PROCEEDINGS OF A SEMINAR

A REVIEW OF ROAD, RIVER AND STREAM ZONES IN SOUTH WEST FORESTS

Held at Manjimup

Tuesday, 9 July 1991

SPONSORED BY

LANDS AND FOREST COMMISSION

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INTRODUCTORY COMMENTS BY THE CHAIRMAN OF THE LANDS AND FOREST COMMISSION, THE HON BARRY HODGE

The Lands and Forest Commission is a three person Commission formed under section 20 of the Conservation and Land Management Act.

The current members of the Commission are myself as Chairman, Mr Ray Perry, who is also present today and Dr Syd Shea.

The functions of the Commission are spelled out in section 19 of the CALM Act. They include:

- To have vested in it State forest and timber reserves.
- To develop policies to achieve the purposes to which the land is vested.
- To consider proposals for land exchange and changes in boundaries, or changes in purpose in respect of land vested in it.
- To submit Management Plans to Minister in respect of land vested in it.
- To monitor the carrying out of management plans by CALM.
- To provide advice to the Minister on matters on which advice is sought.
- To cause study on research to be undertaken for the purpose of developing policies to achieve or promote the objectives of multiple use forests and timber reserves.

This seminar is one of a series of seminars, workshops, field trips and meetings scheduled during the drafting phase of a review of the Forest Strategy in Western Australia.

The LFC and the NPNCA have played a prominent role in hosting these opportunities for public involvement and information sharing.

The objective of today's seminar is two-fold:

- To present technical information about the values provided by a network of road, river and stream zones in the south west forests.

- To invite comment and discussion from specialists and the community about the issues pertaining to this important matter.

CALM will use this feedback in writing the relevant section of the new forest strategy.

Todays seminar will consist of three main stages:

Firstly, a series of papers by CALM staff.

Secondly, a question and answer and discussion session following on from the papers.

Finally, a workshop session in which seminar participants will have the opportunity to discuss issues in a small group format.

We trust that by providing an opportunity for public input in the early stages of this review an informed debate will be possible.

REVIEW OF ROAD, RIVER AND STREAM ZONES IN SOUTH-WEST FORESTS

Introduction to a workshop at Manjimup, July 1991

by Roger Underwood

I am very pleased to have the opportunity to provide the introductory notes at this seminar today. I was involved in the development of the concept of special management zones on roads, rivers and streams in the karri forest back in the early 1970s; and I have since been involved in the implementation of the system and the assessment of its merits. It is very satisfying now to also be involved in the review of the system, and I hope, its further development.

In this introduction I wish to discuss three issues:

> ***Firstly**, the philosophy of management which we attempt to apply in CALM, and the framework into which this seminar fits;*
>
> ***Secondly**, the land use classification system which applies to forests in WA, and the framework into which the road, river and stream zone system fits; and*
>
> ***Thirdly**, the special values which are ascribed to road, river and stream zones which must be provided for.*

Before I start, however, I would like to make a brief personal observation. I am well aware, as are we all in CALM, of the sensitivity of this issue. I expect that most of you in the hall today are passionately concerned with the overall issue of forest conservation and management in WA, or with some aspect of it such as the protection of roadside or riparian zones. I know that each one of you would like to be able to influence the outcome, when issues like this are being reviewed.

I therefore would like to emphasise CALM's two principal aims today: *firstly,* we are here to try to share with you the most up-to-date information we have on the subject, and *secondly* that we are here to listen to what people have to say.

However, it is important to consider the decision-making processes in which we are involved. CALM's statutory role is to prepare draft management plans for its controlling bodies (the Lands and Forests Commission and the National Parks and Nature Conservation Authority). These bodies may, and frequently do amend draft plans prepared by CALM before submitting them to the Minister for the Environment. He, in turn, may also amend them if he feels he must do so. In the case of the 1987 forest region management plans, the endorsement of the EPA and of Cabinet was also required. In the special case of the road, river and stream zones in the Southern Forest Region, the approval of the EPA is required before any changes can be made, because the original system was approved by them as part of the original Environmental Impact Statement for the woodchipping industry, and because of Ministerial conditions imposed when the licence was recently reviewed.

So it is a complicated business, and many people will have their finger in the pie. As I see it, CALM's job is to try to provide the best technical information available, upon which decisions will be based, and to try to ensure that there are proper opportunities and avenues for the views of the concerned public to be heard and incorporated. CALM will be making recommendations on this issue, but not final decisions.

CALM'S MANAGEMENT PHILOSOPHY

Those personal observations lead nicely into the first general introductory point I wish to make: CALM's management philosophy.

Under the legislation which established CALM, and in our approved mission statement and key objectives, the department has both a direction and a goal to manage lands and wildlife for the benefit of present and future generations. This is not as easy as it sounds. Many members of the present generation don't agree about how this should be done, and we don't know exactly what the future generations want. The best we can all do in these situations is to use the most up-to-date scientific information, make the best social and political judgements we can at the time, and then make adjustments as we go along and we learn from our mistakes, or recognise our successes and try to build upon them.

This philosophy is turned into action by the preparation and publication of management plans, which are then periodically reviewed and updated. The management plans specify what is to be done, and where, over a specified time period. At the same time, research is ongoing to try to improve the scientific data base upon which the management plan is based. A variety of means are used to find out the public's views, and to incorporate these into the plans. For example, we identify and meet with special interest groups, we hold open workshops and seminars, we publish plans in draft form so that people can clearly see what is intended. In addition, there are several layers of approval and endorsement required, including the controlling bodies, EPA, Shire Councils and Minister, all of which allow for public input.

In some cases our management plans have specifically **not** dealt with some issue or other in a particular area. A case in point is the system of road, river and stream zones in the Southern Forest Region. In our 1987 plan for this region we made it clear that we thought the system could be improved, but that the subject was too complex to be dealt with in a regional plan. At the time we foreshadowed the review process in which we are now involved.

In a nutshell then, our management approach is to make our intentions explicit in published management plans, to try to incorporate the best scientific information as well as community opinion, and to review the results and update the plans on a regular basis.

THE LAND USE CLASSIFICATION SYSTEM APPLYING IN FORESTS IN WA

Public forests in the south-west of WA fall into one of four major land use categories:

> *Nature Reserves*, where the primary purpose of management is nature conservation and scientific study;
>
> *National Parks*, where the dual principal purposes of management are nature conservation and recreation;

Conservation Parks, which are similar to national parks, but generally smaller and less pristine (Note: this category has only recently been created and no areas have yet been designated, but numerous areas have been managed for some years as if they were conservation parks); and

State forests, which are managed for a variety of purposes, including nature conservation, recreation, the production of water, timber, minerals and other minor products, as well as for their amenity and landscape value.

Within each of these areas, a further definition of special management zones can occur. For example there may be parts of a national park in which some forms of recreation are not permitted and this is spelled out in the management plan for the park.

The identification of special zones or places in the forest is particularly important in the multi-use State forests. This is because not all the outputs for which we are managing State forests are able to be provided for simultaneously from the same hectare of forest.

THE SPECIAL CASE OF THE ROAD AND STREAM ZONES IN THE SOUTHERN FORESTS

The designation of special zones along roads, streams and rivers in the Southern Forest Region is a case in point. Although these areas still have the official tenure of State forest, they are managed differently from surrounding State forests so as to ensure certain values are maintained in the forest as a whole.

The special values which must be provided from State forest as a whole are fourfold:

(i) *Wildlife*. It is important that we provide for the full range of wildlife habitats throughout the forest;

(ii) *Timber*. The southern forests are the major hardwood timber producing areas in the State;

(iii) *Fresh Water*. Most of the rivers and streams arising in the southern forests are still fresh and unpolluted. They are also the habitat for aquatic fauna and flora. The physical and ecological integrity of major watercourses needs to be maintained;

(iv) *Landscape*. The southern forests are very beautiful and vistas of mature forest along roadsides is a special attraction of the region, and form part of the backdrop for many recreational pursuits.

In order to provide for timber, and at the same time protect the other special values, the system of road, river and stream zones was developed and implemented over 15 years ago. These zones support the permanent reserve system which occurs throughout the forest.

They were originally called "Road River and Stream Reserves" in the days before CALM. The use of the word "reserves" was discontinued by CALM because it implies that the areas had a special tenure, like nature reserve. At the time they were designated, the road and stream zones were never regarded as being permanent; they were there to provide mature undisturbed forest values while adjoining forests were being harvested and regenerated.

The system comprises a network of forests of varying widths along major roads, rivers and streams. Along selected streams 100 m either side is protected, this width is increased to 200 m either side of rivers; and along selected roads 400 m either side is protected. (The original EIS for the Marri Woodchip project required only 200 m either side of roads, but this was voluntarily increased to 400 m.) A total of 76,000 ha of forest is included in the network which averages about 20 per cent of each forest block.

In these areas no clearfelling for sawlogs and chipwood logs occurs or is planned. The network was carefully designed, on the basis of the best information available in the early 1970s. The aims were, in the forest blocks in which timber production was planned to occur, to provide special protection for fresh water resources, to inter-connect conservation reserves, provide mature tree habitat at a local level, and preserve the special attractiveness of the roadside vistas along the major tourist roads of the region.

The system adds to, and often links, the mature forest within the system of major conservation reserves (nature reserve, national park and conservation park) which occur throughout the forest. When the system of road, river and stream zones was developed in the early 1970s, we used the best information available at that time. However, at the very time it was being first implemented research programs were also set up to see whether the system could be improved. Specifically, we wanted to study the questions of optimising the protection of water resources, conserving fauna at the local level and managing forested landscapes.

Fifteen years later this research has suggested to us that the original system can be improved. Furthermore, we now have computer technology for mapping and comparing options which was simply unavailable years ago.

IN CONCLUSION ....

The designation of special road, river and stream zones in the multiple use forest was one of the most popular moves forest managers have ever taken. The value of these areas for nature conservation at the local level, water resource protection and regional tourism is widely recognised. Indeed they have become so highly regarded that when we first proposed that the system be modified a couple of years ago, there was a major outcry. As one of those who helped design the original system, but now one of those who believes the system can be improved, I'm not sure whether to feel proud or mortified by this!

I am a firm believer in the need to move, amend and adjust as new information and changing values come to light. I believe responsible managers need constantly to be looking at research results, at new techniques, new concepts and new approaches. We would be very arrogant managers if we thought the *status quo* could never be improved upon.

As Mr Hodge said in his opening remarks, this is one in a series of workshops on this, and related forest management issues. After the general review of options here today, further more detailed consideration of the issue will follow.

Finally, thank you for participating in this review. I hope that the outcome is a superior system of protecting the special values of the multi-use forest in the southern region than we have at present; most of all I hope that if a new system is developed and adopted, that people will understand the basis and genesis of the changes, and that they will support CALM in its implementation in the field.

1 July 1991

RETAINING REMNANT MATURE FOREST FOR NATURE CONSERVATION: A REVIEW OF THE SYSTEM OF ROAD, RIVER AND STREAM ZONES IN THE KARRI FOREST

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Introduction

Karri (*Eucalyptus diversicolor*) occurs predominantly in the Nornalup and Denmark Systems of the Warren Botanical Subdistrict of Beard (1980). Of the 167 500 ha of karri in this area, approximately 48 700 ha occurs in nature reserves, national parks and proposed conservation parks. The other 118 800 ha is gazetted as State forest and managed for multiple uses (Anon 1987a).

Harvesting for timber in Western Australia began soon after European settlement. Since the passing of the Forests Act in 1918 (Nunn 1957) there has been a continued evolution in forest management and silviculture (Stoneman 1986, Stoneman *et al.* 1989, Bradshaw and Lush 1981, Abbott and Loneragan 1986 and Havel 1989). In the karri forest, for example, clearfelling was replaced by selection cutting in 1938. It was reinstated as the main silvicultural system in 1967. The woodchip industry was established to utilise non-millable trees in the karri forest in 1975.

Within State forest, we divide the structure of the karri forest into four categories based on how timber is removed and the forest regenerated (Fig. 1).

The first category consists of approximately 65 800 ha of mature forest (including 25 200 ha of pure karri and 40 600 ha of mixed karri/marri). This includes unlogged stands where the forest canopy is recognisable as a single layer of mature and senescent trees, and approximately 25 300 ha of forest which has had some timber removed but where the mature forest character has been little altered.

The second category includes approximately 5 900 ha of largely even-aged stands resulted from clearfelling and slash burning, clearing for agriculture, or wildfires prior to 1940. Areas of this regrowth may include up to ten mature trees per hectare retained at the time of logging, burning or clearing. These highly productive stands (heights of 45-50m are reached by 50 years of age) are mostly in the Big Brook and Treen Brook forest blocks to the west of Pemberton. Thinning commenced in these stands in 1980, removing suppressed and subdominant trees, and is progressing through this older regrowth at a rate of approximately 400 ha per year. The resulting stands consist of dominant and co-dominant trees at a stocking of not less than 90 stems per hectare. Second and subsequent thinnings are planned for the future.

A third category includes two-tiered forest resulting from group selection cutting from 1940 to 1966. These stands consist of a mosaic of patches of mature and regenerated forest which vary in size from less than a quarter of a hectare up to two hectares. Any patches of regrowth greater than two hectares is treated as even-aged forest. Two-tiered forest covers an area of 8 900 ha. The silvicultural prescription for these forests varies with the quality of the regrowth and the size of the gap in which it grows. Some areas will be thinned several times before clearfelling, while others will be pre-logged to remove smaller trees that would otherwise be damaged in the subsequent clearfelling. There is a further 3 300 ha of two-tiered forests not created by selection cutting, but resulting from moderate fires in mature forest.

Category four includes approximately 33 000 ha of even-aged forest logged and regenerated after the silvicultural practice of clearfelling was reinstated in 1967. The average coupe size has varied considerably over time. In the early 1970s coupes were up to 200 ha. By 1981/82 coupe size had fallen to 85 ha. In 1990 the average coupe size in karri was 47 ha. An average of 30 such areas are cut each year giving a total clearfelled area of less then 1 500 ha per annum (Anon 1987b). Stands are regenerated using a high intensity slash burn in summer or autumn, using seed trees as the source of regeneration if seed is available. Direct seeding, planting nursery raised seedlings, or a combination of both, is used in 50 percent of the area regenerated. These even aged patches will be first thinned when they acquire a top height of 30m. Thinning intensity will vary with site quality, but will generally leave 350 - 400 stems per hectare. Second and subsequent thinnings will also be carried out. Thinning of these younger stands commenced in 1990. The planned rate for the first few years is 300 ha per year subsequently increasing to around 800 ha per year.

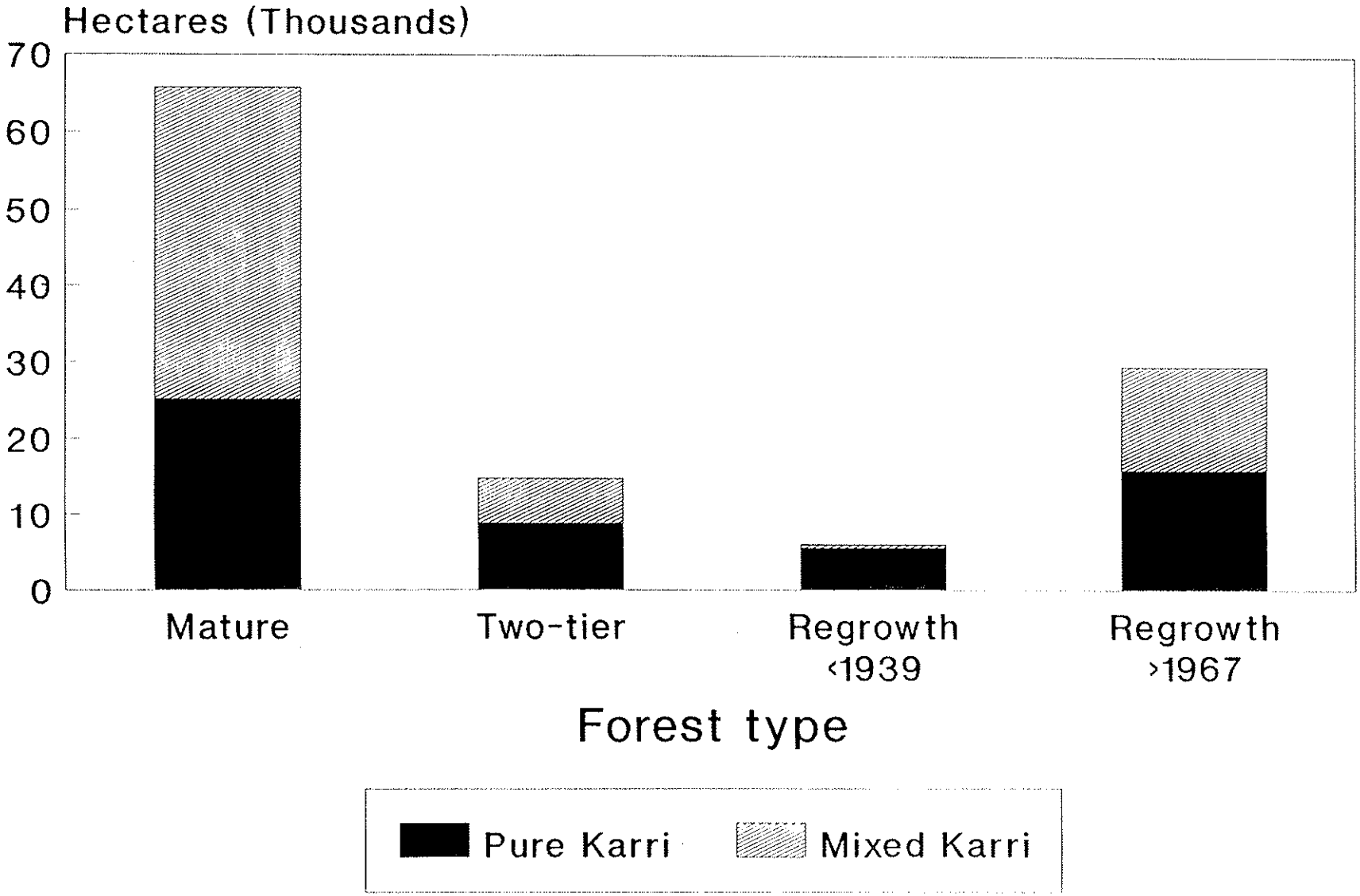
The first cutting cycle should be completed by 2040 if cutting continues at the present rate (based on area not volume). If this regime continues State forest will be a mosaic of largely even-aged patches of regeneration, the bulk of which will be less than 100 years old. This will be interspersed with mature forest in conservation areas which will, together with the road, river and stream zones, provide a vital area for fauna dependent on mature habitat (Fig. 2).

Two forms of conservation strategy were designated with the Environmental Impact Statement (EIS) for the introduction of woodchipping in 1975 (Anon 1972). The first involved discrete areas of forest reserved from exploitation such as National parks, nature reserves and management priority areas for flora, fauna and landscape. The second involved a network of remnant mature vegetation to be left unlogged along road, river and stream systems and comprising some 20 percent of the forest within each forest block. Thus a series of strips or corridors of forest were left unlogged on a block by block basis forming a network of mature forest on road, river and stream zones to connect with the reserve system. After the reserve system was designated, road zones of 800 m total width, river zones of 400 m total width and stream zones of 200 m total width were allocated such that approximately 20 percent of the forest block remained unlogged. This system aimed to ensure the regional conservation of species and communities. 73 700 ha of road, river and stream zones (including 24 300 ha of karri forest) were designated and mapped throughout the Nornalup and Denmark Systems of the Warren Botanical Subdistrict (Anon 1987a).

A review of the existing road, river and stream zone system (Wardell-Johnson 1987) recommended a redistribution of the network to more effectively cater for wildlife in the karri forest. This review assumed no reduction in timber yield and continuation of the 73 700 ha of unlogged road, river and stream zones. A subsequent report (Anon 1988) also recommended a reallocation, and the selective logging of some road and river zones. A total 500 000 m^3 of karri sawlogs was to be removed from the road, river and stream zone system, to compensate for timber made unavailable by the reservation of the Shannon National Park (Anon 1988).

This paper considers only the biological issues concerned with the most appropriate distribution and management of the current area of road, river and stream zones. We review the existing conservation system within karri forest in State forest. We begin by reviewing the theory and practice of wildlife conservation in areas subject to harvesting. We refer to research carried out in the Warren Sub-district since 1971 which allows a preliminary assessment of the conservation value of the current of road, river and stream zone system. We conclude by recommending a reallocation of this system. Our main emphasis will be on the karri forest of the Nornalup and Denmark Systems, though timber production also occurs in jarrah (*Eucalyptus marginata*) forest. Silvicultural systems are different in jarrah forest where, for example, habitat trees and crop trees are retained throughout the harvested area. We conclude by recommending that a system of road, river and stream zones should be put in place in all areas of State forest.

