# A COMPARATIVE ECONOMIC STUDY OF WOOD GROWING IN AUSTRALIA AND SELECTED COUNTRIES

MANDY WALLACE

1992 GOTTSTEIN FELLOWSHIP REPORT

The information contained in this report is published for the general information of industry. Although all reasonable endeavour has been made to verify the accuracy of the material no liability is accepted by the Author for any inaccuracy therein nor by the Trustees of the Gottstein Memorial Trust Fund. The opinions expressed are those of the author and do not necessarily represent the opinions of the Trustees.

# JOSEPH WILLIAM GOTTSTEIN MEMORIAL TRUST FUND

The Joseph William Gottstein Memorial Trust Fund was established in 1971 as a national educational Trust for the benefit of Australia's forest products industries. The purpose of the fund is *"to create opportunities for selected persons to acquire knowledge which will promote the interests of Australian industries which use forest products for the production of sawn timber, plywood, composite wood, pulp and paper and similar derived products."*

Bill Gottstein was an outstanding forest products research scientist working with the Division of Forest Products of the Commonwealth Scientific Industrial Research Organization (CSIRO) when tragically he was killed in 1971 photographing a tree-felling operation in New Guinea. He was held in such high esteem by the industry that he had assisted for many years that substantial financial support to establish an Educational Trust Fund to perpetuate his name was promptly forthcoming.

The Trust's major forms of activity are,

1. Fellowships - each year applications are invited from eligible candidates to submit a study programme in an area considered to be of benefit to the Australian forestry and forest industries. Study tours undertaken by Fellows have usually been to overseas countries but several have been within Australia. Fellows are obliged to submit reports on completion of their programme. These are then distributed to industry if appropriate.

2. Seminars - the information gained by Fellows is often best disseminated by seminars as well as through the written reports.

3. Wood Science Courses - at approximately two yearly intervals the Trust organises a week-long intensive course in wood science for executives and consultants in the Australian forest industries.

4. Study Tours - industry group study tours are arranged periodically and have been well supported.

Further information may be obtained by writing to,

The Secretary,
J.W. Gottstein Memorial Trust Fund,
Private Bag 10,
Rosebank M.D.C.,
Clayton, Victoria, 3169 Australia

# *GOTTSTEIN REPORT*

## *A Comparative Economic Study of Wood Growing in Australia and Selected Countries*

*March 1994*

*Mandy Wallace*
*Gottstein Fellow, 1992*

Mandy Wallace is Chief Projects Officer with Primary Industries (SA) Forestry (formerly the Woods and Forests Department of South Australia) having held that position since 1986. Previously she was a Principal Research Officer with the Australian Bureau of Agricultural and Resource Economics. She has a Bachelor of Economics degree from Flinders University. Her special fields of interest are forestry economics research, investment analysis, forecasting, cost-benefit analyses and industry assistance issues. Her main responsibilty in recent times has been the design of projects that optimise profitability and other strategic factors in the forestry and forest products sectors. The aim of her project was to assess Australia's wood growing viability in relation to industrial forest plantations in terms of world markets.

# CONTENTS


| | PAGE |
|---|---|
| Acknowledgements | |
| Executive Summary | |
| 1. Introduction | 1 |
| 2. Approach | 3 |
| 3. Australia | 6 |
| 4. New Zealand | 24 |
| 5. Chile | 39 |
| 6. United States | 56 |
| - Southern Pines | |
| - Pacific Northwest | |
| 7. Canada - British Columbia | 95 |
| 8. Economic Comparison | 116 |
| Appendix: Itinerary | 124 |
| References | 126 |

Figures: 3.1 Estimated Age Class Distribution of Plantations, Australia
3.2 Annual Plantation Areas Established, Australia, 1991
3.3 Plantation Ownership, Australia, 1991
3.4 Log Removals by Product, Australia, 1991
3.5 Projected Wood Products Consumption, Australia

4.1 Plantation Ownership, New Zealand, 1992
4.2 New Zealand Plantation Establishment per Decade
4.3 NZ Exotic Roundwood Removals by Type, 1990
4.4 Trends in Real Log Prices, New Zealand
4.5 Current and Future New Zealand Log Supplies

5.1 Age-Class Distribution of Radiata Plantations, Chile, 1990
5.2 Roundwood Consumption, Chile
5.3 Nominal Radiata Log Prices, Chile
5.4 Real Radiata Log Prices, Chile
5.5 Eucalypt Pulplog Prices, Chile
5.6 Woodchip Exports by Species, Chile
5.7 Nominal Export Woodchip Prices, Chile
5.8 Projected Availability by Log Type, Chile, 1990 to 2019

6.1 Tree Planting, United States
6.2 Pine Plantations by Ownership, US South, 1985
6.3 Log Removals by Species and Type, 1986, United States
6.4 Indexes of US South Forestry Costs and Price
6.5 Indexes of US South Log and Product Prices
6.6 Roundwood Removals by Type, Pacific Northwest, 1986
6.7 Projected Roundwood Demand and Exports, US
6.8 Projected Price Indexes of Selected Products, US
6.9 Log Availability and Removals Trends, US South.

7.1 Area and Availability by Maturity Class, British Columbia, 1991
7.2 Sawntimber and Plywood : US and Canadian Housing
7.3 Pulp and Paper Production British Columbia, 1991
7.4 Trends in Average Real Stumpages, British Columbia by Region
7.5 Sawntimber, Pulp and Woodchip Price Indexes, Canada
7.6 Long-term Profile of Forest Resources, British Columbia
7.7 Demand and Supply Outlook, British Columbia

8.1 Profitability comparison of Selected Sawlog Regimes

Tables: 1.1 Area of Major Plantations by Type and Country, 1985

3.1 Plantation Area by Species, Australia, March 1991
3.2 Trends in Roundwood Removals, Australia
3.3 Processing Plants by Output, Australia, 1991
3.4 Forest Products Trade, Australia, 1991
3.5 Economic Indicators, Australia
3.6 Regime Details, Radiata
3.7 Range in Log Prices, Australia, 1991-92
3.8 Financial Results for Radiata Plantation Regimes - Australia, Base Case
3.9 Regime Details, Hardwood, Australia
3.10 Financial Results for Typical Hardwood Pulpwood Plantations, Australia
3.11 Projected Net Trade and Selected Economic Indicators

4.1 Plantation Area, New Zealand, March 1989
4.2 Processing Plants by Output, New Zealand, 1990
4.3 International Trade in Forest Products, New Zealand, 1990
4.4 Economic Indicators, New Zealand
4.5 Export and Forestry Incentives Paid to Forestry Companies
4.6 Regime Details
4.7 Financial Results for Typical New Zealand Plantation Regimes
4.8 Actual and Projected New Zealand Forest Product Exports to Australia

5.1 Forestry Resource, Chile, December 1990
5.2 Roundwood Consumption by Product, Chile
5.3 Pulp Production Trends and Prospects, Chile
5.4 Principal Exports, Chile, 1991
5.5 Forest Product Exports by Composition, Chile
5.6 Economic Indicators, Chile
5.7 Regime Details, Chile
5.8 Financial Results for Typical Plantation Regimes, Chile
5.9 Projected Radiata Log Availability, Chile
5.10 Future Forest Product Exports, Chile

6.1 Land Forest Area by Region, United States, 1987
6.2 Area of Timberland by Forest Type, United States, 1987
6.3 Volume of Growing Stock by Ownership, Region, Species Type, 1987
6.4 Processing Plant Capacity by Region, United States, 1985-86
6.5 Forest Products Trade, United States, 1989
6.6 Economic Indicators, United States
6.7 Regime Details, US South
6.8 Current and Projected Real Log Price Movements, US South
6.9 Delivered Pulpwood Prices, Southeast USA
6.10 Export Prices for Log and Woodchips, US South
6.11 Financial Returns for Typical Plantation Regimes - US South, Base Case
6.12 Area and Productivity of Forest Land, Douglas-fir subregion, PNW, 1986
6.13 Regime Details - Douglas-fir, Pacific Northwest
6.14 Financial Results for Typical Douglas-fir Plantation Regimes - PNW
6.15 Current and Projected Forest Product Exports, USA.

7.1 Gross Merchantable Wood Availability - B.C., 1991
7.2 Forest Product Output, British Columbia, 1990
7.3 Forest Product Trade by Value, British Columbia, 1990
7.4 Economic Indicators, Canada
7.5 Selected Payments to Governments by B.C. Forest Companies

8.1 Wood Growing Areas
8.2 Log Removals from Selected Countries

# ACKNOWLEDGEMENTS

I would like to thank the trustees of the J.W. Gottstein Memorial Trust Fund for awarding me a 1992 Gottstein Fellowship and making this study and report possible.

My thanks also to my employer, the Department of Primary Industries (SA), formerly the Woods and Forests Department of South Australia, for the support and encouragement to undertake the project.

Many thanks also to the many people who so willingly gave their time and hospitality during the tour. I am especially grateful to Dan Jepsen of the Association of British Columbia Professional Foresters, Prochile in Sydney and Concepcion and Wink Sutton, Tasman Forestry, New Zealand for their assistance in arranging contacts and itinerary planning.

# EXECUTIVE SUMMARY

Greater investment in plantations is proposed by various bodies as the future wood resource policy for Australia; either to reduce the need to harvest native forests, provide sufficient resource for large international scale processing mills, or provide alternative income to agriculture on cleared land. This increased investment in plantations by public and/or private growers, is likely to be proportional to plantation profitability. The economic competitiveness of Australian wood growing to other countries is also important.

## Improving Australian Wood Growing Profitability

Australia's viability as a wood grower could be improved by increasing plantation productivity, reducing early rotation costs and achieving higher prices for wood commensurate with market forces. Options for this include:

- research to improve crop productivity and reduce establishment costs,
- removal of assistance provided to other activities competing for the same land base,
- ensuring that commercial tree plantations are an "as of right" use,
- forming marketing co-operatives of individual growers,
- greater trading of plantations and when appropriate, easing log export restrictions.

## Economic Comparison

The Pacific Northwest of the United States (PNW) and British Columbia, Canada (BC) were selected for study because they are as major wood traders globally, as well as to Australia. The United States' South, Chile and New Zealand, were included in the study given their large plantation log supplies becoming available. Of the areas studied, the US South has the largest wood growing area and log harvest. Its plantation base was also the greatest, though Chile has the most area of radiata.

Using high and average costs, prices, yields and assumptions for sawlog oriented representative plantation stands, the highest real internal rates of return before tax results were achieved in Chile. New Zealand and Australia were the next most profitable. One significant factor contributing to Chile's success is its DL 701 decree providing subsidies of up to 75% of certain establishment and silvicultural costs.

The best returns for softwood pulpwood regimes were also realised in Chile in comparison to the US South and the Pacific Northwest. For average site quality clearwood regimes New Zealand achieved higher returns than Australia. BC was excluded from the results because their industry and government experts claimed wood growing was not financially viable.

Sensitivity analysis revealed that wood growing profitability was the most sensitive to changes in revenues, irrespective of whether the revenue was raised through yields, prices or both. This sensitivity was most apparent in Chilean radiata plantations, the US South and in hardwood pulpwood plantations in Australia.

Over time a variety of assistance measures have applied to forest growing activities. Chile and New Zealand Governments have provided direct cost-sharing assistance to major industrial forestry companies growing wood. The US Government offers cost-sharing assistance to wood growing but mainly to the smaller particularly agricultural, landholders. Overall, private industrial growers in Australia may not have been offered the level of direct assistance provided in other countries.

From the study examination, Chile appeared to have the most favourable taxation regulations applying to forestry, with no land tax and a much lower corporate income tax rate.

**Future Outlook**

The long term viability of plantations is affected by future changes in product markets. However there are always uncertainties in long term projections and regional variations.

By the year 2000 Chile and New Zealand together could provide over 40 million $m^3$ to the Pacific Rim market which is more than double their current log harvest. Whether this is further processed or exported as log may depend on substantial financial investments in wood processing plants and infrastructure. These increased supplies will be in addition to the softwood supplies becoming available in Australia and the declining hardwood harvest.

In contrast BC and the PNW are experiencing a period of constrained sawlog supplies during the transition from old-growth to second growth and reductions from more forest areas being included in environmental set-asides. For BC lower long run sustained yield allocations are foreshadowed. The declining PNW trend could reverse by 2030 however, when second growth starts maturing. US South projections are for removals to exceed supplies.

Trade

New Zealand is our major trading partner and will continue to export to Australia but recognizes the expanding nature of the Australian radiata resource. Constrained softwood sawlog supplies in British Columbia will limit any growth in their share of the Australian sawntimber market, in contrast to pulp. Though aggregate US exports are expected to increase from 1986 levels, exports from the PNW are likely to decline in quality and quantity commensurate with the reduced old-growth availability for processing.

# CHAPTER 1 - INTRODUCTION

Industrial forest plantations are playing an increasingly larger role in meeting global and Australian wood requirements. To date there is no agreed national policy on plantation management, though the recent draft national policy statement provides objectives for increasing the resource (AFC and NZECC 1992). Greater investment in plantations is also put forward by various bodies as the future wood resource policy for Australia; either to reduce the need to harvest native forests (ACF 1988), provide sufficient resource for large international scale processing mills (FAFPIC 1987), or provide alternative income to agriculture on cleared land (NPAC 1991). This increased investment in plantations by public and/or private growers, is most likely to occur if the plantations are commercially viable and their products competitive on the domestic market, preferably the international market.

It is therefore useful to resolve the economic competitiveness of Australian wood growing on the world market. This will contribute to a better understanding of Australia's competitive strengths and weaknesses as a wood grower and of the investment climate for growers, wood buyers, industry investors and forest industry policy makers.

## Global Plantations

Globally plantations have an increasing share of world wood supply. World Resources Institute (1988) has estimated that together industrial and non-industrial plantations were being established at a rate of 14.5 million hectares per year. The global plantation estate has been estimated at 6.7 million hectares in 1975 (Lanley and Clement 1979). Table 1.1 indicates the major plantation countries by region in 1985. More recently, Sutton (1991) estimated a total of 100 million hectares in 1990, solely of industrial plantations.

**Table 1.1 Area of Major Plantations by Type and Country, 1985**

| | Country | Coniferous ('000 ha) | Broadleaved ('000 ha) |
|---|---|---|---|
| Fast Growing | Brazil | 1,475 | 2,280 |
| | New Zealand | 1,122 | 23 |
| | Chile | 1,050 | 50 |
| | Australia | 774 | 43 |
| | South Africa | 604 | 370 |
| | Portugal | | 450 |
| Medium Growing | US South | 9,000 | - |
| | Portugal | 512 | - |

*Sources: APM (1990), Ewing and Chalk (1988), USDA (1988).*

**Australian Plantations**

There are over one million hectares of plantations in Australia at present, 66% of these being radiata pine (Pinus radiata) and the main conifer, and 10% being eucalypt and the dominant broadleaf. The average rate of current annual planting is approximately 15,000 hectares for radiata pine and 10,000 hectares for eucalypt (ABARE 1992).

Future planting rates will depend on the domestic availability of suitable land, estimated costs, yields and prices. Some of these prices can be influenced by trends in imported price levels and quantities, as Australia has a net trade deficit in forest products.

The main sources of imported sawnwood are Douglas-fir from the United States and Canada, tropical broadleaveds from Malaysia and Radiata pine from New Zealand. For newsprint the main source countries are Canada and New Zealand, printing and writing paper - Finland, and wrapping, packaging and paperboard - the United States. Major plywood sources are Indonesia and New Zealand.

**Study Regions**

Noting the importance of the Pacific Northwest of the United States (PNW) and British Columbia, Canada (BC) as the major wood traders globally as well as to Australia and their resource bases being in transition from old to second growth meant their necessary inclusion in this study. Due to large supplies of softwood plantations becoming available, the United States' South, Chile and New Zealand were also selected.

# CHAPTER 2 - APPROACH

The basic approach was to select representative or typical plantations for both high yielding and average sites in the selected countries and determine their financial profitability. From a sensitivity analysis, the variables most likely to impact on profitability were also identified.

**Variables affecting plantation viability**

For a given species the multitude of factors impinging on the financial viability of plantations can be condensed into four groupings - cost, yields, revenues and risks (McKenzie 1992).

Likely costs include expenditures on land purchase or leasing, site preparation and plantation establishment annual charges and overheads, logging and hauling, cost of capital, taxes and subsidies (if appropriate).

The plantation harvest or yield is determined through environmental and management factors, site quality, silvicultural management, climate and seed quality.

Revenues are the outcome of both quality and quantity of the yields and the log prices obtained on sale of the plantation.

There are risks associated with any plantation project. These include natural ones such as insect attack, diseases, fire, wind, drought and earthquakes. With plantations being long term ventures, there is always a chance that changes in market demand or technology will affect the results.

**Assessment**

The analysis is based on a single hectare model as forest estate modelling is too complex to complete in the time available. Therefore the assumption is made that growers are profit maximizer at the single stand level and their chosen regimes approximate the optimum for a forest estate. This may not always be the case. Furthermore, in large vertically integrated firms profit maximization will apply over the entire firm's operations and so wood flow or other strategic considerations may take precedence.

The model also assumes that there are markets available at the prices and yields used.

Various measures are available for the investor to determine plantation viability. The return on investment measures used are the internal rate of return (IRR) and the net present value (NPV). The IRR is that rate of return where the sum of the discounted costs and discounted returns equal zero. It measures the rate of return on funds invested in the plantation. The general decision rule is to accept/reject the proposal if the IRR exceeds/falls below the grower's target or hurdle rates of return.

As there is a slight chance of NPV and IRR giving disparate results (Mills and Dixon 1982) both criteria are calculated. The NPV is the sum of the discounted cash flows at a predetermined discount rate. This can either be the grower's weighted average cost of capital or target rate, or a rate derived from portfolio analysis using the Capital Asset Pricing Model (CAPM). This model takes two types of risk into consideration, systematic and unsystematic. Fuller descriptions of CAPM as it applies to forestry can be found in Redmond and Cubbage (1990) and Riordan (1992). As the factors that determine real rates of returns or the target rates for decision making can vary over the life of long-term projects such as forestry it is advisable to use a range of discount rates rather than an authoritative single rate based on past performance. The decision rule when using net present values is to accept/reject the proposal if the NPV exceeds/falls below zero.

For a comparison of proposals of differing lengths there is an alternative measure - equal annual equivalent. This combines all costs and returns into a single annual sum that is equivalent to all cash flows during the rotation spread uniformly over that period. Further details can be found in Hunter and Haney 1984.

**Taxation**

Using a simplified model the effect of taxation and special taxation assistance (where applicable) on plantation profitability has been analyzed where possible. [The taxation material presented is a guide only and not meant to substitute for contact with the relevant taxation office.]

**Incentives**

Various types of afforestation incentives are offered in a number of countries worldwide to improve forest management and to increase production. These include cost sharing arrangements, grants, provision of goods and materials, professional services, subsidized credit, special taxation arrangements and others. Where possible the effect of these arrangements applying in the country under study are quantified.

**Sensitivity Analysis**

Sensitivity analyses are useful for testing the robustness of assumptions and identifying the main variables impacting on plantation profitability. In general, one of the most sensitive factors will be discount rates. The other major plantation variables selected for sensitivity analysis were land costs, annual charges, establishment costs and final yields. To further account for uncertainty all these variables were altered in combinations by ± 25% in appropriate directions for high risk scenarios.

**Future Outlook**

Investments in plantations and the selected silvicultural and management regimes are often dependent on current market trends and perceptions of demand in the future. Log supply and demand projections are therefore examined to assess the likely impact on Australian forest products and therefore on the plantation sector.

# CHAPTER 3 - AUSTRALIA

## Plantation Trends

Plantations cover over 1 million hectares of Australia's 768 million hectares of land (ABARE 1992). To date the major species is Radiata Pine *(Pinus radiata* D. Don). Other conifers include P. elliottii, P. pinaster, P. caribaea and Araucaria's. Eucalypt plantations currently form 10% of the resource (see Table 1) and are becoming more popular with the main species being E. globulus, E. nitens, E. regnans, and E. grandis.

**Table 3.1 Plantation Areas by Species, Australia, March 1991**

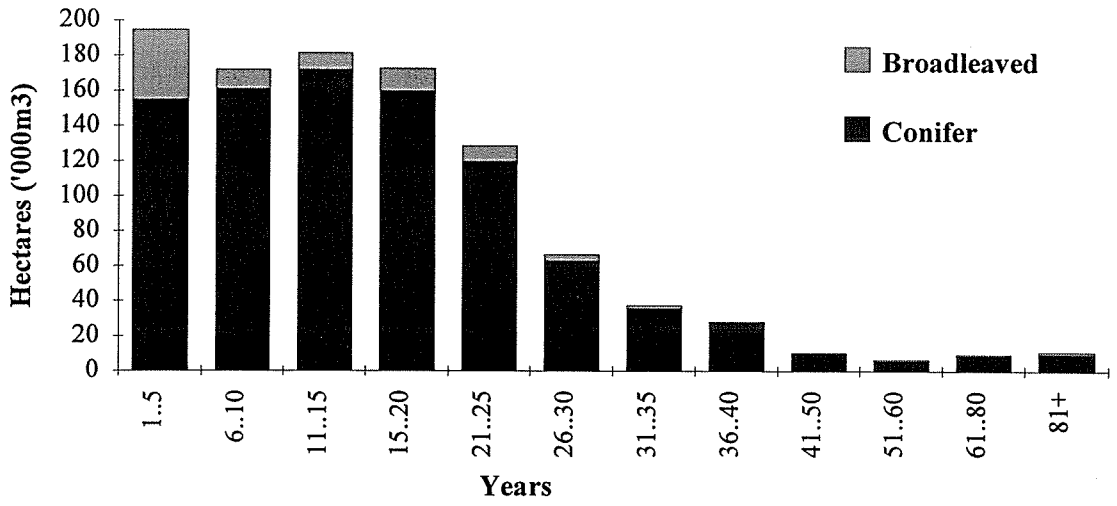
| Species | | Area ('000 hectares) | % |
|---|---|---|---|
| Coniferous | P. radiata | 695 | 66 |
| | P. elliottii | 84 | 8 |
| | P. caribaea | 56 | 5 |
| | Araucaria spp. | 47 | 5 |
| | P. pinaster | 32 | 3 |
| | Other | 25 | 2 |
| | Total | 939 | 90 |
| Broadleaved | Eucalyptus spp. | 102 | 10 |
| | Populus spp. | 2 | .. |
| | Other | 3 | .. |
| | Total | 106 | 10 |
| | Total[a] | 1,046 | 100 |

[a] Totals may not add due to rounding. .. Less than 1%.
*Source: ABARE (1992).*

Availability of cleared land for plantation expansion (except areas of high agricultural intensity which may be prohibitively expensive) is nearly 0.5 million hectares (RAC 1992).

Reflecting the timings of plantation establishment, most of the planted resource is under 20 years old (see Figure 3.1). Annual areas of conifer (particularly radiata pine) increased until the early 1970's, most markedly in the 1960's and 1970's when the Softwood Forestry Agreements Acts (1967, 1972, 1976 and 1978) where in operation. In contrast, the rate of eucalypt establishment only gathered momentum in the late 1980's (see Figure 3.2) in response to increased demand for hardwood based pulps, and financial incentives from the National Afforestation Program and other structural adjustment packages. In fact, some softwood plantations are being converted to hardwood (RAC 1992).

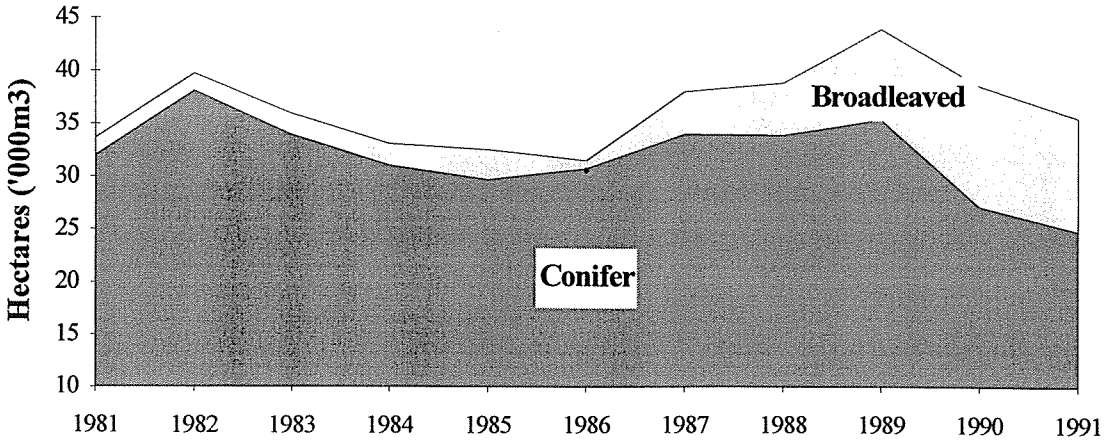
**Figure 3.1** **Estimated Age Class Distribution of Plantations, Australia**




*Sources: Benson and Jacobs(1984), Tibbits (1986) State Forest Services.*

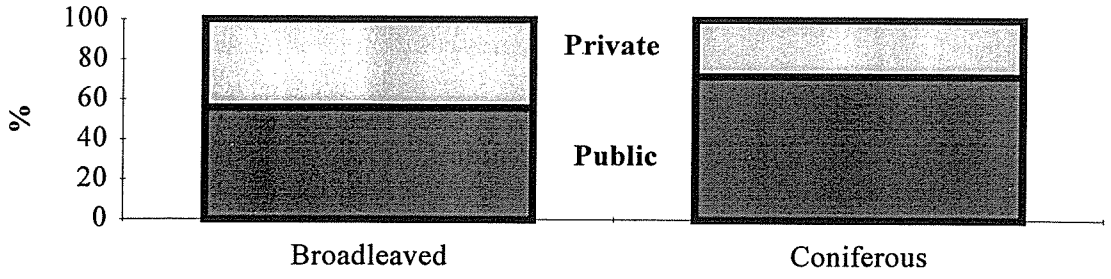
Ownership of the coniferous plantations is predominantly public (see Figure 3.3). This could change should any privatisation proposals for publicly owned pine plantations result in their sale to the private sector. In hardwood plantations the ownership is almost equally divided. Major private owners (all species) include CSR Softwoods, S.E.A.S Sapfor Ltd, APM Forests North Forest Products and Forest Resources.

**Figure 3.2** **Annual Plantation Areas Established, Australia, 1991**




*Source: ABARE (1992)*

**Figure 3.3** **Plantation Ownership, Australia, 1991**




*Source: ABARE (1992)*

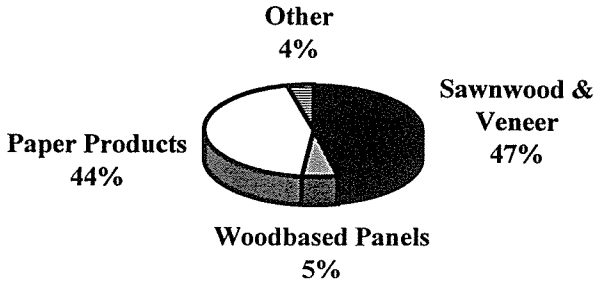
Log or roundwood removals from Australian forests have averaged nearly 17 million $m^3$ since 1984-85 (ABARE 1992). About two thirds are from native forests with the remainder harvested from softwood plantations. As native hardwood log removals decline and additional plantation softwoods come on stream, the share of softwood log removals expected to continue increasing. Nearly half of the current removals are for sawntimber and plywood production and 44% for paper and paperboard (see Figure 3.4).

**Table 3.2** **Trends in Roundwood Removals, Australia ('000 $m^3$)**

| Year | Broadleaved | Coniferous |
|---|---|---|
| 1949-50 | 6,989 | 985 |
| 1959-60 | 9,355 | 1,751 |
| 1969-70 | 9,106 | 2,415 |
| 1979-80 | 11,720 | 3,866 |
| 1989-90 | 10,265 | 6,948 |

*Source: ABARE (1992).*

**Figure 3.4** **Log Removals by Product, Australia, 1991**




*Source: ABARE (1992)*

**Industry and Trade**

The wood processing industry in Australia produces a full range of forest product mainly for the domestic market. Details of its composition are in Table 3.3 below.

**Table 3.3 Processing Plants by Output, Australia, 1991**

| Processing Plant | Number | Output | |
|---|---|---|---|
| Sawmills | 236 | 1.4 | Million $m^3$ sawn softwood |
| | 1,549 | 1.5 | Million $m^3$ sawn hardwood |
| Plywood mills | 15 | 101.1 | Thousand $m^3$ board |
| Woodbased panels + MDF[a] | 20 | 921.3 | Thousand $m^3$ board |
| Pulp and Paper | 23 | 422.4 | Kt, mechanical pulp |
| | | 614.8 | Kt, chemical pulp |
| | | 2,028.0 | Kt, paper and paperboard |
| Export Woodchips | 9 | 5.1 | Kt |

[a] Includes an estimate for MDF production.
*Sources: ABARE (1992), NAFI (1990)*

Australia is traditionally a net importer of forest products. In 1990-91 imports exceed exports by $1.4 billion. The main imports are paper, paperboard and sawnwood from countries such as New Zealand, United states, and Canada. Exports are predominantly woodchips, paper and paperboard to Japan and other Asian neighbours (see Table 3.4). Currently, woodchip exports require approval from the Commonwealth Government which has announced its intention to ban woodchip exports by the year 2000.

The average protective tariff on Australian imports for 1989-90 was 7% and is scheduled to fall to 2% by the year 2000 through a Federal program announced in March 1991.

An alternative measure, the average effective rate of assistance (i.e., nominal assistance afforded by tariffs etc. less duties on imported materials used) was 15% for manufacturing overall in 1989-90 and is should fall to 5% by the year 2000. Forest product details are:-

- paper and paper products: average of 18% in 1989-90 to 6% by year 2000;
- wood and wood products: average of 10% falling to 4%;
- veneers and manufactured boards: 23% reducing to 6%;
- resawn and dressed timber: 14% down to 6%; and
- log sawmilling: 3.8% up to 4% (Industry Commission 1991).

This will further increase the competitiveness of imported forest products.

**Table 3.4 Forest Products Trade, Australia, 1991**

| Item | Value ($m) | Main Countries |
|---|---|---|
| Imports | vfd[a] | |
| - Paper and Paperboard | 930 | NZ, Finland, USA, Canada |
| - Sawnwood and Sleepers | 397 | USA, NZ, Canada, Malaysia |
| - Paper Manufactures | 240 | |
| - Pulp and Waste Paper | 146 | Canada, NZ, USA |
| - Other Wood Manufactures | 119 | Malaysia |
| - MDF and other panels | 91 | NZ, Indonesia, Singapore |
| - Other | 54 | |
| Total Imports | 1,977 | |
| Exports | fob[b] | |
| - Woodchips | 393 | Japan |
| - Paper and Paperboard | 134 | China, Japan, Malaysia, NZ |
| - MDF and other panels | 26 | Taiwan, UK, PNG, NZ |
| - Pulp and Waste paper | 26 | Indonesia, India |
| - Paper and Other Wood Manufactures | 26 | |
| - Other including Softwood | 22 | UK, NZ, USA |
| Total Exports | 627 | |

[a] Value for duty.
b Free on Board

*Sources: ABARE (1991 and 1992) .*

For exporters tariff structures in most other countries impose higher rates of protection as the degree of processing embodied in the item increases. This progressive system implicitly favours international trade in raw materials over our processed products such as wood and paper. Tariffs applicable to most types of Australian forest products exported are currently quite low. Woodchips to Japan are free, all products to New Zealand under Closer Economic Relations, and radiata based products to USA are free. However wrapping and packaging papers to Japan and China have 2.5 to 3.5% and 20% ad valorum tariffs respectively (Evison and Glass 1991).

**Economic Indicators**

A selection of major economic indicators from 1983 to 1991 is presented in Table 3.5. Both Australian economic growth and housing activity have been cyclical and are currently experiencing recessionary conditions. Real long term interest rates (as measured by the long term bond rate of interest deflated by the consumer price index) have averaged 5.5% over that time period. Forecasts of the real rate of interest are projected to remain at approximately that level for a few years (BIS - Shrapnel 1992).

**Table 3.5 Economic Indicators, Australia**

| Indicator by Financial Year | Real GDP[a] %pa | Long-term Bond Rate %pa | Consumer Price Index[b] %pa | Hourly Wages Rate Index | Rates of Return on Capital[c] %pa | Dwelling Approvals No. '000 |
|---|---|---|---|---|---|---|
| 1983 | -1.6 | 14.9 | 11.5 | 88 | | 116.4 |
| 1984 | 6.1 | 13.9 | 6.9 | 93 | | 150.7 |
| 1985 | 5.2 | 13.5 | 4.3 | 98 | | 160.5 |
| 1986 | 4.1 | 13.0 | 8.4 | 103 | | 140.7 |
| 1987 | 2.4 | 12.8 | 9.3 | 108 | | 120.8 |
| 1988 | 4.3 | 12.0 | 7.3 | 113 | 12.9 | 151.2 |
| 1989 | 4.4 | 13.5 | 7.3 | 120 | 13.7 | 186.4 |
| 1990 | 3.2 | 13.4 | 8.0 | 127 | 12.7 | 140.0 |
| 1991 | -1.4 | 11.2 | 5.3 | 133 | 11.1 | 124.0 |

pa = per annum.
[a] Gross Domestic Product, volume index.
[b] 1985 = 100.
[c] In the business sector. The average for 1980-1987 was 10.8% pa.

*Sources: ABS (1992) and OECD (1992).*

Inflation (measured by the consumer price index) averaged 7.6% over the 1983 to 1991 years but has declined in recent years due to low economic activity and asset price deflation (particularly commercial property). Short-term expectations are for sustained low inflation until the economy recovers. Medium term expectations are for the trend rate to be 3.5% (Jones et al. 1993). Long term housing requirements are expected to gradually decline as the immediate post-war population boom matures.

**Assistance Measures**

Public softwood afforestation, particularly from 1967 through to the 1981 was aided by the provision of specially adapted long-term loans from the Commonwealth to the State Forest Services. These were 35 year loans at a rate of interest commensurate with the long term bond rate and capital and interest payments deferred for ten years. Over $74 million between 1966-67 and 1980-81 was advanced under the Softwood Forestry Agreements Acts in several programs (SSTTC 1981). The first three made provisions for the establishment of a total of 234,000 hectares of softwood plantations and the 1978 program was for maintenance of those plantations.

More recently the Commonwealth Government has provided grants totalling $13.7 million from 1987-88 to 1990-91 (Australian Government 1991) under the National Afforestation Program to public and private sector applicants. The program had three main objectives; to stimulate commercial broadacre hardwood plantations, applied research trials and use of hardwoods for land rehabilitation. About 12,000 hectares were expected to be established, nearly 5,000 of these for land rehabilitation (DPIE 1990).

Plantation establishment is also one of several criteria of structural adjustment packages advanced by the Commonwealth to the States of Tasmania, Victoria and Queensland in compensation for Commonwealth decisions on World Heritage Listings or native forest harvesting restrictions in those states. The likely funding will exceed $33 million.

There are a number of smaller scale schemes by State Governments and industrial forestry companies offering assistance of various forms (not always monetary) to encourage private landowners to establish plantations. Some of these commenced in the 1960's. Over 28,000 hectares have been planted under these schemes (NPAC 1991).

Special taxation assistance was in very limited forms and has been terminated. Until September 1985, one third of the calls paid by shareholders in afforestation companies could be claimed as a deduction for income tax purposes. Since May 1988 deductions for future years forestry management and services expenditure paid in advance have to be spread over 10 years. Prior to this the expenditure was allowed as a deduction in one year.

**Plantation Silviculture**

The main aims of silviculture is to improve the health, productivity and profitability of the plantations. The initial radiata regimes in Australia were adapted from those employed in South Australia by the Woods and Forests Department and reflected the need to maximise wood supply in a State deficient of native log supplies. Knowledge of radiata in plantations and its response to various practices has grown since then as illustrated by Boardman 1988 for South Australia. Nowadays the choice of silvicultural regime reflects the site specific conditions such as topography, soil fertility, and climate as well as the desire to maximise returns by taking into consideration the availability of markets and level of prices for thinnings, sawlogs and pruned logs. There is now an extensive range of silvicultural regimes practised in Australia (Shepherd et al. 1990). The major ones include:-

- an intensive sawlog driven regime incorporating multiple thinnings and relatively high stocking to minimise branching and knot size;

- a predominantly pulplog regime with some sawlog and lower stand stockings;

- a clearwood regime concentrating on pruning and non-commercial thinnings.

Mean annual increment can range from 2 to 35 $m^3$ per hectare per annum though the norm is for 15 to 20 $m^3$ per hectare per annum (Neilsen and Wilkinson 1990 and RAC 1992). Rotation length varies depending on the regime and varies from 25 to 45 years.

Currently, most plantation establishment is on cleared agricultural land except South Australia which is on a second rotation basis. As the resource matures Australia-wide then second rotation will become the norm (Mutton 1992).

**Assumptions**

Details of an average and a high yielding site for a sawlog-oriented regime and an average clearwood regime are given in Table 3.6.

**Table 3.6 Regime Details, Radiata**

| Factor/Regime | | Clearwood | Sawlog Oriented | |
|---|---|---|---|---|
| Site Quality | | Average | Average | High |
| Land Purchase | $/ha | 1,000 | 1,500 | 1,500 |
| Establishment Costs | $/ha | [a]870 | [b]715 | [b]570 |
| Weeding | $/ha | na | 180 | 160 |
| Tending (pruning/thinning) | Yrs | 5, 7, 9 | 16, 22, 28 | 13, 20, 27 |
| Annual Costs and Overheads | $/ha | 78 | 50 | 50 |
| Yields: | | | | |
| Veneer logs | $m^3/ha$ | 200 | - | - |
| Sawlogs | $m^3/ha$ | 180 | 295 | 805 |
| Pulplogs | $m^3/ha$ | 130 | 240 | 210 |
| Clearfell Age | Yrs | 25 | 35 | 35 |

[a] may include weeding costs.
[b] includes some weeding.

As the majority of radiata plantations are located in New South Wales and Victoria, the sawlog-oriented regimes are typical from those areas (see Wilson and O'Hara 1989, Greig and Kennedy 1984 and Trapnell and Lavery 1989). The clearwood regime (Tasmania) was adapted from RAC 1992.

Quantifying representative costs is difficult given the wide variances in management objectives, topography, site preparation and land quality. Land costs between the average and high sites may or may not differ. In the analysis land is purchased prior to establishment and sold after clearfell.

Discount Rates

Currently various levels of the cost of capital apply to private and public sector growers in Australia, ranging from 3% to 9% in real terms.

Determination of a real rate from bond rates or yields vary with the time span chosen. Averaging the long term bond interest rate from 1983 to 1991 in the above table, a risk free real long term rate would be 5.5%. Analysis from the real long term bond yields from 1950 to 1989 determines a rate of 1.1% (Department of Treasury 1990). This estimate incorporates very low and even sub-inflation yields, especially in the early 1950's that may not reoccur (Quinn 1992). A 4% to 10% range in discount rates was therefore included in the analysis.

