The Winston Churchill Memorial Trust of Australia

MANAGING NATIVE FOREST FOR ALL ITS VALUE

A Report of a Study Tour of the United States of America, Sweden and Germany

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EXECUTIVE SUMMARY

Report of a study tour to the Winston Churchill Memorial Trust of Australia:

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Project: To examine the application of management practices in native forests that are aimed at jointly satisfying conservation, recreation, production and protection needs in both the short and the long term.

Itinerary: The study tour included the forests of the West coast of the United States, Connecticut on the East Coast, southern Sweden and west Germany. I had discussions and visited public and private forests with managers, research scientists, academics, environmentalists and industry personnel. The primary objective was to examine the underlying philosophies of forest management in several diverse countries. I had the opportunity, in some cases, to see the results of several centuries of past use which has led to the development of their current practices and philosophy of management. The tour, carried out in May and June 1991 provided an excellent perspective for Australian forest management.

Conclusions: The developed countries of the world are heavy users of wood products, and at the same time they have a strong interest in the conservation values of forests. There is a re-evaluation of forest use in progress in all these countries and it has led to severe and unresolved conflict, in particular in the United States . At the present time these countries are able to lessen the conflict by importing their excess wood needs from other countries. In the long term this will be ecologically unsustainable for the exporters and economically unsustainable for many of the importers. Alternatives to the use of wood are likely to be even less environmentally acceptable because of increased pollution created by the energy demand of these products. There is a growing acceptance by managers and scientists that with increasing populations and a finite area of forest land the luxury of single purpose forest management is no longer tenable as the primary basis for management.

Genuine multiple use management is seen as the most feasible alternative. However there is little evidence that the trade-offs essential in this process are based on objective analysis. Elaborate and technically advanced planning techniques used in the USA have not been successful in conflict resolution because of a lack of trust between the parties involved.

There is every indication that the problems of the joint 'production' of conservation, wood products, recreation and other values are technically feasible, but the political processes required to resolve the conflicts are currently inadequate in countries such as Australia and the USA.

Copies of this report have been made available to land management agencies and tertiary institutions in Australia.

PREFACE

With a population that is increasing in size and affluence, and a finite forest area, there is growing pressure to increase the intensity of management of the forests for all of its values. Intensification of management for one purpose often means that other values will no longer be satisfied by default but must be specifically managed with equal attention.

These increasing demands on the forest have led to conflict between the various interest groups, not only about the objects of forest management but also about the techniques. In Australia in recent years the debate has become a political power struggle in which logic, science and even the truth have become less and less important. This approach is unlikely to lead to sound policies of sustainable forest management.

I was interested to investigate the management of these issues in other countries. The countries I was able to visit as a Churchill Fellow were selected with the following in mind:

* West Coast of the United States - many of the issues being debated are similar to those in Australia, the area supports a large timber industry, virgin old growth forests are a central issue and the debate has a similar high media profile.

* East Coast of the United States - Connecticut is the most densely populated and one of the most densely forested parts of the United States but without the conflicts that characterise the West coast.

* Sweden - has a reputation for high environmental standards and social responsibility, it has a large timber and pulp industry and a long history of co-operative forest management by the State, large corporations and small farmers.

* Germany - has a long history of forest use and management; a large population with relatively small and diverse forest areas and a politically active green movement.

My primary interest was in philosophies and systems rather than matters of technical practice.

During the tour I had the opportunity to discuss these issues with people from Forest Services, Universities, research establishments, the timber industry, environmental organisations, and large and small forest owners. Even within these groups my initial contacts had gone to considerable lengths to put me in touch with individuals with widely divergent viewpoints on many issues. I am indebted to all of them for the frankness of these discussions. I am very conscious of the pitfalls of drawing wide ranging conclusions of complex issues from a brief visit to a foreign country. However most of the conclusions which I have drawn in this report have been expressed to me more than once by people with considerable knowledge in that field.

Silviculture, the practices by which the objectives of forest management are achieved, is the application of science to produce the values that society wants from its forests. Silvicultural practices therefore make no sense without a knowledge of the social context of the times in which the systems were applied. I am grateful for the efforts made by my hosts to give me some insight into the relevant history of their country which was not only essential to the project but fascinating and enjoyable as well.

The tour was highly successful both personally and professionally. I am indebted to all those associated with the Winston Churchill Memorial Trust for the award of the Fellowship, to the Department of Conservation and Land Management of Western Australia for providing me with special leave and to my overseas hosts for their quite extraordinary hospitality and assistance.

INTRODUCTION

Forest use throughout the world has historically gone through several broad phases:

* the period of exploitation ('taming' the land).
* the period of limited, broadscale control.
* the period of production efficiency.
* the re-evaluation.

The developed countries of the world are all now engaged in the re-evaluation phase in which a wider range of forest values are being considered or where forest use is being given different priorities. What values are important and how can forests be managed to provide them?

Forests provide a large number of values. They include catchment protection, climate amelioration, wood production, soil protection, flora and fauna conservation, wilderness, recreation and landscape values and many others. There are a number of different ways of managing forests to cater for all these values.

* One is to designate separate areas in which one of these uses is given an exclusive or priority use. It does not mean that other values will not be present but rather that they are catered for only by default. Examples would be wilderness areas or industrial plantations.

* Another way of managing for these values is to deliberately manage for all values on the same piece of forest but not necessarily at the same time. But they are catered for all the time in the forest as a whole. Most uses with the exception of wilderness values can be compatibly managed on this basis, albeit at less than the maximum level that would be achieved under single use management.

* A third way is to attempt to manage for all values on all parts of the forest at all times. While this may be achievable to a large degree it can never be fully achieved (it is a condition that rarely, if ever, occurs in nature).

In a conceptual sense all of these methods have much in common since they differ primarily in the scale at which they are applied to the forest. In application, result and the degree of trade-off required however they differ significantly. All of them have been given the name multiple use management. The term 'multiple use' has become confused. In the minds of some people multiple use management only applies to the management of utilitarian values such as wood, game, water and so on. To include the other forest values, terms such as 'multi-resource management', 'integrated management', 'holistic forestry', 'new forestry', and 'ecosystem management' have been coined. Throughout this report however, I will use the term 'multiple use management' to mean the management for all forest values and 'single use management' to describe the first of the methods outlined above. At various times and places all of these interpretations have been practiced and none are without conflict.

Most silvicultural systems adopted in native forests in Australia in the past have been developed with the primary object of ensuring that the forest is adequately regenerated after logging (to provide the continued opportunity for productivity in the future), and that it is maintained in a healthy condition. The assumption has been made that forests that are well managed for sustained wood production would also provide for the sustained production of all the other important values of the forest; namely catchment protection, conservation of flora and fauna, recreational opportunities and aesthetic values.

This has generally been the case in the past and where there were concerns, various limitations have been imposed on the extent and intensity of these operations to protect water quality, and other flora and fauna values.

With the increasing demands on the forest, this approach is no longer sufficient. The purpose of this tour was to see how successfully these demands were being catered for in other developed countries.

This report aims to provide a summary of forest development history, current practice, key issues and their relevance to Australia. Much of the discussion relates to wood production activities. This is because it is the source of the greatest change taking place in the forest and it is also the source of greatest controversy.

WEST COAST OF THE UNITED STATES

Itinerary

During the three and a half weeks spent in California, Oregon and Washington I had the opportunity to visit forests and meet with people from the US Forest Service Pacific North West and Pacific South West Regions and Experiment Stations; the Universities of California and Oregon and the Oregon State University; the California Timber Association; the Sierra Club Legal Defense Fund; the California Forestry Board; the California Department of Forestry and Fire Protection; Congressional advisers; and the Association of Forest Service Employees for Environmental Ethics. I also had the opportunity to attend a two day seminar on the US Forest Service's 'New Perspectives' program. See appendix 1 for details of the itinerary.

Historical Background

Forest ownership on the West coast is shared between the US Forest Service (National Forests), the National Parks Service, the Bureau of Land Management (BLM), State Forestry Departments and private companies. The relative proportions vary from State to State but State and BLM forests constitute the smallest areas overall. Federal laws cover the three Federal services while State laws cover State and private lands. National Forests are required to be managed for multiple use and sustained yield of all the goods and services for which the National Forest System was created.

The Multiple Use and Sustained Yield Act of 1960 has for practical purposes been interpreted by the Forest Service to mean the allocation of areas for single use. This was given the effect of law for wilderness areas within the National Forests by the Wilderness Act of 1964. For those parts of the forest used for production, the 'public good' has been interpreted as the *maximisation* of sustained yield by using rotation lengths of maximum yield and improved genetic stock. Other values were taken into account but there was seemingly little attempt to manage for those values beyond the requirements for the protection of water and endangered species. It was assumed (and correctly so for many values) that the well managed wood production forest would provide most other values and the less tangible values were catered for in the National Parks and Wilderness Areas. However the concept of timber primacy, with 'consideration' given to watershed, fisheries, wildlife, recreation began to change.

The Forest and Rangeland Renewable Resources Planning Act of 1974 identified the combination of management objectives that was considered to best serve the national interest. This was followed by the National Forest Management Act of 1976 which defined the planning process and the specific standards that were to be applied to meet these objectives. The forest management plans now in the process of completion are the consequence of this legislation.

These Acts together with the National Environmental Protection Act have placed the management of the Forest Service under the direct scrutiny of the courts. They provide the opportunity for individuals to challenge planning decisions and management practices usually by asserting that the environmental analysis has been inadequate.

Much of the private forest land has its origins in the land grants that were made in return for the construction of the railways to the West in the 1850's. The land administration system had surveyed the land on a one mile grid. Under the land grants every alternate one mile square surrounding the railways became private and the remainder became Federal land with the exception of a small proportion for the States for the maintenance of schools. (Figure 1). This legacy has created tremendous management difficulties on some National Forests.

Until recent times most of the wood production on the West Coast has come from private forests. There was a long standing arrangement with the private forest industry that the timber harvest from National Forests would be kept at a low level while private forest was available in order to maintain the price of wood in the market. Major incursions into the National Forest have therefore only begun in the last twenty years. Faced with a rapid escalation of logging on National Forest many members of the public are now questioning the role of National Forests; they had for so long been relatively untouched that they are often perceived to be pseudo National Parks. The public don't want them turned into tree farms like the private forests. Industry on the other hand argue that they had in good faith always anticipated the availability of the wood resource from National Forest and had structured their own logging rates accordingly. To back out now is seen as a breach of faith and suddenly leaves them without a resource until their own forests are again old enough to be harvested again.

As a result of this history there are still substantial areas of virgin forest in the North West. By contrast, in California much of the forest of the Sierra Nevada Range is 'natural' second growth forest resulting from the heavy exploitation which accompanied the gold rushes of the 1850's and the development that followed.

Planning Process

The National Forest Management Act requires that comprehensive management plans and an Environmental Impact statement (EIS) be prepared for each National Forest. The process is:

* Public participation is sought prior to starting the plan by seeking comment on areas of concern.

* Each region prepares guidelines for the interpretation of policy within that region.

* Plans are prepared for 10 years (for each National Forest) on a 150 year horizon for timber yield.

* An EIS is prepared by the Forest Administration and approved by the US Forest Service. The National Environmental Protection Act primarily requires that environmental effects are *disclosed*.

* Several options must be prepared, each giving different weighting to various uses e.g. recreation, timber, wildlife. Plans are largely based on specifying areas of primary use. FORPLAN (a mathematical modelling system) is required to be used to calculate the effects of different options or to calculate optimal solutions. A preferred option is prepared.

* For each of the alternatives the non-declining yield of total volume is calculated together with the yield of sawlogs for the next decade.

* There is a 90 day period to appeal to the Regional Forester.

* A final plan is released.

* If not satisfied an appellant can seek a court injunction on the plan. Court appeals are usually based on claims of non-disclosure of environmental impacts, especially the very long term accumulated effects. An injunction may be issued on all or part of the operations in the plan.

* Even after a plan is finalised each separate timber sale is also required to have a separate environmental assessment which may (and often is) challenged in the Courts.

To date, approximately $4 billion has been spent on the planning process and all completed plans have been appealed.

In addition to the requirements of the planning process there are also regulations to be complied with which are quite detailed and prescriptive in nature. They include such things as coupe size and dispersal, age of clearfelling[1], standards of regeneration and so on.

Running parallel to this are the State regulations which apply to State and private forests and which are controlled by such bodies as the California Board of Forestry. These laws can also be made directly by citizens developing 'initiatives' for referendum. These are often extremely detailed and prescriptive. While State regulations do not have a direct connection with the federally controlled National Forest, there is an inevitable flow-on effect because of the expectation that the management requirements for National Forest should be more stringent than those for private land.

Management practices

Practices on National Forest are in a state of rapid change at the present time. The practices described here are those that are still in general use. New developments are covered later under the heading of New Perspectives.

Preferred management plans, when and if they are approved, categorise the forest into a variety of use areas which vary from forest to forest. They may include; wilderness, wild rivers, research natural areas, high country management, recreation, habitat protection, general forest (for wood production); overlain by various other qualifiers such as rotation length or visual resource management zones. There is a tendency to reserve areas for specific uses rather than to manage for specific values within the forest. eg to reserve old growth rather than to identify and manage for the critical elements of old growth. In the Tahoe National Forest for example 90% of the wood production comes from 40% of the area. This philosophy is not necessarily through choice but because of the lack of trust that exists.

Most plans require a certain percentage of the forest be maintained in each seral[1] stage (in California it is 5% in each of the seven stages in conifers).

The total timber harvest from National Forest is directed by Congress and allocated to each of the Forests. Given that no plans are yet finalised it is difficult to see how this relates to the yield that is predicted in the preferred option in the management plans. Under the Reagan administration, for example, there was a dramatic increase in the harvest as part of a policy of national debt reduction, undertaken with a conviction that the forests were capable of higher production.

Timber is sold standing by verbal auction with a reserve price based on residual stumpage[1]. There is no security of resource for the buyers and an individual sawmill may have to win half a dozen timber sales each year to meet the mill requirements. Income from the sale may be allocated directly to the establishment of the regeneration and its tending till the age of ten. 25% of the nett income goes to the counties that contain National Forest for the upkeep of schools and roads.

The principal silvicultural system used is clearfelling and planting with the indigenous species, wherever possible with improved genotypes. Shelterwood[1] systems are used for

1 See Glossary, Appendix 4.

red and white fir at higher elevations. Federal regulations govern coupe size and dispersal. Maximum coupe size for Douglas fir forest is 24 ha and for other types it is 16 ha. No adjacent cutting is permitted till a specified number (usually 750 per ha) of regeneration has reached a height of 1.5 m. These coupe size and dispersal standards are progressively tightened according to whether the land is in one of five visual quality objective zones. In practice this did not appear to have a strong influence on much of the area but it was difficult to assess because of the intermingling of National and private forest. (Figure 2).

Utilisation standards are relatively high and little large debris is left on the ground after logging.

Logging is by ground skidding or by cable yarding[1] on steep country. The lack of soil damage or erosion is very impressive. It is technically possible to carry out cable logging for thinning[1], shelterwood and quite complicated retention logging, but in practice this is limited by costs. Operator safety is a problem with cable yarding if dead trees are retained. There is an increased use of helicopters for logging, primarily because of public pressure to retain roadless areas.