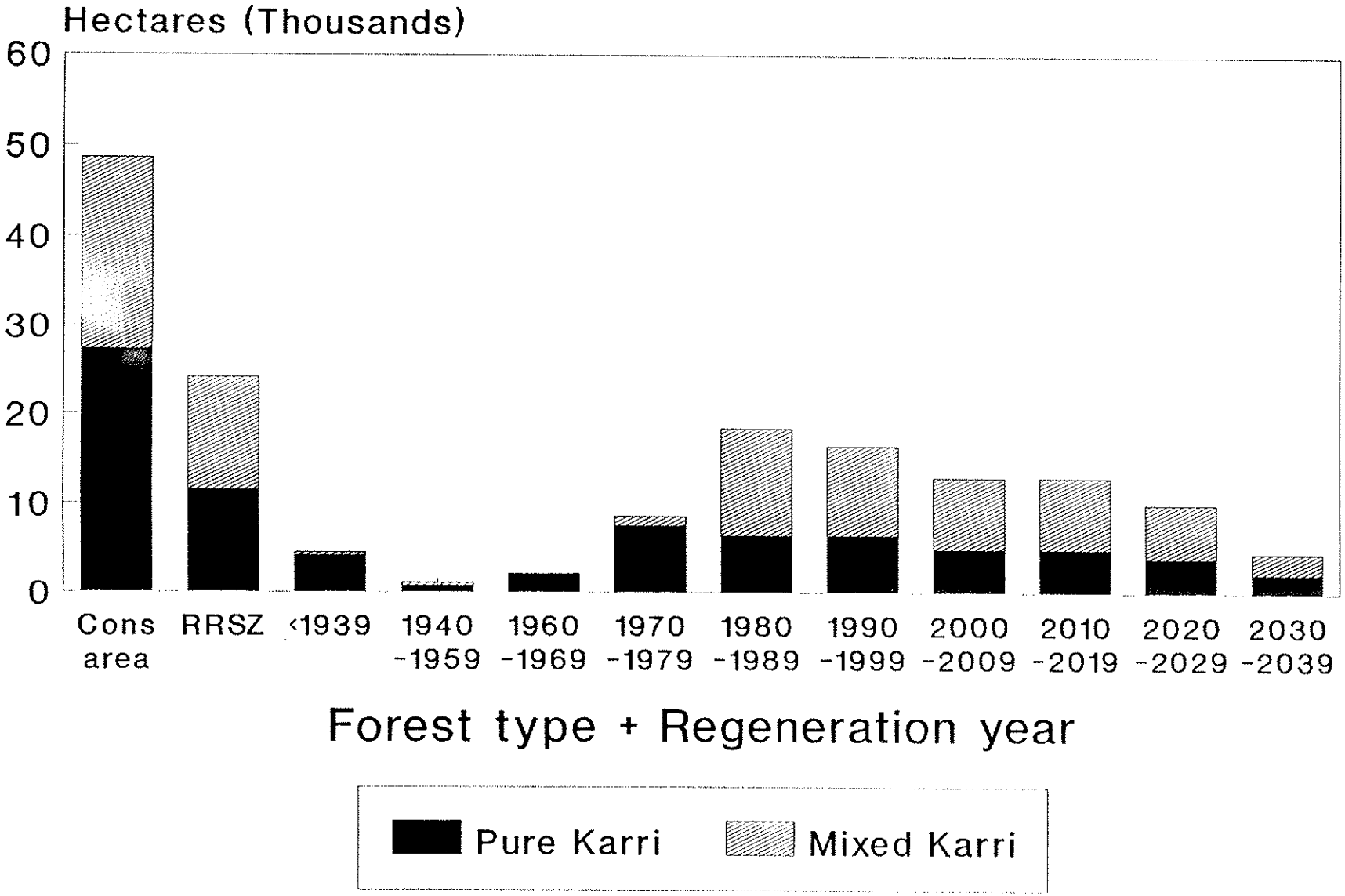
Area of Karri Forest
Tenure : State Forest - 1990



Areas incl road, river and stream zones

Figure 2

Area of Karri Forest
All CALM Lands - 2040



Cons area = Nat Pk, Nat Res, Cons Pk

Approaches to Wildlife Conservation

There is an abundant world literature on the interaction between timber harvest, regeneration and wildlife, particularly birds. For instance, it is well established that the organisation of bird species and communities at any one place or time is determined primarily by the structure of their habitat within a given forest type (Recher 1969, 1971, Tingay and Tingay 1984 for the karri forest). Temporal and spatial scales must be considered, however, in examining the effects of broadscale management operations on wildlife.

Five approaches to wildlife conservation in areas subject to harvesting operations can be defined.

(1) *Reserve more and/or larger areas specifically for wildlife (eg, national parks or nature reserves) and not make particular effort to conserve wildlife in areas used for other purposes (eg, mineral extraction or timber production).*

This approach is unlikely to sample the full range of species, communities and genetic diversity of forest wildlife in a region and would isolate populations and hinder recolonisation. While recognising the need for large reserves for wildlife, we reject this approach as a viable option. We stress the need for multiple use forest to contribute to fauna conservation and be managed in a manner sympathetic to that objective.

(2) *Manage for selected components of the habitat that are known or assumed to be limiting. Trees bearing hollows is an obvious example due to their long time in formation (Inions 1985, Inions et al. 1989, MacKowski 1984).*

There are several disadvantages in using only this approach. Firstly trees provide more than hollows (eg, the provision of nest boxes does not fill the role of mature forest). Secondly, certain management constraints such as fire control and suppression of surrounding regrowth (Rotheram 1983) must be addressed, and thirdly we may be directing conservation efforts at the wrong scale (eg, localised invertebrate fauna of poor colonisation ability are not considered). Habitat trees are of considerable importance however, particularly in areas where large gaps occur or in areas managed under short rotations, and should be a part of the total strategy.

(3) *Extend felling rotations so that there is time for suitable habitat to develop and be recolonised by breeding populations from surrounding undisturbed areas before it is logged again.*

This option involves the sustained yield of suitable habitat. We have yet to obtain detailed knowledge of the growth and development of trees (eg, see Jacobs 1955) and stands as habitat in the karri forest. In any case, present timber commitments in the karri forest largely limit this option until the second rotation. Changes may enable the extension of the current nominal rotation (Bradshaw and Lush 1981) beyond 100 years. This option may, however, already be available for particularly valuable areas as envisaged by Recher *et al.* (1987). Management can also be used to enhance the development of desirable characteristics eg, fire for the formation of hollows.

(4) *Reduce gap sizes or change silvicultural regimes.*

Within any given cutting level, this option leads to the completion of cutting within a forest block, and the overall area, in the same time scale and may not offer an improvement except where gap-sizes are very large. In addition there may be some disadvantages such as a requirement for additional roads. Small gaps lead to problems with damage to regrowth during removal of larger trees of the second crop. Regeneration burning without damage to regrowth is also very difficult. However, the influence of adjacent mature forest on the recolonisation of regeneration benefits from this approach.

(5) *Retain strips or patches of mature forest within harvested areas.*

This option has been found to be useful in the initial logging phase in Australia, North America and New Zealand. It is particularly attractive where important areas of sensitive wildlife occur in patches. Riparian zones, rock outcrops, areas of poor regeneration potential and areas of high nutrient status are examples. It is also useful where previous logging has encouraged patch formation (eg, some areas of jarrah forest).

At the scale of the entire south-west, option one is vital to wildlife conservation. Each of the other options, however, contribute to wildlife conservation at the scale of a forest block. The first and fifth options were those originally chosen when the EIS was drawn up in preparation for the introduction of woodchipping in the karri forest in Western Australia in 1975 (Anon 1972). Options two and four have also been used in the jarrah forest. Option three is being considered in a review of forest management in Western Australia that is currently underway (Jones personal communication 1991). We believe that option five remains the most valuable for wildlife conservation and should continue to be the first priority in multiple use forest containing karri.

Models of size, shape and placement of zones for wildlife habitat

Four principles derived from the theory of island biogeography (MacArthur and Wilson 1967) are widely accepted among biologists for most wildlife (Recher *et al.* 1987 page 178):

"1. large reserves retain more species than small ones;

2. reserves with a small boundary in relation to area retain more species of the original habitat than those with long or irregular boundaries

3. linking reserves with corridors is an effective way to enhance the size of reserves; and

4. multiple reserves provide a hedge against catastrophic loss."

We need to consider the relevance of these theories to reserves amongst multiple use forest which includes wildlife conservation components. Some species may be corridor specific within regrowth, but this will not be the case for all species and the value of regrowth as habitat will vary with time. Remnants of retained mature forest are vital to the regional conservation of a broad spectrum of species (Loyn 1980, Loyn 1985, Recher *et al.* 1980, 1987, Recher 1985, Shields *et al.* 1986). Harris and Scheck (1991) argue that a managed, interconnected system of protected areas that utilises movement corridors is better than a system of dispersed protected areas with no connected corridors. As logging proceeds, these patches and strips of unlogged forest will represent a major resource for wildlife requiring mature forest (dependent fauna *sensu* Tyndale-Biscoe and Calaby 1975). These patches have already figured in the development of management plans for nature conservation in the karri forest (Anon 1987a). The distribution of these retained patches will become critical as mature forest within multiple use forests becomes more highly fragmented. The large area of regrowth forest will provide some, but not all the needs of wildlife dependent on mature forest. Given the large area of regrowth forest, some effort should also be made into maintaining the later developing characteristics of these stands.

Dependent fauna include species that require hollows. In karri forest 20 species of birds are known to use hollows (Christensen and Kimber 1977). Wardell-Johnson (1984) found that 14 of 44 species, or 32 percent, of birds observed in karri forest in spring 1982 were species that used tree hollows as nest sites. Thirty four percent of all bird detections (4 327 total) were using hollows during this period. Hence hollows are not only important for the large

numbers of species, but also for the total numbers of birds in communities in the south-west forests. This trend has also been recorded for mammals. Nine species (30 percent of the total forest mammal fauna) require hollows in trees in the karri forest. The sensitivity of these species to fragmentation is not known.

Hollows take a long time to form. Of forty trees examined in four small areas of karri forest, the youngest to contain hollows suitable as nesting sites for small passerines, was 168 years (Wardell-Johnson and Christensen 1991). However none of the coupes examined had experienced high intensity fire during the time of the records examined. High intensity fire decreased the average age of trees containing hollows occupied by possums by about 100 years in a study carried out in jarrah forest in the Perup Nature Reserve (Inions 1985, Inions *et al.* 1989). Fire may be a useful tool in promoting hollow development in karri regrowth.

Mature forest is required by animals for many purposes besides nest sites. Mature trees are also perching and shelter sites, as well as foraging substrates. All of these purposes can be fulfilled by regrowth of sufficient age and development, and some may be fulfilled initially by isolated dead trees (Wardell-Johnson own data). Isolated trees may be inadequate for some animal species for which stand characteristics are important (Swallow *et al.* 1986). The other values of mature forest and the changing characteristics of the stand with time must be considered.

The most valuable areas for wildlife conservation tend to be those lowest in the landscape profile (Dobbyns and Ryan 1983, Loyn 1980, Smith 1985, Recher *et al.* 1980, 1987, Shields 1984) and those with the highest nutrient status (Braithwaite *et al.* 1984). Sites lowest in the profile are most valuable for the spectrum of bird species found in any particular forest type and include greater numbers of individuals than upland sites (Loyn 1980, Recher *et al.* 1980, Recher *et al.* 1987, Watkins personal communication 1987, Wardell-Johnson own data). The structure of the habitat (Recher 1971) and the position in the profile are critical factors (Howe *et al.* 1981). Sites lowest in the profile are also valuable for other vertebrate groups (Recher *et al.* 1987), and for invertebrate conservation (see Halse and Blyth 1991). This is not to say that upland habitat is unimportant for conservation, but known vulnerable species have only been found in lowland habitat and these sites should be priority areas in wildlife conservation.

The mammal fauna of the karri forest is not rich but includes several vulnerable species such as *Setonix brachyuris* (Quokka) and *Falsistrellis mckenzei* (McKenzies Bat). In the karri forest, small mammals reach their highest numbers (species and individuals) in sites low in the profile (Christensen and Kimber 1975). The *Hydromys chrysogaster* (Water Rat) and the Quokka are most common in these sites. Stream terrace areas are critical habitat for the Quokka (Christensen and Kimber 1975).

The reptile and frog fauna of the karri forest is also not rich but includes several endemic species such as *Geocrinia lutea* and *G. rosea*. Other terrestrial breeding species restricted to the south-west such as *Pseudophryne nichollsi* are most abundant there. Sites lowest in the profile are most valuable for the full spectrum of amphibians found in the karri forest including species restricted to these sites (eg, *Geocrinia lutea* Wardell-Johnson and Roberts 1991). All reptiles known in the karri forest also occur in stream zones including two that are most common there (*Chelodina oblonga* and *Egernia luctuosa*). Recher *et al.* (1987) found that species abundances of frogs and reptiles were more affected by aspect than by disturbance by logging at Eden, New South Wales. They found no evidence of any of these species being disadvantaged by logging, regeneration and maintenance of creek reserves. We would expect position in the profile also to be important, but concur with Recher *et al.* (1987) for those species studied in the karri forest (Wardell-Johnson and Roberts 1991).

Although the relatively small area and isolated nature of the south-west forests, together with previous climatic changes, may have worked against evolutionary diversity in the larger vertebrates, there is a larger, though imperfectly known, profusion of smaller vertebrates and invertebrates. Hence, in wildlife conservation, we need to be considering not only those

species and communities that are dependent on habitat components readily perceived (eg, hollows and hollow nesting species), but also those of different scales. These include species of poor colonisation ability (eg, some snails and spiders) and species and habitats that are of limited distribution.

Aquatic fauna of the karri forest has been reviewed by Halse and Blyth (1991). They report the occurrence of nine species of native fish and five species of decapod crustacean in streams in karri forest. The aquatic invertebrate fauna of the karri forest is imperfectly known, but research in the jarrah forest in the south-west of Western Australia (Bunn 1986, Bunn *et al.* 1986) suggest that 200-300 species of macro-invertebrate and a large number of smaller animals occur, undoubtably including many that have yet to be named. Many of the species are endemic to Western Australia and probably a considerable number including Gondwanan relicts (see Main 1987, 1991) are restricted to the karri forest. Some species with restricted distributions are intolerant of environmental changes. This suggests that measures should be taken to minimise the undesirable impact of harvesting operations on the stream environment. Undisturbed zones along streams can protect those sites from sedimentation, changes in water temperature, erosion and log-jams and thus conserve sensitive and vulnerable invertebrate species and communities (Campbell and Doeg 1989).

Riparian zones are a small but critical source of diversity within the forest system. A high proportion of the landform units defined by Churchward *et al.* (1988) are based on riparian zones (17 of 52) but these occupy a minor proportion of the total landscape of their study area. Riparian zones are also sensitive to disturbance. Although the communities in these zones may recover rapidly, they can also be altered by soil compaction, erosion and sedimentation during harvesting and regeneration operations (Halse and Blyth 1991). Sedimentation in particular could cause long-term impact on aquatic invertebrate communities. These changes can be largely prevented by retaining strips of undisturbed riparian vegetation of approximately 30 m width (Clinnick 1985).

Optimal width and length attributes of corridors for mature forest dependent species, are impossible to specify because they are species, time, habitat and landscape specific (Friend 1991). The size of the corridor should always be assessed in comparison with the organism being conserved. For example invertebrates require a different scale of corridor to medium-sized mammals but a corridor suitable for the latter will usually also be suitable for the former. Fine-scale variation in habitat must however be considered for some invertebrates (eg, Gondwanan relicts see Main 1987, 1991) Thus information on the requirements of species high in the food chain or most vulnerable to habitat change (including invertebrates) should be gathered and used as a minimum estimate of necessary widths.

Hopper *et al.* (1991) have provided a list of vascular flora from the Warren Botanical Sub-district which includes 1778 native and 299 introduced taxa. They suggest that coastal heath, granite outcrops, swamps and woodlands include the majority of the endemics and threatened taxa. The main karri forest has few of the endemics and none of the Declared Rare Flora nor any species requiring monitoring. Nevertheless several vulnerable species occur on the margins of the karri forest. For example *Banksia seminuda* ssp. *seminuda*, a species common in stream zones on the margins of the karri forest and in other forest in high rainfall areas of the south-west, is vulnerable to frequent fires (Baird 1988). Wardell-Johnson *et al.* (1989) derived a floristic classification of the Walpole-Nornalup National Park based on 219 quadrats and 233 species. Only three of the 12 community types include forest, highlighting the diversity of vegetation bordering the forest of the area. The recognition of the need for a thorough survey to address the possibility of poorly known and vulnerable plant taxa should be recognised in a redistribution of the road, river and stream zone network. Hence, any scheme must allow for local scale planning particularly for rare or vulnerable species.

Discussion

Many biological surveys have been carried out in the Warren Botanical Subdistrict (see Christensen *et al.* 1985 and How *et al.* 1987), but a thorough biogeographic survey is yet to be undertaken. The pattern of the biota in the area can currently be assessed from the patterns of landforms and soils (see Churchward *et al.* 1988) and vegetation structure (see Smith 1972, Wardell-Johnson and Nichols 1991). Such assessments are limited by assumptions concerning pervasive homogeneity of units and determinism (McKenzie *et al.* 1989, 1991). Similarly, although many studies have examined the impact of disturbance in the Warren Botanical Subdistrict (see Christensen and Kimber 1975 and Wardell-Johnson and Christensen 1991 for reviews), no studies have been designed to look specifically at the effectiveness of the current or proposed road, river and stream zone network for wildlife. A preliminary assessment of the present system of road, river and stream zones can be made however, based on wildlife research carried out in the Nornalup System of the Warren Botanical Subdistrict since 1971 (see Christensen and Kimber 1975, Wardell-Johnson and Christensen 1991). This system could be improved by rearrangement.

We believe that a shift in emphasis from road to stream zones is desirable in the context of wildlife conservation in south-west forests. This is necessary because, although effective where allocated, there is no formal protection of some stream zones and other important habitat areas under the current system. Following completion of harvest within a forest block, large areas of regeneration will occur between remnant mature vegetation. Species that are dependent on mature forest will not be catered for by differences in the age of adjacent areas of regeneration logged during the same cutting cycle. This is because some habitat components (eg, hollows) take much longer to form than the envisaged age differences of the regrowth within a forest block. These components should be retained but the more important principle concerns the distribution of retained mature forest and other habitat.

The effectiveness of this shift in emphasis will depend on the sustainability of narrow zones low in the profile and also on the zones being of adequate width for fauna conservation. Recher *et al.* (1987) found that retained mature forest of less than 40 m total width was inadequate for fauna conservation in pine plantations in eastern Australia. Not only were such reserves too narrow to provide the resources necessary for wildlife but also trees retained within such sites were found to be subject to loss of vigour and windthrow. Exceptions have been observed including very narrow zones (less than 20 m total width) along streams in areas of steep slopes such as Gray 5 which have not deteriorated in the 10 years since regeneration. There are also considerable areas of relatively narrow road reserve adjacent to cleared private property. Observations of these areas and the variation in age classes within such stands suggest that much narrower zones than the 800 m zones along roads will be sustainable. Similarly, zones on streams are likely to be better protected from windthrow than upland sites, although these may be more subject to changes in hydrological balances in areas of limited relief.

Recher *et al.* (1987) recommends large widths on remnants based on the theory of central place. Many species at Eden (eg, various species of glider) require patchy resources over a large area of undisturbed habitat. Thus many species require large, approximately circular territories which are inadequately catered for by narrow zones. Gliders are not present in south-western Australia, although this theory may hold for other mammals and birds. Similarly this theory could be tested for Quokkas in Dombakup Forest Block where trapping data have been gathered prior to logging (Christensen *et al.* 1985). The current rotation is now complete in this forest block allowing assessment of the effectiveness of the 200 m wide corridor for Quokka movement and habitat.

Highest order streams (such as rivers) supply greater variation in habitat and harbour more species than lower order streams. They usually have a greater width of terracing (where terracing is present) and more areas of steep slope than lower order streams. Thus the larger buffers should be allocated to the largest streams (based on the size of the stream).

Remnant vegetation 50 m either side of gullies is likely to be adequate to maintain a high proportion of the conservation values within coupes in the karri forest based on the species known to occur there. It will however be necessary to ensure that all streams include such zones and that the zones are linked across saddles. This will ensure that the conservation values are enhanced in a greater proportion of any forest block than under the current scenario. This scheme would maximise the distribution of remnant mature forest and other habitat in the karri forest. Retained patches of connected forest will most effectively serve as wildlife corridors, as areas for dispersal and colonisation and will provide the best opportunity for the conservation of patchily distributed species. The same recommendations apply to jarrah forest, where habitat groups and crop trees are retained.

One major reason for the richness of riparian zones is that they represent ecotones between major landscape features. Ecotones represent sites of exceptional species richness. Other sites that include ecotonal features include granite monadnocks and sites in swampy terrain. These sites are of exceptional importance in adding to the habitat diversity present in the south-west (see Hopper *et al.* 1991, Wardell-Johnson and Christensen 1991). Although these sites are not disturbed by timber harvest, their recognition as valuable sites for wildlife conservation should be acknowledged in any proposed change to the existing system. Dieback caused by *Phytopthora spp.* can have a severe impact in some of these communities. These sites should have protection from traffic and timber harvesting operations.

Recommendations to optimise wildlife values

1. All drainage lines (as marked on CALM 1:50 000 maps and interpreted through aerial photography) should be protected by retained vegetation.

2. A width of approximately 50 m on each side of first-order, second-order and third-order drainage lines should be retained. This would be considered as a 100 m total width, with a minimum of 20 m on any side to enable zone boundaries to follow ecological boundaries.

3. A width of approximately 100 m on each side of fourth-order drainage lines should be retained. This would be considered as a 200 m total width, with a minimum of 50 m on any side to enable zone boundaries to follow ecological boundaries.

4. A width of approximately 200 m each side of fifth-order and greater drainage lines (rivers) should be retained. This would be considered as a 400 m total width with a minimum of 100 m on any side to enable zone boundaries to follow ecological boundaries.

