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NEW ZEALAND FOREST RESEARCH INSTITUTE LIMITED
PROJECT RECORD COVER SHEET

PROJECT RECORD NO.: 6175

PORTFOLIO: FOREST TECHNOLOGY

PROJECT: PLANTATION MANAGEMENT

CODE:

97 / 98	105	1166	01		
Financial Year	Old Resource Centre No.	Project	Sub-project	FRST Contract	Obj.

WORK PLAN NO.: **EXPERIMENT NO.:**

TITLE: BRITAIN AND FRANCE DOUGLAS-FIR FORESTRY STUDY TOUR 1997

AUTHOR(S): MARK BELTON **DATE:** 08.06.98 (dd/mm/yy)

DISTRIBUTION:

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Collaborators etc _____ _____

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AUTHOR'S PROPOSAL FOR FUTURE PUBLICATION:
Part of the Douglas-fir Proceedings for the meeting held on 8 June 1998 at Rotorua.

Recommended as a satisfactory record of work done and results achieved:

Project Manager: RL Knowles **Date:** 18/6/98

FUTURE PUBLICATION(S) OR OTHER METHOD OF INFORMATION TRANSFER REQUIRED:

Portfolio Manager: [signature] **Date:** 18/6/98

Distribution actioned:

Technical Information Officer: JW Williams **Date:** 26/6/98

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PORTFOLIO: FOREST TECHNOLOGY

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CODE: 97 / 98 (Financial Year) | 105 (Old Resource Centre No.) | 1166 (Project) 01 (Sub-project) | (FRST Contract) (Obj.)

WORK PLAN NO.:

EXPERIMENT NO.:

TITLE: BRITAIN AND FRANCE DOUGLAS-FIR FORESTRY STUDY TOUR 1997

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KEYWORDS: DOUGLAS-FIR, BRITAIN, FRANCE

ABSTRACT*

The purpose of the study tour was to gather information and make industry contacts that could be helpful to New Zealand's developing Douglas-fir forest industry.

* Note: This material is unpublished and must not be cited as a literature reference.

DOUGLAS-FIR COOPERATIVE

BRITAIN AND FRANCE DOUGLAS-FIR FORESTRY STUDY TOUR 1997

Mark Belton
Ministry of Forestry

Report No. 25 June 1998

BRITAIN AND FRANCE DOUGLAS-FIR FORESTRY STUDY TOUR 1997

Mark Belton
Ministry of Forestry

INTRODUCTION

This report is a record of my Study Tour of Douglas-fir forestry in Britain and France during September and October 1997.

The Study Tour was undertaken in tandem with a series of seminar presentations for New Zealand Trade Development Board, and for Douglas-fir industry participants in North America and Europe. I also spent three weeks working on a private forest estate "Domains de la Pouyade" in South-West France.

The British tour arrangements were made through Rob Guest (ex Ministry of Forestry) and British Forestry Commission staff and researchers involved with Douglas-fir forestry. The Study Tour began at the Forestry Commission Headquarters and Northern Research Station at Edinburgh, followed by field tours to forests in Central and Southern Scotland. The Scottish field visits included the private Buccleaugh Forest Estates in the border country. In England I visited the Forestry Commission forests in Cumbria, and in the Marches near the border of England and Wales. I also visited the Forestry Commission Alice Holt Research Station.

In France I was joined by John Warjone, President of Blakely Pacific Tree Farms Ltd. The French tour was arranged by my brother Roger Belton in conjunction with French Douglas-fir industry people from AFOCEL[1] , CRPF[2], and INRA[3]. Roger, forest manager for "Domains de la Pouyade", a private forest in Perigord, acted as interpreter for the French tour. John Warjone and I made presentations on Douglas-fir forestry in the Pacific North West (PNW) and New Zealand, to a meeting of French Douglas-fir industry leaders in Limoges.

The purpose of the Study Tour was to gather information and make industry contacts that could be helpful to New Zealand's developing Douglas-fir forestry industry. Douglas-fir is New Zealand's second-most important plantation species but only accounts for five percent of New Zealand's planted forest area. A surge in investment in Douglas-fir planting has occurred in New Zealand over the last five years, and accounted for 20 to 25 percent of new planting investment in 1997. This high level of investment in Douglas-fir forestry can be expected to continue because:

1. A large land bank of good growing sites for Douglas-fir exists in cooler parts of New Zealand (>1.0 million has).
2. Good economics of greenfield Douglas-fir investment opportunities in New Zealand compared with opportunities in North America and Europe.
3. The perception that Douglas-fir is a better market risk prospect than radiata pine.
4. Douglas-fir is a lower risk species than radiata pine with respect to wind and snow damage in these areas.
5. Douglas-fir growing in New Zealand has lower environmental compliance costs and risks than in Europe and North America.

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[1] AFOCEL - Forestry and Cellulose Association
[2] CRPF - Regional Centres of Forest Ownership
[3] INRA - National Institutes of Agronomic Research

Information needs of New Zealand Douglas-fir investors

Compared with radiata pine forestry there is a relative lack of knowledge about Douglas-fir in New Zealand. Better information and strategic advice is needed to reduce investment risk, and to maintain and increase investor confidence. Newcomers to Douglas-fir investment in New Zealand require access to relevant information and experience as soon as possible.

I consider the most urgent areas for better information and strategic advice are:

- Identification of superior Douglas-fir breeds for New Zealand conditions. There is considerable potential for gains in productivity, wood quality, "environmental toughness" and disease resistance.
- Site quality characterisation – identifying favourable growing conditions for Douglas-fir (eg, moisture relations, soil qualities, exposure, temperatures). Many new plantings are established on average sites.
- Improvement of forest establishment and reduction of risks of establishment failure through attention to seedling quality, storage, handling, planting, releasing, and mycorrhiza innoculation.
- Reduction of establishment and management costs (New Zealand Douglas-fir seedling costs are often high).

In addition to these forest management information needs, I was interested in learning about the positioning of Douglas-fir in European lumber markets and its market value compared with other European softwoods.

Both British and French Douglas-fir forestry practices are relevant to New Zealand's situation because plantings have been focused on the productive sites. Also as in New Zealand, Douglas-fir in Europe is an introduced "plantation" species whereas in the PNW it is managed as a natural species. In addition, Douglas-fir has had to compete with well known established European timber species to gain market share. This is potentially instructive for the New Zealand Douglas-fir industry with respect to market opportunities for different Douglas-fir wood products, and their range of market values.

Many people generously assisted with the Study Tour. I wish to record my appreciation to all people mentioned, who generously gave their time and knowledge in the text of the report.

I am particularly grateful to Roger and Christine Belton for arranging the French tour and their translation work, and to my employer, the Ministry of Forestry for its support of both the British and French Tours.

Key Points learnt from the Study Tours:

- Douglas-fir is already one of Europe's major softwood species (600 000 has planted) and it will become a leading species in European construction timber markets with harvest levels set to increase to over 7 million cubic metres by 2030.

- France is the centre of Europe's Douglas-fir industry, with the highest growth rates, and two thirds of the resource, and it will compete strongly with Northern European producers of Norway spruce for market share.

- Forest growing investment decisions in Europe are strongly influenced by direct subsidies, and favourable estate duties on forests.

- Douglas-fir investment has been driven by its high growth rates and robustness, rather than price advantages.

- Price differentials for European grown Douglas-fir lumber are very small compared with competing lumber from other conifers. Market preference is driven by appearance, not mechanical performance.

- The French are pruning 25 to 30 percent of their post 1980 Douglas-fir plantings.

- French Douglas-fir breeding programme is focusing on "hardiness" and "good form" as much as volume growth, and is based on "single flush" families.

- The growth habit of Douglas-fir in France is similar to the PNW, with excellent tree form, high height growth and relatively low stockings and basal areas. Site class 1 areas have MAIs of 24 to 26 cubic metres per ha per year, which is very high by world standards for Douglas-fir.

- Excepting pruning, Douglas-fir management in Europe is similar to the PNW, with moderate initial stockings and repeated light production thinnings.

- France and Europe do not offer an opportunity for US or Asian investment in Douglas-fir forestry due to the fractured land titles, and cultural and environmental issues.

- In the short to medium term French and other EU Douglas-fir breeding programmes represent the most important "information" opportunity for the New Zealand industry.

- NZ has an opportunity for developing a major Douglas-fir industry, with it's large land bank, and excellent growth rates. However matching the quality (better log grade out-turns) of PNW and European grown Douglas-fir will be a major challenge for NZ growers, given the tendency, on highly productive NZ sites for larger branching, greater sinuosity, and(on very windy sites) stem sweep.

BRITAIN

Friday, 15 August
Edinburgh

My first visit was to the British Forestry Commission Headquarters in Edinburgh to meet Bob Selmes, Head of Forest Practice Group with the Forestry Authority, and Alan Corson, Manager Harvesting and Marketing, South Scotland Forest Enterprise. The purpose was a briefing on tour arrangements and an overview of key interest themes.

My principle interest was to learn about Douglas-fir forestry from British experience. However, other aspects of British forestry seen were also instructive and worth recording.

Firstly to introduce British forestry. Britain experienced a steady trend of deforestation over some 2000 years culminating with less than five percent of the land having canopied forest cover by WW1. The Great War timber shortages heightened awareness of forestry as a strategic resource and led to the establishment of the British Forestry Commission and government encouragement of forestry development, which has resulted in 2.2 million has or 10.5 percent of the land area as canopied forest today.

The great majority of new planting has been with conifers, which account for almost 75 percent of the total forest area. Forestry Commission forests are 95 percent coniferous and occupy almost half the total forest area. The majority of Britain's broadleaf forests are privately owned and principally managed for amenity.

The government has made a partial withdrawal from forestry over the last decade, although Treasury plans for privatisation, and major downsizing of the Forestry Commission, have been stymied by public opposition. Partial "reforms" have resulted, such as the 1988 change in forestry taxation (withdrawal of tax deductibility provisions the exact opposite to New Zealand). Other related changes include the introduction of the European Community (EC) related Woodlands Grant Scheme which strongly favours amenity-orientated woodland planting, and downsizing of government new planting and land acquisition. Restructuring has resulted in the formation of a more commercial Forestry Enterprise Division to manage the Forestry Commission forests, a Research Division, a Forestry Authority to manage government grants, education and forestry regulations, and other units.

Multiple-use forest management is a political necessity in Britain with very strong public interest in retaining public ownership. About 50 million day visits are made to Forestry Commission forests annually with some 35 major visitor centres located throughout Britain. Landscape, management, nature conservation and ancient monument (archaeological) conservation are major responsibilities. Balanced multiple-use forest management is the reality in British forestry today.

Following major restructuring and downsizing, Forest Enterprise employs about 2300 staff, and indirectly about 2500 contractors. Forest Enterprise showed a small operating surplus last year for the first time. Operating surpluses are projected to increase to around 18 million pounds by 1999/2000.

Britain imports almost 90 percent of its wood products. Per capita consumption of wood averages 0.783 cubic metres, which is high considering the low level (10 percent) of timber framed building. Timber product prices are set by the import market conditions. Scandinavian

and Eastern Europe are the main softwood product suppliers.

Britain's wood production is currently around 6.0 million cubic metres, and is projected to increase to approx 15 million cubic metres as 1960s and 1970s planting boom harvests are processed, thereafter declining by between 20 to 30 percent as a result of a 50 percent reduction in new planting rates (following the removal of tax deductibility on management costs in 1998). Current new planting levels are around 16 000 hectares per year. Demand is also projected to increase in the future, and in the long-term the percentage self sufficiency for roundwood is projected to remain close (eg, 8 to 12.4 percent) to the current level of 10 percent (Forestry Commission Technical Paper 19). Recycled fibre has a major impact on supply/demand, accounting for 55 percent and expected to increase to 65 percent to 75 percent in the longer term. The growth of recycling has significantly depressed the market for pulp roundwood.

Wood product and roundwood prices peaked most recently in 1994/95 and have since declined 10 to 20 percent. A protracted decline in wood product prices is expected, a consequence of increased Scandinavian and Eastern European/Russian competition for markets and of the mid-1990s recession of German and French economies. Increased recycling of paper has added to supply pressure.

The wider commercial context of British forestry includes the effects of EC subsidies, cheap imports, high-quality imports, as against inferior domestic logs, recycled fibre, low volume local production and processing, strong societal/recreational/amenity interests. While the British market is huge, it is a difficult and highly competitive market, which is essentially "out of reach" for New Zealand producers of commodity timber products.

The regulated nature of British forestry is evidenced by the Woodlands Grant Scheme and how it determines investment patterns. Planting grants are worth up to NZ$2000 per hectares for conifers, and NZ$4000 per hectares for broadleaves, plus annual payments of between NZ$300 per year and NZ$1000 per year for 10 to 15 years, to compensate for loss of income from the land. Similar large payments are made to forestry investors in other EC countries completely distorting investment decisions from market-based profit and risk drivers. Despite the assistance from grants, economic attractiveness is countered by high land values, (up to NZ $18 000 per hectares for prime agricultural land in Britain), high management costs, high crop failure risks, long rotations and low roundwood prices. Internal rates of return 3 to 5 percent real on greenfield plantings are good by British standards. Agricultural and conservation landuses are also heavily subsidised. The net outcome from current regulatory settings (since the 1988 tax changes and introduction of the grants) is reduced levels of investment in new planting for wood production.

A major issue for British plantation forestry is the performance of Sitka spruce which, because of its good growth on marginal agricultural land (including peat soil uplands), accounted for more than 80 percent of plantings between 1930 and 1980. Sitka spruce has not performed to expectation in Britain, producing inferior lumber which generally does not meet structural machine stress grading standards if planted at spacings wider than 2.1 metre centres or thinned too heavily. Sitka spruce wood strength and density is strongly negatively correlated to growth rate ($R^2 = -0.7$).

