The Changing World of Forest Management

Final Report at the World Forest Institute

Phil Lacy

May, 2004

Acknowledgments
This report represents the culmination of one year spent at the World Forestry Centre as an International Fellow with the World Forest Institute. The Fellowship was generously funded through the Forest and Wood Products Research and Development Corporation and the J.W. Gottstein Memorial Trust Fund. State Forests of New South Wales and the World Forest Institute, through the Harry A. Merlo Foundation, also provided funding. I am sincerely thankful to all of the funding bodies for this opportunity.

The education experience has been excellent and I would like to thank all the staff at the World Forestry Centre for their openness and enthusiasm towards the International Fellows. In particular, I would like to thank Angie DiSalvo (WFI Program Manager), Sara Wu (WFI School Director) and Rick Zenn (Education Director). Your knowledge of forests and forestry, both locally and globally, is a great asset to the program.

I would also like to thank all the companies that I had the chance to interview for their willingness to participate and provide open, and candid, comments.

Reprint Information
World Forest Institute, a program of the World Forestry Centre
4033 SW Canyon Road, Portland, OR 97221 USA
www.worldforestry.org/wfi
(503) 488-2130

Contents

1 Introduction

Forest management is a global business. It is also a capital-intensive business. With wood increasingly seen as a commodity, the forest industry looks around the world when it comes to making strategic decisions such as should we grow our own wood? And, if so, should we grow it locally or somewhere else? Forest owners face these questions due to the economic and global competition that they now find themselves in.

Forest ownership is changing, and the new owners bring with them a new focus that is highly financially driven. How these new demands pan out in the future remain to be seen, but one thing is already clear: today's forest managers will see big changes in how they are expected to manage industrial timberlands. The changes are most apparent when comparing across various industrial forest ownership types, since who owns the forest largely determines management objectives and priorities.

Within this globally competitive context, there are many factors that impact decisions on forest management. For industrial forest owners, the chief factors are:

1. Biological — growth rates, species selection, silvicultural regimes, and the analysis of cost against return of such regimes.
2. Environmental and social constraints – public perception, legislation, sustainability, and changing values.
3. Securitisation — increasing economic analysis leading to changing forest ownership and the emergence of timberland as an asset class.
4. Information Technology — the application of IT for decision making by forest managers.

The purpose of this project was to understand each of these factors within the context of the Pacific Northwest and understand the context in which a particular factor (or number of factors) becomes the main driver affecting forest management.

This report will discuss each of these factors, based on information gained from a qualitative survey of a number of industrial forest management companies, as well as through literature review.

Following discussion of the Pacific Northwest, the findings of this report will relate to forest management in Australia, which is currently undergoing a similar trend of changing ownership patterns – mainly the privatisation of state assets.

2 Survey Description and Results

A qualitative survey of 10 industrial forest companies was conducted. The companies surveyed covered the range of industrial companies in the PNW:

- Large-scale private companies that own mills and timberland or only timberland,
- Publicly listed companies that own various wood processing plants and large tracts of timberland (‘traditional’ forest industry companies), and
- Third party forest managers or Timberland Investment Management Organisations (TIMOs). These companies manage forests that are owned by various investment bodies.

Representatives surveyed were:

- ‘on-the-ground’ foresters
- planning and strategic planning managers
- precision forestry managers
- area and regional managers
- technical service managers, and
- information systems managers.

The survey involved meeting with company representatives and asking them a standard series of questions, listed below. The questions were designed to generate discussion on key topics and, as such, are qualitative in nature. Where it was not possible to meet face-to-face, phone interviews were conducted or email was utilised. All survey results were then grouped by question and each response was compared.

In the interest of confidentiality, specific comments by company representatives are not cited.

2.1 Survey Questions

1. What is the extent and nature of the forests that you manage (species, area, distribution, site quality, age classes etc.)?
2. What primary forest products does your company supply (logs, poles, chip material etc.) and what quantity of each per year?
3. Define the proportion of emphasis your company's management plan places on economics, silviculture, and social/environmental factors.
4. What criteria do you use to divide the estate into manageable stands (or woodlots)? What is the smallest area that you would consider when defining a stand?
5. What are the silvicultural regimes (e.g. site preparation techniques, fertilising, pruning, thinning) that you adopt to achieve these product goals? Are these flexible?
6. How were these regimes developed?
7. Does your company participate in certification? If so, what scheme and what impact does this have over silvicultural operations?
8. Are there specific criteria that you use to determine when a stand should be thinned (Basal Area, live crown ratio, others)?
9. What decision support tools do you utilise to help determine optimum stand regimes? Such tools might be spatial information systems, inventory information, modelling programs, financial analysis (return on investment), wood flow schedulers or others.
10. What decision support tools do you utilise to help when deciding estate level planning operations?
11. There are reports of a trend for large forest industry companies to sell-off their forests. What is your perception of this trend and how (if at all) do you see it affecting your company?

2.2 Survey Results

The responses to the survey questions from those companies interviewed are summarised below. Responses have been summarised and grouped according to the type of company (as listed in the survey description).

Extent and nature of forest resources

Private

- Tens to hundreds of thousands of hectares in the PNW only. Complete range of age classes, on all site quality classes.

Public

- Millions of hectares, both in the PNW and worldwide. Complete range of age classes, on all site quality classes (in PNW).

TIMO

- Hundreds to millions of hectares, both in PNW and worldwide. Complete range of age classes, on all site quality classes (in PNW).

Forest products

Private

- From logs to a wide range of timber products.

Public

- The whole range of wood fibre based products (timber, paper, veneer etc).

TIMO

- Logs only.

Proportion of emphasis that company's management plan has on economics, silviculture and social/environment

Private

- Although economics is very important, focus tends to be on producing a quality product over the long term.
- Social/environmental issues are also very important

Public

- Economics is the most important factor, but have to take into account public perceptions and environmental issues. Long-term planning is important.
- Four goals: Sustainability, Integration, Financial Performance, and Stewardship. Emphasis of one over another is not specified.
- Adding value to shareholders is a high priority.

TIMO

- Economics is the most important factor.
- Adding value to shareholders is a high priority.

Criteria used to divide estate into manageable stands/woodlots

Private

- Areas that will be managed under the same regime.

Public

- Areas that will be managed under the same regime.

TIMO

- Areas that will be managed under the same regime.

Minimum and average sizes of stands/woodlots

- 2 hectares minimum, average ranged from 12 to 36 hectares. 48 hectares is the maximum size (determined by the state Forest Practices Act).

Silvicultural regimes employed

- Silvicultural regimes are annotated in Figure 1. The table shows the range of silvicultural regimes that were described to me during the interviews. Regimes are listed as Private, Public, or TIMO. It should be noted that not all companies gave a response to this question and some companies gave two regimes. The regimes are displayed with a timeline down the left hand side and, where specified, retained stocking following thinning.

Background to the development of above regimes

Private

- Based on experience.
- Realisation that large logs do not bring a premium, so rotation age was shortened.

Public

- Computer modelling scenarios to determine best regimes through cost/benefit analysis.
- Involvement in University cooperatives.
- Internal and external research.

TIMO

- Cost/benefit analysis of each treatment. Each treatment must achieve an incremental financial return over no treatment.

Certification

Private

- Sustainable Forestry Initiative (SFI) - majority
- Not aiming for certification – one response

Public

- SFI
- ISO14001

TIMO

- SFI in whole or in part, or working towards SFI certification.

Silviculture Regimes [All stocking rates in stems per Hectare]

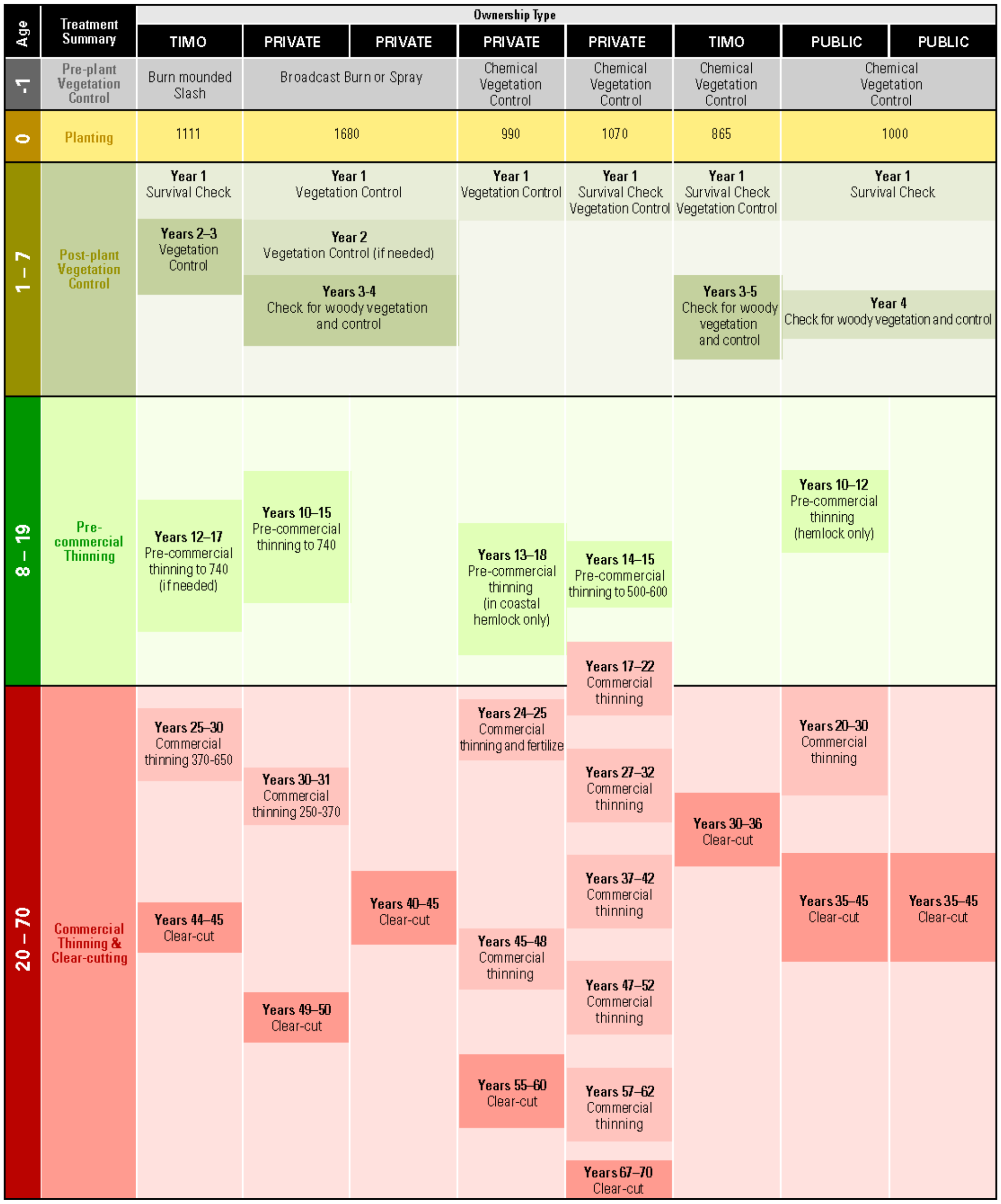

Figure 1: Cross section of silvicultural regimes practiced by the surveyed companies

Certification constraints

Private

- Has not changed operational procedures at all.
- Complying with state laws has the same outcome as certification.
- More paperwork and historical tracking.
- Additional cost for no financial return.