5. Ecological boundaries should be used to define stream zone boundaries and may include terraces on larger streams (eg, Dombakup Brook, Big Brook) in which case the zone edge will be above the terrace to include a narrow band of mature trees and to ensure that roads are above steep slopes and seasonally moist sites.

6. All seepage sites and valley head-waters should be protected. These sites may contain merchantable trees albeit at wide spacing. These areas are readily identified using aerial photographs and on the ground by the presence of *Lepidosperma tetraquestrum* or *Oxylobium lanceolatum*. These areas should not be harvested.

7. Movement corridors should cross saddles and join stream head-waters.

    a. In the northern part of the Nornalup System, karri occurs low in the profile (Bradshaw and Lush 1981) and allowance should be made in silvicultural prescriptions for the jarrah forest for the continuation of movement corridors between catchments.

b. In the central part of the Nornalup System, karri occurs throughout the landscape (Bradshaw and Lush 1981). The retention of corridors of karri forest linking catchments will be necessary.

c. In the southern part of the Nornalup System and in the Denmark System, karri occurs only in the highest parts of the landscape or adjacent steep gullies. In these areas special emphasis should be paid to granite outcrop sites which are surrounded by karri forest.

8. Additional protection of stream zones would be created by reallocation of existing zones from road to stream zones. Road zones would then be reduced to an aesthetically acceptable landscape criterion and the balance made available for stream zones. Similarly, 200 m wide zones along third-order or smaller streams would be reduced to 100 m.

9. The scope for reallocation includes the Warren Sub-district but the principles should be applied more generally in the Darling Botanical District.

10. As with the present system of road, river and stream zones, proposed zones should be allocated and demarcated prior to the commencement of harvesting operations in a forest block. For those forest blocks where the first harvesting rotation is nearing completion (eg, Dombakup, Warren, Iffley), the introduction of these guidelines would be delayed until the second rotation.

11. No timber harvesting should occur within designated stream and river zones. Vehicle movement should be minimised across stream zones and should be restricted to well designed road crossings.

12. Coupes in which harvesting operations are being conducted may include forest retained in stream zones. These zones may need to be burnt at the time of regeneration, in which case prescribed fire should be of low intensity. Adjacent stream zones should not be burnt at the same time unless it is essential to achieve security in the regeneration burn or reduce the risk of fire damage to the zone itself. Prescribed fire should be excluded from at least some zones.

13. In addition to the existing zones, there are other areas which would not be logged but which are important wildlife habitat. These areas include

a. Granite outcrops which are usually surrounded by shallow, sensitive and moist soils. These areas should be subject to a zone of undisturbed vegetation including transitional vegetation to at least 50 m from the surface rock. Outcrops shown on API plans (0.2 ha or greater) would be formally recognised, although all areas of shallow soils would receive protection in implementation.

b. Areas of jarrah forest and woodland in the Warren Subdistrict which are difficult to regenerate or highly susceptible to dieback (site-types R, B, F and A of Strelein 1988). Timber harvest in these areas should be deferred.

c. Areas of shrubland which include valuable wildlife habitat and considerable variety in floristic pattern (eg, Wardell-Johnson *et al.* 1989, Hopper *et al.* 1991). These areas are not subject to harvesting but may be subject to other operations. They should be designated for protection in forest plans accordingly.

14. The impact of disturbance on the wildlife of road, river and stream zones will require research. No research has been carried out on the effects of disturbance on predation in these zones. Predation may be an important factor for some species of medium-sized mammal that are already in decline (eg, Quokka). Soule and Gilpin (1991) provide a theoretical basis for suggesting that the mortality rate of a species will be the major factor that determines the limits of corridor capability for those species that depend on corridors as movement zones between habitat. In the meantime it is recommended that harvesting, regeneration and thinning operations not be carried out in river and stream zones.

15. Groups of trees and logs should be retained to maintain habitat components within a forest coupe.

Conclusion and reallocation in practice

Wildlife conservation values would be retained in a greater proportion of any forest block by this scheme. Retained patches of connected forest will most effectively serve as wildlife corridors, areas of dispersal and colonisation, and as transitional ecotones. They will also provide a better opportunity for the conservation of patchily distributed species.

Wardell-Johnson (1987) examined case studies of a reallocation of the existing road, river and stream zone system in six forest blocks. He assumed no reduction in timber yield or increase in area of zones. There was considerable variation between loss and gain in area following redistribution, although equal numbers of forest blocks showed an increase, as showed a decrease, in the total area contained within road, river and stream zones. In addition, no area had less than 10 percent retained remnant vegetation. The aim of the existing system for about 20 percent of the forest in each forest block to be retained unlogged, was seen as a good idea, but has little scientific basis and variations to this would allow the best use of the area available.

The knowledge and data base from which these recommendations have been derived, like the forest environment for which they are intended, is not constant. Questions of corridor capability, the linear nature of road, river and stream zones, and the patchy distribution of wildlife make it difficult to predict the long-term effectiveness of managing wildlife in these ways and it is recommended that the program of research advocated during a previous review (Wardell-Johnson and Halse 1988) be implemented to determine the viability of the scheme advocated.

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CAPTIONS FOR FIGURES

Figure 1 Area of karri in State forest in 1990. Categories are based on logging and regeneration history. The area of road, river and stream zones is included in the total.

Figure 2 Estimated area of karri on all CALM land in 2040. Categories are based on logging and regeneration history. Areas assume a gradual reduction in cutting levels in mature forest, and the maintenance of current areas of road, river and stream zones.

SEMINAR PAPER

REVIEW OF ROAD, RIVER AND STREAM ZONES IN THE SOUTH WEST FORESTS

Hydrological Values

Alan Walker

INTRODUCTION

In reviewing the adequacy and effectiveness of a system of buffer zones in the forest for the protection of water values, I will first look at water as a forest value, and discuss briefly the parameters of water quality used to assess impacts.

I will then outline the history of hydrology research in the forests of Western Australia with a focus on the southern forests. The salient points of this research will then be outlined in presenting recommendations for allocation of buffer zones in the future.

Finally, I will mention some of the practical considerations in the management of activities in the forest, particularly forest harvesting, important for optimising water quality.

1. Water as a Forest Value

Water derived from forested catchments is generally perceived to have two major values: as a commodity for human consumption and use, and as the medium for aquatic ecosystems and their biota.

The commodity value of water is related to its use by rural and urban communities, for personal, industrial and agricultural purposes. The quantity and quality of water available for such purposes is critical. In the south west of Western Australia water is considered to be a very important, if not the most important forest product.

The main conservation values of forest water are related to aquatic ecosystems, namely rivers, streams, creeks and wetlands found in the forests or dependent on forested catchments for their water supply. The importance of water for maintaining the conservation value of the forest ecosystem itself is generally taken for granted.

Most of you will be familiar with the hydrological cycle, however I will briefly recap. There are a number of physical and hydrological processes which determine the quantity of water flowing from a catchment. Water enters a catchment as rain, and is lost mostly through streamflow, or transpiration and evaporation to the atmosphere; over an extended period, more water is lost from forests by evapotranspiration than streamflow. Total evapotranspiration is the sum of evaporation from the stream surface, soil surface, intercepted water on the forest floor and forest canopy, and evapotranspiration from plants. Stream water is largely derived from soil surface runoff and overland flow, subsurface flow of water after rain storms, and flow of water through the ground (base flow/groundwater flow). The water quantity of a catchment is influenced by factors such as climate, soil type, catchment physiography, vegetation density, amount of litter on the soil surface, and management practices adopted in the catchment area.

A range of water quality parameters can be assessed in the hydrological system. These include levels of sediment, either suspended in the water column or deposited on or in the stream bed, turbidity, salinity, dissolved nutrients, oxygen, light availability, and organic debris. These attributes are in turn affected by factors such as flow rates of the water (especially the proportion of base flow to storm flow), groundwater levels and water temperature.

In south west forests, catchments are managed to optimise the quality of water produced. CALM land on gazetted catchments and water reserves is managed by CALM to the requirements of WAWA.

The quantity of water collected varies according to seasonal rainfall, soil storage and natural use by forests and agricultural crops. Clearing, clearfelling and forest thinning operations increase water yield.

Increased salinity is regarded as the most serious threat. In low rainfall zones, clearing for crops and pasture releases soil stored salts. Water quality in the Blackwood, Warren, Frankland, Kent and Hay Rivers which drain the southern forests, has been degraded in this way.

[show overhead of Southern Forest Region catchments and dams]

2. Hydrology Research in South West Forests

There is a sound body of information available to decision makers about the impacts of agricultural and forest activities on water quality.

For the purpose of this paper it is proposed only to consider forest harvesting and associated roading and regeneration activities and their impacts.

In 1973, following approval of the Environmental Impact Statement for commencement of a woodchipping operation in the southern part of the forests, research commenced to determine if proposed harvesting would have any impact on the hydrology of the region. Projects undertaken included:

- identification of areas vulnerable to salinity increases;
- a paired-catchment study to provide information on surface and groundwater hydrology;
- monitoring major rivers to identify large scale changes in water quality;
- monitoring of operational wood harvesting coupes for groundwater responses.

[show overhead of paired-catchment locations]

The results of this research has been reported in a series of Water Authority reports and scientific papers published from 1987 to 1989 [Borg et al (1987 a b); Borg et al (1988 a b); Borg and Stoneman (1989); Stoneman et al (1987)].

Hydrological research in the northern jarrah forest has also been extensive over the last two decades and this work was summarised by Schofield et al in 1989.

Streamflow

The paired-catchment study in Sutton Block in the southern forest provided an opportunity to compare streamflow following clearfelling in a catchment with a buffer 100 m either side of the main stream (April Road North) and a catchment with no stream buffer (March Road).

The data shows an insignificant difference in annual streamflow between the catchments despite the fact that 10% of the April Road catchment was retained unlogged.

[show overhead of March Road/April Road data]

Stream Sediment Concentration

The paired-catchment studies indicated that 100 m wide stream buffers were effective in preventing nearly all of the sediment produced as a result of clearfelling from reaching the streams.

[show overhead of sediment data]

A further study on six experimental coupes in 1985 and 1986 showed that halving the width of river and stream buffers had no effect on sediment concentrations, when logging took place in summer.

Buffers less than 30 m wide have been found to be effective in stopping sedimentation in eastern Australia (Clinnick, 1985), however factors such as soil type, slope steepness and vegetation cover are important in selecting buffer width.

Stream Salinity

The buffers kept on streams in the April Road North and Yerraminup south catchments reduced the groundwater rise in the valleys following logging. This probably moderated the associated increase in salt discharge and stream salinity, although it was not obvious from the data. It is significant that the largest increase in annual flow weighted salinities (about 150 mg/1 TSS) occurred in a catchment in the intermediate rainfall zone which did not have a stream buffer.

[show overhead of salinity data]

Since the research programme began there has been particular interest in the effect of the new logging and regeneration strategies on water quality in the low rainfall zone where the soil salt storage is high. However, experimental results have shown there is no stream salinity increase in this area. This is because recharge was small and the depth to groundwater was sufficiently large that groundwater (the major source of salt) did not contribute to streamflow following harvesting and regeneration.

In the intermediate and high rainfall zones, groundwater contributed to streamflow before logging. Following logging in these zones, permanent groundwater levels rose and stream salinities increased, briefly in the order of 50 to 150 mg/L, indicating an increase in the discharge of salts from groundwater to streams. However all flow

weighted salinities remained below 500 mg/L, the limit for high quality drinking water. Similarly, as groundwater levels began to fall following regeneration, stream salinities fell. It is expected that stream salinities will return to pre-logging values. This has already occurred in several of the experimental catchments.

The Water Authority reports concluded that from a regional water resource perspective, the salinity increases observed are minor and temporary. However, the low flow salinities measured at greater than 1500 mg/L, if they persist for many weeks, could cause problems with small-scale public water supply systems based on low-volume storages. This potential problem can be overcome by appropriate design of vegetative stream buffers.

Groundwater storage

Results from the southern forest projects showed that groundwater responses to logging were much less in the low rainfall (less than 900 mm per annum) zone than other zones. Stream vegetation buffers would reduce the rate of groundwater rise and should be employed where salinity risk is greatest in the intermediate zone.

In Summary [show overhead]

The presence or absence or the width of buffers is unlikely to seriously alter:

- water quantity (although increase of up to 10% of rainfall may occur for 2-3 years following harvest) or peak flow rates;
- chemical or bacteriological values.

The presence or absence or the width of buffers is likely to alter:

- sediment, especially in the high rainfall zone and if harvesting is on steep slopes, adjoining logging roads or conducted in winter (on some soils);
- salinity, especially in the intermediate rainfall zone;
- debris in streams, stream channels and the likelihood of algal blooms - if no buffer is present.

Aquatic Fauna

In their review of the impact of timber harvesting and production on streams, Campbell and Doeg (1989), concluded that major short term impacts of timber harvesting on the aquatic biota result from increased sediment input and the removal of riparian vegetation. Sediment which settles on the stream bed is of more concern than suspended sediment, and can lead to long-term deleterious changes to fish and invertebrate populations.

The provision of a network of stream buffers which prevent or minimize changes to sediment and salinity levels and protect streamside vegetation is clearly the most effective way to minimize impacts on aquatic biota.

3. Recommendations for Redistribution of Buffer Zones [show overhead]

The preferred distribution of buffers to reduce the impacts stated above is:

3.1 To reduce the width but increase the length of stream zones protected. Research suggests that a width of 30-50 m is adequate for this purpose.

3.2 The zone of least priority is the low rainfall zone.

Other factors which need to be considered are:

3.3 The understorey vegetation provides the primary protective function in reducing stream sedimentation. Some trees could be removed from buffers without increasing the risk of sedimentation provided that the understorey was not removed.

3.4 The location and construction of stream crossings can markedly influence water quality, especially sediment concentration.

3.5 The influence of road construction and drainage is significant. Logging under "sloppy" soil conditions also must be minimised.

3.6 It is difficult to keep all buffers unburnt and it may be desirable to either plan to burn some (limited research indicates that this does not affect water quality) or construct stream crossings in advance of burning.

3.7 During harvesting it is possible to implement measures that will significantly reduce the risk of sedimentation. These include the timing and method of scrub rolling, the type and method of snigging, the timing of regeneration burning as well as the proper use of erosion control measures such as cross drains or snig tracks.

3.8 Some drilling may be necessary in the intermediate rainfall zone to determine depth to water table.

[show overheads of redistribution of stream zones, according to stream order, for four forest blocks]

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SOUTHERN FOREST REGION
CATCHMENTS AND DAMS

CATCHMENT CLASSIFICATIONS

Surface catchments and ground water management areas in the south west of the State have been classified as follows by the Water Authority for management purposes. Restrictions on recreation are indicated

Type 1a	Public Water Supply Area
Type 1b	Groundwater Area
Type 1c	Water Reserve
Type 2a	Active catchment area—domestic supply
(i)	Small diversion dam. Access is only permitted, if at all, along open roads, marked walk trails, designated picnic areas, but not to the water area
(ii)	Large dam. Pedestrian access within 2 km from the water area is only permitted along open roads, marked walk trails and at designated picnic areas. Pedestrian access beyond 2 km is unrestricted
Type 2b	Active catchment area—irrigation. Access is permitted to all of the catchment, the water area, and to the dam wall.
Type 2c	Active catchment area—domestic and irrigation. All are currently as for 2a (ii) large dams
Type 3	Water reserve. Potential water resource that has been gazetted
Type 4	Important potential surface water catchment area (not gazetted)
Other	Not classified

No.	CATCHMENT	TYPE
1	UPPER BARLEE BROOK	3
2	FLY BROOK	4
3	CAREY BROOK	4
4	PEMBERTON	2a(ii)
5	DONNELLY RIVER	3
6	FOUR MILE BROOK	2a
7	LEFROY BROOK	2a
8	MANJIMUP	2a(i)
9	WILGARUP RIVER	3
10	WARREN RIVER	3
11	DOMBAKER BROOK	4
12	GARDNER RIVER EAST	4
13	UPPER SHANNON RIVER	4
14	DEEP RIVER	3
15	BOW RIVER	4
16	KENT RIVER	3
17	DENMARK RIVER	2a(ii)
18	MITCHELL RIVER	4
21	WALPOLE RIVER	2a(ii)
22	SLEEMAN RIVER	4
23	QUICKUP BROOK	4
24	SCOTSDALE BROOK	2a(i)
25	KORDABUP RIVER EAST	4
26	KORDABUP RIVER WEST	4
27	COLLIER RIVER	4
28	BUTLERS CREEK	2a(i)
29	LOWER SHANNON	4
30	GARDNER RIVER WEST	4
31	NORTHCLIFFE W.S.	2a(i)
32	BIG BROOK	2a
33	PHILLIPS CREEK	2a(i)

FROM: CALM Regional Management Plan (1987)

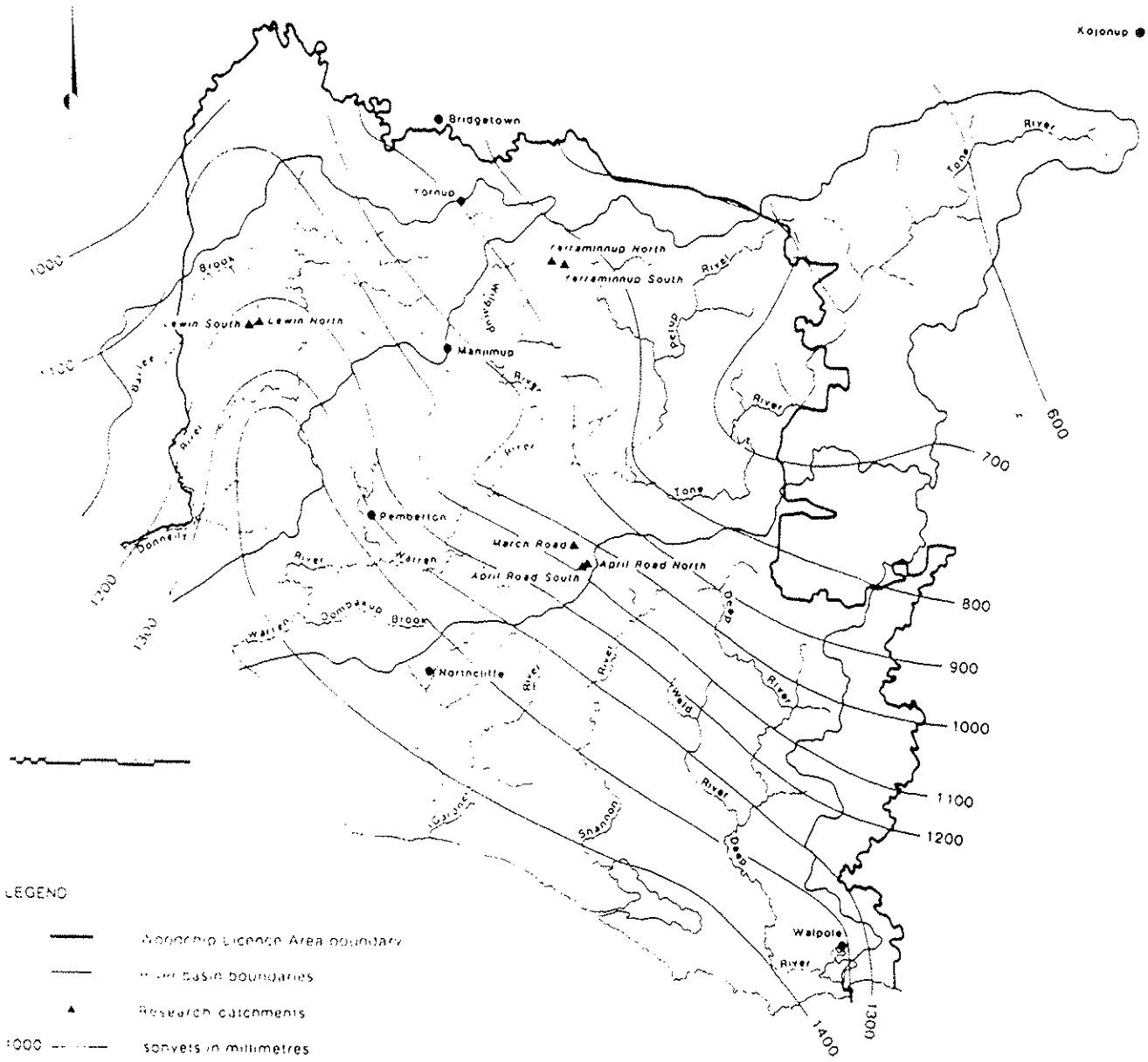
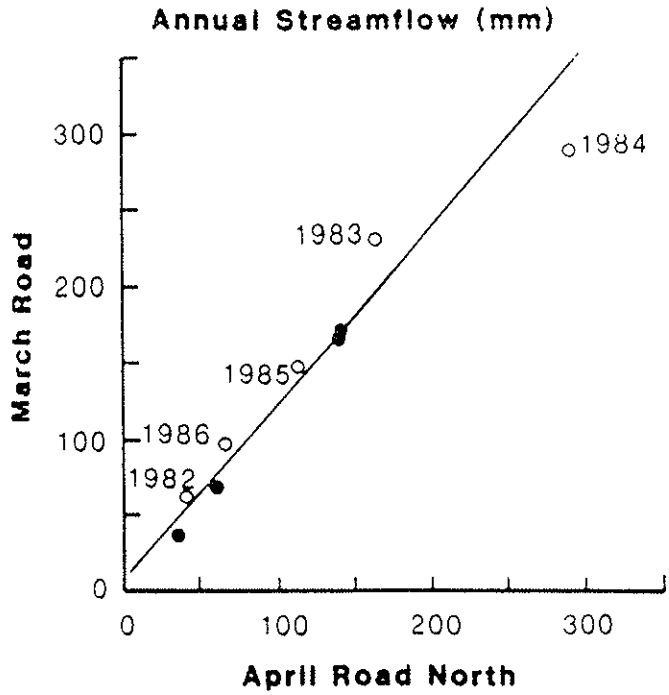


Figure 2

Mean annual rainfall in the research area. (Data from Loh and King 1978.)



