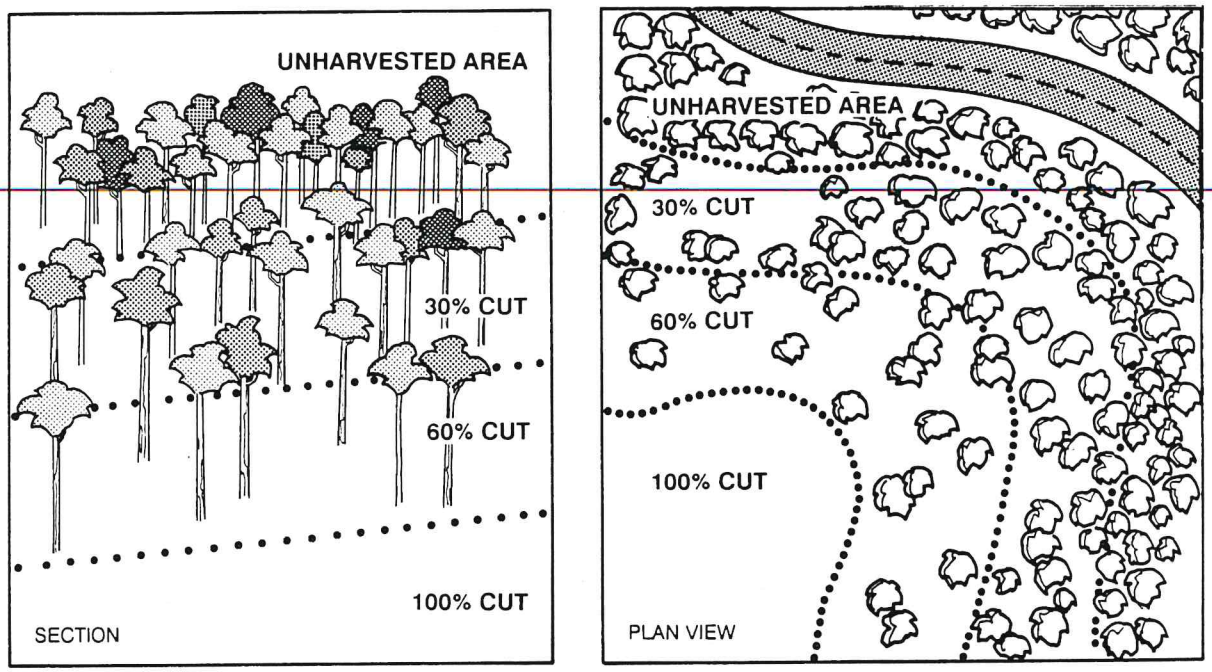


Figure 3
Feathering clearing edges for gradual transition.

In addition to undulating the clearing line, another key method of reducing the line, form, colour and texture contrast is to feather the edges. Successful feathering involves a reduction of vegetative density in transitional dregrees as well as a gradation of tall vegetation down to low vegetation at the clearing edge. Thus, the contrast is faded out into a wide transitional band and focalisation on an artificial line is decreased.

Feathering has an added benefit of reducing possibilities of large trees falling across or onto the highway. Windthrow is less likely to occur.

In addition to varying the method of cut to accommodate the landscape it is proposed that a representative range of tree size classes must be left to provide for conservation requirements.

Cutting must take place under strict guidelines laid down by the landscape architect. Flexibility in the level of cut should be allowed so that cutting intensity can vary from a 70% cut to no cutting.

Again flexibility is essential to obtain maximum benefit from the input of landscape architects.

All areas cut will be regenerated. N.B. It may be necessary to delay regeneration where fire buffers are critical. Once the fire buffer requirement is no longer necessary regeneration should proceed.

The proposed changes are summarized below.

TABLE 1 Summary of present and proposed zoning

Zone category	Present	Proposed
Rivers	5th order 200m buffer either side. No cutting.	5th and 4th order rivers 100m buffer either side. Selective cutting in outer 50m.
Streams	4th order rivers and 3rd order streams and some 2nd order streams 100m buffers either side.	3rd, 2nd and 20-30% 1st order streams 50m buffers either side. No cutting.
Roads	Selected major/ tourist roads 400m buffers either side No cutting.	Selected roads and amenity areas or portions of roads with buffers averaging 200m either side. Selective cutting.