It has been determined that a minimum stocking of 2 500 stems per hectares (2x2 metres) spacing is required, combined with more conservative thinning and longer rotations to improve lumber grade outturn. The Forestry Commission now requires a minimum establishment

stocking of 2250 stems per hectares for Woodland Grant plantings and 2500 per hectares for its own (Forest Enterprise) plantings. Incredibly, these standards have been applied to all conifer plantings irrespective of species, evidence that a centrist regulatory ethos can still defy reality. Over 95 percent of new conifer planting in Britain is covered by Woodland Grants and therefore comes under the 2250 stems per hectares rule.

The British problems with Sitka spruce wood quality arose partly from past breeding and selection programmes which neglected wood density and focused on growth rate and form, and partly from lower stocking, shorter rotation management that was fashionable in the 1960s and 1970s. The sorry saga of inferior lumber quality and subsequent problems with market penetration has some obvious similarities to our current experience with "new crop" radiata pine.

The British plantation industry has a difficult period ahead given the poor marketability of domestic spruce lumber, strong competition from good quality lumber imports, and the depression of pulp prices, partly due to depressed demand as subsidised recycled fibre increases its market share.

Britain pioneered Douglas-fir into Europe but planting levels have been low, partly because much of the new forest development has been relegated to peat "wastelands" which are unsuited for Douglas-fir. Douglas-fir grows exceptionally well on better quality British sites, and is Britain's fastest growing conifer, with site yield classes (YC) of 25 cubic metres per hectare per year* (m^3/ha/yr). However, the average yield class for Britain's 50 000 hectares Douglas-fir resource is only YC 14. Top Yield Class land has generally been "too valuable" to be made available for forestry. The Forestry Commission has only 20 000 hectares of Douglas-fir, again partly because much of their land bank has been relatively poor quality land.

* The British Forestry Industry classifies sites by Yield Class numbers, which indicate the potential recoverable mean annual increment for the species concerned. For example, Douglas-fir Yield Class 25 indicates a recoverable MAI potential of 25 cubic metres per hectare per year for the site in question.

Monday 18 August

Visit to Forestry Commission Northern Research Station at Roslin, Edinburgh. Meeting with Chris Quine (Silviculturalist and Wind Researcher)

Given an overview and history of British silviculture. British confidence with Douglas-fir affected by its relatively poor wind resistance. On some fertile sites toppling of young Douglas-fir is a recurring problem. Douglas-fir is not regarded as a particularly wind resistant species in Britain. Chris Quine is currently working with John Moore (ex Canterbury University Wind Researcher). He mentioned forest wind insurance provided by British company, Agricultural Risk Management Ltd.

British Douglas-fir regimes are essentially identical to their other conifer species, very conservative (and expensive) with high initial stockings (av. 2500 stems per hectare), followed by light production thinnings from 10 metre height until clearfelling at 50 to 70 years. No pruning is undertaken.

Britain's wind climate is one of the most extreme in the world and addressing the risks of catastrophic wind storms is one of the key considerations in British Forestry. The gradual and frequent light thinnings that characterise traditional British silviculture are partly a wind damage

risk management response. With Continuous Cover Forest Management now in vogue the possibility of selective logging and multi-aged plantation forest with irregular canopies is being revisited.

Windthrow hazard classification has been undertaken over much of Britain, it is based on wind zone, elevation, topex (a measure of site exposure/shelter) and aspect. New Zealand forestry could gain much from British experience and research on the effects of wind on forest growth, and managing wind risks. I collected a number of publications on forestry and wind research in Britain (refer attached publications list).

Meeting with Steve Lee on Douglas-fir Tree Improvement

British Douglas-fir breeding research was progeny based until 1992, and is now focused on clonal breeding programmes. French forestry leads Douglas-fir breeding research in Europe. The best performing British Douglas-fir provenances originate from Darrington in coastal Washington, north of Seattle.

Interesting discussion was held on sinuosity problems in Douglas-fir with Steve Lee. Sinuosity and rogue form trees are widespread problems on British Douglas-fir sites. Steve Lee attributed the problem to moist soil conditions through British summers resulting in continuing growth and insufficient cell wall lignification. He noted the problems were most severe on valley bottoms or poorer drained sites, and least on free-draining valley sides in drier areas. I believe the New Zealand relationships of sinuosity and site are similar. I have observed similar sinuosity problems with Douglas-fir on valley bottom sites in the PNW, Golden Downs in Nelson, where summers are distinctly dry, but ground water is possibly available year round. Sinuosity problems are also evident on moist New Zealand high country and South Island West Coast sites. Regarding heritability and sinuosity, Steve Lee's view was that heritability was low, and site conditions were the main factor. Does this mean that growing Douglas-fir on moist and productive sites has an unavoidable sinuosity penalty? And what relationship is there between sinuosity and structural wood qualities? These questions need to be answered. The "costs" of low grade recovery due to poor tree form and wood quality could outweigh the benefits of faster growth? South Island experience with Ashley and Eyrewell Douglas-fir confirms that seed lots on drier sites have good form compared with moist sites. For example, Ashley seedlots growing on some Southland sites have extreme sinuosity; however, the better form of some Southland seedlots on the same sites strongly points to a strong genetic factor. Better matching of genetics to site conditions is a priority for New Zealand Douglas-fir forestry.

The European Douglas-fir breeding programmes are based on IUFRO collections from the PNW made in 1966-68. These extensive collections from British Columbia to Northern California have been planted throughout European countries. In Britain the origins which exhibited the most favourable growth and form were from below 500 metres and from Western Washington and north-west Oregon. More southern Oregon and Northern Californian selections, which have been favoured in selections for New Zealand's breeding programmes, had high intra-population variation, comparatively poor survival and distinctly poorer form and branching habits. British provenance trials have concentrated on 44 near-coastal selections. Assessment of 38 origins on highly productive British sites at 16 years (Fletcher and Samuel 1990) confirmed that for growth and form in Britain, the best origins came from coastal stands west of the Cascades in Washington, and from south-west Oregon.

More recent developments in the British Douglas-fir breeding programme are also part of a

collaborative EU project involving testing about 250 open-pollinated Washington families and 70 Oregon families which were planted out in 1994-95. The opportunity is being taken to compare family performance for vigour and form amongst PNW and British and French sites. If any families are consistently superior on all trial sites, advance clonal seed orchard materials already established in the US will be introduced to accelerate the EU breeding programmes.

My thoughts re the current NZ Forest Research Co-op breeding programme with its emphasis on Southern Oregon and Northern Californian fog belt selections, is some nervousness re form, particularly for high rainfall, summer moist New Zealand sites.

Helen McKay – On Hardiness of Douglas-fir Seedlings

Helen McKay has done a lot of research on the hardiness of conifer seedlings in Britain, and Douglas-fir has been shown to be the most vulnerable species to low temperature (freezing) and desiccation damage to seedling roots. Root damage is now seen as a major factor in the often poor performance of Douglas-fir seedlings following planting in Britain. Seedlings exposed to sub zero temperatures in storage show significant decline in vigour. Current recommendation is cool storage at around 2°C, and never below 0°C. Spring planting is also recommended in Britain. McKay commented that Douglas-fir seedling root growth is continuous through the winter and the new roots are particularly susceptible to desiccation and frosting. Also noted that Douglas-fir new feeding root growth appears to depend largely on fresh photosynthate, and hardly at all on stored photosynthate, hence with winter planting recovery capability is very low. These comments accord with New Zealand experience of the sensitivity of Douglas-fir seedlings to injury and stress. Root damage may be a major factor in recurring seedling mortality problems in New Zealand. One wonders how often Douglas-fir seedlings stored in shady frosty conditions have suffered injury. A number of papers by Helen McKay on Douglas-fir seedling hardiness are referenced.

McKay also recommends shorter storage period (3 to 4 weeks maximum) following milder winter conditions whereas after colder winters storage up to 10 to 12 weeks is okay.

British mycorrhizal work by Chris Walker has indicated that Douglas-fir root symbionts are so specific that repeated inoculation of nursery soils is necessary to get desired symbionts established.

Most Douglas-fir planting in Britian is with 2/0 bare rooted seedlings, with current prices around NZ$250 per 1000. Containerised seedlings are used on more difficult sites and cost around NZ $350 per 1000. These costs are significantly below average New Zealand Douglas-fir seedling costs.

Chris Nixon, Project Leader, Continuous Cover Management

There is increasing public pressure in Britain to avoid clearfelling and to retain forest canopy for both conservation and amenity purposes. Douglas-fir is considered a prime candidate for "continuous cover management" and a major research effort is underway to test its suitability for this purpose. North Americans are generally sceptical of Douglas-fir suitability for "continuous cover management", partly because of regeneration competition from more shade-tolerant species, especially hemlock.

The British Forestry Commission has established a Continuous Cover Forestry Group (Chris Nixon is Research Leader and contact person) and publish a regular newsletter. The Group has been active in setting up field experiments and in involving private forest owners. There is clearly much New Zealand forestry can learn from the British experimentation with "continuous cover management," and contact needs to be maintained.

Meeting with Bill Mason, Head of Silviculture

Historic commentary provided on British forestry that traced political/social pressures on the effects of plantation development on landscapes, the early 1970s end to conversion of broadleaf forest to conifer plantations, the late 1970s to 1980s movement against dominance of Sitka spruce and against conversion of peatlands to forest, the 1988 taxation change that halved investment in new planting (currently 15 000 hectares per year), and the 55 percent of broadleaf amenity planting with little commercial value. British forest industry has "lost confidence" and policy setting initiatives from the EU are further disadvantaging commercial forestry. The Grant Schemes determine planting and silivulture with 97 percent of new plantings covered by grants. Bill Mason also commented that Douglas-fir would remain a minor species owing to shortages of suitable land, and wind stability problems following first thinning. I commented that early instability might be partly a function of high initial stocking and restricted root development.

Graham Pyatt – Ecological Site Classification

The Forestry Commission is committed to multi-purpose forestry, and is developing Ecological Site Classification of all forest land to provide a sound information base for integrated management for timber, biodiversity and nature conservation. A milestone in the programme was the publication of "Ecological Site Classification for Forestry in Great Britain" by Pyatt and Suarez (refer publications list) which uses the Grampians region in Scotland as a case study to demonstrate application of the ESC method. The classification employs three principal factors to determine site quality: climate, soil moisture regime and soil nutrient regime. The approach is similar to that used for the British Columbia
biogeographic classification system, and to other soil quality based systems. which are widely used in Europe. Part of the driver for these initiatives is sustainable forest management initiatives stemming from Government policy and international protocols. An interesting feature is the integration of ecological/conservation objectives with productive forest management across all forestlands, an approach that New Zealand has largely bypassed with its separation of productive landuse functions from conservation management objectives. A commercial benefit also exists with the detailed site quality classification which enables more sophisticated (less risky) selection of species, regimes, management options and a more accurate prediction of yields.

Tuesday 18 August

Visit to Glentrees Forest near Peebles with Alan Corson, Harvesting and Marketing Manager, Forest Enterprise

Glentrees is a small forest, 1200 hectares planted, 1000 hectares Sitka spruce and 120 hectares Douglas-fir on better drained slopes. A 65-year old Douglas-fir stand is a major recreational feature, large trees, DBH 65 centimetres. Alan commented they were unsaleable, too large for local mills, which have maximum diameter specifications of 45 centimetres. Douglas-fir was very healthy, six-year needle retention, marked sinuosity evident. Continuous Cover Management experiments at Glentrees were not showing success. Failures with natural

regeneration with Douglas-fir, Grand fir and larch.

Prices paid locally for Douglas-fir were no better than the low prices paid for Sitka spruce. The South Scotland timber market is completely isolated from the Douglas-fir world market signals. Viewed Sitka spruce plantings which were too widely spaced, a high outturn of pulp grades, and low outturn of lumber grades was expected. Comment that Sitka spruce genetic improvement programmes had focused on growth and form and not on density and strength. Very small price differentials between pulp and sawlogs (eg, pulp NZ$80 to $90 per cubic metre, sawlogs NZ$100 to $115 per cubic metre at mill door). Considerable evidence of investment in recreation and wildlife with sculpture, tracks, information boards, and amenity plantings, wildlife planting, ponds, (habitat creation) and nesting boxes.

Wednesday 20 August
Visit to Tay Forest Park, Dunkeld Perthshire (North of Edinburgh)

Met Tay Forest Park Advisory Board over lunch at Dunkeld. The Forestry Commission administers 17 forest parks covering 300 000 hectares, with over 50 million day visitors annually, 1.2 million campers annually. Very high standards of landscaping and design of recreational facilities.

Visited the tallest Douglas-fir in Britain at the Hermitage within Craiginean forest, one of Britain's oldest planted forests, established with European larch in the 18th Century when cannon were used to shoot seed at steep bluffs. Nineteenth century follies, antique looking bridges, and "ruins" were relics of Victorian gentry recreational mythology. Walked within Allean forest above Loch Tummel. Unfortunately mist obscured the views but the landscape was extremely beautiful. On the Allean forest walks were ruins of an 8th Century fort and abandoned crofters cottages. Most of the forest was Sitka spruce, with some Douglas-fir on drier slopes and larch and Scots pine on lower slopes. Conservation landscapes and recreational management objectives appeared to be well balanced with timber management.

Thursday 21 August
Buccleugh Estates, Border Country, Southern Scotland

Visit hosted by Andy Little, Head Forester. The Duke of Buccleugh is Europe's largest landowner with three large estates in Southern Scotland and one in England totalling 250 000 acres. The Estate company also had land-based investments in Australia and North America. Commercial forests cover 10 percent of the estates, ancient woodland approximately one percent.