$y = 7.10 + 1.16x$

6 data points

$R^2 = 0.968$

year	observed flow at March Road (mm)	predicted flow at March Road (mm)	absolute difference (mm)	relative difference (%)
1982	61	55	6	11
1983	231	199	32	16
1984	290	346	-56	-16
1985	149	140	9	6
1986	98	85	13	15
			mean = 0.4	

Figure 7

Annual streamflow at March Road (stream area logged) in relation to annual streamflow at April Road North (stream area not logged.) (The regression is based on the data from 1976 to 1981 inclusive.)

From Bag et al (1987)

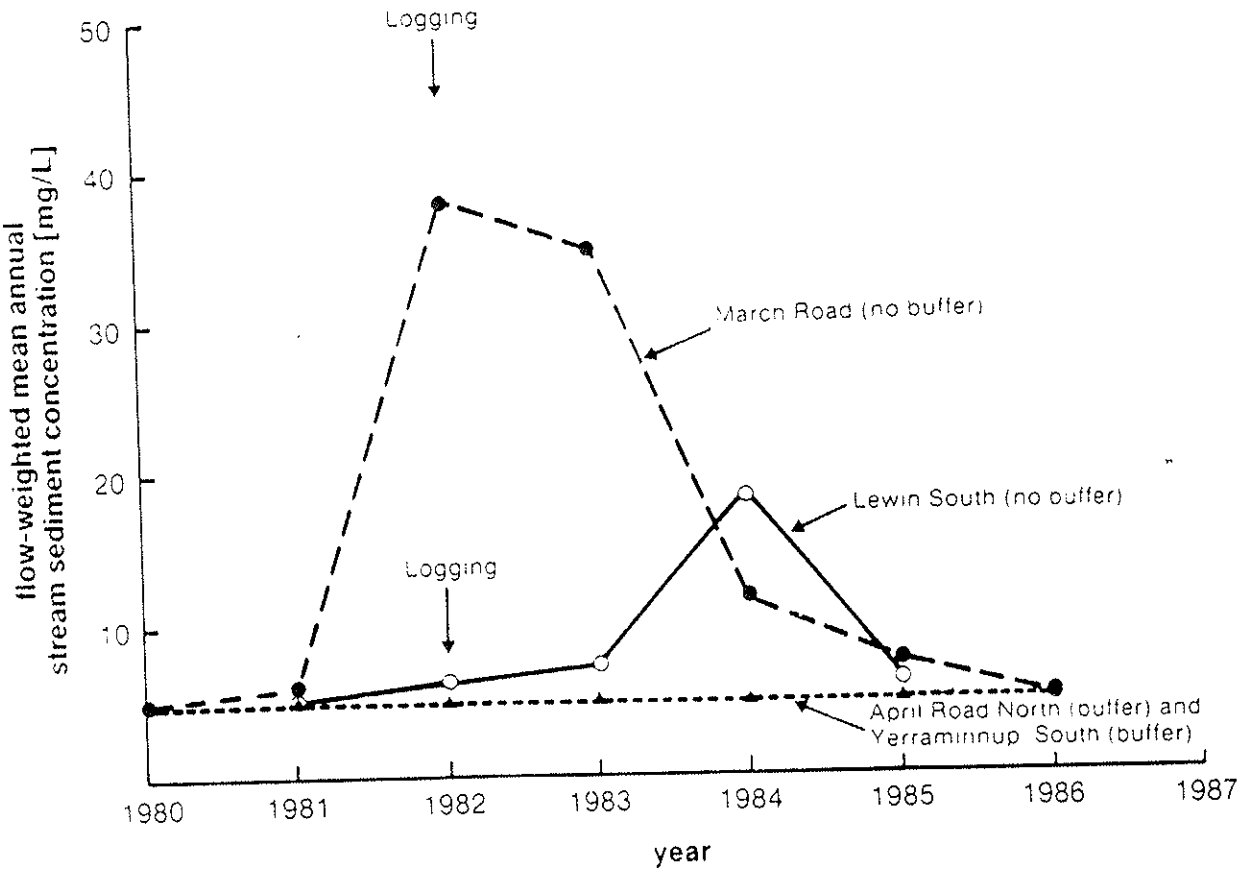


Figure 9
Changes in flow-weighted mean annual stream sediment concentration following logging

From Borg et al (1987)

Table 4
Annual flow-weighted salinities of streams draining experimental catchments before and after logging

Coupe/ Catchment	Mean Annual Rainfall (mm)	Year of Logging	Mean TSS Before Logging (mg/L)	Maximum TSS After Logging (mg/L)	TSS in 1985 (mg/L)
PROJECT 4					
Crowea	1380	1977	142	192 (1979)	153
Poole	1310	1977	102	196 (1979)	163
Iffley	1200	1977	352	432 (1979)	307
Mooralup	880	1977	no data	142 (1980)	no flow
PROJECT 2					
Lewin South	1220	1982	99	182 (1985)	182
March Road	1070	1982	153	314 (1985)	314
April Road North	1070	1982	101	140 (1985)	111
Yerraminnup South	850	1982	133	114 (1985)	114

Notes (1)

Values are the Total Soluble Salts (TSS) concentration determined as the sum of major ions dissolved in the water sample. The annual flow weighted mean is effectively the concentration derived by the annual mass of solute discharged via the stream is divided by the annual volume of water discharged via the stream.

From Borg et al (1987)

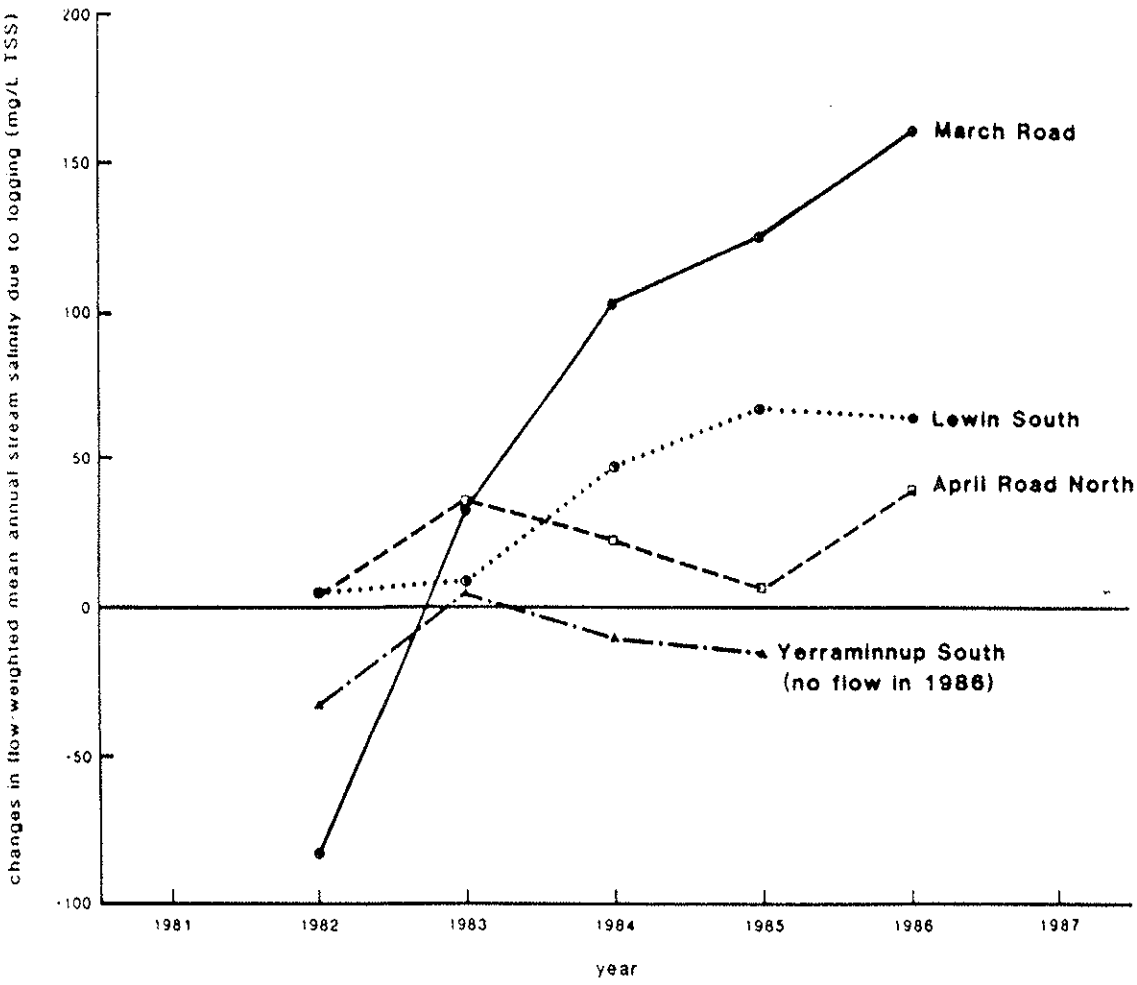


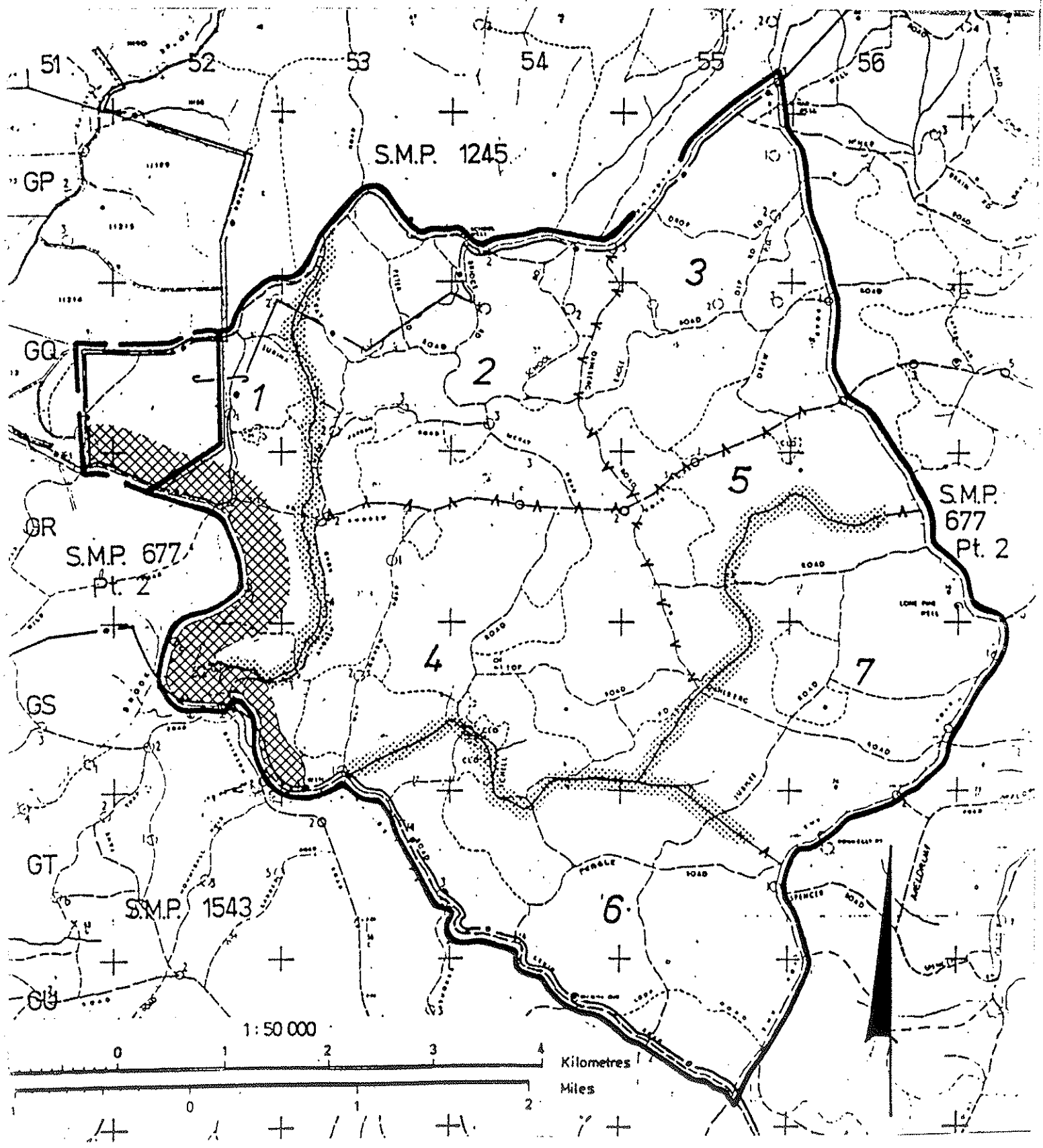
Figure 9

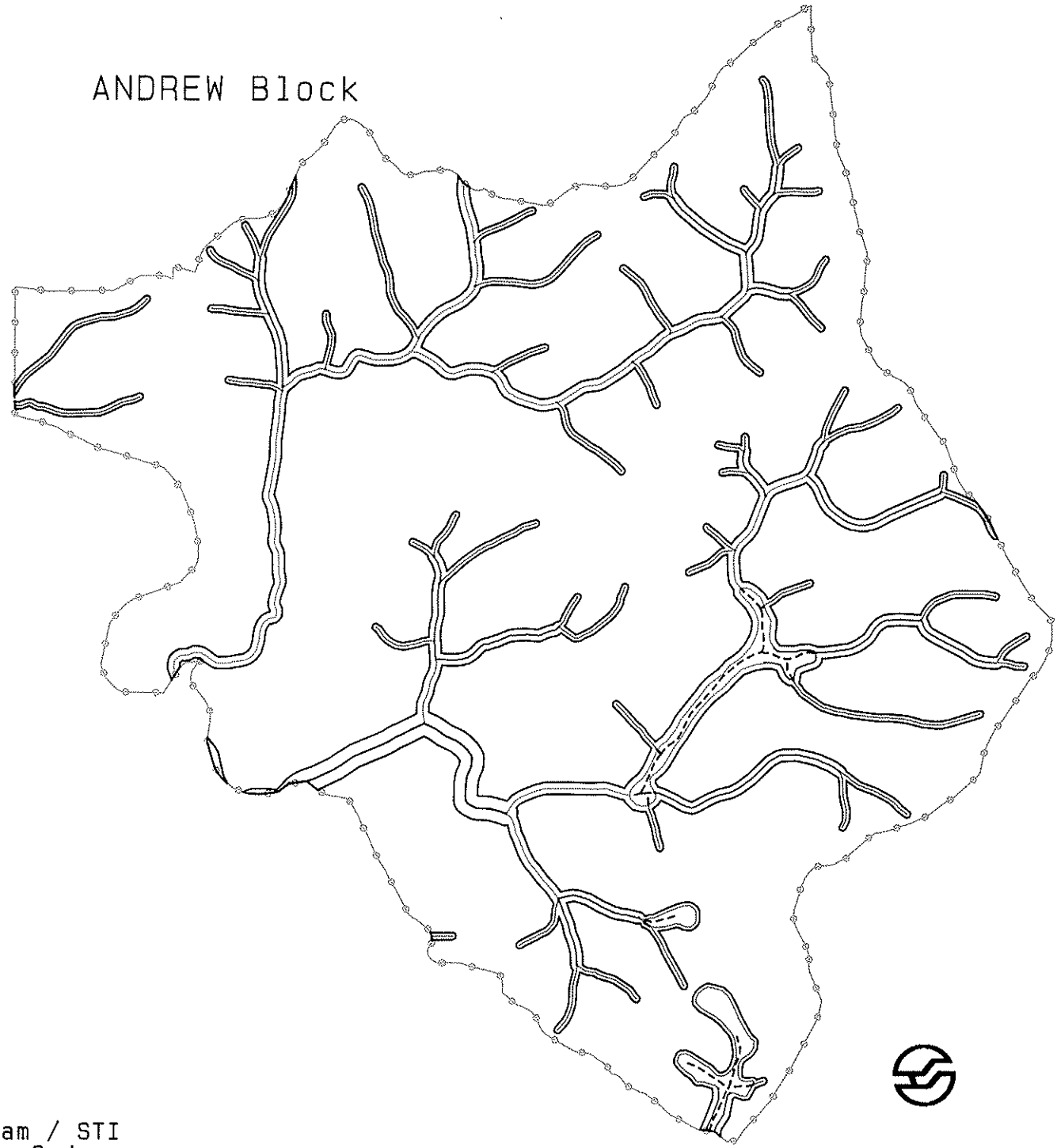
Changes in flow-weighted mean annual stream salinity in the four cut-over research catchments due to logging.

FROM: Borg, King and Loh (1987)