While some burning of logging slash is carried out on steep country, most site preparation is by heaping with a grapple machine and burning the heaps after snow fall (Figure 3). Concerns for air pollution are probably one of the major reasons for controls on the use of fire in the forest and these are such as to make it almost impossible to achieve a silvicultural burning program.

To achieve the regeneration establishment criteria, control of competition is important. Threats of disruption have effectively prevented the use of herbicides for this purpose on National Forest though their use is legal and they are used for all purposes on private land. Regeneration is hand weeded two or three times at a cost of about $3000 per ha (compared with $400 per ha for herbicide). Some areas cannot be effectively regenerated without herbicides for competition control. Exclusion of these areas and slower growth elsewhere is estimated to result in a 30% reduction in future production in some areas.

Many areas are non-commercially thinned at about ten years of age.

At the present time in California most of the logging is confined to the salvage of trees that have died from the effects of drought-induced bark beetle mortality. Most stands are vulnerable when they reach a density of 50 m^2 per ha of basal area[1].

Logging operations on private land are essentially the same except that the rotation lengths are shorter (perhaps 50 years) to maximise economic return rather than maximising volume production; dispersal is minimal; and there seems to be little if any consideration given to landscape values even in visually sensitive areas (Figure 4). The intermingling of land tenure makes it impossible for the public to distinguish between the private and Federal land.

Conflicts and Issues

Forest management on the West coast is characterised by conflict with a high media profile. There are numerous contributing factors, but undoubtedly a central theme is the rapidly increasing urban population who see the primary value of forests as a source of recreational opportunity. In California, for example, there are 4 million people within one hours drive of the El Dorado National Forest.

Many people are prepared to travel as much as two hours to work in order to live on the fringe of the forest. For them the forest is part of their backyard and they are not prepared to see it changed in any way. Forests are also seen as a security blanket in an

1 See Glossary, Appendix 4.

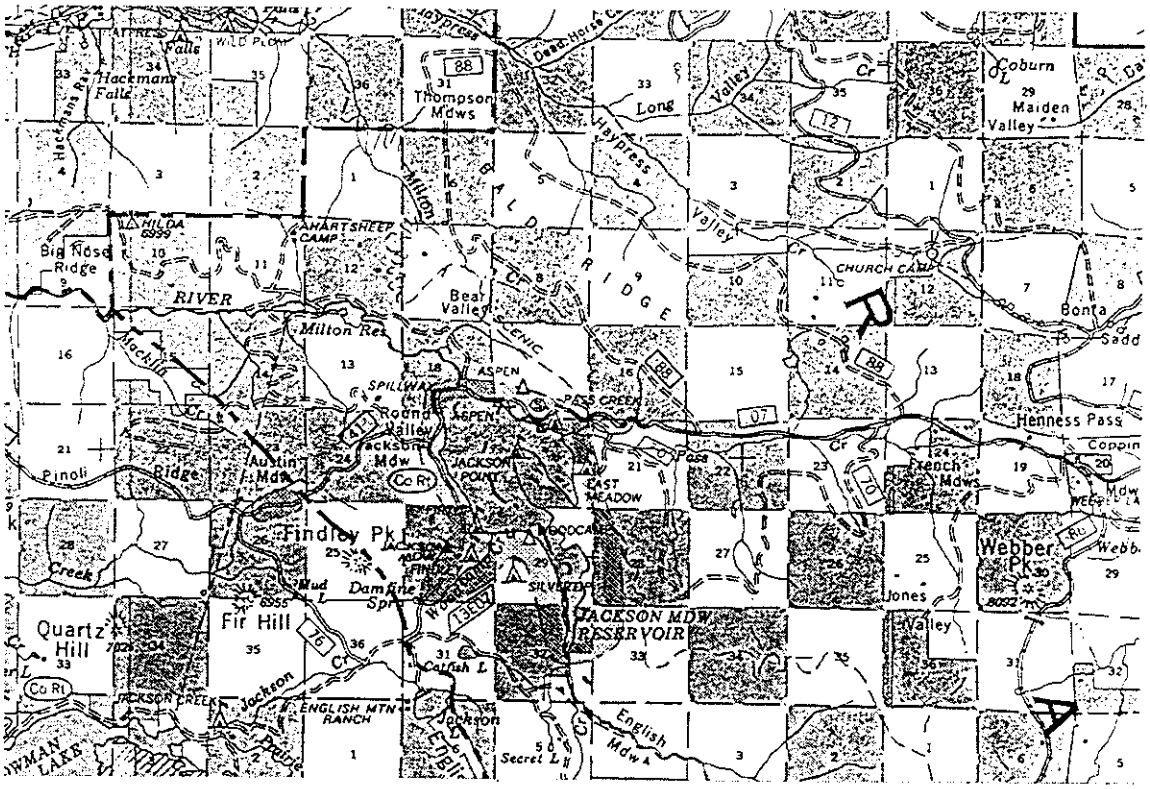

Figure 1 One mile squares of alternate ownership resulting from land grants in the last century create management difficulties in some National Forests. It is a major impediment to 'catchment' planning.

Figure 2 Any disturbance in these forests is highly visible and there is little evidence of landscape management in this visually sensitive landscape

Figure 3 Logging debris is heaped to allow access for planting and is burnt after snowfall. This small coupe was cable logged.

Figure 4 Many private forests give little consideration to visual sensitivity.

increasingly polluted and rapidly changing world. They are regarded as complex, delicate, but static biological systems.

At the same time Americans have the highest per capita consumption of wood products in the world, 30% of which comes from the forests of other countries.

Political power resides with the urban population most of whom are unaware of their usage of wood products or who believe that the country is sufficiently affluent to preserve its forests and import its wood products. The providers of these products have little political influence at the national level and certainly not in places like California where although the wood products industry is large, it represents only 4% of the economy.

The US Forest Service is charged with the responsibility of accommodating all forest uses through a process of evaluation and concensus. However, views on forest management have become totally polarised, often deliberately so in order to serve other political agendas. As a consequence almost every practice of the Forest Service, particularly those associated with wood production, is a source of bitter controversy.

The issues which attract most attention and controversy are; wood production and sustained yield, the practice of clearfelling, fragmentation, the retention of old growth, planning, New Perspectives and the impact on industry.

Wood Production and Sustained Yield

The primacy of the production philosophy in the National Forests is often attributed to the influence of the German-trained Fernow who was the first chief of the US Forest Service. It is argued that it was his teaching of the sustained yield forestry ethos based on the 'normal' forest[1] that was responsible not only for the production ethic itself but also for clearfelling. This view appears to reflect a misunderstanding of the concept of sustention and of the 'normal' forest. It seems to imply that the 'normal' forest provides only for the sustention of wood production; and that the concept incorporates some fundamental need to *maximise* sustained timber yield to the exclusion of other values.

This interpretation overlooks the fact that the 'normal' forest merely implies a particular representation of age classes from regeneration to rotation age. A representation of all age classes in the forest is essential to sustain all forest values in the long run, including the continued maintenance of old growth. Whether wood production or other values are favoured depends primarily on the rotation length. Short rotations are not a fundamental requirement of 'normality' but a function of productivity and economics. Similarly the 'normal' forest implies nothing about the structure of the forest. Both even-aged and uneven-aged forests may constitute part of a 'normal' forest as long as the age classes are appropriately represented.

Production primacy and the way it is practiced in American forestry seems more to do with the economic rationalism that underpins the society than it has to do with sustainability. It will be a pity if clearfelling and sustained yield are both abandoned in the process of reducing the dominance of wood production in forest management.

Clearfelling

Clearfelling produces forest stands of one age. In itself this may not be very different to the condition that exists in many parts of a natural forest. However, when it is practiced with the intensity and at the rate that it is on the West coast in recent years the forests can take on the appearance of rather monotonous tree farms.

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1 See Glossary, Appendix 4.

While the American public are prepared to tolerate this on private land they do not wish the National Forests to be managed in this way. This issue has escalated in recent years for several reasons; in the private forest area many owners have done little or nothing to ameliorate the visual impacts of logging; some forests have been the subject of a rash of corporate takeovers and have been excessively cut to provide cash flow; and there has been a deliberate increase in the rate of cutting because of a fear of further constraints on logging. On the National Forests there has been a sudden increase in cutting rate as it takes over supply from the private forests but also because of a deliberate increase in the rate during the Reagan administration. Because of the high visual impact of this amount of logging, the dramatic impact in this mountainous topography and the intensity with which it has been practiced, it is easy to appreciate the public concern. And it has been easy for the opponents of logging to exploit the image even further to equate clearfelling with total and permanent destruction. The consequence has been a vigorous campaign to stop the practice of clearfelling. Most people are unaware that some of the 'pristine' forest that they wish to protect from this permanent destruction is itself the result of uncontrolled clearfelling in the 1850's and later.

In the mixed conifer forests of the Pacific South West, coupe sizes of 20-40 ha are believed to provide maximum diversity of wildlife. But for many people even the smallest gap in the forest is regarded as clearfelling and therefore unacceptable.

In my view, however, it is not the practice of clearfelling per se that has created the problem but the intensity and in particular the rate at which it has been done.

Fragmentation

Federal regulations limit the size and dispersal of logging coupes. Small size and maximum dispersal was perceived as a means of minimising visual and environmental impacts and increasing diversity. However the practice is now seen to create fragmentation rather than diversity. It is believed by some scientists to have a negative impact on the movement of large-range animals, snow management of catchments and visual impacts (Figure 5). There is a growing scientific opinion that aggregation of cutting coupes is more desirable than dispersal for many forest values. Data is beginning to be collected to try to determine the requirements of all the various elements involved and to manage for these things on a landscape or catchment basis rather than at the coupe level or by specific reservations.

Associated with this is the issue of roading for logging. Some of the opposition to logging stems not from the impact of logging itself which may be seen as transient or even beneficial to some fauna but that the associated roading provides permanent access for vehicles and hunters. Hunters and other recreationists see this as beneficial but the proponents of wilderness press for more helicopter logging. This is becoming more common but it is much more costly and in some cases the input of kilojoules for logging exceeds the energy value of the wood that is produced.

Old Growth

The most controversial issue at the present time is undoubtedly the question of old growth forest. It is controversial because it, together with other virgin forest, is the major source of timber until the earlier cutover forest becomes old enough for the second cycle of cutting. But old growth forest also has other important values. It has special emotional, even spiritual values, because it is old, it is relatively untouched and it provides an illusion of unchanging stability. It has special aesthetic values because it often contains large trees, and there is usually no evidence of recent major disturbance. It has particular conservation values because it represents one of the stages of succession of a forest. It contains a higher proportion of decay in the tree layers and at ground level, and in many of the north American forests it contains climax species that are absent from younger seral stages (Figure 6).

Figure 5 Dispersed coupes in Douglas fir forest. Dispersal is now considered by some to create undesirable fragmentation and there is now a move to amalgamate cutting coupes.

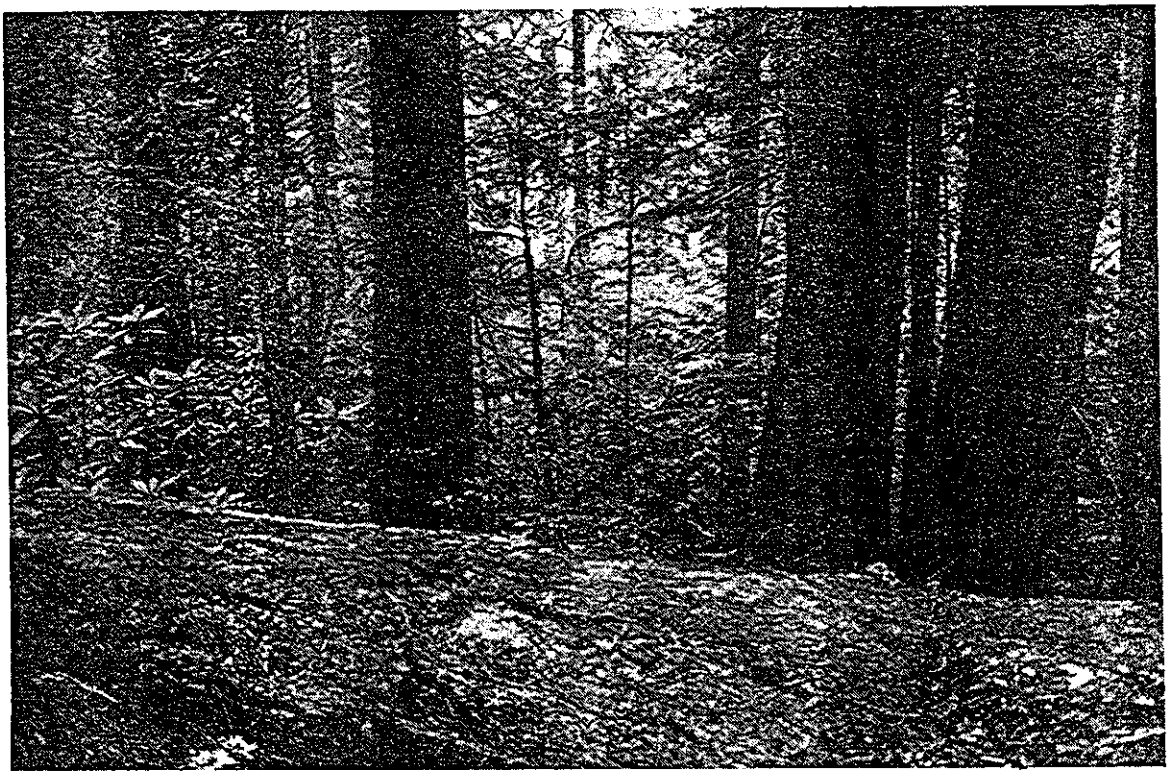

Figure 6 Old growth forest of the Pacific North West contains species and other structural elements that are not present in early seral stages.

Figure 7 This trial of New Forestry incorporates retained trees and log debris. It is planned to cut the tops of 10% of these trees each decade to maintain a continuing supply of dead stags for woodpeckers and the species that follow them.

Figure 8 Trials of new forestry in a mixed aged forest with retained hardwoods and groups of young trees.

Some fauna species are associated only with this stage. While it may be no more important than any other seral stage, it does require special attention because once disturbed it takes longer to replace.

Much of the argument revolves around how much should be placed in reserves and whether all of it or representative areas should be reserved. One argument is that there are already sufficient areas in National Parks and Wilderness areas to represent this stage and to protect the associated species; the other view is that most National Parks and Wilderness areas were selected because of their spectacular scenery or remoteness and tend to be at higher elevations. It is argued that the lower elevation, highly productive forest is not adequately represented. (At the present time there is 1.2 million hectares of old growth forest reserved in the Pacific North West.)

Conservation groups are committed to the reservation of all the remaining old growth forest while the industry and those communities dependent on it argue for continued access for logging at least sufficient to sustain the industry.

Recently the Endangered Species Act has been invoked to protect the Spotted Owl, and with it large patches of old growth forest on which it is said to depend for its survival. This has itself lead to a great deal of argument about the definition of old growth and there is confusion between old growth and Owl habitat. Considerable energy is expended by different interest groups on mapping old growth forest to different definitions.