Trends in Price and Costs

The range of log prices currently applying to both native forest and plantation sawlogs and pulplogs is presented in Table 3.7. However it is difficult to make an exact comparison across the Australian States because log specification, log qualities, roading and promotion levies and distance from the market vary considerably.

**Table 3.7 Range in Log Prices, Australia, 1991-92 ($/m$^3$)**

| Log Type | Pulplog | Sawlog |
|---|---|---|
| Softwood | 1.45 - 18.10 | 12.15 - 81.60 |
| Hardwood | 2.21 - 16.11 | 9.00 - 73.00 |

*Sources: State Forest Services, pers. comm.*

There has been a variety of royalty determination methods in Australia. A summary of those in operation in 1990 is included in ABARE 1991. Over time royalty rates have increased in nominal terms and most have increased in real terms. However some of this increase could reflect changing log size mix in states with plantations that are still maturing or an increased commercialised focus on wood sales.

In the longer term the prices of hardwood and softwood timbers will rise initially in response to declining North American supplies but the projected increased supplies of plantation softwoods in Australia as well as New Zealand and Chile will provide downward pressure on this trend (Ferguson 1990). Currently adding to the downward pressure on log prices is the greater degree of concentration of processing firms within Australia. So in contrast to the short term it is feasible that real long term log prices will be steady. Productivity improvements and greater use of contracting has meant reductions in harvesting and transporting costs in real terms also (Simons Ltd. 1990). For this study the current relativity between prices and costs was maintained.

**Results**

The results for the base case are presented in Table 3.8 below.

**Table 3.8 Financial Results for Radiata Plantation Regimes - Australia, Base Case**

| Regime/Site Quality | Discount Rate | Clearwood | Sawlog-Oriented | |
|---|---|---|---|---|
| | | Average | Average | High |
| Internal Rate of Return | na | 5.6% | 6.7% | 9.3% |
| Net Present Value ($/ha) | 4% | 1,340 | 2,840 | 7,380 |
| | 7% | -790 | -180 | 1,810 |
| | 10% | -1,670 | -1,350 | -370 |

na Not applicable.

The sawlog-oriented regime would provide acceptable rates of return and net present values for most Australian growers. These results are in line with those reported by RAC 1992, Ferguson 1986, Department of Conservation & Environment, and Sedgley pers. comm.

A substantial portion of Tasmanian clearwood plantations are still to mature and the above results reflect royalty rates from limited sales in depressed market conditions. Returns could improve with pruned log diameters increase and mainland veneer royalty rates.

For a predominately pulplog regime by a small private grower Piercy and Cameron 1989 calculated returns of 7% and 9.8% for an average and a high site quality. Land costs were $1000 per hectare, mean annual increments were 18 and 30 $m^3$ per hectare per year and rotation length was 25 years.

Using both a 25% increase and decrease in the costs of land purchases, site establishment, annual charges and in plantations revenues a sensitivity analysis was undertaken. Revenues showed the greatest sensitivity resulting in changes to internal rates of returns of approximately 1%. When all four factors were combined into two scenarios, 25% more and 25% less advantageous, internal rates of return moved ± 1.5 to 2%. This is one measure of the extremes of risk involved. For some growers the likely returns from high sites are acceptable but average site returns may only be marginal. Further corporatisation of various state government growers is likely to improve costs and returns over time.

**Taxation**

Taxation may influence plantation profitability and also their financial attractiveness compared to other land based pursuits. Ideally, taxation should be neutral between differing investments across the economy so that pre-tax comparisons match post-tax ones. Hansard and Dean, 1991 have shown that period inequities and lack of cost indexation mean that there are significant differences between the ranking of the pre-tax and post-tax incomes of agriculture and forestry. Various agencies have suggested tax amendments (AFDI 1990, NPAC 1991) or changes to the Income Tax Assessment Act 1936 be made to allow indexation of deductions to be carried forward for forestry (RAC 1992), or that the taxation system be reviewed to remove disincentives on plantation development (ESDWG 1991).

If classified as a primary producer or as carrying on the business of afforestation there are three main expenditure criteria; non-depreciable assets, depreciable capital and operating costs. Some examples are:

- Land purchase and any clearing costs are considered non-deductible capital though a reduction for clearing was available until 1983.

- Capital items that can be depreciated include roads for access to plantations (4%), and fencing (7.5 - 9% diminishing value basis (DV)).

- Annual operating expenses are deductible in the year of occurrence and site preparation if established in the planting year. Land taxes or local governments rates are deductible. Amounts vary across regions and the use of a capital valuation basis incorporating tree crop value increased South Australian rates markedly during 1991- 93.

Sale of timber is assessable in the year of income though primary producers can apply five-year income averaging provisions or utilise income equalisation deposits. However benefits from these provisions are severely restricted due to the long term nature of forestry investments. Company income tax is currently 39% and a capital gains tax with an indexed cost base applies.

Depreciation for plant and equipment (including kilns) in sawmilling is now 18% DV, wood working plant 13.5% DV and chainsaws 60% DV. These rates apply after July 1991 when new depreciation rules were introduced.

Post-tax Results

A simplified model, excluding any financing charges, was used to assess the impact of taxation on profitability. This may or may not be representative of the taxation situation for major growers. Rates of return were almost 0.5 to 1.5 lower than pre-tax results.

**Eucalypts**

Considerable debate over the potential for hardwood plantations to substitute for native forest resource has occurred in recent years (FAFPIC 1989, ACF 1988). Central to the discussion is the desirability and viability of eucalypt sawlog driven regimes. Yet most eucalypt plantations established are predominately pulpwood oriented, particularly those planted by industrial forestry companies.

For all regimes, good cultivation practices, week control, fertiliser application, protection from browsing animal and insects is required to ensure reasonable early growth. However, it is likely that pruning will be necessary to produce suitable sawlogs (Neilsen and Wilkinson 1990).

Research has shown that eucalypts grown in Australia have the same kind of potential for high growth rates as those overseas (Beadle and Inions 1990). Expected mean annual increments in Tasmania range from 2 to 35 $m^3$ per hectare per year (Neilsen and Wilkinson 1990) though the actual mean annual increments reported in RAC 1992 only range from 4 to 15 $m^3$ per hectare per year. This could be from using different rotation lengths, as eucalypt growth rates are known to be quite rapid in the early years then stabilise, resulting in lower mean annual increments for longer rotations. In addition, reliable yield data for long rotation eucalypt plantations is still being developed.

**Assumptions**

A number of case studies using present day royalty rates including that prepared by consultants to the Australian Conservation Foundation have determined that hardwood sawlog-oriented regimes often have rates of return well below those preferred by both public and private growers (ACF 1988, FAFPIC 1989, O'Brien et al. 1990, CFPLM 1989).

Added to this there is a paucity of mature plantations from which to determine appropriate yield and sawlog royalty rates, meaning estimates for the latter have to made from native forest grown logs on deduced from the economics of processing, as done by Rawlins for regrowth logs in Kerruish and Rawlins 1991. Therefore the financial analysis was completed for pulpwood regimes on average and high yielding sites. Details are included in Table 3.8.

As for radiata plantations, costs can vary between locations, particularly land purchase, establishment costs and royalty rates. Currently, pulpwood rates close to the APM paper mill are at a premium over those applying elsewhere. To account for this, as well as the use of coppicing species such as E. globulus, this high site has a royalty rate of \$15 per $m^3$ and a twenty five year rotation, whereas the average site royalty was \$10 per $m^3$ over two 10 year rotations.

**Table 3.9** **Regime Details, Hardwood, Australia**

| Factor/Regime / Site Quality | Unit | Pulpwood | |
|---|---|---|---|
| | | Average | High |
| Land Purchase | \$/ha | 1,000 | 1,300 |
| Establishment Costs | \$/ha | 940 | 940 |
| Weeding | \$/ha | 260 | 260 |
| Tending (thinning) | Yrs | - | 14, 18, 25 |
| Annual Costs and Overheads | \$/ha | 50 | 50 |
| Yields: | | | |
| Pulplogs | $m^3$/ha | 378 | 528 |
| Clearfell Ages | Yrs | 10, 20 | 25 |

**Results**

Base case results are presented in Table 3.10 below.

**Table 3.10 Financial Results for Typical Hardwood Pulpwood Plantations, Australia, Base Case**

| Regime/Site Quality | Discount Rate | Pulpwood | |
|---|---|---|---|
| | | Average | High |
| Internal Rate of Return | Not applicable | 2.3% | 6.6% |
| Net Present Value ($/ha) | 4% | -$540 | $1,950 |
| | 7% | -$1,160 | -$220 |
| | 10% | -$1,490 | -$1,270 |

The high yielding site rates of return are acceptable though lower than those of Piercy and Cameron 1989 and RAC 1992 due to the inclusion of harvesting supervision costs and a slightly lower royalty rate.

The poor result for an average site and yield is in keeping with research done by O'Brien et al. 1990 and Kirby 1992 that shows the possibility of improved returns should royalties be increased substantially.

As with the radiata results, a sensitivity analysis showed that the investment is most sensitive to changes in yields and under the most and least favourable scenarios, the internal rates of return moved ± 2%.

The effect of including the impact of taxation to the costs and returns reduced internal rate of returns by 0.1 to 1.2%.

**Future Outlook**

The most recent projections for Australian wood availability (plantations plus native forests) and wood consumption are those published by RAC 1992. From a survey of different projections provided by various individuals/ and rganisations the RAC concluded:-

- a deficit in both hardwood and softwood sawlog supplies to the year 2000; and
- a surplus in availability of pulplogs up to the year 2030.

As these comparisons made no allowance for international trade in wood products the RAC evaluated alternative projections using its simulation model INFORM.

In the "Current Trends" scenario, past trends were expected to continue. The major ones include:-

- The net area of native forest available for harvest reduces at past rates while the softwood plantation estate increases to one million hectares and the hardwood area to 300,000 hectares.

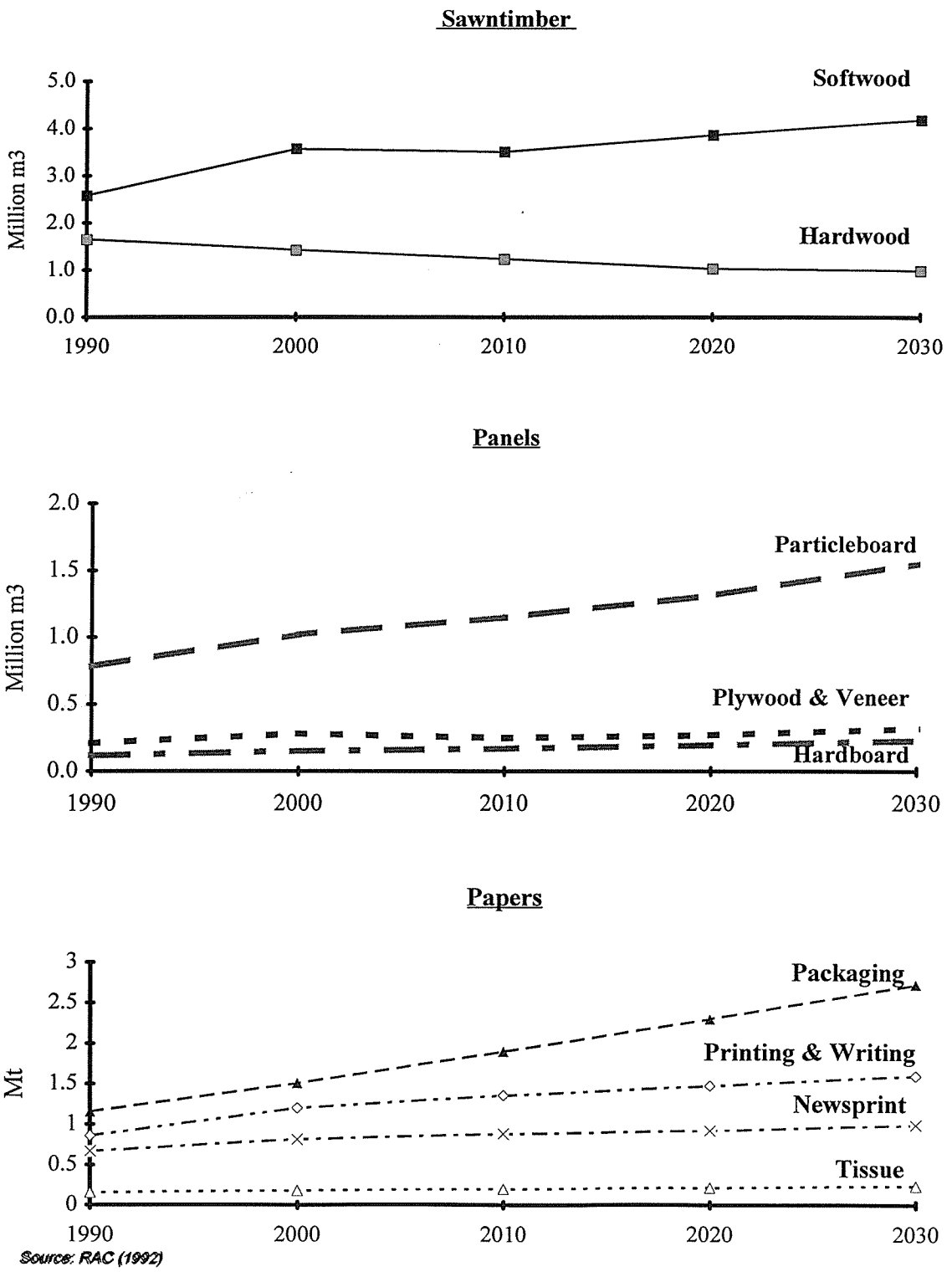
- Continuing improvements in log conversion, hardwood sawntimber production fluctuating at current levels (about 1.6 million $m^3$) and softwood imports are 35% of the softwood sawntimber market which comprises 65% of the sawntimber market.

- Investments in pulp and paper encompass a new lightweighted coated paper mill and a hardwood pulp and paper facility and capacity expansions in pulp, newsprint and uncoated woodfree paper.

The domestic consumption trends for softwood and hardwood sawntimber, various panels and paper types are illustrated in Figure 3.5

A summary of the projected net trade in forest products and the impact on selected economic indicators is presented in Table 3.11. Resource requirements exceed the expected log availability with surpluses likely to occur in softwood log and hardwood woodchips. NAFI (1992a) has indicated that the softwood sawntimber competitiveness and processing assumptions are too pessimistic and that future restriction on hardwood woodchip export is likely to unnecessarily depress tree growing returns.

**Figure 3.5** **Projected Wood Products Consumption, Australia**
**"Current Trends Scenario"**




Source: RAC (1992)

**Table 3.11 Projected Net Trade and Selected Economic Indicators "Current Trends Scenario"**

| Item /Year | 1990 | 2000 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|
| Projected Net Trade | | | | | |
| Hardwood chips[a] (kt) | 4 757 | 3 584 | 2 578 | 2 539 | 1932 |
| Softwood chips[a] (kt) | 260 | 532 | 0 | 0 | 546 |
| Hardwood pulp[a] (kt) | -44 | 160 | 526 | 461 | 324 |
| Softwood pulp[a] (kt) | -66 | -23 | -36 | -13 | -14 |
| Hardwood sawn timber ('000 $m^3$) | -62 | -425 | 107 | -209 | -254 |
| Softwood sawn timber ('000 $m^3$) | -1 037 | -1 361 | -1 319 | -1 478 | -1 697 |
| Plywood and veneer ('000 $m^3$) | -89 | -69 | 2 | -32 | -82 |
| Boards[b] ('000 $m^3$) | [a]48 | -48 | -140 | -180 | -369 |
| Printing and writing paper (kt) | -501 | -571 | -521 | -624 | -560 |
| Newsprint (kt) | -281 | -206 | -132 | -87 | -56 |
| Packaging (kt) | -78 | -82 | -110 | -129 | -164 |
| Tissues (kt) | -12 | -2 | -1 | 60 | -4 |
| Selected Economic Indicators | | | | | |
| Total value added[c] ($ million) | 2 898 | 3 718 | 4 362 | 4 539 | 4 819 |
| Trade deficit[d] ($ million) | [e]1 342 | 1 455 | 963 | 1 337 | 1 635 |
| Employment ('000) | 45 | 49 | 48 | 42 | 38 |

a Includes woodchips and pulp used for domestic production and for export.
b Particleboard and hardboard
c 1990-91 prices
d Wood and wood products
e 1990-91 trade deficit

*Source: RAC (1992, p. L23 and L28)*

# CHAPTER 4 - NEW ZEALAND

## Plantation Trends

Plantations now cover 5% of New Zealand's land area, 26.9 million hectares (Ministry of Forestry, 1992). Radiata pine is the dominant species (89%), followed by Douglas Fir *(Pseudotsuga menziesii)* and other conifer species (e.g. *Pinus contorta, P. ponderosa)*, Eucalypts (e.g. *E. saligna, E. pilularis, E. regnans, E. delegatensis, E. nitens, E. fastigata)*, and other hardwoods (e.g. Tasmanian Blackwood) see Table 4.1. Ministry of Forestry (1992b) considers that there may be another three million hectares of pastoral farmland economically suited to commercial afforestation.

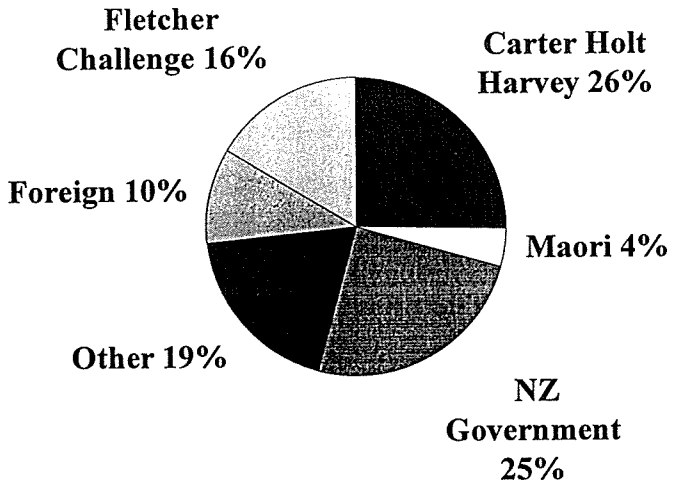
**Table 4.1** **Plantation Area, New Zealand, March, 1989**

| Species | Area (1,000 hectares) | % |
|---|---|---|
| Radiata Pine | 1,108 | 89 |
| Douglas-fir | 63 | 5 |
| Other Softwoods | 47 | 4 |
| Hardwoods | 22 | 2 |
| Total | 1,240 | 100 |

*Source: Turland and Novis (1990).*

Annual areas planted peaked at 54,000 hectares in 1985 (Ministry of Forestry 1988) to a low of 13,000 hectares in 1991. Various factors contributed to this decline. These include the relatively unattractive non-indexed, deferred deduction "cost of bush" taxation system applying from 1987 to April 1991, the removal of planting incentives between 1984 and 1986, reduced State planting prior to their forest asset sales and private companies targeting purchase of existing Government plantations rather than establishing their own. This trend could be reversed with the new taxation arrangements for forestry investments as of 1991, improved arrangements for forestry joint ventures and buoyant log export markets to Japan, Korea and China. Depending on the stocking rate, 40,000 to 60,000 hectares are expected to be planted in 1992 (Brown, 1992) compared with 13,500 hectares in 1991.

**Figure 4.1** **Plantation Ownership, New Zealand, 1992**




*Source: Ministry of Forestry*

**Figure 4.2** **New Zealand Plantation Establishment per Decade**

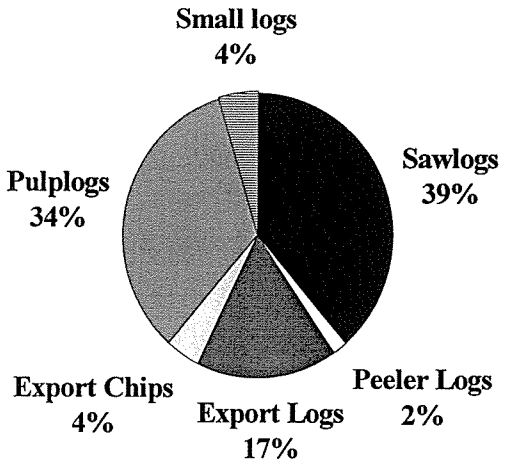

*Sources: Ministry of Forestry, Cox et al.*

As a result of the New Zealand Government plantation assets' sales in recent years, there has been considerable change in the ownership of the plantation estate. Up until March 1987, the New Zealand Forest Service had the greatest area of plantations. Figure 4.1 depicts the ownership pattern as of January 1992 where private ownership dominates with the larger owners being the long established domestic companies of Carter Holt Harvey and Fletcher Challenge. There are also four new foreign groups in the industry:- Juken-Nissho, Earnslaw One, Wenita Forestry and ITT Rayonier.

Figure 4.2 depicts the history of plantation establishment in New Zealand since the 1920's. There have been two planting booms. The first was in the late 1920's to early 1930's and centred on the North Island. This is known as the "Old Crop" which was mostly untended and formed the raw material basis for the existing processing plants. It is nearly cut-over. The second boom started in the 1960's - the "New Crop" which, unlike the previous one, has been intensively tended silviculturally for clear log production.

Total log removals from plantations over the past decade (1981-1990) have averaged 9.5 million cubic metres. Sawlog and pulplogs are the major types by volume (see Figure 4.3).

**Figure 4.3** **NZ Exotic Roundwood Removals by Type, 1990**




*Source: Cox et al.(1991)*

**Industry and Trade**

These logs, along with nearly half a million $m^3$ of indigenous species logs were exported, or processed domestically at the following plants.

**Table 4.2 Processing Plants by Output, New Zealand, 1990.**

| Processing Plant | Number | Output |
|---|---|---|
| Sawmills | 253 | 2 million $m^3$ sawn timber |
| Plywood mills | 5 | 69 $m^3$ plywood |
| Fibreboard (mainly MDF) | 5 | 443 $m^3$ board |
| Particleboard | 3 | 171 $m^3$ board |
| Pulp and Paper | 8 | 1 1 million $m^3$ ADT, mechanical pulp<br>1 million m3 ADT, chemical pulp<br>1 million T, paper and paperboard |
| Export Woodchips[a] | 4 | 600 Kt |

[a] 1991 estimate.

*Source: Cox et al. (1991)*

Forestry was the fourth biggest exporter after meat, dairy and wool (Crocombe 1991) and for the 1990 year, there was a trade surplus for New Zealand forest products of $0.7 billion (see Table 4.3). The major products exported were paper and paperboard ($225 million), sawn timber ($139 million) mainly to Australia, and both logs ($93 million) and woodpulp, including woodchips, ($77 million) to Japan. Imports totalled only $0.4 billion. The major items were paper and paperboard of $198 million, mainly from Australia and Europe, and sawn timber of $30 million, mostly from Canada and Malaysia.

Log exports have risen markedly in recent years, from averaging $0.3 million in 1985 to $154 million in 1990 (Ministry of Forestry, 1988 and Cox et al. 1991). Contributing to this increase was the relaxation of log export controls, reduced levels of domestic sawn timber production and increased harvest levels.

For many years, Australia has been New Zealand's most important trading partner for forest products, and in 1990 the trade balance favoured New Zealand by $0.3 billion. Under Closer Economic Relations (CER) and its predecessor, NAFTA (New Zealand Australia Free Trade Agreement, 1966-1982), no tariffs apply to forest products traded between the countries. By 1995, it is planned that Australia-New Zealand will be a single market with all barriers to investment (e.g., taxation distortions) and trade removed.

**Table 4.3** **International Trade in Forest Products, New Zealand 1990, $ million, c.i.f.**

| Country | Logs & Poles | Sawn Timber | Wood pulp[a] | Paper & Paperboard | Panels[b] | Other | Total |
|---|---|---|---|---|---|---|---|
| **Exports** | | | | | | | |
| Australia | .. | 103 | 74 | 139 | 39 | 54 | 409 |
| Japan | 93 | 24 | 77 | .. | 20 | 35 | 249 |
| Korea | 51 | .. | 35 | - | 7 | .. | 93 |
| Taiwan | 1 | 3 | 22 | 4 | 20 | .. | 49 |
| Indonesia | - | - | 33 | 5 | .. | 4 | 43 |
| Hong Kong | - | .. | .. | 22 | 1 | 1 | 24 |
| Others | 9 | 9 | 47 | 55 | 17 | 26 | 163 |
| Total Exports | 154 | 139 | 288 | 225 | 103 | 121 | 1,031 |
| **Imports** | | | | | | | |
| Australia | 1 | 2 | .. | 42 | 1 | 36 | 83 |
| United States | 1 | 2 | 10 | 13 | 1 | 10 | 37 |
| Japan | .. | .. | .. | 23 | .. | 10 | 33 |
| F.R. Germany | .. | .. | .. | 27 | 1 | 4 | 32 |
| Great Britain | .. | .. | .. | 19 | .. | 5 | 25 |
| Canada | 1 | 12 | .. | 7 | 1 | 1 | 22 |
| Others | 1 | 13 | 1 | 66 | 4 | 40 | 125 |
| Total Imports | 4 | 30 | 10 | 198 | 7 | 109 | 358 |
| Trade Balance | 150 | 109 | 278 | 28 | 96 | 12 | 673 |
| NZ-Australia Trade Balance | -1 | 101 | 74 | 97 | 37 | 18 | 326 |

a Includes woodchips.
b Includes wooden furniture and paper and paperboard manufactures.
.. Less than $1 million. - Nil.

*Source: Cox et al. (1991).*

**Economic Indicators**

A selection of major economic indicators is presented in Table 4.4. Growth in real Gross Domestic Product has fallen from its peak 1985 levels. The exchange rate against the Australian dollar has been comparatively stable, though appreciating in the mid to late 80's, it has now returned to early 1980 levels.

**Table 4.4** **Economic Indicators, New Zealand**

| Indicator by Financial Year | GDP[a] %pa | NZ$ per A$ | Long-term Bond Rate %pa | Consumer Price Index %pa | Hourly Wages Index[b] | Rates of Return[c] %pa | Dwelling Permits No.[d] '000 |
|---|---|---|---|---|---|---|---|
| 1983 | 0.5 | 1.34 | 13.6 | 13.0 | 89 | | 16.0 |
| 1984 | 2.9 | 1.36 | 10.1 | 4.3 | 90 | | 20.2 |
| 1985 | 5.0 | 1.39 | 17.3 | 11.7 | 95 | | 21.8 |
| 1986 | 1.1 | 1.23 | 15.2 | 13.6 | 109 | | 23.0 |
| 1987 | 2.6 | 1.21 | 15.5 | 16.7 | 122 | | 21.1 |
| 1988 | 0.5 | 1.18 | 12.9 | 10.3 | 132 | 14.7 | 19.9 |
| 1989 | -1.3 | 1.32 | 13.0 | 4.6 | 139 | 16.1 | 19.6 |
| 1990 | 1.4 | 1.34 | 12.1 | 7.3 | 145 | 17.1 | 22.9 |
| 1991 | -1.3 | 1.33 | 9.7 | 4.3 | 150 | 14.8 | 20.8 |

a Gross Domestic Product at constant 1982-83 prices.
b Base: 1985 = 100.
c On capital in the business sector. Average for 1980-1987 was 11%.
d Year ending March.
pa Per annum.
*Sources: Department of Statistics (1992), Evison (1990), IMF (1992), Reserve Bank NZ (1992), ABS (1992) and OECD (1992).*

A Goods and Services Tax of 10% was introduced in 1986 which boosted inflation by 6%. Recently, inflation has fallen as a result of static domestic demand, tight monetary policy and industry restructuring. An Employment and Contracts Act was introduced in 1991 allowing more flexible wage-bargaining and voluntary unionism.

The real long-term bond rate (nominal yield on long-term Government bonds less the rate of inflation) has averaged nearly 4% but has exceeded this in recent years. Forecasts for the real bond rate (in this case, nominal bond rate less rate of inflation expectations) is projected to vary between 6% and 8% from 1991/92 to 1995/96 (Morgan 1992).

**Plantation Silviculture**

Current stocked stands of radiata can be classified into four major types of tending regimes (not withstanding that Williams, 1982 found over 70 distinct silvicultural regimes in use in 1979):-

- minimum tending
  - without production thinning (493,000 hectares)
  - with production thinning (103,000 hectares)
- intensive tending
  - without production thinning (436,000 hectares)
  - with production thinning (208,000 hectares)

Here, intensive tending means that the pruning prior to age twelve years ensures that over 50% of the final crop standing will contain a pruned butt log greater than four metres in length (Lavery 1990).

In 1968, the New Zealand Treasury introduced a requirement that Public afforestation achieve a minimum rate of return of 10% (Whyte 1988). This emphasis on profitability has led to the "Ure" silvicultural regime involving multiple commercial thinnings as practised in South Australia at the time, losing favour to the "clearwood" or "direct" sawlog regime of high pruning and no commercial thinnings advocated by Fenton and Sutton 1968. The aim was to produce clear knot-free butt logs with heavy non-commercial thinnings and prunings early in the rotation. Given a reasonable price premium for large defect free logs this can maximise value at the expense of volume production. If pulplogs are required, a commercial thinning would be undertaken between ages 12 and 16, a "production thinning" regime.

Average rotation length is generally 30 years but can be as early as 27 years on high quality sites or as long as 35 years. Mean annual increment usually ranges from 16 to 26 $m^3$ per hectare per annum.

Though expected profitability is one of the prime determinants of the choice of silvicultural regime, the forestry site itself is important. Gently contoured land allows mechanical harvesting for the commercial thinnings of the production thinning regime. Lands with gorse or of low nutrient levels are often minimum tending site (Levack 1986).

**Assistance Measures**

Various assistance measures contributed to the second planting boom. Loans of up to NZ$200 per hectare were provided in a forestry encouragement loan scheme in 1962. This was followed in 1970 by a forestry encouragement grant scheme offering annual grants to the smaller growers for up to 50% of certain expenditure. Later this scheme was broadened to include commercial afforestation of national or local benefit. An amendment in 1983 extended the grants to 45% of all costs. By November 1984, the scheme was considered distortionary (with respect to other possible investments) and replaced with taxation deductions for pre-planting expenses (Deloitte et al. 1992).

From 1970 to the mid 1980's taxpayers funded 70 to 75% of the total afforestation effort (Morgan 1992). In addition, Le Heron (1988) in Table 4.5 details the assistance afforded to private forestry companies by the forestry encouragement schemes and export subsidies in operation from 1975 to 1986.

**Table 4.5 Export and Forestry Incentives Paid to Forestry Companies.**

| Company / Period | Allowances and Grants (NZ$ million)[a] | | | |
|---|---|---|---|---|
| | 1975-79 | | 1980-86 | |
| Fletcher Challenge (FCL) | | | 174.9 | |
| Tasmanian Pulp and Paper,<br>- taken over by FCL in 1981 | 33.5 | | 10.6 | |
| Fletcher Industries | 27.9 | (18.4) | | |
| Carter Holt Harvey (CHH) | 4.4 | | 12.0 | (1.9) |
| New Zealand Forest Products (NZFP),<br>- taken over by CHH in 1990. | 27.6 | (6.0) | 163.8 | (64.4) |
| Henderson and Pollard,<br>- taken over by NZFP in 1983 | | | 5.1 | |
| Odins, taken over by Winstones in 1985 | | | 3.6 | (1.0) |
| Winstones | 3.8 | (2.2) | 16.0 | (5.3) |

a Export Market Development, Export Incentive Allowances and Export Credits, and Forestry Encouragement Grants. The latter is in brackets where known.

*Source: Le Heron (1988)*

**Assumptions**

Table 4.6. gives details of the regimes selected as indicative of average and high yielding sites for "clearwood" or "direct" regimes and a production thinning regime. All costs are within the ranges suggested by Keating (1992) and Ministry of Forestry (1991). Appropriate economic factors such as discount rates and future changes in prices and costs were also selected.

**Table 4.6** **Regime Details**

| Factor/Regime | | Clearwood/Direct | | Production Thinning | |
|---|---|---|---|---|---|
| Site Quality | | Average | High | Average | High |
| Land Purchase | $/ha | 440 | 550 | 440 | 550 |
| Establishment Costs | $/ha | 290 | 180 | 290 | 180 |
| Weeding (releasing) | $/ha | 70 | 40 | 70 | 40 |
| Tending (pruning/thinning) | Yrs | 6, 8, 10 | 5, 7, 9 | 5, 8, 14 | 4, 8, 12 |
| Disease Control (Dothistroma) | $/ha | 40 | 20 | 40 | 20 |
| Annual Costs and Overheads | $/ha | 40 | 45 | 40 | 45 |
| Yields: | | | | | |
| Pruned Logs | $m^3/ha$ | 165 | 241 | 116 | 200 |
| Unpruned Export Logs | $m^3/ha$ | 356 | 418 | 301 | 449 |
| Pulplogs | $m^3/ha$ | 114 | 145 | 183 | 170 |
| Clearfell Age | Yrs | 30 | 30 | 30 | 30 |

Discount Rates

Historically various real discount rates have been applied to New Zealand forest investments. The New Zealand Treasury required 10% for applications under the Forestry Encouragement Grants Scheme. The large integrated forest companies used 4% to 7% during the late 1980's (Riordan 1992). A range of 6% to 10% for current projects is suggested by Keating (1992).

An alternative for determining appropriate discount rates is possible from portfolio analysis using the CAPM. Based on the data for New Zealand in Riordan (1992) and assuming that the pre-tax and post-tax beta factors (measures of sensitivity to the market in terms of systematic risk) are similar, suitable rates of return are 6% plus.

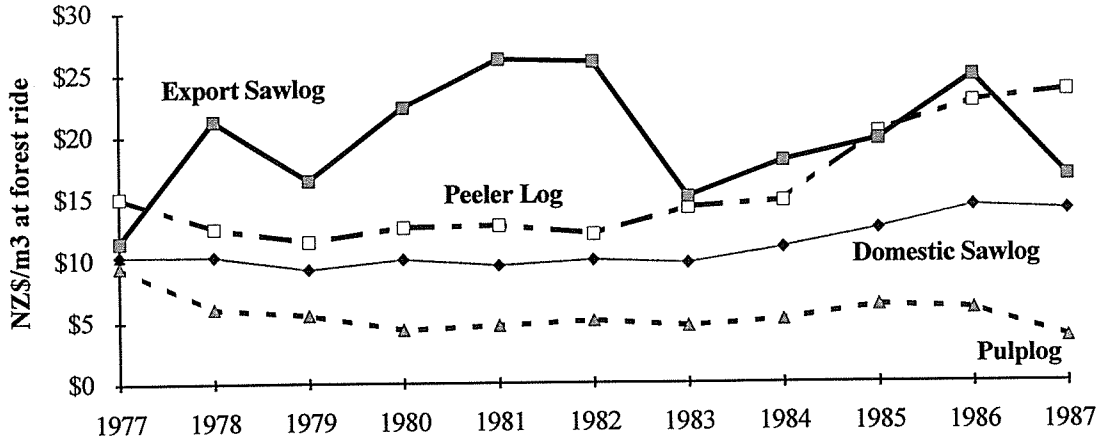
In consideration of the above discussion, a range of 4 to 10% real discount rates was used in the financial analysis.

**Trends in Prices and Costs**

Royalties (log prices or standing timber stumpages) appear to have increased from 1977 to 1987 as shown in Figure 4.4. However these royalties are averages over a wide range of localities, conditions and qualities, therefore the graphical trends may not be an accurate indicator of real movements in log prices. The time period was also one of constrained log supply compared to projected levels of future availability (see Figure 4.5).

Views differ for the trend in future royalties in New Zealand due to disparate emphases or assessments of balances in future world demand and supply. Sutton (pers. comm.) concludes that a real increase of up to 2% per year is possible for clear logs given a continuing increasing demand for wood products globally and decreasing supplies of clear logs as old growth forests (e.g., PNW) are cut-over and replaced by lower quality second growth. BERL in Horgan (1991) determined that New Zealand royalties could increase by 2.95% per year for the next two decades falling to 0.7% for the following decades. Sedjo (pers. comm.) considers future demand for industrial wood supplies could be met without major real price increases. For the study, the current relativity between costs and prices was maintained.

**Figure 4.4** **Trends in Real Log Prices, New Zealand**




*Source: Ministry of Forestry*

**Results**

The results for the base case are presented in Table 4.7. Based on data used in the analysis all regimes have acceptable rates of return and net present values, the "clearwood" or "direct" sawlog regime providing slightly better profit potential. The actual regime chosen by growers will depend on their specific costs and prices and if they are processors, will need to consider log types and quantities required.

These internal rate of return results are in line with those quoted by Sutton (1984) for the early 1980's, more recently those calculated on the basis of logs delivered to mill by Whiteside (1988), Pearson (1992) - 9% and also returns deduced from the recent Crown forest assets' sales.

A sensitivity analysis was carried out using both a 25% increase and decrease in the costs of land purchases, site establishment, annual charges and in the plantation revenues (whether from changes to yields or prices or both). The greatest sensitivity was to revenues resulting in adjustments to internal rate of returns of +0.9 to -1.3.

As a simple measure of the extremes of the risk involved (one of many) when all four factors were combined into a 25% more advantageous scenario and a 25% less advantageous scenario the internal rate of return results altered approximately ±2% and were still within acceptable ranges.

**Table 4.7 Financial Results for Typical New Zealand Plantation Regimes - Base Case**

| Regime/Site Quality | Discount Rate | Clearwood/Direct | | Production Thinning | |
|---|---|---|---|---|---|
| | | Average | High | Average | High |
| Internal Rate of Return | na | 8.5% | 9.7% | 7.5% | 9.5% |
| Net Present Value ($/ha) | 4% | $4,420 | $6,590 | $3,080 | $6,330 |
| | 7% | $830 | $1,740 | $250 | $1,640 |
| | 10% | $530 | $10 | $810 | $182 |

na not applicable

## Taxation

As most of New Zealand plantations are privately owned it is important to consider post-tax as well as the pre-tax returns.

A new forestry taxation regime was introduced in April 1991. Basically there are three main considerations for costs incurred for forest growers; capital costs that are non-depreciable, capital related costs that are depreciable against current income and annual expenses that qualify for immediate deductions. Some examples are:

- Land purchase, associated fees and land contouring are non deductible, non depreciable items.

- Access roads can be depreciated (metal at a rate of 25% diminishing value (DV)) unless their life expectancies are under 12 months making it a deductible expense.

- Most other expenditure in preparing for planting such as clearing and weeding is considered capital to be depreciated at 6.25% DV.

- Annual operating and overhead expenses are normally fully deductible in the year of occurrence.

Land solely used for forestry is exempt from land tax.

Income from the sale of standing timber is assessable in the year it is received. This assessable income may be spread over that year and the previous three years. Company income tax rate has been 33% since it was reduced with the introduction of the Goods and Services Tax.