Norway Spruce and larch dominated early plantings. Since 1930, 70 percent of planting hectares been with Sitka spruce; Douglas-fir planting limited by availability of suitable sites, requires freer draining and more fertile sites. Rainfall ranged between 900 millimetres in valleys to 1800 millimetres on the tops. Douglas-fir regimes governed by log size maximum of 50 centimetres l.e.d. at local mills. All planting on the estates covered by Woodland Grants. Grant levels increased in response to concern about falling planting. Andy Little commented that pulp market was depressed, only NZ$80 per cubic metre delivered and Douglas-fir pulpwood only NZ$60 per cubic metre. Comment that Douglas-fir not planted extensively because of establishment difficulties, also seen as poor pulp prospect. Also it requires the best soils. Commented that pulp markets were depressed due to recycling with EU landfill tax subsidies of up to NZ$200 per tonne. Some pulp mills use 80 percent recycled fibre.

The forest landscapes were beautiful, mixed species, and blended with other elements in the rural landscapes.

British log marketing very localised, little intra-regional sales, no export markets. There is also strong market competition from imports and recycled fibre. Without subsidies new planting in Britain would be minimal. Because of subsidies forest establishment and management in Britain is essentially a societal investment for maintaining the cultural values of rural Britain. The commercial objectives of British forestry are secondary.

Friday 22 August
Visit to Forest Enterprise Ae Forest, Dumfries, SW, Scotland with Julian Fryer, District Forester, Hectaresrvest and Marketing

The 38 000 hectares Ae Forest was developed post WWII, with establishment of forest villages, and broad acre planting of peat uplands (120 to 500 metre altitude). Very exposed marginal sites, Sitka spruce yields 12 to 18 cubic metres per hectare per year, with high wind hazard rating (4 and 5 on scale to 6). Eighty percent of Ae Forest is Sitka spruce. Early plantings were at 1.5 metre square spacing (4500 stems per hectare), since 1980 average spacing is 2.0 x 2.0 metre square (2500 per hectare). Log grade outturn expectation was 50:50 sawlog:pulp, actual result is 80:20. Windthrow losses are major, average 20 percent loss of volume, about half recoverable.

Julian commented on Latvian log and lumber imports depressing local prices, 20 to 25 percent sawlog price decline over last two years. Departed Ae Forest at 4.00 pm for Drumlaurig Castle Woodlands, one of the finest forest landscapes in Britain according to my guide. The woodlands at Drumlaurig are 90 percent conifers but due to skilful layout and use of broadleaf and amenity conifer plantings, a remarkably varied and harmonious landscape has been achieved. The Castle Gardens contain the oldest Douglas-fir and Western hemlock in Britain, planted around 1830 by the brother of botanist David Douglas who collected the seed near the Columbia River, Washington in the 1820s.

Saturday 23 August

Travelled south, stopped at Hectaresdrians Wall, the first relic of Roman occupation I had seen in Northern Britain. The wall was surprisingly small in scale and appeared to serve as much as a demarcation as a defence. The surrounding landscape was principally open land, the dense forest of Roman times long erased. Many hills in Southern Scotland had visible mounds and ditches that were sites of pre-Roman forts and settlements. The archaeological richness of the British landscape is extraordinary.

Sunday 24 August
Visit to Grizedale Forest Park, in the Lake District, Northumberland

Picture book beauty, rugged glaciated landscapes with narrow lakes, and beautiful rural villages and farms in stone and slate and drystone walls. The Lake District was mostly forested until major clearance began during Roman times. The first record of management of the native oak, birch, ash and hazel woodland at Grizedale was 11th Century coppicing by Furness Monastery. Grizedale Forest Park has 350 000 visitors annually, a major visitor centre, education programmes, an outdoor theatre, and an internationally famous gallery of outdoor sculptures which are located along its numerous forest walks.

The forest is quite intensively managed for timber production and I was pleasantly surprised by the close proximity of harvesting to walking tracks. New Zealand's OSH paranoia would not fit well with British multiple-use forestry. Sitka spruce predominates the commercial plantings, being best suited to the high rainfall and windy climate. Six foot high fencing is an expensive feature of re-establishment, its purpose being deer exclusion. Deer fencing is retained for 10 to 15 years. Thinning is undertaken at 5 to 7 year cycles from age 25 till clearfell at 55 to 70 years. Larch and Scots pine are also important species at Grizedale. While Douglas-fir is only a minor species, the stands I observed all had excellent form and vigour.

Monday 25 August
Westonbirt Arboretum

Travelled south to Bristol, via Manchester, the Midlands, and Fosse Way, the route of a 1st Century Roman military road. Visited Westonbirt Arboretum which contains one of the world's greatest tree collections, 18 000 specimens planted amidst 600 hectares of beautifully landscaped grounds. Plantings began in 1829, and have been managed since 1956 by the Forestry Commission. The arboretum walks total about 30 kilometres and includes national collections of elm, ash, beech and oak and a major larch and Douglas-fir plantation. An absolutely amazing experience, I only regret I had limited time. Visitors to the arboretum should allow at least a full day to explore it.

Tuesday 26 August
Visit to Mortimer Forest in the Welsh Border Marches hosted by Ian Hickman, District Manager

Mortimer Forest has some of Britain's most extensive and productive Douglas-fir plantings. Yield Classes ranged from 16 to 24 cubic metres per hectare per annum. Basic regime similar to elsewhere, plant 2500 stems per hectare, 2x2 metre spacing 12 months after harvest, and site preparation with herbicides and disc scarified. Intention to expose mineral soils. Releasing by "Roundup" with shield to protect seedlings. Birch regeneration "cleaned" at 7 to 8 years. First thinning to 1200 stems per hectare at 18 to 20 years, subsequent thinning cycle at 5 to 7 year intervals until clearfell at 42 years.

IRR's estimated as 4.5 percent average, which is high for Britain. Approximately two-thirds of Mortimer Forest is planted with Douglas-fir. Douglas-fir on drier (900 millimetre rainfall) and more sheltered sites. Windthrow problems mentioned. Wind Hectareszard Class III, 60 kilometres per hour winds common. Major windthrow occurred in the 1987 and 1991 storms. Sitka spruce planted on higher ground. Some scepticism expressed about Continuous Cover Management for conifer stands, suggested it was best suited to broadleaves.

Douglas-fir 2/0 seedlings costed at £85 per 1000 = NZ$240 per 1000. Average stumpage value at clearfell $120 per cubic metre. Preference for Douglas-fir based on high yield, not log price. No significant premium paid for log quality. Ian commented that price differential for Douglas-fir compared with Sitka spruce has declined. "UK timber retail yards only sell imported products, no appreciation of local product". Major market development needed. Health of Douglas-fir excellent, an insect scale being the only noteable problem (*Inglesia* species). Although Swiss Needle Cast was present it was not seen as a health problem (most British foresters were unaware of SNC on their Douglas-fir).

Wednesday 27 August
Bristol – Preparation for London TRADENZ Seminar

Thursday 28 August
Alice Holt Research Station

Sessions with Paul Tabbush, Head of Silviculture Division, Janet Methley, head of Mensuration, Robert Mathews, Growth Modelling. Paul Tabbush revisited themes of establishment problems due to seedling roots "sensitivity" to physical/ temperature/ desiccation damage, and toppling risks. Also noted Douglas-fir more palatable than spruce, deer browse a major problem. Suggested that absence of adequate summer moisture in Britain prevented conditioning required for hardening off seedlings, and young plantings. On economics Paul commented that the very high opportunity cost of good land for forestry (eg, NZ$12 to 15 000 per hectares) due to agricultural options being more heavily subsidised by EU agricultural policies. Farmers also suspicious of risks of long-term subsidies for forestry, given the certainty of more changes. Paul Tabbush considered poplar the most profitable forestry investment option for good agricultural land in Britain, shorter rotations (17 to 20 years) and high IRRs (15 percent plus based on 20-year rotation, 150 stems per hectare, 2 cubic metres per tree recoverable 300 square metre per hectare, MAI 15 cubic metres) and production of clear veneer bolts. Stumpages £25 (cubic metres, - £7500 per hectare). Only 200 hectares per year being planted in poplar in Britain. However, this rather optimistic view is based on rather limited information.

Discussions with Janet Methley and Robert Mathews focused on silviculture, mensuration and growth modelling. Traditional British forestry growth models are represented by the Forestry Commission's published Yield Class Tables. The Tables are based on visual interpretation of plotted stand measurements and harvest out-turn studies. They illustrate relationships between principal stand variables for commercial species in terms of stand age, height, stocking, basal area, total and recoverable volume. A vigorous programme of yield model construction occurred from 1920 till 1980 and culminated in publication of Forest Management Tables for all major commercial species. The best known Yield Class publications were by Hamilton and Christie (1973) and Edwards and Christie (1981).

The Yield Class Tables have served the British industry extremely well by providing a sound information framework for forest managers to work with and particularly by allowing forest site quality to be directly represented by a yield class (site productivity) description. All British land is characterised by Yield Class for best prospect species, and by wind damage hazard rating. A major weakness of Yield Class Tables is their lack of flexibility compared with predictions based on computer functions. For example, if the described thinning regime is not complied with, this cannot be accounted for by the yield tables because they assume compliance.

One of the key advantages of the yield class system is British foresters (and non-forestry people) can readily identify the productivity potential or site quality of forest land. The British system also promotes awareness of maximising forest productivity and regulating thinning intensity to maintain high productivity. New Zealand foresters have tended to scorn the British approach; however, our focus on site index, and failure to appreciate the volume and quality losses associated with wide spacing management (low basal area) have significantly affected the productivity and quality of much of our forest estate. Furthermore, New Zealand foresters are possibly not so attuned to site quality as a key issue for forest growing which is reflected in the often poor site selection decisions made by New Zealand foresters.

The Forestry Commission is currently working on a new suite of computer based yield models for Sitka spruce that will be available in Windows software.

Friday 29 August
Forestry Investment TRADENZ Seminar in London with John Falloon

Saturday 30 August
Visit to Rob Guest

Very useful discussions on British forestry compared with the New Zealand situation covering ongoing British Treasury pressure to downsize the Forestry Commission, ongoing restructuring, job losses, and effects on morale. The sale of public forests is not considered likely under a Labour government.

Difficult market conditions can be expected to continue for some years due to dumping of excess production from Scandinavian and former communist Baltic countries, and because of the inferior quality of most British-grown wood.

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(These publications are held by, and may be accessed, via Mark Belton, Ministry of Forestry, Christchurch.)

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FRANCE

The total area of French forests is 15 million hectares, double the area of 200 years ago. Seventy percent of France's forest area is privately held by 3.7 million owners, the average holding size being just 2.8 hectares. Coniferous forests account for almost five million hectares. The largest planted forest in Europe is one million hectares of *P. pinaster* in the Le Landes region in the SW corner of France.

The dominance of small private ownership necessitates major activity in the provision of strategic and technical advice to the numerous (35 000 plus) forest owners. It also necessitates co-operative arrangements for research, technology transfer, and marketing for the French forest industry to be internationally competitive.

As with Britain, the rural landscapes of France are an integral part of the national identity and culture, and rural landowners are custodians of this "cultural resource". Forestry is the major land use over much of France, and the general population are very protective of their "hunting and gathering" and other usage rights. I was told one-third of French adult males have hunting permits, and certainly during the hunting season the high density of hunters on the ground is beyond belief. On one occasion, from one viewing position, I could see four hunters and two mushroom gatherers all "stalking their prey". In addition to the French populace's strong attachments to their "traditional" forest rights, the forest landscapes are very important for the tourism industry. France has the world's largest tourist industry, and the tourists increasingly pursue the rural experience.

France has comprehensive and complex government involvement in landbased industries. The most important organisation for private Douglas-fir forestry in France is CRPF, which is publicly funded to provide strategic and technical assistance to forest owners. CRPF has 256 staff including 70 foresters. CRPF audits forest management plans that are required under French law for all forests larger than 25 hectares. CPRF approval of plans and regimes is a condition for eligibility for subsidies from the National Forest Fund (FFN). The FFN is a special fund mainly based on tax on forest products which is directed back to reafforestation and CPRF approved management. The tax base has been halved since 1992, reducing money available for subsidies, and contributing to the marked reduction in reafforestation since 1992. Public research organisations include INRA (Tree breeding), ONF (National Forest Statistics), and the main private research organisation is AFOCEL (a forest industry research organisation).

Douglas-fir afforestation began developing strongly from 1950s, peaked in the 1970s and 1980s and has since declined, particularly since the 1992 tax changes. Douglas-fir represents about 30 percent of the conifer cover in France. The Douglas-fir estate now totals about 360 000 hectares and is 82 percent privately owned. Expansion of the Douglas-fir estates has also slowed due to environmental constraints and the depressed state of the French economy. Based on recent trends the French Douglas-fir estate is likely to plateau around 450 to 500 000 hectares. If significant price differentials develop between log prices for Douglas-fir and other softwoods, further rapid expansion could occur from post-harvest replacement of less commercial species by Douglas-fir. To some extent this is already occurring as a result of Douglas-fir being promoted as being faster growing and more robust than other conifers in most French forest growing regions. Current new planting of Douglas-fir is about 10 000 hectares per annum, whereas during the peak planting years 30 000 hectares per annum was being established.

Current Douglas-fir production is 1.5 million cubic metres, by 2005 it will reach three million

cubic metres and six million cubic metres by 2030 (based on recoverable MAI of almost 17.5 cubic metres per hectare per year which is close to the New Zealand average, cf. PNW av. eight cubic metres per hectare per year, and Britain 14 cubic metres per hectare per year).

France is destined to become one of the world major producers of high quality Douglas-fir structural softwood, and a major competitor in world Douglas-fir markets.

Unlike New Zealand, France is not a significant investment prospect for international investors in Douglas-fir forest growing. Forest ownership is too complex, the average Douglas-fir holding being only 2.5 hectares. Industry infrastructure is also complex and inefficient and disadvantages French forest owners, particularly in getting product to Pacific rim markets.

Wednesday 24 September
Toulouse

Arrived at Toulouse at 5.00 pm to meet with John Warjone, President of Blakely Pacific Ltd, Seattle, USA and Roger Belton, Forest Manager, Domaine de la Pouyade, Perigord. Roger Belton had arranged the French Forestry section of the Study Tour with assistance from French Douglas-fir forest industry leaders and provided translation services throughout the tour.