It is difficult to quantitatively assess the proposed changes in terms of conservation, amenity, fire protection and timber production. However, a qualitative comparison with the present zone system is possible.

Comparison of the present and proposed system of zoning.

	Present system	Proposed system
Rivers & streams	Well protected where zones exist but not protected in some areas where there is no zoning.	Very well protected in all cases where protection is needed.
Roads & amenity areas	Some roads and sections of roads are well protected, but some zoning is not the best option available based on current knowledge.	Almost all areas on roads and some off roads which have been identified as being of importance, will be protected.
Karri sawlog potential	Almost nil, only thinnings are available from regrowth areas.	Availability is good using a 50% selection cut.
Fire Protection	Good	Good, but there may be some conflict with silviculture (i.e. burning/regeneration).

N.B. Protection of road reserves is taken in its broadest sense and includes catering for visual values and other amenities.

c. Special considerations

1. All streams, gullies and drainage lines (as marked on CALM 1:50 000 maps and interpreted through aerial photography) in areas subject to clearfelling and regeneration should be protected by a strip of retained vegetation.

2. 'Ecological boundaries' must also be determined. These may include terraces on larger streams (e.g. Dombakup Brook, Big Brook) in which case the zone edge will be above the terrace and thus include a narrow band of mature trees and ensure that roads are above steep slopes and seasonally moist sites. Although terraces do not usually support stands of mature trees they will serve as effective movement corridors for a large range of species.

3. Protection of seepage sites and valley headwaters is particularly important. These areas can be identified by aerial photographs and on the ground by the presence of **Lepidosperma tetraquestrum** or **Oxylobium lanceolatum**. These areas must not be disturbed by logging and will thus form the upper slope areas of the buffer system.

4. The revised zone system will cater for hydrological needs with respect to sedimentation but will not in itself be sufficient to cater for salinity in the low and medium rainfall zones. Salinity control is dealt with by other management techniques, e.g. split phase logging, not relevant to this discussion on stream protection zones.

5. Links between zones, for example between stream zones across ridges, are no longer considered necessary.

6. Variable depth of roadside zones will be used to fit most effectively with the landscape where appropriate for amenity purposes.

7. Certain road zones are currently of high priority in the existing fire protection system for the karri forest. These may be highlighted and retained as 800m total width where necessary.

8. Rare and endangered species will be protected as required where these occur. Other systems are in place to ensure this.

9. The re-allocation of road, river and stream zones refers primarily to forest blocks still to be harvested and regenerated, but should be applied where appropriate if logging is planned for areas already cut over in the past.

10. There are other extensive areas which are retained uncut, (e.g. forest around special recreation areas, granite outcrops, lakes, low jarrah woodland, scrub, flats and Warren River Cedar occurrences) but which are not formally declared or mapped, see Fig. 4. These 'de facto reserves', totalling some 28,400ha within the chipwood licence area, should be recognised formally, shown on maps, and considered as additions to the 76,100ha of road, river or stream zones wherever they occur as independent areas.