BLOCK	:	ANDREW
AREA UNDER F.D. CONTROL	:	4265 ha
AREA OF V.C.L., L.A.A.	:	147 ha
TOTAL BLOCK	:	4412 ha

SHIRE BOUNDARIES
CATCHMENT BOUNDARIES
STREAM RESERVE
ROAD RESERVE
COUPE BOUNDARY



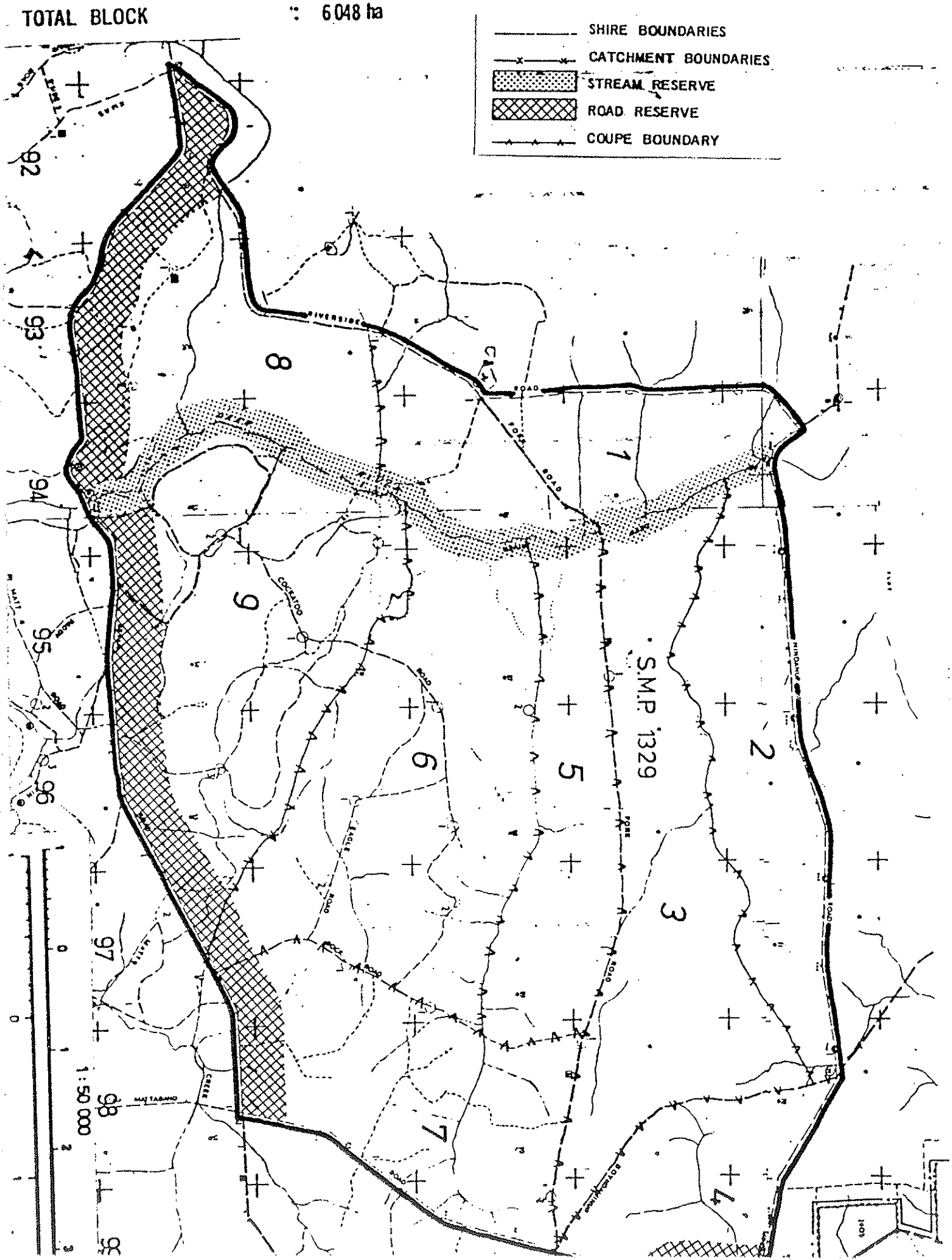


Possible Distribution of Riparian Zones for ANDREW Block

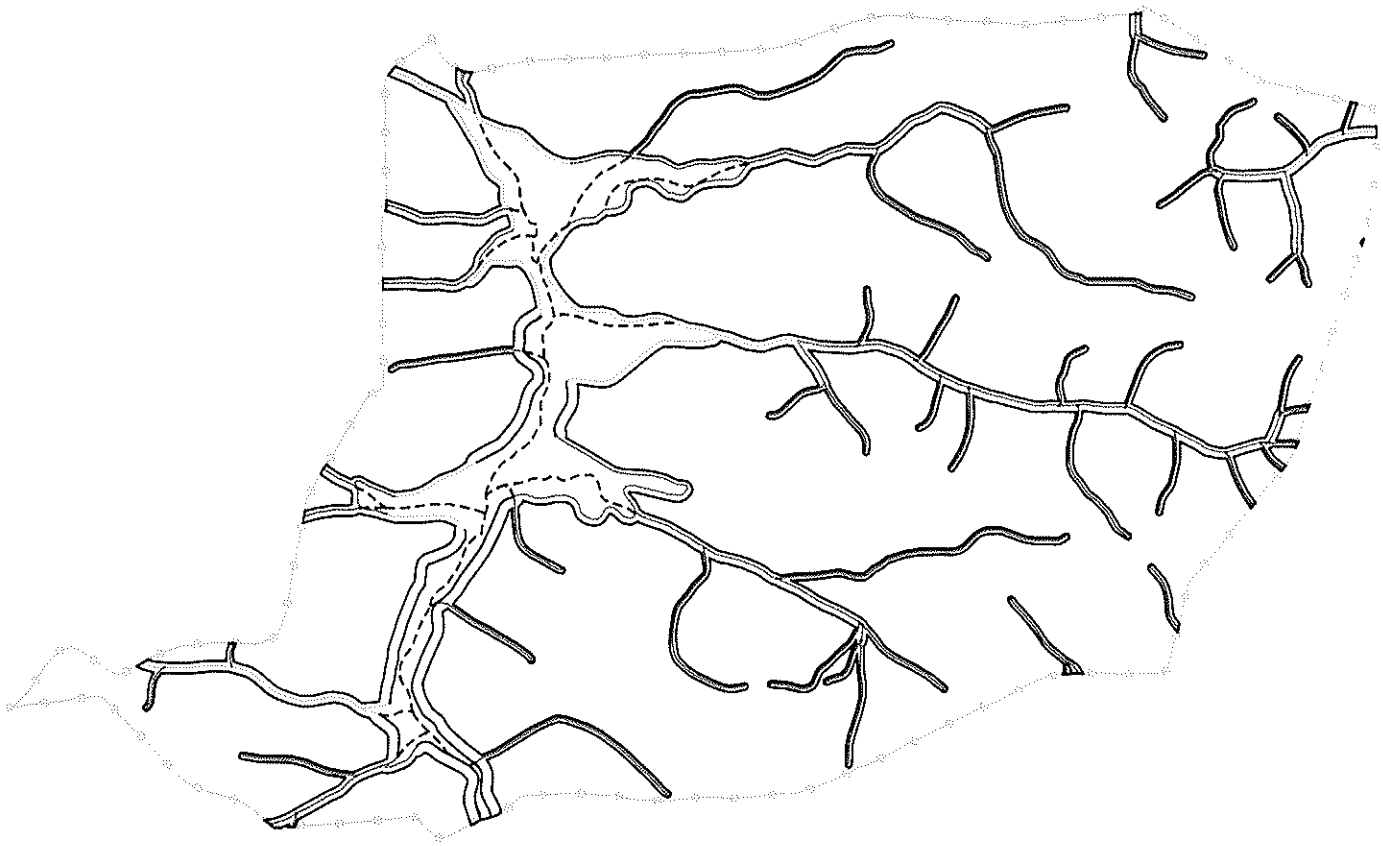
DIVISION : PEMBERTON
BLOCK : CHALLAR
AREA UNDER F.D. CONTROL : 6048 ha
AREA OF V.C.L. :
TOTAL BLOCK : 6048 ha

SHIRE MANJIMUP

CATCHMENT DEEP



CHALLAR Block



Stream / STI
Order Codes

1st

2nd

3rd

4th

Block Boundary

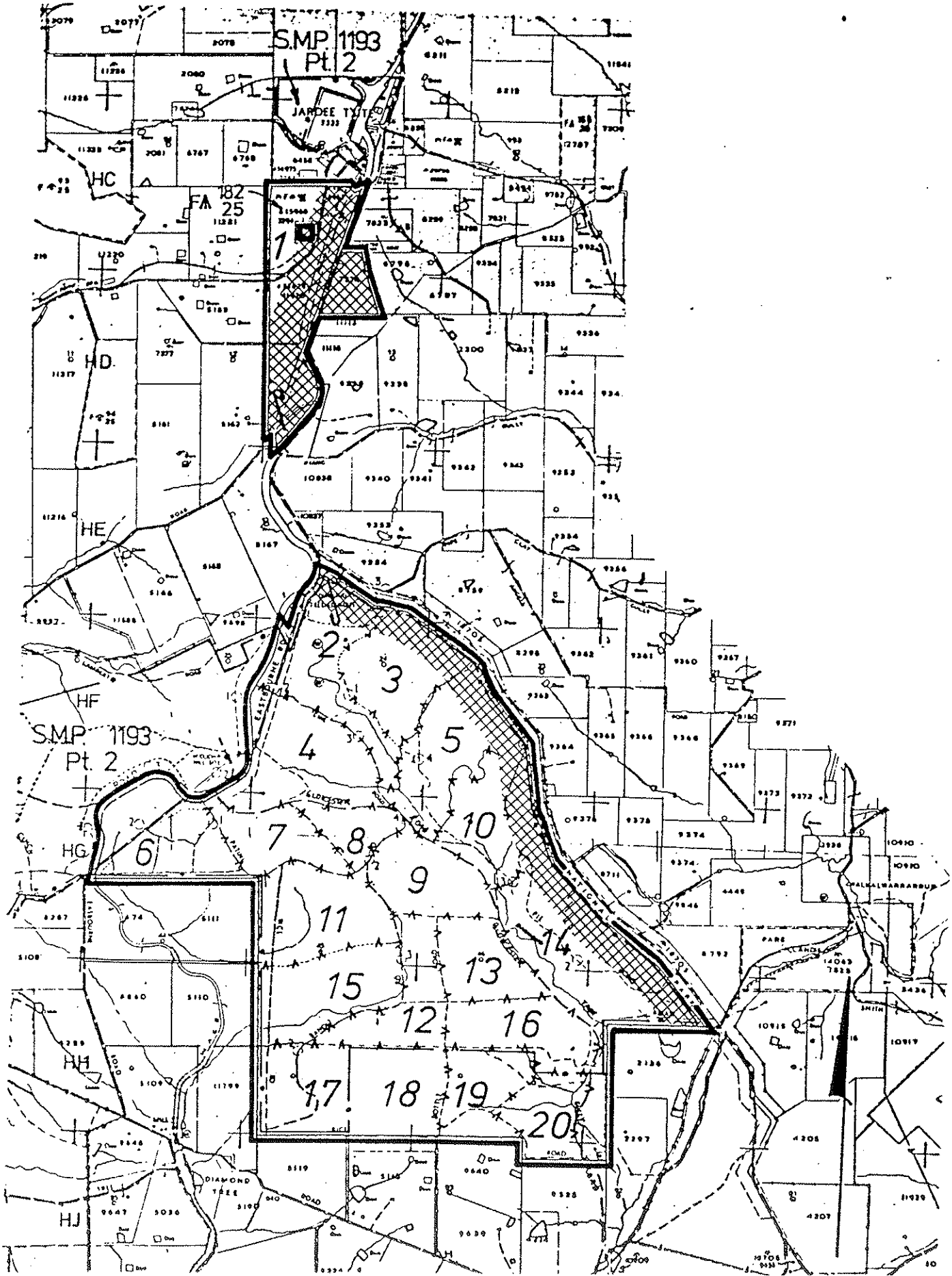
CALM/LIB july 91

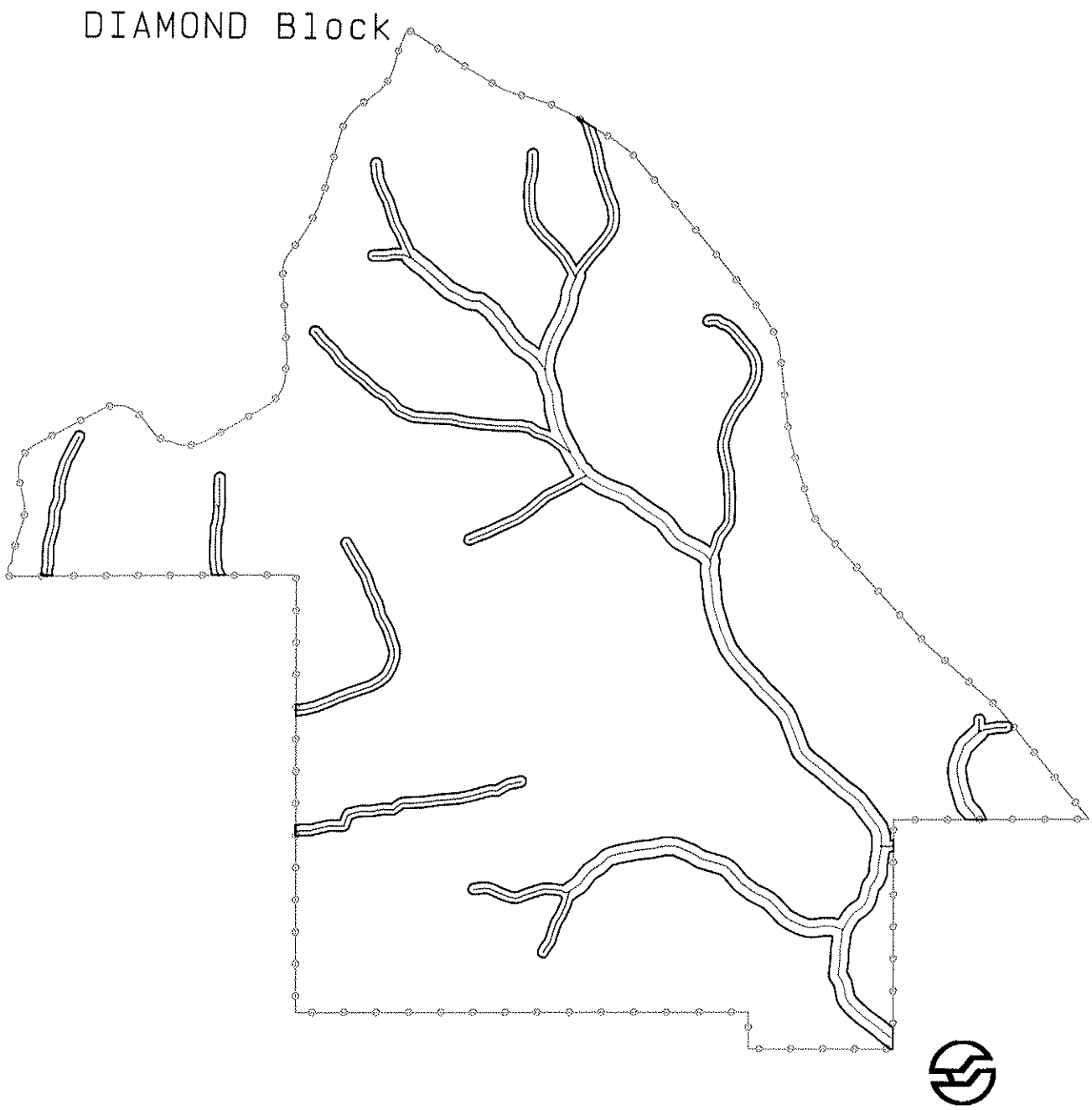
Possible Distribution of Riparian Zones for CHALLAR Block

BASE PLAN 5

BLOCK	: DIAMOND 1
AREA UNDER F.D. CONTROL	: 1710 ha
AREA OF V.C.L.	:
TOTAL BLOCK	: 1710 ha

SHIRE BOUNDARIES
CATCHMENT BOUNDARIES
STREAM RESERVE
ROAD RESERVE
COUPE BOUNDARY





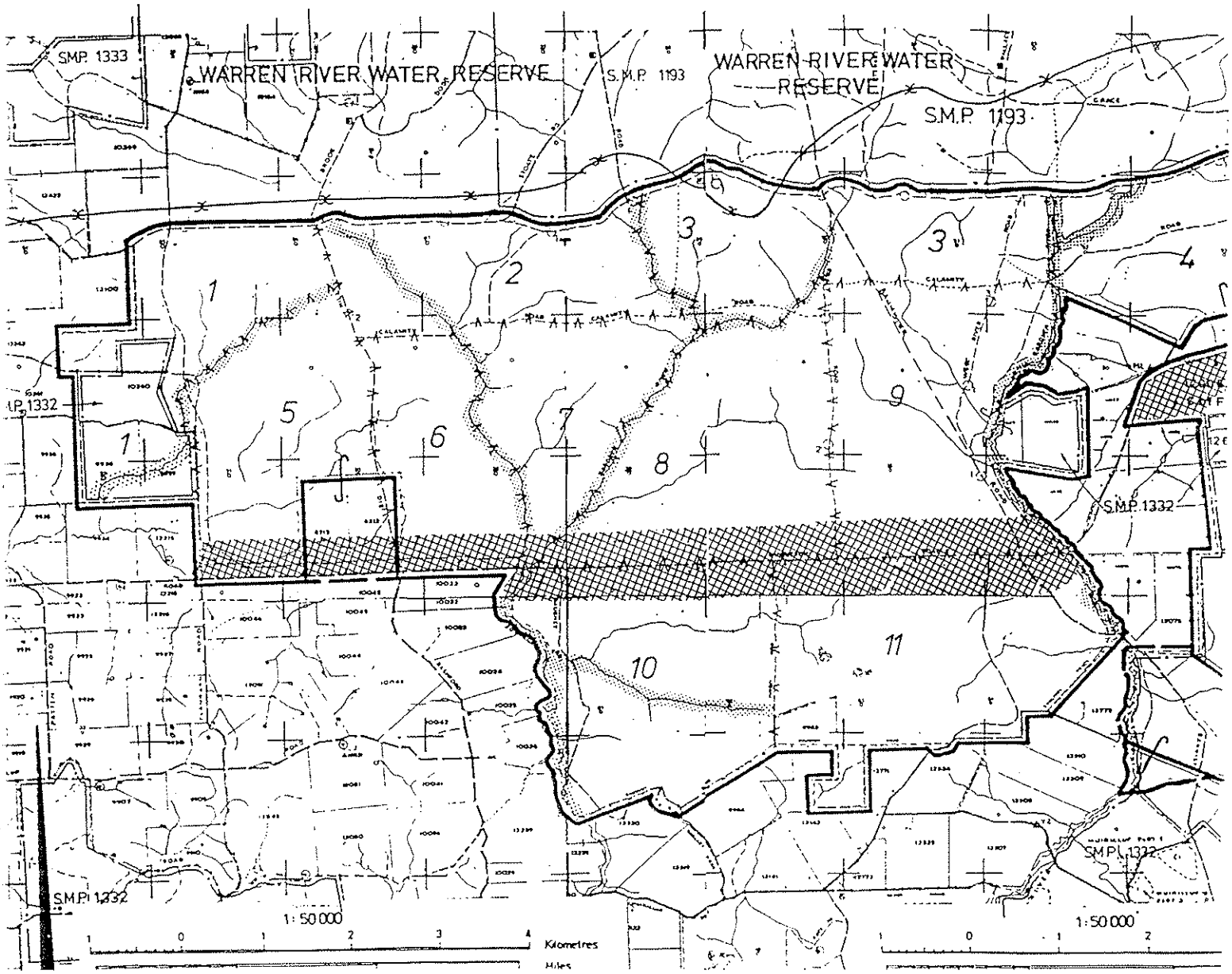
Possible Distribution of Riparian Zones for DIAMOND Block

: JANE (WEST)
UNDER F.D. CONTROL : 7082 ha
OF V.C.L. & L.A. A : 353 ha
BLOCK : 7435 ha

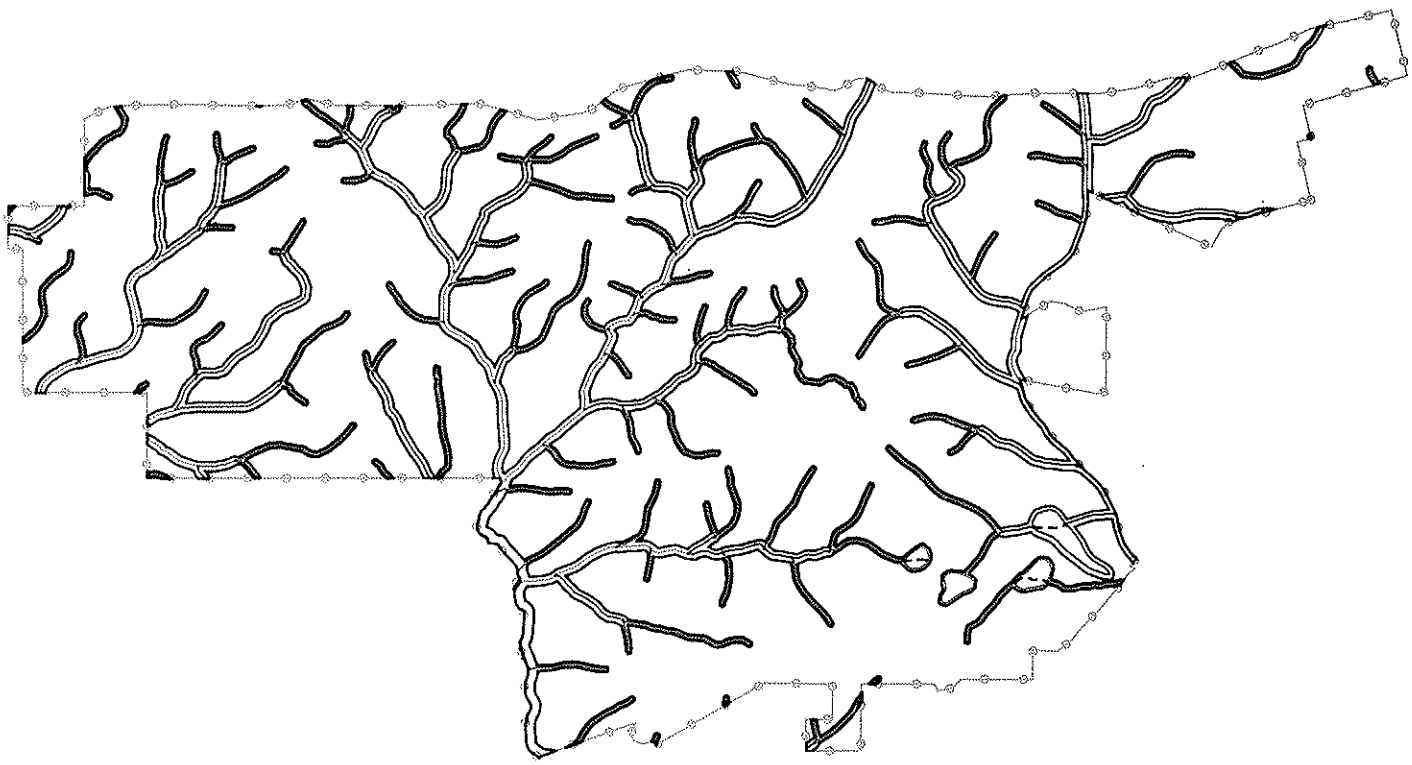
CATCHMENTS SHANNON
WARREN

BLOCK
AREA UNDER F.D. CONTROL : 7082 ha
AREA OF V.C.L. & L.A. A : 353 ha
TOTAL BLOCK : 7435 ha

SHIRE BOUNDARIES
CATCHMENT BOUNDARIES
STREAM RESERVE
ROAD RESERVE
COUPE BOUNDARY



JANE Block



Stream / STI
Order Codes

1st

2nd

3rd

4th

Block Boundary

CALM/LIB july 91

Possible Distribution of Riparian Zones for JANE Block

MANAGING AND SUSTAINING VISUAL LANDSCAPE VALUES IN WESTERN AUSTRALIA'S SOUTH WEST FORESTS

Grant Revell

BACKGROUND

Many land uses and management practices can change the visual character of the landscape. Such uses and practices, while they may be scientifically or technically correct, may not always result in attractive landscapes, especially in the short term. Moreover, where land use activities are not carefully planned and executed, the result can be long term or permanent degradation of the visual landscape. In many instances, it is this loss of scenic quality associated with environmental change that is most apparent to the public and which results in criticism of land-management activities. Often this can be avoided through sensitive planning and management of the landscape.

Landscape management, or visual resource management (VRM) as it is frequently termed, is the scientific discipline concerned with the management of land, vegetation and water resources so as to maintain or enhance their visual quality.

The prime goal of visual resource management is to ensure that all uses and activities are planned and implemented so as to complement rather than detract from the visual qualities of the environments in which they occur.

Visual Resource Management is a positive and integral component in land use planning and management processes. It is not a cosmetic exercise in which the results of careless planning and development are hidden from view, or superficially treated to make them more palatable to the viewing public.

The Visual Landscape Management System, as described, addresses all landscapes across the CALM Estate, and does not solely focus on those Road, River and Stream Zone areas currently under review.