A great deal of mystique has developed around old growth and its degree of complexity, much of it based more on enthusiasm and awe than scientific evidence. However research is now underway to attempt to define old growth characteristics for different forest communities, and to determine those elements that are essential to the associated species. Research is also underway to determine the means by which appropriate logging practices may be used to encourage the regeneration of more tolerant species and speed up the development of late seral stages. This latter approach has been used in Europe (for different reasons) for many years and there is no reason why it should not be successful in the U.S.

The issue has now gone well beyond trying to work out what is essential for species conservation. It is now well recognised that campaigns such as the Spotted Owl are a means by which the powerful Endangered Species Act can be used as a tool to preserve the old growth forest. A management solution to the protection of the Owl will not resolve the issue because it is the 'spiritual' attachment to old growth which is the real motivation for preservation. Evidence that the Owl does occupy second growth forest has not reduced the intensity of the argument. Resolution is made more difficult on National Forest by the fact that; the US Forest Services manages habitat, the States have jurisdiction over the actual wildlife, and the Endangered Species Act is a federal law. It is now a question of a political rather than a biological trade-off.

Planning

The massive planning task begun fifteen years ago on the National Forests is only now coming to fruition. The primary purpose of the plan is to consider the impacts of a range of management options and come up with a preferred option after public comment. FORPLAN is the central planning tool that is used to calculate solutions from the constraints that are input. While it has its limitations it is nevertheless a powerful tool and is probably limited more by the standard of the data and the assumptions than by the program itself. Forest Service plans and FORPLAN in particular have come under a good deal of criticism, at times the plans being said to be too complicated and at other times too superficial. Critics constantly demand more and more factors to be considered but want the answer to be simple and straightforward.

The greatest weakness of FORPLAN is that it has no spatial analytical capacity, yet more and more issues are needing to be analysed within that framework. It is therefore very much a top down analysis which does not cater well for the accumulation of localised constraints. When an attempt is made to achieve the predicted yields it is often found that the targets can't be met. This is partly due to the inability to handle some of the management rules (e.g. dispersal). It is also due to external factors such as disruption by protests, pending court action or problems created by the actions of private owners on adjacent properties. Great play is made of these inaccuracies by opponents of the plan. They claim that the planning process is unreliable at best or deliberately deceiving at worst. The engineering precision expected of these plans by a critical public is quite unrealistic and will probably never be achieved regardless of the money expended.

Critics of the US Forest Service regard FORPLAN as a black box with which the Forest Service can prepare dozens of plans and select those that give the answers they want. While this may seem a jaundiced view it probably hides the reality that this type of planning tool can also be used to test the impact of the proposals of various interest groups, thus making it more difficult for them to brush aside as trivial, the possibly adverse impacts on other values. Whatever the reason, the US Forest Service and its critics have a huge gap of understanding and trust.

Various Federal Acts require that plans are prepared to provide for multiple use and the sustained yield of goods and services from the National Forest System in a way that maximises long-term net public benefits in an environmentally sound manner. These laws define these benefits. From this point on it is the responsibility of the US Forest Service (not the Government) to provide that balance of goods and services. The Forest Service therefore becomes the focus of discontent rather than the Government or the Administration. Furthermore it has the effect of shifting the emphasis from the political system, which is built on majority opinion, to the courts. This effectively nullifies the value of consultation and concensus as part of the planning process because it puts far greater power in the hands of individuals through the court process. Unlike the political process, there is no incentive to compromise. The nature of the law and the American propensity to use it makes it a common tool in the environmental area, especially as the US Forest Service pays the legal costs. One advocate group alone, the Sierra Club Defense Fund, has a turnover exceeding $10m a year. In some sale areas the costs of court actions exceeds the value of the timber sale.

There is no doubt that better data and techniques for analysis would produce a better understanding of the interaction of the various competing values. It seems highly unlikely however, that it would result in better plans or reduce conflicts. It is also unlikely that more sophisticated methods of conflict resolution will help while the laws and the court system are used in the way that they are.

New Perspectives

New Perspectives is the name given to a program by the US Forest Service to change the emphasis of forest management on the National Forests. It aims to abandon the emphasis on single use management (at least in those areas where timber production is occurring) and replace it with a system of genuine multiple use where the forest is managed for multiple values as well as multiple (utilitarian) uses. There are a great many views on what that really means and at this stage this diversity of opinion seems to be encouraged by the Forest Service. Some of the phrases used to describe it are; a recognition that values are as important as uses; extends sustained yield to the ecosystem; placing the emphasis on ecological principles to sustain forest values; the ecosystem limits the yield; management that mimics natural processes; integrated management. There are as many views on how it would be achieved.

There appears to be two basic philosophies with some currency. One is that forests should be managed to replicate 'natural' processes with human services coming as a by-product; the other is that forests should be managed to produce human needs *while at the same time* ensuring that the basic ecological processes are maintained.

'New Forestry' is seen as one of the ways of achieving at least the latter objective. The object is to move away from the plantation forest on the one hand and pristine reserves on the other to a system where the essential biological elements of the forest can be provided throughout the whole forest. It is based on the assumption that the reserve systems will never be large enough to satisfy all the biological needs and with good management of the multiple use areas there is no need to limit our conservation sights to the reserves alone. The strongest proponent of the argument, Dr Jerry Franklin, argues that much of the recovery of a forest after a natural disturbance, (eg fire), comes from the 'legacy' of the remnants of the original forest such as stags[1] and logs. It is these that speed the recovery of other forest dependent organisms by providing some of the elements that are important in the old growth forest. He argues that the intensive practices now used in the US do not leave this legacy. Given the intensity of current practice, it is easy to understand his concern. He therefore presses for the retention of more stags (or trees that will become stags), and large logs. He is not arguing for selective cutting, at least in the wet forests of the Pacific North West, nor at this stage for any particular configuration of retained trees. The proposals seem eminently logical and practical and a number of field trials have been implemented (Figures 7 & 8). Despite its biological advantages, it is unlikely that this approach will diminish the opposition of the most influential critics. Indeed it may increase criticism from an aesthetic viewpoint because it will be less 'tidy'.

The US Forest Service has begun a major research program to underpin New Perspectives. Once established it will have an annual budget of $13 million. At this stage it appears to be largely directed at trying to determine how natural forests developed and acquiring a better understanding of the basic ecological processes of forests. The objectives of individual researchers seems to be widely divergent and it is likely to be a long time before this type of work makes a major contribution to practices on the ground. Field application of 'new forestry' does not seem to be supported with much applied research. The Coastal Oregon Productivity Enhancement Program (COPE), a co-operative research program involving several agencies, has this objective.

One of the more interesting areas of research is the work aimed at determining the forest (not just stand) structure that provides conditions for critical species or for the greatest (or critical) diversity. Related to this is the growing emphasis on the management of forests at the landscape, or catchment level rather than at the stand level. Together they provide the prospect for developing the concept of biological diversity into a management reality.

New Perspectives in its present form abandons timber primacy as an aim (as presumably it should always have been since 1960) and suggests that timber targets should also be abandoned. In its place will be a system that aims to be more natural and be based on managing to produce a 'desired future condition'. At present the difficulty is that the 'desired future condition' is different in everyone's mind and in some cases has little more substance than a visually diverse landscape. Under the philosophy of allowing timber supply to be a byproduct of a future desirable condition, it is evident that wood production will fall to a very low level, effectively becoming a salvage operation. This is because it will seldom be possible to show that cutting trees is *essential* to forest health even though it may not be detrimental. In a more subtle way, the same problem arises for fauna, water supply and all other values. What are the targets? Managing for ecological well-being is not specific enough to provide guidance for management. Unless it can be specified in terms of desirable and minimum acceptable standards sensible management cannot follow. Nor will it be possible to provide for consistency of supply of wood or any other forest attribute.

1 See Glossary, Appendix 4.

Oddly enough in this search for more natural approaches to management, the use of fire, the most important source of natural disturbance, is rarely mentioned or if it is, fire is specifically excluded or made difficult to use because of pollution controls.

Regulation of Private Forest

The State Government, on the basis of recommendations from the Board of Forestry, controls forest practice on State and private land. In 1990 several different 'citizens initiatives' were put to referendum, which if passed would become law. Some of these would have limited or banned the practice of clearfelling, prevented the logging of old growth forest and obliged the state to repurchase it. In addition they included a wide range of detailed forest prescriptions. They were not passed but most commentators believed that they would have been had they not involved an increase in taxes.

Following this the industry and major conservation groups developed a joint proposal which while severely restricting operational practices was nevertheless agreed to by both parties. This development was almost immediately followed by the announcement by a faction within the conservation movement that they would continue with their own, much more restrictive 'initiative' at the next election. This highlights the difficulty of attempting to resolve these issues by concensus under the political system that exists. While the process of referenda may seem admirably democratic, one wonders at the value of voting on detailed management prescriptions when in this particular example 50% of the voters had never visited a forest in their lives.

Industry and Community Stability

At the present time wood production is a permitted use on 31% of the National Forest, 17% is designated Wilderness and the remainder is under a variety of other categories (presumably this is under the preferred options). The preferred options in the new management plans have resulted in substantial reductions in the level of the allowable cut from the National Forest. It was not possible to obtain overall figures because it was changing almost daily. However in the Tahoe Forest there had been a reduction of 30% with a further 25% likely as a result of appeals. In the Willamette Forest, 56% of this area had been available for wood production but had been reduced to 35% under the preferred option. Proposals of the conservation movement would have reduced it to 9%. In addition to this further areas of Owl habitat are regularly removed with the attendant restrictions on the intensity of cutting in the intervening areas (Figure 9). Many areas are challenged as each sale is offered, even after the plans are approved. A variety of orchestrated delays have meant that only 5% of the logging target from the Mt Hood National Forest, for example, had been reached midway through the logging season. The additional impact of New Perspectives on this level of wood production is uncertain at this stage. It will depend on which philosophy is finally adopted.

The final impact on the production of wood is impossible to predict at this time but it has been suggested that the production from the Pacific North West may be reduced to perhaps 15% of its former level. Industries and communities that depend on wood supply are seriously affected. Because the supply was shared by both the private sector and the public forests, no-one accepts responsibility for this situation. Industry points to a broken commitment by government, conservationists accuse industry of over-cutting their resources, the Forest Service reduces the harvest to match the areas available and the Federal government has so far not responded in any effective way. The industry has not helped itself or its argument by continuing to export sawlogs to Japan for processing, presumably because it is more profitable than local processing. Ironically this was partly encouraged by the absence of long term access to supply, and therefore a disinclination to invest in new technology.

While the industry is vital to Oregon and Washington these States have little influence in Congress. However it seems clear that the present laws will continue to be exploited by a section of the community to bring the industry to a halt regardless of whether that is the intention of the law. In seeking to redress the balance from an excessive emphasis on production, the conditions have been created to produce the reverse. Unless Congress assumes responsibility for natural resource priorities, rather than leaving it the judicial system to do so by default, the present trend is likely to continue. The consequence is that the industry could effectively disappear. The consumer, for whom the industry exists, will not feel the impact for a long time and probably not while other countries are prepared to cut their forests for the American market. It is this 'delayed impact' that will make it difficult for politicians to act to resolve the situation.

EAST COAST OF THE UNITED STATES

Itinerary

I spent three days on the East coast and visited several State forests and Parks in Connecticut, forests of the New Haven water supply catchment area and the Yale University forest in Massachusetts. I had the opportunity to meet and discuss multiple use issues with staff of the Connecticut Department of Environmental Protection, Yale University and the catchment management authority for New Haven. (Appendix 1)

Historical Background

Connecticut was originally a forested landscape. By 1850 more than two thirds of it had been cleared for agriculture and the remainder had been heavily exploited for construction material, fuel and smelting. The development of the mid-western plains for agriculture and improved transport made it uneconomical to farm the stony land of Connecticut. From 1850 to 1960 agriculture was abandoned on large tracts of land. Today the State is 60% forested, most of which resulted from the natural regeneration of the abandoned farmlands (Figure 10). 20% of the forests are publicly owned and the remainder is privately owned by about 90,000 different owners.

About 20% of the State is urban or industrial land, and it is increasing at more than 1000 hectares per annum.

Connecticut is one of the most densely populated parts of the United States. Communities are highly decentralised and many of them are dormitory communities for larger centres. The forests therefore serve as a backdrop to the living environment of a large number of people. Catchment protection, recreation, landscape and wildlife are all values that are in great demand from these forests.

The majority of the forests are about 90 years old and are mainly mixed hardwoods (Black Beech, Red Maple, Paper Birch, Tulip, and Red, White and Black Oak). White Pine also occurs and there are some plantations of introduced Red Pine. The main form of natural disturbance is hurricanes to which the forest is increasingly susceptible when it reaches maturity. It also becomes more susceptible to insect and fungal attack beyond about 120 years of age.

Management Practices

The primary objective of management for the State Forests of Connecticut is to maintain a healthy forest with reduced susceptibility to large scale losses by wind, insect or fungal attack. The main impediment to this is seen as the high proportion of forest approaching maturity. The policy is therefore to work towards the creation of a range of age classes by a program of cutting and regeneration. There is no commitment of resource to industry but in order to maintain the capacity to achieve the regeneration there is a need to ensure that the industry continues to exist. The Department is encouraging the development of an industry to utilise the hardwoods available, mainly for furniture manufacture. With the maturing of the forests of Connecticut, the re-establishment of a timber industry is now possible. Growth rate exceeds the current cutting rate from the forest by a factor of two.

When regeneration is required it is produced by cutting to shelterwood with the object of retaining the existing species mix. A substantial patch of regeneration (perhaps 50 ha) is required to minimise grazing damage by deer. When the regeneration is 15-20 years old (2-3 m high) the shelter is removed in 1-4 hectare patches (Figure 11). Thinning is carried out in intermediate stands. The silvicultural system that is applied is not unlike that practiced in the jarrah forest of Western Australia.

Great care and attention to detail is required when logging operations are confined to small areas of forest close to housing development. The owners of adjacent houses, often very affluent ones, regard these forests as extensions of their own land and use them extensively for recreation as well as for their landscape values. Very high levels of 'neatness' are demanded. However, the Department has been very successful in satifying neighbours requirements without compromising sound silvicultural practices. There are several contributing factors. The trees are not particularly large and the operation is generally of low intensity with a high level of utilisation. Firewood is often sold to neighbours and there is little debris evident after the operation, even to the point where it could be said to be quite unnatural. Care is taken to clear walking paths at the end of each day, to limit the noise of machinery, to lop felling tops, limit soil disturbance and to grass all landings after the operation is finished. While they do not advertise the intention to log, they explain what is happening and are frequently available on site to discuss the concerns of neighbours (Figure 12).

Excessive deer populations sometimes create regeneration problems. Hunting as a means of control is not particularly effective. This is because hunters wish to maintain stocks, hunting in the 'suburbs' is difficult, and there is growing opposition from animal liberationists.

Practices in water catchment areas are similar though they are less subject to aesthetic scrutiny because of restrictions on public access. Logging occurs very close to the waters edge and sedimentation is not a problem. Hunting is not permitted.

There does not appear to be a lot of conscious effort given to specific wildlife measures and it not clear whether this is because it is not needed or it is not known. There certainly appeared to be the willingness to do whatever was necessary to manage for specific wildlife.