In December 1991 depreciation rates for all plant and equipment were increased by 25%. These new rates apply to April 1993 when a thorough revision of depreciation rates by the New Zealand Government should be completed. Some wood processing equipment such as sawmilling, veneering and plymilling is depreciated at 12.5% DV, nearly matching Australian rates. For other panel products, pulp and paper equipment or machinery, an higher than Australian depreciation rate will apply, 26.5% DV. International competitiveness will be a major consideration in setting future rates (Clarke 1992).

**Post-tax Results**

To assess the impact of taxation, a simplified model was adopted that assumed most of the plantation operational costs were carried out under contract. This may or may not be representative of major corporate growers. Rates of return were 0.5% lower on average than those for the before tax and interest charges scenarios above. Although the magnitude may vary this drop in returns is to be expected (Shirley, pers. comm.).

**Eucalypts**

The most significant plantings of eucalypts commenced in the mid 1960's and only about 15,000 hectares were in existence by the late 1980's, which is relatively minor compared to radiata. Eucalyptus regnans and delegatensis are the main species although the substantial falls in growth of the latter due to the fungus *Mychospharella nubilosa* has meant a reduction in recent plantings (Thode 1988). Expectations are that they will be grown on pulpwood regimes for about 20 years and may achieve similar levels of profitability as radiata (Whiteside 1988).

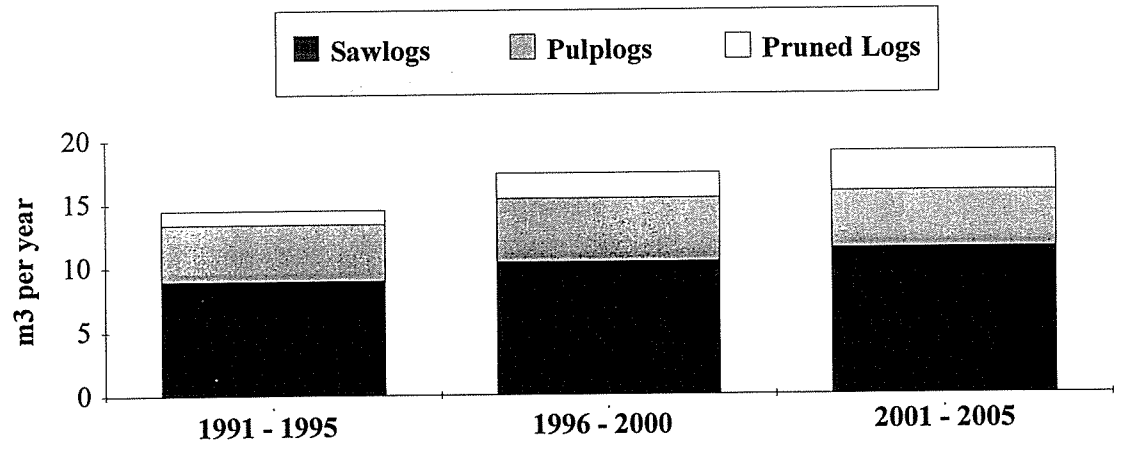
To eliminate the knots causing degrade of eucalypt timber, the New Zealand Forest Service pruned 250 hectares of *E. grandis, E. botryoides, E. delegatensis, E. nitens, E. fastigata* and *E. regnans* during 1980 to 1985 (Deadman et al. 1988)

## Future Outlook

The most recent projections of future availability from plantations by log type are presented in Figure 4.5. The annual harvest is expected to increase from current average levels of 9.4 million $m^3$ to an annual average of 14.4 million $m^3$ between 1991 and 1995 and to 19.9 million $m^3$ by the year 2000 (Edgar 1992). Sawlogs will still comprise the majority of the logs harvested and their supplies will gradually increase. Pruned logs will increase also, while pulplogs will remain relatively static.

Apparent domestic consumption fluctuated in cycles between 4.3 million $m^3$ and 6.8 million $m^3$ per year from 1960 to 1987 (Ministry of Forestry 1988). Optimistic projections for future consumption is for 6.7 million $m^3$ per year. Assuming imports continue at 700,000 $m^3$ per year there will be potential supplies available to export a minimum of 3.3 million $m^3$ up to a maximum of 7.1 million $m^3$.

**Figure 4.5** **Current and Future New Zealand Log Supplies**




*Source: Edgar et al. (1992)*

Several major reviews of future market prospects and domestic processing capabilities have been conducted in New Zealand in the last decade; New Zealand Forestry Council in 1981, Conversion Planning Conference in 1987 and New Zealand Forest Industries Strategy Study in 1992. It has been estimated that the investment required to process these future supplies will cost $4 billion to $8 billion over the next 10 to 15 years.

However there is still some uncertainty as to whether export markets will exist to absorb the supplies, type and location, and if New Zealand would be competitive. In part, the silvicultural emphasis on clear log regimes is to provide an assured supply of high quality logs that should provide a market "edge" in export markets.

**Table 4.8 Actual and Projected New Zealand Forest Product Exports to Australia**

| | Actual | Projected | | |
|---|---|---|---|---|
| Item | 1990[a] | 1995 | 2000 | 2010 |
| Sawntimber ('000m$^3$) | 347 | 400 | 420 | 400 |
| Paper (tonnes) | 176 | 175 | 160 | 150 |
| Pulp (tonnes) | 93 | 95 | 95 | 95 |
| Panels (tonnes) | 69 | 80 | 80 | 80 |

[a] Year ended 30 June.
*Sources: Cox et al. (1991), ABARE (1990).*

Despite fears to the contrary arising from expectations of large increases in New Zealand sawlog supplies available for export and free trade under CER, it has been projected that New Zealand exports to Australia may not increase substantially (see Table 4.8). The main product affected is sawntimber. Assuming real prices remain constant it is suggested that New Zealand exporters to Australia will seek niche markets for radiata sawntimber rather than compete for industrial wood sales. Paper sales would be confined to a few grades that exclude fine papers. Medium Density Fibreboard and waferboard are likely to become more important than plywood.

# CHAPTER 5 - CHILE

## Plantation Trends

Chile has a land area exceeding 200 million hectares, seventy five million of which are on the American continent and the remainder on surrounding islands and Antarctica. National Parks, National Reserves and National Monuments cover 13.7 million hectares and plantations almost 1.5 million hectares of which 85% are radiata pine (see Table 5.1).

**Table 5.1** **Forestry Resource, Chile, December 1990**

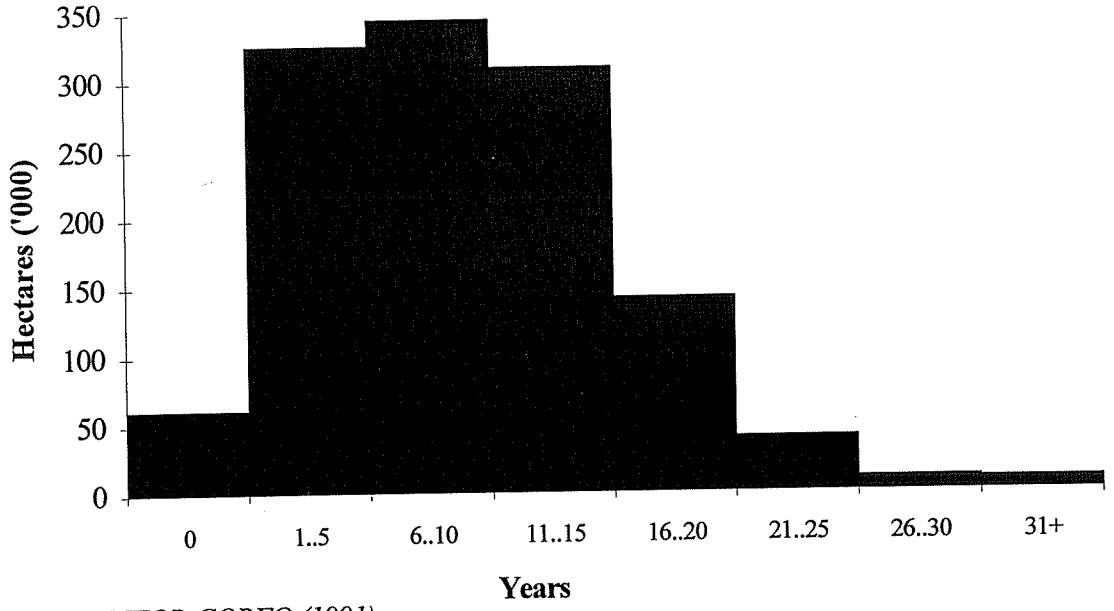
| Type/Species | Area ('000 hectares) | | Volume (million $m^3$) |
|---|---|---|---|
| Native Forests | | 7,616.5 | 915.1 |
| Plantations | | 1,460.5 | 196.5 |
| Radiata | 1,243.3 | | |
| Eucalypts | 101.7 | | |
| Atriplex | 37.9 | | |
| Tamarngo | 20.6 | | |
| Oregon | 11.3 | | |
| Poplars | 3.5 | | |
| Algarrabo | 3.2 | | |
| Other | 39.0 | | |
| Total Resource | | 9,077.0 | 1,111.6 |

*Source: CORFO-INFOR (1991)*

Most of these have been planted since 1974 by private companies, the Government agency CONAF (Corporacion National Forestal) ceasing new planting operations in 1985. The bulk of the plantations are located in Regions VII and VIII, south of Santiago.

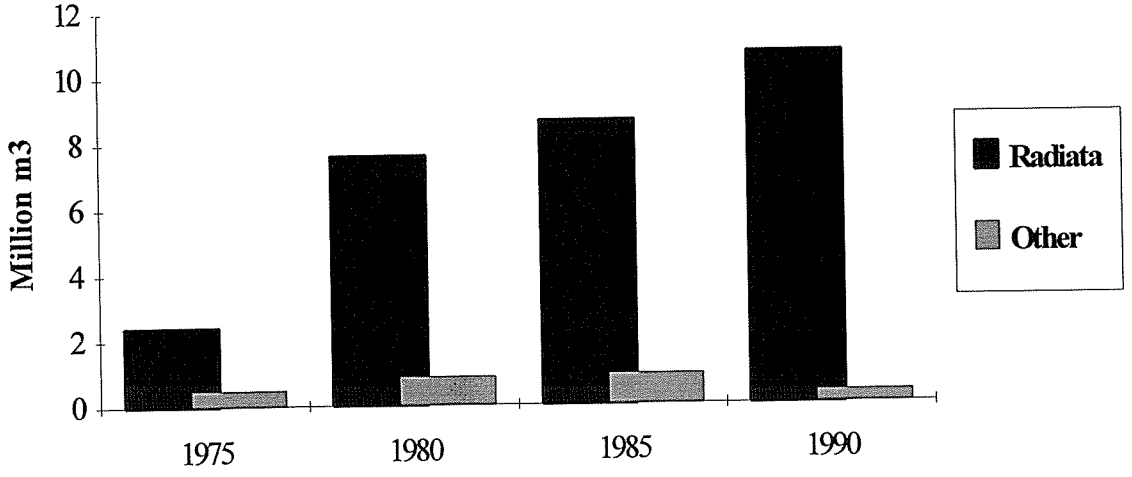
The major private owners include COPEC (Angelini) and under part control by Carter Holt Harvey (NZ), with over 300,000 hectares, CMPC also with part control by Fletcher Challenge (NZ), INFORSA, Bosques de Chile (Shell), and Cholguan (Angelini) (CORFO-INFOR 1987).

**Figure 5.1** **Age-Class Distribution of Radiata Plantations, Chile, 1990**




*Source: INFOR-CORFO (1991)*

**Figure 5.2** **Roundwood Consumption by Species, Chile**




*Source: INFOR-CORFO (1991)*

The average annual planting rate since 1974 is almost 80,000 hectares (INFOR-CORFO 1991). Planting prior to this was under 35,000 ha and even below 10,000 hectares per year before 1968. As a result the Chilean plantations are relatively young with 84% under 15 years old, see Figure 5.1.

Over the last decade industrial roundwood consumption has increased markedly from 5 million $m^3$ in 1976 to over 14 million $m^3$ in 1990 (CORFO-INFOR 1991). Nearly half of this was for sawnwood production and 18% for the pulp and paper industry (see Table 5.2). Radiata pine is the dominant species forming 4.8 million $m^3$ of the log removals in 1976 and over 10.7 million $m^3$ in 1990, as illustrated in Figure 5.2.

**Table 5.2 Roundwood Consumption by Product, Chile, ('000 $m^3$ log)**

| Product | 1980 | 1985 | 1990 |
|---|---|---|---|
| Sawnwood | 4,563 | 4,578 | 6,998 |
| Woodchips[a] | - | - | 2,250 |
| Chemical Pulp[b] | 2,380 | 2,999 | 2,182 |
| Export Sawlogs | 1,056 | 1,260 | 1,033 |
| Veneers and Boards | 281 | 316 | 608 |
| Export Pulplogs | - | 14 | 579 |
| Mechanical Pulp | 255 | 394 | 414 |
| Other[c] | - | - | 195 |
| Total | 8,472 | 9,561 | 14,259 |

Note: Data estimated from production details.
[a] Excludes woodchips from sawmilling.
[b] Woodchips from pulplogs.
[c] Includes roundwood consumed in case and box making.

*Source: INFOR CORFO (1991).*

**Industry and Trade**

Paralleling this increase has been a rapid growth in the forest products industry. In gross value terms the furniture sector is the most important ($27 million in constant 1977 prices) then paper mainly of chemical pulp, newsprint and other papers ($20 million), and then sawn timber ($10 million). In volumes of log consumption however, sawn timber is bigger than pulp and paper (INFOR-CORFO 1991).

**Table 5.3 Pulp Production Trends and Prospects, Chile, ('000 tons)**

| Company | 1989 | 1990 | 1991 | 1992 | 1993 |
|---|---|---|---|---|---|
| Copec | 375 | 438 | 438 | [a]708 | 788 |
| CMPC | 425 | 440 | 443 | [b]711 | 786 |
| Bio-Bio | 74 | 74 | 74 | 74 | 74 |
| Santa Fe | - | - | 80 | 180 | 220 |
| Total | 874 | 952 | 1,035 | 1,673 | 1,868 |

[a] Commissioning of Arauco II.
[b] Commissioning of Celpac and Inforsa expansion.

*Source: EIU (1992)*

Installed production capacity in the pulp and paper sector (see Table 5.2) is now over 1.7 million tonnes per year, 66% being pulp and 34% paper and paper board (Servigraf 1991). The most recent addition is a second pulp mill Arauco II, with 350,000 tons capacity of bleached long-fibre pulp and expected to cost almost A$800 million (Arauco 1990).

In 1990 total production of sawn timber was 3.3 million $m^3$, of which 87% was radiata pine and seven new sawmills commenced operations with a combined capacity of 260,000 $m^3$ per shift per year (Servigraf 1991). Larger mills exceed 25,000 $m^3$ per year capacity with the latest Arauco sawmill being 50,000 $m^3$ per year per shift (Arauco 1991). Most of the larger mills are modern, some with kilns and treatment plants (Jelvez et al. 1990). Nevertheless, in 1985 there were over 1,500 sawmills under 25,000 $m^3$ in capacity (CORFO-INFOR 1987). Many are only portable mills operating as market conditions warrant. Antifungal and anti-stain chemicals (sodium pentachlorophenate and pentachlorophenol) are in common use.

Production of panels, MDF and veneers was 350,000 $m^3$ in 1990.

**International Trade**

Most of Chile's forest product sectors are export oriented. At least 72% of pulp production, 67% of newsprint, and over 30% of sawntimber, panels and veneers were exported in 1990. Since 1973, there has been an overall increasing trend in forest product exports to a value of $1,200 million in 1991. Their share of total Chilean exports has averaged 10% over the last decade (INFOR-CORFO 1991 and CONAF-INFOR 1992).

Bleached and unbleached pulp, woodchips and radiata sawnwood are the major products exported (see Table 5.4). Japan (31%), USA (7%), Belgium (7%) and Germany (7%) are the major destinations by value in 1991. Exports to Australia exceeded $1.3 million f.o.b.

**Table 5.4** **Principal Exports, Chile, 1991**

| Product | Value $ million f.o.b. | Quantity '000 | | Major Destinations |
|---|---|---|---|---|
| Bleached Pulp | 208 | 314 | ton | Belgium, Germany, Japan |
| Woodchips[a] | 200 | 3,066 | ton | Japan, Finland |
| Radiata Sawnwood | 168 | 949 | $m^3$ | Middle East, Japan, UK |
| Unbleached Pulp | 128 | 241 | ton | China, Belgium, Japan |
| Newsprint | 89 | 269 | ton | Brazil, Peru, Argentina |
| Radiata Logs[b] | 67 | 10,639 | ton | Korea, Japan, Turkey |
| Processed Sawnwood | 49 | 182 | $m^3$ | Japan, Holland, Belgium, |
| Boards and Veneers | 43 | 75 | $m^3$ | USA |
| Other | 249 | | | Korea, UK, Germany, USA |
| Total | 1,201 | | | Japan, Belgium, Germany |

[a] Includes Eucalypts, Native Species and Radiata.
[b] Includes Pulplogs and Sawlogs.

*Source: CONAF-INFOR (1992)*

Table 5.5 indicates the trend for exports disaggregated into traditional and new products. Export incentives exist for "non traditional exports" where the Government subsidizes 10% of the value of exports of a specific product, provided less than $2.6 million was exported in the prior year (Price Waterhouse 1991b).

**Table 5.5 Forest Product Exports by Composition, Chile, $million f.o.b.**

| Year | Traditional Exports[a] | | New Products[b] | | Total |
|---|---|---|---|---|---|
| 1970 | 31,100 | (83%) | 6,300 | (17%) | 37,400 |
| 1980 | 373,300 | (94%) | 23,200 | ( 6%) | 396,500 |
| 1990 | 766,200 | (69%) | 339,800 | (31%) | 1,106,000 |
| 1991 | 779,000 | (65%) | 422,400 | (35%) | 1,201,400 |

f.o.b Free on Board

a Roundwood, Sawnwood, Pulp, Newsprint, Veneers and Boards.

b Processed wood, Woodchips, Paper and paperboard, Furniture. Components and Pallets, Mouldings and Joinery, Seeds and Leaves.

*Source: CORMA (1992).*

The major forest products imported in 1990 included paper and paper manufactures worth $1.8 million f.o.b. from the United States, $1 million f.o.b. from West Germany and $0.4 million f.a.s. from Japan (EIU 1992). Customs duties (tariffs) on all imports have been reducing over time. The average level for 1991 was 11%, down from 35% in 1984 (Prochile 1991). For chemical pulp, newsprint, printing and writing paper, kraft paper and linerboard, import duties were 20% in 1988 (WRA 1988).

Chile has been a part of ALADI (Association of Latin American Integration) and membership of the newly formed NAFTA (North American Free Trade Association) is under consideration by the current partners (United States of America, Canada and Mexico).

**Economic Indicators**

The economy of Chile has been steadily improving over the last decade. Since 1984, it has experienced continual growth in economic activity (see Table 5.6) and this trend is expected to be maintained during the next few years (EIU 1992). Its population of 13 million in June 1990 (International Monetary Fund 1992) has been democratically governed by President Aylwin since March 1990, following the military rule of General Pinochet.

Annual interest rates are high but have fallen from excessively high levels in the late 1970's to 29% nominal for lending in 1991. As a consequence real interest rates are relatively high, averaging 11% between 1987 and 1991 and falling to 8% in 1991. Standard and Poor recently assigned a credit rating to Chilean Government debt, BBB (Anon.1992a) indicating an acceptable level of economic and political risk in Chile, relative to other South American countries.

There are also expectations that the double digit consumer price inflation will gradually abate. In contrast wage inflation is expected to continue to rise. On May 1, 1991, the Minimum Wage was increased from US$60 to almost US$100 per month. A further rise to US$200 per month was expected within the next 12 months. These increases mean that some forest industry executives are concerned about Chile losing its low labour cost advantage in the international trading arena.

**Table 5.6** **Economic Indicators, Chile**

| Indicator by Financial Year | Real GDP[a] %p | Chile Pesos/ Aust. $[b] | Real Interest Rates[c] %pa | Consumer Price Index %pa | Wages Trend %pa | Dwelling Permits '000 $m^2$ |
|---|---|---|---|---|---|---|
| 1983 | -0.7 | 70 | 12.9 | 27.3 | 13.7 | |
| 1984 | 6.3 | 82 | 10.4 | 19.9 | 20.0 | 2,400 |
| 1985 | 2.4 | 110 | 7.3 | 30.7 | 25.1 | 3,050 |
| 1986 | 5.6 | 128 | 9.1 | 19.5 | 22.0 | 2,900 |
| 1987 | 5.7 | 159 | 9.3 | 19.8 | 19.7 | 3,550 |
| 1988 | 7.4 | 210 | 7.5 | 14.7 | 22.2 | 4,000 |
| 1989 | 10.0 | 212 | 11.9 | 17.0 | 19.2 | 4,850 |
| 1990 | 2.1 | 234 | 16.4 | 26.0 | 28.4 | 4,500 |
| 1991 | 6.0 | 265 | 8.3 | 21.8 | 23.1 | 5,000 |

[a] Gross Domestic Product. [b] As at end December. pa Per Annum.
[c] For short-term loans. A new deflator was introduced in 1987.

*Sources: EIU (1992), Reserve Bank of Australia (1992).*

**Plantation Silviculture**

There are three main silvicultural management regimes for radiata plantations practised in Chile; Intensive (manejo intensivo), Traditional (manejo tradicional), and a regime without silvicultural treatment (sin manejo). The most common management regime now is Intensive, practised on 40% of the area, followed by the Tradicional regime (33%) and lastly, the No Treatment regime (27%). By the turn of the century the percentage of plantations under intensive management will have increased up to 60% with some consequential reductions in the other management regimes (CORFO-INFOR 1990).
In general the prescriptions for these regimes are:

(a) Intensive:
This management technique was not widely adopted until the early 1980's. The overriding objective is to maximize clearwood not unlike the New Zealand "Clearwood" regime. Prescriptions can include:-
- Two and four prunings between the ages of 5 and 10 years.
- Pre-commercial thinning at 5 or 6 years to 700 trees per hectare followed by a commercial thinning between ages 12 to 14.
- Rotation age between 26 and 30 years.

(b) Traditional
- No pruning with two commercial thinnings between ages 12 and 15 years.
- Likely rotation length 20 to 25 years.

(c) Sin Manejo (No Treatment)
This is more common on sites of poor quality or near pulp mills, and a predominately pulpwood operation.
- Minimum or no management: clearfell between 18 and 24 years.

Initial stocking can range from 1,100 to 1,600 trees per hectare. Mean annual increments range from 15 to 35 cubic metres per hectare per year. As in New Zealand, gorse can be problematical and expensive to eradicate while various pests and diseases are apparent (e.g. Dothistroma, European pine shoot moth, Pine Bark beetles). Sirex wasp infestations evident in radiata plantations in neighbouring Argentina are being closely monitored.

Roading on the steep sites can be expensive ($30,000 per kilometre mainly due to imported materials required to minimize erosion) and may only last for five years. Technology for thinning and clearfelling operations varies from tower or cable logging, skidders, or to manual labour and animals (oxen).

**Assistance Measures**

The increase in plantation establishment since 1974 was in most part encouraged by the provision of incentives/subsidies under Legislative Decree 701 (DL 701) enacted in 1974. For CONAF approved afforestation proposals on land designated for forestry production, subsidies or bonuses of up to 75% of planting, pruning and management costs are provided. The bonus is only acknowledged as income on plantation exploitation. CORMA (pers. comm.) disputes the percentage level of the subsidy considering that it is more like 50% because the subsidy costs are based on representative sites selected by CONAF in 1974/75 and indexed annually by the consumer price index rather than the current costs incurred by growers.

In addition no real estate tax (land tax) is assessed on land designated suitable for forestry (USDA Classes 6 and 7) and surtax on income received from plantation harvest is reduced by 50% (Price Waterhouse 1991b).

Recipients are obligated to replant for which there is no subsidy. Species and planting density (but not less than 50% of the original) can be changed.

Since the scheme's inception over 600,000 hectares have been planted (not all radiata), 250,000 hectares pruned, 3.5 million hectares of land have been preferentially classified to forestry, and $105 million has been provided to the approved growers (INFOR-CORFO 1991). Most of this assistance (80%) has been received by the companies rather than individual growers (NPAC 1991).

This scheme is due to finish in 1994. The draft of a new law to determine a subsidy for enrichment and silvicultural management of native forests is currently under consideration. It is intended that this law will also define more clearly conservation and forestry production zones.

Incentives and mechanisms to encourage foreign investment in Chile are considered liberal, are supported by legislation and quite generous compared to Australia and New Zealand. One hundred percent foreign ownership is permitted, earnings can be repatriated annually and capital after three years. More information is outlined in Price Waterhouse (1991b) and Jelvez et al. (1989).

## Assumptions

Details of the regimes selected as average and high yielding sites are given in Table 5.7.

Discount Rates

Real interest rates have been much higher than other countries under study (see Table 5.5). It was also apparent that company hurdle rates range 8% plus (pers. comm.). However to maintain comparability with New Zealand and Australian results the range of discount rates selected for the Net Present Value calculations was from 4 to 10%.

**Table 5.7** **Regime Details, Chile**

| Factor/Regime | | No Treatments | | Traditional | | Intensive[a] |
|---|---|---|---|---|---|---|
| Site Quality | | Average | High | Average | High | Average |
| Land Purchase | $/ha | 605 | 470 | 605 | 470 | 605 |
| Establishment Costs[b] | $/ha | 335 | 300 | 335 | 300 | 300 |
| Replanting | $/ha | 35 | 35 | 35 | 35 | na |
| Pruning | Yrs | na | na | na | na | 5, 7, 8, 10 |
| Thinning | Yrs | na | na | 10, 14 | 10, 14 | 5, 10, 15 |
| Yields - Clearlog | $m^3$/ha | - | - | - | - | 205 |
| - Sawlog | $m^3$/ha | 273 | 369 | 87 | 332 | 159 |
| - Pulplog | $m^3$/ha | 136 | 78 | 339 | 227 | 92 |
| Clearfell Age | Yrs | 24 | 20 | 24 | 20 | 27 |

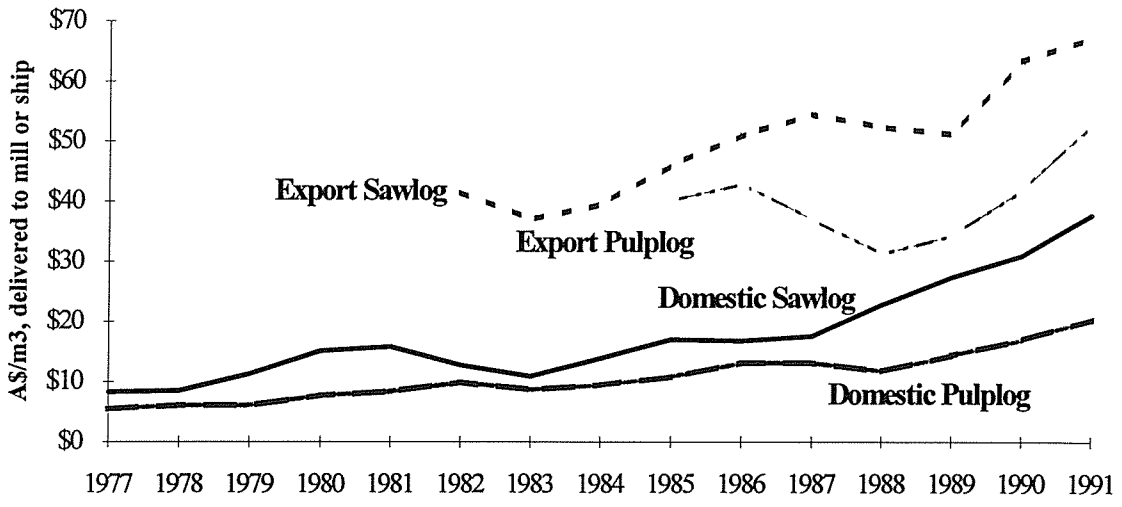
[a] Proposed.
[b] Excluding gorse treatment.
*Source: Peters et al. 1985 and personal communication with Chilean industry*

Trends in Prices and Costs

In nominal terms average log prices for radiata pulplogs and sawlogs, whether delivered to the processing centre or free on board ship have increased steadily over time (see Figure 5.3). Included in these averages would be an increase in average log diameter as the plantations have matured. In real terms and converted to Australian dollars, all logs have fallen markedly from mid 1980's levels, to more stable trends in recent years (see Figure 5.4).

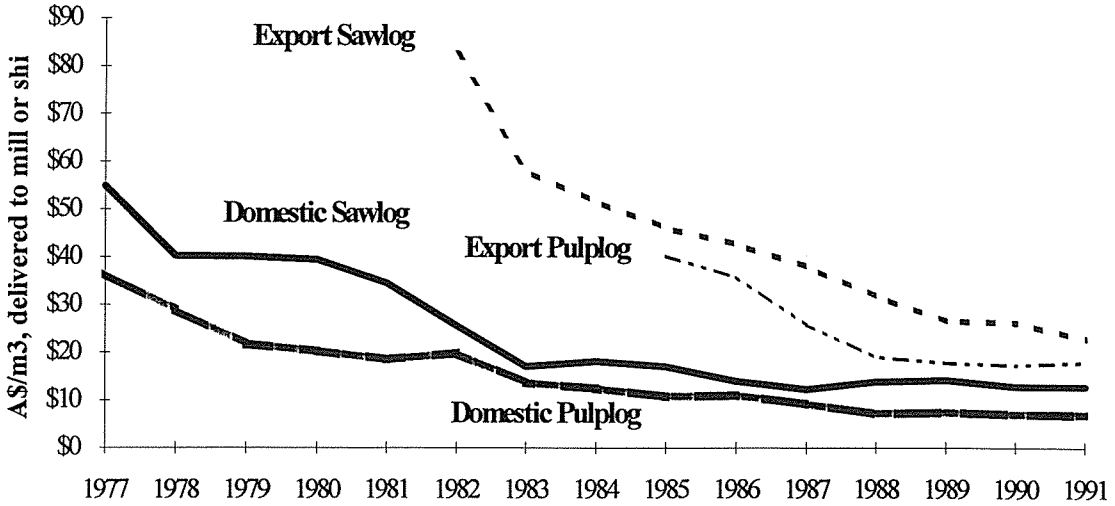
For the study, current relativity between costs and prices was maintained.

**Figure 5.3** **Nominal Radiata Log Prices, Chile**




*Sources: CORFO-INFOR (1992), IMF(1992), INFOR-CORFO (1991)*

**Figure 5.4** **Real Radiata Log Prices, Chile (a)**




(a) Deflator CPI: 1985 = 100

*Sources: CORFO-INFOR (1992), IMF(1992), INFOR-CORFO (1991).*

**Results**

The results for the base case for the no treatment and traditional regimes are presented in Table 5.8. Due to re-afforestation requirements of DL 701, the land was not sold at the end of the rotation as in previous analyses. As the intensive regime was not widely adopted until recently, prices for pruned log are not readily available. However one major grower expects to achieve an internal rate of return of 11% for a 24 year rotation or, achieve a net present value of $1,830 at an 8% discount rate with a 25 year rotation.

**Table 5.8 Financial Results for Typical Plantation Regimes - Chile, Base Case**

| Regime/Site Quality | Discount Rate | No Treatment | | Traditional | |
|---|---|---|---|---|---|
| | | Average | High | Average | High |
| Internal Rate of Return | na | 8.8% | 13.0% | 9.3% | 14.1% |
| Net Present Value ($/ha) | 4% | $2,085 | $4,650 | $2,440 | $4,400 |
| | 7% | $500 | $2,570 | $690 | $2,090 |
| | 10% | -$240 | $1,420 | -$140 | $850 |

na Not applicable.

All regimes, based on the data used, would appear to provide acceptable rates of return and net present values, the Traditional regime having a higher profit potential.

A sensitivity analysis using both a 25% increase and decrease in the costs of land purchases, site establishment, annual charges and in plantation revenues was undertaken. The greatest degree of sensitivity was to the change in revenues, resulting in movements in the internal rate of returns of +1.5 and -2.1. All four factors were varied by 25% into one advantageous and one disadvantageous scenario each, as a simplistic measure of risk extremes. The internal rates of return altered by approximately ±3%.

A separate analysis was carried out to determine the effect of the DL 701 subsidy. Rates of return for average and high quality sites were higher by about 0.5% and 1% respectively and the sensitivity analysis showed similar trends.

**Taxation**

The current rate of domestic corporate income tax is 15% and is to be reduced to 10% after 1993. Dividends distributed to non residents are taxed at 35% of the total taxable income, whereas those paid to residents are subject to Surtax, a progressive tax. Surtax on income received from harvesting plantations is reduced by 50%.

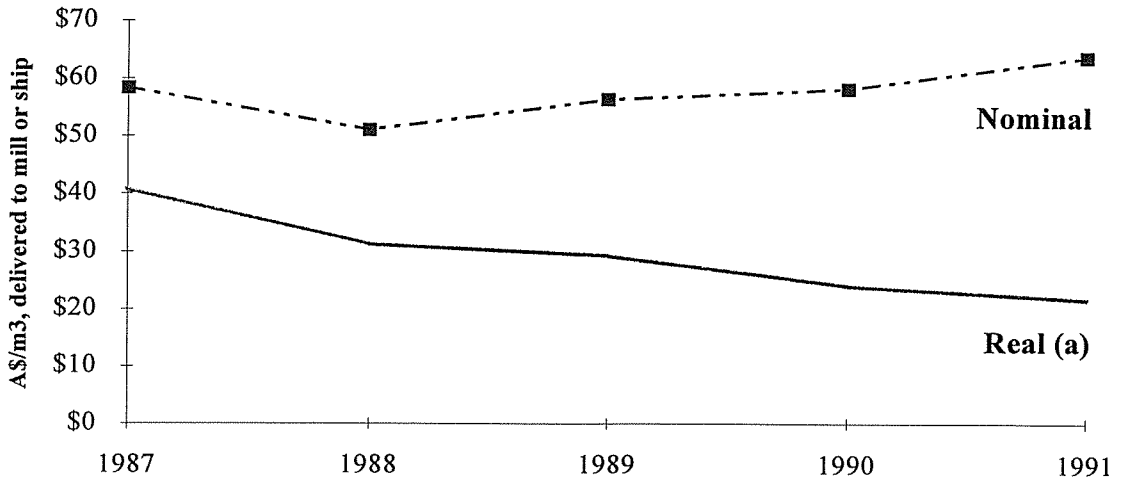
Accelerated depreciation rates can be applied to new fixed assets (bought locally or imported) or used imported assets, if their normal useful life exceeds five years. This life is reduced by a third for the calculation of the accelerated depreciation rate (Price Waterhouse 1991).

**Post Tax Results**

Using a very simplified model that excludes depreciation and assumes profits are reinvested, the impact of taxation was assessed. This was relatively minor, increasing rates of returns on average by 0.3%.

Future rates of return are likely to decrease as companies progress to second rotations and no longer receive the DL 701 subsidies. Erosion on steep inclines may also have an impact though forest managers are seeking methodologies to combat it.

**Figure 5.5** **Eucalypt Pulplog Prices, Chile**




(a) Deflator: CPI=1985=100

*Source: CORFO-INFOR (1992), IMF(1992), INFOR-CORFO (1991).*

**Eucalypts**

Plantings of eucalypts are a recent phenomenon. Just over 100,000 hectares have been established to date with over 29,000 planted in 1990 (INFOR-CORFO 1991). By the year 2000, the total area is projected to be 300,000 hectares (Servigraf 1991). The most favoured species are E. globulus, E. nitens, E. fastigata, E. regnans and E. grandis.

Most plantations are grown mainly for pulpwood. Limited quantities of sawlogs and plylogs are currently being processed from 15,000 hectares owned by the Shell, Scott Paper and Citibank consortium at Colcura.

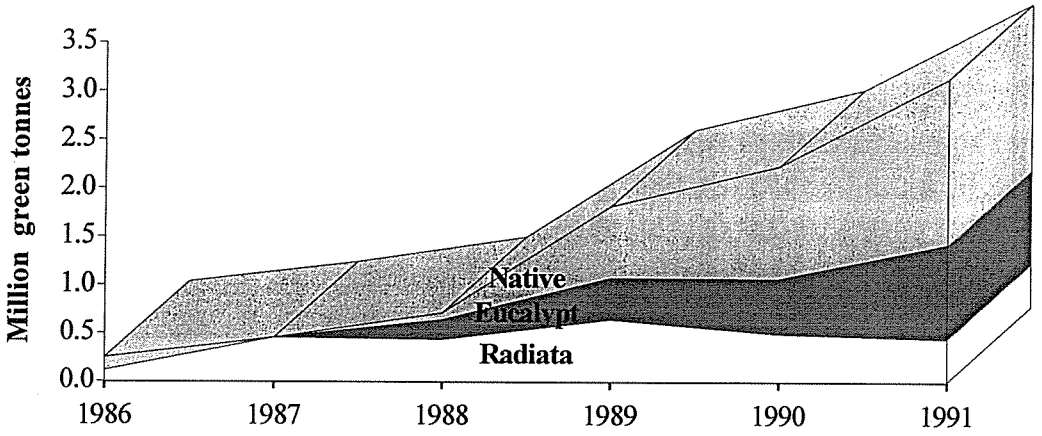
Plantation costs have been estimated at $520 (NPAC 1991) and rotation lengths are likely to be 12 years for commercially spaced afforestation and 8 years for agroforestry. Under both regimes total yields of 250 $m^3$ per hectare are expected (Forestal Mininco, pers. comm.).

Eucalypt products from the plantations will include export woodchips and pulplogs, and domestic pulp. Export pulplog prices have marginally increased over recent years to $52 per $m^3$ in 1991, but declined in real terms (see Figure 5.5). Almost 270,000 tons were exported in 1991 (CONAF- INFOR 1992), though as planned pulp and paper capacity expansions for 1992 and after are completed (e.g. Sante Fe - 230,000 tons/year of eucalypt pulp and Forestal Anchile - 360,000 tons/year) availability of pulplogs for export may decrease.

While exports of eucalypt, radiata and native species woodchips have risen since 1986, their prices have stabilized (see Figures 5.6 and 5.7).