Public

- Restrictions on clear-cut harvesting (area, adjacency, green-up time).
- More paperwork and historical tracking.
- Additional cost for no financial return.

TIMO

- Still assessing constraints.
- Not very different to compliance with state laws.
- More paperwork and historical tracking.
- Additional cost for no financial return.

Determining the timing of thinning

Private

- Age.

Public

- Minimum volume removed specification.
- Basal area.
- Age combined with a density measure (competition index).
- Tree height.

TIMO

- Stocking and stand vigour.
- Thinning is not practiced (low stocking planted, so thinning is not necessary).

Description of Decision Support System

Private

- Geographical Information System (GIS) for mapping, historical tracking and inventory.
- GIS with third-party software.
- GIS but no detailed financial analysis tools.
- Just started using GIS.

Public

- Estate level modelling (combining growth and financial models) used to determine best set of regimes that produce the highest financial return.
- GIS linked to inventory data.
- Detailed financial modelling.

TIMO

- GIS with third-party software for forest analysis and management.
- Detailed financial modeling, based on cash flow.

Trend for timber companies to sell off their forests

Private

- Not affecting them. All are seeking more forestland.

Public

- It is not necessary for industry to own forestland any more.
- Consolidation and focussing on the most profitable areas, rather than selling off their forests.

TIMO

- This trend is why they exist!
- Expectation that this trend will continue or increase globally in the future.

3 Biological Factors in the Pacific Northwest: A Great Place to Grow Trees

3.1 Biology

The Pacific Northwest is a great place to grow trees. Rainfall, soil quality and recurring disturbance have created an environment with few biological limitations for the growth of trees.

The most unique feature of the climate of the Pacific Northwest is the annual rainfall distribution. The climate is marked by extremely wet winters and near drought conditions in summer. Annual precipitation is typically 1700 to 3000 mm or more on the coast and 800 to 1200 mm in the Puget Basin and Willamette Valley (Franklin and Dyrness, 1988). These unique conditions have led to the dominance of conifers rather than hardwoods as they are more adapted to the near drought conditions in summer and can continue to grow when the deciduous trees are dormant.

The soils of the PNW are based on parent material (mainly basalt and marine sediment) and volcanic activity. They consist mainly of weathered sandstone (providing a rich source of nutrients), deep sandy to silty clay loam (Willamette Valley), pyroclastic soils (poorly drained but highly fertile) and soils derived from basic igneous rocks (mainly basalt and andesite) (Franklin and Dyrness, 1988). Such fertile soils are excellent for the growth of trees, especially Douglas-fir.

(For a more detailed description of the topography, climate and forest types in the Pacific Northwest, please read Appendix 1).

Disturbance is a regular characteristic of the PNW. Disturbance events arise from volcanic eruptions, strong windstorms, fires, insect infestations, disease epidemics, landslides, overgrazing, logging, and the clearing of land for other commercial purposes (Whitney, 1989). The species in this area have had so long to evolve with periodic disturbances that they are incredibly adapted to them. Essentially this means that an area of land can be completely cleared, even with soil removal, and eventually a forest will grow back, guaranteed. The Mt. St. Helens National Volcanic Monument is a classic illustration of this (see photo in Appendix 1). Following the devastation of a major eruption in 1980, trees have begun to grow, even in areas left unmanaged. However, the Mt. St. Helens example also makes a strong case for intensive management, as the neighbouring Weyerhaeuser lands, which were aggressively replanted and managed, have returned at a much faster rate. Weyerhaeuser has been so successful with this intensive operation that they intend to begin harvesting this area in the coming years.

Weyerhaeuser land on left with natural revegetation on right (Weyerhaeuser , 2001)

Clearly, there are few biological limitations to growing forests in the PNW. However, natural succession is a slow process, and industrial forest managers are under pressure to grow wood volume fast to return value to their shareholders or investors. Industrial forest managers must also consider the choice of species, and will opt for silvicultural regimes that encourage the growth of some species with greater commercial value (i.e. Douglas-fir) over others.

Disturbance

Disturbance is a regular characteristic of the PNW. Disturbance events arise from volcanic eruptions, strong windstorms, fires, insect infestations, disease epidemics, landslides, overgrazing, logging, and the clearing of land for other commercial purposes (Whitney, 1989). The species in this area have had so long to evolve with these disturbances that they are incredibly adapted to them. Essentially what this means is that you can totally clear an area of land, even scarify the soil, and eventually a forest will grow back, guaranteed. The Mt St Helens Historical Monument is a classic example (see photo in Appendix 1).

3.2 Silviculture

In the PNW, most companies employ similar silvicultural techniques (vegetation control, planting, thinning etc.) to achieve their growing objectives, although there is some variation in the timing and application of these techniques. Figure 1 (in Chapter 2.2) demonstrates this observation, although it should be noted that these are generalisations and that many companies are more site – or at least forest – specific when it comes to determining regimes.

Figure 1 shows that the practice of silviculture on industrial timberlands is diverse. Each company is confident that their particular practices will ultimately yield trees on a profitable basis. This finding was intriguing and the wide range of silvicultural practices adds weight to the argument that the PNW is a great place to grow trees. Forest Managers could virtually do next to nothing to a cleared area or they could plant, fertilise, and thin multiple times before clearcutting, and either method would produce a large volume of saleable logs. There are, however, limitations to this, both legally and economically, and these will be discussed in the proceeding chapters.

As can be seen in Figure 1, clearcutting is a common practice for all industrial forest managers in the PNW. Industrial forest managers argue that the best method of producing the most amount of wood is through clearcutting because the preferred species, Douglas-fir, is not shade tolerant. This practice generates maximum yield and makes the forests easier to manage from a wood production viewpoint.

Whilst clearcutting has regrowth and economic advantages, this harvesting system remains unpopular among the general public, which has expressed a desire to revert forests back to 'old growth' structure and condition. Consequently, a considerable amount of focus (and funding) for the research community has gone into the area of multiple age/multiple structure stand management. Long-term studies have been set up to assess methods such as group selection (addressing how large/small should the group be?) and individual tree selection (addressing how best to assess and measure the benefit/impact of this method?). These studies also tend to promote the introduction of mixed species and mixed age stands and there are valid reasons for this type of forest management when timber production is not the primary goal. It should be noted that operator safety is a major consideration in determining gap size and distribution. Managers of Federal and State owned forests are moving towards this type of management as they strive to find a balance between wildlife, recreation, production and public values.

Until research can prove that group, or individual tree, selection safely produces as much volume at similar costs over the same time frame, it is unlikely that the practice of clearcutting will change on industrial forestlands. The only other way industrial forest managers will cease using this practice is if society demands it by putting this practice to vote (see Chapter 4.3).

3.2.1 Growth Rates

Current information on growth rates for Douglas-fir in the PNW are in the order of 12 m3/ha/year (Talbert, 2004). This rate is based on historical information from stands that were not managed as intensively as new stands are now.

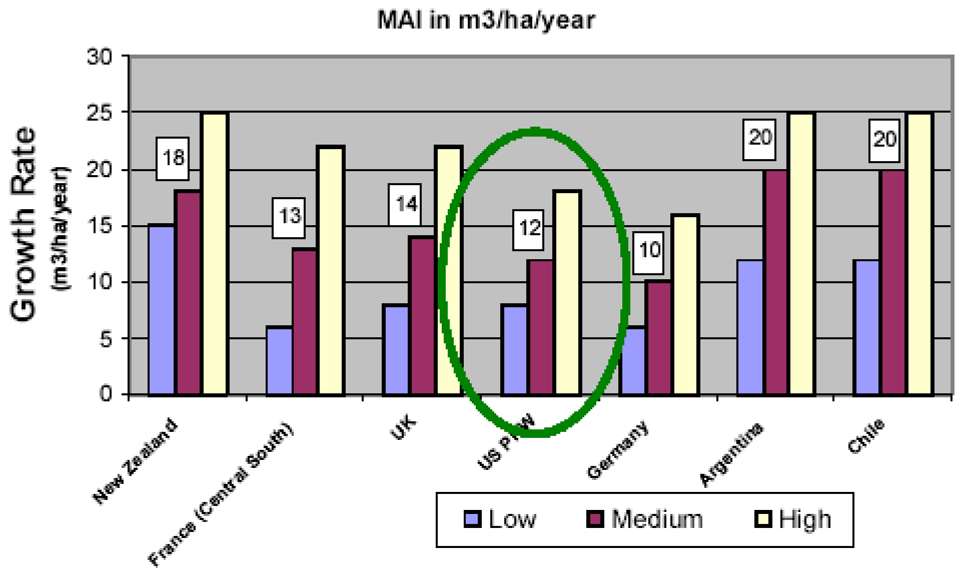

Figure 2: Comparison of Douglas-fir growth rates from various countries (Talbert, 2004)

Figure 2 shows that the PNW does not have the highest growth rates; the mean annual increment for Douglas-fir in New Zealand, Chile and Argentina is up to 40% higher (Talbert, 2004). This is due to more favourable growing conditions as well as more intensive management practices (practices calculated to produce the highest volume and/or value of desired products in the shortest possible time). These competing countries have been working on genetic improvements for longer and have a better growing climate with fewer natural pathogens than the PNW. Even under clearcutting and intensive forest management, growth rates in the PNW are projected to reach 17-22 m3/ha/year for Douglas-fir (Talbert, 2004). Although this rate of growth is comparable with the best countries, the competition's growth rates are predicted to increase to 30 m3/ha/yr through improved genetic material and advances in silvicultural practices (Talbert, 2004).

Intensive Forestry

A small private grower in Oregon, George Fenn of Fenn Farms, believes that the growth potential in the PNW is far greater than 17-22 m3/ha/yr. He has been growing trees since 1979 and has developed some very interesting, high intensity, silvicultural regimes. George's regimes include a high stocking of multiple species (at least two), physical and chemical site preparation, fertilisation in the first, second, third years and every five years through the rotation, vegetation control in the second and third years, pre-commercial thinning, commercial thinning and clearfall at age 29. Based on growth models developed from his own tree growth data, George predicts an MAI of 43 m3/ha/yr. Financial analysis of this regime shows very high input costs, but the end of rotation return is much greater, resulting in an internal rate of return of 13% (Fenn, 2003).

Industrial companies have been interested in George's work and many have met with him, although few have attempted to take his methods and apply them to the larger scale. It would be difficult for public companies to justify the additional cost to their shareholders, even if the returns were worth the investment. Perhaps companies will have another look at George's silvicultural regimes when his plantations go through a full rotation and the growth models can be validated.

3.2.2 Log Quality

Silvicultural techniques to improve log quality, such as pruning, thus far have not been a major factor for PNW timber growers. Processors in North America have tended to focus on improvements in their mill conversion technology to compensate for the general reduction in wood quality (as harvested logs are smaller in diameter). This method of value adding has been successful - there has been an increase in timber recovery in North America of 1.3% per year for the last 20 years (Binkley, 2004) - so it may be some time before processors focus on log quality in the PNW. Technological advances in sawing techniques (for example a mill that saws with the curve of the log, thus increasing recovery by about 30%) and composite products have served to maintain the profitability of the wood processing industry.