Thursday 25 September
Le Tarn, Midi Pyrenees

We met with French Douglas-fir foresters at 9.30 am near Mazamet in the Tarn Region. Our hosts were Philip Therenet (Assistant Director of CRPF, Midi Pyrenees), Jean Pierres Outisset (CRPF Forest technician and Douglas-fir specialist), Bertrand Caurin (International Missions AFOCEL), Jacques and Elizabeth Berry, and Renee Raynaud, (who were owners of substantial Douglas-fir forests in the region), and heads (Presidents) of national and regional private forest owners associations.

Le Tarn is the southern most extension of the "Central Massif", the mountains and uplands in the centre of France which have the greatest concentration of Douglas-fir forestry. The five leading Douglas-fir regions in France are within the Central Massif uplands.

The Le Tarn Douglas-fir forest areas are on granitic soils, averaging pH 4.5, rainfall 1000 to 1800 millimetres per year and altitude ranging from 600 to 900 metres. The Le Tarn is where Mediterranean and Atlantic climates meet and strong equinoxal gales (fohn winds) are a feature of the climate. Le Tarn region has one of the highest levels of forest cover in France (85 percent), and a high proportion of private ownership (80 percent), a result of massive reafforestation of abandoned farmland over the last 100 years. Major forest owners include leaders of the region's tanning industry who have provided employment for ex-farm owners through purchasing and planting their land. Mixed deciduous hardwood forest dominates harder sites with conifer plantations on the better sites. New planting virtually stopped 15-years ago, because of pressure to preserve remaining pastureland, and more recently because of concerns about monocultures with introduced trees and landscape issues. The region has strong winds and heavy snows. Douglas-fir is noted as being faster growing and hardier than other conifers in the Le Tarn.

The first site visit was to an establishment trial at Bellessere. Norway spruce had been harvested, and windrowed. Vigorous broom affected most of the site except where minimum mechanical site disturbance had been practised.

A 3-year old planting at 1270 stems per hectare with 2/0 barerooted seedlings had established well amongst broom without use of herbicides. At a nearby site 2-year old plantings with 2 plus 1 transplant seedlings had been established at 5 x 2.5 metre spacings. Wide spacings are common practice and large branches on lower 6 metre logs were to be "controlled" by pruning. Comment was made that it was more important to get a smaller number of seedlings growing strongly to beat weed competition. Expected little difference in branch size between establishment stockings of 800 and 1300 stems per hectare.

Thinning Trial at Cros Haut. We examined a 28-year old thinning trial stand, productivity Class 1, max MAI 25 cubic metres per hectare per year, planted at 1800 stems per hectare. Two thinning intensities being trialed with target final stockings of 350 stems per hectare and 650 stems per hectare. First thinning at 16 years, second thinning at 21 years. Expected harvest age 50 years. The basal area in the unthinned control was 70 square metres per hectare. Thinning control method developed after a major storm in 1982 which caused massive damage to local forests. Thinning stopped when height: diameter reaches 75:1 (eg, 25 metre height:33 centimetre diameter).

Visited 60 to 80-year old and very beautiful Douglas-fir forests belonging to the Berry families. Visited a 68-year old stand that was last thinned at age 55 years. Some wind fall logs had been extracted just prior to our visit. A strong response to the thinning at 55 years was evident in the ring count. The stand had been planted at 2000 stems per hectare as a mix of Norway spruce, Sitka spruce and Douglas-fir. First thinning occurred at 35 years and subsequent light thinnings at 6 to 7 year intervals. Douglas-fir were selected as crop trees, the current stocking was 200 to 250 stems per hectare, height 45 to 50 metres, BA 55 square metres per hectare, volume 1000 to 1100 cubic metres per hectare, BA 4.5 square metres per tree. Value was only 350 to 400 FF per cubic metre stumpage (NZ$100 per cubic metre). Value was penalised because of over-size of trees.

Lightning-damaged Douglas-fir were seen in this area. Surrounding trees also set back, attributed to root damage from the lightning strike. (Stand age 50 years, MAI 20 cubic metres per hectare per year.)

Visit to another of the Berry's forests, planted 1926 and first thinned in 1975, subsequently thinned at 8 year-intervals. Stocking was 240 stems per hectare, DBH 60 centimetres, volume 900 cubic metres per hectare, BA 55 cubic metres per hectare.

Average log sale price was 500 FF per cubic metre delivered at mill door (NZ$125 per cubic metre). There was a 10 percent price premium on Douglas-fir compared with spruce. All sales are to local mills. No log transport by rail occurs in France due to problems with railway unions. Obtaining a better price for logs was the key issue for the French growers. John Warjone estimated the large logs we observed would have a two to three times higher value in the PNW markets.

Young seedlings were released by mowing broom and other hardwood regeneration. There was a reluctance to use chemical releasing. Animal damage to seedlings was a major problem.

The Le Tarn countryside was exceptionally beautiful, and forestry totally integrated into the landscape.

Friday 26 September
Rodez-sawmill visit

Met with M Phillippe Collas, Forest Engineer of the regional Forest and Wood Industry Association. M Collas worked in marketing forests to log buyers and wood products marketing. The Midi Pyrenees region has 300 plus sawmills, average size 3000 to 4000 cubic metres annual production. The largest mill had 30 000 cubic metres production. The average Douglas-fir mill door price 450 to 500 FF per cubic metre for 70 centimetres l.e.d. logs (NZ$100 to NZ$130 per cubic metre). Competition from cheap imported lumber from Eastern Europe and Scandinavia was cited as the main reason for the depressed log prices.

EU has not yet established a common forest policy, or common industry standards. Working towards common EU log grade standards. Scandinavians trying to retain visual grading. French Douglas-fir industry pushing for machine stress grading. French Douglas-fir has much better stress:strength characteristics than Norway spruce. Achieving acceptance of MSG is essential to French industry.

The 10-year-old mill at Rodez processed 13 000 cubic metres of logs annually (52 percent recovery). Paying NZ$500 per cubic metre at mill door for Douglas-fir. Twenty-five percent of production Douglas-fir, balance was a spruce or pine. Douglas-fir being CCA treated which was a surprise as this treatment is not used in New Zealand. Processed for flooring, cladding, beams and framing. Arisings were chipped, dried and sold as fuel 120 FF per cubic metre dry, NZ$40 per cubic metres (4.5 cubic metres per tonne).

Saturday 27 September
Domain de la Pouyade

We visited La Pouyade forest, a 1000 hectare estate of mainly chestnut coppice and oak. The property also had undertaken small plantings with Douglas-fir since the early 1900s, but very poor results on some sites caused a loss of confidence in the species. Most extensive conifer plantings on the estate were *Pinus sylvestris, P. pinaster* and *P. nigra* (laricio) and Norway spruce.

The problems with Douglas-fir were due to low soil fertility, particularly phosphorus (P) deficiency on impoverished granitic glacial deposits. Calcerous soils on the property had adequate fertility and supported good growth for the local rainfall level of 900 millimetres. Some Douglas-fir plantings on infertile sites had very high mortality and suppression by volunteer tree regeneration (oak and chestnut) with surviving trees as small as 4 metre height and 15 centimetre dbh at 60 years. Nutritionally stressed trees had 1 to 2-year needle retention, whereas healthy trees had only 3 to 4-years retention. Foliar phosphorus nutrient levels on stunted trees were as low as 0.05 percent phosphorus.

In the 1970s CPRF established a fertiliser trial with Corsican pine at La Pouyade and achieved a 700 percent volume growth response following application of phosphorus. The estate forester of the time had declined to apply fertiliser despite these results on the grounds it increased branch size too much!

Management issues for the property were methods for conversion of exhausted chestnut coppice and post-harvest conversion of other conifers, to Douglas-fir. Fertilising was essential to achieve growth potential; however, fertiliser exacerbated problems with wild animal damage and weed competition. There was a reluctance to use herbicides and tree rows were mown annually to control woody weeds. Roe deer damaged young trees but were valued as game, and their numbers were controlled through regulated hunting agreed to by the local government hunting association.

Returns from hardwood forestry have declined by up to 25 percent over the last two decades. Hardwood pulp is the main product from chestnut coppice, but stumpage prices were extremely low. Only a very small proportion, (eg, 10 percent) of the oak managed on 120-year plus rotations produced high value veneer logs.

Douglas-fir is seen as being the leading commercial forestry opportunity on La Pouyade as it is for much of France; however, conversion to Douglas-fir is constrained because of mounting "environmental sensitivities". Nevertheless post-harvest conversion to Douglas-fir from other conifer species, rather than new planting on bare land, will be the main form of development in the future.

Monday 29 September
Limousin CRPF and AFOCEL trials

The day's programme was organised by Daniel Michaud, Assistant Director AFOCEL, Alain Bailly, Director AFOCEL, and Maryse Bigot, Research forester AFOCEL also participating. We were joined later in the day by Jean Charles Bastian from the INRA tree breeding programme, and Jean-Louis Ferron, Assistant Director of CRPF Limousin.

The first site visited was a young poor performing Douglas-fir stand which had various fertiliser treatments which confirmed phosphorus application was essential on acidic granitic soils. Dramatic improvements in crown health and growth had been achieved with modest applications of phosphorus. Comment made that copper deficiency was also common. A significant part of the higher rainfall Douglas-fir growing area in the Central Massif is on strongly leached granitic soils. Fertilising is an integral part of good management, being promoted to private growers. DAP and rock phosphates are the commonly used fertilisers.

The second site was a Douglas-fir trial which incorporated a thinning intensity design. Generally trees were lightly branched and good form even at quite low stockings. Modern French silviculture has moved to low initial stockings and pruning of Douglas-fir.

Long discussions were held on the rationale behind the extensive Douglas–fir pruning programmes in France. Pruning has been heavily subsidised through government grants and has been promoted by CRPF who approve private forest management plans (a condition of eligibility for subsidies) and provide technical advice. The view was widely held that pruned Douglas-fir would be stronger, more versatile in enduse, and attain higher values. The pruning strategies appeared to have been developed without reference to economic analysis or proof of price differentials for clear Douglas-fir. No analysis was presented which justified the substantial investment in pruning. The case was made by John Warjone and I, that unpruned Douglas-fir already attained premium prices in large volume structural markets, and that no worthwhile premium was paid for clearwood Douglas-fir in these markets. Further, the pruned wood remanufacturing market was relatively small, and Douglas-fir wood qualities were not

particularly well suited for remanufacturing. Also, other conifer species (notably radiata and other pines) could be managed to supply these markets with better quality wood at lower cost. The AFOCEL people agreed with these arguments. Fashions are more powerful than reason. The Douglas-fir pruning programme in France is very large (3000 hectares per annum) and will deliver a premium appearance product which should provide market share if not price advantages.

Breeding Trials

The third site visited was a major Douglas-fir breeding trial at Valmate about 40 kilometres north-east of the regional capital, Limoge. The trials are jointly managed by AFOCEL and INRA. The Valmate trial site covered 30 hectares, one of a series of five replications established across France in 1989. The within-trial design was 40 plot replications of 600 progeny, each represented by a single tree. Similar trials (from the 600 progeny) are planted in Spain, Belgium, Germany and Britain.

The French Douglas-fir breeding programme is the major force in the IUFRO programme, based on 640 Washington selections, 350 from Oregon, and over 1000 collections from within France. The range of latitudes covered in the trial series is much wider than the latitude range of their origins. Californian collections were not included because they flush too early, which increases the risk of frost damage, and second flushes being "dried off" during hot, dry summers which stresses stands. Also "double flushing" progeny were noted to be more prone to sinuosity, forking and rougher branching habit.

As a consequence the French breeding programme has focused on selecting from late-flushing families. Date of flushing was noted as one of the most stable heritable characteristics. Coastal Washington (Fog Zone) provenance were all round best performers (eg, Umberto 144). This coastal material is uninodal and slower growing for first 12 to 15 years than double flushing provenances. Single flush provenances were observed to catch up in growth rate after about age 20. Huge genetic gain was expected from selections of best individuals from these trials, which will be used for a clonal bank.

The French work reinforces my query about the current focus of the New Zealand breeding programme. In the South Island. late frosts and dry summers are a feature of Douglas-fir growing areas. Also, the Washington progenies which exhibit the better form, and possibly lower climatic risk characteristics, are clearly capable of far higher growth rates than in their place of origin (eg, MAIs of $\geq$ 26 cubic metres in Europe cf. 20 cubic metres per hectare) and also demonstrably grow well over quite a wide range of latitudes. It would seem prudent to avail ourselves of the EU Douglas-fir breeding programme elite selections, and to include some in NZFR Douglas-fir Co-op progeny trials.

Establishment and PSP Trials

Our next visit was to 3-year-old establishment trials which examined interaction of seedling types, different releasing strategies and fertilising. Transplant seedlings were most vigorous.

Our next stop was at the St Amand thinning trial which served as the outdoor setting for a demonstration of the AFOCEL Douglas-fir growth model which has recently been developed by Maryse Bigot and Alain Bailly. Leith Knowles, the NZFR Douglas-fir Co-op manager, has had direct contact with the AFOCEL growth modellers. The AFOCEL Douglas-fir growth model

had been calibrated for a very wide range of thinning intensities and its capabilities were well demonstrated. French site class 1 sites are typically production thinned from age 19 to 21 years onwards at 5 to 6 year intervals, with basal area removals up to 20 percent of total basal area, which is very similar to PNW management.

The French site class 1 stands attain recoverable MAIs of 23 to 25 cubic metres per hectare by age 50. Crowns are quite light with generally only 3-years needle retention (I rarely observed 4-year retentions). Basal area maxima were 60 to 70 square metres. Overall the growth habit of French Douglas-fir forests was similar to PNW forests, that is; relatively low stand basal areas and high stand height growth. This is quite different from the high productivity of South Island New Zealand sites which exhibit lower height growth and exceptional basal areas.