Unfortunately I did not have the opportunity to see operations on private property but they are certainly not visually intrusive from public access roads as they are on the West Coast.

Issues

Competing pressures for the use of these forests (in what Professor Dave Smith describes as the 'most densely forested metropolis in the world') is extreme. Despite this, at least on the public lands, it appears to have been possible to cater for the full range of forest values in a truly multiple use sense. While there were areas where various uses were subjected to greater restrictions, such as catchment areas and town parks, there were no areas of strictly single use. Furthermore, although wood production is a tiny part of the economy it is nevertheless an acceptable use on virtually all of the forests in the State.

There are many reasons why this success has been achieved. I believe the most important of these are:-

* there are no old growth forests remaining and therefore the forests do not attract the same 'spiritual' following as the forests on the West coast.

* for that reason the forests have not become the focus of attention for national conservation bodies. This has allowed conflicts to be resolved at the local level to the satisfaction of the community concerned rather than serving some larger political agenda.

* the trees they are dealing with are relatively small, they are tolerant species and therefore can be managed with much less disturbance than many of the virgin forests on the West coast. The aesthetics of logging are much more acceptable.

* the rate of harvest has been much more reasonable.

Nevertheless the pressure on the forests primarily to provide an attractive landscape for dormitory communities is likely to grow and continued production from these forests will become more tenuous, regardless of how well they are managed.

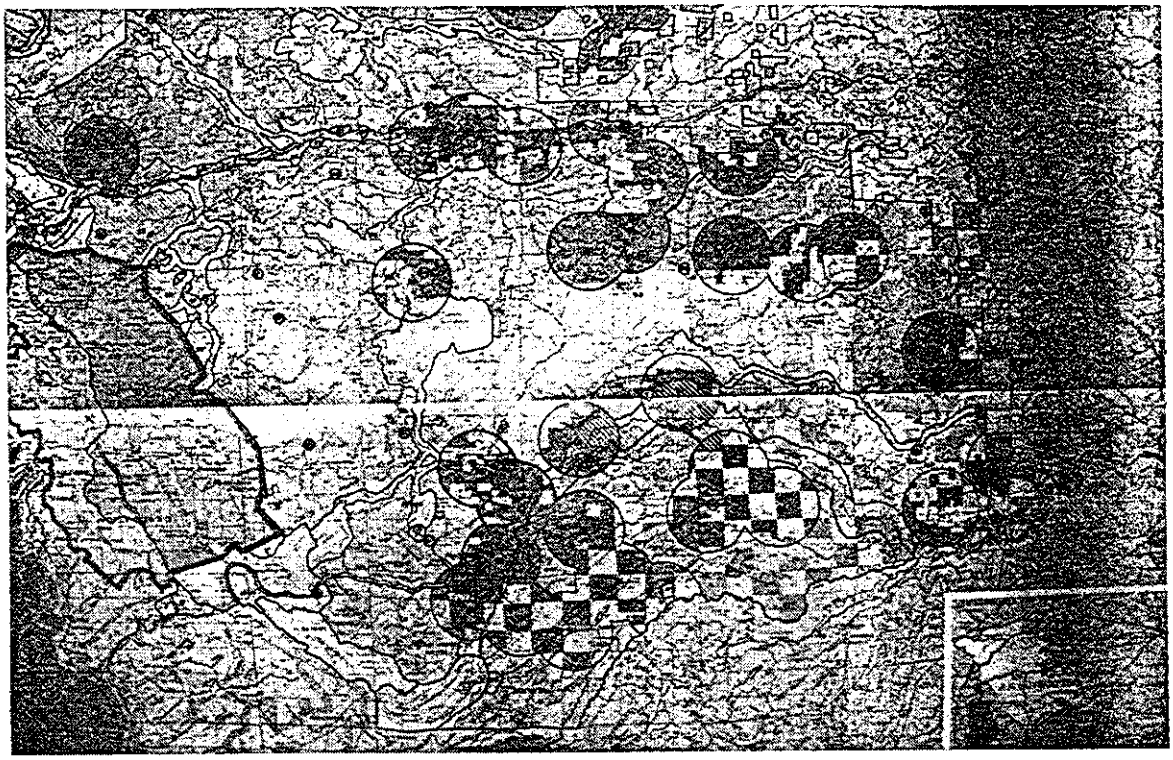

Figure 9 Owl habitat sites on the Tahoe National Forest.

Figure 10 Forests of Beech, Oak and Maple have reclaimed the abandoned farms of Connecticut.

Figure 11 Shelterwood is removed in small patches in the mixed hardwood forest. Great care is required when logging in the proximity of housing. Occupiers regard these forests as extensions of their own land.

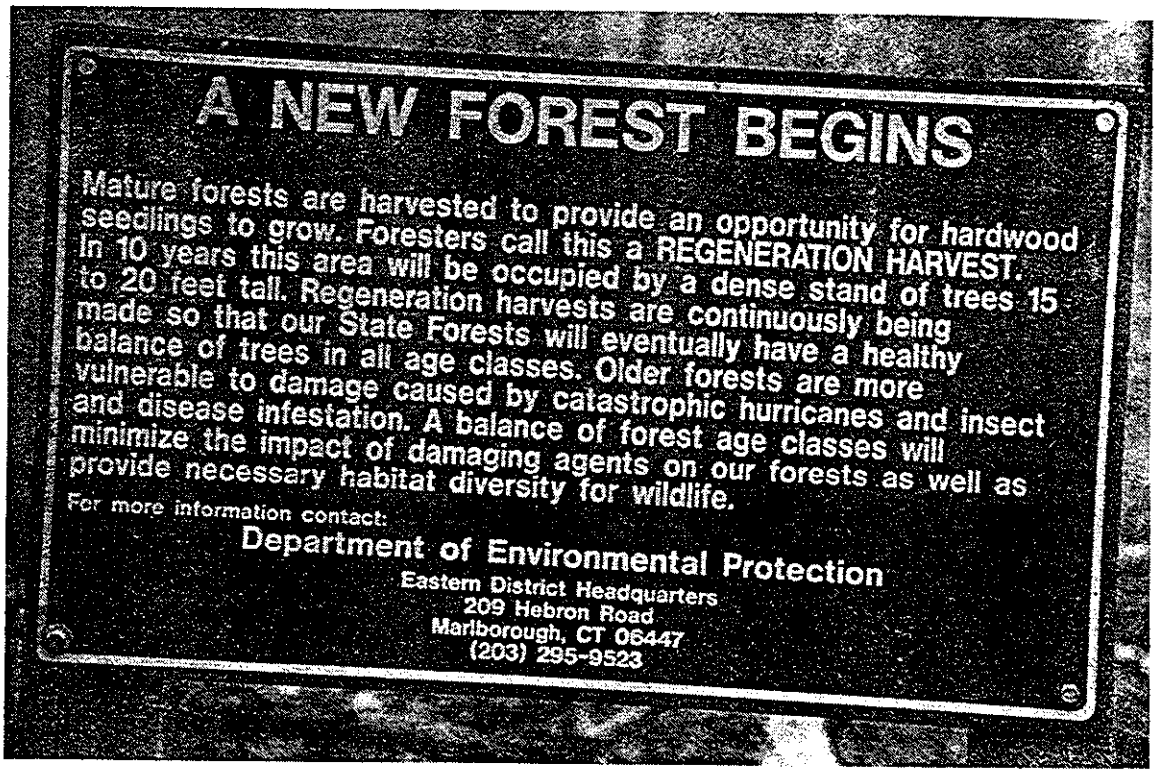

Figure 12 Attention to detail, appropriate scale of operations and explanations of the work are used successfully in very sensitive areas.

SWEDEN

Itinerary

One week was spent in southern Sweden visiting State and private forest, principally near Falun and Växjö. I had the opportunity to meet staff of Domänverket (the State owned Swedish Forest Enterprise), Stora (the largest forest products company in Europe), Södra Skogsägarna (the largest of the Swedish forest owners associations) as well as a retired officer of the Krononberg County Forestry Board and a forest farmer (Appendix 1).

Historical Background

Grazing and farming has been practiced in Sweden for more than 2000 years, much of it by a form of shifting agriculture even up until quite recent times. Although some controls have existed over the use of forests since the 12th century, most of the forests of southern Sweden (the most densely populated area) had been cleared by the 1500's. Apart from clearing for agriculture, forests were also used extensively for the process of mining and the smelting of copper and iron. Pressure on the forests increased in the 1850's with the development of steam sawmills, pulp mills and the general building boom in Europe. Shortage of forest resources occurred and in many areas there was severe land degradation and consequent emigration.

Effective control of forest use did not occur till the passing of the Forests Act of 1903. This controlled the age at which forests could be clearfelled and made their replacement mandatory. Regular revision of the Act has occurred since that time, initially directed at increasing productivity and maintaining forest health and more recently with a greater emphasis on conservation of species and landscapes. The Act applies equally to State and private land.

The majority of the forests of southern Sweden date from 1910 to 1940, deriving from the natural regeneration of abandoned farmland or by deliberate afforestation. Some areas of virgin forest still exist in the north and are mostly within high mountain reserves. 60% of Sweden is forested (23.5m ha), predominantly with Norway Spruce and Scots Pine with lesser proportions of Birch and other hardwoods.

3% of the total forest area is reserved in National Parks or Nature Reserves. Most, but not all of the reserves are State land and the majority are in the north of Sweden.

Half of the forest is privately owned by small private owners and distributed among 240,000 separate holdings. The other half is equally divided between the State and large corporations. The small private holdings vary in size from 5 to 3000 hectares and about half are owned by absentee owners.

The forest products industry is a major force in the economy and is responsible for about half of Sweden's nett export earnings. However, increasing urbanisation over the last thirty years means that there is now only about 5% of its workforce employed in forestry and agriculture. Sweden regards its forests very highly. Forests and their associated lakes are used extensively for outdoor recreation and hunting and Swedes jealously guard their rights of access to all forests, regardless of ownership.

Policy and Administration

Forest policy in Sweden is based on the presumption that there will be a continuing demand for forest products and that they will continue to be a major contributor to the Swedish economy. Productive forests are also seen as an important means of maintaining a

population in the north, and is therefore strategically important. Forests are also valued for soil protection, recreation, and the quality of rural life.

These policies are brought into effect through the wide ranging powers of the Forestry Act. Though it is aimed primarily at sustained and high levels of wood production, it must be done by taking heed of nature conservation. It is subservient to the Nature Conservancy Act. The Forestry Act provides that:

* land that is capable of growing forest will be planted to forest unless it is used for another purpose;

* regeneration must be done by the clearfelling method (because it is the most successful) and forest that is clearfelled must be regenerated;

* clearfelling may not be done till the stand has reached maximum average growth (ie culmination of MAI[1]), and it may then be required to be cut;

* the size and shape of coupes and the type of trees to be left will be regulated;

* an even distribution of age classes on each holding will be encouraged and that the proportion of each holding that may be cut or retained will be regulated;

* non-commercial and commercial thinning will be done where the stand is overstocked;

* difficult-to-regenerate sites will not be cut.

It is the owners responsibility to regenerate but regeneration with hardwoods and non-commercial thinning is partly subsidised

Forest policy in Sweden is administered by the National Board of Forestry through the County Forestry Boards. The Board is responsible for strategic planning and for the administration of the Forestry Act.

There will be further changes to the Act in the near future which are likely to require more specific conservation measures to be taken in forest operations. This will be welcomed by many sectors of the industry who regard the present practices as too production oriented.

The Swedish University of Agricultural Sciences is responsible for the National Forest Inventory which covers all ownerships.

State Forests are managed by Domänverket (the National Forest Enterprise) which is required to operate on a commercial basis. It manages the forest, gravel and concrete supplies, and owns 13 sawmills and part owns a pulp mill. In addition to that it runs 70,000 ha of farmland, forest related commercial tourism, hunting and fishing and does consulting work. It returns a fixed sum to the government plus 51% of the profit.

Large corporations manage their forests to provide sawlogs and pulpwood for their own plants.

About half of the very large number of small owners are shareholders in highly professional forest management associations. They provide management plan services, any required level of management of the forest, coordinated marketing and price negotiations as well as owning sawmills and pulp mills in their own right. The largest of these, Södra Skogsägarna, represents 40,000 owners and manages the sale of 5.5 million m^3 of wood

1 See Glossary, Appendix 4.

each year. Farmers also have access to advice from the County Forestry Boards, large companies, and private consultants.

The organisation of a large industry on the basis of a large number of diversified owners has reached a very high degree of sophistication and appears to be highly successful.

Silvicultural Practices

The most common means of regeneration is by clearfelling and planting for spruce, and by clearfelling with seed trees for Scots Pine. In sites subject to summer frosts there are advantages in using a shelterwood for spruce. This is usually provided by the more wind-firm Scots Pine. There is a growing interest in the use of Birch for shelter. This may be achieved as a 'low shelterwood' when the birch regenerates as little as a year or two before the spruce is planted or as a 'high shelterwood' if it is already well established. The proportion of hardwood to softwood can then be regulated by later thinning. The increased use of hardwood has a number of advantages; it improves surface soil fertility, the mixture is believed to be more productive, it has conservation benefits and it is aesthetically more attractive (Figure 13). Given that birch is an aggressive pioneer species, it is surprising that it has not been used for this purpose in the past.

Although selection[1] systems were used at times during the 1920's to the 1950's they were found to give poor growth response in this climate. It was found that it was necessary to provide a gap of at least 2 ha in the south and 5 ha in the north to avoid unacceptable suppression of the regrowth. The Forestry Act now precludes the use of selection systems.

Despite considerable levels of hunting, deer and moose are frequently a problem for regeneration, especially for hardwoods. Fencing is sometimes required to ensure adequate survival and private owners are subsidised for this work.

Non-commercial thinning is usually carried out when the regeneration reaches 1-2 meters and there are several commercial thinnings prior to the rotation age of 70 years(in the south) or 140 years(in the north). Thinning intensity is conservative by Australian standards.

Logging is highly mechanised but soil damage is kept to a minimum by concentrating operations in the period when the soil is frozen.

Although the Act permits coupe sizes of 200 ha, the most common is 10 - 50 ha with much smaller coupes on private holdings where the total area of forest may be smaller than that. Despite the fact that there is not much evidence of deliberate landscape planning in the logging operations they do not very often become a dominating feature. This is due to several factors; the trees are small, the land is relatively flat, and the scale of the operation is in keeping with the open areas of farmland and the lakes. Despite the lack of botanical diversity in these forests, the mix of land uses and the varying age structures of the forest blend together to form an attractive landscape.

Until very recent times, there has been very little attention given to management for wildlife values, but this is changing.

Issues

Nature Conservation

Compared to the United States there does not appear to be much public concern about the use of clearfelling in Sweden. This was not the case about 20 years ago when

1 See Glossary, Appendix 4.

clearfelling was seen to represent overcutting. However the gradual increase in growing stock that has occurred over the years has overcome this perception.

There is, however, concern about the effect of forest practices on wildlife and there is pressure for 'softer' practices. This is rather ironic considering the forests in question have been created from cleared farm land or seriously degraded forest. Nevertheless some changes to practice would be beneficial to both wildlife and aesthetics. This is beginning to occur and is taking the form of retention of hardwoods for habitat, leaving rock outcrops undisturbed, and restricting the drainage of swamp land. There does not appear to be much objective evidence of the precise needs or benefits, but there is general agreement that it will be beneficial. Large forest owners appear to be in favour of these changes and are beginning to implement them. It is likely to become part of the Forestry Act regulations in the near future.