These new – technologically advanced – wood conversion plants prefer a smaller log size and there are now price penalties for growing logs that are too large for these plants. PNW growers with large diameter trees are finding that there is only a small market for their product. For example, prices in Western Washington for Douglas fir logs less than 28 cm in diameter gained on logs larger than 50 cm throughout most of the 1990s (Erb, 2001). The replacement of traditional solid wood products with composite products (e.g. I-beams replacing large, solid-wood beams, see Figure 3) may also mean that log quality is less important.

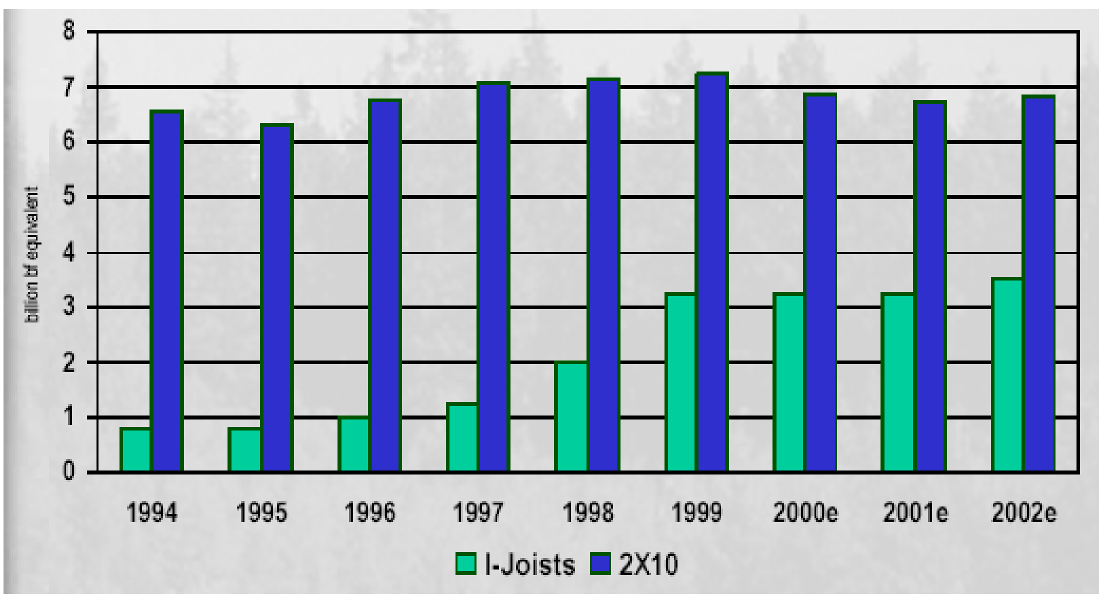

Figure 3: US Consumption of 2X10 lumber vs. I-Joists (Binkley, 2004)

This log quality issue is in contrast to radiata pine managers in New Zealand, where there is a significant price differential between pruned and unpruned logs. Unpruned logs have limited uses, thus there is a more restricted market for them. Pruned logs, however, have far more end uses and there is a much greater demand for this type of log (Brown and Ortiz, 2001). There are other silvicultural techniques that have either a positive or negative affect on the log quality of Douglas-fir. These are:

- Shorter rotation length has a negative effect on stiffness, strength, dimensional stability, warp, how easily a log can be peeled (peelability), surface roughness, fibre yield (for paper, related to microfibril angle)
- Wide spacing has a negative effect on stiffness, strength, dimensional stability, appearance, peelability, gluability, warp, fibre yield
- Thinning has a positive effect on stiffness, strength, dimensional stability, treatability, peelability, gluability and a negative effect on softness and smoothness (related to paper) (Gartner, Newton, and McKinley Russ, 2004)

In the PNW, it is possible that, as more forestland shifts out of the hands of processing companies, processors might become more specific about the size of log and other log quality characteristics that optimise (i.e. reduce the cost of) their manufacturing ability. Growers who can meet these specifications may then be rewarded financially, thus creating more value for both the processor and the grower. Technology (such as in-field scanning) could play a big part in this process. It will enable the forest industry to learn more about the qualities of each log in the field, and will facilitate segregation, which could lead to value realisation. Obviously, value realisation will only come about if buyers will pay more for specific wood qualities, and growers calculate that the additional management cost is beneficial.

4 Environmental and Social Constraints in the PNW

The PNW has been through dramatic social change towards environmental practices in the last 25 years. The environmental movement in the eighties and nineties successfully challenged federal land agencies in the west, ultimately winning legal restrictions regarding harvesting on public lands. Until this change, federal lands had supplied the majority of wood to the processing industry. The result is that harvesting on federal forests has virtually stopped, leaving manufacturers to scramble for alternative raw material supply. The region, once known as the “Timber Basket” of the US, has seen many forestry companies move their operations to less environmentally restrictive areas.

In order to understand how environmental and social constraints have impacted forest management in the PNW, it is necessary to understand:

1. the various forest ownership types in the region,
2. the changing perceptions and values held by the PNW public,
3. the legislation surrounding forest practices, and
4. the evolution of voluntary forest certification.

4.1 Forest Ownership in Oregon and Washington

Across Oregon and Washington, there are 19.9 million hectares of forest (defined as land with more than 10% coverage of trees), which is 47% of the total area of land (Oregon Forest Resources Institute, 1999;Washington Forest Protection Association, 2001). There are a number of different types of forest owners in the states of Oregon and Washington: Federal and State owned forests, private non-industrial forests, industrial forests and tribal forests. Figure 4 shows the proportions of each type of forest owner.

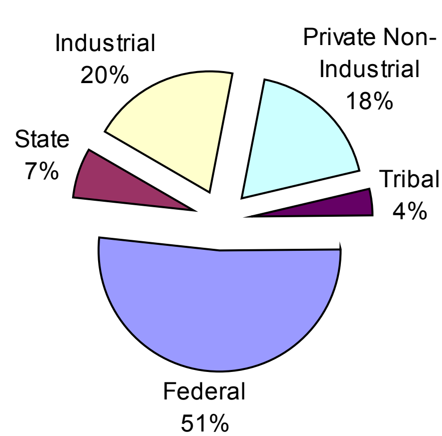

Figure 4: Forest Ownership in Oregon and Washington

Each type of ownership has different objectives and strategies for the management of their forests although all (except Federal forests) are bound by State laws developed to ensure sustainability and minimise degradation of the forests and the habitats that they influence (such as salmon habitat). See the following section (3.2) on Forest Practices Acts for more details.

Federal forests are managed by many agencies. The US Forest Service, Bureau of Land Management, National Park Service, Fish and Wildlife Service, and the Bureau of Indian Affairs all manage different areas of federally owned forests. Management practices in federally owned forests have changed considerably over the last decade. For much of their history, federal land agencies managed forestland primarily to provide timber to the forestry sector. In the last 15 years, management has shifted to a multiple use focus, although, in practice, little federal timberland is now harvested for commercial timber. The most recent federal lands initiative, the Healthy Forests Restoration Act 2003, is designed to facilitate thinning for fuel reduction and more productive forests. Funding for the thinning operations is supposed to come from selling the thinned material. It remains to be seen how extensively this practice will be carried out and how much material will be supplied to processors.

The State owned forests are managed by the Oregon Department of Forestry (ODF) and the Washington Department of Natural Resources (WADNR). State lands have been affected by the public outcry over the management of public forests and their management practices have changed to focus on the multiple benefits that forests provide to the public. Management plans cover recreation, wildlife, conservation and timber production in order to maintain a balanced and sustainable forest resource. Although multiple use is the objective, these lands are more timber focussed than the federal lands.

Native Americans manage tribal forests on reservation land. Management of these forests is varied, but some reservations exceed the State's environmental regulations, as careful land management is fundamental to some Native American philosophies. For example, the Warm Springs Reservation (Oregon), have developed comprehensive management plans for their forests that specify (along with many other things) streamside buffers of 200 feet. The State requirement in Oregon is a 100 feet buffer on the largest streams.

Private non-industrial forest owners account for a smaller proportion of the total forest estate in both Oregon (17%) and Washington (19%). Their desires and objectives for their forests are many and varied. Some rely on their forests to provide an income for themselves and for future generations, whilst others prefer to conserve the natural state of their forests and use them primarily for recreation. There are many permutations of these two extremes so it is difficult to characterise the small private forests and their management.

A large proportion of private non-industrial forestland is certified by the American Tree Farm System (ATFS). This active organisation has a certification system that currently has 65,549 certified tree farms covering 10.5 million hectares across the 48 contiguous states of the U.S (American Tree Farm System, 2004). This certification system is administered in house and was designed specifically to recognise small landowners who have developed, and are operating within, a business plan for their property along the ATFS guidelines. The mission of the ATFS is to *promote the growing of renewable forest resources on private lands while protecting environmental benefits and increasing public understanding of all benefits of productive forestry.* With such a well-developed national body, and so many members, it is clear that private non-industrial forest managers are actively managing their lands for sustainable forestry.

Industrial forests are now where the bulk of timber comes from. Industrial forests are increasing in importance in the forest industry. Although they are a small percentage of the total forestland, they provide the bulk of the timber harvested in the US. For example, in 1996, private forests provided 89% of timber harvested in the US even though they account for only 9% of the total land (USDA Forest Service, 2001).

As outlined in the survey description, there are three major types of industrial forest managers; private, publicly listed, and TIMO. Although there are multiple objectives, there is a strong focus on productivity and profit. The different perspectives of these types of forest managers will be discussed in the proceeding chapters.

4.2 Changing Public Perceptions and Environmental Constraints

Changes in the PNW demographic are resulting in changes towards the value of forests and a high level of scepticism about the way forests are being managed. Public perception and the democratic process have a strong influence over how forests are managed in the PNW.

The populations of Oregon and Washington increased by 20% and 21% respectively between 1990 and 2000 (Federation for Immigration Reform, 2000). Much of this population increase is through migration, both internationally and within the US. Most of the people who are moving to the PNW are moving from large cities and other areas where few people relied on forests for a livelihood and an understanding of the PNW forests was limited to what they read or heard in the media. A state-wide study in Oregon in 2001 of 1400 people found that less than half of them believe that sustainable forest management is being practiced on both private and federal lands (Davis, Hibbits & McCaig Inc., 2001). With these changes, it is unlikely that forests will go back to being viewed primarily as a source of raw material. Rather, their management will continue to be scrutinised and the many other values of forest will be seen as more important.

A number of forest management companies are well aware of this change in perception and they invest a significant amount of time and money in their own education programs. These companies tend to be long standing and privately owned, who recognise their role in their local community and understand that they must provide opportunities for the public to learn how and why they manage their forest like they do. A notable example of this is the employment of an Education Forester by family owned company, Starker Forests. The primary role of this employee is to educate and inform the local community about forest management for multiple uses. Oregon State recognises the need to educate its public of the role of forestry, and the creation of the Oregon Forest Resources Institute (OFRI) is one way it tries to improve public understanding. OFRI, whose role is to improve public understanding of the state's forest resources, provides unbiased information and many activities to achieve this objective.

It is through society's perceptions, and an increasing awareness of environmental issues, that regulation on forest management and the development of forest certification have come about.