Monday 29 September
Meeting with French Douglas-fir Forest Industry leaders at "Genoscope de Lenaud".

Genoscope de Lenaud is a modernistic functions/event venue, and is the centre for local CRPF, and the centre for the Limousin pedigree cattle sales. It is built entirely from Douglas-fir.

After dinner, John Warjone and I gave slide presentations on PNW and NZ Douglas-fir forest industries (ably translated by Roger and Christine Belton). The following people were present:

* Mr Guillard, President of the industry group "Interbois Limousin"
* Mr Fockeday, "France Douglas", President
* Mr De Seze, "L'Union Regional de la foret Privee", President
* Mme Reyre, "CRPF", President (Regional)
* Mr De Mijolla, "Centre d'Etudes des Techniques Forestier (Technical Forestry Studies Centre, President
* Mr Bouvarel, CRPF Limousin, Director
* Mr Bailly, AFOCEL Centre West Region, Director
* Mr Michaud, AFOCEL Centre West Region, Assistant Director
* Mr Moreau, "Bris et Scierie du Centre", Manager
* Mr de Boncourt, GEPROBOIS, Director (co-operative company servicing forests)
* Mr Ferron, CRPF Limousin, Assistant Director and Chief Executive "France Douglas"
* Ms Bigot, AFOCEL

Tuesday 30 September
Parc de Bort , Tour leader Jean-Louis Ferron,

The day began with a visit to a large estate "Parc de Bort" belonging to Edmond De Seze who was one of the pioneer planters of Douglas-fir in the Limousin Region. Mr De Seze also headed the Limousin Association of Foresters. His grandfather had established a group of Douglas-fir seedlings in the estate garden in 1860, and this had been his inspiration to plant Douglas-fir before the species was supported by Government foresters. Mr De Seze had afforested much of the estate, locating Douglas-fir in the best soils. Original plantings after WWII were planted as alternate rows of Norway spruce and Douglas-fir at 2x2 metre spacing. The spruce was sold as Christmas trees and repeated production thinning had resulted in the current stocking of 400 stems per hectare. The best crop trees had been pruned to 2.5 metre, clearfelling was scheduled for 50 years. At 40 years stand age and 400 stems per hectare, basal area was only 40 square metres per hectare.

The Limousin Region was experiencing a problem with "over supply" of Douglas-fir thinnings. Since 1970 planting rates in the region had averaged 2000 hectares per annum. A typical regime was to plant 1100 stems per hectare, thin (to waste) at 13 years to 600 to 850 stems per hectare, with production thinning at 20 years including pruning 220 stems per hectare final crop trees to 6 metres. Early production thinning promoted undergrowth and improved habitat for wildlife. A third thinning at 35 years produced 60 cubic metres per hectare, stumpage prices were only NZ$50 per cubic metre for medium sawlogs, NZ$25 per cubic metre for posts and NZ$8 per cubic metre for pulpwood. A feature of cut stems was the large sapwood zone averaging 12 rings, and up to 17 rings. Log prices were generally NZ$25 to NZ$40 per cubic metre cheaper than at La Tarn. Price competition from Northern Europe supplies is stronger in this part of France.

Sawmill , Robert Moreau

In the late morning we visited the largest and most modern wood processing mill in Limousin, at Moissannes. The mill, owned and operated by Robert Moreau and family, was built in 1993. It has a 80 000 cubic metre log input, produces 36 000 cubic metres of lumber, and 30 000 cubic metres of chip, the sawdust goes to a panel plant and bark is processed for fuel. The mill was custom built by Kallfass, a German company, to process small dimension logs from thinnings. Input was 45 percent spruce, 40 percent Douglas-fir, 15 percent larch and fir. The largest mill in France, in the Rhone Valley, processes 200 000 cubic metres per annum of logs.

The Moreau mill produced outdoor furniture, decking, fencing materials and cladding in addition to construction lumber.

Average log size is 35 centimetres l.e.d., 18 centimetres s.e.d. and 7.5 metre length. The mill paid NZ$70 cubic metres on forest ride up to 80 kilometre distant. As the marketing and processing of wood has become more competitive over the last 10 years, several hundred small mills in the central Massif region have closed.

In the afternoon we travelled into the hills east of Limoge to visit CRPF experimental sites. First stop was a 30-year-old stand on a windrowed chestnut coppice. Regrowth had been cleared manually. At La Croix CRPF, 33-year-old thinning trials were visited. Common thinning "steps" from 1250 stems per hectare were at 20 years to 700, 26 years to 500, 30 years to 350 stems per hectare. CRPF support for pruning has existed since 1985. CRPF in Limousin guides the management of about 60 percent of private planting. CRPF influence on small private growers is mostly through educational services and demonstration plots as well as through auditing management plans and administering subisidies.

Pruning Douglas-fir became a common practice from the mid 1980s. Harvest age target is 50 to 55 years and pruning DOS aims at being within one-third of final dbh. The Limousin region's high pruning programme covers about 400 hectares per year. Limousin's clearwood Douglas-fir production projected to reach 18 000 cubic metres per annum by 2010.

Typical Douglas-fir Regime Costs - 1997:

Plant	**1100 s/ha**		
Subsidised Cost	**France**	**PNW**	**NZ**
Seedlings	1.5FF/s (NZ32c/s)	US15c/s	NZ40c/s
Planting	1.5FF/s (NZ32c/s)	US12c/s	NZ25c/s
Weeding	3000FF/ha (750/ha)	$75/ha	$100/ha

7.5 metres, thin to waste and prune 300 to 2.5 metres 3500FF/hectare
12 metres, production thin, prune 220 to 6 metres 1500FF/hectare (pruning cost) NZ$450/ha
17 metres, production thin - no cost
IRR expectation 8 percent
Subsidy 40 percent of cost
Land Price 5000FF/hectare 1997 (NZ$1200)

Wednesday 1 October 1997
Visit to Cosylva Lamination Plant at Bourzaneuf.

The Cosylva factory specialises in production of laminated beams for industrial uses. Lumber used is 80 percent imported Norway spruce and 20 percent Douglas-fir thinnings. Scandinavian lumber is delivered to exact specifications and is cheaper. A Russian consignment of spruce had been rejected the previous week, quality control is very important. I queried why only 20 percent of Douglas-fir used? Response: "Slightly more expensive, but stronger, clears are the Rolls Royce". They also considered the appearance of the Douglas-fir was not as good as imported spruce. Machine stress grading had demonstrated that the weakest Douglas-fir lumber was stronger than any of the imported Norway spruce lines. The arguments against using more Douglas-fir were mainly based on appearance, and only slightly on its marginally higher cost.

The example illustrates the difficult marketing future for the French Douglas-fir industry. A major education programme will be required to promote knowledge and acceptance of the superior mechanical performance of Douglas-fir lumber. Only when this is achieved will a market preference for Douglas-fir begin to develop, and more realistic price differentials based on its superior utility be achieved. I fully expect the French forest industry to be highly effective in promotion of Douglas-fir and market development. Whether this will create opportunities for New Zealand Douglas-fir or stiff competition in our overseas markets remains to be seen.

French Forestry Publications List:

Le Douglas, AFOCEL, 1997 Editor Jean de Champs, 416 pages (The French Equivalent to the Radiata Pine Growers Manual – with each chapter written by leading French Douglas-fir experts). (French Translation of key sections available on request.)
Chapter:
1 Background of Douglas-fir
2 Douglas-fir in Europe
3 Establishment of Douglas-fir
4 Management of Douglas-fir
5 The Timber of Douglas-fir
6 Douglas-fir Woodflows and Productivity
7 The French Douglas-fir Regions
8 Economics of Douglas-fir
9 Douglas-fir and the Environment (Fr)

Info – Douglas – Industry Newsletter
1996, 8 pages (Fr)

Douglas dans le Tarn – Industrial Wood Applications – address to Chamber of Commerce, 1996, 35 pages (Fr)

"Replanting in Douglas in Le Tarn"
1996, 4 pages (Fr)

Thinning of Douglas-fir Plantations Forest Enterprise no 78
1988, 30 pages (Fr)

Sustainable Forest Management in France
National Plan for the Implementation of the Statement of Forest Principles
Rio, 1992, Ministry of Agriculture and Fisheries, 1997 (Eng)

Why Prune – Brochures including National Forestry Fund information (Fr)

"Douglas-fir Growth Model"
AFOCEL Bulletin, 1997 (Fr)

CRPF Douglas-fir Trials and Demonstration plots in Limousin
10 Brochures (40 pages) covering key Douglas-fir silviculture issues (French)

Stocking Levels in Douglas-fir Plantations
AFOCEL, 1994, Forest Information , 29 pages (Fr)

Aspects of the Variability of Douglas-fir Provenance from Western Washington
D Michasud et al, 1987, AFOCEL, 38 pages (Fr)

Site Preparation for Douglas-fir
AFOCEL 1987, 21 pages (Fr)

Fertilisation of Coniferous Plantations
AFOCEL, 1982, 27 pages (Fr)

Analysis of a Multi-site Experiment in Douglas-fir Maternal Progenies from Approved French Stands, D Michasud et al, 1990 , 34 pages (Fr)

What Stocking for Douglas-fir Plantations?
AFOCEL, 1990 (Fr)

NEW ZEALAND FOREST RESEARCH INSTITUTE LIMITED CONFIDENTIAL

PROJECT RECORD NO.: 6175

PORTFOLIO: FOREST TECHNOLOGY

PROJECT: PLANTATION MANAGEMENT

CODE: 97 / 98 (Financial Year) | 105 (Old Resource Centre No.) | 1166 (Project) 01 (Sub-project) | (FRST Contract) (Obj.)

WORK PLAN NO.: EXPERIMENT NO.:

TITLE: BRITAIN AND FRANCE DOUGLAS-FIR FORESTRY STUDY TOUR 1997

AUTHOR(S): MARK BELTON DATE: 08.06.98

KEYWORDS: DOUGLAS-FIR, BRITAIN, FRANCE

ABSTRACT*

The purpose of the study tour was to gather information and make industry contacts that could be helpful to New Zealand's developing Douglas-fir forest industry.

* Note: This material is unpublished and must not be cited as a literature reference.

DOUGLAS-FIR COOPERATIVE

BRITAIN AND FRANCE DOUGLAS-FIR FORESTRY STUDY TOUR 1997

Mark Belton
Ministry of Forestry

Report No. 25 June 1998

BRITAIN AND FRANCE DOUGLAS-FIR FORESTRY STUDY TOUR 1997

Mark Belton
Ministry of Forestry

INTRODUCTION

This report is a record of my Study Tour of Douglas-fir forestry in Britain and France during September and October 1997.

The Study Tour was undertaken in tandem with a series of seminar presentations for New Zealand Trade Development Board, and for Douglas-fir industry participants in North America and Europe. I also spent three weeks working on a private forest estate "Domains de la Pouyade" in South-West France.

The British tour arrangements were made through Rob Guest (ex Ministry of Forestry) and British Forestry Commission staff and researchers involved with Douglas-fir forestry. The Study Tour began at the Forestry Commission Headquarters and Northern Research Station at Edinburgh, followed by field tours to forests in Central and Southern Scotland. The Scottish field visits included the private Buccleaugh Forest Estates in the border country. In England I visited the Forestry Commission forests in Cumbria, and in the Marches near the border of England and Wales. I also visited the Forestry Commission Alice Holt Research Station.

In France I was joined by John Warjone, President of Blakely Pacific Tree Farms Ltd. The French tour was arranged by my brother Roger Belton in conjunction with French Douglas-fir industry people from AFOCEL[1], CRPF[2], and INRA[3]. Roger, forest manager for "Domains de la Pouyade", a private forest in Perigord, acted as interpreter for the French tour. John Warjone and I made presentations on Douglas-fir forestry in the Pacific North West (PNW) and New Zealand, to a meeting of French Douglas-fir industry leaders in Limoges.

The purpose of the Study Tour was to gather information and make industry contacts that could be helpful to New Zealand's developing Douglas-fir forestry industry. Douglas-fir is New Zealand's second-most important plantation species but only accounts for five percent of New Zealand's planted forest area. A surge in investment in Douglas-fir planting has occurred in New Zealand over the last five years, and accounted for 20 to 25 percent of new planting investment in 1997. This high level of investment in Douglas-fir forestry can be expected to continue because:

1. A large land bank of good growing sites for Douglas-fir exists in cooler parts of New Zealand (>1.0 million has).
2. Good economics of greenfield Douglas-fir investment opportunities in New Zealand compared with opportunities in North America and Europe.
3. The perception that Douglas-fir is a better market risk prospect than radiata pine.
4. Douglas-fir is a lower risk species than radiata pine with respect to wind and snow damage in these areas.
5. Douglas-fir growing in New Zealand has lower environmental compliance costs and risks than in Europe and North America.

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[1] AFOCEL - Forestry and Cellulose Association
[2] CRPF - Regional Centres of Forest Ownership
[3] INRA - National Institutes of Agronomic Research

Information needs of New Zealand Douglas-fir investors

Compared with radiata pine forestry there is a relative lack of knowledge about Douglas-fir in New Zealand. Better information and strategic advice is needed to reduce investment risk, and to maintain and increase investor confidence. Newcomers to Douglas-fir investment in New Zealand require access to relevant information and experience as soon as possible.

I consider the most urgent areas for better information and strategic advice are:

- Identification of superior Douglas-fir breeds for New Zealand conditions. There is considerable potential for gains in productivity, wood quality, "environmental toughness" and disease resistance.
- Site quality characterisation – identifying favourable growing conditions for Douglas-fir (eg, moisture relations, soil qualities, exposure, temperatures). Many new plantings are established on average sites.
- Improvement of forest establishment and reduction of risks of establishment failure through attention to seedling quality, storage, handling, planting, releasing, and mycorrhiza innoculation.
- Reduction of establishment and management costs (New Zealand Douglas-fir seedling costs are often high).

In addition to these forest management information needs, I was interested in learning about the positioning of Douglas-fir in European lumber markets and its market value compared with other European softwoods.