There are also calls for the reservation of more forest land for nature conservation. However the areas most in need of representation are in the south where most forest land is privately owned and the cost of repurchase has prevented action on this issue.

Increasing the Forest Area

In common with the rest of Europe, Sweden has an excessive amount of subsidised agricultural production. In the next few years it is intended to convert a half to one million hectares back to forest (Figure 14). Beyond that farmers will be subsidised to maintain the land under pasture as a strategic source of agricultural production, to maintain the open nature of the countryside and to retain the rural communities.

The use of forests as a source of increasing quantities of fuel wood is an area of growing interest. The search for alternatives to nuclear power has resulted in the construction of pilot bio-energy plants which use the lops and tops of logging operations for fuel for the centralised production of domestic heating (Figure 15). Research has already been done on the use of 2-3 year rotations of Willow for this purpose and these are likely to become part of the program to reduce the area under agricultural crops.

Acid Rain

Acid rain is an important issue in Sweden. In southern Sweden pollution loads exceed the acceptable levels by as much as eight times for sulphur and three times for nitrogen. One of Sweden's most significant imports is air pollution. 90% of the sulphur and 75% of the nitrogen pollution comes from neighbouring countries. Even with the reductions that have been agreed to, sulphur pollution levels in southern Sweden will be double the acceptable level in 25 years time. There are no predicted reductions in the levels of nitrogen pollution, most of which comes from vehicle emissions.

The whole question of acid rain and its impacts on the forest is extremely complex. It affects the forest through complex chemical interactions directly through the foliage and indirectly through the effects that it has on soil. Because the effects of the different pollutants is different and the proportions of each pollutant varies from place to place it is not possible to simply talk about 'acid rain'. At the present time the growth rates of the forests have never been higher because of the increased inputs of nitrogen. What is unknown is the point at which nitrogen levels will become excessive and become deleterious to growth as it has in parts of central Europe.

The effects of acid rain on soil has been described as follows: 'When the processes in the soil begin to suffer from the negative effects of excess nitrogen and acidification, a chain reaction throughout the whole of the ecological system is set in motion. The consequences of soil acidification include aluminium leaching, which results in difficulties for the trees in taking up nutrients and water. This, in turn, leads to the trees failing to take up the increasing quantities of nitrogen - a quantity that is being supplemented the whole time by

air pollution. Thus, the excess becomes greater and greater, with the risk of the loss of basic cations; this then further reduces the ability of the soil to resist the future effects of acid rain. The more the growth of the stand stagnates because of the effects of acidification, the more rapid becomes the impairment of the soil. After a critical load point has been reached, changes take place very rapidly.'[2]

Measurements show that pH has been reduced by one unit over a period of fifty years in some areas but the overall impact on the forest is still difficult to assess. A variety of cultural practices are recommended to minimise the effects on the forest as well as on the ground water. These include the greater use of hardwoods, reduction in rotation age, creation of hardwood forest edges, manipulation of cutting sequences, the management of slash and the use of liming. However it is stressed that these are holding actions only and the only way to prevent a major catastrophe in the long term is the rapid reduction in pollution levels.

2 Lundmark, J-E (1991) "Woodlands in Danger". Domänverket, Falun, Sweden.

Figure 13 Birch is used to provide shelter for regenerating spruce. The birch originally started as a low shelterwood and is now ready for thinning. It has benefits for wildlife, aesthetics and soil fertility.

Figure 14 Agricultural land being converted to forest; fenced to prevent browsing of the birch regeneration by deer.

Figure 15 Piles of logging tops ready for transport to a bio-energy plant at Växjö. Removal of nutrients in the litter is said to be counter balanced by the excess nitrogen entering the system from acid rain.

Figure 16 By 1800 much of the forest of northern Europe had been replaced by heather which was maintained by sheep grazing and fire. After a century of successful reforestation this is the last area of remaining heather in Germany and is being maintained in a nature reserve.

GERMANY

Itinerary

I spent three weeks in Germany, visiting hardwood and softwood forests in Bavaria, Lower Saxony and Baden-Württenberg. These were State and Town forests, National Parks, the Munich University forest and a large private estate. I had the opportunity to discuss forest policy and management issues with the staff of the State Forest and National Park services, the Universities of Freiburg and Munich, and representatives of the 'Near to Nature Silviculture' movement. My comments relate only to West Germany. See Appendix 1 for detail.

Historical Background

The forests of Germany have a fascinating history of development, a background to which is essential to the understanding of the current debate on forest management.

By the early 1800's nearly all the forests, with the exception of the forests retained for hunting by the Bishops and Barons, were badly degraded. They had been cleared for farmland or had been cut over for timber, fuel or smelting. Regeneration was prevented by grazing and the soil fertility was severely depleted by 200 years of 'littering'. This was the practice of removing the forest litter and using it in the cattle barns over the winter then spreading it over the agricultural land as fertiliser. These combined practices converted much of the land to heather and it was maintained that way by sheep grazing and fire (Figure 16). The heather (and moss) was also periodically removed and used as 'litter'. As a result there was severe wind erosion in some areas, dunes began to form and threatened to engulf villages.

In 1803, when the monasteries were secularised, some of that land was given to farmers in exchange for their 'littering' and grazing rights. This was the origin of much of the private forest of Germany. At the same time, lack of wood for fuel and other uses, erosion, and competition from Australian wool caused a major exodus from much of the countryside. Removal of sheep provided the opportunity for reforestation. Soil protection was the primary motivation. Effective regeneration did not really occur till the 1850's when abandoned farms were purchased by government and replanted. The program continued for a hundred years. From 1850 to 1900 the forests of Lower Saxony for example increased from 8% to 20% of the State.

Hardwoods were the endemic species on most of the low elevation country, but they could not be re-established under the harsh conditions of exposure (frost) and the poor nutritional status of the soil. For that reason the native pioneer species, Scots pine, was planted and seeded in mixture with Norway spruce. Writings of the period show that it was intended to replace these forests with hardwoods when the problems of exposure and nutrition had been alleviated.

From the 1860's the economic theories of Faustmann and Pressler began to dominate forest policy. They argued that afforestation projects should maximise return on investment. This encouraged the planting of the faster growing spruce which could be grown on shorter rotations thereby reducing the burden of interest costs. This policy persisted till the 1960's. Spruce planting was further encouraged by the need to restore rapidly the loss of forests that resulted from the heavy cutting during and after the two wars.

The end result of this afforestation program over the last 150 years is that West Germany is now about 30% forested (7.3 m hectares). Approximately 30% of the forest area is composed of mixed hardwood forest; predominantly beech with lesser amounts of oak and

still less of maple, ash, cherry etc. 70% of the forest is composed of softwood species, predominantly spruce and Scot pine, but also some plantations of Douglas fir. Many of the hardwood forests have been managed for several centuries, first as hunting and then as wood production forests.

However, the spruce plantations are notoriously unstable. In 1972, 70 million m^3 (on 100,000 ha) were blown down by wind in Germany and a similar quantity was blown down in 1990 (Figure 17). These catastrophes, as well as previous outbreaks of insect damage, have emphasised the fallacy of the use of an economic theory that does not adequately account for risk.

Primarily as a result of these catastrophic losses the emphasis has now changed to the creation of forests that are more wind firm and therefore financially more secure. This means the progressive conversion to the more stable hardwood forests. A good deal of effort has been devoted to determining the original distribution of species and the objective is to replace many of the softwood plantations with those species at the end of the present rotation. Given the improved site conditions this is now an achievable objective.

The move to hardwood forests has the support of the environmental groups and the 'Near to Nature Silviculture' movement but there is still a good deal of argument that the problems were predictable long ago and that the changes should be made now rather than wait for the end of the current rotation.

Germany imports about 50% of the wood products that it uses though there is recognition that these imports will not always be available. It is aiming to convert more of its agricultural land to forest, both as a source of further wood production and as a means of reducing the subsidies to the over-productive agricultural sector. Despite this intention the conversion of agricultural land is not permitted where there is already a high proportion of forest. There is a very strong demand to maintain the character of the open rural landscape.

Germans value their forests very highly for recreation. The forests are very heavily used by walkers of all ages. Federal law ensures that all forest is accessible to the public as they are in Sweden.

Policy and Administration

The State Forest Services are responsible for the management of State and in some cases, the town forests. They enforce forest law on private forests and assist private owners in various ways.

About half the forest is publicly owned, mainly by the States and towns. 440,000 owners share the remainder and half of these have an average holding of only 5 hectares. Associations of owners are therefore actively encouraged by the government to promote efficient management and to assist owners in getting a fair price for their products.

Forests that are harvested are required to be regenerated and subsidies are available for planting to hardwoods, for liming (as an acid rain protection) and for some other operations.

Broad land use plans are prepared and approved at County level and indicate which areas will be forest, agricultural, urban, military land etc. Within that broad framework the forest service,for example, considers the various values of its land. On State Forest the philosophy is that all the land will be used for multiple use, as far as possible at the same time.

Figure 17 Severe wind storms blew down 80 million m³ of timber (mostly spruce) in Europe in 1990.

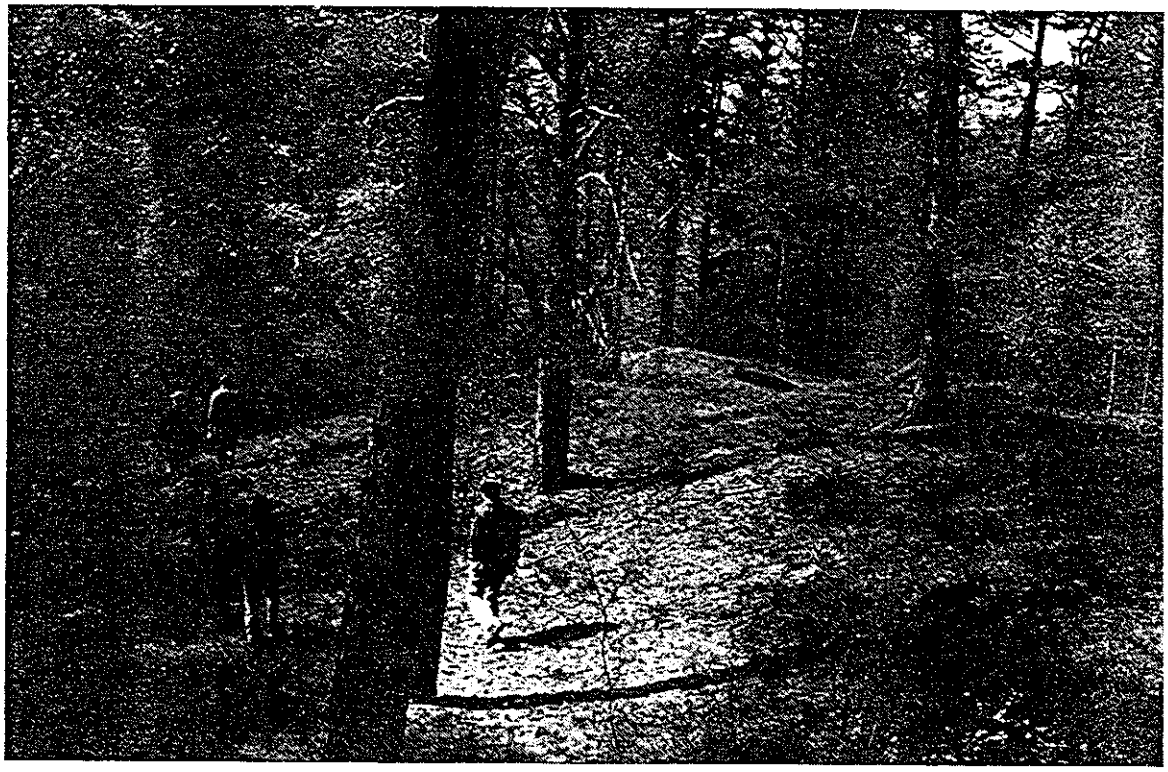

Figure 18 This dune (100km from the coast) threatened to engulf a village until its movement was arrested by the successful establishment of Scots pine.

It does not allocate areas to single use nor does it place priorities on use. It does however indicate which areas have particular values that must be taken into account. It appears to do this at a local level with only informal public participation. Wood production is regarded as a normal and legitimate use on most land. In Lower Saxony for example, only 1% of the forest has wood production excluded and another 10% where it is somewhat restricted.

The Spruce forests are uncompromisingly production oriented and until they reach a reasonable age are not very attractive for recreational purposes.

The public generally seems to accept wood production as a normal and valid use of the forest and the concept of good utilisation is responsible for the high degree of tidiness that is evident in the forests. It is noticeable that wood production activities are far more acceptable to the recreating public than is motorised recreation.

In recent years two National Parks have been created in West Germany (in the Bohemian Mountains and the Alps) and another is in the process of declaration on the border of East and West Germany (in the Harz mountains). The existing parks are seen as important tourist drawcards providing employment in otherwise depressed areas and there seems to be some conflict over their joint use for recreation and for their ecological values. The existing parks have a history of past use, but both of them have substantial portions that are relatively undisturbed.

Silvicultural Practices

There are a variety of silvicultural practices in use depending on the past history of the forest and its ownership. The comments that follow apply particularly to the publicly owned forests.

Even-aged Conifer Forests

Many of these forests originated from the seeding of mixtures of Scots pine and Norway Spruce. While Scots pine is the more vigorous pioneer, the more shade tolerant spruce eventually dominated in many areas. Stands of pure spruce have also been planted. Stocking levels have traditionally been very high and they have been managed very conservatively by Australian standards. Growth rate is slow and it was difficult to find out why such high stand densities are retained. I was given a number of explanations for this. One is simply tradition and the desire to maximise the volume production of high quality (ie close ringed) spruce, another was a lack of funds for non-commercial thinning until it was too late to thin without getting windfall. Other reasons given are that spruce is very susceptible to butt rot resulting from damage that can accompany thinning and another is the lack of market and the high labour costs of thinning. A consequence of this is that while the wood quality is superb, the forest is even more susceptible to windthrow once wind gets into the stand. There is also some evidence that these short crowned trees are more susceptible to the effects of acid rain.

Most of the spruce plantations are based on low elevation provenances because of their superior growth rates. These trees have a different crown structure to higher elevation provenances and are much more susceptible to snow break which can be a serious problem. Apart from the obvious physical damage, it encourages insect attack and is now believed to make the trees more susceptible to acid rain effects because of the extra stress that it represents.

Heavier thinnings are now becoming more common but experience with the attendant pruning is very limited. Private forests are less likely to be thinned.

During this year all the logging effort has been devoted to the huge job of salvaging the 60m m^3 which was blown down in 1990. Logging crews from all over Europe have been

brought in to help and the price of timber has plummeted. Forest roads are littered with logs and there are huge piles of wood under sprays all over the country.

For these reasons the spruce forests of Germany are the target of a good deal of criticism both inside and outside the forestry profession. It is easy to overlook that although the spruce is off-site and in many ways unsuitable, at the time of their establishment there were few choices available for the task of afforesting the severely degraded landscape and to fill the perceived needs of wood supply. Despite its problems it is a much better situation than existed before and it continues to fill an important role of production and protection (Figure 18).