4.2.1 The "Spotted Owl" Effect

The biggest impact from society's changes in how they perceive forest values has been on federal forests. Due to public concern across the country about the loss of habitat within federal forests, the government succumbed to pressure and significantly reduced their harvest level. Efforts to protect the northern spotted owl and the marbled murrelet, which are both dependent on old growth forest structures found mainly on federal lands, have resulted in an 80% reduction in harvesting on federal forests. The dramatic reduction of volume from federal forests can be seen in Figure 5.

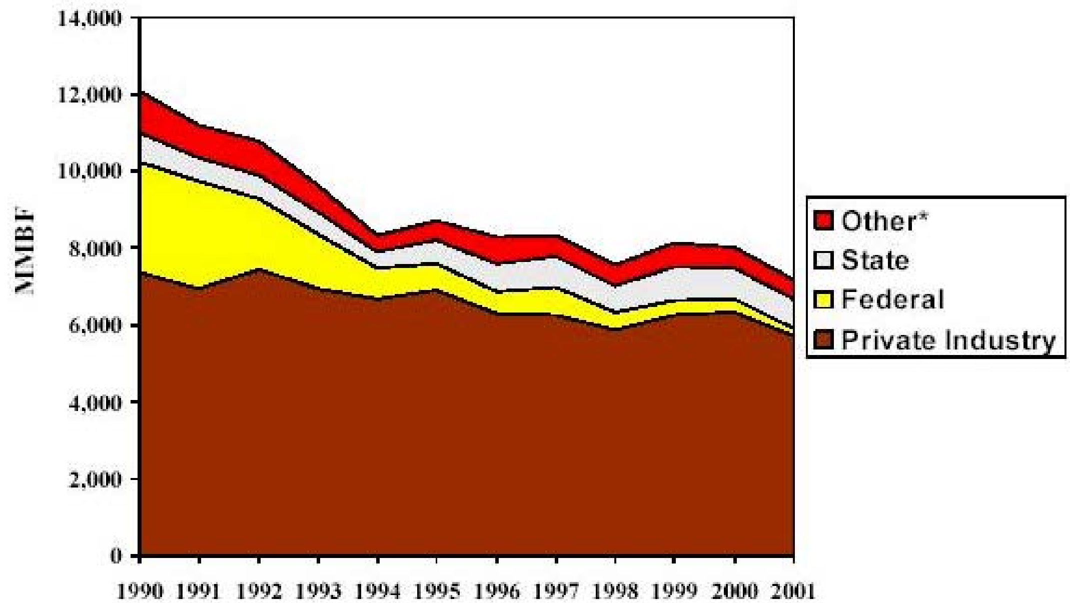

Figure 5: Washington and Oregon timber harvest by land source 1990-2001 (ODF and WADNR, 2001)

Because old growth forests were largely found on federal forestland, state and private land were affected to a lesser degree. However, state lands only comprise 7% of the region's forestland. This means that the burden of providing local wood supply to processing companies fell to private forestlands. The result is that private forestlands in the Pacific Northwest have assumed a much more important role as a timber supplier. Projections of timber supply indicate that this trend will continue (see Figure 6).

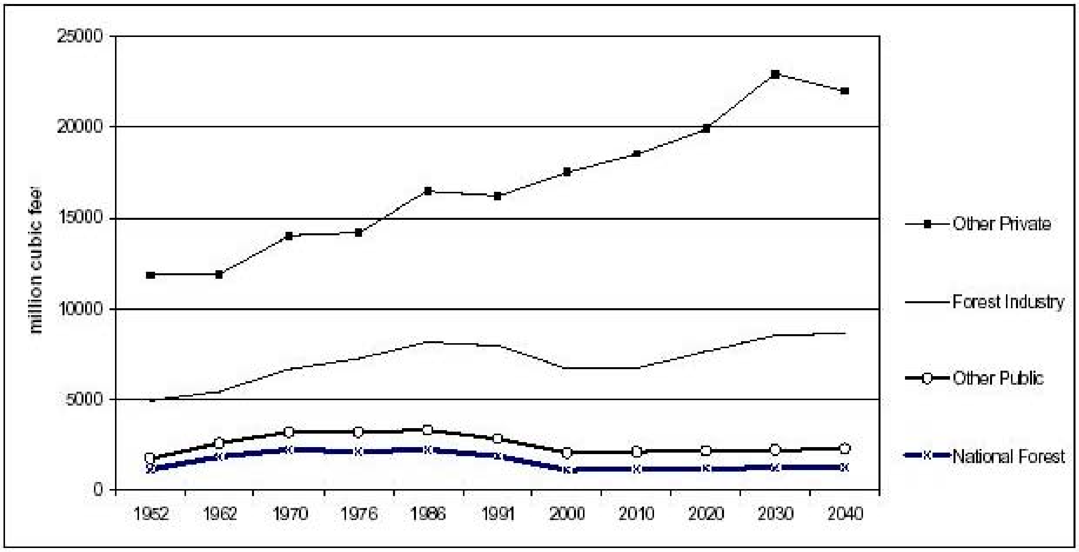

Figure 6: Historical and projected volume of timber harvested from all US forests (Kathryn Collins, 1999)

4.3 Forest Practices Acts

The PNW has a history of leading the nation in regulating forest practices. In Oregon the Forest Practices Act was the first of its kind in the USA and passed in 1971. The Washington Forest Practices Act passed in 1974. These Acts are a statutory framework for a program that includes rules, technical assistance and monitoring. They were developed to ensure the protection of soil, air, water, fish, wildlife, and forest resources (Garland, 1996). Through time, these Acts have been revised and amended to mitigate problems in forest practices.

Any company or individual working in state or privately owned forests in these two states must comply with the practices set out in these Acts. Federally owned forests are exempt, but federal management agencies have agreed to meet or exceed the standards in the respective Forest Practices Acts. This is the minimum standard to which all forest managers must comply. In this sense, the state Forest Practices Acts ensure that some level of intensive management is practiced following clearcutting. The legislated rule in Oregon is that every harvested acre must be replanted within two years and be “free to grow” and “well distributed” within six years. In Washington, three years is the cut off for replanting, but there is allowance for natural regeneration over one to ten years. Following this, the level of intensive management is up to the forest manager.

In Oregon, a voter-based initiative system allows the public to propose regulations that can be voted into law by popular referendum. Initiatives on banning clear-cuts and other forest management activities are routinely put on voter ballots. It can be very frustrating for a forest manager, trained as a professional, to be required to do things that do not seem to be based on science. However, in a democracy, the public have a right to be involved in things that affect them and, as such, they have a right to influence how forests are managed, at least on public land.

Complying with the state standards in Washington and Oregon is a cost to the forest industry. The standards mean that they cannot extract all the timber from their total estate (e.g. buffers on streams, leaving 'wildlife' trees and down logs), they must replant harvested areas (subject to the type of harvest) within two years and there are many restrictions and rules when it comes to harvesting and roading. The environmental standards for forestry around the world are variable. The high standards in Oregon and Washington mean greater costs and add weight to the argument that the Pacific Northwest is an increasingly difficult place for a forest growing business. In a comparison for forest industry investment between 5 other countries, the United States forest industry ranked the lowest in regard to public image, environmental legislation and environmental pressure (Brown and Ortiz, 2001).

4.4 Forest Certification

The rise of environmental activism and the public's concern that forests around the world were not being managed on a sustainable basis also gave birth to the evolution of independent forest certification bodies in the eighties. However, it would not be until the late nineties, when major retailers such as Home Depot announced that all its wood suppliers had to show proof that it was sourcing from sustainably managed forests, that the certification movement gained serious momentum in the US.

These independent forest certification groups (Non Government Organisations) define minimum forest management standards and facilitate a process of independent, third party auditing to 'certify' that these management standards are being practiced. If a company passed the third party audit, the forests that they manage would then be certified as being 'well-managed' according to the particular certification system.

The expansion of certification bodies promoting their label in the early nineties was huge. There were over 600 labels, which merely led to consumer confusion about the whole issue. Now, there are only a small number of well-recognised certification bodies, such as (but not limited to) ISO14001, Forest Stewardship Council (FSC), Sustainable Forestry Initiative (SFI), Canadian Standards Association (CSA), the American Tree Farm System (ATFS), Pan-European Forest Certification (PEFC) and the Australian Forestry Standard (AFS).

Although technically voluntary, certification has become a requirement for many large and even small forest owners, either because the end retailer is requiring some form of certification, or the company belongs to an industry association that requires it of all their members (e.g. American Forest and Paper Association). Perhaps one of the unintended consequences for smaller forestland owners is that certification (apart from the ATFS) has placed a proportionally greater financial burden on them. For example, one local private forestland owner has FSC certification at a yearly cost of $US1500. At this stage, he hasn't seen a financial benefit to this certification, although he does believe that it has widened his marketing opportunities.

All of the companies interviewed for this report, except for one, had achieved certification over part or all of their forest estates. The certification achieved was through the Sustainable Forestry Initiative, which was developed by the American Forest and Paper Association. The survey found that, whilst certification may have broadened the monitoring perspective of forest managers at some companies (e.g. recording non-tree species and wildlife), all companies reported that certification rarely changed their on-the-ground forest practices. Many pointed to the already strong requirements of the Forest Practices Acts in the two states as the reason for this. In fact, the Forest Practices rules are more detailed in certain areas than the certification systems. Simply by operating within state law, forest managers are exceeding some of the requirements of SFI certification.

FSC or SFI certification, what's the difference?

Although they both have the same basic objective – to improve forest management practices – there are differences between FSC and SFI certification. FSC was developed largely by environmental and social equity NGOs, whereas SFI was developed by US forest products companies (Meridian Institute, 2001). FSC explicitly addresses social, economic, and environmental issues in its standards. SFI focuses primarily on environmental standards, social issues are seen to be adequately addressed by US laws and regulations, and economic viability is seen to be determined by marketplace competition (Meridian Institute, 2001).

The companies interviewed agreed that certification definitely required greater amounts of paperwork and time, and that sales of certified wood did not, for most, return a premium. However, it is well accepted now within the industry that certification is a cost of doing business and maintaining access to large-scale retailers.

5 Securitisation: The Emergence of Timberland as an Asset Class

The previous chapters have examined how biological, silvicultural, and social/environmental changes have impacted forest management in the Pacific Northwest. Forest managers have long been sensitive to these factors. But perhaps the most significant factor to impact forest management on private land in the US in recent years is the development of timberland as an asset class, and the separation of forest ownership from wood processing. This trend of securitisation has changed the way in which many in the forest industry regard forestlands, and therefore the way such forests are managed.

5.1 The Industrial Forest Ownership Shift

Industrial forests in the United States have been changing hands. There has been a significant shift from "traditional" forestland owners, typically vertically integrated wood processing companies that own their own fibre resource, to a growing sector of third-party management companies that own land but do not operate processing facilities. These owners are investment-oriented, and focus primarily on earning maximum returns from their forest investment.

The shift in forest ownership has occurred for a number of reasons, such as:

- Weak financial performance in the forest industry: companies looked for ways to increase profits
- tax advantages associated with new investment holding vehicles
- environmental risk associated with holding timberlands, and
- global consolidation: companies refocused on their core strengths in manufacturing and away from timberlands.