Both British and French Douglas-fir forestry practices are relevant to New Zealand's situation because plantings have been focused on the productive sites. Also as in New Zealand, Douglas-fir in Europe is an introduced "plantation" species whereas in the PNW it is managed as a natural species. In addition, Douglas-fir has had to compete with well known established European timber species to gain market share. This is potentially instructive for the New Zealand Douglas-fir industry with respect to market opportunities for different Douglas-fir wood products, and their range of market values.

Many people generously assisted with the Study Tour. I wish to record my appreciation to all people mentioned, who generously gave their time and knowledge in the text of the report.

I am particularly grateful to Roger and Christine Belton for arranging the French tour and their translation work, and to my employer, the Ministry of Forestry for its support of both the British and French Tours.

Key Points learnt from the Study Tours:

- Douglas-fir is already one of Europe's major softwood species (600 000 has planted) and it will become a leading species in European construction timber markets with harvest levels set to increase to over 7 million cubic metres by 2030.

- France is the centre of Europe's Douglas-fir industry, with the highest growth rates, and two thirds of the resource, and it will compete strongly with Northern European producers of Norway spruce for market share.

- Forest growing investment decisions in Europe are strongly influenced by direct subsidies, and favourable estate duties on forests.

- Douglas-fir investment has been driven by its high growth rates and robustness, rather than price advantages.

- Price differentials for European grown Douglas-fir lumber are very small compared with competing lumber from other conifers. Market preference is driven by appearance, not mechanical performance.

- The French are pruning 25 to 30 percent of their post 1980 Douglas-fir plantings.

- French Douglas-fir breeding programme is focusing on "hardiness" and "good form" as much as volume growth, and is based on "single flush" families.

- The growth habit of Douglas-fir in France is similar to the PNW, with excellent tree form, high height growth and relatively low stockings and basal areas. Site class 1 areas have MAIs of 24 to 26 cubic metres per ha per year, which is very high by world standards for Douglas-fir.

- Excepting pruning, Douglas-fir management in Europe is similar to the PNW, with moderate initial stockings and repeated light production thinnings.

- France and Europe do not offer an opportunity for US or Asian investment in Douglas-fir forestry due to the fractured land titles, and cultural and environmental issues.

- In the short to medium term French and other EU Douglas-fir breeding programmes represent the most important "information" opportunity for the New Zealand industry.

- NZ has an opportunity for developing a major Douglas-fir industry, with it's large land bank, and excellent growth rates. However matching the quality (better log grade out-turns) of PNW and European grown Douglas-fir will be a major challenge for NZ growers, given the tendency, on highly productive NZ sites for larger branching, greater sinuosity, and(on very windy sites) stem sweep.

BRITAIN

Friday, 15 August
Edinburgh

My first visit was to the British Forestry Commission Headquarters in Edinburgh to meet Bob Selmes, Head of Forest Practice Group with the Forestry Authority, and Alan Corson, Manager Harvesting and Marketing, South Scotland Forest Enterprise. The purpose was a briefing on tour arrangements and an overview of key interest themes.

My principle interest was to learn about Douglas-fir forestry from British experience. However, other aspects of British forestry seen were also instructive and worth recording.

Firstly to introduce British forestry. Britain experienced a steady trend of deforestation over some 2000 years culminating with less than five percent of the land having canopied forest cover by WW1. The Great War timber shortages heightened awareness of forestry as a strategic resource and led to the establishment of the British Forestry Commission and government encouragement of forestry development, which has resulted in 2.2 million has or 10.5 percent of the land area as canopied forest today.

The great majority of new planting has been with conifers, which account for almost 75 percent of the total forest area. Forestry Commission forests are 95 percent coniferous and occupy almost half the total forest area. The majority of Britain's broadleaf forests are privately owned and principally managed for amenity.

The government has made a partial withdrawal from forestry over the last decade, although Treasury plans for privatisation, and major downsizing of the Forestry Commission, have been stymied by public opposition. Partial "reforms" have resulted, such as the 1988 change in forestry taxation (withdrawal of tax deductibility provisions the exact opposite to New Zealand). Other related changes include the introduction of the European Community (EC) related Woodlands Grant Scheme which strongly favours amenity-orientated woodland planting, and downsizing of government new planting and land acquisition. Restructuring has resulted in the formation of a more commercial Forestry Enterprise Division to manage the Forestry Commission forests, a Research Division, a Forestry Authority to manage government grants, education and forestry regulations, and other units.

Multiple-use forest management is a political necessity in Britain with very strong public interest in retaining public ownership. About 50 million day visits are made to Forestry Commission forests annually with some 35 major visitor centres located throughout Britain. Landscape, management, nature conservation and ancient monument (archaeological) conservation are major responsibilities. Balanced multiple-use forest management is the reality in British forestry today.

Following major restructuring and downsizing, Forest Enterprise employs about 2300 staff, and indirectly about 2500 contractors. Forest Enterprise showed a small operating surplus last year for the first time. Operating surpluses are projected to increase to around 18 million pounds by 1999/2000.

Britain imports almost 90 percent of its wood products. Per capita consumption of wood averages 0.783 cubic metres, which is high considering the low level (10 percent) of timber framed building. Timber product prices are set by the import market conditions. Scandinavian

and Eastern Europe are the main softwood product suppliers.

Britain's wood production is currently around 6.0 million cubic metres, and is projected to increase to approx 15 million cubic metres as 1960s and 1970s planting boom harvests are processed, thereafter declining by between 20 to 30 percent as a result of a 50 percent reduction in new planting rates (following the removal of tax deductibility on management costs in 1998). Current new planting levels are around 16 000 hectares per year. Demand is also projected to increase in the future, and in the long-term the percentage self sufficiency for roundwood is projected to remain close (eg, 8 to 12.4 percent) to the current level of 10 percent (Forestry Commission Technical Paper 19). Recycled fibre has a major impact on supply/demand, accounting for 55 percent and expected to increase to 65 percent to 75 percent in the longer term. The growth of recycling has significantly depressed the market for pulp roundwood.

Wood product and roundwood prices peaked most recently in 1994/95 and have since declined 10 to 20 percent. A protracted decline in wood product prices is expected, a consequence of increased Scandinavian and Eastern European/Russian competition for markets and of the mid-1990s recession of German and French economies. Increased recycling of paper has added to supply pressure.

The wider commercial context of British forestry includes the effects of EC subsidies, cheap imports, high-quality imports, as against inferior domestic logs, recycled fibre, low volume local production and processing, strong societal/recreational/amenity interests. While the British market is huge, it is a difficult and highly competitive market, which is essentially "out of reach" for New Zealand producers of commodity timber products.

The regulated nature of British forestry is evidenced by the Woodlands Grant Scheme and how it determines investment patterns. Planting grants are worth up to NZ$2000 per hectares for conifers, and NZ$4000 per hectares for broadleaves, plus annual payments of between NZ$300 per year and NZ$1000 per year for 10 to 15 years, to compensate for loss of income from the land. Similar large payments are made to forestry investors in other EC countries completely distorting investment decisions from market-based profit and risk drivers. Despite the assistance from grants, economic attractiveness is countered by high land values, (up to NZ $18 000 per hectares for prime agricultural land in Britain), high management costs, high crop failure risks, long rotations and low roundwood prices. Internal rates of return 3 to 5 percent real on greenfield plantings are good by British standards. Agricultural and conservation landuses are also heavily subsidised. The net outcome from current regulatory settings (since the 1988 tax changes and introduction of the grants) is reduced levels of investment in new planting for wood production.

A major issue for British plantation forestry is the performance of Sitka spruce which, because of its good growth on marginal agricultural land (including peat soil uplands), accounted for more than 80 percent of plantings between 1930 and 1980. Sitka spruce has not performed to expectation in Britain, producing inferior lumber which generally does not meet structural machine stress grading standards if planted at spacings wider than 2.1 metre centres or thinned too heavily. Sitka spruce wood strength and density is strongly negatively correlated to growth rate (R^2 = -0.7).

It has been determined that a minimum stocking of 2 500 stems per hectares (2x2 metres) spacing is required, combined with more conservative thinning and longer rotations to improve lumber grade outturn. The Forestry Commission now requires a minimum establishment

stocking of 2250 stems per hectares for Woodland Grant plantings and 2500 per hectares for its own (Forest Enterprise) plantings. Incredibly, these standards have been applied to all conifer plantings irrespective of species, evidence that a centrist regulatory ethos can still defy reality. Over 95 percent of new conifer planting in Britain is covered by Woodland Grants and therefore comes under the 2250 stems per hectares rule.

The British problems with Sitka spruce wood quality arose partly from past breeding and selection programmes which neglected wood density and focused on growth rate and form, and partly from lower stocking, shorter rotation management that was fashionable in the 1960s and 1970s. The sorry saga of inferior lumber quality and subsequent problems with market penetration has some obvious similarities to our current experience with "new crop" radiata pine.

The British plantation industry has a difficult period ahead given the poor marketability of domestic spruce lumber, strong competition from good quality lumber imports, and the depression of pulp prices, partly due to depressed demand as subsidised recycled fibre increases its market share.

Britain pioneered Douglas-fir into Europe but planting levels have been low, partly because much of the new forest development has been relegated to peat "wastelands" which are unsuited for Douglas-fir. Douglas-fir grows exceptionally well on better quality British sites, and is Britain's fastest growing conifer, with site yield classes (YC) of 25 cubic metres per hectare per year* (m^3/ha/yr). However, the average yield class for Britain's 50 000 hectares Douglas-fir resource is only YC 14. Top Yield Class land has generally been "too valuable" to be made available for forestry. The Forestry Commission has only 20 000 hectares of Douglas-fir, again partly because much of their land bank has been relatively poor quality land.

* The British Forestry Industry classifies sites by Yield Class numbers, which indicate the potential recoverable mean annual increment for the species concerned. For example, Douglas-fir Yield Class 25 indicates a recoverable MAI potential of 25 cubic metres per hectare per year for the site in question.

Monday 18 August

Visit to Forestry Commission Northern Research Station at Roslin, Edinburgh. Meeting with Chris Quine (Silviculturalist and Wind Researcher)

Given an overview and history of British silviculture. British confidence with Douglas-fir affected by its relatively poor wind resistance. On some fertile sites toppling of young Douglas-fir is a recurring problem. Douglas-fir is not regarded as a particularly wind resistant species in Britain. Chris Quine is currently working with John Moore (ex Canterbury University Wind Researcher). He mentioned forest wind insurance provided by British company, Agricultural Risk Management Ltd.

British Douglas-fir regimes are essentially identical to their other conifer species, very conservative (and expensive) with high initial stockings (av. 2500 stems per hectare), followed by light production thinnings from 10 metre height until clearfelling at 50 to 70 years. No pruning is undertaken.

Britain's wind climate is one of the most extreme in the world and addressing the risks of catastrophic wind storms is one of the key considerations in British Forestry. The gradual and frequent light thinnings that characterise traditional British silviculture are partly a wind damage

risk management response. With Continuous Cover Forest Management now in vogue the possibility of selective logging and multi-aged plantation forest with irregular canopies is being revisited.

Windthrow hazard classification has been undertaken over much of Britain, it is based on wind zone, elevation, topex (a measure of site exposure/shelter) and aspect. New Zealand forestry could gain much from British experience and research on the effects of wind on forest growth, and managing wind risks. I collected a number of publications on forestry and wind research in Britain (refer attached publications list).

Meeting with Steve Lee on Douglas-fir Tree Improvement

British Douglas-fir breeding research was progeny based until 1992, and is now focused on clonal breeding programmes. French forestry leads Douglas-fir breeding research in Europe. The best performing British Douglas-fir provenances originate from Darrington in coastal Washington, north of Seattle.

Interesting discussion was held on sinuosity problems in Douglas-fir with Steve Lee. Sinuosity and rogue form trees are widespread problems on British Douglas-fir sites. Steve Lee attributed the problem to moist soil conditions through British summers resulting in continuing growth and insufficient cell wall lignification. He noted the problems were most severe on valley bottoms or poorer drained sites, and least on free-draining valley sides in drier areas. I believe the New Zealand relationships of sinuosity and site are similar. I have observed similar sinuosity problems with Douglas-fir on valley bottom sites in the PNW, Golden Downs in Nelson, where summers are distinctly dry, but ground water is possibly available year round. Sinuosity problems are also evident on moist New Zealand high country and South Island West Coast sites. Regarding heritability and sinuosity, Steve Lee's view was that heritability was low, and site conditions were the main factor. Does this mean that growing Douglas-fir on moist and productive sites has an unavoidable sinuosity penalty? And what relationship is there between sinuosity and structural wood qualities? These questions need to be answered. The "costs" of low grade recovery due to poor tree form and wood quality could outweigh the benefits of faster growth? South Island experience with Ashley and Eyrewell Douglas-fir confirms that seed lots on drier sites have good form compared with moist sites. For example, Ashley seedlots growing on some Southland sites have extreme sinuosity; however, the better form of some Southland seedlots on the same sites strongly points to a strong genetic factor. Better matching of genetics to site conditions is a priority for New Zealand Douglas-fir forestry.

The European Douglas-fir breeding programmes are based on IUFRO collections from the PNW made in 1966-68. These extensive collections from British Columbia to Northern California have been planted throughout European countries. In Britain the origins which exhibited the most favourable growth and form were from below 500 metres and from Western Washington and north-west Oregon. More southern Oregon and Northern Californian selections, which have been favoured in selections for New Zealand's breeding programmes, had high intra-population variation, comparatively poor survival and distinctly poorer form and branching habits. British provenance trials have concentrated on 44 near-coastal selections. Assessment of 38 origins on highly productive British sites at 16 years (Fletcher and Samuel 1990) confirmed that for growth and form in Britain, the best origins came from coastal stands west of the Cascades in Washington, and from south-west Oregon.