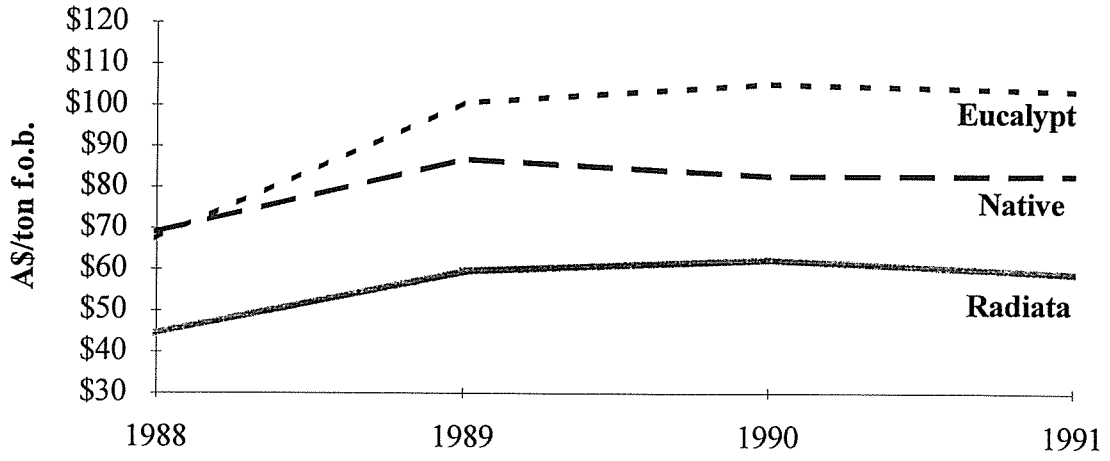
Until the plantations mature, there are proposals to utilize suitable native forest species in greater quantities e.g. Magallanica de Bosques project. Approximately 4.1 million hectares of potentially commercial native forests could be harvested under sustained yield principles (CNF 1991) and over 600,000 hectares of second growth native forests are considered suitable for commercial forestry production. Several species have been successfully thinned and pruned. A draft law to encourage silvicultural management or enrichment of native species is under consideration. Not unlike other countries, there is community concern over native forest harvesting proposals.

**Figure 5.6** **Woodchip Exports by Species, Chile**




*Source: CORFO-INFOR (1992), INFOR-CORFO(1991)*

**Figure 5.7** **Export Woodchip Prices, Chile**




*Source: CORFO-INFOR (1992), IMF (1992).*

**Future Outlook**

Similar to Australian and New Zealand radiata log availability is expected to increase markedly in the next decade. The latest projections for Chile (CORFO-INFOR 1991) have some new assumptions and cover different options than previous estimates. The assumptions now include a decline in the rate of plantation establishment at the conclusion of the Decree Law 701 subsidies, and lower yields incorporated for the smaller growers. The various options include a non-declining yield (A), which is then adjusted in accordance with total projected demand based on plant capacities for another scenario (B), and one with the log availability adjusted for sawlog demand (C). In general terms, log supplies are expected to double current levels by early next century, and triple by the year 2017 (see Table 5.9)

**Table 5.9** **Projected Radiata Log Availability, Chile**

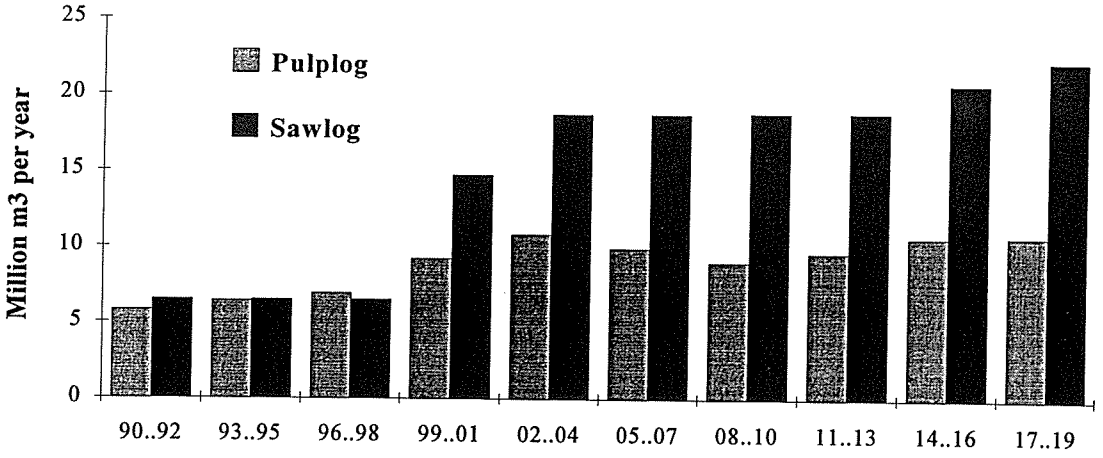
| Tri-ennium | Availability (million $m^3$ per year) | | |
|---|---|---|---|
| | A | B | C |
| 1990-92 | 16.5 | 15.1 | 12.3 |
| 1993-95 | 17.2 | 17.2 | 12.9 |
| 1996-98 | 18.7 | 17.7 | 13.4 |
| 1999-01 | 17.9 | 22.2 | 23.9 |
| 2002-04 | 19.4 | 23.2 | 29.5 |
| 2005-07 | 19.0 | 22.9 | 28.6 |
| 2008-10 | 21.2 | 23.1 | 27.8 |
| 2011-13 | 22.2 | 23.1 | 28.4 |
| 2014-16 | 28.1 | 30.1 | 31.3 |
| 2017-19 | 33.0 | 36.9 | 32.9 |

A Non-declining yield.
B As for A, and constrained by aggregate log demand forecasts to 1999.
C As for A and constrained by sawlog demand forecasts to 1999.

*Source: CORFO - INFOR (1991).*

In a closer examination of these scenarios of potential log supplies and usage by region, it is likely that pulplog demand in the central region will exceed supply until 1999 at least, and also in the southern region during 1997-1999 (CORFO-INFOR 1991). This may lead to an increase in pulplog prices, increased frequency of commercial thinnings, reduced rotation ages, and alter the sawlog-pulplog balance (see Figure 5.8).

**Figure 5.8** **Projected Availability by Log Type, Chile, 1990 to 2019: Non-declining yield adjusted for demand**




*Source: CORFO-INFOR (1991)*

Given the substantial increase in overall log supplies projected, future exports could be worth $2.4 billion by the year 2000 and nearly $4 billion by 2010 (Servigraf 1991). Increases are expected to be in pulp (1.6m tonnes by year 2000), sawnwood, mouldings and clearwood for furniture, see Table 5.10. Currently sawnwood exporters are facing a small dilemma. Fewer and fewer countries are accepting PCP treated radiata and the Chilean producers fear that the costs of kiln drying will reduce their competitiveness (CORMA pers. comm.).

For export increases of any magnitude to occur particularly in forestry conversion, substantial investments, are required. One estimate was $1.8 billion between 1986 and 2000 with additional public expenditure on transport infrastructure of $190 million (Jelvez et al. 1989).

**Table 5.10** **Future Forest Product Exports, Chile, $f.o.b. million**

| Product | 2000 | 2010 |
|---|---|---|
| Pulp | 1,229 | 1,829 |
| Radiata Wood Products | 200 | 500 |
| Radiata sawnwood | 204 | 402 |
| Newsprint and other papers | 104 | 104 |
| Radiata sawlogs | 60 | 100 |
| Other | 50 | 50 |
| Total | 1,847 | 2,985 |

*Source: CORMA in Servigraf (1991)*

# CHAPTER 6 - UNITED STATES

Nearly one third of the United States' land area is forested (296 million hectares). Commercial timberlands (defined as areas of forest land with the capability of producing more than 1.4 $m^3$ per hectare per year of industrial wood in natural stands, excluding any inoperable or inaccessible sites) comprise two thirds of the forests (see Table 6.1) and in 1985, these timberlands produced 15% of the world output of industrial roundwood (FAO 1991). On the basis of area, hardwoods are the predominant cover (56% in 1987, see Table 6.2) but softwoods are amongst the most highly productive. These have roundwood growth rates exceeding 8.4 $m^3$ per hectare per year, cover only 11% of the timberlands and include the following species mix:-

- Loblolly Pine (*Pinus taeda*), shortleaf (*Pinus echinata*), oak-pine, oak-hickory and oak-gum-cypress forests in the United States' South and

- Douglas-fir (*Pseudotsuga menziesii*), Western Hemlock *(T. heterphylla)* and red alder (*Alnus rubra*) stands of the Pacific Northwest, and the coast Redwood (*sequoia sempervirons*) of California.

**Table 6.1 Land Forest Areas by Region, United States, 1987 (Million hectares)**

| Type | North | South | Rocky Mountains | Pacific Coast | Total |
|---|---|---|---|---|---|
| Timberland[a] | 63 | 79 | 25 | 9 | 196 |
| Reserved Timberland | 3 | 1 | 5 | 5 | 14 |
| Other Forest Land | 2 | 2 | 28 | 55 | 86 |
| Total Forest Land | 67 | 82 | 58 | 89 | 296 |
| Other Land | 100 | 134 | 242 | 141 | 618 |
| Total Land | 167 | 216 | 300 | 231 | 914 |

Note: Totals may not add due to rounding.
[a] Capable of producing at least 1.4 cubic metres per hectare annually.
*Source: Haynes (1990).*

These highly productive areas include plantations as well as natural forests. Establishment of industrial plantations commenced as early as the late 1940's (Binkley 1987), though recorded data show tree planting commencing as early as the 1930's encouraged by programs such as the Civilian Conservation Corps (mid 1930's to 1940's) and the Soil Bank Program (1956 to 1961) (see Figure 6.1).

In the last decade, an average of 1.1 million hectares of trees has been planted annually with more than 80% on private lands (Mangold et al. 1992). Fluctuations in annual planting levels can arise from movements in housing commencements that in turn can vary lumber production levels and consequently harvested areas made available for planting. Major species being planted include various pines, Douglas-fir, spruces and firs.

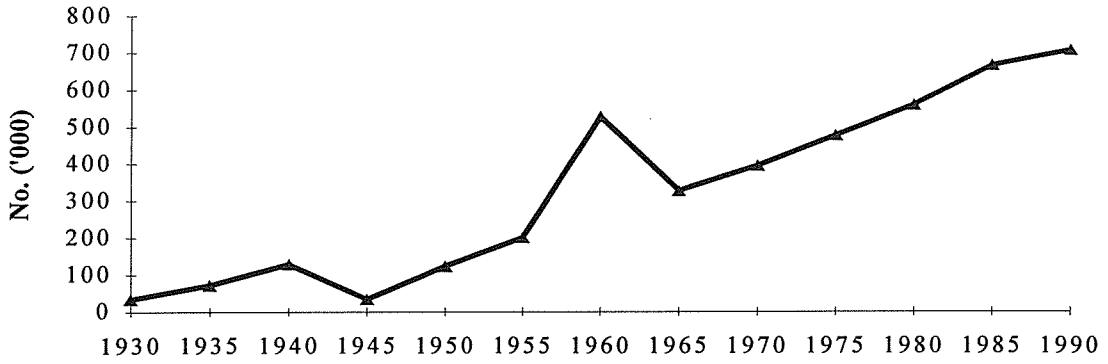
**Table 6.2 Area of Timberland by Forest Type, United States, 1987 (Million hectares)**

| Forest Type | Area | Forest Type | Area |
|---|---|---|---|
| Western Softwoods | | Eastern Softwoods | |
| Douglas-fir | 13 | Loblolly-shortleaf pine | 20 |
| Ponderosa pine | 10 | Spruce-fir | 7 |
| Fir-spruce | 11 | Longleaf-slash pine | 6 |
| Lodgepole pine | 5 | White-red-jack-pine | 6 |
| Hemlock-sitka spruce | 4 | Total | 38 |
| Larch | 1 | | |
| Redwood | 0 | Eastern Hardwoods | |
| White pine | 0 | Oak-Hickory | 48 |
| Other western softwoods | 0 | Maple-beech-birch | 18 |
| Total | 45 | Oak-pine | 13 |
| | | Oak-gum-cypress | 11 |
| Western Hardwoods | 6 | Aspen-birch | 7 |
| | | Elm-ash-cottonwood | 6 |
| | | Total | 103 |
| Total Western | 52 | Total Eastern | 141 |
| Total Non-stocked | 1 | Total Non-stocked | 2 |
| TOTAL | 53 | TOTAL | 143 |

Note: Totals may not add due to rounding.
*Source: Haynes (1990).*

Most plantations are located in the United States' South, having a total of 8.5 million hectares in 1985 and there is a further 8.8 million hectares of agricultural land identified that could be more profitable in pine plantations (USDA 1988). The Weyerhaeuser Company owns just over 1.1 million hectares (Weyerhaeuser 1991) in the US' South and an equal amount in the Pacific Northwest. Ownership of all the US' South plantations is concentrated in the lands of forest industry (63%) and other private, including farmers and corporate investors (31%), see Figure 6.2. This ownership pattern is not reflected in the overall United States' commercial timberland areas, where private ownership is only 72% and public is 28% (Haynes 1990).

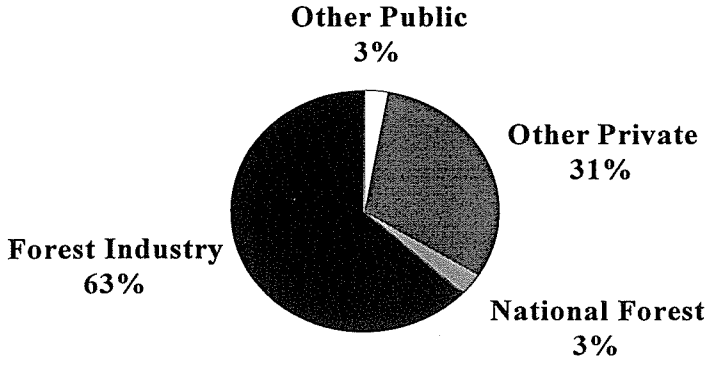
**Figure 6.1** **Tree Planting, United States**




*Source: Mangold et al.(1992)*

Total growing stock (volume of trees exceeding 12.7cm (5") at diameter breast height) is 21.4 million $m^3$ (see Table 6.3). 54% of it is concentrated in the Pacific Northwest and the United States' South. Softwoods comprise the greatest share, nearly 60%, and is mainly found in the Pacific Northwest (34%) and the United States' South (23%). Whereas the National Forests is the biggest owner in the Pacific Northwest, other private owners excluding the forest industry are the biggest in the United States' South. Hardwood growing stock volume is concentrated in regions other than the Pacific Northwest and the United States' South, mainly in the Eastern States and is of low diameters. The other private growers (not industry) have roughly equal volumes of softwoods in the Pacific Northwest and the United States' South, and are the biggest owners of hardwood volumes in the South.

**Figure 6.2** **Pine Plantations by Ownership, US South, 1985**




*Source: USDA (1988)*

Log removals in 1986 were over 465 million $m^3$, 70% from the US South and mostly softwood. In comparison to 1976, log removals in total, and from PNW and US' South in particular, have increased.

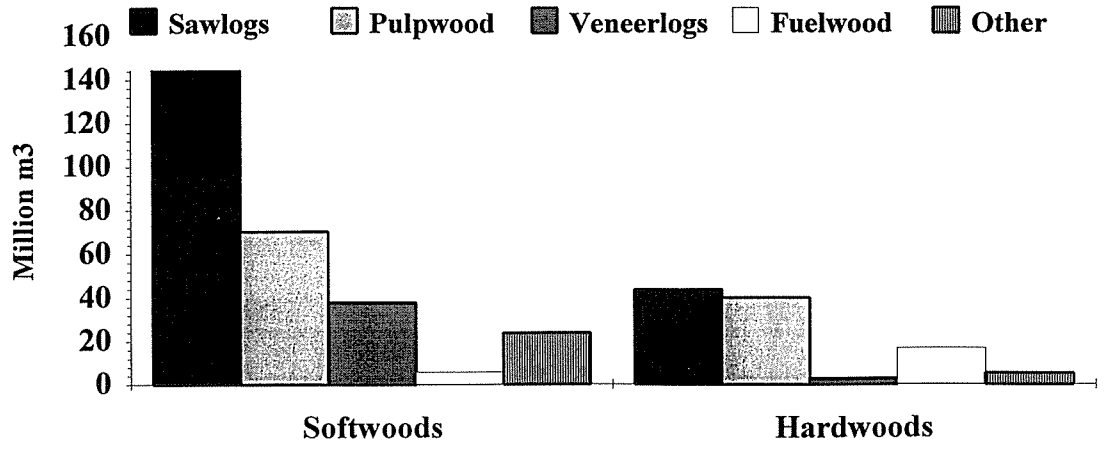
**Table 6.3 Volume of Growing Stock by Ownership, Region, Species Type, 1987 (Million $m^3$)**

| Species Type and Region | National Forest | Other Public | Forest Industry | Other Private | Total |
|---|---|---|---|---|---|
| Softwoods | | | | | |
| Pacific Northwest | 2,125 | 920 | 692 | 600 | 4,337 |
| South | 264 | 134 | 674 | 1,868 | 2,940 |
| Other | 2,891 | 556 | 684 | 1,365 | 5,496 |
| Total | 5,280 | 1,610 | 2,050 | 3,833 | 12,773 |
| Hardwoods | | | | | |
| Pacific Northwest | 4 | 119 | 110 | 213 | 446 |
| South | 271 | 161 | 492 | 2,879 | 3,803 |
| Other | 425 | 612 | 387 | 2,969 | 4,393 |
| Total | 700 | 892 | 989 | 6,060 | 8,642 |
| TOTAL | 5,980 | 2,502 | 3,309 | 9,893 | 21,415 |

*Source: Waddell et al. (1989)*

Forty nine percent of the growing stocks harvested was sawlogs and 27% was pulpwood in 1986 (Haynes 1990). Figure 6.3 shows volume of growing stock harvested by product.

**Figure 6.3 Log Removals by Species and Type, 1986, United States**




*Source: Haynes (1990)*

**Industry and Trade**

**Table 6.4 Processing Plant Capacity by Region, United States, 1985-86[a]**

| Region | Sawntimber million $m^3$ | Softwood Plywood million sq.m" basis | Woodpulp million tonnes | Paper and Paperboard million tonnes |
|---|---|---|---|---|
| Pacific North-West | 396 | 1,023 | 7.5 | 6.8 |
| South | 362 | 1,180 | 37.2 | 36.8 |
| Other | [b]272 | [b]145 | 10.3 | 27.1 |
| Total | [b]1,030 | [b]2,348 | 55.0 | 70.7 |

[a] Average annual capacity for the two-year period.
[b] Excludes North region as data unavailable.
Conversion factors used:
1 $m^3$ = 0.0283 board ft lumber tally: 1 sq.m = 0.093 square ft: 1 tonne = 0.907 tons.
*Source: Haynes (1990).*

In response to changing log supplies over the last decade, some large integrated firms have relocated headquarters from the PNW to the US South. This contributes to the US South being the biggest producer of pulp, paper and paperboard (see Table 6.4). National sales of forest products totalled $240,000 million with the largest sector being paper and paperboard manufactures (Haynes 1990).

International Trade

In 1989, the US accounted for 16% of world forest product imports and 13% of exports (FAO 1991). It is one of the world's leading producers, importers and consumers of forest products, and second to Canada as an exporter of forest products. Accordingly bilateral trade between these countries is one of the largest in forest products in the world.

For some time the United States has been a net importer of forest products, with imports exceeding exports by $4,500 million in 1989 (see Table 6.5). Major imports included paper and paperboard including newsprint from Canada and Scandinavia, softwood sawnwood from Canada, and woodpulp from Canada and Brazil. With an increasing demand for log imports, the UDSA has been investigating the pest risks and appropriate quarantine regulations for log imports from NZ including radiata, and other countries (USDA pers comm.). Log imports from USSR have been banned.

Woodpulp to Japan and Korea is the main export. Australia is one of the major destinations for softwood sawnwood, after Japan, Canada and Latin America. The main species exported include Douglas-fir, Hemlock and Southern Yellow Pine (USDA 1989).

**Table 6.5 Forest Products Trade, United States, 1989 ($ million)**

| Item | Value | Main Countries |
|---|---|---|
| Imports | cv | |
| - Newsprint | 6,158 | Canada, Sweden, Finland |
| - Softwood Sawnwood | 4,378 | Canada, Chile |
| - Other Paper and Paperboard | 4,206 | Canada, Finland, Sweden |
| - Woodpulp | 4,039 | Canada, Brazil, South Africa |
| - Wood-based Panels | 1,482 | Canada, Indonesia, Brazil |
| - Hardwood Sawnwood | 379 | Canada, Brazil, Philippines |
| - Other Forest Products | 275 | |
| Total Imports | 20,918 | Canada |
| Exports | fas | |
| - Woodpulp | 4,647 | Japan, Korea, Germany F.R. |
| - Other Paper and Paperboard | 3,659 | Canada, Latin America, Japan, China |
| - Softwood Sawlogs | 2,885 | Japan, China, Korea, Canada |
| - Softwood Sawnwood | 1,916 | Japan, Canada, Latin America, |
| - Hardwood Sawnwood | 902 | Australia |
| - Wood-based Panels | 854 | Canada, Japan, Latin America, U.K. |
| - Newsprint | 519 | U.K., Canada, Belgium, Luxembourg |
| - Woodchips | 515 | Japan, China |
| - Other Roundwood | 346 | Japan, China |
| - Other Forest Products | 173 | |
| Total Exports | 16,416 | Japan, Canada |

cv Customs value. fas Free alongside ship.
*Source: FAO (1991).*

Tariffs imposed on wood products into the US are generally low (wood in the rough - nil, primary wood products 0.4%, and secondary wood products 2.4%) though rates on specific items can be higher. Particleboard was 4% in the mid 1980's (Sedjo 1986). Plywood was 20% (most favoured nation basis) in 1991 (Evison and Glass 1991). Agreement was reached with Canada in 1992 on new plywood standards resulting in lower tariffs. Most paper and paperboard enter duty free although certain printing and writing papers were 2.5% and corrugating medium 4% in 1988 (WRA 1988).

For trade between Canada and the United States there was a 1989 US-Canada free trade agreement to remove all tariff barriers between the countries by 1998. This is being expanded to a "North American Free Trade Agreement" that includes Mexico. Trade barriers between the countries are now to be eliminated in 15 years, starting January 1994 (EIU 1992).

Countervailing duties

Canada supplies 99% of the US imports of softwood sawnwood. Since 1973 these supplies have risen to 27% from 23% of US consumption, peaking at 29.5% in 1982 and 33% in 1986 (Adams et al. 1988 and WWPA 1991). Under the current free trade agreement the imports to the US should be free. Since 1986 however, countervailing duties have been imposed by the US on Canadian shakes and shingles (now phased out completely) and separately on softwood sawnwood, on the basis that their producers are being injured by Government subsidies to Canadian sawmillers.

Initiated by Pacific North West sawmillers in 1981, an attempt by US softwood sawnwood producers to prove this case in 1982 was dismissed by the United States International Trade Commission (ITC) as *de minimus*. During this period, the Canadian market share was increasing and the US industry depressed. US housing commencements were at a cyclical low, and both US and Canadian sawntimber pricing at very low levels and aggregate sawntimber production falling (Adams et al. 1988, Chemlik et al. 1989 and Haynes 1990). However sawntimber production in the US South had increased.

In 1986 the United States producers repetitioned the ITC alleging unfair subsidisation of Canadian softwood stumpages and requested a 27% countervailing duty on Canadian softwood sawnwood (Chen et al. 1988). In defence Canadian producers claimed there was a consumer preference for their wood and their competitive pricing was a result of higher sawmill productivity than US producers (Blackman 1986). In addition, royalties paid under the different tenure systems were not directly comparable. Exchange rate movements at the time were also in Canada's favour, having fallen from 94cents to the US dollar in 1977 to 72cents in 1986. In complete contrast to the 1982 economic conditions, housing commencements were reaching a cyclical peak, and both Canadian imports and US sawntimber production were thriving (WWPA 1991). A preliminary ITC ruling in October 1986 suggesting a subsidy existed was considered flawed by Canadian industry in terms of methodology, US law and arithmetic. Nevertheless a "Memorandum of Understanding" (MOU) was reached allowing the Canadian Government to impose a 15% export tax and replace this with increased royalties (Anon. 1987). While the Canadian Government felt an export levy an inappropriate basis for a negotiated settlement, industry preferred an export tax. This would only apply to the sawntimber exports to the US whereas a royalty increase would impact on the cost basis of forest products in all markets. Some thought was also given in the US to expanding the countervailing duties action to pulp and newsprint.

The MOU was abandoned by the Canadian Government in September 1991. Almost immediately the US Government opened a new case based on both Canadian stumpages being set administratively and log export restrictions reducing domestic log prices. Under Section 301 a provisional 15% duty was imposed requiring US importers to post a 15% bond against Canadian sawnwood imports (EIU 1992). By June 1992 a countervailing duty 6.5% was declared by the ITC (Random Lengths 1992). This was estimated at $200 million on $3billion of shipments annually. The Canadian Government is expected to appeal both the subsidy and the injury rulings and a GATT panel formed (Anon 1992b). Sawnwood from British Columbia has been exempted in recognition of their recent log price increases. MacMillan Bloedel's exemption application based on half their log harvest being from owned lands and on paying economic rent for Crown logs, was denied (MacMillan Bloedel 1992).

It is believed that US sawmillers are not alone in benefitting from countervailing duty actions. Considerable quantities of Canadian sawnwood from the interior provinces is kiln-dried and railed to southern US states. In fact Canadian imports more than doubled between 1983 and 1987 (Chemlik et al. 1989). Through their effect on prices, countervailing duties (even if only provisional) can increase US South timberland values, enabling owners to increase rents. Even if the decision is not in their favour, timberland owners may have increased their valuations and rents in the meantime (MacMillan Bloedel pers. comm.).

Due to the appreciation of the Canadian against the US currency, it is difficult to ascertain how effective the imposition of countervailing duties has had on the Canadian market share.

Log Exports

Economic distortions in the proponent country apparently do not prejudice the case. Part of the US reasoning referred to reduced domestic prices caused by log export restrictions applying in Canada. Yet there are Federal Government constraints on log exports from the US itself. In September 1990 the Federal Forest Resources Conservation and Shortage Relief Act was enacted. This placed a permanent ban on log exports from trees harvested on Federal lands (previously approved annually) and from state-owned lands in the western states except Alaska and 75% of that sold in Washington. Restrictions on utilising Federal logs for processing while exporting logs harvested from private lands are also being tightened (Gruenfeld & Flynn 1991). Exports of logs from Pacific Coast ports have been declining since their 1989 peak of 23.6million $m^3$ (WWPA 1991) and may continue declining. Japan is purchasing from other suppliers as reduced US Federal log harvests increase royalties and prevent the US from remaining a lowest-cost country (Random Lengths 1992a). Sawntimber exports substituting for log, to Japan from North America have been increasing. Meanwhile Korean sales have declined in competition with alternative suppliers such as Chile and NZ.

There are merits for and against log export restrictions. Reasons for limiting exports include:

- downstream value-added employment is increased,
- greater availability of lower priced logs delivered to domestic mills,
- improved trade balance from the reduced need to import wood,
- and higher export prices where pricing controls are in force.

Arguments against restrictions include:

- additional markets for material not required by domestic processors,
- increased employment in the exporting region,
- enhanced returns to resource owners and therefore increased investment in plantations due to extra competition increasing raw material prices.
- comparative trade advantage may be in raw material export rather domestic processing,
- *ceteris paribus,* improved trade balance without major capital expenditure,
- free trade is preferable to provoking retaliatory trade action from imposing trade barriers,
- encouragement of paper recycling when sufficient pulpwood is exported,
- where license restrictions apply and add uncertainty and delay, reduced likelihood of overseas buyers seeking alternative sources, and
- enhanced ability to maintain forests in a healthy well-managed state.

Additional tightening of US softwood log export controls could be economically detrimental, given the dominance of PNW states in the Pacific Rim market (Sedjo et al. 1992).

Pinewood Nematode

In contrast to self-imposed restrictions, the European Plant Protection Organization in 1985 recommended a ban on all imported softwood products into Europe (except kiln-dried sawnwood) from countries known to have the pinewood nematode *B. xylophilus* (Smith 1985). Distinct from the parasitic nematode *Deladenus siricidicola* used as a biological agent to control Sirex Wasp, this pinewood nematode is considered to be a causal agent of pine wilt disease. Infestations were detected in coniferous woodchips being exported from the US South and Canada to Finland in 1984 and led to the banning of all US South coniferous woodchips to Nordic countries (Dwinell and Nickle 1989). Prior to this ban, annual exports of coniferous woodchips from the US South to Europe peaked at 670,000 tonnes (Chemlik et al. 1989). Woodchip exports to Japan are not affected as the pinewood nematode exists there.

Since then the European Community has placed a ban on green coniferous sawnwood imports from the US and Canada commencing January 1993. It was thought this would mean diversion of this wood to other markets or costly installation of kilns to reduce moisture content to below 20°C. Research has now shown that heat pasteurization to 56°C for 30 minutes may be an acceptable alternative to kilns (Random Lengths 1992b). Exports from the US South to Europe are kiln-dried and unlikely to be affected.

**Economic Indicators**

A selection of major economic indicators is presented in Table 6.6 below.

**Table 6.6 Economic Indicators, United States**

| Year | Real GDP[a] %pa | US$ per A$ | Long-term Bond Rate %pa | Consumer Price Index %pa | Labour Cost per hour Manufacturing A$/hr | | Rates of Return on Assets[c] %pa | Housing Starts[d] '000 |
|---|---|---|---|---|---|---|---|---|
| | | | | | Wood[b] | Paper | | |
| 1983 | -0.6 | 0.87 | 10.6 | 4.3 | 11.6 | 15.8 | 2.6 | 1,068 |
| 1984 | 6.8 | 0.86 | 13.0 | 3.7 | 12.1 | 16.7 | 3.0 | 1,084 |
| 1985 | 4.4 | 0.67 | 10.4 | 3.9 | 15.9 | 22.4 | 3.3 | 1,072 |
| 1986 | 3.6 | 0.68 | 8.2 | 2.9 | 15.9 | 22.8 | 4.5 | 1,179 |
| 1987 | 5.5 | 0.72 | 8.6 | 2.2 | 15.3 | 22.1 | 6.6 | 1,146 |
| 1988 | 4.1 | 0.79 | 9.0 | 4.2 | 14.2 | 20.5 | 7.3 | 1,081 |
| 1989 | 3.3 | 0.76 | 8.4 | 4.6 | 15.1 | 21.9 | 7.6 | 1,003 |
| 1990 | 1.7 | 0.79 | 8.6 | 4.8 | 15.1 | 21.8 | 4.2 | 895 |
| 1991 | -0.3 | 0.77 | 8.5 | 5.5 | 15.9 | 23.4 | -0.2 | 842 |

[a] Gross National Product.
[b] Excludes furniture.
[c] For forest industry. Rates of return on capital in the business sector averaged 11% for .. 1980-1987
[d] Single family units.
pa Per annum
*Sources: ABS (1992), COFI (1992), OECD (1992), WWPA (1991), and ILO (1992).*

Real long term interest rates between the years of 1983 and 1991 averaged 5.2% and Consumer Price Index inflation 4% per year in the US. During 1993 and 1994 inflation and Gross National Product growth should average 3% and interest rates increase slightly (Caton 1993). Long-term forecasts utilized by the USDA Forest Service as a basis for long-term projections give annual real interest rates around 4.4% and underlying inflation at 4.3% (Haynes 1990).

The average duration of the housing cycle has been estimated at about 20 years due to the durability of housing (Duerr 1989). Single family housing commencements for the period 2000 to 2040 are expected to peak at 1.25 million in 2000 and fall to 0.9 million by 2040 due to the ageing of the population base (Haynes 1990). Immediate expectations are for 1 million starts in 1992 and 1.1 million in 1993 (NAHB 1992).

**Plantation Silviculture - Loblolly Pine**

As the young plantations mature, pine plantations are expected to exceed half of the US South softwood inventory by 2030, a substantial increase from the current share of about 13%. Major species are Loblolly Pine (47%) and Shortleaf Pine (19%), following in importance by Slash, Longleaf, and Cypress Pines (USDA Forest Service 1988). Over 90% of the plantations are privately owned, of which forest industry has 63% (see Figure 6.3). As the US South is the commanding producer of pulp and paper in the US (see Table 6.4), pulpwood removals dominate the raw material harvests, 44% in 1984 compared to sawlog (including 'Chip and Saw") removals at 41% (USDA Forest Service 1988).

Loblolly Pine is the most favoured species for intensive forest management as it suits a variety of silvicultural systems. With the industry objective of minimizing cost of wood grown and delivered to mills, pulpwood regimes aim to maximize wood-fibre production with high density planting (1700 to 2000 stems per hectare) and short rotations (20 to 35 years). Thinnings are uncommon. Alternatively for sawlog production (integrated sawlog and pulpwood regimes), planting densities are lower and rotations as long as 35 to 45 years. First thinnings are often scheduled between the ages of 15 and 20 years, and the second between 22 and 28 years (McNeel 1990 and Holtman pers. comm.).

Establishment costs vary little between high and low site qualities but differ between first and second rotations. As the economic benefits of fertilization are unproven and their application is limited. Chemical costs are reportedly similar to those in Australia (Hubbard, pers. comm). Insurance to reduce investment risk is limited due to lack of actuarial data on natural hazard losses (Newman and Wear 1990). Prescribed burning at regular intervals is therefore practised to reduce wildfire hazard and control understorey vegetation. However care is needed to ensure compliance with the local laws and regulations to avoid litigation.

Short rotations also help to affray the risk from pests, diseases and endangered species limitations. The most widespread disease of Loblolly Pine is fusiform rust (*Cronartium quercuum*) infecting nearly 7 million hectares by 1991, and most prevalent in Georgia (Bechtold et al. 1992). Rust resistant strains are now available. The southern pine beetle (*Dendractonus frontalis* Z.) is the most destructive pest. It usually attacks poor stands and progresses into neighbouring vigorous stands. In 1991 25 million ha of natural and planted areas were infected, including old-growth wilderness areas; red-cockaded woodpecker habitat (Bechtold et al, 1992). These birds were one of the first species listed under the Endangered Species Act 1973 and recently Georgia Pacific Corp. agreed to 4 ha buffer zones around their colonies in order to continue logging remaining US South timberland. Grazing or hunting leases of $2 plus per ha per year can affray annual taxes and charges (Welker, pers. comm.).

**Assistance**

Small private landowners possess nearly 60% of US commercial timberland (Haynes 1990). In order to improve both land, forest management and low productivity, public assistance schemes for private afforestation (plantations and natural regeneration) have been made available in various forms since the Clarke-McNary Act of 1924 (USDA 1988).

- The Civilian Conservation Corps brought about an increase in planting from the late 30's to the early 40's (see Figure 6.1.).

- By far the longest program providing afforestation assistance is the Agricultural Conservation Program (ACP), enacted in 1936. In the US South alone, nearly US$60 million was spent between 1936 and 1986 (USDA 1988). For the year 1986 itself, $9.5 million was spent on forestry practices on 51,000 hectares across the US. Over 50% of this was directed to the US South, 28% to the North and 16% to the West (Haynes 1990). In 1991 ACP funded tree planting for almost 56,000 hectares.

Agricultural Conservation Program

- As the title suggests ACP is a national soil conservation program. Compensation for withdrawing soil from agricultural cultivation under this scheme allows landowners to receive cost-share assistance (i.e. partial reimbursement) for tree planting, site preparation for natural regeneration, timber stand improvement (e.g., thinnings, fertilization, etc.) and wildlife improvement. In addition they can receive annual payments during a contract period, usually 10 years (USDA 1988). The maximum cost-share rate is 65% per practice and maximum earnings receivable per fiscal year is US$3,500. Best Management Practices are encouraged and landowners must meet and maintain certain performance standards of forest management practice for a minimum of 10 years (Olmstead et al. 1989). A survey by Kurtz et al. 1980 found that conifer plantings under ACP were retained 10 to 15 years at least after planting. Only 11% were considered failures.

- Due to decreased ACP funding in the 1960's and county farm management boards that were reluctant to approve forestry practices, a separate cost-share program was enacted in 1973, the Forestry Incentives Program (FIP) (Cubbage et al. 1991). This has similarities to the ACP but is more oriented to wood production, constrained to sites that can produce 3.5 $m^3$ per hectare per year (Kronrad and Morzuch 1985) and includes small private forest landowners as well as farm forests (USDA 1988).

Forestry Incentives Program

From the mid-70's to the mid-80's FIP funding exceeding US$100 million was provided to 40,000 landowners for afforesting over 500,000 hectares. For the 1979 investment alone, the increase in yield over a rotation is expected to be nearly 37 million $m^3$ (Pitcher and Risbrudt 1986). In 1986 funding was $16.7 million for over 92,000 hectares (Haynes 1990). As most of the small private growers are concentrated in the South, those states received 75% of the 1986 allocation while there was only 12% for the Northern areas.

Like ACP, FIP provides cost-share payments for reforestation and standing timber improvement, natural regeneration site preparation and firebreak construction on contiguous sites between 4 and 500 hectares. Participation is restricted to tracts with potential to produce over 3.5 $m^3$ per year. Required is an approved management plan including the application of Best Management Practices for ten years. The cost-share rate is determined by each state, and ranges from 50% (Cubbage et al. 1991) up to 75% (Mather 1990). From the 1974 FIP investments a 10% rate of return was achieved (Mills and Cain 1979).

- In addition, several States have introduced their own assistance measures. These accounted for over one-third of the area regenerated with cost-share assistance in 1985 (Haynes 1990). Most schemes are special cost-share or reimbursement arrangements such as the Alabama Resource Conservation Program, Mississippi Forest Resource Development Act, North Carolina Forest Development Program and the South Carolina Forest Renewal Program (Cubbage et al. 1991). The Californian forest improvement program when it started in 1980 offered up to 90% of forest improvement costs (Mather 1990).

- The source of funds can vary. The Texas Reforestation Foundation that provides financial assistance for reforestation and land management for 10 years to landowners on a matching basis is funded by tax-deductible industry harvesting levies (Cubbage et al. 1991). The Florida Reforestation Incentives Program is backed by forest industry contributions, related industry and private sponsors to give landowners free pine seedlings (Olmstead et al. 1989). The 1970 Virginia Plan or Reforestation of Timberlands Program, aimed at converting non-forest or hardwood forest into pine production offered 50% incentive payments (up to US$148 per hectare). Funding is partly financed by a severance tax supplemented by Federal sources such as FIP and ACP (USDA 1988).

Conservation Reserve Program

- Tree growing assistance is currently available under the Conservation Reserve Program (CRP) authorized in the Conservation Title of the 1985 and 1990 Farm Bills. Like FIP & ACP, CRP is an USDA program with technical forestry assistance provided through USDA Forest Service and State Foresters (Mangold et al. 1992). As the name implies the program's main objectives are reduced soil erosion, improved fish and wildlife habitat, reduced surplus agricultural production and provision of farmer income support. As one eighth of the set-aside land has to planted with trees, (Cubbage et al. 1991) total tree planting under CRP is over 0.95 million hectares (Moulton et al. 1991 and Mangold et al. 1992).