Historically, 'traditional' forest industry companies owned timberland to maintain a secure fibre source. In the PNW, most companies first sourced their raw material from the large tracts of public forests, and then used their own forests to supplement supply. This seemed to be a wise strategy for those vertically integrated companies when, in the eighties and nineties, federal timber supply declined rapidly (Figure 5). Many of the processing-only companies that did not have the security of their own timberlands during this period had to fold. During the period between 1989 and 1993, 242 mills closed and 30, 000 mill and wood industry jobs were lost in the PNW. By 2000, mill closures increased 3-fold and the number of jobs lost doubled (Rural Technology Initiative, 2001).

Owning timberland as a fibre security strategy began to come under question in the 1990s, as a number of developments converged. Poor financial performance in the forest products sector, especially amongst publicly held companies, led investors to question whether these companies should sell timberlands to improve cash flow and profitability. Due to US accounting standards, timberland assets are recorded at cost, and therefore the true value of the timberlands cannot be captured for shareholders. Faced with poor financial returns, publicly held companies in the industry came under pressure to find ways to reduce capital expenditure and selling their timberland assets was one option to improve cash flow.

At the same time, the forest products sector was undergoing, and continues to undergo, consolidation both in North America and elsewhere. As companies merged and consolidated, they sought efficiencies and refocused on core strengths in manufacturing. Non-strategic assets such as timberland were sold to relieve debt, creating a new market for timberland (Block and Sample, 2001). Of 40 companies identified by Sampson et al (2000) as being large timberland owners (more than 160, 000 hectares) in 1979, almost half (19) are gone or no longer own timberland (Sampson et al, 2000).

Whilst vertically integrated forestry companies were the big sellers of timberland in this shift, the largest purchases of timberland in recent years have been by Timberland Investment Management Organisations (TIMOs) (Block and Sample, 2001).

TIMOs are essentially the timberland portfolio managers for a variety of clients such as public and private pension funds, foundations, wealthy individuals and endowments. Some of these institutional clients may have very large asset values (in the billions), for example California Public Employees Retirement System ($US174b), General Motors ($US95b) and Harvard University ($US13b) (Block and Sample, 2001). Some TIMOs manage timberlands themselves (such as The Campbell Group and Forest Systems), and some contract this out (Hancock Timberland Investments Group and GMO Renewable Resources). Wood processors can still maintain fibre security through long-term timber supply agreements with TIMOs.

TIMOs recognise the counter-cyclical nature of the forest industry compared to other sectors. By holding, say 1% of their money in timberland, they are diversifying their portfolio and reducing risk. 1% of a large fund may well be over $US1 billion.

TIMOs appeared in the US in the eighties, when institutions became interested in buying timberland and the traditional forest industry companies were selling. Figure 7 shows the increase in institutional investments from 1982 to 2002; from $US30 million to over $US11 billion in 20 years. TIMOs are not subject to double taxation as the institutions are mostly tax-exempt. They are not vertically integrated so they have no fibre supply concerns (although some have signed agreements with processors to supply fibre).

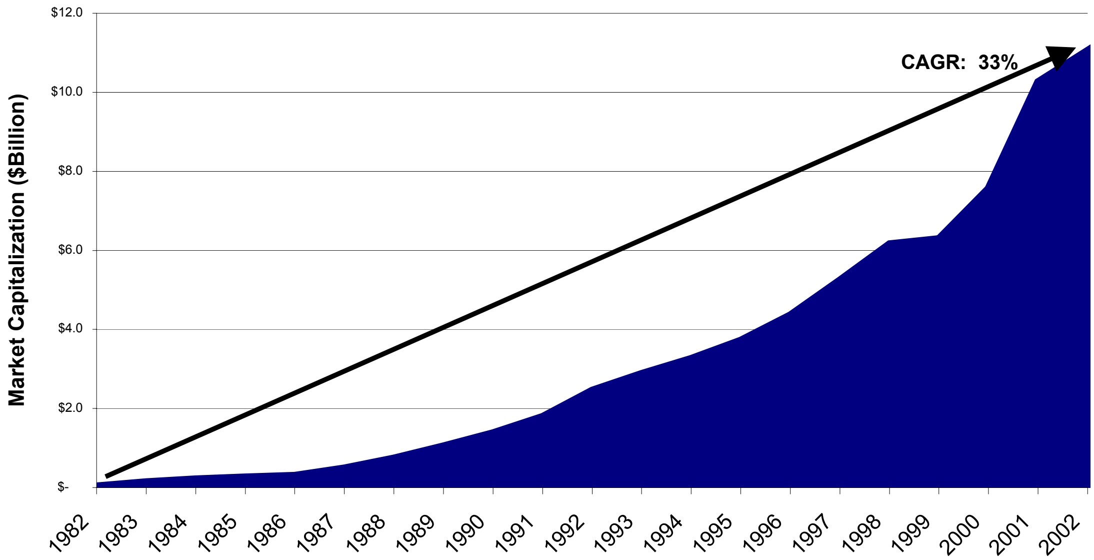

Figure 7: Growth in institutional investments in timberland, 1982-2002 (Kelly, 2003)

5.2 Impact of Securitisation on Forest Management

In discussions with various forest managers and ownership types, it is clear that the type of forest owner influences the forest management practices. Each type of forest owner seems to be motivated to varying degrees by different drivers, although they are all out to make a profit.

The publicly owned forest industry companies are under additional stock analyst scrutiny and are vulnerable to the swings of the stock market. Wall Street's short-term investment horizon is more preoccupied with short-term profitability; they want to see good profits every year. Although this outlook does not suit the long-term business of forest management very well, these public companies must strive towards increasing value to their shareholders.

Of the companies surveyed, the public listed ones said that adding value to the shareholders was their primary concern, although most also recognised that there were legal and social limitations to this.

The privately owned companies are not subject to the same financial pressures as the public companies. As such, they have less external pressure to optimise the forest-growing aspect of their operations, and they can place more importance on developing an accessible, long-term, quality resource. These companies seem to be willing to spend more money on their timberlands in order to achieve this objective. Some vertically integrated companies may even be willing to subsidise their forestland operations through other business parts, as long as the company as a whole is profitable. For some of these companies, maximising profit is not necessarily more important than managing a quality resource and being a part of the community. As mentioned in Chapter 4.2, Starker Forests is a good example of recognising community values.

TIMOs have a very different view of forest management and the days of primarily focussing on the biological and silvicultural regimes necessary to achieve optimal growth are fading. Today's forest managers are operating in a market environment where their timber must compete with cheaper imports and alternatives to timber, provide returns that meet Wall Street's short-term investment horizon, satisfy more stringent environmental regulations, and ensure public acceptance of their practices. The investment oriented landowners are demanding financial, market and productivity data about all aspects of timber growing that far exceed what many traditional land owners would typically collect and consider in making forest management decisions.

The bottom line is the main focus for TIMOs. Motivation percolates through these organisations to the point where every significant cost needs to provide a benefit that is usually expressed in monetary terms. TIMOs demand a more sophisticated level of information gathering on which to base their forest management decisions, which is placing new demands on forest managers to be able to account for the cost and benefit of any proposed management activity (see Chapter 6).

TIMOs also have a shorter investment horizon than traditional timberland owners. Whereas traditional timberland owners often state that ensuring a sustainable resource for generations is a key goal, the typical time period on closed end funds is 10 to 15 years, after which the fund is sold (Block and Sample, 2001). The length of ownership appears to be a contributing factor to determining the level of management intensity. For TIMOs it would be difficult to justify to their investors that an additional treatment (such as fertilising) will be of benefit to them. The return from such an investment would not be seen before the TIMO sells off the land. Because the highest costs associated with growing a stand occur at establishment, financial analysis shows that the sooner the company can capitalise on that expense, the more profitable it will be. For this reason, TIMOs tend to invest in treatments that are more apparent in the short term, as such treatments would appear as increased growth in a pre-sale inventory. As forest management companies became more financially accountable and as the forests change to second growth, financial analysis of silvicultural regimes highlight the impact of reducing rotation age on profitability.

The results from the study seem to indicate that the vertically integrated, public companies were practicing the most intensive silviculture. Vertically integrated companies tend to manage their forests for the full length of a rotation so they realise the full benefit of their intensive practices. However, whether these companies are realising a good return on their investment is questionable. In fact, one company stated that they were planning to move their operations from the PNW to the Southeast “where the economics are better”.

6 Information Technology in Decision-making

Forest management has been going on for centuries, long before the advent of personal computers and information technology. However, as the previous chapters describe, forest management is far more complex than it used to be. No longer do forest managers focus solely on biological factors to grow a crop of trees. They have a greater range of silvicultural options, are limited by environmental restrictions and, most importantly, have to understand the financial benefit of their operations. This is where information technology comes to the fore.

The trend towards investment type ownership has impacted the way in which forest managers base their forest management decisions. Coming from the financial sector rather than the tree-growing sector, these third-party companies closely examine financial and production data and are heavily dependant on information technology to aid their decision-making. This new breed of forest manager is far more focussed on the bottom line and relies on information technology to provide the financial reports that their investors expect.

In relation to forest management, information technology encompasses:

- Decision support systems (incorporating growth models and economic analysis), and
- Geographic Information Systems (GIS)

Decision support systems (DSS) are essentially programs that enable a forest manager to understand the impact of a particular treatment, or series of treatments, and provide them with likely outcomes. DSS have the ability to collect, analyse, display and communicate data to the users in a way that enables them to make decisions. DSS, for stand management, use growth models and, in some cases, financial models to predict the outcome of silvicultural regimes.

Growth models are based on empirical data gathered from repeated measurements of trees subjected to different silvicultural regimes over time. They are the backbone for projecting future yields and many of these are publicly available. They are publicly available because they were developed using public funds by government agencies, such as the PNW Research Station of the US Forest Service. Universities have developed other models. Examples of the growth models available are FVS (1973, 1982), DFSIM (1981), CRYPTOS (1981), CACTOS (1986), ORGANON (1986), and more recently RVMM (1996) and CONIFERS (2001) (Marshall and Turnblom, 2004)

Table 1 shows a list of commonly available stand-level DSS used in the Pacific Northwest. These tools serve to describe the stand condition through summarising inventory data, or project the growth of a stand and estimate the yield and/or economic return.

Tool	Owner	Description	Comments
FINSIL3	MacMillan Bloedel Ltd. Vancouver (public domain)	Spreadsheet program for financial analysis of silviculture treatments.	Based on data obtained in mid- to- late 1980s, can easily be updated with new data.
FPS	J. Arney, Oregon, U.S.A.	Forest Projection System - growth and yield model for single and mixed species; even- and uneven-aged stands.	Some calibration for BC.
PROGNOSIS	British Columbia Forest Service, Victoria	Stand Prognosis Model - growth and yield model for single and mixed species, even- and uneven-aged stands.	Part of a family of models that allows analysis of economics, pests, tree crowns and environmental indicators. Calibrated for 14 regions of the U.S. Being calibrated by BCFS for BC interior species, starting in the Nelson Forest Region.
PRUNSIM, DF PRUNE	Forest Resource Systems Institute, Florence, Alabama	Spreadsheet programs that estimate the financial return from pruning coastal Douglas-fir stands.	Helps determine how many and which trees in a stand should be pruned. Calibrated for southern Oregon.
SPS	Mason Bruce and Girard Ltd. Oregon.	Stand Projection System - growth and yield model for single and mixed species, even- and uneven-aged stands.	Some calibration for BC.
STIM WINSTIM	CFS, Victoria	Stand and Tree Integrated Model - growth and yield model.	Also projects the growth of spaced and thinned stands. Calibrated for hemlock in BC and Pacific Northwest.
SYLVER	BCFS, Research Branch	A system of practices models that evaluate the impact on yield, lumber value and economic return.	Consists of models that grow stands, buck logs, saw lumber, grade boards and perform financial analyses.
TASS	BCFS, Research Branch	Tree and Stand Simulator - biologically based growth and yield model for even-aged pure-species stands. See TIPSY.	Calibrated for most even-aged stands of pure coniferous species of commercial importance in coastal and interior BC forests. Part of the SYLVER family of models.
TIPSY	BCFS, Research Branch	Table Interpolation Program for Stand Yields - retrieves and interpolates stand yield information from a database generated by SYLVER.	Windows system that generates tables for standing yield (including stand and stock tables), mortality, snags, products (logs, lumber and chips) and economic return. Repression has recently been added for lodgepole pine.
XENO	MacMillan Bloedel Ltd., Nanaimo	A distance-dependent stand growth model capable of growing single or mixed species under both natural and managed regimes.	Model simulates development of Douglas-fir and western hemlock, also allows for economic analysis in consideration of wood quality attributes.