THE BASIS FOR VISUAL LANDSCAPE MANAGEMENT

The term "landscape" refers to the appearance or visual expression of an area as determined by its geology, soils, landforms, vegetation, water features and land use history. Visual Resource Management is based on the premise that the visual quality of a landscape is a resource in its own right. This resource can be measured, assessed and managed in much the same way as other resource values such as fauna, flora, water, timber and recreation.

Managing the visual resource is dependent on a knowledge and assessment of the landscape itself as well as a thorough understanding of proposed land use(s). After the various landscape elements have been identified and assessed, it is possible to evaluate how particular management alternatives will affect the appearance of any landscape and subsequently to develop landscape specifications compatible with other resource management objectives.

In the past four years, CALM has adopted a systematic approach to the inventory and assessment of visual landscape values based on systems now operating in other Australian States and overseas. This approach enables scenic values to be described, evaluated, compared and mapped with a minimum amount of subjectivity. To date, visual landscape values in the Southern Forest Region and several national parks elsewhere in the State have been classified and mapped using the VRM System.

CALM'S VISUAL LANDSCAPE MANAGEMENT POLICY

CALM's commitment to managing the visual landscape on an equal basis with all other natural resources is spelled out in the Department's Policy Statement No. 34 (Visual Resource Management on Lands and Water Managed by CALM), attached, and in key passages of strategic and regional management plans for the 3 Forest regions, as follows:

> *"To ensure that all land uses on lands and water managed by CALM are planned and carried out in ways that sustain the beauty of the natural environment."*
> *(Policy Statement No.34, 1989)*
>
> *and*
>
> *"To ensure that activities on CALM land are planned and carried out in ways that compliment rather than detract from the inherent visual qualities of the natural environment. Outstanding scenic landscapes will be protected from impairment of visual amenity".*
> *(Southern Forest Region Strategic Plan, 1986)*

A major strategy spelt out in the Policy is that CALM will:

- Harvest multiple use forest areas in which timber production is permitted in ways that sustain the desired visual character of the forest and according to accepted landscape planning and design principles.

BASIC LANDSCAPE PLANNING AND DESIGN PRINCIPLES

87 % of Humans' Perception Is Based on Sight

Visual Landscape Character:

- Every landscape being viewed has an identifiable and descriptive visual character. This character results from various geological, hydrologic and climatic processes and associated soils and vegetation.

Landscape Dominance Factors:

- Visual landscape character can be described in terms of four component elements or dominance factors:

  Form - the shape or structure of landscape features. It is found in topographic land form in distant views and individual rocks, trees, etc, in foreground views.

  Line - often described as the result of a point which has been extended. It is found in such things as tree trunks, twigs and branches, roads and pathways and at macroscale in shorelines, ridgelines, etc.

  Colour - the visual sensation or perception that enables one to differentiate objects even though the objects may appear otherwise identical. Distant views often have their colours muted into a bluish haze.

  Texture - defined as the visual surface characteristics of the landscape feature/s.

Management Application Example:

With a forest landscape dominant in texture, it is extremely difficult to impose an activity strong in form and line (such as a road or clearfell area) and yet retain the texture characteristic.

Elements Affecting Landscape Dominant Factors:

- Motion
- Distance -
  - *Foreground*: textual details are most evident.
  - *Middleground*: land forms and vegetation patterns link together into whole units. Textual patterns are most evident.
  - *Background*: the expansive views reduce form to simple shapes and removes any sense of texture. Line and form qualities become more dominant.
- Observer Position
- Lighting
- Scale
- Time Span - Viewing time
- Weather
- Season

Landscape Contexts:

- Landscapes can be viewed in many contexts depending upon the observers location, the surrounding environment and the particular subject of interest. Landscape contexts include: Panorama, Feature, Enclosed, Focal, Canopied, Detailed, Ephemeral, etc.

Landscape Diversity:

- Diversity in the landscape is visually desirable.
- Given any area viewed, small, large or moving, there is a point at which variety increases from zero (monotony) until it becomes visually pleasant. As it continues to increase, it approaches the point where it is no longer pleasant; then finally, it is infinite and no longer recognisable or zero again.

Scenic Quality:

• The scenic quality of any landscape varies from place to place. Scenic quality generally increases with naturalness, uniqueness, ruggedness and diversity in landform, vegetation and waterform features. Scenic quality can be defined in specific terms for each Landscape Character Type.

Visual Landscape Change:

- Human imposed changes in the landscape can have dominant, overpowering impact, or they can maintain, enhance or restore visual quality by complimenting the surrounding landscape's aesthetic forms, lines, colours and textures.

VISUAL RESOURCE MANAGEMENT APPLICATION

Broad Scale Planning Level:

A flow chart illustrating the main components of the broad scale planning system is shown in Figure One.

The System integrates a Resource Base (Figure 1: Column 1) of:

1. Physical Landscape Elements, and
2. Social Considerations.

From an Inventory (Column 2) and Assessment (Column 3) procedure, Recommendations (Column 4) are made with Landscape Management Zones mapped, depicting levels of concern for the visual resource. For each recommended Zone a Visual Quality Objective (VQO) is written providing standards for conservation and land management activities, outlining levels of protection, enhancement, alteration, and techniques for measuring results. This objective can then be monitored and reviewed according to the determined standards. The VRM process is thus a valuable tool for a systematic identification, evaluation and management of the scenic resource. It equips the land manager with the means of developing rational arguments and predictive models to formulate policy for management of the scenic resource.

As a landscape management system, VRM cannot stand alone. It must be part of an integral, multi-resource planning system.

Project Application Level:

The second stage of the Visual Resource Management System is devoted to incorporating the Landscape Management Zones and their corresponding Visual Quality Objectives (VQO) to specific land management projects (refer to Figure 2). This work requires further extensive on site investigations and data analysis and is combined with other resource data to form specific planning and design documents. Operational guidelines and specifications for various management activities are defined, to include such activities as plantation establishment and harvest, recreational developments, roading, utility corridors, etc.
Examples of VRM project application level analyses are shown in Overlay Figures 3 - 6, viz: Dombakup Forest Block.

Other site analysis factors should include:

slope/topography
aspect
vegetation structure and density
vegetation species composition and patterns
view contexts
viewer position/angle of view
view duration/critical view directions
season
soils and erodibility
alteration type - scale, size, configuration, sequence
etc.

FUTURE DIRECTIONS IN VISUAL LANDSCAPE MANAGEMENT

There is a growing need to undertake extensive research and development projects in the field of Visual Landscape Management. These projects will attempt to fill the gaps in the knowledge base and application techniques for improved, and more holistic methods of landscape management. Areas of study will include:

- Landscape change simulation and prediction modelling.
  Using land information computer systems to prepare 3-dimensional visual scenarios and regional landscape analyses. This will be particularly valuable for planning timber harvest areas.

- Understanding human perceptions and preferences of Western Australian landscapes.
  What are the products of scenic quality, and what produces it ? How do we respond to landscape change ?
  We know a great deal more about how wildlife responds to landscape change than the human animal.

- Understanding and managing the non-visual landscape values.

In complimenting the above projects, an extensive staff training program will be carried out. Land managers will be better equipped with the skills and tools of sensitive landscape management.

MANAGING ROAD, RIVER AND STREAM LANDSCAPES

There are a number of approaches or scenarios that could be applied in the management of road, river and stream landscapes. Such scenarios could range from the existing, inflexible approach; the 'hands off' option; the narrow visual resource management option; or finally, to a fully integrated resource management approach, using multi-discipline land conservation and management processes.

The reality of balancing natural resource requirements and associated community values will probably demand a hybrid of the above management options. Viz:

1. Existing Option

- Road, river and stream zones remain as they are, and are managed as static, restricted, linear corridors with minimal respect to the dynamic and organic qualities of landscapes.

2. 'Hands Off' Option

- Maximise scenic quality through preservation of all landscapes.
- Little change acceptable other than by natural evolution, protection, and/or enhancement or rehabilitation of degraded landscapes. That is, no timber production.
- In many ways, this would be the easiest option to manage.

3. VRM Option

- Achieve the systematically derived Visual Quality Objectives without any scenic value trade-off.
- Maximise landscape values through the retention of established character and/or enhancement of modified cultural landscapes using the VRM System.
- Sensitive landscape management areas would be defined by the overlaying of land system data, resource elements and bio-physical factors only - not linear, geometric distances or volumetric factors. Visually sensitive areas would include all areas of high scenic quality and Landscape Management Zone A areas.
- Ensure that representative areas of each Landscape Character Type are reserved.
- Allow a degree of flexibility in sensitive management area boundary definition to reflect increasing and greater understanding of resource factors. Avoid getting locked-into boundary lines. Reflect recommendations resulting from in-built monitoring and evaluation systems.

4. Integrated Resource Option

- Manage the systematically derived Visual Quality Objectives with visual value trade-offs.

- Maximise landscape values through the retention of established character and/or enhancement of modified cultural landscapes through the use of the principles and procedures of the VRM System, and in the integration of multi-discipline land management processes.

5. Recommended Option

- A combination of Options 2, 3 and 4.

SUMMARY AND RECOMMENDATIONS

The Visual Resource Management system provides a systematic and objective basis for the inventory, assessment, management and protection of visual resources throughout W.A's forest estate. It is applicable to all landscapes and not solely for road, river or stream type areas. The system focuses on both broad scale planning and specific project levels.

CALM's VRM system will ensure the on-going maintenance, protection, restoration and enhancement of the visual quality of our managed landscapes, not only in the forested Southwest, but throughout the State.

The very nature of managing visual landscape values is inseparably linked with the management of other forest resource values. As stated above, VRM cannot stand alone. Visual resource values are the aesthetic consequences of sensitive or insensitive land management.

All visual landscape values, including those characteristic to Road, River and Stream Zones, should be sensitively managed. The forest management priorities should be derived from the balanced assessment of **all** forest resource values - not simply on timber requirements. Indeed, this is the essence of multiple-use management and conservation of forest landscapes.

If a multiple-use or resource planning approach, incorporating visual resource management, is feasible then we believe that the Road, River and Stream Zone system can be modified.

Current resources within CALM - both human and financial, allow for progressive implementation of the VRM System. A more rapid multiple resource planning approach would require additional resources. These commitments or assurances are clearly stated in CALM's Policy No.34.

Finally, it is recommended that:

1. CALM's Policy No.34 be implemented as resources allow.

2. A multiple resource, multi-disciplinary land planning approach, incorporating the VRM System, be adopted in the management of all forest landscapes, including Road, River and Stream Zones.

GLOSSARY OF TERMS

LANDSCAPE - refers to the appearance or visual expression of the countryside. It combines the visual elements of both the natural and built environs to include such ingredients as landform, vegetation, waterform, land use, architecture, etc. It is fundamental to consider the general public, user or consumer of the landscape, and how these ingredients combine to contribute to the overall effect on such public perceptions.

VISUAL RESOURCE - that portion of a landscape falling within a person's view.

SCENIC QUALITY - is the relative visual character of a landscape, expressed as an overall visual impression or value held by society after perceiving an area of land.

LANDSCAPE CHARACTER TYPE - is a broad scale area of land with common distinguishing visual characteristics based on an amalgamation of landform, climate, vegetation, water form and land use pattern.

LANDSCAPE MANAGEMENT ZONE - is a specific parcel of land within a defined Landscape Character Type which has common visual assessment classification.

VISUAL QUALITY OBJECTIVE (VQO) - is a written guideline which provides a measurable standard for the acceptable protection of the characteristic landscape.

PUBLIC SENSITIVITY LEVELS - each travel route/road or use area is classified according to their level of viewer sensitivity. This relates specifically to the extent of how many and what type of viewers are observing the State's landscapes. Specific criteria is set for these levels.

SEEN AREA - the total area observed from one or more viewpoints. It is often measured in terms of foreground, middleground and background distance zones.

DISTANT ZONES - these zones refer to the following measured portions of the visual resource or Seen Area.

Foreground (fg):	0 - 0.5 km	Evident textual detail
Middleground (mg):	0.5 - 6.5 km	Evident textual patterns
Background (bg):	6.5 - Infinity	Mapping confined to 16 km Mainly mass colour patterns

Figure 1

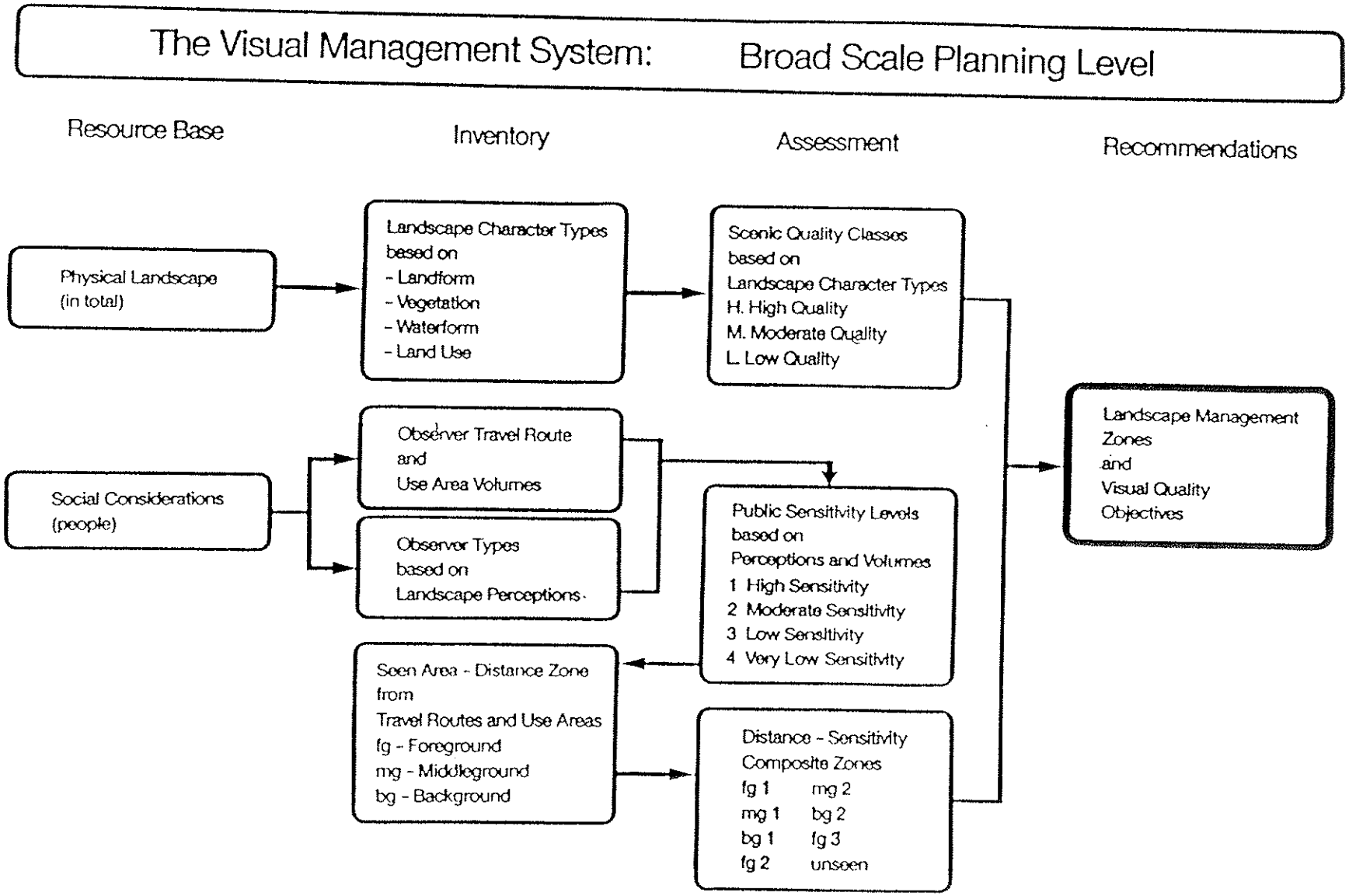
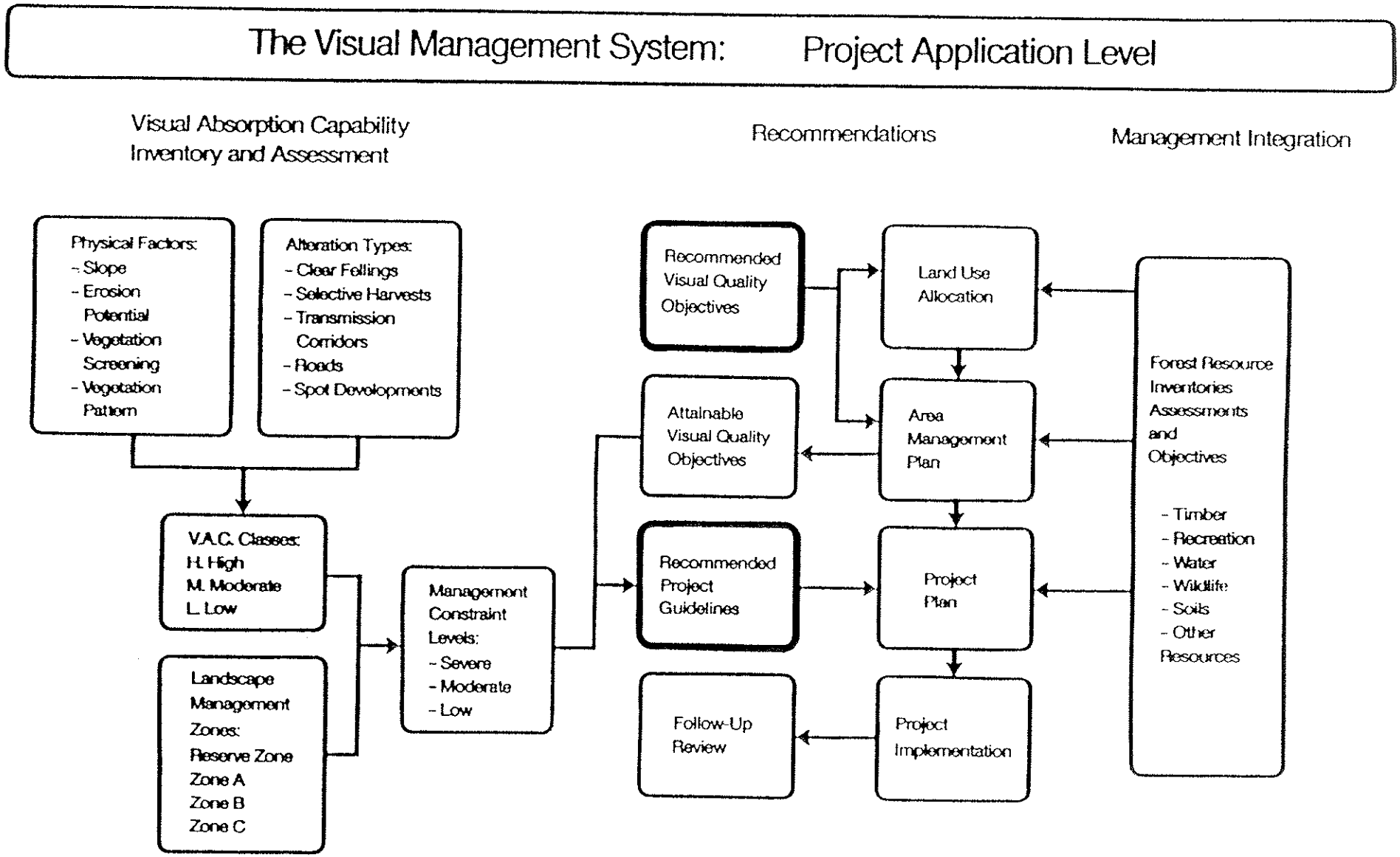

The Visual Management System: Broad Scale Planning Level
Resource Base
Inventory
Assessment
Recommendations
Physical Landscape (in total)
Landscape Character Types based on
- Landform
- Vegetation
- Waterform
- Land Use
Scenic Quality Classes based on Landscape Character Types
H. High Quality
M. Moderate Quality
L. Low Quality
Social Considerations (people)
Observer Travel Route and Use Area Volumes
Observer Types based on Landscape Perceptions
Public Sensitivity Levels based on Perceptions and Volumes
1 High Sensitivity
2 Moderate Sensitivity
3 Low Sensitivity
4 Very Low Sensitivity
Seen Area - Distance Zone from Travel Routes and Use Areas
fg - Foreground
mg - Middleground
bg - Background
Distance - Sensitivity Composite Zones
fg 1 mg 2
mg 1 bg 2
bg 1 fg 3
fg 2 unseen
Landscape Management Zones and Visual Quality Objectives

Figure 2


The Visual Management System: Project Application Level
Visual Absorption Capability Inventory and Assessment
Recommendations
Management Integration
Physical Factors:
- Slope
- Erosion Potential
- Vegetation Screening
- Vegetation Pattern
Alteration Types:
- Clear Fellings
- Selective Harvests
- Transmission Corridors
- Roads
- Spot Developments
V.A.C. Classes:
H. High
M. Moderate
L. Low
Landscape Management Zones:
Reserve Zone
Zone A
Zone B
Zone C
Management Constraint Levels:
- Severe
- Moderate
- Low
Recommended Visual Quality Objectives
Attainable Visual Quality Objectives
Recommended Project Guidelines
Follow-Up Review
Land Use Allocation
Area Management Plan
Project Plan
Project Implementation
Forest Resource Inventories Assessments and Objectives
- Timber
- Recreation
- Water
- Wildlife
- Soils
- Other Resources