CRP aims to take 16-18 million hectares of the most erodible and fragile farmland out of production by providing 50% Federal cost-share payments to establish permanent covers and 10 annual rental payments under conservation contracts to maintain designated vegetation e.g., conifer trees, or 15 years of rental payments for hardwood (Moulton 1991). The rental payment amounts are determined by a sealed bid process with the lowest accepted first (Cubbage et al. 1991), and are limited by both the maximum rental rates admissible by the Secretary of Agriculture (Moulton et al. 1991) and a payment ceiling of US$50,000 per participant (Olmstead et al. 1989). A management and conservation plan is required and monies refunded if certain performance standards are not met. In 1986 and 1987, the tree planting payments averaged $160 per hectare (Cubbage et al. 1991).

By 1990 nearly 14 million hectares were enrolled in the CRP. The tree plantations have averaged 16 hectares in size and more than 90% are located in the South in such states as Georgia, Mississippi, Alabama and South Carolina. Over 90% of the species are Southern Pines (Moulton et al. 1991) with the major species being Loblolly Pine.

Under the 1990 Act, lands accepted will be based on the highest environmental benefits per Federal dollar. Benefits to natural resources from the whole program have been estimated by USDA Economic Research Associates at $7.7-18billion (present day value) given improvements in soil productivity, water and air quality, wildlife habitat, groundwater supplies as well as other non-quantitative advantages (Moulton 1991).

Stewardship Incentive Scheme

- Also authorized in the 1990 Farm Bill under the Forestry Title was the Stewardship Incentive Scheme (SIP) to be operated by the USDA Forest Service to improve resource management on private forest lands. Federal funding for SIP in 1992 is $26.7 million with individual state's allocations based on criteria such as area of non-industrial private land and population. Like its predecessor schemes it is also offering cost-share (limited to US$10,000 per year) and technical assistance for tree planting as well as for forestry, recreation, wildlife, aesthetics, soil and water improvement. Tree planting under SIP was not likely to commence until fiscal 1992 (Mangold et al. 1992).

Private Company Assistance

As early as 1939 assistance to smaller private growers was being provided by private companies (e.g., International Paper Company). This, as well as leasing enabled firms to establish or expand log supplies without the expense of timberland purchase. Often, technical assistance was also given by forest industry groups, particularly pulp and paper (USDA 1988). Most firms meet 5% or less of their wood requirements from contracts or assistance programs (Meyer et al. 1986).

Industrial assistance programs in the US South totalled 1.7 million hectares in 1984 (USDA 1988) and average tract size was 196 hectares. This can vary. Cubbage and Skinner (1984) reported that in Georgia tract sizes differed by sector, with the industrial company average being over 1000 hectares, areas receiving consultants advice averaging 175 hectares, and Forestry Commission only 73 hectares.

The types of assistance offered include free seedlings, long term planning, management plan or advice, technical assistance at reduced cost or free with other services provided at cost. In return growers grant companies (e.g., Mead Coated Board) the right of first refusal on log sales or to meet/exceed stumpage prices of any other firms. In 1983 none required exclusive harvest rights in Georgia (Cubbage and Skinner 1985).

Increment contracts are another type of assistance. Developed and mainly used in the US South, by 1980 there was over 200,000 hectares of non-industrial private forest land in Alabama, Louisiana and Florida covered by increment contracts (Zinn & Miller 1984). The owner receives annual or quarterly payments linked to prevailing prices and based on a specified percentage (such as 65% or 75%) of the potential average mean annual increment under management (using criteria such as site index, species composition and stocking). Typically contracts exceed 60 years and are designed to ensure landowners retain tax benefits (Zinn & Miller 1984). However, other types of long-term contracts can be more acceptable to both parties (Meyer et al. 1986).

Under all assistance types, minimum tract size and distance to processing mill restrictions may apply. In Georgia in 1983, Cubbage and Skinner (1985) found the minimum tract size varied from 12 to 40 ha, while maximum distance to the mill ranged from 96km to 416km.

Leasing

As land value is included in company accounts at historical cost values, there is no incentive for forest industries to own land (Welker, pers. comm.) Leasing of private land by forest industry firms began in the 1940's and 1950's. Nearly 2 million hectares in the US South was covered by leases in 1982 and average tract size was 840 hectares (Cubbage and Skinner 1985). Under most leases taxation is a major concern of landowners (Meyer et al. 1986).

Results of Studies into Assistance Measures

Awareness of cost sharing programs by landowners in the US South has increased the likelihood of reforestation after harvesting by 19% (Royer and Moulton 1987). De Steiger (1984) in modelling non-industrial private grower behaviour showed that the ACP and FIP cost sharing programs induced additional investment rather than replacing private capital into afforestation. Forestry assistance schemes and research and development may also be a factor in reducing the productivity differential as measured from 1974 and 1984 between non-industrial private forestry relative to forest industry and the forest service (Wallace and Newman 1986). Nevertheless economic analysts have suggested one potential impact of the cost-share arrangements is to decrease future log prices and hence reduce profitability of industrial forest lands. Furthermore, benefactors of growing subsidies and technical forestry assistance in North Carolina tend to be the wealthier landowners, meaning that the assistance measures are not justified on wealth redistributive grounds (Boyd et al. 1988). This is supported by Romm et al. 1987 survey for non-industrial private owners in northern California being full-time residents with high incomes.

**Assumptions - Loblolly Pine**

Details of the loblolly pine regimes selected as indicative of average and high yielding sites for Loblolly Pine in the US South are presented in Table 6.7 below.

**Table 6.7 Regime Details, US South**

| Factor/Regime | | Pulpwood Regime[a] | | Integrated Sawlog /Pulp[b] | |
|---|---|---|---|---|---|
| Site Quality | | Average | High | Average | High |
| Land Purchase | $/ha | $800 | $800 | $800 | $800 |
| Establishment Costs | $/ha | $540 | $540 | $500 | $500 |
| Weeding (Culling) | $/ha | $35 | $35 | $35 | $35 |
| Thinnings | Years | None | None | 15, 25 | 16, 27 |
| Annual Costs / Overheads | $/ha | $16 | $16 | $16 | $16 |
| Yields[c]: | | | | | |
| Large Sawlogs | $m^3$/ha | 0 | 0 | 3 | 94 |
| Chip-N-Saw | $m^3$/ha | 52 | 73 | 161 | 108 |
| Pulpwood | $m^3$/ha | 57 | 66 | 19 | 36 |
| Clearfell Age | Year | 28 | 23 | 35 | 38 |

(a) cutover site.
(b) oldfield site.
(c) Sources: TVA YIELDplus (v2.20), Welker, Gunter, Cubbage and Holtman, pers. comm.
General notes:
Site indexes ranged from 62 to 80 at age 25.
Annual costs exclude roading, firebreaks and prescribed burning.

Discount Rates

Federal US agencies have been required to use a 10% real discount rate since 1969, unless a special rate is set by law (Fortson 1986). In contrast to this the US Forest Service uses a minimum 4%, or in the case of Oregon State Forest Service, 4.5% (Sessions 1991), as an approximation of a risk-free real rate of return expected in the corporate sector. It has been suggested that these low discount rates reflect a desire by foresters to ensure the optimum economic rotation age does not differ significantly from the age of maximum MAI or maximum sustained yield (Fortson 1986).

Trends in Prices and Costs

In real and US dollar terms softwood and hardwood sawlogs fell nearly 2% per annum from 1975 to 1985 while softwood pulpwood increased 0.4% per year (see Table 6.8). For the 1984 to 2030 period, USDA Forest Service (1988) is expecting a turnaround in these price trends in the US South due to future supply problems, with nearly 2% real growth per annum in sawlog prices and 0.5% for softwood pulpwood.

**Table 6.8 Current and Projected Real[a] Log Price Movements, US South.**

| Product/Year | 1975 - 1985 (% p.a.) | 1984 - 2030 (% p.a.) |
|---|---|---|
| Softwood | | |
| Sawlogs | -1.9 | +2.0 |
| Pulpwood [b] | +0.4 | +1.9 |
| Hardwood | | |
| Sawlogs[b] | -2.4 | +0.5 |

[a] Deflator is the Producer Price Index [b] Average of South Central and Southeast.
p.a. per annum
*Source: USDA (1988)*

While real price increases would be most welcome by the large private growing sector, there are several additional factors to take into consideration with these forecasts.

- Rising real prices will only exist while industry can process the logs profitably.

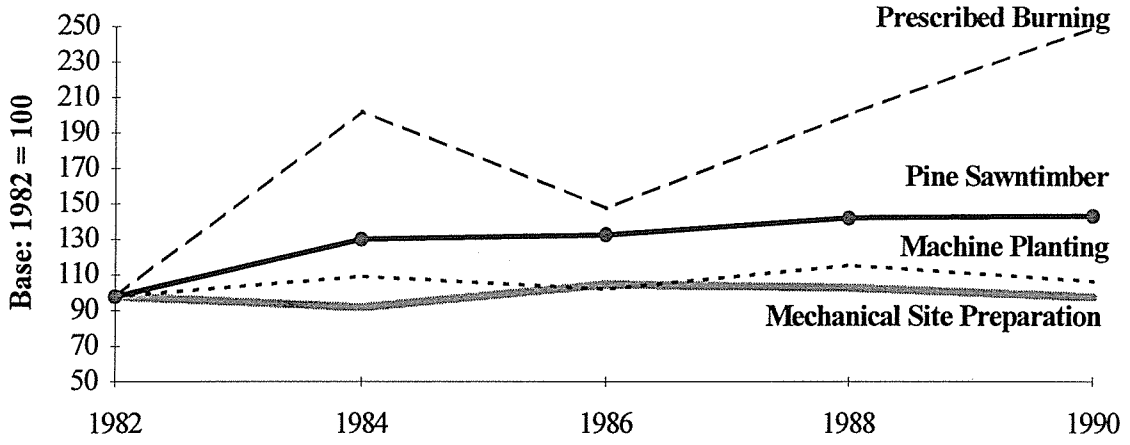
- The imbalance in negotiating power between the diverse smaller-sized growers compared to the large concentrated producers creates a buyers market for pulpwood putting downward pressure on pulpwood prices.

- Pulpwood and sawlog prices in the US South should move in tandem. When sawmills lower their intake, loggers switch from harvesting sawlogs to pulplogs, lowering potential pulplog prices.

- Substitutes and increased recycling will provide a ceiling to the extent of price increases.

Nevertheless some firms and advisors suggest using 1 to 1.5% growth in sawlog prices in financial and economic analyses.

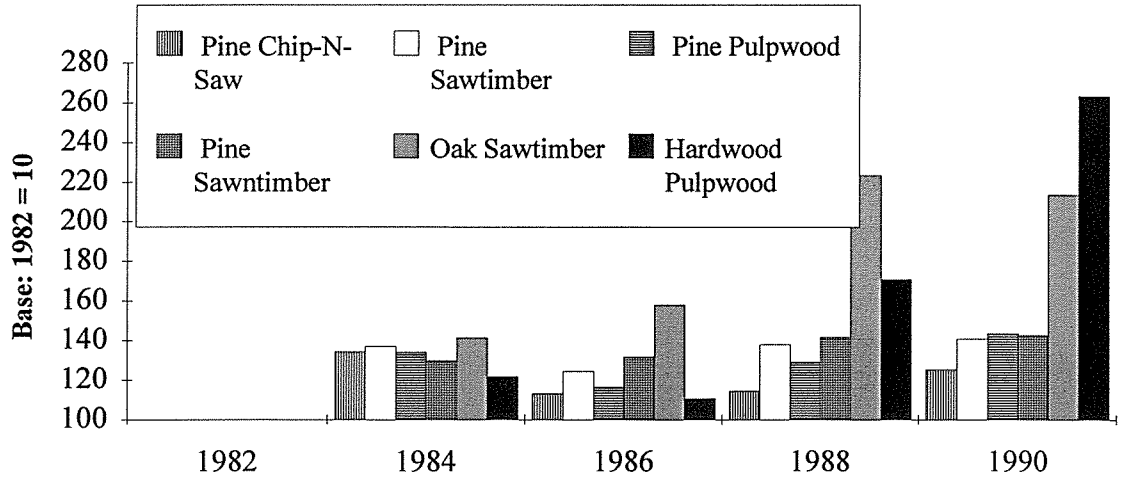
**Figure 6.4** **Indexes of US South Forestry Costs and Price ($A)**




*Source: Dubois et al. (1991)*

Trends in real costs of forestry practices in the South from 1982 have varied, with mechanical site preparation and machine planting declining while control burning, chemical culling and hand planting increasing see Figure 6.4. Hardwood logs have experienced substantial growth while Southern pine logs and Southern pine sawntimber have only maintained 1984 levels, based in $A terms (see Figure 6.5).

**Figure 6.5** **Indexes of US South Log and Product Prices ($A)**




*Source: Dubois et al. (1991)*

Pine harvesting and hauling including profit margins in the US South is estimated to cost $18, $14 and $13 per $m^3$ for pulpwood, Chip-N-Saw (smaller diameter sawlogs) and large sawlog respectively (Norris, 1991). The trend is toward the use of long length harvesting systems. Research by Cubbage and Carter (1991) determined substantial increases in productivity and reduced costs between 1979 and 1987 for long length harvesting but not for short length systems. Expectations are for a real 0.7% annual increase in costs to the year 2040 as stand diameters reduce over time (Haynes 1990).

An examination of delivered pulpwood prices in nominal $A for various years between 1982 to 1991 (see Table 6.9) shows that both hardwood and softwood pulpwood including woodchips have risen by 4% to 5% annually. In US$ terms, the growth was slower.

**Table 6.9 Delivered Pulpwood Prices, Southeast USA.**

| Year | 1982 | 1983 | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|---|
| Woodchips (A$/green tonne) | 24.9 | 29.9 | 36.7 | 33.3 | 35.7 | 34.7 | 36.0 |
| Softwood | 16.9 | 16.8 | 19.4 | 20.2 | 19.9 | 21.7 | 23.3 |
| Hardwood | | | | | | | |
| Pulpwood (A$ per $m^3$) | 13.0 | 16.4 | 20.4 | 18.4 | 20.4 | 17.8 | 18.8 |
| Softwood | 9.5 | 9.5 | 10.2 | 10.3 | 11.0 | 10.6 | 11.3 |
| Hardwood | | | | | | | |

Conversion factors: 1 green ton = 0.9 tonnes, 1 standard cord = 0.276 $m^3$

*Source: Howell (1991).*

A selection of export prices by country of destination for woodchips, including softwood woodchips to Australia, and softwood log from the US South is presented in Table 6.10.

**Table 6.10 Export Prices for Log and Woodchips, US South[a]**

| Product/Destination | Price ($/$m^3$) | Product /Destination | Price ($/$m^3$) |
|---|---|---|---|
| Softwood Woodchip | | Southern Pine Logs | |
| • Mexico | 63 | • Turkey | 95 |
| • Taiwan | 78 | • Egypt | 168 |
| • Australia | 66 | • Japan | 136 |
| Hardwood Woodchip | | | |
| • Japan | 111 | | |

a Prices for January - March 1991 and free alongside ship.

*Source: (Norris 1991)*

**Results**

The results for the base case for the pulpwood and the integrated sawlog and pulpwood regimes are presented in Table 6.11 below.

**Table 6.11. Financial Results for Typical Plantation Regimes - US South, Base Case**

| Regime/Site Quality | Discount Rate | Pulpwood Regime | | Integrated sawlog/pulp | |
|---|---|---|---|---|---|
| | | Average | High | Average | High |
| Internal Rate of Return | na | 3.4% | 5.2% | 5.5% | 6.5% |
| Net Present Value-$/ha | 4% | -$230 | $490 | $880 | $1450 |
| | 7% | -$960 | -$520 | -$510 | -$160 |
| | 10% | -$1250 | -$1030 | -$1040 | -$840 |

na: Not applicable

Based on the cost and yield assumptions presented earlier and given the average real long-term rates of return in the US, the Internal Rates of Return and the Net Present Values for all bar the average pulp only regime would be acceptable.

The results are lower than those determined by Cubbage et al.(1991 Holley (1985) and Franklin (1989) which ranged between 6 - 11% and 5 - 10% (Gunter pers. comm.). However these analyses excluded land purchase and sometimes incorporated real increases in log prices.

Low profitability for pulpwood regimes is partially explained by the low pulpwood prices arising from the dominant negotiating position of the corporate pulp and paper producers over the dispersed, smaller private growers.

A sensitivity analysis varying land purchase costs, site establishment costs, annual charges and yields by ± 25% was completed. The greatest sensitivity was to yields, changing Internal Rates of Return by nearly +1% or -2.3%. In the advantageous/disadvantageous scenario with all factors altered 25% to simulate more extreme risk, results varied between +1.8% to -3.0%.

**Taxation**

Special tax laws are widely used to encourage private afforestation (Meeks, 1982).

State or Local Government Taxes

State or local government taxes are mainly property based. Traditionally they were ad valorem taxes, where a rate per dollar value of the forest plus land was struck on the (real) property's fair market value in its highest and best use. Increasing taxes reduces both profitability and areas under commercial forestry as economically marginal investments fail. Earlier this century, local municipalities keen to maintain funding from declining local forest resources, constantly raised taxes on forest properties (Newman 1988). These could be sold to raise unpaid taxes and ownership of any unsold forests, possibly where unpaid taxes were too high compared to the current sales values, reverted to the government. Many holdings of State Forests in the US started this way in the 1930's (Leuschner 1984). In the Lake States, private owners often responded to high taxes by clear-felling the forests then letting them become "tax delinquent". These lands then formed the "new public domain" (Gregory 1972).

Unmodified property taxation is still considered a deterrent to proper forest management (Kronrad and Morzuch, 1985). Other deficiencies include:

(1) annual tax payments on the increase in unrealised value when the income is only realised on harvest; a situation rare in other land based or tax paying sectors,
(2) being a non-neutral tax because it encouraged shorter rotations (Hickman 1982),
(3) inaccuracy of forest land assessments in the absence of multiple sales in a region,
(4) and failing to relate to afforestation income producing potential.

As a result, a plethora of special tax policies have been introduced including:-

(1) Exemption Laws; permanently or temporarily de-listing forest land and/or growing timber from property tax registers.
(2) Yield Tax Laws: deferral of the annual ad valorem standing timber taxes until harvest while the land tax continues to be paid annually.
(3) Modified Assessment laws: application of a differential valuation category (i.e., current use rather than fair market value in highest and best use) or differential rates from other forms of taxable property.
(4) Severance Tax laws: Usually levied in addition to ad valorem property taxes, either as a fixed amount per unit harvested/manufactured or as a percentage of it.

The main aims of these special tax arrangements are to

(1) redress the inequity between forestry and shorter term investment options thereby attract additional finance capital and land to afforestation, and
(2) compensate private forest owners for the maintenance of any non-commercial forest values of benefit to society generally.

Yield Taxes

This is essentially a harvest tax. In 1986, 24 States levied yield taxes in addition to property tax or as an alternative revenue source. Those states collecting the greatest tax revenues included Washington, Oregon and California. Property enrolment or classification in a yield tax arrangement usually exempts the standing timber from annual taxation. Classification criteria vary: some states require minimum (at least 12 hectares) or maximum areas (e.g., ranging from 100 to 5000 hectares, or minimum stocking levels are set or other management practices prescribed (Clements et al. 1986). Examples of some special yield tax rates are:

- For standing timber over 10 years old:
  - annual tax of 1% or less of the log value as at time of classification, and
  - yield tax on log value commencing @ 2% and increasing 1% every decade to a maximum of 7% - Connecticut,
- For pulpwood 5% and all other products 2.25% tax on current average log values - Louisiana,
- For unmerchantable timber a 10% tax. For merchantable timber, 40% of log value if harvested that year, reducing 2% per year to a minimum of 10% - Minnesota, (Clements et al., 1986).
- Tax rate of 8% of total harvested revenue if forest land is under a planned forest management program, exceeds 25 contiguous hectares and under US$10 per hectare in a special modified assessment - Massachusetts, (Kronrad and Morzuch, 1985).

Despite these special tax concessions many small forest landowners fail to elect for the optional yield tax deferral arrangements because:-

- fear of its effect of property title and future liquidity,
- dislike of management or use restrictions e.g., permitting open access for hunting,
- or being unaware of the deferral arrangements (Haynes 1990).

Severance Taxes

This is the second type of harvest tax. Rather than an income related tax it is considered a "privilege tax", originally introduced to compensate society for the exploitation of a natural resource and discourage wasteful practices (Hickman 1989). Though it is similar to a yield tax but is usually levied in addition to ad valorem property taxes. In 1989 it applied in 12 states (Hickman, 1989) either as a fixed amount per unit harvested or manufactured (e.g., in Alabama, Arkansas, Mississippi, North and South Carolinas, Oregon and Virginia) ranging from ½ cent per railroad tie to 95 cents per $m^3$ (Clements et al. 1986), or as a percentage of harvested or manufactured value (e.g., in Arizona - 1.5%, Illinois - 4%, New Mexico - 0.125% and West Virginia - 2.5%). Some exemptions apply e.g., Oregon exempts the first 10,600 $m^3$ harvested.

Most tax statutes specify some proportion of tax revenues to be reinvested in forestry. In Illinois, North and South Carolina tax funding is applied to forestry cost-sharing programs for non-industrial private forestry. Alternatively, forest protection is funded in Alabama, Arkansas and Virginia, or fire control and forestry research in Oregon (Clements et al. 1986).

Modified Assessment Taxes

Most landowners have placed their forest land under special modified assessment regimes. These appear to offer more forestry management incentive than optional yield taxes (Haynes 1990). Most commonly there is a change in valuation base from fair market valuation (FMV) in highest and best use to a current use valuation. By 1982 this regime applied in at least 23 states (Meeks 1982). More specifically Alabama, Arkansas, Florida, Louisiana, Mississippi, North and South Carolina, Oklahoma, Tennessee, Texas and Virginia were employing it in 1989 (Hickman, 1989), though eligibility restrictions varied. Value is assessed by capitalisation of the average annual net income per unit area for lands of differing productivity. Oklahoma and Tennessee also consider data from forest land sales transactions.

Georgia uses the FMV as its base reducing this to 40% should the property (of under 5,000 ha) be placed into a 10 year covenant as a conservation use property or alternatively 30% valuation if the land is classified for agricultural preferential treatment (Dangerfield et al. 1992). Massachusetts applies the local tax rate for commercial property to the greater of 5% FMV or $25 per ha (Kronrad 1985).

It has been argued that the taxation concessions from reduced value assessments will be capitalised into higher land values and unfairly increase the tax burden of ineligible property owners as local municipalities strive to maintain their funding base (Gayer et al. 1987).

Exemptions

Exemptions from property taxation of growing timber or forest land are provided in Delaware and Rhode Island and at least five of the southern United States - Alabama, Louisiana, Mississippi, North Carolina and Tennessee. In most cases there is a permanent exemption for the value of standing timber (Hickman 1989 and Meeks 1982).

Impact of the Property Taxation Arrangements

The impact of different property taxation arrangements in the US on private forestry management has been a matter for discussion for sometime (Amacher et al. 1991). The financial impact will be determined by whether or not any tax change is passed on in terms of higher log prices, lower land values or lower discount rates for evaluating investments or any combination of the above. Given the degree of competition in wood production globally Klemperer (1977) considered that property taxes are more likely to lower forest land values and are therefore biased against capital intensive land uses. In terms of direct forest management, Newman (1988) considers that Government property or standing timber taxation reduces the rotation length and volume per hectare from its optimum and yield and severance taxes increase rotation length and volume per hectare from the optimum. All the taxes reduce total volume.

As standing timber is currently exempt from property taxation in Australia and New Zealand it would appear that these countries would enjoy a slight advantage. However this conclusion cannot be drawn until a more detailed analysis is undertaken which takes into account the actual tax rates, land values etc., and the benefit derived by non-industrial private forestry from forestry programs funded from specific taxes.

Federal Taxation

Forest-Related Activities

Before 1988, the US Internal Revenue Code allowed income and sales from forest growing to be treated as capital gains. Corporations were only liable for a 28% marginal tax rate as opposed to 46% for ordinary income. Only 40% of individual's capital gain was classified as taxable income. All reforestation costs were capitalised and carried forward (no inflation indexing) to be deducted from any forestry income, before the introduction of Public Law 96-451 in 1980 (FICTVT).

This legislation provides a 10% reforestation credit and a seven year depreciation schedule for a maximum of $10,000 capitalised reforestation costs. This financial ceiling effectively limits the incentive to smaller growers. Costs that are likely to be capitalised and eligible expenditure for the tax credit or alternatively carried forward to the next harvest, include site preparation, planting, labour, equipment leasing and vegetation control. Annual tending, administration and property taxes are more often deducted annually.

Quarantining of forestry income and the acceptance of negative gearing since the 1988 amendments depend on the taxpayer's status:

(1) Active trade or business - costs are not quarantined to forestry income if owner materially participates in the business.
(2) Investment - negative gearing of interest charges disallowed though property taxes are fully deductible and management costs are deductible if, when aggregated with certain other miscellaneous items, they exceed a particular limit.
(3) Passive - Quarantining of costs to forestry income and negative gearing disallowed. Net losses can be carried forward to offset future gains (Cubbage et al. 1991).

In measuring net gains or losses, the cost-basis of timber is identified. Original proportions of the property component costs of bare land, standing timber and other improvements are applied to the original purchase cost of any combined property and used as the cost basis. If half the current crop is then harvested, the taxpayer can recover half of the accumulated (but not previously claimed) standing timber costs including the estimated cost-basis for standing timber (McEvoy 1988).

A certain amount of administration costs are required to be capitalised and added to inventory unless the corporation has itself grown or harvested the trees (Edgar et al. 1992).

Forest-related Taxation Impacts

Guertin and Rideout (1987) found that the taxation changes between 1986 and 1988 applied to some representative Southern Loblolly Pine (25 year site-indexes of 50, 60 and 70) and Pacific North West Douglas Fir plantations (50 year site-indexes of 80, 110 and 140) made marginal site qualities less economic but did not give cause for appreciable differences in rotation length or plantation density. One of the main reasons for this was the use of log prices that reflected log diameter. Furthermore, changes in the slope of the price gradient have more impact on silvicultural management decisions than changes in taxation arrangements.

Using regression analysis, Royer and Moulton (1987) found that in the US South, the effects of the two programs (reforestation tax incentives and cost-sharing arrangements (see previous section were additive in encouraging landowners to reforest. Those familiar with both incentives were 38% more likely to reinvest in forestry.

General Applications

Income Taxes

Corporations with income exceeding $134,000 are taxed at the marginal rate of 34% without inflation adjustments. Individual taxpayers' marginal rates of tax are 15% or 28% depending on the level of income which is indexed for inflation. Spreading the receipt of forest-related income over a number of years is also possible.

Individual states can levy income or capital based taxes with rates ranging from 1 to 12%. Normally these are income based and allocated to a state via a combination of tangible assets, sales & other receipts, and payroll. Other state taxes include property taxes (as discussed previously), franchise, sales and use taxes; and taxes on corporation capital. State taxes are deductible for Federal income tax purposes.

Net operating losses may be carried back for 3 years or if not fully utilised, may be carried forward for 15 years (Price Waterhouse 1991a).

Capital Gains

After 1 July 1987, long term (over 12 months) capital gain tax rate equals the ordinary income tax rate (i.e. 34%). Capital losses exceeding capital gain in a taxable year may be carried back 3 years or carried forward 5 years to offset capital gains.

Depreciation

There are 6 classes of personal property and two of real property with each class assigned a particular depreciation methodology and recovery period. After 1987 most assets have an accelerated basis of depreciation where Diminishing Value of 150% or 200% applies and the taxpayer can switch to Straight-line (Prime Cost) if this gives a greater deduction. Some rates are:

- Sawmilling Machinery, 28% or 40% DV
- Pulping Equipment 28% DV
- Timber processing buildings, 31% PC (Edgar et al. 1992).

Rapid amortization may be allowed for certain pollution control facilities.

Environmental tax

For 1987 to 1995, an environmental tax of 0.12% of the modified alternative minimum taxable income (corporation's regular taxable income modified by special adjustments and "tax preference" items e.g., substantial accelerated depreciation or tax deductions) over $2.7 million applies.

General Tax Incentives

Exports - A portion of export-related foreign sales or commission income of a Foreign Sales Corporation (FSC) is exempt from US tax.

Employment - In some cases, tax credits are available for employing certain classes of workers. This credit is normally the first $8000 of each qualified employee annual wage.

Research and Development - for pre-1992 expenditures, there is a Federal tax credit being 20% of the sum of qualified research expenses over a base amount plus basic research payments. Unused credits can be carried back 3 years or carried forward 15 years (Price Waterhouse 1991a).

**Investment Incentives**

Federal Government

As with many other countries, the US offers a range of incentives to attract investment. While there are no direct cash grants, there are incentives available such as low cost loans, substantial tax relief and training schemes. Regional development is also encouraged through a range of programs. There are 104 Foreign Trade Zones in 42 states where goods are afforded duty free status and cleared for export without formal customs entry.

State Governments

Among the types of assistance in the US South and the Pacific North West States are:

- Property tax relief (e.g., for all property stored in warehouses - Alabama, or for Industrial Development Bonds - Alabama, Florida)
- Industrial site preparation grants (Alabama)
- Financial assistance through Industry Development Bonds (California, Florida, North Carolina, Oregon, and Washington)
- Long-term loans with interest subsidies (Alabama, Georgia)
- Small business administration assistance (Alabama, Florida, South Carolina)
- Small business loan guarantee programs (California, Georgia, and Washington)
- Innovation Bonds (California,
  Foreign Trade Zones (North Carolina)
- An Oregon Economic Growth Plan aiming to ease the transition from dependence on forest products and agriculture towards tourism and high technology industries (Oregon).
  - With job creation afforded high priority, loans to manufacturing, industrial or service businesses (South Carolina).
- Gap financing or working capital accounts through a revolving loan fund program (Florida and Washington) (IBI 1987).

Export Incentives

Wood product exports can be financed by Export Credit Guarantee Programs GSM-102 and GSM-103 through the USDA. Finance is provided at prevailing commercial bank rates and the terms can range from 6 months to 10 years. The generous terms (i.e. extending beyond normal commercial circumstances) of these export credit arrangements may constitute an export subsidy (Rogoway 1987). Total commitments in 1988 and 1989 were $339 million and $369 million respectively (USDA 1989). Tax benefits also available to corporations exporting goods, including logs.

**Post Tax Results**

Taxation reduced the Internal Rates of Return achieved for the loblolly pine plantations in Table 6.11 by up to 1.5% from pre-tax levels. This would be equally acceptable as the pre-tax results because target after-tax rates of return are effectively 1.8% lower using a marginal corporate income tax rate of 34%. Similarly, after tax returns calculated by Cubbage et al. (1991) fell 1.1% from pre-tax returns using individual marginal tax rate of 28%. With cost-share and tax incentives, the results improved above the pre-tax levels by 15%.

**Natural Regeneration**

Due to reduced outlays early in the rotation, it is possible for natural regeneration of loblolly pine to yield better financial returns than intensive management such as those calculated by Holley (1985). Despite being cost efficient there is likely to be greater risk in achieving quality and yields. In fact, the lower wood yields from natural regeneration could swing the balance the other way and lead to returns lower than plantations (e.g., Cubbage et al. 1991 and Holtman 1987).

Natural regeneration of hardwoods as simulated by Franklin 1989 achieved around 6% rate of return while direct seeded establishment achieved just under 4%.

**Other Southern Pines**

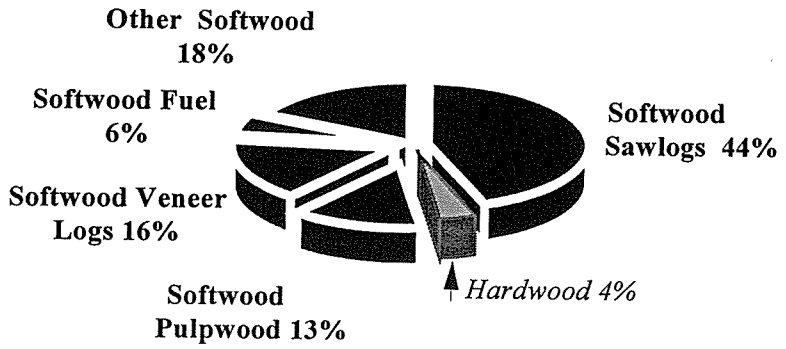
The area of Longleaf Pine *(Pinus palustrius)* has declined from 4.9 hectares to 1.5 million hectares over the last 30 years. The largest owner grouping is "Other Private" (Non-forest industry corporations) who own 55% of the resource, with the public sector being the next biggest owner (Kelly and Bechtold 1990). In simulations by Cubbage and Hodges, 1990 the highest rates of return for longleaf were from an 80 year rotation of natural regeneration giving nearly 7% (with 1% price inflation) compared to 6% for a 50 year plantation.

Slash pine results tested over a variety of site prescriptions and site qualities by Moorhead and Dangerfield (1991) achieved returns of 9.5% to 12.5%.

**Plantation Silviculture - Douglas-fir, Pacific Northwest**

The Pacific North West is the major sawntimber producing region of the US (see Table 6.4) particularly for softwood sawlog removals (see Figure 6.6) which are almost 30% of all US softwood sawlog and 40% of all US softwood veneer log (Waddell et al. 1989). Douglas-fir has been the predominant softwood sawntimber species comprising 86% share of lumber production in the 1930's (Haynes 1986) to 67% in the late 1980's (WWPA 1991).

**Figure 6.6** **Roundwood Removals by Type, Pacific Northwest, 1986**




*Source: Waddell et al. (1991)*

Of the unreserved Douglas-fir forest land of the PNW in 1986, forest industry owned the most productive growing sites, then other public owners e.g., State Forest Services (see Table 6.12) with average mean annual increment being at least 7.9 $m^3$ per hectare. Productivity is expected to increase as lower productive areas are set-aside for wilderness, wildlife habitat (e.g., Spotted Owls), sold to forest industry or converted to agriculture and urban use.

**Table 6.12 Area and Productivity of Forest Land[a], Douglas-fir subregion, PNW, 1986**

| Ownership | Area (million ha) | Productivity [b] ($m^3$/ha/yr.) |
|---|---|---|
| Forest Industry | 1.7 | 7.9 |
| Other Public | 1.4 | 7.6 |
| Farmer and Other Private | 0.8 | 7.4 |
| National Forests | 2.0 | 6.3 |
| Total | 5.8 | 7.2 |

[a] Unreserved
[b] Estimated from minima or midpoints of productivity ranges - may be underestimates.
*Source: Waddell et al. (1989)*

Conifers, like Douglas-fir are the natural climax form of vegetation in the Pacific Northwest. These conifers are intermingled with western hemlock, western red cedar, Sitka Spruce, grand fir and in northern California, coast redwood. Intensive management of coastal Douglas-fir has increased markedly in the last 25 years (Oliver 1986) and at least 100,000 hectares are planted each year (Cafferata, 1986). With this management, the natural mixed species forests will be converted to almost pure Douglas-fir stands.

Regeneration is usually effected by clearcutting then broadcast burning and unless the site is suited to mechanical means, hand planting. State laws mandate replanting after harvest, Washington - within 3 years, Oregon - within 3 to 6 years.

Planting densities vary between 750 to 1350 stems per hectare, commonly 1170. Over time the densities are falling due to improved genetic seed stock or seedlings with better survival rates, and doubts about the viability of commercial thinnings (Cafferata 1986). Eng et al 1990 has found that a low stand density provided best returns for a Southwest Oregon study.

Early in the rotation vegetation control is required to dampen the vigour of other intensely competitive species. In addition, young plantations need protection from browsing animals such as the mountain beaver, deer elk and rabbits. The more densely planted stands may be non-commercially thinned prior to later commercial thinnings. Nitrogenous fertiliser is applied but there is insufficient conclusive evidence to warrant varying the application according to site quality (Holtman, pers comm).

Though second growth Douglas-fir will not produce as much clearwood as the old growth, pruning is not yet common. In the latter ages, plantations become more susceptible to root pathogens and the Douglas-fir Beetle *(Dendroctonus pseudotsugae),* snow and ice damage.

In mixed species plantations Douglas-fir may be at risk from the Asian Gypsy Moth, sighted recently in Oregon and Washington. It is more aggressive and spreads quicker than its European counterpart already well established in the US. Current forest control measures include chemical insecticide use. Long term economic benefits of Asian Gypsy Moth eradication in the PNW have been calculated as US$821 million based on suppression costs avoided or US$3.5 billion of resource losses if no eradication or suppression is undertaken. These estimates exclude impacts on agricultural activities, wildlife habitats etc. (Forest Pest Management Task Force 1988).

Clearfell age depends on the selection of final products required and may be from 40 to 100 years.

**Assumptions - Douglas-fir, Pacific Northwest**

Details of the regimes selected as indicative of Douglas-fir grown in the Pacific Northwest are shown in Table 6.13.

**Table 6.13 Regime Details, - Douglas-fir, Pacific Northwest**

| Factor/Regime | | Pulpwood Regime | | Integrated Sawlog/Pulp | |
|---|---|---|---|---|---|
| Site Quality | | Average | High | Average | High |
| Land Purchase | $/ha | $2400 | $1600 | $2400 | $1600 |
| Establishment Costs | $/ha | $725 | $400 | $725 | $400 |
| Weeding (Culling) | $/ha | $160 | $160 | $160 | $160 |
| Precommercial Thinning | Years | None | None | 15 | 10 |
| Annual Costs/Overheads | $/ha | $16 | $16 | $16 | $16 |
| Yields: | | | | | |
| Large Sawlogs | $m^3$/ha | 0 | 0 | 540 | 540 |
| Pulpwood | $m^3$/ha | 400 | 360 | 60 | |
| Clearfell Age | Year | 40 | 30 | 60 | 50 |

Price Trends

Both softwood sawlog prices and softwood logging and hauling costs declined in real terms from 1976 to 1986 (Haynes 1990). Contributing factors to this decline include a marked reduction in log diameter, lesser quality logs and increased harvesting productivity. [A note of caution: these trends are sensitive to the commencement year. As real prices fell in the early 1980's, a more positive result can be determined starting an analysis period then].

For the period 1986 to 2020, the trends in real softwood sawlog prices and logging (including hauling) costs are expected to reverse markedly. Sawlog prices are set to increase in real terms by nearly 3% annually in response to substantial reductions in log availability. Smaller log diameters could increase harvesting costs by nearly 1% per year. Overall, delivered softwood sawlog to mills is projected to grow 2% real per year in that time period then stabilize (Haynes 1990).

Pulpwood prices in the PNW relate directly to pulp and paper demand but are inversely related to sawmill output levels, and demand from the pulp and paper sector. Accordingly, the forecast reductions in sawlog availability and fairly static level of demand for pulp and paper (see Future Outlook section) suggest that a real increase in pulpwood prices is possible.

**Results**

Presented in Table 6.14 below are the results for the base case of pulpwood and integrated sawlog/pulplog regimes for the Pacific Northwest.