Table 1: Stand level DSS used in PNW region (Ebata, 1999)

The systems in Table 1 have enabled forest managers to explore a range of silvicultural regimes for a particular stand and determine the one that will provide the most of a particular product (e.g. specific log size) and/or the one with the highest financial return.

Although a number of companies have developed in house decision support systems, there is an increasing availability of software packages that can be bought off the shelf. New companies, such as the Forest Technology Group and Remsoft, have appeared in recent times to provide such packages. The fact that these companies exist shows that more forest managers are utilising such tools.

GIS help forest managers map, analyse and store data about the land that they manage. All companies interviewed used GIS, although some were new to the concept. One would think that forest management companies in one of the best places in the world to grow trees would have been using this sort of technology since its inception in the sixties. Perhaps it is because trees grow so well in the PNW that forest managers, in the past, have not had the need to utilise the best available technology. With the changing landscape of forest management described in the preceding chapters, most companies (especially TIMOs) are recognising the benefits of using sophisticated information technology.

The increasing use of information technology means that modern forest managers need to keep abreast of new developments in this area. In order to not only make educated forest management decisions, but prove the benefit of them to investors, forest managers must utilise the tools of information technology. Although information technology is not the driver, it is certainly assisting the changing world of forest management.

7 Back to Australia

There are great places to grow trees in Australia, but it too has been going through significant change. Native forests are no longer the primary source of timber; plantations are. Between 1996 and 2001, 9.1 million cubic metres of timber was harvested from native forests and 12.2 million cubic metres was harvested from hardwood and softwood plantations (National Forest Inventory, 2003). It is very likely that this trend will continue in coming years.

Regional Forest Agreements (RFA's), developed between 1997 and 2001, were initiated by both the Federal and State governments to develop a comprehensive, adequate reserve system and to ensure a 20-year timber supply from native forests. To date, not all RFA's have been signed by both the Federal and State governments. Social perceptions toward native forest harvesting since the completion of RFA's have initiated unilateral changes by State governments to some of these agreements. For example, additional areas of multiple use forests in the Upper North East (New South Wales) region have been added to reservation. In fact, since 1998, there has been a 22.2% increase in forest area placed in conservation reserves and a reduction of 14.6% of the area available for multiple use (National Forest Inventory, 2003). Harvesting of all native forest in the state of Queensland is planned to be fazed-out by 2020, resulting in a forest industry which will be solely based on plantation timber.

Socially, the Australian public are strongly influenced by what they hear and see in the media, and the environmental movement have been very successful in swaying public opinion. The environmental movement is advocating the use of plantation grown timber in favour of timber from native forests and the federal government developed a plan in 1997 to triple the area of planted forests to 3 million hectares by 2020 (Plantations 2020, 2001). In the future, given this background, it is very likely that an increasing proportion of timber used in Australia, and exported, will be from plantations.

Forest ownership is also changing. Softwood plantations were established in the 1870's by government agencies. In the 1960's the rate of softwood planting increased throughout the states and territories, as the supply from native forests was forecast to decline. Except for Victoria, the state and territory governments still manage significant areas of public softwood plantations. As is the trend in the US, investment through large, multinational financial institutions is likely to increase. For example:

- the softwood plantations in Victoria were sold to Hancock Timber Resource Group and a consortium of Australian funds managers,
- half of the softwood resource in Tasmania was sold to GMO Renewable Resources, and
- there has recently been a report commissioned by the NSW Treasury in regard to the sale of their plantation resource.

The change from public to private ownership is likely to see significant changes to the way these plantations are managed. In order to maximise shareholder returns, private companies will scrutinise all operational practices and make decisions that are based on sound economic principles. The likely result being minimal silvicultural input to achieve the desired product, shorter rotation lengths, and log prices that reflect the true cost of plantation management.

The planting of eucalypts is a relatively new trend in Australia and has increased significantly since the eighties. This increase has primarily been the result of private investment in the hardwood sector through joint venture and annuity schemes funded by prospectus-based companies. 85% of all hardwood plantations in Australia are privately owned (National Forest Inventory, 2003). Although changes to taxation rules saw a significant drop in this sector in 2001-2002, the tax rules changed again and investment in 2002-2003 was very high; many prospectuses had completely filled their subscriptions before the end of the financial year (Hopkins, 2003).

The majority of these new plantations are for the production of woodchip for conversion to pulp and paper products both in Australia and overseas. The companies that are planting and managing these plantations are using highly intensive practices to ensure maximum growth and short rotation times. However, even with intensive management, growth rates in Australia are not as high as in other countries, where significant investment into genetic improvement and the lack of natural predators give them a distinct growth advantage.

Although other countries can achieve higher growth rates, Australia still has some advantages over them including political stability and proximity to new and emerging Asian markets. Perhaps this is why a significant component of more than $A6.5 billion invested in the forest industry over the last decade (National Forest Inventory, 2003) has come from international companies.

With a shift away from harvesting native forests and the trend to increased privately owned plantations, forest management in Australia will also change. The new forest owners will focus primarily on economic return, just as they do in the US, and forest managers will need to focus far more on financial accountability than they do on biological growth.

8 The Bottom Line: Economic Returns in a Changing World

The combination of topography, climate and soils in the PNW create ideal conditions for the extraordinary growth of the conifers that have adapted to this area. But modern forest management is not just about growing trees. Forest managers not only have to comply with environmental regulations, based on science and society's values, they have to prove to their investors that they are maximising returns. Commercial forest management is focussed on maximising the economic return from the stands, while balancing the biological, social and environmental limitations.

Today, economics is the main driver of forest management decisions. As Colin Mackenzie stated, "forest management can be thought of as the business of growing trees" (McKenzie, 1999). This is a far cry from the traditional approach of forest managers, who were primarily concerned with the biological and technical aspects of establishing and protecting forests, silvicultural treatments, and harvesting.

Managing forests to produce economic returns has taken on increased importance as wood has become a globally traded commodity and countries compete for market share in several product categories.

Under these economic conditions, there are more players in the field of timberland ownership and the new players, worldwide, are institutional investors. Such investors view this as an asset class that, like any other, should provide a 'good' return on their investment. TIMOs, that manage these funds, heavily scrutinise the economic benefits of all forest management exercises.

Intensive management is a costly exercise. Compromises between intensive and extensive management are generally made to reduce these costs. An understanding of the benefit from each management option is where decision support systems are valuable.

The increased use of information technology is expected as forest managers strive to achieve greater returns from their forests. Technology is an aid to forest management. Advancements in this field have assisted forest managers through improved operational efficiencies and a greater awareness of the implications of forest management decisions. The economic benefits of the use of technology will continue to change how forest managers operate.

Publicly listed companies, the world over, are driven by economics and the mantra of "increasing value to their shareholders". Wherever possible, technology will be used to focus treatments into areas that will provide the best return. Long rotations, the nemesis of economic forest analysis, will become as short as possible whilst still achieving the desired product.

The privatisation of plantations in Australia is likely to continue and this is also likely to mean that more plantations will be owned by institutional investors. The impact for forest managers is that they will be expected to have a far greater focus on the economic benefit of operations than they may have had in the past. They will also need to utilise current information technology to achieve these aims.

The world of forest management is changing, and today's forest manager can see big changes in how they are expected to manage industrial timberlands.

1 A Brief Geologic History of the Pacific Northwest

The Pacific Northwest region has variable boundaries, depending on which source of information you consult, or whom you talk to. Whitney (1989) defines a very broad area incorporating northern California (from San Francisco and up the coast), Oregon, Idaho, Washington (in their entirety), western Montana, the coastal range of British Columbia and extending through to southern Alaska (Anchorage) – see Figure 8.

Figure 8: Map of North America with Pacific Northwest area shaded, based on Whitney (1989)

Most publications tend to agree that the heart of the region is in the states of Oregon and Washington (Franklin and Dyrness, 1988). It is in these two states that this report is centred, although many of the observations will carry through to the broad - albeit hard to define - region of the Pacific Northwest. For the purpose of this report, the 'Pacific Northwest', or PNW, refers to the area indicated on Figure 9. This report will focus on the area west of the Cascade Range, as this is where growing conditions have produced unique, productive forests.

Figure 9: Map of Oregon and Washington showing focus of report, Pacific Northwest zone shaded

Geologically speaking, this region is relatively young and still in a state of flux. It is a classic example of the theory of plate tectonics where, in this case, the oceanic crust is slowly sliding under (being 'subducted' by) the continental crust. The Juan de Fuca plate is being subducted by the North American plate at the rate of 3 cm/yr (Noson, Qamar, and Thorson, 1988). This subduction is due to the more dense sheet of basalt being forced under the relatively light, mostly granite, crust of the North American plate (Matthews, 1994).

Mountain ranges are produced by subduction in a number of ways. At the point where the two plates meet, the upper layers of the oceanic crust can be 'scraped off' and forced against the continental crust. This material can be composed of both basalt and overlying marine sediments that built up over time on the ocean floor (Matthews, 1994). Evidence for this action can be seen on the Oregon coast where hard, basalt headlands (see Photo 1) are interspersed with more erodable sedimentary material. The Oregon and Washington Coast Ranges were formed in this way and consist primarily of sandstones and mudstones (Matthews, 1994).

Photo 1: Oregon coastline showing basalt headland (photo by Min Chung Yang, 2003)

The Olympic Peninsula was formed somewhat differently. Although the same subduction was happening, it was being blocked by two very hard land parcels, Vancouver Island and the North Cascades (Matthews, 1994). This blocking caused the build up and rise of the basalt and marine sediment layers to a point where the basalt was folded to the top and bent into an arc, showing the tremendous force driving it and the resistance it faced.

Another typical feature of subduction is a line, or 'arc', of volcanoes some distance in from the point where the two plates meet. This arc of volcanoes is caused by the melting of some minerals within the basalt sheet, which tend to rise as a fluid magma in pulses (Matthews, 1994). It is this action that formed the Cascade Range over a period of 36 million years (Swanson et al. 1989).

Sometimes, the rising magma can change in its chemical composition into a viscous fluid that rarely breaks the surface of the earth. When it does, however, the result can be explosive, as in the eruption of Mt St Helens on the 18th of May, 1980 (Matthews, 1994) (see Photo 2). The formation of lava domes is from this same process.