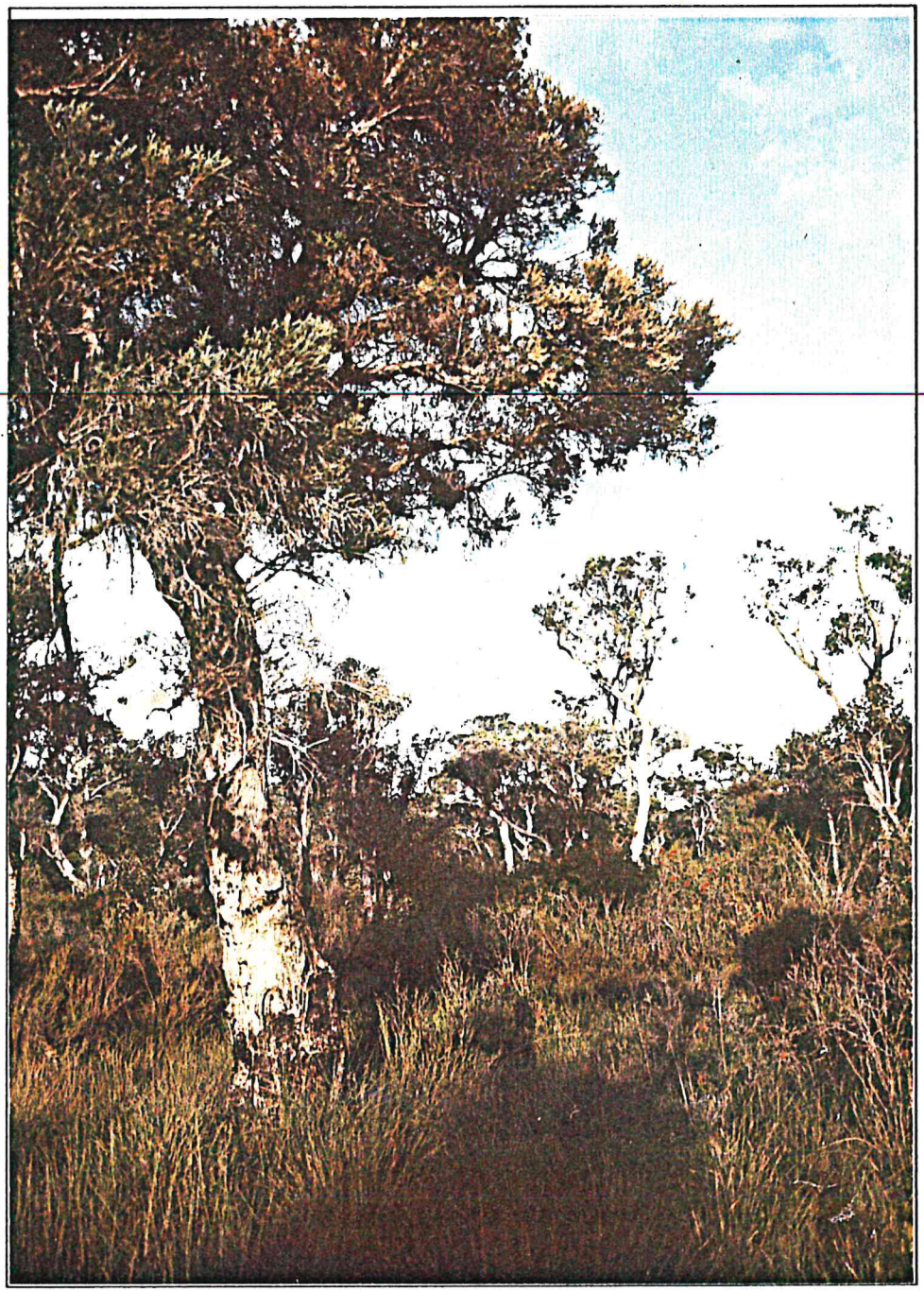


Figure 4
A woodland association, one of several vegetation associations currently recognized as 'de facto' reserves. More formal recognition for these areas is proposed

10. MANAGEMENT OF THE ROAD, RIVER AND STREAM ZONE SYSTEM

1. Coupes in which harvesting and regeneration operations are being conducted often border or include stream or river zones. When this occurs, the stream zone should not be burnt at the same time as the regeneration area unless it is essential for security in the regeneration burn or to reduce the risk of fire damage to the zone.

2. No clearfelling may take place within road, river and stream zones. Selective cutting in zones may occur as specified under Section 8.4 and this could take a variety of forms. Selection cutting in karri forest is an acceptable form of silviculture where long-term timber production is not the primary objective. Considerable variation in result is achievable using this technique and can be used for ecological or amenity purposes. Selective cutting does not necessarily devalue the visual quality of the forest; at times it may enhance it by introducing diversity. In areas designated for fuel reduction burning, or in high fire risk areas, cutting may have to be modified or regeneration delayed until the protection requirement changes. This occurs when the regeneration in adjacent clearfelled areas is old enough to allow fuel reduction burning.

3. Vehicular traffic and road construction should not occur within road river and stream zones. If it is simply unavoidable that a new road must be built across a valley, meticulous drainage work must be carried out to ensure the stability of the road surface and to minimise stream sedimentation.