More recent developments in the British Douglas-fir breeding programme are also part of a

collaborative EU project involving testing about 250 open-pollinated Washington families and 70 Oregon families which were planted out in 1994-95. The opportunity is being taken to compare family performance for vigour and form amongst PNW and British and French sites. If any families are consistently superior on all trial sites, advance clonal seed orchard materials already established in the US will be introduced to accelerate the EU breeding programmes.

My thoughts re the current NZ Forest Research Co-op breeding programme with its emphasis on Southern Oregon and Northern Californian fog belt selections, is some nervousness re form, particularly for high rainfall, summer moist New Zealand sites.

Helen McKay – On Hardiness of Douglas-fir Seedlings

Helen McKay has done a lot of research on the hardiness of conifer seedlings in Britain, and Douglas-fir has been shown to be the most vulnerable species to low temperature (freezing) and desiccation damage to seedling roots. Root damage is now seen as a major factor in the often poor performance of Douglas-fir seedlings following planting in Britain. Seedlings exposed to sub zero temperatures in storage show significant decline in vigour. Current recommendation is cool storage at around 2°C, and never below 0°C. Spring planting is also recommended in Britain. McKay commented that Douglas-fir seedling root growth is continuous through the winter and the new roots are particularly susceptible to desiccation and frosting. Also noted that Douglas-fir new feeding root growth appears to depend largely on fresh photosynthate, and hardly at all on stored photosynthate, hence with winter planting recovery capability is very low. These comments accord with New Zealand experience of the sensitivity of Douglas-fir seedlings to injury and stress. Root damage may be a major factor in recurring seedling mortality problems in New Zealand. One wonders how often Douglas-fir seedlings stored in shady frosty conditions have suffered injury. A number of papers by Helen McKay on Douglas-fir seedling hardiness are referenced.

McKay also recommends shorter storage period (3 to 4 weeks maximum) following milder winter conditions whereas after colder winters storage up to 10 to 12 weeks is okay.

British mycorrhizal work by Chris Walker has indicated that Douglas-fir root symbionts are so specific that repeated inoculation of nursery soils is necessary to get desired symbionts established.

Most Douglas-fir planting in Britian is with 2/0 bare rooted seedlings, with current prices around NZ$250 per 1000. Containerised seedlings are used on more difficult sites and cost around NZ $350 per 1000. These costs are significantly below average New Zealand Douglas-fir seedling costs.

Chris Nixon, Project Leader, Continuous Cover Management

There is increasing public pressure in Britain to avoid clearfelling and to retain forest canopy for both conservation and amenity purposes. Douglas-fir is considered a prime candidate for "continuous cover management" and a major research effort is underway to test its suitability for this purpose. North Americans are generally sceptical of Douglas-fir suitability for "continuous cover management", partly because of regeneration competition from more shade-tolerant species, especially hemlock.

The British Forestry Commission has established a Continuous Cover Forestry Group (Chris Nixon is Research Leader and contact person) and publish a regular newsletter. The Group has been active in setting up field experiments and in involving private forest owners. There is clearly much New Zealand forestry can learn from the British experimentation with "continuous cover management," and contact needs to be maintained.

Meeting with Bill Mason, Head of Silviculture

Historic commentary provided on British forestry that traced political/social pressures on the effects of plantation development on landscapes, the early 1970s end to conversion of broadleaf forest to conifer plantations, the late 1970s to 1980s movement against dominance of Sitka spruce and against conversion of peatlands to forest, the 1988 taxation change that halved investment in new planting (currently 15 000 hectares per year), and the 55 percent of broadleaf amenity planting with little commercial value. British forest industry has "lost confidence" and policy setting initiatives from the EU are further disadvantaging commercial forestry. The Grant Schemes determine planting and silivulture with 97 percent of new plantings covered by grants. Bill Mason also commented that Douglas-fir would remain a minor species owing to shortages of suitable land, and wind stability problems following first thinning. I commented that early instability might be partly a function of high initial stocking and restricted root development.

Graham Pyatt – Ecological Site Classification

The Forestry Commission is committed to multi-purpose forestry, and is developing Ecological Site Classification of all forest land to provide a sound information base for integrated management for timber, biodiversity and nature conservation. A milestone in the programme was the publication of "Ecological Site Classification for Forestry in Great Britain" by Pyatt and Suarez (refer publications list) which uses the Grampians region in Scotland as a case study to demonstrate application of the ESC method. The classification employs three principal factors to determine site quality: climate, soil moisture regime and soil nutrient regime. The approach is similar to that used for the British Columbia
biogeographic classification system, and to other soil quality based systems, which are widely used in Europe. Part of the driver for these initiatives is sustainable forest management initiatives stemming from Government policy and international protocols. An interesting feature is the integration of ecological/conservation objectives with productive forest management across all forestlands, an approach that New Zealand has largely bypassed with its separation of productive landuse functions from conservation management objectives. A commercial benefit also exists with the detailed site quality classification which enables more sophisticated (less risky) selection of species, regimes, management options and a more accurate prediction of yields.

Tuesday 18 August
Visit to Glentrees Forest near Peebles with Alan Corson, Harvesting and Marketing Manager, Forest Enterprise

Glentrees is a small forest, 1200 hectares planted, 1000 hectares Sitka spruce and 120 hectares Douglas-fir on better drained slopes. A 65-year old Douglas-fir stand is a major recreational feature, large trees, DBH 65 centimetres. Alan commented they were unsaleable, too large for local mills, which have maximum diameter specifications of 45 centimetres. Douglas-fir was very healthy, six-year needle retention, marked sinuosity evident. Continuous Cover Management experiments at Glentrees were not showing success. Failures with natural

regeneration with Douglas-fir, Grand fir and larch.

Prices paid locally for Douglas-fir were no better than the low prices paid for Sitka spruce. The South Scotland timber market is completely isolated from the Douglas-fir world market signals. Viewed Sitka spruce plantings which were too widely spaced, a high outturn of pulp grades, and low outturn of lumber grades was expected. Comment that Sitka spruce genetic improvement programmes had focused on growth and form and not on density and strength. Very small price differentials between pulp and sawlogs (eg, pulp NZ$80 to $90 per cubic metre, sawlogs NZ$100 to $115 per cubic metre at mill door). Considerable evidence of investment in recreation and wildlife with sculpture, tracks, information boards, and amenity plantings, wildlife planting, ponds, (habitat creation) and nesting boxes.

Wednesday 20 August
Visit to Tay Forest Park, Dunkeld Perthshire (North of Edinburgh)

Met Tay Forest Park Advisory Board over lunch at Dunkeld. The Forestry Commission administers 17 forest parks covering 300 000 hectares, with over 50 million day visitors annually, 1.2 million campers annually. Very high standards of landscaping and design of recreational facilities.

Visited the tallest Douglas-fir in Britain at the Hermitage within Craiginean forest, one of Britain's oldest planted forests, established with European larch in the 18th Century when cannon were used to shoot seed at steep bluffs. Nineteenth century follies, antique looking bridges, and "ruins" were relics of Victorian gentry recreational mythology. Walked within Allean forest above Loch Tummel. Unfortunately mist obscured the views but the landscape was extremely beautiful. On the Allean forest walks were ruins of an 8th Century fort and abandoned crofters cottages. Most of the forest was Sitka spruce, with some Douglas-fir on drier slopes and larch and Scots pine on lower slopes. Conservation landscapes and recreational management objectives appeared to be well balanced with timber management.

Thursday 21 August
Buccleugh Estates, Border Country, Southern Scotland

Visit hosted by Andy Little, Head Forester. The Duke of Buccleugh is Europe's largest landowner with three large estates in Southern Scotland and one in England totalling 250 000 acres. The Estate company also had land-based investments in Australia and North America. Commercial forests cover 10 percent of the estates, ancient woodland approximately one percent.

Norway Spruce and larch dominated early plantings. Since 1930, 70 percent of planting hectares been with Sitka spruce; Douglas-fir planting limited by availability of suitable sites, requires freer draining and more fertile sites. Rainfall ranged between 900 millimetres in valleys to 1800 millimetres on the tops. Douglas-fir regimes governed by log size maximum of 50 centimetres l.e.d. at local mills. All planting on the estates covered by Woodland Grants. Grant levels increased in response to concern about falling planting. Andy Little commented that pulp market was depressed, only NZ$80 per cubic metre delivered and Douglas-fir pulpwood only NZ$60 per cubic metre. Comment that Douglas-fir not planted extensively because of establishment difficulties, also seen as poor pulp prospect. Also it requires the best soils. Commented that pulp markets were depressed due to recycling with EU landfill tax subsidies of up to NZ$200 per tonne. Some pulp mills use 80 percent recycled fibre.

The forest landscapes were beautiful, mixed species, and blended with other elements in the rural landscapes.

British log marketing very localised, little intra-regional sales, no export markets. There is also strong market competition from imports and recycled fibre. Without subsidies new planting in Britain would be minimal. Because of subsidies forest establishment and management in Britain is essentially a societal investment for maintaining the cultural values of rural Britain. The commercial objectives of British forestry are secondary.

Friday 22 August

Visit to Forest Enterprise Ae Forest, Dumfries, SW, Scotland with Julian Fryer, District Forester, Hectaresrvest and Marketing

The 38 000 hectares Ae Forest was developed post WWII, with establishment of forest villages, and broad acre planting of peat uplands (120 to 500 metre altitude). Very exposed marginal sites, Sitka spruce yields 12 to 18 cubic metres per hectare per year, with high wind hazard rating (4 and 5 on scale to 6). Eighty percent of Ae Forest is Sitka spruce. Early plantings were at 1.5 metre square spacing (4500 stems per hectare), since 1980 average spacing is 2.0 x 2.0 metre square (2500 per hectare). Log grade outturn expectation was 50:50 sawlog:pulp, actual result is 80:20. Windthrow losses are major, average 20 percent loss of volume, about half recoverable.

Julian commented on Latvian log and lumber imports depressing local prices, 20 to 25 percent sawlog price decline over last two years. Departed Ae Forest at 4.00 pm for Drumlaurig Castle Woodlands, one of the finest forest landscapes in Britain according to my guide. The woodlands at Drumlaurig are 90 percent conifers but due to skilful layout and use of broadleaf and amenity conifer plantings, a remarkably varied and harmonious landscape has been achieved. The Castle Gardens contain the oldest Douglas-fir and Western hemlock in Britain, planted around 1830 by the brother of botanist David Douglas who collected the seed near the Columbia River, Washington in the 1820s.

Saturday 23 August

Travelled south, stopped at Hectaresdrians Wall, the first relic of Roman occupation I had seen in Northern Britain. The wall was surprisingly small in scale and appeared to serve as much as a demarcation as a defence. The surrounding landscape was principally open land, the dense forest of Roman times long erased. Many hills in Southern Scotland had visible mounds and ditches that were sites of pre-Roman forts and settlements. The archaeological richness of the British landscape is extraordinary.

Sunday 24 August

Visit to Grizedale Forest Park, in the Lake District, Northumberland

Picture book beauty, rugged glaciated landscapes with narrow lakes, and beautiful rural villages and farms in stone and slate and drystone walls. The Lake District was mostly forested until major clearance began during Roman times. The first record of management of the native oak, birch, ash and hazel woodland at Grizedale was 11th Century coppicing by Furness Monastery. Grizedale Forest Park has 350 000 visitors annually, a major visitor centre, education programmes, an outdoor theatre, and an internationally famous gallery of outdoor sculptures which are located along its numerous forest walks.

The forest is quite intensively managed for timber production and I was pleasantly surprised by the close proximity of harvesting to walking tracks. New Zealand's OSH paranoia would not fit well with British multiple-use forestry. Sitka spruce predominates the commercial plantings, being best suited to the high rainfall and windy climate. Six foot high fencing is an expensive feature of re-establishment, its purpose being deer exclusion. Deer fencing is retained for 10 to 15 years. Thinning is undertaken at 5 to 7 year cycles from age 25 till clearfell at 55 to 70 years. Larch and Scots pine are also important species at Grizedale. While Douglas-fir is only a minor species, the stands I observed all had excellent form and vigour.

Monday 25 August
Westonbirt Arboretum

Travelled south to Bristol, via Manchester, the Midlands, and Fosse Way, the route of a 1st Century Roman military road. Visited Westonbirt Arboretum which contains one of the world's greatest tree collections, 18 000 specimens planted amidst 600 hectares of beautifully landscaped grounds. Plantings began in 1829, and have been managed since 1956 by the Forestry Commission. The arboretum walks total about 30 kilometres and includes national collections of elm, ash, beech and oak and a major larch and Douglas-fir plantation. An absolutely amazing experience, I only regret I had limited time. Visitors to the arboretum should allow at least a full day to explore it.

Tuesday 26 August
Visit to Mortimer Forest in the Welsh Border Marches hosted by Ian Hickman, District Manager

Mortimer Forest has some of Britain's most extensive and productive Douglas-fir plantings. Yield Classes ranged from 16 to 24 cubic metres per hectare per annum. Basic regime similar to elsewhere, plant 2500 stems per hectare, 2x2 metre spacing 12 months after harvest, and site preparation with herbicides and disc scarified. Intention to expose mineral soils. Releasing by "Roundup" with shield to protect seedlings. Birch regeneration "cleaned" at 7 to 8 years. First thinning to 1200 stems per hectare at 18 to 20 years, subsequent thinning cycle at 5 to 7 year intervals until clearfell at 42 years.

IRR's estimated as 4.5 percent average, which is high for Britain. Approximately two-thirds of Mortimer Forest is planted with Douglas-fir. Douglas-fir on drier (900 millimetre rainfall) and more sheltered sites. Windthrow problems mentioned. Wind Hectareszard Class III, 60 kilometres per hour winds common. Major windthrow occurred in the 1987 and 1991 storms. Sitka spruce planted on higher ground. Some scepticism expressed about Continuous Cover Management for conifer stands, suggested it was best suited to broadleaves.