All States have a program of converting a proportion of their softwood forests to hardwood. Despite the disadvantages of Spruce, it is likely that much of the private forest will continue to be planted with that species.

Hardwood Forests

Most regeneration of hardwoods is achieved through the classic shelterwood system. The overstorey density is reduced to the point where regeneration can establish but where it is still dense enough to inhibit the growth of grass and to provide shelter from frost (Figure 19). The initial intensity of cut is critical; if it is too heavy the grass that establishes will harbour mice which ringbark the hardwood regeneration; if it is clearfelled it will be almost impossible to regenerate hardwoods at all because of the frost and the opportunity for conversion may be lost for many years.

The same regeneration process is followed whether the overstorey is softwood in the process of conversion or whether it is hardwood. If there is no seed source of the desirable hardwoods then the area is planted, usually at very high density (about 10,000 stems per hectare). Alternatively it is artificially seeded. If oak is to be established it must be done at or before the beech otherwise it will be suppressed and ultimately killed by beech.

A major impediment to the regeneration of hardwoods is grazing by the high populations of deer. This is an area of considerable controversy in German forestry. Because of the method of granting permits for hunting and the strong political influence of hunters it is extremely difficult to keep deer populations to acceptable levels. If this cannot be done then regeneration is only possible by the fencing of regenerating areas, a practice that is both expensive and unpopular with the hunting lobby (Figures 20 & 21). Hunting and the associated deer problem are blamed for much of the reluctance to convert from spruce to hardwoods in earlier times.

Having established the regeneration, the major difference in practice is the length of time over which the overstorey shelter is removed.

* In the past it was common to remove the overstorey when the regeneration was a few meters tall. This resulted in an even-aged stand of regrowth of the classical shelterwood system.

* A more common practice now is the removal of the overstorey over a 30-40 year period either by progressively enlarging the gaps to create a grouped shelterwood, or by removing the larger overstorey trees as they come up to suitable size. i.e. as it would be under a single tree selection system, to create an irregular[1] shelterwood.

This results in a stand which is two storied for a longer period (perhaps the most critical period) but for the most part of the rotation it will still be more or less even-aged (Figure 22).

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1 See Glossary, Appendix 4.

* The third method involves the removal of the overstorey over a much longer period and the stand begins to approach the appearance of an uneven-aged selection forest.

There are very few true selection forests, though some claim to be. Most are a form of shelterwood in the sense that the regeneration comes mainly from a single regeneration wave but the overstorey is removed over a long period at 5-10 year cutting cycles and it is often removed as a thinning from above. It will take more than one rotation to create a true selection forest from a previously even-aged forest (Figure 23).

Regardless of the treatment of the overstorey, the regrowth is maintained at very dense stockings till the maximum clean bole (10-12 m) has been achieved. This may take 70 years during which time only very light non-commercial thinnings are done to remove wolf trees and little else.

Commercial thinnings begin at about 70 years of age. They are usually very conservative and may be repeated on a 5-10 year cycle. Where beech and oak mixtures occur the beech is maintained as an understorey to the oak at all times to shade the bole to prevent the development of epicormic branches. There is no predetermined intensity of thinning, it is based on individual judgement of the stand condition.

Thinnings become heavier at the end of the rotation and in effect become the shelterwood cut for the next rotation.

High Elevation Forest

Group selection systems are not commonly used but are applied in the mixed fir/beech/spruce forest at high elevation. The purpose is to allow the more shade tolerant fir to regenerate without the competition of the others; then to open it up further to allow for their regeneration. In effect it reverses the successional process of the forest. A group selection system gives closer control of shade and provides a variety of edge effects.

Other Management Practices

Great care is taken to ensure that soils are not damaged by logging and all forests have a system of premarked extraction tracks. Logging operators are not permitted to move off these tracks. There is subsidy paid to owners for the purchase of horses for logging as a means of minimising the impact on the soil.

Rotation length varies according to species. It averages 120 years for spruce, 130 years for Scots pine, 150 years for beech, and 220 years for oak. The Pressler economic model is no longer used by the State services now that sustained yield has been achieved and there is a more or less constant annual income and expenditure. The abandonment of interest rates for a cash flow system of evaluation means that the forest can be managed on long rotations of hardwoods. Indeed they argue that one long rotation is better than two shorter ones because it reduces the proportion of the time that the forest is under regeneration when it is most at risk and most expensive to manage. Their objective is to produce high value forest products rather than maximising volume production.

In any of the silvicultural systems described above there is the opportunity to retain mature trees or culls for nature conservation purposes but there does not appear to be a great deal of data on the requirements nor does there appear to have been a great deal of attention given to this in the past. There is a very high level of utilisation which leaves little debris on the ground and very few older trees.

Sustained yield is calculated on the basis of total volume but the level of the harvest for the ensuing 10 years is based on a combination of this figure and the 'silvicultural' yield for that period. The representation of age classes varies in different parts of the country.

Figure 19 After one rotation this Scots pine/spruce forest has restored the site condition to the extent that hardwoods can now be regenerated. The shelterwood must be open enough to allow regeneration to establish but dense enough to retain enough shade to inhibit grass development.

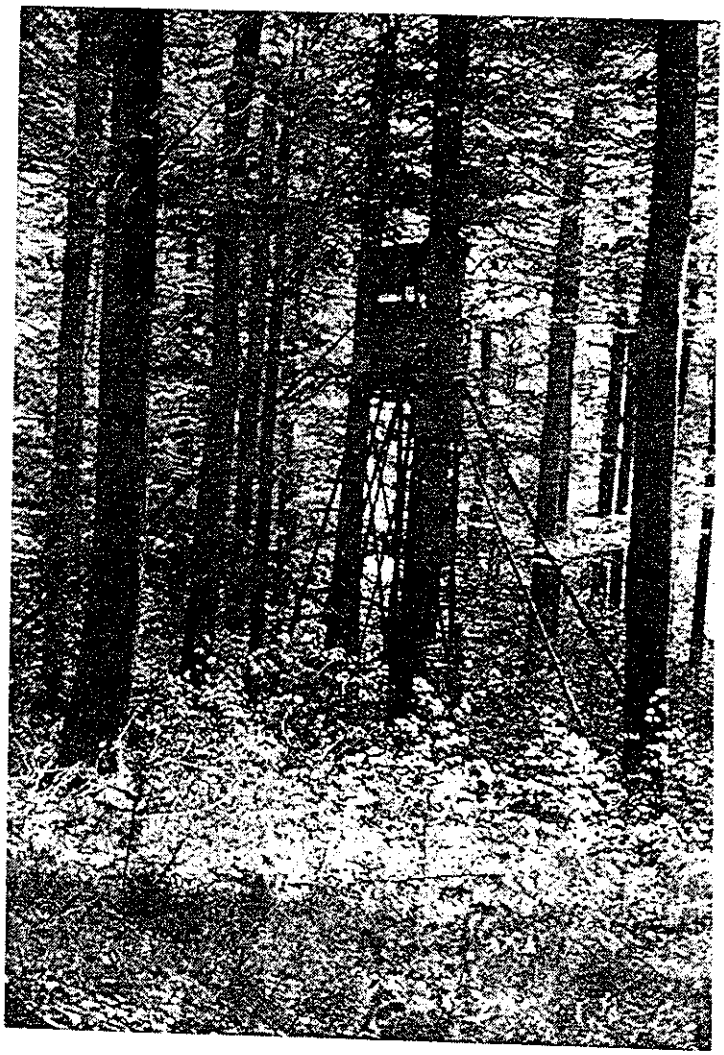

Figure 20

Hunting stands are erected throughout the forest. A hunting permit bestows considerable status as well as providing exclusive rights to hunt a specific area of public or private land for 9 years. Permit holders have a much greater interest in encouraging deer populations than in reducing them.

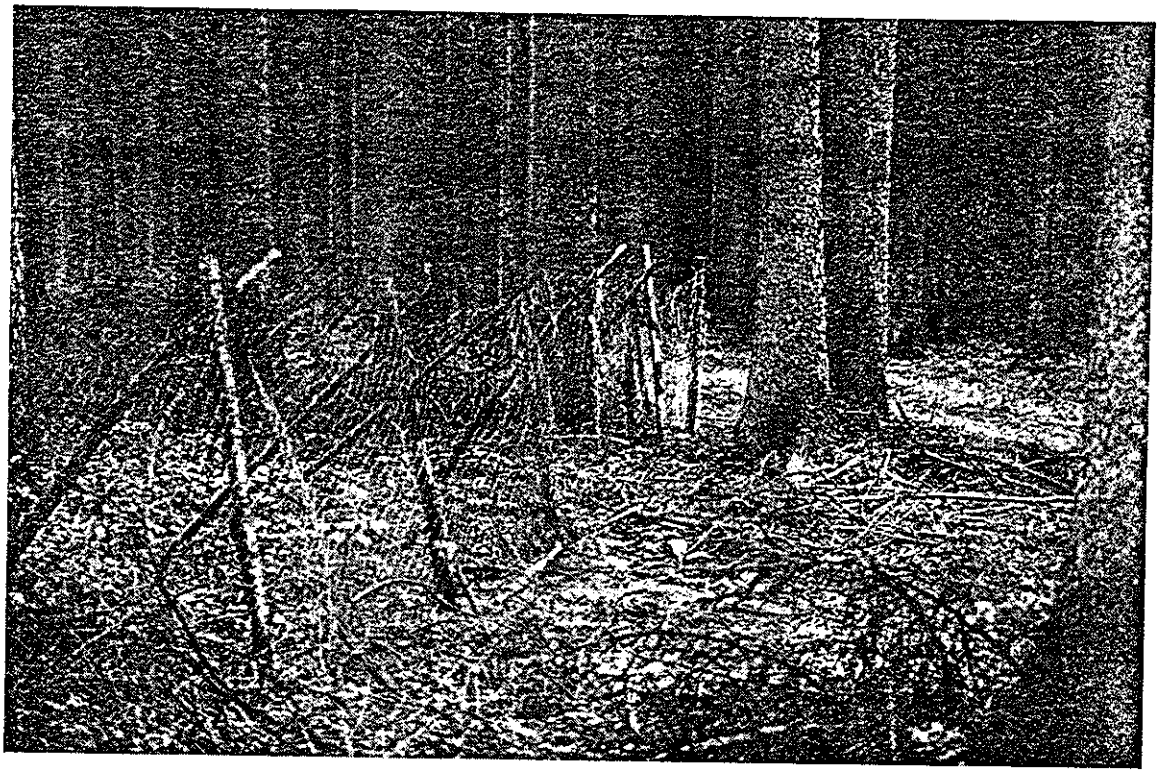

Figure 21 Deer-proof fences are more effective than hunting in ensuring the survival of hardwood regeneration.

Figure 22 The shelterwood overstorey of this oak forest is gradually removed over 30 years or more.

Timber is sold by negotiation of the price (based on the market), by the auction of parcels or by the auction of individual high value logs. The price varies from $\$100/m^3$ for normal sawlogs to $\$700/m^3$ for peelers and as much as $\$3400/m^3$ for top quality oak logs. It is easy to appreciate why they go to so much effort to ensure that the oak remains branch and defect free (Figure 24).

The forests are very intensively managed. There is about one forester for every 1000 hectares (about 10 times that of Western Australia) and in the hardwood forests in particular the forest work is extremely labour intensive. It is very difficult to understand the economics of these operations and it appears to be part of the whole rural subsidy package where the primary objective is to maintain a rural population.

Undoubtedly the most remarkable forest I visited was the spruce/fir forest of Bad Rippoldsau in the Black Forest. This was a tract of 1600 ha under the shared ownership of 35 families who each owned separate 30 m strips through the forest. It was managed under a single tree selection system for high value products, originally to produce masts for the Dutch navy and now for peeler logs. The condition of each strip reflects the interest and the economic fortunes of each family. It has been managed under sustained yield for 500 years, for the past 100 years by three generations of the same family of foresters!

National Parks

None of the National Parks have been free of past human disturbance and there are only tiny parts that could be described as virgin. Parts of one park are still subject to grazing rights of farmers. Each of the National Parks has a different philosophy for the 'naturalising' of the previously disturbed portion; one is a do-nothing policy while the other aims to speed up the process by deliberate intervention.

The past removal of predators has perhaps had the greatest impact on natural development. Populations of deer may be such as to preclude the regeneration of hardwoods. In the absence of natural predators interference is necessary to either reduce their numbers or to fence them out. While the biological conditions are suitable for the re-introduction of some of these predators, political and public pressure prevent it being done.

Conflicts and Issues

Even-aged or Uneven-aged Silviculture

Within the forestry profession the most active source of debate concerns the conversion of even-aged softwood forests to uneven-aged hardwood forests. The primary reason for conversion is greater security from the catastrophic damage that has happened to the spruce forests. There seems to be no real disagreement with the need for conversion in principle. However there is one group who believe it should be done now, and that there should be a complete change to the original species. The other group argues that the change should occur at the end of the present rotation and only on those areas that are capable of growing reasonable quality hardwoods, the remainder being planted with Scots pine, an endemic pioneer species. They also argue that there is still a place for exotic plantations.

An active promoter of the uneven-aged hardwood philosophy is the 'Near to Nature Silviculture' movement which now has a membership of 1500 foresters in Germany. It has its origins in the early part of this century with the philosophies of Möller. The emphasis of the philosophy on light selection cutting favours the maintenance of shade tolerant 'climax' species but tends to ignore the equal validity of the early stages of the successional process. As such it is doubtful that it is any more natural than any other form of silviculture. The differences in the views of this group and the economic rationalists of several decades ago

has been the source of considerable bitterness. This was made even worse by the unfortunate connection with Nazism at one stage and this has led to some enduring divisions between the two groups. At the present time however the differences in philosophy are not as great as it is sometimes portrayed. The primary motivation of many of the 'naturalists' is the economic security of the mixed hardwood forests rather than any particular conservation benefits. Much of the difference in practice relates to the length of time over which the shelterwood is removed. This can be as much a result of the existing forest condition as a fundamental difference in philosophy. Both of these groups however are strongly committed to the role of wood production in the forest.

Acid Rain

Acid rain and it's effects on the forest are a major issue in Germany and to a greater extent than in Sweden. However it is not free of controversy. While there are spectacular examples of the negative impact on forests, the overall productivity of German forests is higher than it has ever been. This is due in part to improved soil conditions following reforestation and also to the increased input of nitrogen from pollution. This trend is expected to reverse when nitrogen inputs reach a critical level. Damage already occurs where sulphur is the major pollution component. It seems to be generally accepted that the effects of acid rain should not be seen as a single cause of forest damage but rather as another source of stress. As such it contributes towards pushing certain forests over the threshold of survival. This is seen as a particular problem for spruce forests because they are often off-site, overstocked and of the wrong provenance. Nevertheless it is difficult to imagine any forest doing well on such acid soils, some of which have been reduced from pH 4.7 (already very acid) to pH 3.2 in 30 years.

High altitude forests are particularly vulnerable because not only is the impact greater but the solution is more difficult. There are few species, other than spruce, that will survive under the cold conditions. Reforestation is being done with high altitude provinance spruce at wide spacing in mixture with mountain ash. A failure to resolve the problem will be serious because of the importance of these forest for soil protection.