4. For other management practices in road, river or stream zones (e.g. development of recreation facilities, or gravel extraction) existing guidelines should be followed.

11. FUTURE STRATEGY

1. The zone system advocated should be delineated accurately on maps for the entire marri chipwood license area. This task should be done by CALM's Inventory and Mapping Branch in co-operation with CALM's Research, Silviculture, Protection and Landscape officers. The map should be certified and become the standard reference for future management in a similar manner to the method adopted for declaring Disease Risk Areas.

2. No unique tenure is proposed but security of purpose is advocated. Because of the need for flexibility, and for opportunity to incorporate future research findings, the system should be reviewed every 10 years (i.e. in conjuction with reviews of the Regional Management Plans).

12. DISCUSSION

The review of current information on conservation, amenity and hydrology suggests that it would be desirable to re-distribute the zoned area to provide better coverage of stream zones. This may be accomplished simply by reducing the width of zones and by distribution of the area.

The requirement for karri sawlogs limits the options. The simplest method of obtaining the required volume of sawlogs would be to clearfell the extra width in the current road reserves. However, this would result in considerably less area for re-distribtuion to fulfill the requirements for conservation, amenity and hydrology. It would be difficult to achieve good coverage of streams whilst at the same time maintaining reasonable coverage of roads and other amenity areas.

For these reasons, selective cutting has been chosen as the means by which timber commitments can be best accommodated. By maintaining the present area, including the extra width in the road zones, the required sawlog volume can be obtained primarily from the road zone, whilst satisfying the conservation, amenity and hydrology requirements.

The choice of the selective cutting option poses certain problems of public perception and acceptability. In effect, what is being proposed is a move from a simple 'regimented' system to a more complex system with a high degree of flexibility.

More flexibility is essential if there is to be any improvement in the system, regardless of whether cutting is involved or not. The cutting requirement makes a high degree of flexibility doubly important.

In particular it will not be possible to achieve amenity objectives without this flexibility.

It is believed that a decision to change to a more flexible system is desirable and that it is warranted.

CALM has the expertise to carry out the proposals.

In addition, there is in place a framework for monitoring the results. The objective of the zoning systems together with criteria for its success are clearly spelled out so there should be no difficulty in making sure that the objectives of conservation, amenity and hydrology are achieved.

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14. GLOSSARY

amenity : Those natural or man-made qualities of the environment from which man derives pleasure, enrichment and satisfaction.

buffer : An area of land managed in such a way as to protect another area from outside influences.

clearfelling : the felling of all trees, including unusable trees, carried out in a given area to achieve uniform, even-aged regeneration.

conservation : Management of human use of the environment so that it may yield the greatest sustainable benefit to present generations while maintaining the potential to meet the needs and aspirations of future generations.

endangered : Flora or fauna in danger of extinction and whose survival is unlikely if the causal factors continue operating.

forest : An ecosystem characterised by a more or less dense and extensive tree cover. An area of land proclaimed to be forest under a Forest Act. To qualify as a forest, an area must be at least 30m in width, at least 0.4 ha in area and have sufficient trees to provide 10 per cent crown cover.

logging : Felling and hauling of logs.

mature forest : The stage at which a stand best fulfils the (main) purpose for which it was maintained e.g. produces the best possible supply of specified products.

prescribed burning : The application of fire to land under such conditions of weather, soil moisture, time of day and other factors that will result in the controlled spread and intensity of heat required to accomplish specific silvicultural, environmental or fire hazard reduction objectives.

rare species : Less than a few thousand reproductively mature specimens are known to exist in the wild.

regeneration : The process of forest renewal, or the plants resulting from natural regeneration process.

regrowth : Regeneration at the sapling or pole stage of growth.

salinity : The concentration of dissolved salts in water.

sawlog : A log of suitable size and grade to produce sawn timber.

selection system of cutting : A silvicultural system in which trees are removed individually over the whole area (usually in the course of a felling cycle), to maintain the stand in an uneven-aged condition.

stream buffer : An area of undisturbed vegetation adjacent to the stream.

stream zone : An area of vegetation adjacent to the stream permanently reserved for conservation.

thinning : A felling made in an immature stand for the purpose of improving the growth of trees that remain without permanently breaking the canopy.