**Table 6.14 Financial Results for Typical Douglas-fir Plantation Regimes - Pacific North West, Base Case**

| Regime/Site Quality | Discount Rate | Pulpwood Regime | | Integrated sawlog/pulp | |
|---|---|---|---|---|---|
| | | Average | High | Average | High |
| Internal Rate of Return | na | 4.3% | 4.3% | 4.3% | 6.0% |
| Net Present Value-$/ha | 4%<br>7%<br>10% | $1140<br>-$2580<br>-$2830 | $190<br>-$1120<br>-$1590 | $610<br>-$2520<br>-$2930 | $3560<br>-$830<br>-$1745 |

na: Not applicable

The high site integrated sawlog/pulplog regime is the only option to have rates of return, given the assumptions used, that exceed the real long-term interest rates in the US. These results are consistent with the findings of a study of more limited scope, by Eng et al. 1992. Certain sites and treatments for Douglas-fir regimes could not return a positive net present value above a 4% discount rate. Expected discount rates for private industry were expected to range between 4 and 6%. Real price increases for logs, as projected in Haynes 1990 could boost the returns from the lower profitable sites and regimes.

Public growers may not obtain the level of commercial returns originally intended at the time of planting. The Bureau of Land Management (BLM) has nearly 940,000 hectares of commercial forest land in the PNW and planted almost 14,000 hectares in 1991 (BLM 1992). Until the passing of the Endangered Species Act and the resulting court injunctions restricting harvesting in potential endangered species habitat, the BLM were intensively managing their harvested areas. Now both new and existing plantations are to lose uniformity of age classes and environmental rather than economic management is their aim (Bayers, pers comm.).

As found in sensitivity analyses presented earlier in the paper, the factor with greatest sensitivity is yield, changing rates of return by nearly ±1%. For the advantageous /disadvantageous scenarios when all factors were varied, returns moved ±1.5%.

**Post-Tax Results**

Post-tax returns were 0.8% lower than pre-tax returns.

**Natural Regeneration**

While early costs of natural regeneration of Douglas-fir are minimal, rotation ages can be longer than plantations, varying from 50 years upwards and log qualities and therefore prices are 25% lower. Yields are 30 - 65% of plantations and are deteriorating in quality with successive rotations due to reduced seed sources.

**Other Species**

Case studies of Californian Redwood assuming 2% real price inflation for the first twenty years and 1% for the remaining half of a forty year rotation gave an internal rate of return of over 8%. Under similar price trends, Ponderosa Pine (*P. Ponderosa*) returned 4.4% (McKillop pers. comm.). Staniford and Ledig (1983) estimated returns for *E. dalrympleana* and *E. viminalis* at 6.2% up to 10%, using a 1.5% real price inflation for logs.

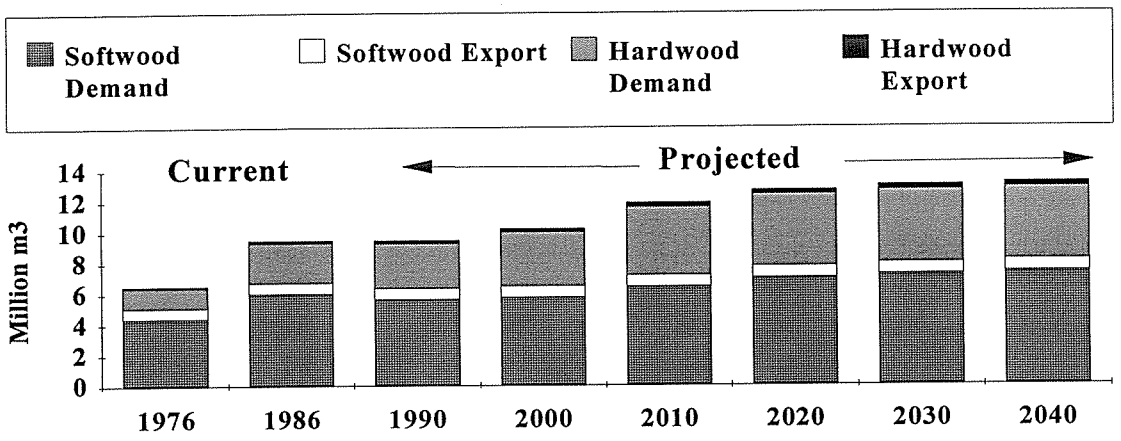
**Future Outlook**

A detailed review of the US forest related industries outlook for 1989 to 2040 was completed as part of the USDA Forest Service requirements under the Forest and Rangeland Renewable Resources Planning Act of 1974 (Haynes 1990). Both long term demand and the supply situations were assessed from their interactions likely price directions developed.

Demand was based on the relevant forecasting variables such as housing, alterations and additions, and manufacturing uses for sawntimber forecasts; population levels, per capita GDP and levels of paper substitutes for paper products. Supply was predicated on such factors as expected public harvest levels, private forest inventory levels, likely changes in forest land area, improvements in harvesting efficiency and log prices. The resultant trends in roundwood demand and exports by species type for the US as a whole are illustrated in Figure 6.7. These show :-

- hardwood demand and exports increasing steadily to the year 2030,
- domestic softwood demand falling from 1986 levels then recovering, and
- softwood exports steady until 2020 then slightly increasing.

**Figure 6.7** **Projected Roundwood Demand and Exports, US**

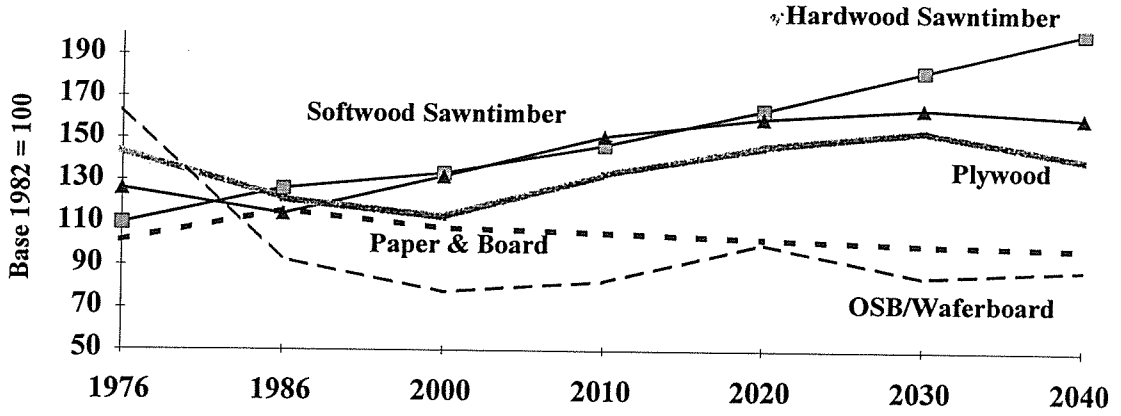



*Source: Haynes (1990)*

Product Prices

Largely due to projected real increases in log prices (discussed previously), product prices are also expected to increase (see Figure 6.8) but be tempered by the availability of imports form Canada, in particular newsprint, pulp and softwood sawntimber. Recovery of the highest grades of Douglas-fir, inland hem-fir and Ponderosa Pine are projected to decline slightly over time (Haynes and Fight, 1992).

**Figure 6.8** **Projected Price Indexes of Selected Products, US**




*Source: Haynes (1990)*

Several researchers have doubted the extent of the shortfall between the projected consumption and domestic production and the resultant real increases in prices arising from the RPA assessment (Sedjo pers comm). Hyde et al. 1991 notes that Clawson observed that past USDA Forest Service projections have all underestimated eventual production levels.

Exports

In the period 1986 to 2040, an increase in lumber, softwood plywood and paper and board exports is projected while pulpwood exports decline (see Table 6.15).

**Table 6.15** **Current and Projected Forest Product Exports, USA**

| Product | Unit | 1970 | 1986 | 2000 | 2020 | 2040 |
|---|---|---|---|---|---|---|
| Softwood sawntimber | million $m^3$ | 2.6 | 4.5 | 5.9 | 6.1 | 6.1 |
| Hardwood sawntimber | million $m^3$ | 0.2 | 1.2 | 1.4 | 1.4 | 1.4 |
| Softwood plywood | million sq. m. | 9.3 | 55.7 | 65.0 | 83.6 | 102.2 |
| Non-structural panels | million sq. m. | 18.6 | 55.7 | 37.2 | 55.7 | 55.7 |
| Paper and board | million tonnes | 3.0 | 4.7 | 5.8 | 6.3 | 6.5 |
| Pulpwood | '000 $m^3$ | 0.9 | 0.9 | 0.8 | 0.7 | 0.7 |

*Source: Haynes 1990*

Pacific Northwest

Given the uncertainty of long-term projections and the possibility of several marked policy and operational shifts impacting on forest management, some alternative scenarios were developed in the RPA assessment. One of these reduced national forest harvests in the Pacific Northwest Douglas-fir region to retain further old-growth habitat for the endangered species, Northern Spotted Owl. A 25% reduction in national forest harvests resulting in higher log prices and increased harvest levels on private lands was assumed. However a 75% reduction from 1986 harvest levels down to 6 million $m^3$ (1.2 billion board feet) is most likely. This level of cutback is equivalent to one third of all 1990 log exports from the Pacific Northwest or their annual rate of lumber exports to Japan during 1987-1990 (WWPA 1991).

The base projections showed declining harvests from 106 million $m^3$ in 1986 to 90 and 80million $m^3$ for the years 2000 and 2010 respectively (Haynes 1990). Immediate implementation of a 6 million $m^3$ limit on wood harvested from National Forests has the effect of bringing forward the low harvest levels of 2010 nearer to the year 2000. Accordingly prices could increase immediately to their projected high levels sooner and stimulate additional cutting of private supplies. This is only possible if private supplies are available and merchantable - even then these may not be a large enough to offset the National Forests decline as environmental restrictions are increasingly being applied to private lands. Another effect of this type of restriction is the earlier than planned harvesting of private supplies in order that they not be considered either old-growth and/or potential habitat for endangered species. During periods of constrained supplies, interregional transfers of product capacity occur from the US South to the PNW due to processing costs increasing relative to the US South.

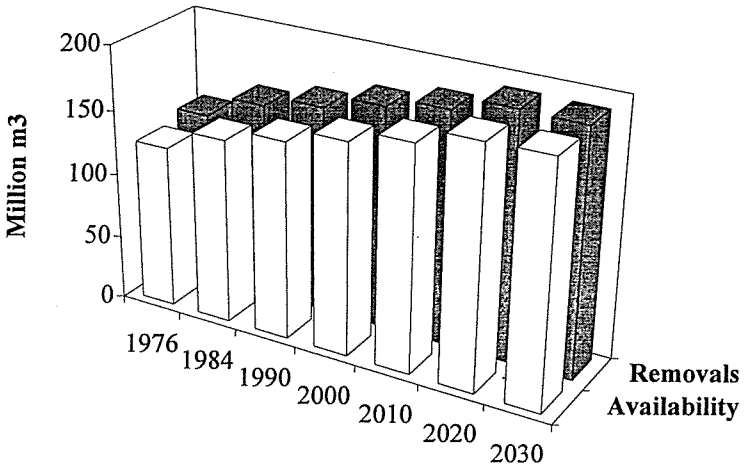
As second growth matures, Pacific Northwest supplies are projected to increase, commencing 2030 (Haynes 1990).

US South

Previously labelled the "Wood basket for the world", future harvests from the US South now exceed growth. A combination of industry expansion, land use changes away from forestry, increased tree mortality, inadequate regeneration measures and slower than expected tree growth are considered the contributing factors to the decline. Shifting age class structures and therefore differing levels of aggregate periodic annual increment is the explanation offered by Adams and Haynes (1991). In addition, Binkley (pers comm.) considers the old inventory method based on 2" radial tree growth measurements may have led to overestimates of log supply forecasts prior to the Fourth Forest Study (USDA 1988).

In the base case of this study, softwood projections show the trend of removals exceeding supplies continuing to 2030 (see. Figure 6.9). Hardwood and softwood sawntimber are expected to experience the highest rates of growth from 1984 to 2030, 1.8% and 1.4% annually respectively. Pulpwood, both hardwood and softwood and plywood are expected to increase only slowly at 0.3% per year between 1984 and 2030 (USDA 1988). Included in the projections are assumptions of Canadian imports declining to the year 2030 and the US South processing capacity increasing with the rise in aggregate US demand.

**Figure 6.9** **Log Availability and Removals Trends, US South**




*Source: USDA (1988)*

# CHAPTER 7 - BRITISH COLUMBIA, CANADA

Canada has 10% of the world's forests. Commercial forests (forest land capable of producing merchantable species of wood as well as a variety of non-wood benefits) cover 237 million hectares or 26% of Canada's land area. Heritage forests (excluded from harvesting by legislation) cover 26.7 million hectares and conservation forests (protected from harvesting by policy) cover 24 million hectares. In the spirit of the Brundtland Commission Report all levels of government have resolved to commit 12% of Canada's natural areas in parks and reserves and British Columbia is to double its designated protected areas before the year 2000. Currently parks and reserves comprise 6.6% of the area of British Columbia and commercial forests cover 49 million hectares or 53% of the land. Over ½ million hectares of forests are considered non-satisfactorily restocked, commonly called "NSR lands". Through special programs the B.C. Government plans to correct this by the year 2000.

Not too dissimilar to the adoption of the National Forests Policy Strategy in Australia, Canadian governments and forest industry have signed a National Forests Strategy and a Forest Accord. This national forest vision aims to implement sustainable development policies and programs over the next quinquennium.

The value of the B.C. forest asset has been variously estimated (FRC 1991);

- $1.3 billion using current government royalty rates and an industry return on equity or
- $5 - $10 billion using imperfect market mechanisms to assess log value.

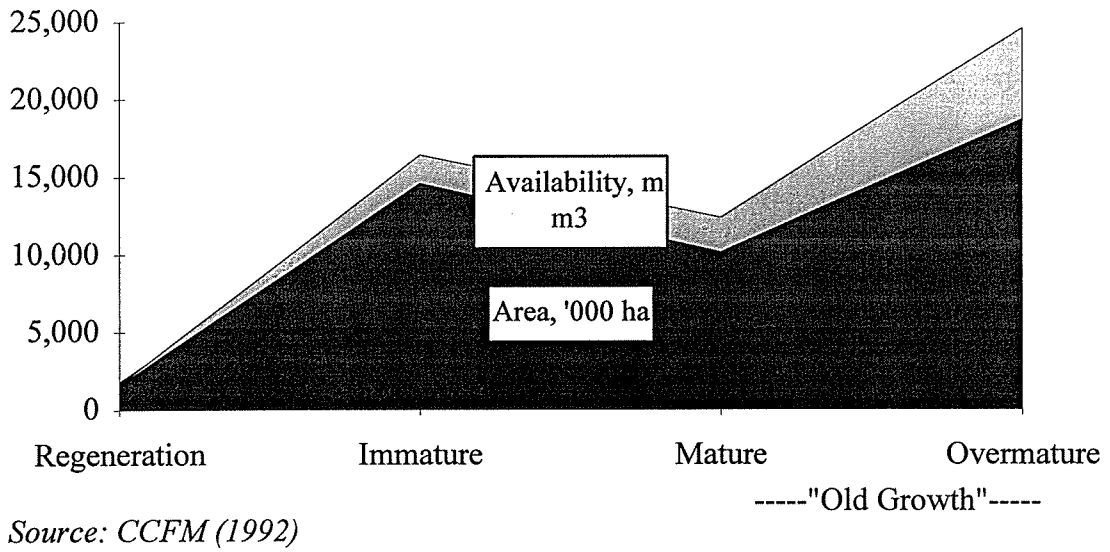
Reflecting a strong ethos towards Government ownership of land, 90% of the Canadian commercial forests and 96% of those in British Columbia (B.C.) are owned by governments, mainly the provincial (state) governments. In BC private non-industrial ownership and nearly 21,000 woodlot owners account for most of the remainder - about 2 million hectares (CCFM 1992). MacMillan Bloedel privately owns at least 200,000 hectares of forest land made possible through an ancestral family being given a land grant of approximately 30 kilometres each side of a railway line they were building on Vancouver Island (Binkley pers comm).

Forest areas planted, rather than naturally regenerated in B.C. have steadily increased from 63,000 hectares in 1975 to almost 200,000 hectares in 1991. This is almost 45% of all planted areas in Canada (CCFM 1992). The Spruce-Pine-Firs (S-P-F) species group including Western White Spruce (*Picea glauca*), Engelmann Spruce (*Picea Engelmannii*), Lodgepole Pine (*Pinus contorta*), and Alpine Fir (*Abies lasiocarpa*) dominated the planting - 81% then Douglas-fir - 8% (CCFM 1992).

Ages, areas and availability of wood in the commercial forests of British Columbia are concentrated in the mature and overmature stands (old growth) as illustrated in Figure 7.1. Stocked with 8.1 billion $m^3$ of this old-growth, B.C. has over half of the Canadian softwood inventory (CCFM 1992).

Growing on two distinct topographical and climatic land areas, coastal and inland (interior), the forests of British Columbia have at least twenty-eight commercial species. In addition to the Spruce-Pine-Firs and Douglas-fir, these commercial species include Western Hemlock (*Tsuga heterophylla*), Sitka Spruce (*Picea sitchensis*), Western Red Cedar (*Thuja plicata*), Yellow Cedar (*Chamaecyparis nootkatensis*) with the main hardwood types being Aspen/Poplar.

**Figure 7.1 Area and Availability by Maturity Class, British Columbia, 1991**




*Source: CCFM (1992)*

Details of the current gross merchantable availability are provided in Table 7.1. Of nearly 10 million cubic metres available, over 90% is from the softwood species and approximately 90% of all roundwood is sawlog (CCFM 1992).

Log Removals

Log removals steadily increased from 50 million $m^3$ in 1975 to a peak of 91 million $m^3$ in 1988 and have since fallen to 75 million $m^3$. Of this, nine million $m^3$ are from private lands (Ministry of Forestry, B.C. 1991b). By region, nearly two thirds of the log harvested is from the BC Interior, where Spruce-Pine-Fir predominates. Western Hemlock (38%), Western Red Cedar (23%) and Douglas-fir (13%) are the most important in the B.C. Coastal forests.

**Table 7.1 Gross Merchantable Wood Availability - B.C., 1991, (million $m^3$)**

| Softwoods | | Hardwoods | |
|---|---|---|---|
| Spruce-Pine-Fir | 6,027 | Aspen/Poplar | 573 |
| Hemlock | 1,632 | Birch | 60 |
| Douglas-fir | 691 | Maple | 58 |
| Larch | 809 | | |
| Other | 80 | | |
| Total Softwoods | 9,239 | Total hardwoods | 691 |
| Total Softwoods and Hardwoods | | | 9931 |

*Source: CCFM (1992)*

The total volume of public log removals is limited by the Annual Allowable Cut (AAC) which in 1992 was 73 million $m^3$, 70 million $m^3$ being softwoods. Eighty five per cent is allocated to major wood processing companies under long term arrangements.

There are two main types that account for 70% of the 1990-91 harvest, Forest Licences within Timber Supply Areas and Tree Farm Licences (TFL's) (Ministry of Forestry B.C. 1991a). Most of the volume (38.5 million $m^3$ in 1990-91) is cut under Forest Licences that were devised to ensure sufficiently large volumes to support investment in manufacturing. Licence holders are required to manage the resource according to B.C. Forest Service strategic management plans.

AAC's may be revised as a result of a current review of availability in the 36 TFL's. These tend to be longer in duration than the Forest Licences - 25 years, but can be replaced with an "evergreen" licence that resets conditions every ten years. If these revised conditions are not accepted, the licence is only valid for the remaining fifteen years. Companies are allowed sole harvesting rights over a specific area, are not required to operate a processing plant, but need to ensure a certain standard of forest tree renewal.

This is where the forest has reached a "free-growing stage". Should reforestation be inadequate the Forest Service can impose penalties. These can include a reduction in the licence holder's AAC and/or being charged double the cost of any afforestation activities undertaken by the Forest Service to re-establish the forest to the standard envisaged in the preharvest reforestation plan. This plan outlines the silvicultural prescription for the site prior to harvest, is made available for public comment and requires Forest Service approval.

In log removal terms the next largest licence is the Small Business Forest Enterprise Program where wood is sold in either of two ways: competitive tenders or bid proposal sales: the latter are awarded to firms with the best proposals for sawnwood remanufacturing or speciality wood products. The volume cut in 1990-91 was just over 7 million $m^3$. The Forest Service is responsible for reforestation, main road construction and planning and spent $77 million on the Program in 1990-91 (Ministry of Forestry B.C. 1991b).

Pulpwood agreements of up to 25 years are also available. These cover a fixed geographical area and require pulpwood based manufacturing. Wood residues including woodchips and pulplogs are to be purchased from other sources first. If supply is insufficient, the licence holder may harvest sub-standard sawlogs. Undercuts experienced in any one year cannot be brought forward to add to the allowable maximum volume in future years. Harvested areas are to be reforested to a certain standard.

Export of unprocessed wood and residue is restricted under Woodlot licence conditions. Preference is given to applicants whose property and preferably, place of residence are adjacent or close to Crown lands and any Crown land portion is less than 400 hectares. These licences are for fifteen years, replaceable every five years.

Very few restrictions apply to the harvesting and regeneration of Timber Land properties which were mainly Crown lands before being sold to the private sector.

Security of tenure for the major licence holders is no longer sacrosanct. Five per cent of AAC's have been rescinded to provide volume for the Small Business Forest Enterprise Program. Early in 1992, MacMillan Bloedel and Fletcher Challenge each lost 2% and 6% of their total cut in British Columbia at an estimated cost to the Vancouver Island economy of $170million (Anon.1992c). Further reductions in volume are likely as protected areas are doubled by the year 2000. The *Forest Act provides* for compensation to licence holders if more than 5% of the AAC's of most tenures is reduced by land withdrawals for non-wood purposes (B.C. Min. of Forestry, pers. comm.).

**Industry and Trade**

British Columbia is a major producer of softwood sawntimber, pulp and newsprint (see Table 7.2).

**Table 7.2 Forest Product Output, British Columbia, 1990**

| Product | No. Mills | Output |
|---|---|---|
| Softwood Sawntimber | } 289 | 34.0 million $m^3$ |
| Hardwood Sawntimber | } | 4.0 thousand $m^3$ |
| Softwood Plywood | [a]26 | 172.0 million $m^2$ |
| Pulp | 15 | 6.6 million tonnes |
| Newsprint | 5 | 1.7 million tonnes |
| Unbleached Kraft Paper and Linerboard | | 0.5 million tonnes |
| Groundwood Publication Papers | | 0.4 million tonnes |
| Other (including tissues, recycled paper and paperboard & construction grade paperboard) | | 0.3 million tonnes |

[a] On 3/8" basis and includes veneer and hardwood plywood.
*Sources: COFI (1992), Forestry Canada (1992), SSS (1991) and Warren (1992).*

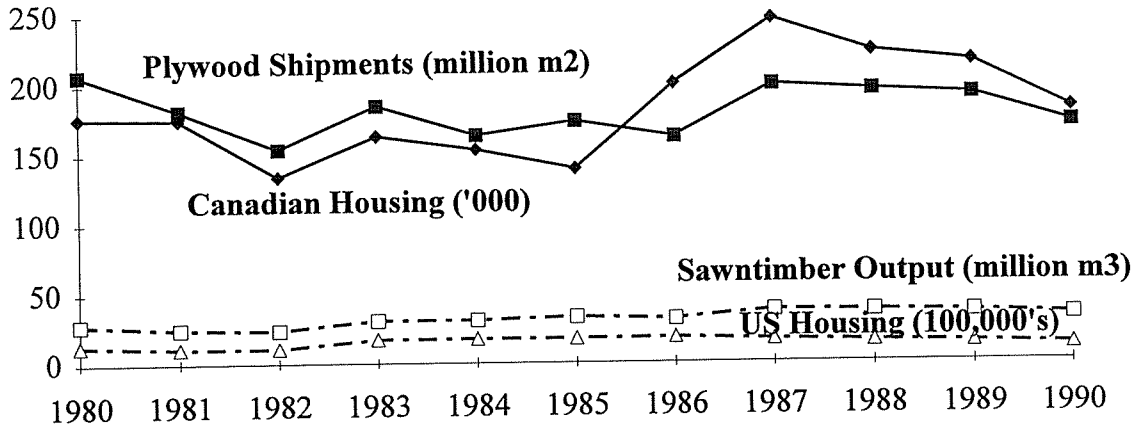
The productive capacity of the B.C. wood processing industry exceeds current harvest levels by about 10% (Reed 1990). Operating capacities and earnings and of the B.C. Forest industries peaked in 1987 at $1.5 billion, but have fallen with losses recorded in 1991 by MacMillan Bloedel Ltd., Noranda Forest, Abitibi-Price Inc., Canfor Corp and Fletcher Challenge Canada Ltd. (COFI 1992 and Anon 1992d).

Wood Products

British Columbia is Canada's largest manufacturer of softwood sawntimber and plywood, producing 61% and 84% respectively of total Canada output of these (COFI 1992) and over half of B.C. sawntimber production is sold to the United States (Forestry Canada 1992).

The fact that demand for Canadian sawntimber is determined by US housing commencements rather than the Canadian housing market (Singh and Nautiyal 1986) is therefore apparent for B.C. resulting in B.C. sawntimber production increasing 1.6% on average per year between 1980 and 1991 (see Figure 7.2). In the mid-80's the B.C. coast had 120 sawmills, some quite large in capacity though most are quite small. Sited near river estuaries to take advantage of water transportation of logs, some sawmills have been modernised and recommissioned on original locations e.g., MacMillan Bloedel's sawmill at Chemainus, Vancouver Island.

**Figure 7.2** **Sawntimber and Plywood : US and Canadian Housing**



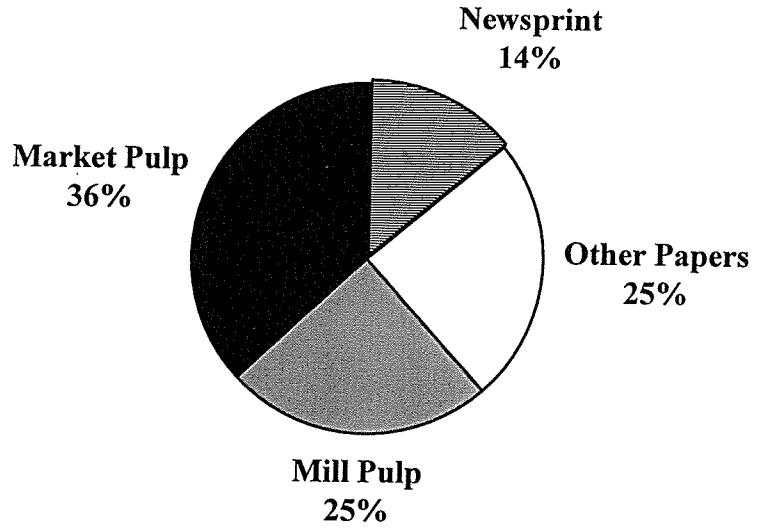

*Source: COFI (1992)*

The production focus of coastal mills is transferring from commodity grade sawnwood for the US markets towards higher value added output for off-shore markets (e.g., Australia) in keeping with the continuing decline in large log availability. In fact, despite using lower proportions of old growth log, B.C. coastal mills have already increased their percentages of higher grade output in recent years (WRA 1988).

There were 229 sawmills in the B.C. Interior in the mid-80's. Several of these are modern, very high volume throughput S-P-F mills making dimension grade sawntimber. With low labour force requirements and streamlined materials handling, manufacturing costs are relatively low in world terms but at the expense of grade and volume recovery.

Most of the structural panel mills in the B.C. are softwood plywood. In the mid 80's there were 17 mills, three particleboard plants and two other panel plants. By 1991 all the B.C.Coast plywood plants had closed, mainly due to lack of resource availability and higher production costs compared to B.C. Interior and to Oriented Strand Board. (WRA 1988) Over the last decade softwood plywood shipments averaged 170 million $m^2$. With more than 80% sold within Canada domestically, there is a strong correlation between shipments and the level of Canadian housing commencements (see Figure 7.2). Production emphasis is now on of unsanded plywood while sanded output is declining.

**Figure 7.3 Pulp and Paper Production British Columbia, 1991**




*Source: COFI (1992)*

Pulp and Paper

B.C. produces 29% and 18% of Canadian output of pulp and paper respectively (COFI 1992). Total capacity of the pulp mills was 7.7million tonnes (Ministry of Forestry, B.C.) indicating that during 1990 pulp mills were operating at an average of 86% of capacity.

Most of the pulp produced in British Columbia is market pulp and the major paper product is newsprint, see Figure 7.3. The United States is one of the main purchasers of both. The main grades of market pulp include bleached softwood Kraft, bleached chemi-thermomechanical (C-CTMP), unbleached TMP, bleached sulphite and unbleached Kraft.

Overall production of B.C. pulp, newsprint and other papers has increased by 1.6% from 1980 to 1990 (COFI 1992). After falling in 1983-84 due to general economic downturn and then recovering, another decline was experienced in 1991-92.

Despite poor profitability the sector spent nearly $0.5billion in 1990 on pollution abatement (COFI 1992). In 1989, Canadian environment regulations were introduced to reduce discharges of chlorinated organics (AOX) to 2.5kg per tonne by 1992. Then in 1992, the B.C. Government tightened these controls to 1.5kg per tonne by the end of 1995 with total elimination by the year 2002 (Anon 1992e).

International Trade

Canada

Canada is the world's largest exporter of softwood sawntimber, chemical pulp and newsprint and accounted for nearly 20% of world exports by value in 1989 (Forestry Canada 1992). Other major exports by value are printing and writing paper, paper and paperboard, particleboard and softwood logs. Imports are only 15% of exports making Canada a net exporting country. The only forest product in which Canada is a net importer is pulpwood, at a net cost of C$36million in 1990 (Forestry Canada 1992). Major imports into Canada are sourced from the United States and include printing and writing paper, paper and paperboard (excluding household and sanitary papers) and hardwood sawntimber.

Under GATT (General Agreement of Trade and Tariffs) and NAFTA (see US Chapter) any existing tariffs on Canadian imports will be reduced or eliminated. In 1987, tariffs on most writing papers ranged from 2.5% to 9.2% (WRA 1988) while the tariff applying to sawnwood varied from zero to 6.8% depending on whether the exporting country received general preferential or most favoured nation status (Canadian High Commission, pers. comm).

Countervailing duties applied by the United States to Canadian softwood sawnwood and EC restrictions on green sawntimber due to pinewood nematode have been addressed in the US chapter.

Exports of pulp, mainly bleached softwood Kraft, to Western Europe, Japan and the US are the second largest export from B.C. Prior to 1985, world pulp prices were denominated in US dollars. EEC then ruled that at least 50% of bleached pulp was to be invoiced in the buyer's currency to protect European pulp producers. In particular this would assist any competitor country with a currency depreciating against the US dollar. However since the ruling, it has been the US and the Canadian dollars that have depreciated against leading currencies, effectively reducing North American pulp prices in world markets, particularly those of western Europe. With the trend towards greater integration of pulp producers with paper and paperboard industry less market pulp and less buyers will exist.

Pulp sales to the US are affected by the increasing competitiveness of new US South producers and also by legislation requiring greater recycled paper content in newsprint in a number of US states (more details provided in Appendix C of (WRA 1988). This legislation acts as a non-tariff barrier and could put B.C. and other Canadian exporters complying with these laws at a cost disadvantage whenever there is a need to import wastepaper.

Newsprint is the third largest B.C. export, mainly to the western pacific states of the US. With increasing royalties, and more stringent pollution abatement requirements and recycled paper content in newsprint legislation in many US states, there may be a need to import wastepaper, putting B.C. at an even bigger cost disadvantage to the US South producers (WRA 1988). As wastepaper may reduce woodchip purchases, this will reduce the economics of sawmilling and or could place quantities of woodchips on the world market.

British Columbia

**Table 7.3 Forest Product Trade by Value, British Columbia, 1990**

| Item | $ million | Main Export Destinations | |
|---|---|---|---|
| **Exports** | | | |
| Softwood Sawntimber | 4,315 | USA, Japan, UK, Other EEC, Other Pacific Rim | |
| Pulp | 3,381 | EEC, USA, Japan, Other Pacific Rim | |
| Newsprint | 1,171 | USA, Pacific Rim (not Japan), United Kingdom | |
| Other Papers | 480 | USA, " " " , EEC (not UK) | |
| Shingles and Shakes | 228 | USA, Other EEC (not UK) | |
| Woodchips | 154 | Japan, USA | |
| Logs and Roundwood | 130 | Japan, USA | |
| Softwood Plywood | 101 | UK, Other EEC | |
| Other Panels | 65 | USA Japan | |
| Misc. Wood Products | 56 | USA, Japan | |
| Hardwood Sawntimber | 5 | USA, Japan | |
| Total Exports | 10,105 | USA, Japan, Other EEC, Other Pacific Rim, UK | |
| **Imports** | $ million | **Imports (continued)** | $ million |
| Softwood Sawntimber | 114 | Pulp (mainly chemical) | 38 |
| Misc. Paper Products | 102 | Paperboard | 34 |
| Misc.Wood Products | 95 | Other Panels | 33 |
| Fine Paper | 50 | Roundwood | 31 |
| Plywood and Veneers | 42 | Hardwood Sawntimber | 22 |
| Total Imports | | | 561 |

*Source: Forestry Canada (1992)*

British Columbia is also a net exporter of forest products exporting over $9.5million in 1990 (see table 7.3) and contributing over half the Canadian exports of softwood sawntimber. Nearly 60% of this is shipped to the US followed by Japan, United Kingdom, other EEC countries and other Pacific Rim countries including Australia. These countries also feature (not necessarily in that order) as important destinations for most other B.C. exports, particularly chemical pulp. Newsprint is the next biggest export.

Major imports into British Columbia include softwood sawntimber, fine papers and softwood plywood. Bans have been placed on ships entering British Columbian ports that were known to have called at Siberian ports at certain times. This was due to an Asian Gypsy Moth infestation in B.C. occurring after visits from USSR grain and coal ships in 1991 and 1992. To eradicate the moth at least $7 million was spent spraying 19,000 hectares near Vancouver. An environmental protest and a lawsuit resulted (Anon. 1992f).

The US is a major trading partner. It has been calculated that a one cent appreciation in the Canadian dollar against the US dollar reduces industry sales by Canadian $100 million (Price Waterhouse 1991c). The same one cent change reduces the after-tax earnings by Canadian C$5million (MacMillan Bloedel Ltd 1992).

Part of B.C.'s competitive success in exporting to the United States may be due to the operation of Section 27 of the Marine Act of 1920 ("Jones Act"). This restricts waterborne shipping between US ports to vessels built and registered in the United States where Canadian cargo can utilise foreign chartered vessels.

In 1990-91 the major species of logs exported from British Columbia were Hemlock, Balsam, Spruce and Douglas-fir and destined for Japan, USA and Korea (B.C. Ministry of Forests, 1991). The quantities however, are considerably less than Pacific Northwest levels partly due to more prohibitive legislation. Since 1906 only logs uneconomic or surplus to domestic processing requirements have been approved for export (Haynes 1990). During recessionary periods these controls have been relaxed and exports grew markedly, from 0.8 million cubic metres in 1981 to 3.4 million cubic metres by 1987 (COFI 1991). There is also a complete ban on the export of Western Red Cedar, Cypress and high grade sawlogs. In 1989 a 100% tax, "a fee-in-lieu-of-manufacture" on the export and domestic selling price differential was introduced to eliminate any financial gain from exporting. This with complicated application procedures, a strengthening Canadian dollar and declining harvest levels have led to the current falling trend in log exports (Gruenfeld and Flynn 1991).

Approval to export woodchips from British Columbia is obtained through a Chip Advisory Board (SSS pers. comm). Exports are required to be excess to domestic requirements and have averaged 1.2 million tonnes annually over the last decade, composed mainly of Spruce-Pine-Fir and sold to Japan and the United States (COFI 1992).

**Economic Indicators**

A range of major economic indicators for Canada is presented in Table 7.4 below.

**Table 7.4 Economic Indicators, Canada**

| Indicator by Financial Year | Real GDP[a] %pa | Can$ per A$ | Long-term Bond Rate %pa | Consumer Price Index %pa | Hourly Wages Index[b] | Rates of Return[c] on assets %pa | Housing Starts No.[d] '000 |
|---|---|---|---|---|---|---|---|
| 1983 | -1.5 | 1.07 | 11.5 | 8.4 | 91 | 1.9 | 163.0 |
| 1984 | 6.1 | 1.36 | 13.7 | 4.9 | 94 | 1.4 | 153.0 |
| 1985 | 5.5 | 0.91 | 10.7 | 3.8 | 98 | 0.0 | 139.1 |
| 1986 | 4.5 | 0.94 | 9.6 | 4.1 | 101 | 5.7 | 199.8 |
| 1987 | 2.5 | 0.96 | 9.8 | 4.3 | 105 | 11.6 | 246.0 |
| 1988 | 5.7 | 0.97 | 10.2 | 4.2 | 108 | 9.2 | 222.6 |
| 1989 | -3.4 | 0.90 | 9.6 | 4.4 | 113 | 6.4 | 215.4 |
| 1990 | 1.1 | 0.92 | 10.8 | 5.1 | 119 | 0.0 | 181.6 |
| 1991 | -2.1 | 0.88 | 10.2 | 5.5 | 126 | -4.2 | 156.2 |

[a] Gross Domestic Product.
[b] Base: 1985 = 100.
[c] For B.C. forest industry. Rates of return on capital employed were 13.9%, 10.9% and 1.7% for 1988, 1989 and 1990 respectively.
[d] Including single, duplex and row and apartments.
pa Per annum.

*Sources: ABS (1992), COFI (1992), EIU (1992), OECD (1992), Price Waterhouse (1991c).*

From 1983 to 1991 real long term interest rates averaged 5.7% and consumer price index inflation centred around 5%. The Federal Government has set a 2% target for inflation and forecasts are for inflation to gradually increase from the 1.5% in 1992 to 2.5% by 1995. A Federal Goods and Services Tax of 7% on personal consumption items was introduced in January 1991. This replaced a Federal sales tax applying to a narrow base of manufacturing items, generally at 13.5% and discriminated against producers in favour of importers.

Growth in economic activity is heavily impacted by economic conditions in the United States and is expected to peak in 1994 at 3.2% then decline in the short term. The slow economic growth of 1991-92 meant lower levels of tax receipts than expected which further exacerbated the already high budget deficits of both the Federal and Provincial governments. Housing commencements are projected to return to their 1989 levels by the late 1990's.

**Silviculture**

Trees harvested on the B.C. Coast region contribute 55% of the B.C. log value, while B.C. Interior provides two thirds of volume (B.C. Min. of Forests 1990 and COFI 1991). This is due to the coast of British Columbia having more valuable standing timber, higher rainfall, a longer growing season and therefore quicker growing species than the B.C. interior. Western Hemlock, Western Red Cedar, True-firs and Douglas-fir are the main commercial species harvested while the Spruce-Pine-Firs predominate in the Interior. Sawlog rotation ages for B.C. coast are only 60 to 70 years while B.C. Interior normally ranges between 70 to 100 years.