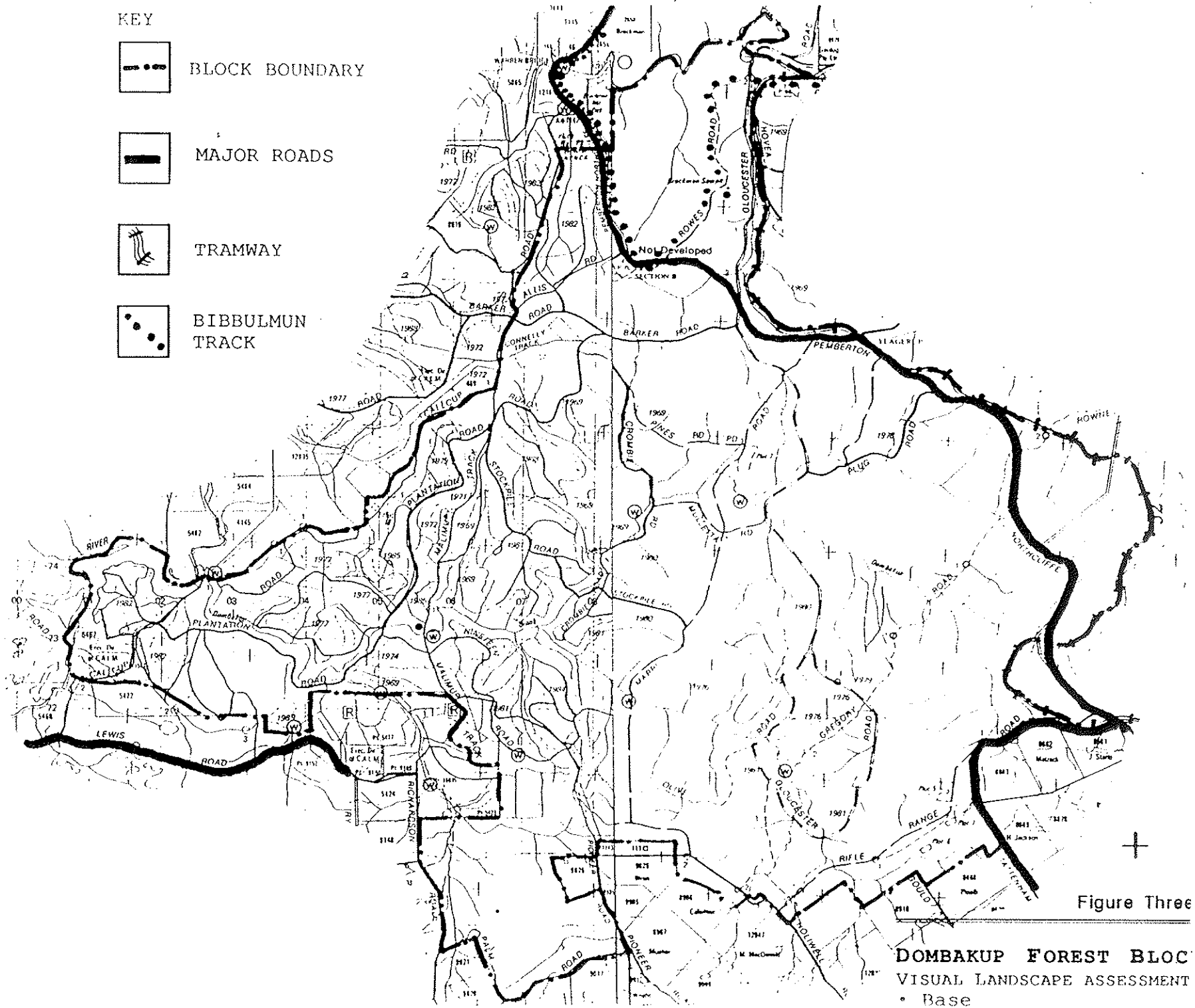


Figure Three

DOMBAKUP FOREST BLOC

VISUAL LANDSCAPE ASSESSMENT

• Base

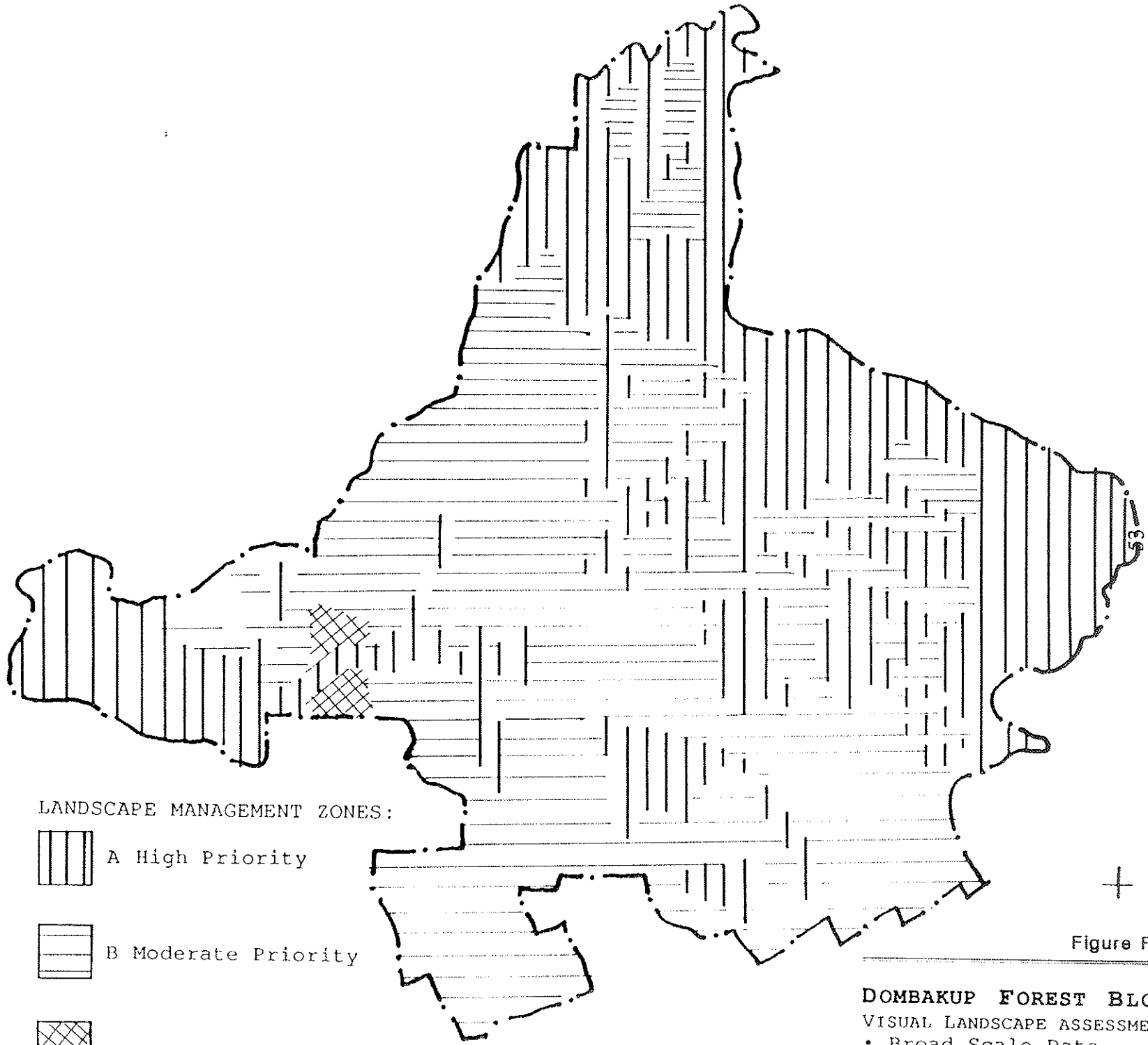


Figure Fo

DOMBAKUP FOREST BLO(
VISUAL LANDSCAPE ASSESSMEN
• Broad Scale Data

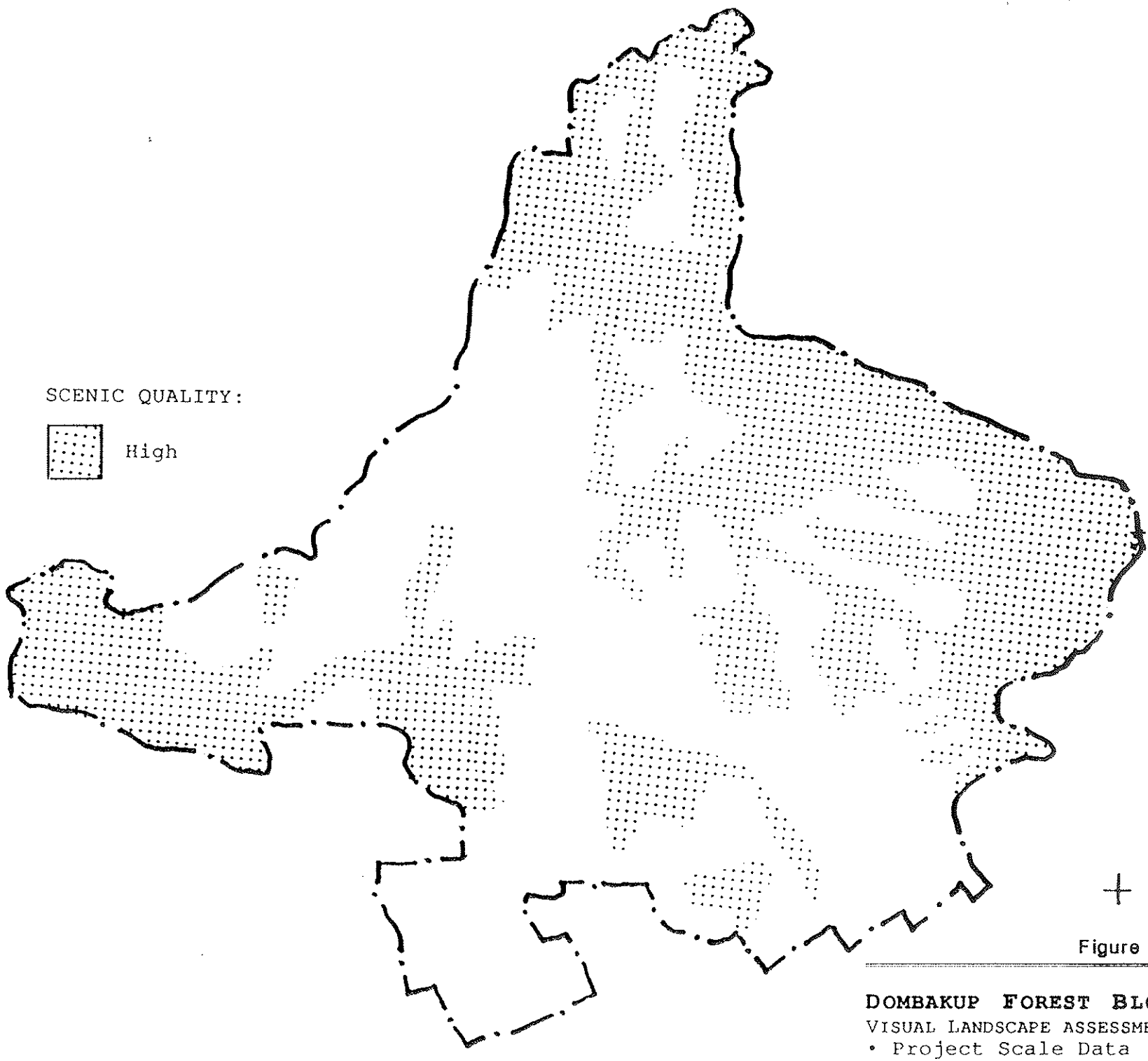


Figure Fiv

DOMBAKUP FOREST BLOC
VISUAL LANDSCAPE ASSESSMENT
• Project Scale Data

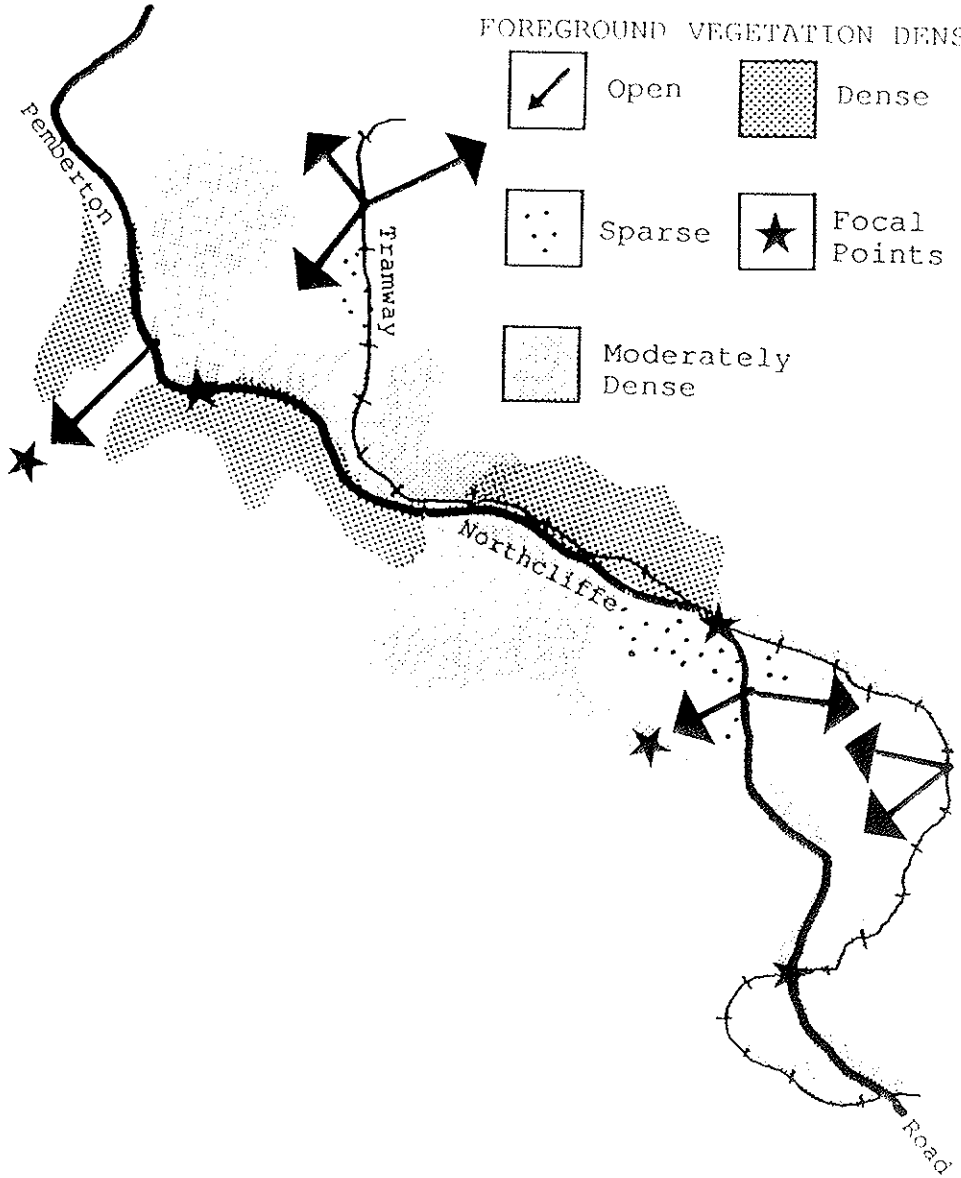


Figure Six

DOMBAKUP FOREST BLOCK
VISUAL LANDSCAPE ASSESSMENT
• Project Scale Data

OPERATIONAL CONSIDERATIONS PERTAINING TO A POSSIBLE REDISTRIBUTION OF THE ROAD, RIVER AND STREAM ZONES IN THE SOUTHERN FORESTS OF WESTERN AUSTRALIA

Kevin Vear

Introduction

This paper aims to provide insights to the role of the manager who is ultimately responsible for the creation, care and maintenance of the agreed system of road, river and stream zones (RRSZ). This seminar and public participation process is the opportunity for the field manager to comment on aspects of the practicality costs and benefits of a proposed option for a network of conservation and amenity areas within the multiple use segment of the CALM estate.

Six main themes are explored in this paper:

1. Fire management
2. Dieback disease management
3. Maintenance of RRSZ health
4. Impacts upon the adjoining activities
5. Road networks
6. Visual amenity

Assumptions

For the purposes of this paper the following assumptions are made:-

1. The system of RRSZ will be a network of corridors throughout multiple use State Forest, linked to larger regional conservation reserves, Nature Reserves and National Parks.

2. The manager will be concerned with protecting the agreed primary values of the RRSZ's:

   - conservation - nature habitat and source of recolonisation.
   - maintenance of visual amenity.
   - protection of aquatic ecosystems and the water resource itself.

3. The manager will aim to minimise all the potential impacts upon the RRSZ from adjoining activities.

4. The example where harvesting and regeneration operations are planned adjacent to RRSZ's will be discussed as this activity has the greatest potential to impact upon the RRSZ's if not carefully planned and implemented.

The Example

Figure 1 illustrates the present situation with 400 metre zones (not shown) retained on some major tourist roads 200 metre zones retained on either side of rivers and 100m zones retained either side of selected streams.

Additional areas are protected during harvesting such as granite outcrops and areas of pure marri (*E. calophylla*).

Access roads for timber harvesting are constructed low in the landscape outside the RRSZ's to minimise the potential introduction of dieback (*P. cinnamomi*). Roads are built in summer when the probability of inadvertently introducing and initiating a new infection are very low. The road surfaces are well drained to maintain an environment unfavourable to the survival of the fungus. Drainage water is channelled via engineered drains to the lowest point in the landscape before being directed through a vegetation buffer into the watercourse.

Logs are brought to landings located adjacent to the access roads and low in the landscape. Generally a herring bone pattern of snigging is used when bringing logs to each landing.

Figure 2 illustrates a possible option to extend the existing network with up to 50 metre wide zones being placed on all first and second order streams. Note how the stream zones may be opportunistically extended to link with the other areas protected during harvesting, to create continuous zones or corridors for fauna movement.

1. Fire Management

Since the RRSZ's are a primary source for the recolonization of the adjoining areas, following harvest and regeneration, it is considered desirable to maintain the major part of the network free from fire - wildfire and prescribed fire which may be necessary during the early regeneration phase.

One of the aims of introducing controlled fire into the forest on a planned strategic basis is to deliberately burn away the leaf and twig litter which is constantly being shed from the tree and scrub canopy onto the forest floor. It is the accumulation of this material that causes summer wildfires to be so intense and fast moving. Should a wildfire occur where fuel reduction burning has occurred recently it is possible to safely attempt to put the fire out by directly attacking the flank of the fire or even the head fire with men and machines. In areas where fuel has not been reduced fire suppression is often extremely dangerous and ineffective. Prior to an area being harvested it may be in an area subject to periodic prescribed burning.

Most controlled burning under the forest canopy occurs when the river and steam zones are damper than the surrounding forest. As a result, a patchwork pattern of burning results in a mosaic of burnt and unburnt forest. Normally 20 % of an area is left unburnt with the major part of the unburnt forest being the moister stream and river zones.

Summer wildfires will be always be difficult to control in long unburnt areas. Unburnt RRSZ's can create a "wick effect", acting as a fuse, which if ignited, will burn quickly and fiercely, presenting a threat to adjoining areas of forest. This threat will be at its worst when the adjacent regenerated forest is between 5 and 20 years of age. During this period rapid fuel accumulation occurs in the young forest and it is still too fire sensitive to enable fuel reduction burning to be commenced. The bark of the young trees is not thick enough to protect the cambium from damage during prescribed burning, whilst the tree's sensitive growing tips are often not high enough off the ground to prevent damage from radiant heat.

In view of this situation it is considered desirable that not all road, river and stream zones should be retained fire free. Some need to be burnt to reduce the hazard described above whilst others will need to be burnt to enable safe and cost effective regeneration operations using fire.

Figure 3 illustrates the use of fire in the regeneration process. Logging debris is ignited when the wind is blowing from the direction indicated. This enables the bulk of the previous network of stream and river zones to be kept fire free. Sparks and embers are blown away from this critical area. On the leeward side of the areas being burnt the uncut forest will have had a recent fuel reduction burn to enable fire crews to rapidly suppress any fires which initiate as a result of sparks or embers being blown across the boundary track.

The options described above also minimise overall soil disturbance and cost for construction of additional mineral earth firebreaks.

The "perimeter to area" ratio of the burning operation is kept practical, the area will not be broken into numerous difficult small burns which will require additional commitment of resources - funds, staff and equipment.

Reduction of the fuel loads in some of the extended RRSZ's will ameliorate the problems of future wildfires and the "wick effect" described earlier. Introduction of fire under controlled conditions is preferable than risking fire escapes from regeneration burns which will result in an intense destructive fire. Also if previously regenerated forest is killed by wildfire, the objective of creating a diversity of forest structure is foregone.

Figure 3 also illustrates the situation where some trees considered unsafe (shown as crosses) will need to be removed during the harvesting and regeneration phase. Unsafe trees are those which may fall over or catch alight and burn down during fires or burning operations, thus threatening fire fighters. These trees also have a high probability of catching alight from flying sparks or embers, and acting as a source from which further sparks may be showered into adjoining areas of forest.

Any tree within a buffer zone felled for safety reasons should have any commercial log timber utilized rather than be left as waste. Logging equipment would not be permitted to enter the zones to remove any such logs. A cable would be used to winch the logs out.

2. Dieback Disease Management

There should be little extra cost or difficulty associated with dieback disease management in an extended RRSZ network. Essentially the existing strategy for disease management will apply.