In some States liming is carried out to try to neutralise the acid input. Foresters see themselves as being able to perform only a holding action till the only long term solution, reduced pollution, has been achieved.

The Changing Role of Forests

The primary role of forests in Germany has continued to change over time; from its value as a hunting area, to wood production and now with a growing emphasis on ecological values and recreation. With its high population and small area Germany recognises that there is no possibility of providing either very large wood exploitation areas nor very large reserves. Their concept of multiple use therefore is a wood producing and a service producing enterprise at the same place at the same time. In many of their forests, especially the hardwood forests, they appear to be successful in this though there is undoubtedly more that could be done to cater for a wider range of ecological values. Many decades of efficient utilisation has produced forests that are 'cultivated' with little evidence of the 'chaos' of completely natural systems. The ethic of good utilisation is deeply ingrained in the minds of the managers as well as the public. As a result there is pressure to utilise all the old trees rather than retain some of them for standing or for ground habitat. These attitudes will be slow to change even though it may have benefits for wildlife.

There are groups who argue for a greater proportion of the forest to be managed for other than utilitarian values. The new National Parks are a reflection of this and they are a source of great national pride. However their establishment was motivated as much by the advantages of tourism as of nature conservation and given their extremely high use this can be a source of conflict. Managers handle this by quite strict zoning which precludes large numbers of the public from much of the park.

Figure 23 There are few true uneven-aged selection forests but some shelterwood forests with long removal periods have a similar appearance for much of their life.

Figure 24 Oak logs are auctioned individually. The highest priced log in this parcel of windthrown trees reached $3400/m³ but the average price for sawlogs is about $100/m³.

The idea of managing in the absence of man is an interesting concept

in Europe where ever since the retreat of the last ice age man has been a pioneer species in the same way as all the other species. There has never been a pre-human condition to which to revert. Development without human interference is therefore something of an interesting academic philosophy rather than a return to nature. It has only been practised to a certain degree. For example, although conditions are suitable for the re-introduction of a number of predators (eg wolves) this is not publicly or politically acceptable. This maintains an imbalance of other species (deer) which then must be controlled by other artificial means if, for example, the forests are to be regenerated to hardwood.

Wood production plays only a minor role in the economics of a highly industrialised society such as Germany. But it plays an important social role in assisting to maintain the rural social structure and will play an increasingly important part in reducing the rural subsidies which Germany is likely to find increasingly difficult to maintain. It is also widely accepted by the public as an appropriate use for forests providing that the essential character of the forest is maintained. Nevertheless with an increasingly urban population, wood production will gradually be seen as less relevant than the role of forests for recreation if not for its conservation values. Wood production is likely to continue as an accepted part of multiple use management for only so long as it continues to be done in harmony with the perceptions of the recreating public; and these may well be different to that which is required for wildlife values.

CONCLUSIONS AND RELEVANCE TO AUSTRALIAN FOREST MANAGEMENT

Management Philosophies

The Churchill Fellowship provided the opportunity to visit a number of countries where the culture, the attitudes and the history of forest management are very different from each other.

The United States has long recognised the value of forests for recreation, conservation and wilderness values and has catered for these by designating specific areas for their protection (National Parks and Wilderness areas). The National Forests, after a long period of little more than protection, have been managed with a strong emphasis on economic wood production. There appears to be a belief that intensive management for wood production was a fundamental requirement of sustained yield management rather than a result of a philosophy of economic rationalism.

In Germany some forests have been managed with the principle objective of economic wood production; and others have been managed with wood production as one of the uses but not the exclusive use. There are examples of even-aged and uneven-aged forests in both categories and both are managed on sustained yield. Here, as well, the other values of the forest have suffered under the influence of the economic rationalists.

In Germany, wood production is predominant to the extent that it occurs in most forests and is regarded as a normal, appropriate part of forest use. People appear to be more comfortable with this because it is historically evident that forests that have been managed for that purpose have been the best protected landscapes in the country - albeit different to what they may have been had humans not existed.

Sweden too has managed its forests primarily for productive purposes perhaps to a greater degree than anywhere else. It is the economic return from these forests that has enabled them to create a much larger forest area than existed one hundred years ago. With it has come improved nature conservation values. Despite the intensity and the size of the production, the diversity of locality, ownership and the scale of the operations tends to make it more aesthetically and publicly acceptable.

Re-evaluation

However, in each of these countries there is a process of re-evaluation of forest use. The decreasing economic importance of all rural industries and the increasing urban populations is shifting the emphasis of forest use from wood production to other values. People are increasingly seeing the importance of forest for recreational use and for its conservation values. This has been made more so by a public that is increasingly of the belief that all natural systems, including forests, are fragile and that any human intervention is likely to cause a calamity. Given a choice most people would probably prefer to see the forests left to their own devices and there are increasing calls in most of the developed countries for more, and sometimes all, of the forest to be preserved.

At the same time wood consumption by the developed countries continues at a high level. If more areas of forest are to be reserved for other uses then there will be an inevitable reduction in the resources of wood products that are locally available and there will be escalating conflict over forest use.

There are a number of alternatives to reduce this competition and the potential conflict:

* the first is to reduce consumption of wood. While this may seem a desirable aim there is little evidence of it happening and growing populations more than offset any reductions in per capita consumption. The more affluent countries, where these pressures originate, are the greatest consumers. Indeed the consumption of paper is now regarded as one of the indices for measuring standard of living. In the developed countries of the world about 75% of the consumption is for industrial wood and 25% for fuel wood; these proportions are reversed in underdeveloped nations.

* the second is to use alternatives to wood. While there are a number of options available, the primary disadvantage is that all the alternatives require a much higher consumption of energy. The materials in a steel and brick house in Australia, for example, consume more than twice the energy to produce than for a wood house. There is ample evidence that the acid rain that has resulted from the consumption of fossil fuels to produce this energy will cause much greater and more permanent impacts on conservation values than even the complete removal of forests did in earlier centuries in Europe. The Chernobyl disaster is a recent reminder of the dangers of some other sources of energy.

* a third alternative is to import the short-fall in wood requirements from other countries. This is the option that has been adopted by most of the developed countries in the world, including Australia. All of the developed countries, with the exception of Canada and some Scandinavian countries, are already nett importers of wood products. Current developments in the USA will dramatically increase their dependence on imports. The disadvantage of this option is that the burden of wood supply and the impact on other forest values is shifted from the developed to the underdeveloped countries. These countries have neither the technical nor the financial resources to resolve the conservation problems that result from the excessive pressure on their forest resources. While there is a good deal of rhetoric from the developed countries, the wood demands are increasing rather than decreasing.

  This option is ecologically unsustainable for the exporters and it will eventually be economically unsustainable for many of the importers. As total world demand increases, prices are likely to restrict the availability of this source of wood except to the most affluent countries.

* the fourth option is to develop techniques that better provide for both production and the essential conservation needs from the forest estate that exists or which can be expanded. It is evident from the experience in America as well as Europe that single use management for wood production is not acceptable. This applies not only to native forests but also to forests that have been established specifically for production; sooner or later they are required to supply other values and to become multiple use forests. There is a recognition by forest managers and others that single use management is only an option when there is a surplus of land; enough for everyone to have what they want. As populations increase, compromise is necessary.

In the re-evaluation of forest use in the USA however, while there is a swing away from single use for wood production there are concurrent pressures to move to single use for conservation. This is still possible at the present time because wood requirements can be imported. As a result there is no incentive to look for a compromise solution. This situation cannot last forever and eventually price competition or pressure from other countries will severely limit this option.

Multiple Use and the Goals of Management

Forest managers in most of the areas that I visited accepted the concept of multiple use as the most appropriate management philosophy for the majority of the forest; at the same time recognising that there were specific areas that still required single use management (eg wilderness areas).

Single use management has been advocated as a panacea for Australia's forest conflict; with wood production from specially established plantations and with the native forest devoted exclusively to conservation. It is seen as being politically and technically more achievable. There is no evidence from other countries to suggest that this would be any more successful than it has been in those places.

Successful multiple use management requires a knowledge of the trade-offs that result from the application of different silvicultural practices in the forest. It also requires a clear statement of the objectives and the acceptable levels for each forest value. I was able to find little indication that this was being done in a particularly objective way in most of the forest areas that I visited. For the most part the silvicultural requirements of non-wood values were not well known and were often based on what seemed like reasonable assumptions (sometimes almost folklore) together with political compromise. The danger of this approach is apparent from the recent reversal of practice in the USA with respect to coupe dispersal and stream management. Even now there appears to be little emphasis on research that will allow an objective approach to trade-offs.

More importantly, both in Australia and overseas, there is frequently no agreement on goals of forest management. It is essential that goals for forest management are put in measurable terms. Objectives such as natural management or ecological sustainability are far too vague and have different meanings to different people. As a result they create more arguments than they solve. While there may be agreement about the sentiments they must be translated into measurable goals for application by the managers.

The historical goal of sustained yield of wood is no longer adequate to ensure the sustainability of other values. However, rather than abandon it, it should be supplemented by sustained 'yield' goals of other critical or indicator values; these might include old growth forest, aesthetic 'yield', water quality, and population goals for sensitive fauna species. Trade-offs will be required to achieve these combined goals at acceptable levels. Such a process will have the additional advantage of focussing research in directions that will provide the essential data to determine the impact of different practices and their acceptability.

Conflict Resolution

A requirement for the development of effective forest management strategies is a planning system that allows for effective and informed public involvement. In the United States a great deal of attention has been given to the presentation of alternative plans for public comment. However its effectiveness is questionable because of the difficulty of presenting complex issues in an easily understood fashion. It is very doubtful if the general public make more informed decisions as a consequence of this process. Furthermore the system is effectively nullified by the capacity of individual litigants to halt the implementation of any of these plans. Management practices are being determined by dedicated minority groups rather than the majority of the population. Experience in other countries suggests that sophisticated conflict resolution techniques are unlikely to be successful in the absence of a reasonable degree of trust and respect on both sides.

Undoubtedly the places that are experiencing the greatest concerns about forest management are those areas where old growth forest still exists or indeed even where the forest is believed to be old growth. In the minds of many people virgin forest is the same as

old growth forest. The arguments being presented for their reservation is that they have irreplaceable conservation values. Since forests are dynamic systems that have replaced themselves many times this is patently not true and there is little doubt in my mind that the *biological* conservation values of old growth can be maintained by appropriate and sensitive management practices. However even if these practices were in place (and they are not) this will not resolve the conflict because in reality the primary concern for these forests is based on their emotional significance. They are seen as the last opportunity to preserve the pre-European past. To my mind the conflict might come closer to resolution if this were more openly acknowledged and evaluated along with the other forest uses and values. Confusing it with (sometimes) spurious conservation arguments won't help to resolve the problem. Determining an appropriate representation of this element is a political, not a technical argument.

Multiple use management that caters for all the values in the forest will not be achieved through technical processes alone. It is heavily dependent on the good will of the participants in the process. Without a preparedness to compromise and to commit themselves to a satisfactory resolution of the conflict it is impossible to achieve workable management programs. At the present time there is little sign of this occurring in Australia or the United States. There is a high level of distrust and a central target for this distrust are the forest managers who have the role of trying to satisfy the legitimate (and often legislated) demands of a variety of forest users. A major cause of difficulties in the United States is the political agenda of some of the groups involved in forest management issues at the national level. Conflict is often resolved at local level but deliberately created at the national level where the issue may have more to do with political power than it does with forest management.

Economic Rationalism

The economic analysis commonly used by many forest services in Australia (and promoted by the Bureau of Agriculture and Resource Economics) to calculate the royalty value of logs on the basis of cost of growing is a distinct disincentive for multiple use management. The reason for that is that the economic analysis that is commonly used invariably favours short rotations. The analysis is based on the convention that all the establishment costs of the new rotation are borne by the new rotation and the interest costs are accumulated from that time. i.e. as if it were the same as an exotic plantation where the decision to establish it might be based purely on economic considerations and where funds are raised for the purpose.

There are sound arguments why in a natural forest, managed on a sustained yield, that the establishment costs of the new rotation should be covered by the proceeds of the felling of the previous rotation. This acknowledges the fact that the regeneration of that forest is not a purely financial decision; that the funds for its establishment are not required until the income from the previous harvest are already in hand; that much of the establishment costs could equally be argued as being the cost of cleaning up from the previous harvest. These arguments are especially true in an analysis of repeated rotations where after the first rotation there is no real difference in time between harvest and establishment. Furthermore when the forest is treated as a whole forest with annual programs of harvest and regeneration rather than as an isolated stand, then cash flow rather than long term discounting are much more relevant. If wood values only are used in the analysis of cost of growing, the more concessions that are made to cater for other values, the greater will be the royalty charges. Unless other forest values are quantified for analysis there remains a disincentive for industry to co-operate in achieving multiple use forestry.

The discounted cash flow method, with establishment costs included at the beginning of the rotation, was the method used in Germany under the influence of Pressler and Faustmann up until about thirty years ago. While it may have been appropriate during the period when new forests were being established, it is no longer considered to be so. Conversion to a method of annual cash flow has allowed for the lengthening of rotations

and an increasing emphasis on hardwood forest. A similar philosophy is used in the National Forests of the USA where the income from the previous cut may be applied directly to the establishment and maintenance of the first ten years of the new rotation. The adoption of these practices would be a distinct encouragement for multiple use management in Australia.

On a whole of forest basis, economic rationalism goes beyond the effect on stumpage. It affects rotation length and yield expectations, usually to the detriment of other values of the forest. Economics should be seen as only one of the forest values to be considered in multiple use trade-offs, not the primary goal.

Ownership

Forest ownership in all the countries I visited is very different to the Australian situation where most of the high forest is publicly owned. The mixed ownership of the forests in those countries has the effect of separating, and to an extent insulating, the forest management decisions from the impacts that these will have on the timber industry. This is because the industry is not totally dependent on the resource from the public forest. This makes it easier for the management agency of the public forest (and the government) to some extent because they are able to make forest management decisions without being seen to be totally responsible for the outcome. However it can also have negative effects in a social sense because there is a tendency for no-one to accept responsibility for the effects of forest management decisions on industry, on conservation values, on the supply of resources for community benefit or for the associated social effects. So far these problems have been minimised because the import alternative still exists. Of all the places I visited Sweden appears to have been most effective in overcoming these potential conflicts. In my opinion Australia would benefit from increased private ownership of forests.

Past Practices

It was a surprise to me to find how few examples there were of different silvicultural systems in the USA and Sweden and even in Germany. This does not mean to say that the systems they are using, primarily various forms of clearfelling or shelterwood, are not the most effective for their purpose. However it does make it very difficult for them to demonstrate to an increasingly sceptical public that the systems they are using are indeed the most effective. In the United States, for example, there are almost no examples still in existence of selection systems, even though it has been practiced in the past. Very few staff have any experience of the techniques. In contrast, we are fortunate in Australia, and certainly in Western Australia, to have a large variety of examples of varied past practices and a considerable body of staff with experience in their application. These physical examples are an invaluable resource for demonstration and research and it is critical that they be documented and maintained.