The steeper slopes of the B.C. Coast mean that most silvicultural and harvesting operations are more labour intensive than those of the Interior except when using helicopters for harvesting and for herbicide and fertiliser distribution. Prior to establishment, a preharvest reforestation plan outlining the silvicultural prescription for the site has to be made available for public comment and requires Forest Service approval. Often the establishment practices involve prescribed burning especially to stimulate seed production and release for Coastal Douglas-fir. Once this practice occurred on 40% of harvested sites but is now declining in frequency with public concerns over smoke in the atmosphere (B.C. Min. of Forests 1990). Alternatively, some scarifying and mounding is carried out (but more so for Lodgepole pine in the Interior). Easy sites to establish could cost as little as $150 to $200 per hectare while difficult areas could range up to $1000 per hectare. Given the hilly terrain hand planting with 1000 to 1200 seedlings per hectare is common and could cost $600 per hectare (Hedin, pers comm.). Seedling survival rate after two years is approximately 84% (B.C. Min. of Forests 1990).

Pre-commercial thinning ("Juvenile spacing") occurs at ages 10 to 20 years for a cost of $400 to $1000 per hectare (Hedin, pers comm.). Commercial thinnings might occur at ages 30 to 50 years using either horses or machines. It is not common because sufficient pulpwood is being obtained from old-growth harvests in Coastal B.C. and from the use of Chip-N-Saws in the Interior.

Competition control is by either manual, biological (e.g., grazing) or chemical means. Herbicide (and pesticide) use is limited under Federal and Provincial regulations to approved and registered chemicals and to applicators with special permits for each site (B.C. Min. of Forests 1990). Manual brush control is estimated to cost a minimum of $400 per hectare (Kofoed, pers comm.). To remove 50 to 75% of competing vegetation, research trials suggest 40 to 50 sheep per hectare and their regular rotation to new sites (B.C. Min. of Forests 1990).

Losses to Mountain Pine Beetle in B.C. have declined from 300,000 hectares in 1986 to 41,000 hectares in 1990 (Forestry Canada 1992). To contain these major bark beetle outbreaks infected areas are harvested promptly. Dwarf mistletoe slows the growth of Hemlock and is controlled by clearfelling and burning infected trees.

Fertilisation is an option to increase Douglas-fir yield by up to 15% (B.C. Min. of Forests 1990) but is usually only funded by Government. On poor sites however, better economic returns may be obtained from natural regeneration rather than "incremental silviculture" i.e., thinning and fertilisation (Duke et al. 1989). If logging conditions are easy and there are reasonable returns from commercial thinnings, some combination of intensive management e.g., thinnings, either commercial or pre-commercial, and fertilisation may be economic on good or medium sites (Heaps, 1986).

Mean annual increments for a 75 to 80 year rotation on the B.C. Coast can range from 2.5 to 20$m^3$ per year but average 4 to 6$m^3$ per year (Hedin, pers comm.). For the Interior, mean annual increments only average 1.5 to 2 $m^3$ per year (Townsend, pers comm.).

Conventional wisdom ascribes a higher value to old-growth forests. Yet there are instances where the quality of second growth forests can exceed the old-growth resource by providing more sound logs of longer length and being in locations with easier access (Sauder, pers comm.).

The steeper slopes of the B.C. Coastal terrain mean roading can cost up to $200,000 per kilometre compared to $35,000 per kilometre for more level sites in the Interior (Forestry Canada, pers comm.). Under most resource tenure conditions, some roading is paid by the Licensee, some by the Government.

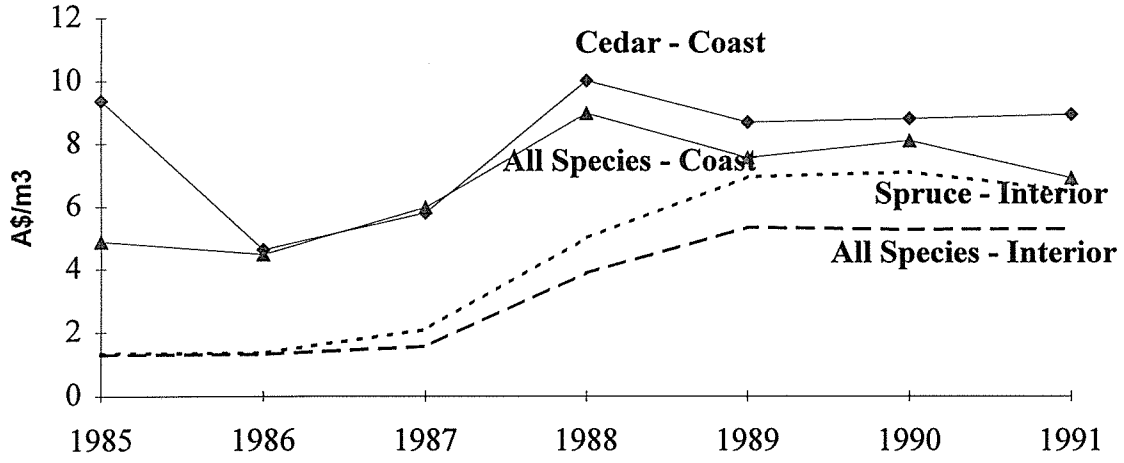
Tree length hauling is the norm for both the Coastal and Interior regions of British Columbia. Off-highway tree length hauling in Coastal B.C. costs about $5.5/$m^3$ for a 45 kilometre distance. Interior B.C. hauling costs about $8.3/$m^3$ for long logs and $9.60/$m^3$ for short logs based on an average distance of 90 kilometres (Clark, pers. comm.).

Logging on the B.C. Coast tends to involve manual felling and grapple or cable yarding using both full phase and company phase contractors. Estimated costs in 1989 and 1990 (excluding stumpages but including reforestation costs) were $57 to $61/$m^3$ respectively. In the Interior, where conditions are such that logging can be more mechanised, the estimated logging costs are approximately C$34/$m^3$ (Price Waterhouse 1991c).

Trends in Prices and Costs

B.C. Province administratively sets a residual stumpage rate that is adjusted to account for specific logging and manufacturing conditions. For coastal harvests the Vancouver (delivered) log market values are used. For various grades of Douglas-fir in 1992 these ranged from $\$24/m^3$ to $\$167/m^3$ (B.C. Min. of Forests, pers comm.). In the Interior sawntimber and sawmill chip prices are used. To reflect movements in the market, the stumpage rate is adjusted quarterly in line with a B.C. softwood lumber index. Trends in average real stumpages in Australian dollars from 1985 to 1990 are presented in Figure 7.4. Contributing to the real increase in this period is the incorporation of the 15% countervailing duty into stumpages and an appreciation of the Canadian dollar. With government deficits increasing, there could be pressure to further administratively increase stumpages.

**Figure 7.4** **Trends in Average Real Stumpages, British Columbia by Region**



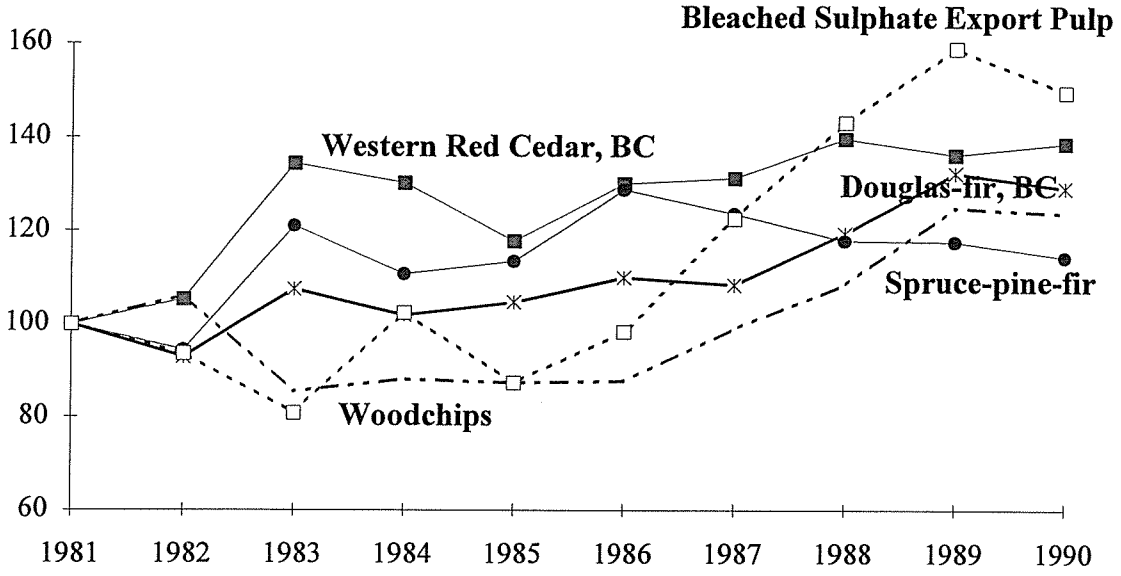

*Source: B.C. Ministry of Forests (1991)*

In the short to medium term real log prices in BC Coast are expected to increase (USDA TAMM output, base-run, spring 1992). This trend will be impacted by the reduction in old-growth availability (see Figure 7.6) which is likely to cause an appreciation of prices by grade, but with average prices declining due to the change in log grade mix. Expectations over the long term are for real log prices to decline. Supply will grow (despite set-asides of forests for environmental considerations) as technology creates wood-based products of similar performance capabilities from progressively lower quality logs of increasing availability (e.g., plantations). When this supply growth exceeds demand, real prices will decline (Scott and Pearse 1989).

Surprisingly, with declining log quality, more difficult access and operating conditions, harvesting costs in North America have remained either constant or slightly decreased over the last forty years (Williams 1991). Technological advances are the most likely determinants and further developments could lead to a continuation of the trend.

Overall, wood raw material costs to industry, taking into account that major licence holders are now responsible for roading and silviculture, are considered amongst the highest in the world (Boyd 1992). As a result, more of B.C. resource is becoming less economically accessible.

**Figure 7.5 Sawntimber, Pulp and Woodchip Price Indexes, Canada**




*Source: Forestry Canada (1992)*

Trends in product price indexes from 1981 to 1990 for various products are shown in Figure 7.5. Western Red Cedar and Douglas-fir sawntimber sold in B.C. have gradually increased relative to the Canadian Spruce-pine-fir.

Discount Rates

A number of long-term discount rates have been used in Canada and the appropriate rate is a matter of continuing debate. Ministry of Forests, B.C. uses a real rate of 4% for financial and economic analyses (Duke et al. 1989). The B.C. Provincial Government has previously applied rates as high as 10% (Pearse et al. 1986).

**Taxation**

During 1989 and 1990 forest industries in British Columbia paid a total of $966 million and $617 million in taxes (excluding stumpages) to all three levels of government, Federal, Provincial and Municipal in Canada. (Price Waterhouse 1991c). Major taxes of importance to forest management included the income taxes of both the Federal and Provincial Governments, property and logging taxes. Trends in their payments by B.C. forest industries are presented in Table 7.5.

**Table 7.5 Selected Payments to Governments by B.C. Forest Companies ($m)**

| Type/Year | 1982 | 1984 | 1986 | 1988 | 1990 |
|---|---|---|---|---|---|
| Federal Income tax | 17 | 20 | 109 | 240 | 14 |
| Provincial Income Tax | 9 | 16 | 73 | 160 | 7 |
| Property Tax | 209 | 175 | 119 | 92 | 133 |
| Logging Tax | 2 | 4 | 9 | 41 | 3 |

*Source: Price Waterhouse (1991c).*

Of these taxes $467 million and $254 million were paid to the Federal Government in 1989 and 1990. In turn the Federal Government provided fund to forestry under a $320 million Federal - B.C. 50/50 cost-share Forest Resource Development Agreement to address major public forestry issues in the 1980's. These included increasing the productivity of selected forest lands, research and development, marketing, technology transfer and training. For 1991 to 1995 the total Federal-B.C. funding is $230million (Canada Forestry and B.C. Min. of Forests, 1991). Programmes focus on sustainable forest development, research, community awareness, opportunity identification, social and economic analyses and small scale forestry. For the latter, $13million is allocated under a Private Woodlands Forestry scheme giving technical advice, incremental silvicultural funding and integrated resource management activities. Operationally, 4,000 hectares are to be planted and 10,000 hectares thinned.

Federal and B.C. Income Taxes

Canadian corporate manufacturing income tax rate was 33% in 1991 reducing by 2% by January 1994, with a 10% abatement for B.C. Province to impose their own corporate income tax. Instead of this 10%, B.C. has a 9% rate for small businesses and 14% for the larger firms. For large corporations a 3% surtax also applies. However, corporations with over Canadian $10 million capital employed also pay a capital tax of 0.175% tax which can be credited against the 3% surtax (Price Waterhouse 1991a).

Income tax consequences of forestry related activities depend on the nature of the taxpayer's interest in the forest property, the extent of other activities and other income sources.

Though treatment of forest management expenses is the same for most taxpayer types the extent of deductibility of losses has varied according to taxpayer activity in forestry business. If forestry is not the prime activity, claiming of forestry losses against other income sources have been restricted. Purchasers of certain standing timber rights prior to May 1974 can depreciate that forest right by 15% annually. Post 1974 acquisitions deduct the purchase unit value attributable to volume harvested until its exhaustion (Boulter 1984).

Since 1972, two thirds of capital gains over historical cost is included as income (Price Waterhouse 1991a). For forests this has been limited to one half of the gain (Boulter 1984).

Most machinery and equipment can be depreciated at 20% per annum diminishing value and buildings at 4% (Price Waterhouse 1991a).

Investment Tax Credits

Various tax incentives such as accelerated depreciation, investment allowances or 3 year tax holidays have been provided by the Federal Government since 1949, often targetted to the slow economic regions. As at 1987 an investment tax credit for a percentage of the cost of certain buildings, machinery and equipment used in manufacturing can be deducted from 75% of Federal income tax. This percentage varies with province and can be 15%, 30% or 45%. Unused amounts can be carried forward for 10 years or back for 3 (Price Waterhouse 1991a).

There is a special investment tax credit of 40% for asset purchases used in expansion or modernisation of existing facilities or establishment of new ones (IBI 1987).

B.C. Property Taxes

Local governments and school districts can levy real property taxes. In B.C., land classified as forest or rural was assessed at 40% of the current actual value (as distinct from its highest use value). The statutory rate of 1% was applicable. Unmanaged forest lands were 3%.

Until 1987 there was a classification "tree farm land" for Taxation Tree Farms that received preferential tax treatment and were only assessed on 80% of the current use value. Owners of these lands were required to practice sustained yield forestry (Boulter 1984). Some of these areas are owned by large forestry corporations (Luckert and Haley 1990).

B.C. Logging profits tax

Logging tax was first introduced to British Columbia in 1953 but its rationale is difficult to comprehend (Boulter 1984). It is currently 10% of logging profits and can be fully abated against Federal income tax by the lesser of two thirds of any logging tax paid to B.C. or 6.3% of logging income from logging in B.C. for a year. B.C. Province also provides an abatement for the tax against its own corporate income tax.

**Incentives**

In addition to the investment tax credits referred to above, the Federal Government has a range of general incentives to encourage regional development. Included are options where:

- up to 37.5% of feasibility study costs and 17 to 25% of market research, modernisation and expansion are met.
- concessional small business loans and bonds are available.
- an Industry Energy Research and Development Programme provides cost-sharing of up to 50% labour, materials and service costs.
- small business assistance includes 30% credit against B.C. income tax or three year interest free loans.
- for investment projects up to Canadian $2million in manufacturing and processing loans of up to 1/3 eligible costs with the first six months interest free and also at half the normal prime rate of interest for 3 years (IBI 1987).

More recently there has been a policy shift by the Canadian Government towards research and development away from encouraging new capacity or purchasing of off-the-shelf technology.

In the past a number of new mills have had their capital debts forgiven (Killan, pers. comm.). It is considered that pulp and paper mills already receive, and are likely to continue receiving financial incentives to build and/or grants to continue operating. As Governments are the major forest owners it pays to keep processing plants operating (Binkley, pers. comm.).

For exporting companies, the Canadian Government has established the Export Development Corporation which provides export insurance, financing arrangements and guarantees to Canadian exporters regardless of size or sales volume.

**Results**

Discussions with major forest corporations and government forest agencies indicate that regrowth forestry from a pure financial consideration is not a viable option.

Current revenues exceed current costs of the major grower, the B.C. Provincial government. However, bare land values for regrowth forestry or Soil Expectation Values using a discount rate of 4% are near zero (Forestry Canada, pers. comm.). Profitability is not there for the private industrial forestry either. Luckert and Haley (1990) attest that stumpage returns compared to the private costs of forest tenure requirements fail to encourage extra silviculture.

In theory it should be worthwhile but not in practice. The major licences of TSA's and TFL's with 25 year licences renewable every 10-15 years, were devised to give the forest companies resource security or guardianship over certain areas and therefore opportunities to harvest regrowth. This should stimulate investment in the intensive management of regrowth/plantations. In reality, the security is not sacrosanct. Already 5% of AAC's have been rescinded from the large licence holders (see Log Removals). Furthermore, conservation pressures signal the possibility of future reductions. Then there is the prospect of stumpages being more costly. Considering the risks and the lack of sufficient "equity" in the resource, there is little financial justification for private expenditure exceeding the minimum necessary to fulfill Licence regulations.

Corporatisation of the commercial resource activities and the formation of a province wide log market as recommended by the FRC (1991) could make more efficient, profitable operations and silvicultural investments more attractive. The report has not been adopted. Other solutions to overcome this and the expected reduction in harvest levels include privatisation, or a land base dedicated to forestry. Boulter (1986) suggests that privatisation resulting in too many small ownerships of native species plantations may be underproductive as per US South. Another opportunity is to capitalise on the two main strengths of Canadian forestry being its extensive land base with a low opportunity cost from few alternative uses i.e., extensive forestry. Labour and capital involved would need to be minimised to ensure low cost but effective natural regeneration and harvesting techniques (Sedjo 1990).

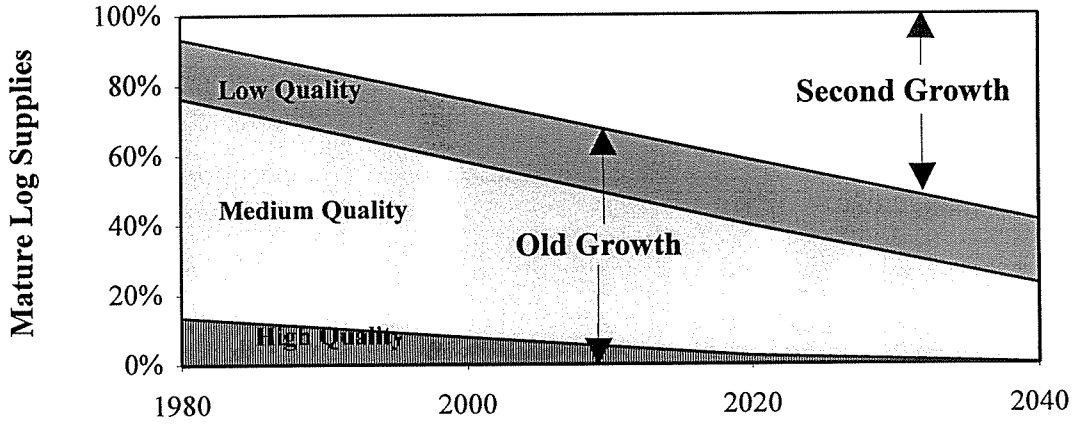
From a social cost-benefit consideration, Government investment in reforestation may be justified (Binkley pers comm.). One analysis of incremental silviculture (investment in stand management beyond basic requirements) for B.C. shows a C$18 million investment could provide a C$64 million net benefit to the Province, 4,100 person-years of employment and a 1.4 million $m^3$ increase in supply (B.C. Min. of Forests 1991c).

**Future Outlook**

The forest industries are in a period of transition from harvesting old-growth to managed regrowth or plantations, as illustrated in Figure 7.6. Concurrently they are also facing a gradual reduction in AAC's (currently at nearly 75 million $m^3$) as the rate of harvest declines to the long run sustained yield (LRSY) levels of nearly 60 million $m^3$ (SSS 1991). This LRSY represents the long term yield capabilities of the operable forest land base, which is an assessment of the possible forest yield from the regrowth/plantations with maximum ages of 70 to 100 years after all the old-growth is harvested. To phase in these lower harvest levels B.C. Province recalculates the required cut every decade. In the past various technological and economic developments e.g., cost of harvesting operations, have resulted in expansions of the possible harvest levels to offset the calculated LRSY declines (Williams 1991).

Adding to this reduction in supply as the LRSY is reached, is the low harvest levels of previous decades - from just over 20 million $m^3$ in 1950, to over 50 million $m^3$ in 1970 rising to 75 million $m^3$ currently (SSS 1991). As a result the areas and most likely the volumes of the newly maturing regrowth will also be commensurably lower than the regrowth from current harvests (Binkley pers comm.). Resource that is economically accessible may also decline if the increase in delivered log costs continues (Boyd 1992).

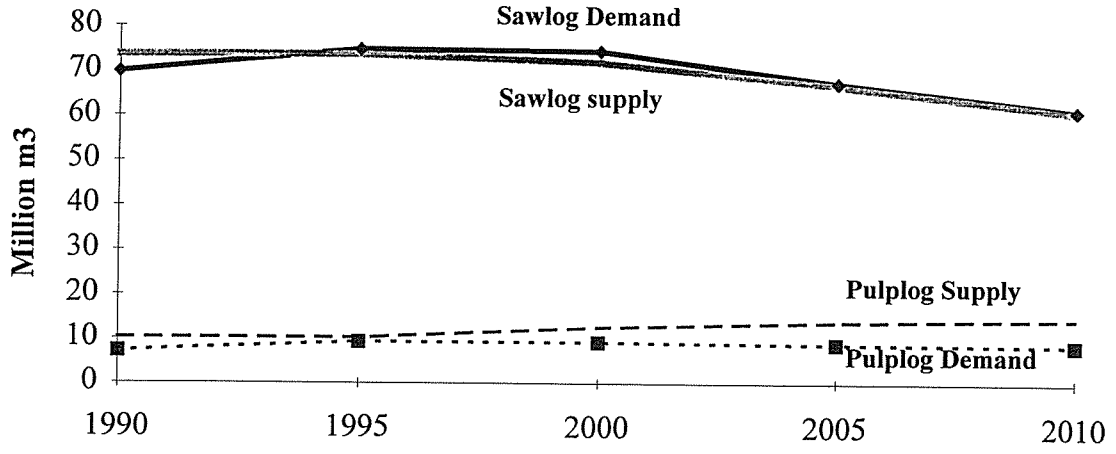
**Figure 7.6** **Long-term Profile of Forest Resources, British Columbia**




*Sources: Simons (1990) and COFI (1992).*

One set of projected demand and supply for logs in British Columbia is illustrated in Figure 7.7. Included in these projections are competitive assessments of the major markets for the forest products and assumptions of a constant LRSY, elimination of all coastal log exports and 15% - 20% of coniferous roundwood being pulped. Softwood sawlog demand for the B.C. Province is expected to exceed supply though regionally this entails a supply shortfall in the Interior and a supply excess on the Coast. However there is likely be a reduction in quality due to the transition from old growth to regrowth. Contrary to the expected sawlog conditions, pulplogs could be in excess supply on balance in the province, with a surplus in the Interior and a shortfall on the Coast (SSS 1991). For hardwoods a roundwood surplus is expected in the province.

**Figure 7.7** **Demand and Supply Outlook, British Columbia**




*Source: SSS (1991)*

# CHAPTER 8 - ECONOMIC COMPARISON

## Wood - Growing Areas

Of the study areas the US South has the largest wood growing area, then British Columbia (See Figure 8.1). It also has by far the greatest plantation base though Chile has the largest area of radiata pine.

**Table 8.1 Wood Growing Areas ('000 hectares)**

| | Plantations | | | Unreserved Forests | |
|---|---|---|---|---|---|
| Location | Coniferous | Broadleaved | Total | Location | Total |
| Australia | 940 | 110 | 1,050 | Chile | 7,600 |
| New Zealand | 1,220 | 20 | 1,240 | Pacific Northwest[b] | 18,300 |
| Chile | 1,360 | 100 | 1,460 | Australia | 34,600 |
| US South | 8,460 | ns | 8,460 | British Columbia | 49,050 |
| | | | | US South | 65,300 |

ns Not stated
a Includes 10.9 million hectares of mixed pine-hardwoods.
b Unreserved forest land, excluding Alaska.
*Sources: ABARE (1992), CCFM (1992), CORFO-INFOR (1991), Cox et al. (1991), and Waddell (1989).*

## Removals

Reflecting its comparatively large size, the US South has the greatest log harvest followed by the Pacific Northwest (see Table 8.2).

**Table 8.2 Log Removals from Selected Countries**

| Country | Million $m^3$ |
|---|---|
| US - South | 246.0 |
| US - Pacific Northwest | 98.4 |
| British Columbia | 73.0 |
| Australia | 16.4 |
| Chile | 14.3 |
| New Zealand | 11.8 |

*Sources: ABARE (1992), CCFM (1992), CORFO-INFOR (1991), Cox et al. (1991), and Waddell (1989).*

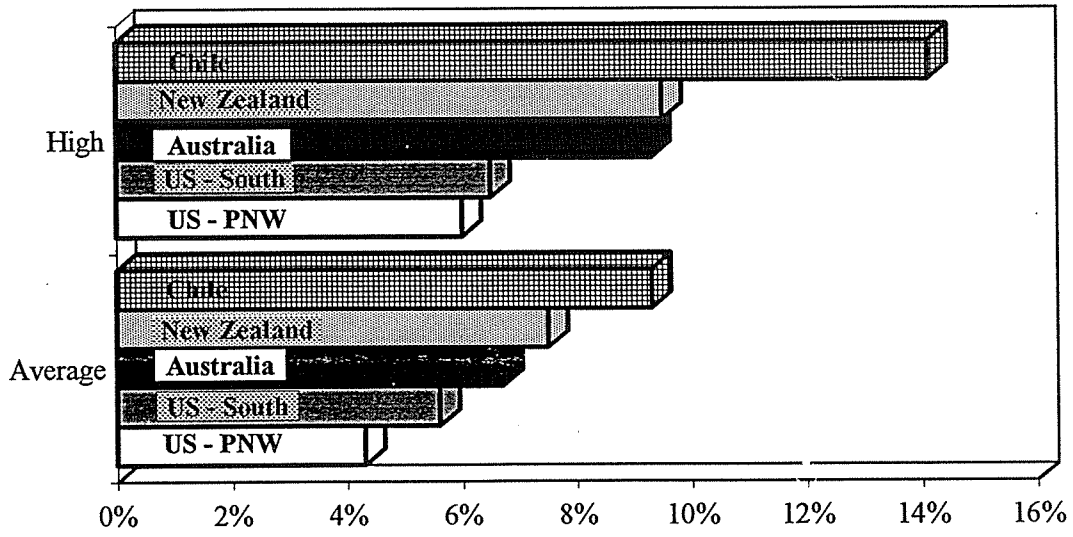
**Productivity**

While the US South may have the largest wood growing base, its annual yield and productivity is lower than that of the other study countries and regions. High yielding sawlog intensive plantations were only one quarter as productive in volume terms as the high yielding intensive plantations in Australia, New Zealand, and Chile. Average site quality plantations were one third to one quarter as productive. The Pacific Northwest ranks between the US South and the others.

**Profitability Comparison**

Using the high and average costs, prices, yields and assumptions for sawlog oriented representative plantation stands as outlined in the previous sections, the highest real internal rate of return before tax results are achieved in Chile. New Zealand and Australia are the next most profitable (see Figure 8.1). A major factor contributing to Chile's success is its DL 701 decree providing subsidies of up to 75% of certain establishment and silvicultural costs.

**Figure 8.1 Profitability Comparison of Selected Sawlog Regimes**




Chile also realizes the best returns for softwood pulpwood regimes compared to the US South and the Pacific Northwest. New Zealand achieved higher returns for average site quality clearwood regimes.

British Columbia is excluded from the result because industry and government representatives confirmed that wood growing in British Columbia was not viable on a purely financial basis.

**Sensitivity Analysis**

Items varied in the sensitivity analysis included land purchase price, establishment cost, annual charges, and revenues and also a disadvantageous/advantageous scenario where relevant factors were varied 25%. Wood growing profitability was most sensitive to changes in revenues (either yields, prices or both), particularly in Chile, the US South and hardwood pulpwood plantations in Australia.

**Increasing Australian Wood Growing Viability**

These sensitivity analysis results suggests that to improve Australia's viability as a wood grower, consideration should be given to increasing plantation productivity and achieving higher prices for wood commensurate with market forces.

To improve yields, greater research into factors that increase crop productivity will assist.

There are several ways in which log prices could be improved. Individual growers combining to form marketing co-operatives to increase their bargaining power *vis a vis* processing firms may improve log prices. In New Zealand growers have benefitted from higher wood prices as log export values increased. Similarly, further easing of log export restrictions in Australia could improve log prices. However, this is of concern to some domestic processing sectors and contradicts a general governmental preference for encouraging exports to be further processed. Ultimately, when supplies of some log types e.g. softwoods, exceed domestic requirements and if optimum future processing options plus wood supply distribution are not jeopardized, this option will be a lesser concern. Business and taxation arrangements that favour greater trading of plantations may also improve plantation values.

As profitability was also sensitive to initial project costs, measures to reduce these should also be considered. Land is a significant cost at the commencement of the investment and therefore impacts on profitability. Greater availability and/or lower priced land could eventuate if any assistance to other activities competing on the same land base was reduced or removed. Furthermore, modifying planning controls to ensure commercial tree planting was an "as of right use" could increase land availability. Progression to second rotations will reduce the impact of land costs on financial (not necessarily economic) profitability to a greater extent for Australia, compared to Chile and New Zealand. Greater research could reduce establishment cost, also a significant cost occurring early in the rotation.

NAFI (1992b) has recommended that governments adopt a more commercial attitude to supplying wood fibre to industry. This may mean reduced wood growing costs and more market-based, and therefore variable, log pricing.

**Direct Assistance Measures**

Afforestation

From time to time a variety of assistance measures have applied to forest growing activities. Chile and New Zealand Governments have or had provided direct cost-sharing assistance to major industrial forestry companies growing wood in competition with Australia where there is no comparable scheme in operation. The US Government also offers cost-sharing assistance to wood growing but it is mainly limited to the smaller particularly agricultural, landholder.

Meanwhile major Australia assistance has been limited to Government to Government loans (Softwood Forestry Agreements Acts) and more recently the National Afforestation Program which distributed funds to a selected cross-section of Government, industry and community growers.

Overall, private industrial growers in Australia may not have received the level of direct assistance that has been available in Chile and New Zealand.

Industrial Development Incentives

All countries offered a variety of incentives to attract major development projects, particularly to regional areas.

**Taxation**

From the study examination, Chile appeared to have the most favourable taxation regulations applying to forestry, with no land tax and a corporate income tax rate of only 15%. New Zealand has attractive depreciation rates for capital items of pulp, paper, reconstituted panel plant processing. The US has had very favourable capital gains tax exemptions but also relatively high yield/harvest taxes in addition to land taxes for forestry. Afforestation profitability was most affected by taxation in Australia and the US South, Chile the least.

**Strengths and Threats**

Factors contributing to Australia's strengths as a wood grower include:-

- Favourable land and climatic conditions with nearly 300,000 hectares of suitable land within 100 kilometres of a processing plant (RAC 1992),
- Exotic species plantations under less pressure for wildlife habitat than native regrowth,
- Political stability relative to countries such as Chile can be an investment advantage,
- Opportunity for increased domestic sales through import replacement,
- Australia's distance from its major wood competitors, bar New Zealand, increases the transport cost of imports and further protects domestic products,
- Closer proximity to several growing Asian markets,
- Declining log quality and increasing prices in the Pacific Northwest and British Columbia as commercial availability of old-growth logs decline, and
- Competitive industry structure for particular sectors in certain regions provides a good basis for international competitiveness and industry survival.

Likely threats to Australia's wood growing viability include:

- Competition from other sources particularly those with similar species or with wood growing assistance measures e.g. Chile,
- Small domestic market limits opportunities to utilize processing plants with significant economies of scale,
- relatively high transport, distribution and input costs such as power (Simons 1990), and
- high levels of assistance in potential export markets in Asia (Edgar et al. 1992)

In comparing typical exporting mills of competing regions using both Jaakko Poyry (1992) and Simons (1990), Industry Commission 1993 concluded that hardwood woodchips and hardwood pulp, particle board, packaging and industrial papers as the most competitive sectors of the Australian forest products industry. Hardwood plywood and sawnwood plus commodity printing and writing papers were the least.

**Future Outlook**

The long term viability of plantations is affected by future changes in product markets. An assessment of likely movements follows however there are always uncertainties in long term projections of demand and supplies and variations within regions.

Additional Supply Areas

It would appear that by the year 2000 Chile and New Zealand together could provide over 40 million $m^3$ to the Pacific Rim market (see Table 8.3), more than double their current log harvest. Whether this is further processed or exported as log may depend on substantial financial investments in wood processing plants plus infrastructure totalling an estimated $6 to $10 billion.

These increased supplies will be in addition to the softwood supplies becoming available in Australia and the reduced hardwood harvest expected (AFC 1989).

**Table 8.3 Projected Softwood Availability, Australia, Chile and New Zealand (million $m^3$)**

| Country/Log Type | 1990 | 2000 | 2005 | 2010 | 2020 |
|---|---|---|---|---|---|
| Sawlogs | | | | | |
| Australia | 4.1 | 6.8 | na | 8.6 | 9.7 |
| New Zealand (a) | 10.1 | 12.3 | 14.4 | na | na |
| Chile (b) | 8.4 | 12.9 | 13.3 | 14.0 | 25.9 |
| Total Sawlogs | 22.6 | 32.0 | | | |
| Pulplogs | | | | | |
| Australia | 5.0 | 5.1 | na | 5.2 | 5.4 |
| New Zealand | 4.4 | 4.5 | 4.5 | na | na |
| Chile | 6.7 | 9.3 | 9.6 | 9.1 | 11.0 |
| Total Pulplog | 16.1 | 18.9 | | | |
| Total Logs | 38.7 | 50.9 | | | |

(a) Pruned logs included with sawlogs
(b) Option B.

*Sources: AFC (1989), INFOR - CORFO (1990), and Edgar et al. (1992)*

Constrained Supply Areas

In British Columbia a period of constrained sawlog supplies is expected during the transition from old-growth to second growth, lower long run sustained yield allocations and pressure for more forest areas to be included in environmental set-asides. Similarly, log supplies and quality are expected to continue declining in the Pacific Northwest with the reduced availability of old-growth. This trend could start reversing by 2030 when second growth matures.

US South projections are for removals to exceed supplies, given processing capacity increases with aggregate wood demand and projected falls in the market share of Canadian imports.

**Trade**

New Zealand is our major trading partner and intends to continue to export to Australia but recognizes the expanding nature of the Australian radiata resource.

Canada, with a major contribution by British Columbia is the world's biggest exporter of chemical pulp, newsprint and softwood sawntimber. The expected constrained softwood sawlog supplies in British Columbia will limit any growth in their share of the Australian sawntimber market. However, pulplog supply is expected to exceed demand and recycling content regulations for newsprint in the United States, a traditional market for Canadian pulp, may mean diversion of more pulp to the Pacific Rim countries.

Aggregate exports from the United States are expected to increase from 1986 levels except non-structural panels and pulpwood (Haynes 1990). PNW exports however, will decline in quality and quantity commensurate with reduced old-growth availability for processing.

A traditional market for Canadian softwood sawntimber is the US. Since 1973 they have mounted countervailing duty actions on Canadian sawnwood. Recent action was based on administratively set stumpages by the Canadian Government and log export restrictions subsidizing Canadian producers. Yet, both countries have various types and levels of log export restrictions in contrast to Chile and New Zealand.

**Price Levels**

Past trends in real prices have been variable. In the short to medium term real log prices from North America are expected to increase, impacting on prices in other Pacific Rim countries. Reduction in old-growth availability is also likely to cause an appreciation of prices by grade, but the resultant change in log grade mix causing average prices decline.

Expectations over the long term are for a cessation in this appreciation of real log prices. Supply will grow as technology creates more wood-based products of similar performance capabilities from inexpensive logs of increasing availability - plantation and regrowth logs.