Photo 2: Mt St Helens (photo by John Guyton, 2003)

Thus the landform of the Pacific Northwest consists of the Coast Ranges, an inland range (the Cascades) and the Olympic Peninsula. Between the two ranges lies the Willamette Valley (Oregon) and the Puget Basin (Washington). In more recent times (during the last 20,000 years) this area has been subjected to major climate shifts, i.e. ice ages (Matthews, 1994). During this time, landform was mostly influenced by glacial and volcanic activity. These two processes served to gouge wide, U-shaped valleys and deposit new material on the surface respectively. This, and the combination of soil type and climate, has led to steep, highly unstable, slopes and flat valleys.

There is one major break in the Cascade Range, through which the Columbia River now flows (see Figure 10). The Columbia Gorge was formed during the last ice age when a large ice dam would periodically float and send millions of litres of water towards the west coast. The floodwaters were from 350 to 100 metres deep and served to scour a deep gorge through the path of least resistance. This flooding action occurred many times; a series of 15 floods at 35-55 year intervals have been observed in a single pile of sediments (Matthews, 1994). The floods would fill much of the Willamette valley when they occurred, defining the soils and topography of this area.

Figure 10: Map of Oregon and Washington showing described features

The soils, based on this parent material and volcanic activity, consist mainly of weathered sandstone (providing a rich source of nutrients), deep sandy to silty clay loam (Willamette Valley), pyroclastic soils (poorly drained but highly fertile) and soils derived from basic igneous rocks (mainly basalt and andesite) (Franklin and Dyrness, 1988).

2 Climate of the Pacific Northwest

The Pacific Northwest climate is strongly influenced by the Pacific Ocean.

> *Winters are significantly warmer, summers are significantly cooler and it is wetter year round near the Pacific Ocean than in comparable areas farther inland.*
>
> (Matthews, 1994)

The Pacific Ocean, combined with latitude and the influence of the two major mountain ranges, essentially define the climate of the Pacific Northwest. Generally, it gets warmer and drier from north to south as well as becoming drier from west to east over the Coastal and Cascade ranges.

The most unique feature of the climate of the Pacific Northwest is the annual rainfall distribution. The climate is marked by extremely wet winters and near drought conditions in summer. This pattern is unequalled anywhere else in the world, where rainfall in December is in the order of 6 to 20 times greater than in June (Matthews, 1994). Annual precipitation is typically 1700 to 3000 mm or more on the coast and 800 to 1200 mm in the Puget Basin and Willamette Valley (Franklin and Dyrness, 1988). These unique conditions have lead to the evolution of equally unique species that are adapted to the near drought conditions in summer.

The dry conditions experienced by most of the Pacific Northwest during summer, are mitigated by fog within an area commonly known as the "fog belt". This area is a narrow strip of land extending from the coast about 20 kilometres inland throughout the Pacific Northwest. This fog is known to add additional moisture to the forest through "fog drip" and could be a factor in the high growth rate of forests in this area. Figure 11 shows average annual rainfall for the states of Oregon and Washington.

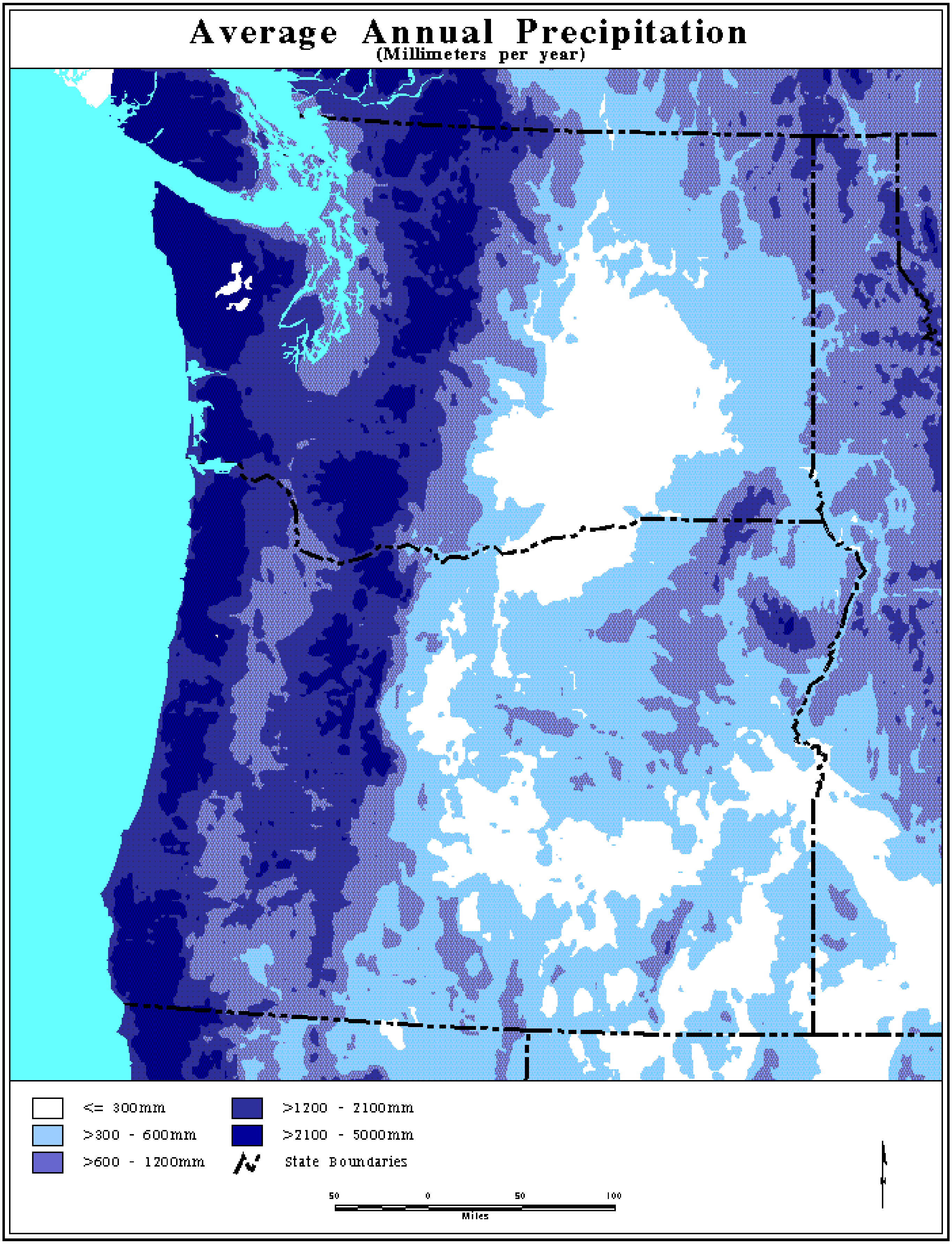

Figure 11: Average annual precipitation for Oregon and Washington (in millimetres)

The bulk of the precipitation comes in from the Pacific Ocean as low pressure systems borne by the dominant westerlies. These cyclonic systems occasionally bring destructive winds that have an influence over the composition of the forests, particularly along the coastal fringe (Franklin, 1988; Matthews, 1994).

One such storm, the Columbus Day Storm, in 1962 has been described as "the most powerful non-tropical storm in the lower 48 state's history" (Willson and Kosovitz, 2003). This cyclone caused extensive damage not only to 50 000 buildings but blew down 35.4 million cubic metres (15 billion board feet) of timber in northern California, throughout Oregon and Washington, western Montana and into British Columbia (Willson and Kosovitz, 2003) (see Photo 3).

Photo 3: Forest damage following Columbus Day Storm (Rockey, 2003)

The Willamette Valley lies in the rain shadow of the Oregon Coast Range hence rainfall is generally lower than the nearby coast by half (Whitney, 1989). The Puget Basin is affected in a similar way by the Olympic Peninsula but not to such an extreme. Marine air is more able to access further into Washington due to the broad valleys of Puget Sound and the Chehalis River, east and south of the Olympics respectively (Whitney, 1989).

The Cascade Range serves as a major barrier to the movement of the maritime and continental airmasses (Franklin and Dyrness, 1988). The westerly winds and moist maritime air tend to be blocked by this range causing the western side to receive high levels of precipitation, in the form of rain and snow. The eastern side of the range is in rain shadow and is outside the boundary of the Pacific Northwest defined in this report.

The Columbia Gorge serves as a passageway for continental airmasses that can result in ice storms in the Portland area. The cool, inland air mass blows down through the gorge and meets with the warmer, moisture laden air of the west. The result is freezing winds and rain that turns to ice where it lands, sometimes building up to cover trees and buildings. Although this is an infrequent event, it is another factor that forests in this area have evolved to cope with.

3 The Forests of the Pacific Northwest

The forests of the Pacific Northwest are unique. The combination of topography, soils and, of course, climate provides the most ideal conditions for the growth of conifers. Their growth rates are astounding.

> *Conifers grow bigger here than anywhere else, and the resulting tonnage of biomass and square-footage of leaf area per acre are among the world's highest, outstripping tropical rain forests as well as temperate deciduous and boreal coniferous forests. (Matthews, 1994)*

Conifers dominate the western forests because they are more suited than hardwoods to the relatively warm winters and near drought summers. Hardwoods are only found where there is high soil moisture, such as riverbanks and the edges of water bodies, as they are severely hampered by the driest period occurring during their peak period of growth. Even in the coastal forests, where there is more summer moisture, the conifers dominate. The main reason for this is that conifers can utilize the abundant moisture during the time when the hardwoods are dormant; from fall through spring. The subsequent growth of conifers during this part of the year serves to give them a growth advantage over the hardwoods and essentially out-compete them (Whitney, 1989).

There are four main factors that determine plant habitats. These are climate, topography, soil, and interactions among plants and animals, including humans. These factors do not operate independently, and it is usually difficult to speak of one without referring to one or more of the others. The climate, topography and soil of the PNW have been described in previous chapters. The influence of humans on this landscape will be discussed in the following chapter. It is worth understanding the types of forests and their limitations and characteristics prior to discussing the impact of humans and the resulting modern day management techniques.

The forests of the PNW can be divided into five major zones: Coastal, Interior, Valley, Southern and Subalpine. It is difficult to mark the boundary between one zone and another, as these zones are fairly arbitrary, however there are certain features of each zone that make them different enough from the others to warrant definition. Figure 12 provides an indication of the location of the zones and the following comments will provide a short description of each.