An Optimistic Future

During the study tour I had the opportunity to see the effects of a wide range of past land management practices, from conservative forest management practices to the most appalling examples of abuse from previous centuries.

These included: forests that were clearfelled over huge areas during the gold rushes of Western USA and have regrown (without assistance) to a condition where they are now mistaken for virgin forest; forests of Europe that were so badly abused in past centuries that they became drifting sand dunes and which are now being replaced with the original vegetation after a hundred years of exotics; forests that have sustained continuous production of high value products for five hundred years; and long managed forests in the process of conversion to natural management in which the greatest impediment to achieving it is public acceptance of the native predators rather than its biological suitability; and forests that have withstood centuries of intensive use but have finally

succumbed to the insidious effects of acid rain. The overwhelming impression is one of the ultimate resilience of forests rather than their sensitivity. There is reason to believe that there is the technical capacity to manage present day forests so that they can sustain all the essential values that they provide. What seems likely to be more difficult to achieve is a commitment by the developed nations of the world of the necessity for them to attempt to manage their forests for all their values rather than exploit the forests of other countries for their wants.

Appendix 1

ITINERARY

MARCH

THURSDAY 28

Perth to San Francisco

CALIFORNIA

FRIDAY 29

San Francisco	US Forest Service Regional office. Ken Denton, Regional Silviculturist.
To Fresno	Meet Bruce Moyle, Sierra National Forest.

SATURDAY 30

Giant Forest	Sequoia National Park

SUNDAY 31

Giant Forest	Sequoia National Park
To Sacramento	

MONDAY 1

APRIL

Sacramento	California Dept Forestry and Fire Protection. John Carter, Bob Ewing (Multiple use planning). California Board of Forestry. Dean Cromwell, Exec. Officer. Timber Assoc. of California. Bill Dennison, President
To San Francisco	

TUESDAY 2

San Francisco	Sierra Club Legal Defense Fund. Julie McDonald. College of Natural Resources, University of California, Berkeley. Prof John Helms (silviculture), Larry Davis (m'ment), Louise Fortman (resource sociology), Reg Barrett (wildlife), Jeff Romm (policy), Bob Martin (fire).

WEDNESDAY 3

San Francisco	US Forest Service, Regional Office. Ken Denton (silviculture), Gary Brogan (l'scape architecture), Katherine Silverman (appeals), Jim Shevak (wildlife)

THURSDAY 4

Nevada City	Tahoe National Forest (with KD) Jane Labora (Silviculturist), Harley Greiman (USFS State Liaison Officer) Seminar to N.F. staff and field visit to mixed conifer forest.

FRIDAY 5

Placerville — Eldorado National Forest (with KD), Dave Thomas (Silviculturist), Gary Bilyeu (Planning).
Seminar to N.F. staff and visit to forest nursery and isozyme lab.

SATURDAY 6

Placerville — Placerville Ranger District (with KD). Duane Nelson (Silviculturist). 'New forestry' logging operation in the field - mixed conifer.

To San Francisco

SUNDAY 7

San Francisco
To Blodgett

MONDAY 8

Blodgett — University of California Experimental Forest. Robert Heald, Manager, Blodgett Forest - mixed conifer forest.

TUESDAY 9

To Redding
Redding — High altitude forest of Sierra Nevada Range and eastern plains. USFS Pac SW Forest & Range Experiment Station (with KD). Phil Aune (Program leader), George Ferrell (entomology), Bob Laake (modelling), Bill Oliver (silviculture), Bob Power (soils), Phil Weatherspoon (vegetation management)

WEDNESDAY 10

Challenge — Plumas National Forest. Long term nutrition trial in Douglas Fir forest. Gary Fiddler

OREGON

THURSDAY 11

To Eugene

FRIDAY 12

Eugene — University of Oregon, Dr Robert Ribe, Dept Landscape Architecture. Seminar to Landscape Architecture students. Tom Ribe. Editor, Newspaper of Association of Forest Service Employees for Environmental Ethics.

SATURDAY 13	
To Corvallis	Visit Willamette National Forest, Cascade Ranges with Dr R. Ribe (Douglas Fir).
SUNDAY 14	
Corvallis	Visit Coast Range forest, Newport
MONDAY 15	
Corvallis	USFS Pac NW Forest & Range Experiment Station. Dr Fred Swanson (Program leader), Tom Spiers (ecology), Gordon Grant (hydrology), Art McKee (ecology), George Lieukemper (GIS), Steve Hobbs (COPE) Seminar to staff and students, College of Forestry, Oregon State University.
TUESDAY 16	
Corvallis	Visit Andrews Experimental Forest (Fred Swanson) and trials of New Forestry at Blue River Ranger District (Forest Service staff & Landscape Architecture students) - Douglas Fir
WEDNESDAY 17	
Corvallis	Oregon State University. Bill Atkinson (Forest engineering), Steve Daniels, Perry Brown, George Stankey (Sociology), Steve Radosevich (Sustainable forestry). Visit OSU's McDonald Forest (Bill McComb)
To Portland	
THURSDAY 18	
Portland	US Forest Service. Walt Knapp, Regional Silviculturist. Visit Clackamas Ranger District, Mt Hood National Forest - Douglas Fir.
FRIDAY 19	
Portland	US Forest Service. Visit Zig Zag Ranger District. Meet with industry representatives and Congressional aides.(W.K)

WASHINGTON

SATURDAY 20	
Hoquiam	Visit Olympic National Park and National Forest and private forests on the Olympic Peninsular, Quinault. (Temperate rain forest).
SUNDAY 21	
To Olympia	
MONDAY 22	
Olympia	US Forest Service. Forest Sciences Lab. Dr Dean DeBell. Attend New Perspectives seminar.

TUESDAY 23

Olympia *To Portland*	Attend New Perspectives seminar.

WEDNESDAY 24

Portland to Hartford, Conn.

CONNECTICUT

THURSDAY 25

Granby	Dept of Environment. Huber Hurlock, Rob Rocks. Visit State Forests, Granby to New Haven - mixed hardwood forests.
New Haven.	Yale University. Prof Dave Smith, Emeritus Professor of Silviculture. Seminar to staff and graduate students, Yale

FRIDAY 26

Connecticut/Massachusetts

Visit Yale University Forest . Dr Bruce Larsen and forest management class.

SATURDAY 27

New Haven	Visit New Haven water catchment forest with Prof David Smith and manager Bob Hart.

New York to London

SWEDEN

SUNDAY 28

London to Falun

MONDAY 29

Falun	Domänverket (National Forest Enterprise of Sweden). Elis Hedén (conservation and land management). Visit Spruce forests.

TUESDAY 30

Falun	Störa Skog (Large forest corporation). Åke Granqvist, Information Manager.

WEDNESDAY 1 **MAY**

To Växjö

THURSDAY 2

Växjö Skögsagana (Forest Owners Association). Henning Hamilton (Information Officer).
Visit private forests. Jan Gustavsson (Regional forester), Hans Erikson (District forester), Ingmar Lundqvist (farmer).

FRIDAY 3

Växjö Visit private forests and research station. Arne Johansson, ex County Forestry Board. Mixed beech/spruce forests.

To Stockholm

SATURDAY 4

Stockholm

SUNDAY 5

Stockholm to Würzburg via Frankfurt

GERMANY

MONDAY 6

Würzburg Würzburg Oberforstdirektion. Forstdirektor Wolfgang Fleder. Visit to Arnstein and Rohrbrunn Forest Districts (Herr Gritz and Herr Burger). Oak/beech forests of the Spessart Mountains.

TUESDAY 7

Ebrach Ebrach Forest District. Dr George Sperber. Oak/Beech forest.

WEDNESDAY 8

Rentweinsdorf Private estate of Baron von Rotenhan, President of 'Near to Nature Silviculture' movement.

THURSDAY 9

To Munich

FRIDAY 10

Munich

SATURDAY 11	
Landshut	Stiftsungwald (University of Munich forest). Prof Dr Peter Burschel, Professor of Silviculture.
SUNDAY 12	
To Zwiesel	
MONDAY 13	
To Grafenau	
Grafenau	Nationalpark Bayerischer Wald. Dr Hans Kiener.
TUESDAY 14	
To Freiburg	
WEDNESDAY 15	
Freiburg	Bad Rippoldsau Forest (private forest in the Black Forest). Prof Dr George Huss, Prof of Silviculture, University of Freiburg.
THURSDAY 16	
Frieburg	Karlsruhe Arboretum (University of Frieburg forestry students).
FRIDAY 17	
Frieburg	Beech forest management (Frau Hehn, PhD student).
SATURDAY 18	
Frieburg	Black Forest (Prof Huss).
SUNDAY 19	
To Karlsruhe	
MONDAY 20	
To Hannover	
TUESDAY 21	
Hannover	Ministry of Food, Agriculture and Forestry, Lower Saxony. Prof Dr Hans Otto, Chief Silviculturist. Visited Nature Protection Area (Heather land), and dune reclamation forests, Selhorn Forest Inspection. (Dr Hanstein).

WEDNESDAY 22

Hannover — Visited acid rain affected Spruce forests of the Harz Mountains, Altenau. (Dr Otto and Dr Hasselback of the Brunswick Forests Dept). Beech forest of the Bovendon Forest Inspection (Dr Hoffle)

THURSDAY 23

To Berchtesgäden

FRIDAY 24

Berchtesgäden — National Park Berchtesgaden. Dr Helmut Wunder and Helmut Franz

SATURDAY 25

To Vienna

SUNDAY 26

Vienna

MONDAY 27

To Innsbrook

TUESDAY 28

To Rome

WEDNESDAY 29

Rome

THURSDAY 30

To Perth

Appendix 2

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Botanist

Appendix 3

SPECIES MENTIONED IN THE TEXT

COMMON NAME	SCIENTIFIC NAME
Ash	*Fraxinus excelsor*
Beech, common	*Fagus sylvatica*
Birch, Downey	*Betula pubescens*
Birch, paper	*Betula papyrifera*
Cedar, Western Red	*Thuja plicata*
Cherry	*Cerasies spp.*
Douglas-fir	*Pseudotsuga menziesii*
Fir, Pacific silver	*Abies amabilis*
Fir, red	*Abies magnifica*
Fir, white	*Abies concolor*
Hemlock, western	*Tsuga heterophylla*
Incense-cedar	*Libocedrus decurrens*
Juniper	*Juniperus Communis*
Maple, red	*Acer rubrum*
Norway Spruce	*Picia abies*
Oak, black	*Quercus velutina*
Oak, California black	*Quercus kelloggii*
Oak, red	*Quercus rubra*
Oak, sessile	*Quercus petraea*
Oak, white	*Quercus alba*
Pine, eastern white	*Pinus strobus*
Pine, Jeffrey	*Pinus jeffreyi*
Pine, Lodgepole	*Pinus contorta*
Pine, ponderosa	*Pinus ponderosa*
Pine, red	*Pinus resinosa*
Pine, sugar	*Pinus lambertiana*
Scots Pine	*Pinus sylvestris*
Sequoia, giant	*Sequoia gigantea*
Silver Fir	*Abies pectinata*
Spruce, Sitka	*Picea sitchensis*
Sycamore, American	*Platanus occidentalis*
Willow	*Salix spp*

Appendix 4

GLOSSARY

Basal area The sum of the sectional areas (measured at 1.3m above the ground) of the trees in a stand. When expressed as m^2 per hectare it is used as a measure of stand density and as an index of stand 'crowding' that is independent of tree size.

Cable yarding The technique by which logs are moved from the stump to a central loading area by the use of winches and cables usually attached to a tall spar. Various configurations may be used and they include the techniques known as skyline logging and high lead logging. They are used particularly in steep country.

Clearfelling A silvicultural system involving the removal of all or most of the trees in the existing stand and their replacement with a new forest of more or less the one age. The regeneration may be acquired by planted seedlings, coppice, or by seed from seed trees retained for the purpose or from seed that has been artificially dispersed. There is no universally accepted size of area that is regarded as a clearfelled stand.

MAI Mean annual increment of a stand at any given age. When referring to volume, nett MAI is the sum of the existing standing volume of all the trees in a stand divided by the current age. Gross MAI includes the previously harvested yield as well as the previous mortality. It may be calculated for total volume or for various products.

Normal forest A forest that has a more or less equal representation of age classes, from age one through to the chosen rotation age. In forest used for production, as the oldest age class is harvested, it is replaced by the next oldest, thus providing the basis for sustained yield. The 'normal' forest structure provides similar stability for the production of a range of values from a natural forest where the rotation age is sufficiently long.

Selection system A silvicultural system involving the removal of a relatively small proportion of the trees in the stand at any one time and their replacement with regeneration on each occasion. It results in a stand that is always uneven-aged. The selection criteria for removal may vary. Trees may be selected for removal as individuals, or in small groups (group selection). The system is particularly suited to shade tolerant species.

Seral stage The natural stages of development of the structural and species composition of a stand that are characteristic of a particular forest type at different ages.

Shelterwood System A silvicultural system involving the removal of a high proportion of the trees in a stand with the exception of those that are retained to provide shelter for the regenerating seedlings. It is commonly applied in areas subject to frost. Once the regeneration is established the shelter is removed and the forest ultimately becomes an even aged stand. The timing of the first removal of the shelter and the length of time over which it is removed may vary considerably. The shelter may be removed at one time (the classical shelterwood) or over several cutting cycles and by a variety of selection criteria (the irregular shelterwood).

Skidding The process of dragging logs from the stump to the point where they can be loaded onto trucks. It's usually done with rubber tyred or tracked machines but in Germany there is a resurgence in the use of horses.

Stag A dead tree, usually emergent above the general level of the forest canopy.

Stumpage The calculated value of a forest product as it stands in the forest.

Stumpage, residual Stumpage that is derived by subtracting all the costs of logging, conversion and reasonable profit from the selling price of the finished product.

Thinning The selective removal of some of the trees in the stand; usually for the purpose of increasing yield by utilising trees that would otherwise die in the normal process of competition, or to promote the growth of the remaining individuals. It differs from selection cutting in that regeneration is not sought at each cutting cycle and indeed is usually discouraged. Thinning aims to keep the stand at less than maximum density.

Appendix 5

ABOUT THE AUTHOR

Jack Bradshaw is a graduate of the Australian Forestry School (Canberra) and the University of Western Australia. He began his career with the Forests Department of Western Australia in 1963 where for some years was involved in forest inventory and planning, yield regulation, aerial photography research and in the early stages of the application of computer technology to forest inventory.

He later transferred to operations work as officer-in-charge of the Kelmscott Division where a major interest at the time was the rehabilitation of forests following bauxite mining in the jarrah forest. With the initiation of a pulpwood industry in Western Australia he returned to the southern forests in 1975 as Regional Planning officer with responsibility for the development of planning systems for integrated forest operations. During that time he was also involved in the design and development of the Department's Geographic Information System and the large scale aerial photograghy program for detecting jarrah dieback based on the research work initiated in 1969. This was followed by a period as Inspector (Operations) before becoming the Department's hardwood silviculturist.

He is now the Manager, Silviculture Branch, in the Department of Conservation and Land Management with responsibility for the development of silvicultural practices on CALM land that is used for single and multiple uses. He is also chairman of the Australian Forestry Council's Research Working Group on Native Forest Silviculture and is the outgoing chairman of the WA Division of the Institute of Foresters of Australia.