Risk of introduction of the disease into RRSZ's and adjacent areas being harvested and regenerated can be minimised by constructing hard surfaced roads low in the landscape, careful engineering and control of drainage and attention to vehicle cleanliness, in particular the cleaning down of heavy machines before they enter each sub-catchment in the logging coupe.

Provided the option to allow some burning in extended RRSZ's is used and additional roads or firebreaks are not required around each of the extensions, then the disease management strategy will not be changed or incur any additional cost by the retention of unlogged segments within the area previously designated as available for harvesting.

3. Buffer Health

The maintenance of the health and condition of an extended network of RRSZ's is not expected to be a significant problem.

Earlier papers touched on the issue of establishing a viable zone width. The manager's task will be to ensure that the use of intense fire when regenerating adjacent areas does not result in excessive scorching of the edges of the zones. This will be more difficult to achieve in stream zone enclaves within the area to be burnt.

Wherever possible operations should be sequenced as far apart in time as possible. For example road building, harvesting and regeneration burning should not be scheduled in the same year .

The removal of isolated dangerous trees should not significantly reduce the value of the zones. The number of trees involved is small and it is known that the value of dead trees as habitat trees (roosts and nesting sites) is low.

The requirement for some sections of RRSZ's to be periodically burnt should also ensure that there is a diversity of understory structural types represented within them thus adding to their value as a source of recolonization of adjoining regenerated areas.

4. Impacts on Adjoining Operations

In some cases there will be a need to cross extended stream zones during the harvesting phase. Figure 4 illustrates the example where the traditional herring bone snig track pattern has been interrupted by the extension to the stream zone. The desired option is to select a single crossing point which will be carefully planned and engineered.

The linking of other habitat patches and strips by an extended network of RRSZ's is expected to add to the sustention of wildlife values during harvesting and regeneration operations.

There would be a requirement to train staff (CALM staff and contractors staff) to recognise the ecotypes boundaries and aesthetic boundaries to be demarcated in the field under the guidelines provided in any earlier paper. The increased "perimeter to area" ratio and boundary length would cost more to implement and maintain. However the small cost involved in implementing these changes are acceptable when the improvement to other forest values is considered.

It some cases it may be extremely difficult to "get it right" in an absolute sense when demarcating extended zones as proposed in the field. An acceptable standard to be achieved in the field would need to be established. When all the discussions and planning are finished it is the field technician who actually makes something happen or change in the forest. Once that alteration is in place the person responsible is held accountable for the result and is subject to criticism, irrespective of their level of endeavour and the sincerity of their intentions, if the field result is not perceived as acceptable.

As discussed earlier provided some burning within an extended zone network occurs then the regeneration and future fire suppression processes should not be any more difficult or expensive than the present system.

5. Road Networks

If an option such as the one outlined above is chosen then figure 4 illustrates the need for small breaks in the network of RRSZ's to facilitate the movement of vehicles. Apart from the log snigging example described earlier there should not be any other significant change or cost associated with building and maintaining an effective road network.

Stream and river crossings are already identified as operations which require very careful planning and sensitive engineering. Detailed procedures and guidelines for these activities have been developed over many years. High standards would continue to be applied in the construction and maintenance of all stream crossings.

6. Visual Amenity

The visual resource management principles and procedures described in an earlier paper would not greatly increase the cost or difficulty of conducting activities adjacent to extended RRSZ's.

In some cases there would be simple extensions of zones, relocation of boundaries, or edge modification to enhance and/or maintain visual resource values. In some areas harvesting may be excluded altogether. Elsewhere modified activity may occur. The main effect in the field would be the increased involvement of the professional staff who would need to translate their skills and knowledge to a technical level and help impart that knowledge to the field technicians. Again, there may be some additional costs incurred by the increased "perimeter to area" ratio in some harvesting operations, but the benefits derived from visually acceptable operations would more than compensate for any additional costs. All field staff would derive a greater sense of job satisfaction for carrying out more skilful and aesthetically pleasing work.

Conclusion

There would be clear benefits from an extended system of RRSZ's, whilst existing standards will be maintained or improved.

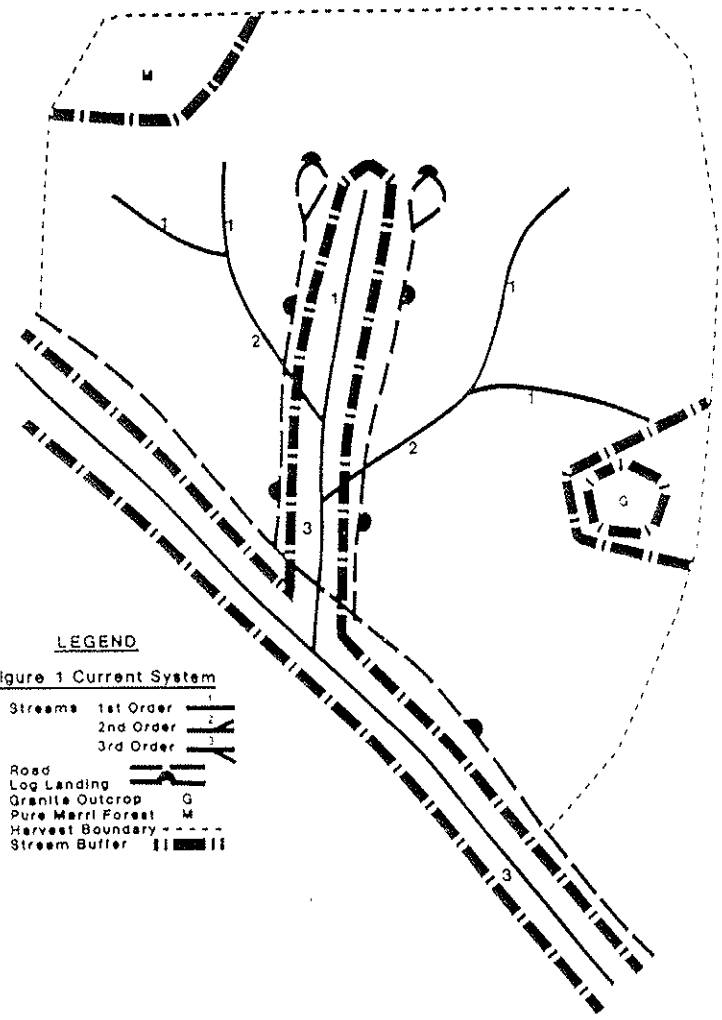
Benefits would include:

- enhanced value for wildlife
- greater protection to aquatic ecosystems and the water resource itself
- enhanced amenity value both in the RRSZ's and in the adjoining forests
- skills acquisition and improved job satisfaction by field staff.

There would be additional, but acceptable costs associated with:

- road construction for timber harvesting
- skills and knowledge training for field staff
- planning and implementing prescribed fire for both regeneration and fuel reduction purposes.

In summary, the community, the consumers of timber products and CALM, as a part of the wider community, will ultimately judge the costs and benefits of changing the system of RRS zones. The cost can be measured either in terms of reduced environmental protection afforded by the present system of RRSZ's or in terms of the extra management costs associated with a system of extended RRSZ's. It is my opinion, as an operations manager, that a better result is achievable at a reasonable cost to the community.



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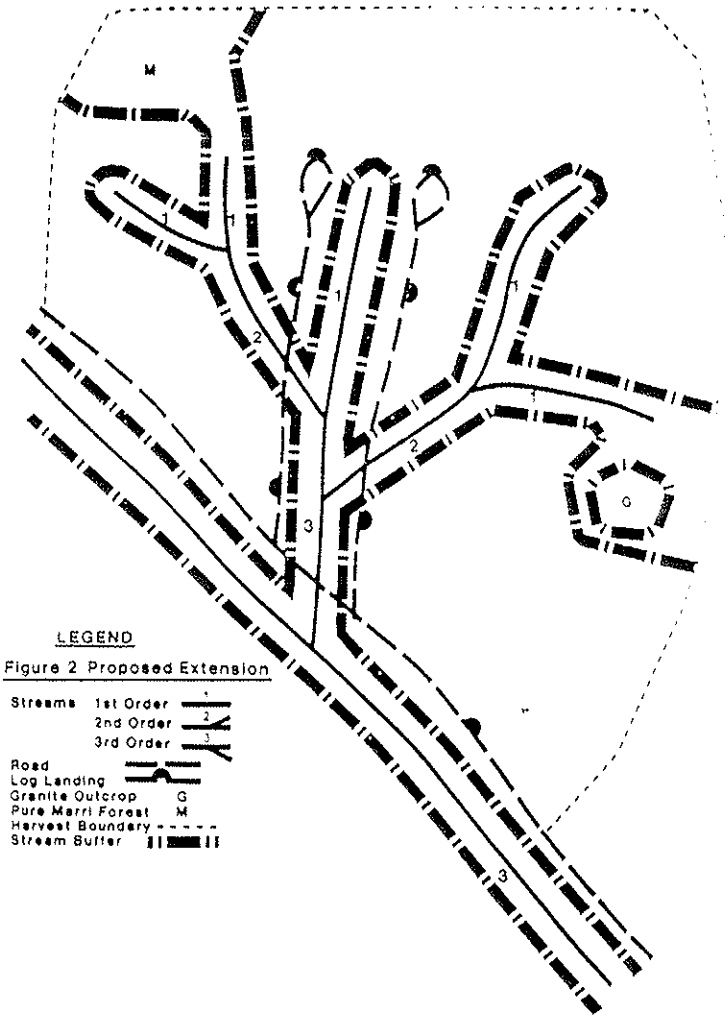

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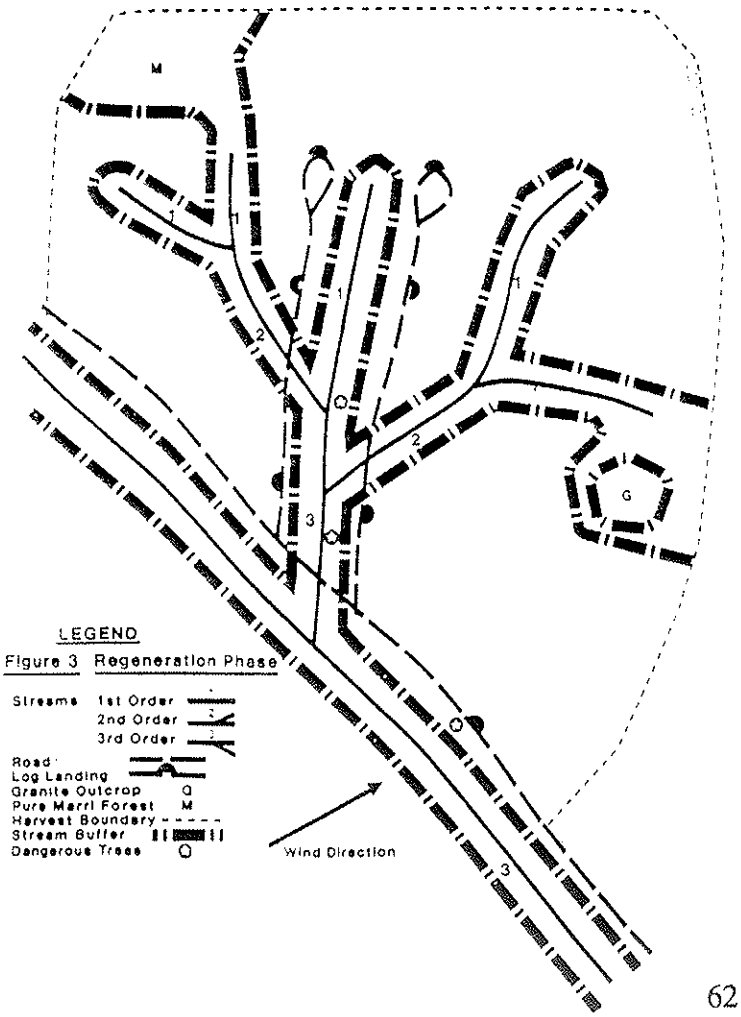

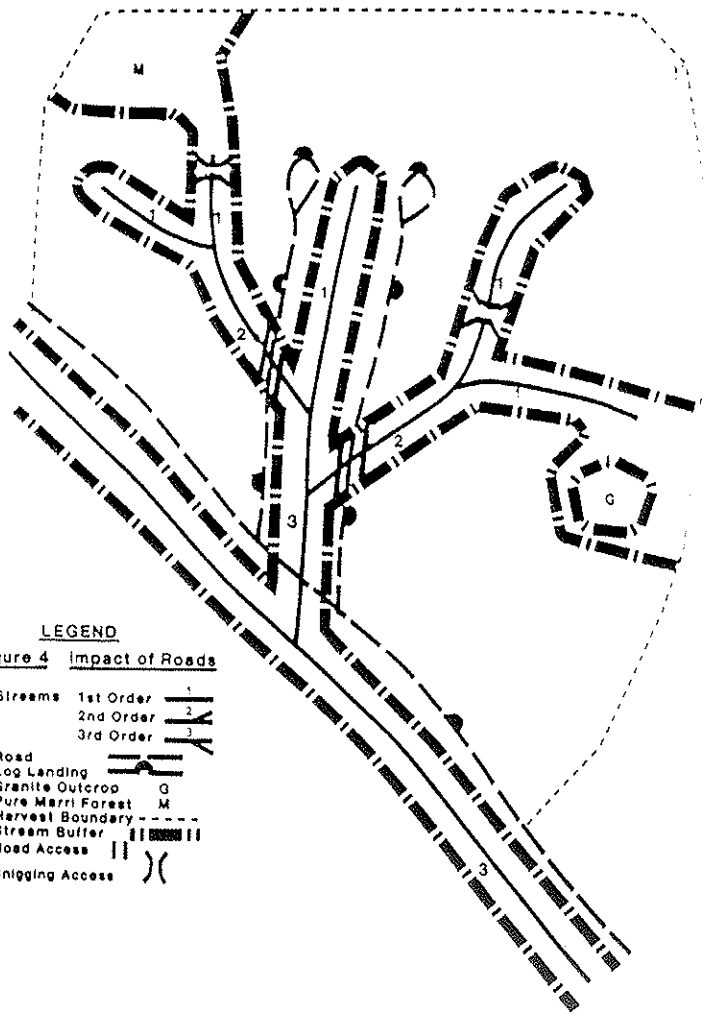

SEMINAR - REVIEW OF ROAD, RIVER AND STREAM ZONES IN SOUTH WEST FORESTS

WORKSHOP SESSION

Issue Identification

A plenary session was used to list the issues arising from the previously presented papers and discussion.

The issues listed were:

(a) What is the impact of changing areas of road, river and stream zones on timber volumes?

(b) What is the desired forest structure for RRS zones?

(c) Should there be different prescriptions for RRS zones in jarrah and karri forests?

(d) What is the judgement on alternative distribution options for RRS zones?

(e) What is acceptable disturbance in RRS zones?

(f) How should field demarcation and width of RRS zones be implemented in the field?

(g) What is the future process of public involvement in the forest strategy review?

(h) How to resolve the conflict between requirements for flexibility and accountability (field audit) in RRSZ allocation.

(i) Can we distinguish between "intrinsic worth" and "aesthetics"?

(j) Will road, river and stream zones support the conservation goals for Western Australia?

(k) Can VRM be used to enhance visual quality?

(l) How to resolve the issue of fire protection difficulty?

(m) Research requirements and priorities?

(n) What is the margin of error when meshing knowledge and operations?

The issues listed were allocated to workshop groups as follows:

Group 1	Issues	(a) to (c)
Group 2	"	(d) to (f)
Group 3	"	(g) to (j)
Group 4	"	(k) to (n)

Groups were asked to prioritise the issues and present discussion outcomes to the final plenary session.

WORKSHOP SESSION

Issue Discussions

Group 1

Issue (a) - How to resolve the impact of changing road, river and stream zones (RRSZ's) on the volume of timber committed to industry.

Points arising in discussion:

- CALM cannot decrease the timber volume to industry as they are constrained by contractual obligations.
- CALM should maximize opportunities for improved utilization of timber as this would provide more opportunities for conservation.
- What are the changes in area and volume of timber arising from the new proposals for RRSZ's?
- The best option for redistribution of RRSZ's is clearly to increase stream (riparian) buffers and move to VRM management as outlined today.
- It would be very desirable if the revised RRSZ system resulted in no loss of area of mature forest or volume of timber.
- Any compromise should favour stream zones over road zones.
- The ideal solution would be to maintain present road and stream zones, increase stream zones as outlined and increase the efficiency of timber use.
- RRSZ's should be maximized to the extent that CALM can meet its contractual obligations and its conservation objectives.
- There should be no depreciation of areas in terms of wildlife habitat.
- There should be an increase in RRSZ's so that 20% of each forest block is kept undisturbed, but special protection for blocks with many streams and enlarged corridors between nature conservation areas.
- There should be comprehensive studies into the flora and fauna of each block.
- There should be no thinning in stream zones.

Conclusion on this issue

It is clearly beneficial to extend stream zones (with width according to ecotype), and CALM can satisfy contractual obligations through improved timber utilization.

Issue (b) - What is the desirable structure for RRS zones?

. Depends on the area in question but decisions should be made on ecological basis.

. The natural qualities of each stream should be preserved.

. Stream reserves previously logged should be rehabilitated.

Ran out of time on this issue.
Issue (c) not discussed.

Two new issues identified:

(i) What is the desirable legal status (security of tenure and purpose) for RRSZ's.

(ii) There may be a case for varying stream widths for different rainfall zones.

Group 2

Issue (d)

Judgement as To RRSZ distribution.

. Should be looking at society's needs and at needs of the timber community.

. Criteria should be applied in total, not as a function of area.

. Need for evaluation on a case by case basis.

. Felt biological data for change was convincing but feel data so complex that more time is needed to evaluate.

. Some felt that parameters - within present timber regime - were too narrow. Some feel overall size of reserves could be increased others very concerned about timber workers jobs.

. Difference of opinion: some felt RRS zone changes should be considered only if they do not impact on timber industries jobs; others felt if jobs impacted then industry would not be ecologically sustainable anyway.

. CALM needs to clarify objectives - and other Departments and community groups. Tensions noted between timber industry - tourism - wildlife protection. Some felt "different values" rather than "tensions" should be a better term - others disagree.

Issue (e)

What level of disturbance should be permitted in RRS zones?

Considered under 5 headings:

(i) ***Logging & Harvesting***

. Level depending on zone.

. If higher streams (in catchment) are not protected then more sediment in system.

- Dieback entering stream and moving with water current.
- Can be some logging if buffer zone is large enough to protect water quality.
- Opinion was against thinning of old growth forest in stream zones, was not acceptable.
- In regrowth forest on stream zones there is difference of opinion - some people felt some trees would die anyway and might as well be used to help forest - could be fire hazard - some felt these areas not for production and could be left.
- More research was felt to be necessary.
- Road zones - difference of opinion - some felt thinning destroys forest aesthetics, but some like more open look of forest.
- Increase in population (and tourism) means aesthetics must be protected.
- Concern was felt by some that thinning and narrower zones could lessen aesthetics (see right through it).
- Some felt that old forest by road sides should be protected.

(ii) ***Passive recreation***

- Should be some allowed however marroning leads to "goat tracks" along streams.
- Easier if roads close to streams - leads to less disturbance.
- Need to assess user levels.
- Could be considered during forestry operations.
- Try to meet demand in managed way.
- Monitor and educate within limits.

(iii) ***Fire***

- Need for mosaics in space and time.
- Burning in RRSZ's should be minimised.
- Concern about spring burns during periods of peak natural processes.
- Also concern felt that autumn burns could be damaging.
- Recommend a variety of burn times with maximal time between them.

(iv) ***Roads and crossings***

- Should be minimised and well engineered to disperse sediments before reaching stream.
- Look at visual amenity of road.
- Should use old roads or tracks wherever possible.

(v) ***Other tree removal (for safety)***

- Many felt that little objection if on the edge of zone.
- Sensitivity should be used if tree has hollows or has any special wildlife significance.
- More education to public about what constitutes a danger and the way this is decided.
- Too much disturbance if tree is in central position of zone.

Issue (f)

Field demarcation width of zones.

Ran out of time. Felt to be an important issue. Some felt this is complex issue needing management, some felt ecological boundaries (rather than fixed distance) should be used.

Group 3

Issue (g)

What is the future public involvement process for forest management review?

Points arising in discussion:

- CALM should seek advice from the Social Impact Unit in implementing a proper process of public consultation with public involvement.
- There should be more time between now and the release of the draft document, AND/OR
  More time between the draft document and the final document to allow for public involvement.
- The allowable cut should be negotiable.

Issues (h) (i) and (j) not discussed.

Group 4

Issue (l)

Fire management in RRS zones.

- Suggest that CALM should try to keep fire out of all stream zones where practical.
- Where not practical apply (min. impact fire) controlled fire in 1st, 2nd and maybe 3rd order streams. Whereby not doing that there will be additional risk to 4th and 5th order streams.
- Where equipment is required to fight fires dieback and streambed disturbance may occur.
- Investigate use of non-fire techniques for regeneration.

Issue (k)

VRM zones for visual amenity.

- Suggested that CALM should apply MINIMUM zone widths for road zones.
  Reason: allows for verification. (Flexibility is difficult to monitor).

Issue (m)

Research requirements.

- Need to establish the viability of narrow zones. e.g. effects of wind, fire etc.
- Base data monitoring trials should be established to determine impact and effectiveness of buffers.
- Need to study human perceptions on RRS landscapes.

Issue (n)

Not discussed.

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