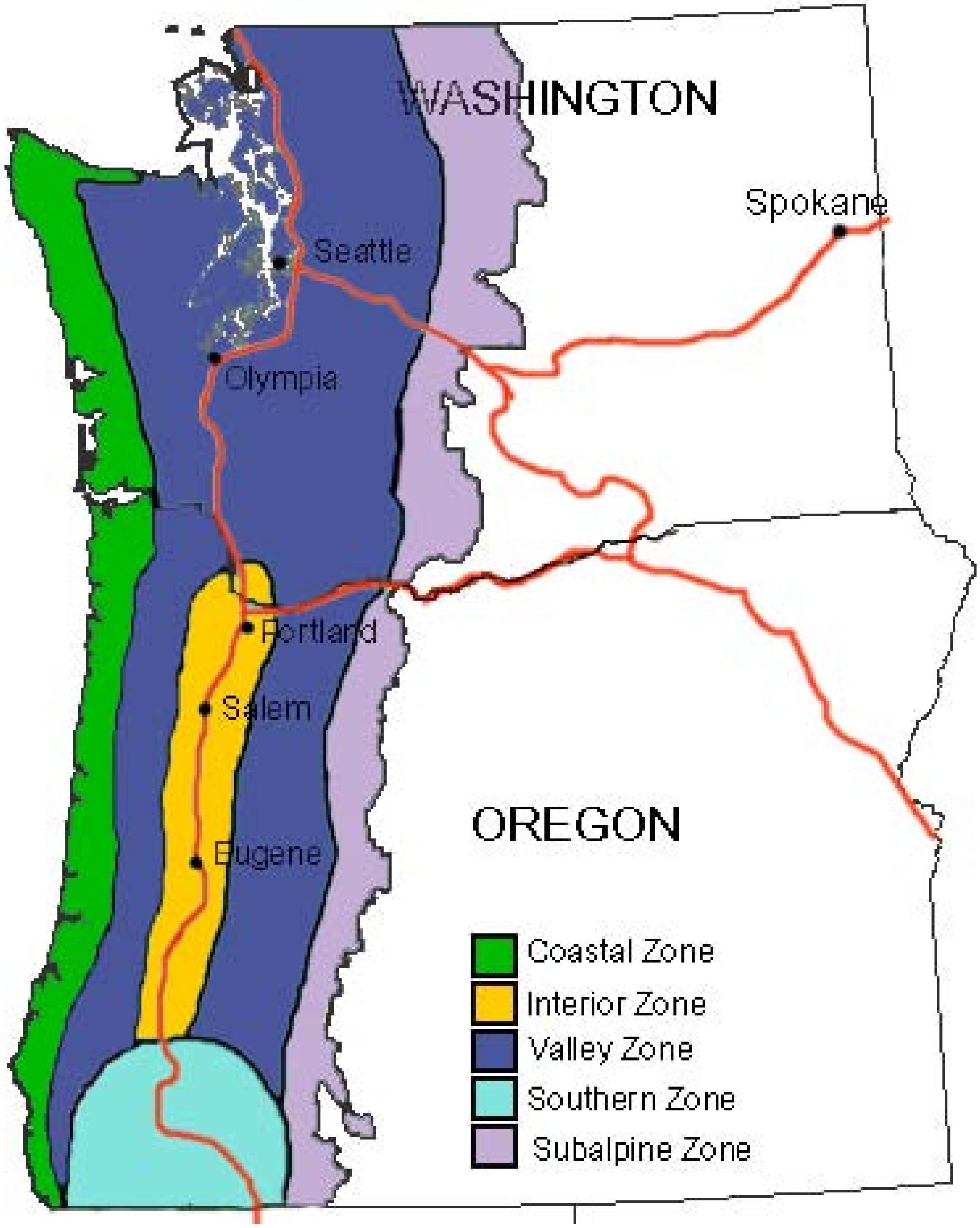

Figure 12: Map of Major Forest Zones in Pacific Northwest

3.1 Coastal Zone

The Coastal Zone is characterised mainly by climate. It generally has the mildest climate in the PNW, with minimal temperature extremes and high rainfall. Rainfall averages 2000-3000 mm and additional moisture is obtained through frequent fog and low clouds during the drier summer months (Franklin and Dyrness, 1988). This zone closely follows the fog belt area described in Chapter 3. The dominant tree species are Sitka spruce (*Picea sitchensis*), western hemlock (*Tsuga heterophylla*) and western redcedar (*Thuja plicata*). The forest stands in this zone are very dense, tall, and highly productive.

3.2 Interior Zone

The Interior Zone is the largest zone in the PNW and Douglas-fir (*Pseudotsuga menziesii*) is by far the most common tree species. It is found in association with other tree species, such as western hemlock and western redcedar, but is usually the most dominant species. Given that this zone is the most extensive in the PNW, the description of climate given in Chapter 3 is basically the climate of this zone.

3.3 Valley Zone

Lying in the rainshadow of the Coast Range, the Valley Zone receives less rainfall than comparative low-lying areas in Washington. The vegetation is made up of oak woodlands and grasslands, with conifer forests confined to the foothills. Before the non-native American settlers arrived, this area was frequently burnt to keep the grasslands and maintain the large oak trees (Matthews, 1994). Following white settlement, most of the flats were cleared for agriculture and, without as frequent fires, the fringes around the flats became populated by conifers. Deciduous forests line watercourses and areas of reliable moisture.

3.4 Southern Zone

The characteristic dominant tree species in this zone is the coastal redwood (*Sequoia sempervirens*) although other species (mainly Douglas-fir) also inhabit this zone. The upper limit of the redwoods, and hence this zone, generally occurs at about 900 metres (Whitney, 1989). The coastal redwood is a far more prominent species in the Northern California forests where exploitation significantly reduced its range. More recent regulations and methods of management have meant that the redwood forests are being maintained for future generations.

3.5 Subalpine Zone

This zone is delineated by the range of Pacific Silver-fir (*Abies amabilis*) which is on the western slopes of the Cascade Range around 1000 to 1500 metres in Oregon, 900 to 1300 metres in southern Washington and 600 to 1300 metres in northern Washington (Franklin and Dyrness, 1988). This species is also found in the Olympic Mountains and the Subalpine Zone is shown in this area accordingly. The climate of this zone is characterised by a short, cool growing season and a significant winter snowpack (Franklin and Dyrness, 1988). Other species associated with this zone are western hemlock (*T heterophylla*), noble fir (*Abies procera*), Douglas-fir (*P menziesii*), western redcedar (*T plicata*) and, in the upper altitudes, mountain hemlock (*Tsuga mertensiana*) and yellow-cedar (*Chamaecyparis nootkatensis*) are found.

Bibliography

American Tree Farm System. 2004. About us.
Available from http://www.treefarmsystem.org/aboutus/index.cfm

Binkley, C. 2004. Global perspectives on intensive plantation forestry. Paper presented at Intensive plantation forestry in the Pacific Northwest, assessment of future potential and economic, environmental and social implications.
Available from http://outreach.cof.orst.edu/plantation/pdf/binkleyc.pdf

Block, N.E. and Sample, V.A. 2001. Industrial timberland divestitures and investments: opportunities and challenges in forestland conservation.

Brown, C and Ortiz, G. 2001. The forest processing investment environment. New Zealand.

Collins, K. 1999. Changes in resource availability. United States forest sector, country brief. Portland, Oregon, World Forestry Center.

Davis, Hibbits & McCaig Inc. 2001. ODF Statewide Research.
Available from http://www.dhiresearch.com/

Ebata, T. 1999. Guidelines for developing stand density management regimes. British Columbia.
Available from http://www.for.gov.bc.ca/hfp/pubs/stand_density_mgt/sdm-72.htm

Erb, G. 2001. Big trees take a fall.
Available from http://seattle.bizjournals.com/seattle/stories/2001/11/05/story2.html

Federation for Immigration Reform. 2000. Immigration impact - Oregon & Washington.
Available from http://www.fairus.org/Research/ResearchList.cfm?c=9

Fenn, G. 2003. Personal Communication.

Franklin, J.F. and Dyrness, C.T. 1988. Natural Vegetation of Oregon and Washington. USA, Oregon State University Press.

Garland, J. 1996. The Oregon Forest Practice Act: 1972 to 1994. Paper presented at Forest codes of practice.
Available from http://www.fao.org/docrep/W3646E/w3646e07.htm

Gartner, B., Newton, D. and McKinley, R. 2004. Producing wood of specific quality for designated end uses. Paper presented at Intensive plantation forestry in the Pacific Northwest, assessment of future potential and economic, environmental and social implications.
Available from http://outreach.cof.orst.edu/plantation/pdf/gartnerb.pdf

Hopkins, P. 2003. Interest blossoms in agribusiness. The Age.

Kelly, M. 2003. The evolution and growth of forestland as an asset class. Paper presented at Who will own the forest? Origins and implications of changing ownership.

Marshall, D. and Turnblom, E. 2004. Extrapolation of short-term research and operational results to long-term yield forecasts. Paper presented at Intensive plantation forestry in the Pacific Northwest, assessment of future potential and economic, environmental and social implications.
Available from http://outreach.cof.orst.edu/plantation/pdf/marshalld.pdf

Mathews, D. 1994. Cascade - Olympic natural history. Hong Kong, Everbest Printing. 1988.

McKenzie, C.R. 1999. Trends in international timber management. Paper presented at Proceedings of the National Agricultural and Resources Outlook Conference.

Meridian Institute, 2001. Comparative analysis of the Forest Stewardship Council and Sustainable Forestry Initiative certification programs.
Available from http://www.merid.org/comparison/

National Forest Inventory. 2003. Australia's state of the forests report.
Available from http://www.affa.gov.au/content/output.cfm?

Noson, Qamar, and Thorson. 1988. Washington State Earthquake Hazards: Information Circular 85.

ODF and WADNR. 2001. Washington and Oregon timber harvest by timber source. Oregon Department of Forestry and Washington Department of Natural Resources.

Oregon Forest Resources Institute. 1999. Oregon forest fact book. Available from www.oregonforests.org

Plantations 2020. 2001. Plantations for Australia: the 2020 vision. Available from http://www.plantations2020.com.au/vision/index.html

Pojar, J. and MacKinnon, A. 1994. Plants of the Pacific Northwest Coast. Canada, Lone Pine Publishing.

Rockey, C. 2003. Columbus Day 1962 Storm Gallery 1. Available from http://www.wrh.noaa.gov/Portland/gallery7.html

Rural Technology Initiative. 2001. Will low prices for large logs mean shorter rotations on private forestlands? RTI Fact Sheet #7. Available from http://www.odf.state.or.us/divisions/protection/forest_practices/fpmp/Projects/BMPCMP/BMPPilotResults(TR5).pdf

Sampson, N., DeCoster, L., and Remuzzi, J. 2000. Changes in forest industry timberland ownership 1979-2000. Available from http://www.sampsongroup.com

Swanson et al. 1989. Cenozoic Volcanism in the Cascade Range and Columbia Plateau, Southern Washington and Northernmost Oregon. AGU Field Trip Guidebook T106.

Talbert, C. 2004. Plantation productivity under current intensive silvicultural practices: results from research and operations. Paper presented at Intensive plantation forestry in the Pacific Northwest, assessment of future potential and economic, environmental and social implications. Available from http://outreach.cof.orst.edu/plantation/pdf/talbertc.pdf

USDA Forest Service. 2001. U.S. forest facts and historical trends. Washington DC.

Washington Forest Protection Association. 2001. Forest facts and figures. Washington, USA. Available from www.forestsandfish.com

Weyerhaeuser . 2001. Mt. St. Helens forest center learning gallery - forest recovery. Available from http://www.weyerhaeuser.com/popups/_frameset.asp?bodyFrame=/citizenship/publicoutreach/sthelens/photogallery/LargePhotos/recovery853_popup.asp

Whitney, S. 1989. A Sierra Club naturalist's guide to the Pacific Northwest. USA, Sierra Club.

Willson, D. and Kosovitz, I. 2003. Columbus Day 1962 Storm. Available from http://www.wrh.noaa.gov/Portland/columbusday.html