# ITINERARY

Week 1 April 7-11
Carter Holt Harvey Wood Products Ltd., Auckland, New Zealand
Investing in Forestry, Auckland, New Zealand
Tasman Forestry Ltd., Rotorua., New Zealand

Week 2 April 12-18
Forest Research Institute, Rotorua, New Zealand
Tachikawa Sawmill, Rotorua, New Zealand
Tasman Forestry Ltd., Rotorua, New Zealand
Forestry Corporation of NZ., Rotorua,New Zealand

Week 3 April 18-24
Universidad Austral de Chile, Valdivia, Chile
Bosques Arauco, Concepcion, Chile
Colcura Eucaliptus S.A., Concepcion, Chile
Forestal Bio Bio, Concepcion, Chile
Prochile, Santiago, Chile
Corporacion Chilena de la Madera, Santiago, Chile
Instituto Forestal, Santiago, Chile

Week 4 May 10-16
University of Florida, Gainseville, Florida, USA
Mead Coated Boards, Columbus, Georgia, USA
University of Georgia, Athens, Georgia, USA
Union Camp Organisation, Savannah, Georgia, USA
USDA Forest Service, Research Triangle Park, North Carolina, USA
North Carolina State University, Raleigh, North Carolina, USA

Week 5 May 17-23
USDA Forest Service, Washington DC, USA
National Forest Products, Washington DC, USA
Resources for the Future, Washington DC, USA
Council of Forest Industries, Vancouver, British Columbia, Canada
H A Simmons Vancouver, British Columbia, Canada
Reid Forestry Management, Vancouver, British Columbia, Canada
Forest Engineering Research Institute of Canada, British Columbia, Canada
Fletcher Challenge Canada Ltd., Vancouver, British Columbia, Canada
MacMillan Bloedel Ltd., Vancouver, British Columbia, Canada
Seymour Demonstration Forest, New Westminster, British Columbia, Canada

Week 6 May 24-30
Woodland Services Nanaimo, British Columbia, Canada
MB Harmac Pulp Mill Nanaimo, British Columbia, Canada
MB Island Phoenix Sawmill, Naimo, British Columbia, Canada
BC Ministry of Forests, Victoria, British Columbia, Canada
Forestry Canada, Victoria, British Columbia, Canada
University of British Columbia, Vancouver, British Columbia, Canada
University of Washington, Seattle, Washington, USA
Weyerhaeuser Company Tacoma, Washington, USA

Week 7 May 31 - June 6
Western Wood Products Assoc., Portland Oregon, USA
USDA Forest Service, Pacific Northwest Research Station, Portland ,Oregon, USA
Portland Forestry Sciences Lab, Portland, Oregon
US Department of Interior, Portland, Oregon, USA
Oregon State University, Corvallis, Oregon, USA
University of California, Berkeley, California, USA

Week 8 June 12
NSW Forestry Commission, Sydney, NSW

Week 9 July
CSR Softwoods, Mount Gambier, SA
APM Forests, Morwell, VIC
Department of Conservation and Environment, Melbourne, VIC

# REFERENCES


ABARE (Australian Bureau of Agricultural and Resource Economics) (1990) *Forest Products Trade* June 1990, Canberra

ABARE (1991a) *Forest Product Trade,* June 1991, Canberra

ABARE (1991b) *Pricing and Allocation of Logs in Australia*, AGPS, Canberra

ABARE (1992) *Australian Forest Resources 1990 and 1991*, AGPS, Canberra

ABS (Australian Bureau of Statistics) (1992) *Australian Economic Indicators March 1992* ABS Catalogue No 1350.0, Canberra

ACF (Australian Conservation Foundation) (1988) *The Wood and the Trees: A Preliminary Analysis of Conservation-oriented Forest Industry Strategy,* Melbourne

Adams, D. M., Jackson K.C., and Haynes, R.W. (1988) *Production, Consumption and Prices of Softwood Products in North America: Regional Time Series Data, 1950 to 1985*, UDSA Forest Service, Pacific Northwest Research Station, Resource Bulletin, PNW-RB-151, Portland, Oregon, USA

Adams, D.M. and Haynes, R.W. (1991) "Softwood Timber Supply and the Future of the Southern Forest Economy" *Southern Journal of Applied Forestry* 15 (1): 31-37

AFC (Australian Forestry Council (1989) *Australian Forest Resources, Present Areas and Estimates of Future Availability of Wood,* Department of Primary Industries and Energy, Canberra

AFC and NZECC (Australian Forestry Council and the New Zealand Environment and Conservation Council) (1992) *A New Focus for Australia's Forests,* Draft National Forest Policy Statement, July 1992, Commonwealth of Australia, Canberra

AFDI (Australian Forest Development Institute) (1990) "Incentives for Encouraging Forestry on Private Property", Submission to the Resource Assessment Commission, Canberra

Amacher G.S., Brazee R.J. and Thomson T.A. (1991) "The Effect of Forest Productivity Taxes on Timber Stand Investment and Rotation Length" *Forest Science* 37 (4):1099-1118

Anon. (1987) "Canada's lumber tax wins House approval" *Forest Industries* July 1987 pp5

Anon. (1991) "Little Change Likely in Canadian Imports" *Forest Industries* 118 (9) 4.

Anon. (1992a) 'Investment Grade Rating for Chile' *Financial Review* 20 August, 1992, page 26

Anon. (1992b) "US Rules Against Canadian Softwood Producers" *The Forestry Chronicle*_68 (4) 409-410

Anon. (1992c) "NDP Reduces Cutting Rights in BC" *The Forestry Chronicle* 68(1) pp5.

Anon. (1992d) "Forest Firms Report 1991 Losses" *The Forestry Chronicle* 68(2):181.

Anon.(1992e) "BC Government Establishes New Pulp Mill Controls" *The Forestry Chronicle* 68 (2) pp193.

Anon. (1992f) "Gypsy Moths Found in BC" *The Forestry Chronicle* 68 (5):570.

APM (Australian Paper Manufacturers) (1990) "Submission to the Resource Assessment Commission Inquiry into Australia's Forest and Timber Resources", Melbourne

Arauco (1991) *Annual Report, 1990*

Australian Government (1991) *Commonwealth Financial Relations with Other Levels of Government,* Budget Paper No. 4, AGPS, Canberra

Beadle, C.L. and Inions, G. (1990) "Limits to Growth of Eucalypts and their Biology of Production" in Dargavel, J. and Semple, N. (eds) *Prospects for Australian Forest Plantations*, CRES, Australian National University, Canberra

Bechtold, W.A., Hoffard, W.H. and Anderson, R.L. (1992) *Summary Report, Forest Health Monitoring in the South, 1991* General Technical Report, SE-81 Southeastern Forest Experiment Station, Asheville, North Carolina, USA

Benson, M.L. and Jacobs, M.R. (1984) "Forest Areas and Centres of Forest Industry" in Hills WE and Brown AG (ed), *Eucalypts for Wood Production,* Chapter 3, CSIRO, Academic Press

Binkley C.S. (1987) "Economic Models of Timber Supply" in Kallis M., Dykstra D.P. and Binkley C.S. (eds) *The Global Forest Sector: An Analytical Perspective* John Wiley & Sons, New York

BIS Shrapnel Pty. Ltd. (1992) *Economic Outlook,* Sydney

Blackman, T. (1986) "Lumber Import dispute moves to center stage" *Forest Industries* 113 (7) 26-27

Boardman, R. (1988) "Living on the Edge - the Development of Silviculture in South Australian Pine Plantations", *Australian Forestry*, 51 (3) 135-156

Boulter D. (1984) *Taxation and the Forestry Sector in Canada* Information Report E-X-33 Economics Branch, Canadian Forestry Service, Agriculture Canada, Quebec, Canada.

Boulter D. (1986) "The Economics of Growing Wood in Northern Ontario" Paper presented to OPFA Annual Meeting, 31 January 1986, Sudbary, Ontario, Canada (unpublished).

Boyd, C.W. (1992) "Timber Supply Outlook in the Pacific Rim". Paper prepared for Chile conference, 6 May 1992 , Santiago, Chile.

British Columbia (B.C.) Ministry of Forests (1990) *All Things Considered, Forest Management in British Columbia* Victoria, BC, Canada.

British Columbia Ministry of Forests (1991a) *Annual Report 1990-91* Victoria, British Columbia, Canada

British Columbia Ministry of Forests (1991b) "The Economic Impacts of Timber Harvesting in British Columbia" Paper by the Economics and Revenue Branch (unpublished)

British Columbia Ministry of Forests (1991c) *Silviculture, Enhancing Our Forest Resources A Forest Renewal Program, 1991-96* Victoria, BC, Canada

British Columbia Ministry of Forests (1992) "British Columbia's Forest Industry" Paper prepared for Deputy Minister by Economics and Trade Branch

Boyd, R.G., Daniels, B.J., Fallon, R and Hyde W.F. (1988) "Measuring the Effectiveness of Public Forestry Assistance Programs", *Forest Ecology and Management,* 23: 297-309

Brown, C. (1992) Market Report - March 1992 *New Zealand Forestry* May 1992, Wellington

Bureau of Land Management (BLM) (1992) *BLM Facts, Oregon and Washington,1991* US Department of Interior, Portland, Oregon USA

Cafferata, S.L. (1986) "Douglas fir Stand Establishment Overview: Western Oregon and Washington" in Oliver, C.D., Manley, D.P. and Johnson, J.A. (1986) *Douglas-fir Stand Management for the future* Institute of Forest Resources, Seattle, Washington, USA

Caton C. (1993) "The Background for Macro Policy!" Paper presented to the Economics Society, 5 March 1993, Adelaide

(CCFM) Canadian Council of Forest Minister (1993) *Compendium of Canadian Forestry Statistics, 1992* National Forest Database Ottowa, Canada (and previous issues)

CFPLM (Centre for Farm Planning and Land Management) (1989) *Consultant's Report to State Plantations Impact Study,* Faculty of Agriculture and Forestry, University of Melbourne

Chemlik J.T., Brooks D.J. and Haynes R.W. (1989) *United States Trade in Forest Products, 1978 to 1987* General Technical PNW-GTR-240 USDA Forest Service, Pacific Northwest Research Station, Oregon USA

Chen N., Ames G.C.W. and Hammett A.L. (1988) "Implications of a Tariff on Imported Canadian Softwood Lumber" *Canadian Journal of Agricultural Economics* 36, 69-81

Clarke, M. (1992) Depreciation Review Decisions - A Boost for Wood Processing, *New Zealand Forestry* 36 (4): 6

Clements S.E., Klemperer W.D., Haney H.L.Jr and Siegel W.C. (1986) *Forest Products Journal* 36 (6) 31-35

CNF (Corporacion Nacional Forestal) (1991), *Chile Forestry News* 14 (154) and previous issues

CONAF-INFOR (1992) *Exportaciones Forestales Chilenas* (Enero-Diciembre 1991), Santiago, Chile

CORFO-INFOR (1987) *El Mercado Forestal Interno* Informe Technico No. 106 Santiago, Chile

CORFO-INFOR (1991) *Disponibilidad de Madera de Pino Radiata en Chile, 1990 a 2019,* Informe Technico No. 125, Santiago, Chile

CORFO-INFOR (1992) *Precios de Productos Forestales* (Actualizados a Diciembre de 1991) Boletin Estadistico No. 25 Santiago, Chile

CORMA (Corporacion Chilena de la Madera) (1992) 'Sector Forestal Chileno 1990-1991' Unpublished

Council of Forest Industries of British Columbia (COFI) (1992) *British Columbia Forest Industry Fact Book 1991* Vancouver, British Columbia, Canada (and previous issues)

Cox, O., Horgan, G., Maplesden, F. (1991) *The New Zealand Timber Industry - Present Status and Future Impact on the Australian Timber Industry* A Report prepared for the Resource Assessment Commission, Canberra

Crocombe, Enright and Porter (1991) *Upgrading New Zealand's Competitive Advantage* Oxford University Press

Cubbage, F.W. and Carter, D.W. (1991) "Southern Pulpwood Harvesting Productivity an Costs 1979 to 1987". In preparation for *Southern Journal of Applied Forestry*

Cubbage F.W., Gunter J.E. and Olson J.E. (1991) Duryea M.L. and Dougherty (eds). *Forest Regeneration Manual* Kluwer Academic Publishers, Netherlands

Cubbage, F. and Hodges, D. (1990) "The Economics of Managing Longleaf Pine" in Farrer, R.M. (ed) (1990) *Proceedings of the Symposium on the Management of Longleaf Pine,* 4-6 April 1989, Long Beach, Mississippi. Southern Forest Experiment Station, New Orleans, Louisiana, USA

Cubbage, F.W. and Skinner, T.M. (1985) "Industrial Forest Management Assistance and Leasing: 1983 Programs and Accomplishments in Georgia" *Southern Journal of Applied Forestry* 9 (4) 217-222

Dangerfield C., Gunter J., and Martin D. (1992) *Understanding Conservation Use and Timber Taxation in Georgia* Co-operative Extension Service, University of Georgia College of Agricultural and Environmental Sciences, Athens, Georgia, USA

de Steiger J.E. (1984) "Impact of Cost-Share Programs on Private Reforestation Investment" *Forest Science* 30 (3): 697-704

Deadman, H. and Claderon, S. (1988) "Pruning Eucalypts in New Zealand" in Proceedings of AFDI Bicentenary Conference, Albury-Wodonga, NSW

Deloitte Ross Tohmatsu (1992) "Forestry Taxation", Part of a paper presented to the New Zealand Society of Accountants Continuing Education Programme, March 1992

Department of Statistics (1992) *New Zealand Official Yearbook,* 95th Edition, Auckland, NZ

Department of Treasury (1990) *Financial Monitoring of Government Business Enterprises: An Economic Framework*, AGPS, Canberra

DPIE (Department of Primary Industries and Energy) (1990) *Annual Report 1988-89*, AGPS, Canberra

Dubois, M., Watson, W.F., Straka, T.J., and Belli, K.L. (1991) "Cost and Cost Trends for Forestry Practices in the South" *Forest farmer* 50 (3) 26-32.

Duerr W.A. (1989) "Pulsations in the Forest Industry" Forest Products Journal 39 (9):64-68

Duke K.M., Townsend G.M. and White W.A. (1989) *An Economic Analysis of Fertilization and Thinning effects on Doulas-fir Stands at Shawnigan Lake* Information Report BC-X-312, Forestry Canada, Pacific and Yukon Region, Victoria, BC, Canada

Dwinell L.D. and Nickle (W.R.) (1989) *An overview of the Pine Wood Nematode Ban in North America* General Technical Report SE-55 USDA Forest Service, Southeastern Forest Experiment Station, North Carolina, USA

Edgar, M.J., (1992) "A Strategic Review of New Zealand's Forestry Industry Investment Opportunities", Paper presented to "Investing in Forestry" Seminar, 8-9 April 1992, Auckland, New Zealand

Edgar, M.J., Lee, D., Quinn, B.P., (1992) *New Zealand Forest Industries Strategy Study,* New Zealand Forest Industries Council, Wellington, NZ

Edwards, M.B. and Dangerfield, C.W. (1990) *Reliable Low-Cost Alternatives for Pine Regeneration in the South.* Research Paper SE-280 USDA Forest Service, Southeastern Forest Experiment Station, Asheville, North Carolina, USA

EIU (Economist Intelligence Unit) (1992a) *Country Profile, Canada, 1992-93* London

EIU (1992b) *Country Report, Chile* 2nd Quarter 1992, London (and previous issues)

Eng, H., Johnson K.N. and Right, R.D. (1990) *Financial Analysis of Early Stand Treatment in Southwest Oregon.* Research Paper PNW-RP-427 USDA Forest ServicePacific Northwest Research Station Portland, Oregon, USA

ESDWG (Ecologically Sustainable Development Working Groups) (1991) *Final Report - Forest Use,* November 1991, AGPS, Canberra

Evison, D.C. (1990) The New Zealand Wood Products Industry in the 1980's and Beyond *New Zealand Forestry* 35 (1) 22-27

Evison, D.C. and Glass, P.C. (1991) "Log Exports from New Zealand: Trends and Issues", Paper presented to "International Trade in Forest Products Around the Pacific Rim" International Symposium, 8-11 October, 1981, Seoul, Korea

Ewing, A.J. and Chalk, R. (1988) *The Forest Industries Sector, An Operational Strategy for Developing Countries,* World Bank, Washington DC

FAFPIC (Forestry and Forest Products Industry Council) (1987) *Forest Industries Growth Plan,* A Submission to the Australian Government, Melbourne

FAFPIC (1989) *Role of Hardwood Plantations in Supplementing Australia's Forest Resource,* Statement by Forest and Forest Products Industry Council, Appendices, Melbourne

FAO (Food and Agricultural Organization) (1991) *Yearbook of Forest Products, 1989,* FAO, United Nations, Rome

Fenton, R.T. and Sutton, W.R.J. (1968) "Silvicultural Proposals for Radiata Pine on High Quality Sites", *New Zealand Journal of Forestry,* 13: 220-228

Ferguson, I.S.(1986) "Financial Returns from Private Investment in Softwood Plantations", Paper presented to Seminar on Private Forestry Investment, AFDI, 17 July, 1986, Melbourne

Ferguson, I.S. (1990) "Resource Cost and Pricing: International Competitiveness of Imports and Returns on Public Assets", Paper presented to AUSTIS 90, March 1990, Launceston, Tasmania

Forest Industries Committee on Valuation and Taxation (FICTVT) undated: *The New Reforestation Tax Incentives,* Third Edition, Washington DC, USA

Forest Pest Management Task Force (1988) *Forest Health Through Silviculture and Integrated Pest Managemnt, A Strategic Plan,* UDSA Forest Service, Washington D.C

Forestry Canada (1992) *Selected Forestry Statistics, Canada, 1991* Policy and Economics Directorate, Ottawa, Ontario, Canada

Forestry Canada (1993) *The State of Canada's Forests 1992* Ottawa, Ontario, Canada and previous issues

Forestry Canada and BC Ministry of Forests (1991) *Canada-British Columbia, Partnership Agreement on Forest Resource Development: FRDAII, 1991-95* Victoria, British Columbia, Canada

Fortson, J.C. (1986) "Factors Affecting the Discount Rate for Forestry Investments" *Forest Products Journal* 36 (6): 67-72

Franklin, C.E. (1989 "Managed Mixed Pine-Hardwood Stands can Yield High Rates of Return on Investment" in Waldrop, T.A. ed (1989) *Proceedings of Pine-Hardwood Mixtures:* A Symposium on Management and Ecology of the Type. Atlanta Georgia 18-19 April. Southeastern Forest Experiment Station Asheville, NC. USA

FRC - Forest Resources Commission (1991) *The Future of Our Forests* Executive Summary, April 1991, British Columbia, Canada

Gayer P.D., Haney H.L., and Hickman C.A. (1987) Financial Impact of Current-Use Assessment of Forest Land in Virginia Research Paper SO-240 USDA Forest Service Southern Forest Experiment Station, New Orleans, Louisiana, USA

Gregory G.R. (1972) *Forests Resource Economics*, John Wiley & Sons, New York, USA

Greig, P.J. and Kennedy, I.R. (1984) *Pine Plantations in Victoria, An Investor's Guide*, Technical Report No. 14, Department of Conservation Forests and Lands, Economics Group, Melbourne

Gruenfeld J. and Flynn, B. (1991) Pacific Northwest Log Exports in the 1990's *Papertree Letter*, August 1991, San Francisco, California, USA

Guertin D.S. and Rideout D.B. (1987) "The Tax Reform Act and Forest Investments" *Journal of Forestry* September 1987: 29-31

Hansard, A.W. and Dean, M.J. (1991) *Taxation and Individual Forestry Investment: Some Issues and Policy Implications*, ABARE Discussion Paper 91.2, Canberra

Haynes, R.W. (1986) "Domestic Markets for Forest Products from the Douglas-fir Region" in Oliver, C.D., Hanley, D.P. and Johnson, J.A. (1986) *Douglas-fir, St and Management for the Future* Institute of Forest Resources, Seattle, Washington, USA

Haynes R.W. (Coordinator) (1990) *An Analysis of the Timber Situation in the United States: 1989-2040* A Technical Document supporting the 1989 USDA Forest Service RPA Assessment General Technical Report RM-199, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado 80526

Haynes, R.W. and Fight, R.D. (1992) *Price Projections for Selected Grades of Douglas-fir and Ponderosa Pine Lumber.* Research Paper PNW-RP-447 USDA Forest Service Pacific Northwest Research Station, Portland, Oregon USA

Heaps T. (1986) "Cost Benefit Analysis of Growing Coast Douglas-fir in British Columbia" in Oliver C., Hanley D. and Johnston J. (eds) *Douglas-fir: Stand Management for the Future,* Institute of Forest Resources, Contribution No 55, University of Washington, Seattle, WA, USA

Hickman C.A. (1982 *Inconsistent Forest Property Tax Policies Within Selected Southern States*, Research Paper SO-253 USDA Forest Service, Southern Forest Experiment Station, New Orleans, Louisiana, USA

Hickman C.A. (1989) "Timber Severance Taxes: Current Status and Changing Role" *Forest Products Journal* 39 (10) 31-34

Holley, D.L. (1985) "Application of Economic Concepts to Forest Regeneration". Paper presented to 64th Annual Meeting, Appalachian Society of American Foresters, 23-25 January. 1985, Norfolk, Virginia

Holtman, B. (1987) "Forest Management Intensity/Wood Growing Costs/Financial Returns". Paper presented to IUFRO Forest Growth Modelling and Prediction Conference 24-28 August. 1987 Minneapolis, MN., USA

Horgan, G.P. (1991) "New Zealand Supplies and the Pacific Market for Forest Products", Paper presented to National Agricultural and Resources Outlook Conference, 29-31 January 1991, Canberra

Howell, M. (1993) *Pulpwood Prices in the Southeast 1992* Research Note, SE-366 and previous issues. Southeastern Forest Experiment Station, Asheville, North Carolina.

Hunter, J.E. and Haney, H.L. Jr. (1984) *Essentials of Forestry Investment Analysis*, OSU Book Stores Inc., Corvallis, USA

Hyde, W.F., Newman, D.H., Sedjo, R.A. (1991) *Forest Economics and Policy Analysis, An Overview.* World Bank Discussion Paper No. 134. The World Bank, Washington DC

IBI (International Business Incentives) (1987) *Investment Incentives Worldwide*, Butterworths, London ILO (International Labour Organisation) (1991) *Bulletin of Labour Statistics* 1991 Geneva

IMF (International Monetary Fund) (1992) *International Financial Statistics* and previous issues

Industry Commission (1991) *Annual Report 1990-91*, AGPS, Canberra

Industry Commission (1993) *Adding Further Value to Australia's Forest Products Report* No. 32, A.G.P.S. Canberra

INFOR (Instituto Forestal) - CORFO (1991) *Estadisticas Forestales 1990* Boletin Estadistico No. 21, Agosto 1991, Santiago, Chile

Jaakko Poyry (1993) *Cost Competitiveness of Australia's Wood Product Industries* Consultancy for the Industry Commission, Melbourne

Jelvez, A., Blatner, K.A., and Govett, R.L., (1989) 'Chile's Evolving Forest Products Industry. Part 2. Investments in an Expanding Industry' *Journal of Forestry* 39 (11/12) 76-78

Jelvez, A., Blatner, K.A., and Govett, R.L., (1990) *Forest Management and Production in Chile*, A Growing Role for Timber Exports. *Journal of Forestry* 88 (3) 30-34

Jones H., Lord R., Dlugosz J. and Bartley S. (1993) "Macroeconomic development and propsects in Australia and Overseas". Paper presented by P. O'Mara to Outlook '93 Conference by ABARE, 2-4 February 1993, Canberra

Keating, J.E. (1992) "Analysing the Forest Investment", Paper presented to "Investing in Forestry" seminar, 8-9 April 1992, Auckland, New Zealand

Kelly, J.F. and Bechtold, W.A. (1990) "The Longleaf Pine Resource" in Farrar, R.M. (ed) (1990) *Proceedings of the Symposium on the Management of Longleaf Pine.* 4-6 April, 1989, Longbeach Mississippi. Southern Forest Experiment Station New Orleans, Louisiana. USA

Kirby, G.T. (in prep) (1992) "Economic Analyses of Commercial Tree-Growing Options for Controlling Land and Water Degradation in Victoria", Department of Conservation and Environment, Victoria

Klemperer W.D. (1977) "An Economic Analysis of the Case Against Ad Valorem Property Taxation in Forestry: A Comment" *National Tax Journal* 30 (4):469

Kronrad G.D. (1985) *Should We Continue to Subsidize Forestry?* Research Note Series No. 62, Small Woodlot Forestry R&D Program N.C. State University, Raleigh, North Carolina, USA

Kronrad G.D. and Morzuch B.J. (1985) "The Forestry Incentives Program and Forest Yield Taxation in Massachusetts: Do We Need the Subsidy?" *Journal of Forestry* December 1985 pp 730, 753-754

Kurtz W. B., Alig R.J. and Mills T.J. (1980) "Retention Condition of Agricultural Conservataion Program Conifer Plantings" *Journal of Forestry,* May 1980 : 273-276

Lanley, J.P. and Clement, J. (1979) "Present and Future Natural Forest and Plantation Areas in the Tropics" *Unasylva* 31 (123) 12-20

Lavery, P (1990) Radiata Plantation Statistics, NEFD and Notes on Chilean, Australian and other Resource Descriptions, *New Zealand Forestry*, 35 (3) 24-29

Le Heron (1988) "The Internationalisation of the New Zealand Forestry Companies and the Social Reappraisal of New Zealand's Exotic Forest Resource", *Environment and Planning A*, Volume 20: 489-515

Leuschner W.A. (1984) *Introduction to Forest Resource Management*, John Wiley & Sons, Inc. New York, USA

Levack, H. (ed) (1986) *1986 Forestry Handbook*, New Zealand Institute of Foresters (Inc.), Wellington, New Zealand

Luckert M.K. and Haley D. (1990) "The Implications of Various Silvicultural Funding Arrangements for Privately Managed Public Forest Land in Canada" *New Forest* 4:1-12

MacMillan Bloedel Limited (MB) (1992) *1991 Annual Review*

Mangold R.D., Moulton R.J. and Snellgrove J.D. (1992) *Tree Planting in the United States, 1991* USDA Forest Service, State and Private Forestry, Cooperative Forestry, Washington, DC

Mather, A.S. (1990) *Global Forest Resources* Belhaven Press, London

McEvoy T.J. (1988) *Federal Income Tax Information for Forestland Owners*, Forestry Fact Sheet FOR-44 Co-operative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, Florida, USA

McKenzie, C. (1992) "Different Forests, Different Returns: Evaluating the Options", Paper presented to "Investing in Forestry" Seminar, 8-9 April, 1992, Auckland, New Zealand

McNeel, J.R. (1990) "Clearfelling Heavily Thinned Low-stocked Stands in the Southeastern United States" in James, R.N. and Tartlon, G.L. (ed.) *New approaches to Spacing and Thinning in Plantation Forestry.* FRI Bulletin No. 151. Proceedings of a IUFRO Symposium 10-14 April, 1989, Rotorua, NZ pp. 340-347

Meeks, G (1982) "State Incentives for Nonindustrial Private Forestry" *Journal of Forestry* January 1982 pp 18-22

Meyer, R.D., Klemperer, W.D. and Siegel, W.C. (1986) "Cutting Contracts and Timberland Leasing: *Journal of Forestry* December 1986, pp. 35-38

Mills T.J. and Dixon G.E. (1982) *Ranking Independent Timber Investments by Alternative Investment Criteria,* Research Paper, PSW-166, USDA Forest Service, Pacific Southwest Forest and Range Experiment Station, Berkeley, California, USA

Ministry of Forestry (1988) *Statistics of the Forests and forest Industries of New Zealand to 1987*, Wellington, New Zealand

Ministry of Forestry (1991) *Report From Forestry Joint Venture Working Group*, Wellington, New Zealand

Ministry of Forestry (1992a) "Forestry Taxation at a Glance", *Forestry Forum*, March 1992, Wellington, New Zealand

Ministry of Forestry (1992b) *New Zealand Investment Opportunities*, Wellington, New Zealand

Moorhead, D.J. and Dangerfield, C.W. (1991) "The Value of Site Preparation Prescriptions: An Economic Analysis" in Coleman, S.S. and Neary, D.G. ed. (1991) *Proceedings of the Sixth Biennial Southern Silvicultural Research Conference* October 30 - November 1, 1990, Memphis, Tennessee. Southeastern Forest Experiment Station, Asheville, North Carolina

Morgan, G., (1992) *The Investment Realities of the New Zealand Economy*, Paper presented to "Investing in Forestry" Seminar, 8-9 April 1992, Auckland, New Zealand

Moulton, R.J. (1991) *"The Conservation Title of the 1990 Farm Bill"*. Paper presented to 1991 Annual Meeting of Southern Forest Economists, Washington DC February 20-21

Moulton, R.J., Baldwin, B. and Snellgrove, J. (1991) "Impacts of Conservation Reserve Program Tree Planting on Biological Diversity". Paper presented to 1991 Annual Meeting of Southern Forest Economists, Washington DC. February 20-22

Mutton, D.R. (1992) "The Future Log Resource - Softwood", Paper presented to FIME '92 Conference, Albury, NSW, 4-5 April, 1992

NAFI (National Association of Forest Industries) (1990) *Submission to the Resource Assessment Commission*, June 1990, Canberra

NAFI (1992a) *Building a Competitive Forest and Forest Products Industry*, A National Forest Industries Policy Statement in response to the Government's draft national forest policy, September 1992, Canberra

NAFI (1992b) *International Competitiveness: The Key to Value Adding*, Submission to the Industry Commission Inquiry into Adding Further Value to Australia's Forest Products, December 1992, Canberra

National Association of Home Builders, (NAHB) National Lumber & Building Material Dealers Association, and American Forest Resource Alliance (1992) "The Housing Recovery - where will the wood come from?" (Unpublished)

Neilsen, W.A. and Wilkinson, G.R. (1990) "Eucalypt Plantation Silviculture - Implications for Sawlog Production in Tasmania" in Dargavel, J. and Semple, N. (eds) *Prospects for Australian Forest Plantations*, CRES, Australian National University, Canberra

New Zealand Forestry Council (1981) *Report of the Working Party on Industry Strategy*, Wellington, New Zealand

Newman D. H. (1988) *The Optimal Forest Rotation: A Discussion and Annotated Bibliography*. General Technical Report SE-48 USDA Forest Service, Southeastern Forest Experiment Station, Asheville, North Carolina, USA

Newan, D.H. and Wear, D.N. (1990) *Research Directions in the study of Lumber Markets and Forest Policies* General Technical Report, SE-62, USDA Forest Service Southeastern Forest Experiment Station

Norris, F.W. (1991) *Timber Mart-South* 2nd Quarter 1991, 17 (2). North Carolina, USA

NPAC (National Plantations Advisory Committee) (1991) *Integrating Forestry and Farming*, Commercial Wood Production on Cleared Agricultural Land, Department of Primary Industries and Energy, Canberra

O'Brien, D.J., Sasse, J.M. and Stewart, H.T.L. (1990) *A Financial Analysis of Selected Hardwood Plantation Enterprises in Victoria*, Lands and Forests Division Technical Report No. 2, Department of Conservation and Environment, Melbourne

OECD (Organisation for Economic Co-operation and Development) (1992) *OECD Economic Outlook*, 51, France

Oliver, C.D., Manley, D.P. and Johnson, J.A. (1986) *Douglas-fir Stand Management for the future* Institute of Forest Resources, Seattle, Washington, USA

Olmstead, J.C., Duryea, M.L. and Harrell, J.B. (1989) *Forestry Assistance for Florida Landowners* Circular 844 Florida Cooperative Extensive Service, Gainesville, USA

Pearse P.H., Lang A.J. and Todd K.L. (1986) *Economic Priorities for Reforesting Unstocked Forest Land in British Columbia* Information Report 85-14, The Forest Economics and Policy Analysis Project, University of British Columbia, Vancouver, BC, Canada

Pearson, F., (1992) *How Forestry Stacks up Against Other Investment Opportunities*, Paper presented to "Investing in Forestry" Seminar, 8-9 April 1992, Auckland, New Zealand

Peters, R.N., Jobet, M.J., and Aguirrea, S. (1985) *Compendis de Tablas Auxiliares Para el Manejo de Plantaciones de Pino Insigne* INFOR Manual No. 14, Santiago, Chile

Piercy, K.J. and Cameron, J.N. (1989) "An Historical Outline of APM Forests and the Private Woodlot Incentive Scheme in Gippsland, Victoria", Paper presented to the Third Victorian Agroforestry Conference, 27-28 April, 1989, Morwell, Victoria

Pitcher, J.A. and Risbrudtt, D.R. (1986) *Southern Journal of Applied Forestry* February 1986: 6-10

Price Waterhouse (1991a) *Corporate Taxes, A Worldwide Summary*

Price Waterhouse (1991b) *Doing Business in Chile* Information Guide, U.S.A

Price Waterhouse (1991c) *The Forest Industry in British Columbia, 1990,* Vancouver, British Columbia, Canada

Prochile (1991) *Chile, Exports, Incentives, Economy* No. 38 September-October 1991, Santiago, Chile

Quinn, A. (1992) "Shares or Bonds", *National Australia Bank Quarterly Summary*, September 1992

RAC (Resources Assessment Commission) (1992) *Forest and Timber Inquiry Final Report*, March 1992, AGPS, Canberra

Random Lengths Export, (1992a) "US Log Exports Drop a As Domestic Market Firms" 6 August, Random Lengths Publications Inc. Eugene, Oregon, USA

Random Lengths Export (1992b) "Wood Pasteurization Proposal Moves Forward" in 6 August, Random Lengths Publications Inc. Eugene, Oregon, USA

Rawlins, W.H.M. (1991) "Economics of Alternative Management Regimes" in Kerruish, C.M. and Rawlins, W.H.M. (eds) *The Young Eucalypt Report - Some Management Options for Australia's Regrowth Forests*, CSIRO, Melbourne

Redmond, C.H. and Cubbage, F.W. (1990) *Comparing the Capital Asset Pricing/Model and Traditional Discounted Cash Flow Analyses to Value Timber Asset Investments*, South-eastern Center for Forest Economics Research Working Paper No 68, North Carolina, USA

Reed F.L.C. (1990) "Implications of Sustainable Development for British Columbia Forestry", *Australasian Forest and Timber Bulletin* 12 (125):14-15

Reserve Bank of Australia (1992) *Bulletin* July 1992, Sydney

Reserve Bank of New Zealand (1992) *Reserve Bank Bulletin*, Vol 55, March Quarter, Wellington, New Zealand (and previous issues)

Riordan, J. (1992) "Valuing the Forest Investment - Understanding the Discount Rate", Paper presented to "Investing in Forestry" seminar, 8-9 April 1992, Auckland, New Zealand

Rogoway D.L. (1987) "Promotional Activities in Latin America: the Demonstration House" in Johnson J.A. and Smith W.R. (eds) *Forest Products Trade: Market Trends and Technical Development)*. University of Washington Press, Seattle, USA

Romm J., Tuazon R. and Washburn C. (1987) "Relating Forestry Investment to the Characteristics of Nonindustrial Private Forestland Owners in Northern California". *Forest Science* 33(1) 197-209

Royer, J.P. and Moulton, R.J. (1987) "Reforestation Incentives - Tax Incentives and Cost Sharing in the South" *Journal of Forestry* 85 (8) 45-47

Scott A.D. and Pearse P.H. (1989) *Natural Resources in a High-Tech Economy: Scarcity Versus Resourcefulness* Working Paper 117, FEPA Research Unit, University of British Columbia, Vancouver, BC, Canada

Sedjo R.A. (1986) "Incentives and Tariff Barriers Related to Forest Products Exports". *Journal of World Forest Resource Management* Vol. 2, pp.105-118

Sedjo R.A., Wiseman A.C. and Lyon K.S. (1992) "Exploiting National Returns to Log Exports" New restrictions limit exports and reduce net benefits. *Journal of Forestry* 90 (4): 35-39

Servigraf (1991) *Chilean Forest Export Guide* Second Edition, Santiago, Chile

Sessions J. (1991) *Timber for Oregon's Tomorrow, The 1989 Update* Forest Research Lab. College of Forestry, Oregon State University, Corvallis, Oregon, USA

Shepherd, K.R., McKinnell, F.H., Neilsen, W.A. and Squire, R.O. (1990) "Silvicultural Regimes for Australian Plantations" in Dargavel, J. and Semple, N. (eds) *Prospects for Australian Forest Plantations*, CRES, Australian National University, Canberra

Simons (H.A.Simmons Ltd) and McLennon Magasanik Associates (1990) *Competitiveness of Australian Forest Industries*, March, Forestry and Forest Products Industry Council, Melbourne

Singh B.K. and Nautiyal J.C. (1986) "An Econometric Analysis of Markets for Canadian Lumber" *Wood and Fibre Science* 18 (3):382-396

Smith, I.M. (1985) Pests and Disease Problems in European Forests *FAO Plant Protection Bulletin* 33: 159-164.

SSCTC (Senate Standing Committee on Trade and Commerce) (1981) *Australia's Forestry and Forest Products Industries*, AGPS, Canberra

(SSS) Simons Strategic Services (1991) *Outlook for the BC Forest Products Industry to the Year 2010* Prepared for BC Hydro, Vancouver, British Columbia, Canada

Staniford, R.B. and Ledig, F.T. (1983) "Economic Evaluation of Eucalypt Energy Plantations" in *Eucalyptus in California* Proceedings of a Workshop 14-16 June, 1983, Sacramento, California USA

Sutton, W.R.J. (1984) "Economic and Strategic Potential of Fast Growing Plantations" in Proceedings of the IUFRO *Symposium on Site and Productivity of Fast Growing Plantations*, 30 April-11 May, Pretoria, South Africa

Sutton, W.R.J. (1991) "Are we too Concerned about Wood Production", *New Zealand Forestry*, 36 (3) 25-30

Thode, P.J. (1988) "Forest Management of Eucalypts for Industry" in Proceedings of AFDI Bicentenary Conference, Albury-Wodonga, NSW

Tibbits, W.N. (1986) "Eucalypt Plantations in Tasmania", *Australian Forestry*, 49 (4) 219-225

Trapnell, L.N. and Lavery, P.B. (1989) *The Economics of Diversifying from Grazing to Pines*, An Analysis for Farms in North-eastern Victoria, A Joint Technical Report by DARA and CF&L, Melbourne, Victoria

Turland, J. and Novis, J. (1990) *A National Exotic Forest Description as at 1 April 1989* Ministry of Forestry, Wellington, New Zealand

USDA (United States Department of Agriculture, Forest Service) (1988) *The South's Fourth Forest: Alternatives for the Future*. USDA Forest Service, Forest Resource Report No. 24 June 1988, Washington DC

USDA (1989) *Wood Products: International Trade and Foreign Markets*. Foreign Agricultural Service, Circular Series September 1989 (Unpublished)

Waddell K.L., Oswald P.D. and Powell D.S. (1989) *Forest Statistics of the United States, 1987*. Resource Bulletin PNW-RB-168 USDA Forest Service, Pacific Northwest Research Station. Portland, Oregon, USA

Wallace, T.D. and Newman, D.H. (1986) "Measurment of Ownership Effects on Forest Productivity in North Carolina from 1974 to 1984" *Canadian Journal of Forest Research* 16: 733-738

Warren D. (1992) *Production, Prices, Employment, and Trade in Northwest Forest Industries, Fourth Quarter 1992*, Resource Bulletin PNW-RB-190, USDA Forest Service, Pacific Northwest Research Station, Portland, Oregon, USA (and previous issues)

Weyerhaeuser Company (1991) *Annual Report 1991*. USA

Whiteside, I. D., (1989) "Economic Advances Made in New Zealand Radiata Pine Plantation Forestry Since the Early 1980's". Paper presented to thirteenth Commonwealth Conference, 18-30 September, Rotorua, New Zealand

Whyte, A.G.D. (1988) Radiata Pine Silviculture in New Zealand: its Evolution and Future Prospects, *Australian Forestry*, 51 (3) 185-196

Williams D.H. (1991) "An Overview of Timber Supply and Allowable Cuts in BC". Paper presented to Western Wood Products Forum, 12-13 March 1991, Vancouver, BC, Canada

Williams, F.J.N. (1982) *Review of New Zealand Radiata Pine Management Practices*, FRI Bulletin No 11

Wilson, R.V. and O'Hara, A.J. (1989) "Current Returns from Plantation Forestry in Australia (with emphasis on New South Wales)", Paper presented to the 13th Commonwealth Forestry Conference, Rotorua, New Zealand, 17-30 September, 1989

Woodbridge Reed & Associates (1988) *Canada's Forest Industry, World Demand/Supply, the next twenty years, prospects and priorities,* Consultancy for the Canadian Forestry Service, Ottawa, Canada

World Resources Institute (1988) *World Resources 1988-1989: An Assessment of the Resource Base that Supports the Global Economy*, New York: Basic Books Inc

WWPA (Western Wood Products Association) (1991) *1990 Statistical Yearbook of the Western Lumber Industry* WWPA Economic Services Department, Portland, Oregon USA

Zinn, G.W. and Miller, G.W. (1984) "Increment Contracts: Southern Experience and Potential Use in the Appalachians" *Journal of Forestry* December, 1984 : 747-749