Douglas-fir 2/0 seedlings costed at £85 per 1000 = NZ$240 per 1000. Average stumpage value at clearfell $120 per cubic metre. Preference for Douglas-fir based on high yield, not log price. No significant premium paid for log quality. Ian commented that price differential for Douglas-fir compared with Sitka spruce has declined. "UK timber retail yards only sell imported products, no appreciation of local product". Major market development needed. Health of Douglas-fir excellent, an insect scale being the only noteable problem (*Inglesia* species). Although Swiss Needle Cast was present it was not seen as a health problem (most British foresters were unaware of SNC on their Douglas-fir).

Wednesday 27 August
Bristol – Preparation for London TRADENZ Seminar

Thursday 28 August
Alice Holt Research Station

Sessions with Paul Tabbush, Head of Silviculture Division, Janet Methley, head of Mensuration, Robert Mathews, Growth Modelling. Paul Tabbush revisited themes of establishment problems due to seedling roots "sensitivity" to physical/ temperature/ desiccation damage, and toppling risks. Also noted Douglas-fir more palatable than spruce, deer browse a major problem. Suggested that absence of adequate summer moisture in Britain prevented conditioning required for hardening off seedlings, and young plantings. On economics Paul commented that the very high opportunity cost of good land for forestry (eg, NZ$12 to 15 000 per hectares) due to agricultural options being more heavily subsidised by EU agricultural policies. Farmers also suspicious of risks of long-term subsidies for forestry, given the certainty of more changes. Paul Tabbush considered poplar the most profitable forestry investment option for good agricultural land in Britain, shorter rotations (17 to 20 years) and high IRRs (15 percent plus based on 20-year rotation, 150 stems per hectare, 2 cubic metres per tree recoverable 300 square metre per hectare, MAI 15 cubic metres) and production of clear veneer bolts. Stumpages £25 (cubic metres, - £7500 per hectare). Only 200 hectares per year being planted in poplar in Britain. However, this rather optimistic view is based on rather limited information.

Discussions with Janet Methley and Robert Mathews focused on silviculture, mensuration and growth modelling. Traditional British forestry growth models are represented by the Forestry Commission's published Yield Class Tables. The Tables are based on visual interpretation of plotted stand measurements and harvest out-turn studies. They illustrate relationships between principal stand variables for commercial species in terms of stand age, height, stocking, basal area, total and recoverable volume. A vigorous programme of yield model construction occurred from 1920 till 1980 and culminated in publication of Forest Management Tables for all major commercial species. The best known Yield Class publications were by Hamilton and Christie (1973) and Edwards and Christie (1981).

The Yield Class Tables have served the British industry extremely well by providing a sound information framework for forest managers to work with and particularly by allowing forest site quality to be directly represented by a yield class (site productivity) description. All British land is characterised by Yield Class for best prospect species, and by wind damage hazard rating. A major weakness of Yield Class Tables is their lack of flexibility compared with predictions based on computer functions. For example, if the described thinning regime is not complied with, this cannot be accounted for by the yield tables because they assume compliance.

One of the key advantages of the yield class system is British foresters (and non-forestry people) can readily identify the productivity potential or site quality of forest land. The British system also promotes awareness of maximising forest productivity and regulating thinning intensity to maintain high productivity. New Zealand foresters have tended to scorn the British approach; however, our focus on site index, and failure to appreciate the volume and quality losses associated with wide spacing management (low basal area) have significantly affected the productivity and quality of much of our forest estate. Furthermore, New Zealand foresters are possibly not so attuned to site quality as a key issue for forest growing which is reflected in the often poor site selection decisions made by New Zealand foresters.

The Forestry Commission is currently working on a new suite of computer based yield models for Sitka spruce that will be available in Windows software.

Friday 29 August
Forestry Investment TRADENZ Seminar in London with John Falloon

Saturday 30 August
Visit to Rob Guest

Very useful discussions on British forestry compared with the New Zealand situation covering ongoing British Treasury pressure to downsize the Forestry Commission, ongoing restructuring, job losses, and effects on morale. The sale of public forests is not considered likely under a Labour government.

Difficult market conditions can be expected to continue for some years due to dumping of excess production from Scandinavian and former communist Baltic countries, and because of the inferior quality of most British-grown wood.

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(These publications are held by, and may be accessed, via Mark Belton, Ministry of Forestry, Christchurch.)

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FRANCE

The total area of French forests is 15 million hectares, double the area of 200 years ago. Seventy percent of France's forest area is privately held by 3.7 million owners, the average holding size being just 2.8 hectares. Coniferous forests account for almost five million hectares. The largest planted forest in Europe is one million hectares of *P. pinaster* in the Le Landes region in the SW corner of France.

The dominance of small private ownership necessitates major activity in the provision of strategic and technical advice to the numerous (35 000 plus) forest owners. It also necessitates co-operative arrangements for research, technology transfer, and marketing for the French forest industry to be internationally competitive.

As with Britain, the rural landscapes of France are an integral part of the national identity and culture, and rural landowners are custodians of this "cultural resource". Forestry is the major land use over much of France, and the general population are very protective of their "hunting and gathering" and other usage rights. I was told one-third of French adult males have hunting permits, and certainly during the hunting season the high density of hunters on the ground is beyond belief. On one occasion, from one viewing position, I could see four hunters and two mushroom gatherers all "stalking their prey". In addition to the French populace's strong attachments to their "traditional" forest rights, the forest landscapes are very important for the tourism industry. France has the world's largest tourist industry, and the tourists increasingly pursue the rural experience.

France has comprehensive and complex government involvement in landbased industries. The most important organisation for private Douglas-fir forestry in France is CRPF, which is publicly funded to provide strategic and technical assistance to forest owners. CRPF has 256 staff including 70 foresters. CRPF audits forest management plans that are required under French law for all forests larger than 25 hectares. CPRF approval of plans and regimes is a condition for eligibility for subsidies from the National Forest Fund (FFN). The FFN is a special fund mainly based on tax on forest products which is directed back to reafforestation and CPRF approved management. The tax base has been halved since 1992, reducing money available for subsidies, and contributing to the marked reduction in reafforestation since 1992. Public research organisations include INRA (Tree breeding), ONF (National Forest Statistics), and the main private research organisation is AFOCEL (a forest industry research organisation).

Douglas-fir afforestation began developing strongly from 1950s, peaked in the 1970s and 1980s and has since declined, particularly since the 1992 tax changes. Douglas-fir represents about 30 percent of the conifer cover in France. The Douglas-fir estate now totals about 360 000 hectares and is 82 percent privately owned. Expansion of the Douglas-fir estates has also slowed due to environmental constraints and the depressed state of the French economy. Based on recent trends the French Douglas-fir estate is likely to plateau around 450 to 500 000 hectares. If significant price differentials develop between log prices for Douglas-fir and other softwoods, further rapid expansion could occur from post-harvest replacement of less commercial species by Douglas-fir. To some extent this is already occurring as a result of Douglas-fir being promoted as being faster growing and more robust than other conifers in most French forest growing regions. Current new planting of Douglas-fir is about 10 000 hectares per annum, whereas during the peak planting years 30 000 hectares per annum was being established.

Current Douglas-fir production is 1.5 million cubic metres, by 2005 it will reach three million

cubic metres and six million cubic metres by 2030 (based on recoverable MAI of almost 17.5 cubic metres per hectare per year which is close to the New Zealand average, cf. PNW av. eight cubic metres per hectare per year, and Britain 14 cubic metres per hectare per year).

France is destined to become one of the world major producers of high quality Douglas-fir structural softwood, and a major competitor in world Douglas-fir markets.

Unlike New Zealand, France is not a significant investment prospect for international investors in Douglas-fir forest growing. Forest ownership is too complex, the average Douglas-fir holding being only 2.5 hectares. Industry infrastructure is also complex and inefficient and disadvantages French forest owners, particularly in getting product to Pacific rim markets.

Wednesday 24 September
Toulouse

Arrived at Toulouse at 5.00 pm to meet with John Warjone, President of Blakely Pacific Ltd, Seattle, USA and Roger Belton, Forest Manager, Domaine de la Pouyade, Perigord. Roger Belton had arranged the French Forestry section of the Study Tour with assistance from French Douglas-fir forest industry leaders and provided translation services throughout the tour.

Thursday 25 September
Le Tarn, Midi Pyrenees

We met with French Douglas-fir foresters at 9.30 am near Mazamet in the Tarn Region. Our hosts were Philip Therenet (Assistant Director of CRPF, Midi Pyrenees), Jean Pierres Outisset (CRPF Forest technician and Douglas-fir specialist), Bertrand Caurin (International Missions AFOCEL), Jacques and Elizabeth Berry, and Renee Raynaud, (who were owners of substantial Douglas-fir forests in the region), and heads (Presidents) of national and regional private forest owners associations.

Le Tarn is the southern most extension of the "Central Massif", the mountains and uplands in the centre of France which have the greatest concentration of Douglas-fir forestry. The five leading Douglas-fir regions in France are within the Central Massif uplands.

The Le Tarn Douglas-fir forest areas are on granitic soils, averaging pH 4.5, rainfall 1000 to 1800 millimetres per year and altitude ranging from 600 to 900 metres. The Le Tarn is where Mediterranean and Atlantic climates meet and strong equinoxal gales (fohn winds) are a feature of the climate. Le Tarn region has one of the highest levels of forest cover in France (85 percent), and a high proportion of private ownership (80 percent), a result of massive reafforestation of abandoned farmland over the last 100 years. Major forest owners include leaders of the region's tanning industry who have provided employment for ex-farm owners through purchasing and planting their land. Mixed deciduous hardwood forest dominates harder sites with conifer plantations on the better sites. New planting virtually stopped 15-years ago, because of pressure to preserve remaining pastureland, and more recently because of concerns about monocultures with introduced trees and landscape issues. The region has strong winds and heavy snows. Douglas-fir is noted as being faster growing and hardier than other conifers in the Le Tarn.

The first site visit was to an establishment trial at Bellessere. Norway spruce had been harvested, and windrowed. Vigorous broom affected most of the site except where minimum mechanical site disturbance had been practised.

A 3-year old planting at 1270 stems per hectare with 2/0 barerooted seedlings had established well amongst broom without use of herbicides. At a nearby site 2-year old plantings with 2 plus 1 transplant seedlings had been established at 5 x 2.5 metre spacings. Wide spacings are common practice and large branches on lower 6 metre logs were to be "controlled" by pruning. Comment was made that it was more important to get a smaller number of seedlings growing strongly to beat weed competition. Expected little difference in branch size between establishment stockings of 800 and 1300 stems per hectare.

Thinning Trial at Cros Haut. We examined a 28-year old thinning trial stand, productivity Class 1, max MAI 25 cubic metres per hectare per year, planted at 1800 stems per hectare. Two thinning intensities being trialed with target final stockings of 350 stems per hectare and 650 stems per hectare. First thinning at 16 years, second thinning at 21 years. Expected harvest age 50 years. The basal area in the unthinned control was 70 square metres per hectare. Thinning control method developed after a major storm in 1982 which caused massive damage to local forests. Thinning stopped when height: diameter reaches 75:1 (eg, 25 metre height:33 centimetre diameter).

Visited 60 to 80-year old and very beautiful Douglas-fir forests belonging to the Berry families. Visited a 68-year old stand that was last thinned at age 55 years. Some wind fall logs had been extracted just prior to our visit. A strong response to the thinning at 55 years was evident in the ring count. The stand had been planted at 2000 stems per hectare as a mix of Norway spruce, Sitka spruce and Douglas-fir. First thinning occurred at 35 years and subsequent light thinnings at 6 to 7 year intervals. Douglas-fir were selected as crop trees, the current stocking was 200 to 250 stems per hectare, height 45 to 50 metres, BA 55 square metres per hectare, volume 1000 to 1100 cubic metres per hectare, BA 4.5 square metres per tree. Value was only 350 to 400 FF per cubic metre stumpage (NZ$100 per cubic metre). Value was penalised because of over-size of trees.

Lightning-damaged Douglas-fir were seen in this area. Surrounding trees also set back, attributed to root damage from the lightning strike. (Stand age 50 years, MAI 20 cubic metres per hectare per year.)

Visit to another of the Berry's forests, planted 1926 and first thinned in 1975, subsequently thinned at 8 year-intervals. Stocking was 240 stems per hectare, DBH 60 centimetres, volume 900 cubic metres per hectare, BA 55 cubic metres per hectare.

Average log sale price was 500 FF per cubic metre delivered at mill door (NZ$125 per cubic metre). There was a 10 percent price premium on Douglas-fir compared with spruce. All sales are to local mills. No log transport by rail occurs in France due to problems with railway unions. Obtaining a better price for logs was the key issue for the French growers. John Warjone estimated the large logs we observed would have a two to three times higher value in the PNW markets.

Young seedlings were released by mowing broom and other hardwood regeneration. There was a reluctance to use chemical releasing. Animal damage to seedlings was a major problem.

The Le Tarn countryside was exceptionally beautiful, and forestry totally integrated into the landscape.

Friday 26 September
Rodez-sawmill visit

Met with M Phillippe Collas, Forest Engineer of the regional Forest and Wood Industry Association. M Collas worked in marketing forests to log buyers and wood products marketing. The Midi Pyrenees region has 300 plus sawmills, average size 3000 to 4000 cubic metres annual production. The largest mill had 30 000 cubic metres production. The average Douglas-fir mill door price 450 to 500 FF per cubic metre for 70 centimetres l.e.d. logs (NZ$100 to NZ$130 per cubic metre). Competition from cheap imported lumber from Eastern Europe and Scandinavia was cited as the main reason for the depressed log prices.

EU has not yet established a common forest policy, or common industry standards. Working towards common EU log grade standards. Scandinavians trying to retain visual grading. French Douglas-fir industry pushing for machine stress grading. French Douglas-fir has much better stress:strength characteristics than Norway spruce. Achieving acceptance of MSG is essential to French industry.

The 10-year-old mill at Rodez processed 13 000 cubic metres of logs annually (52 percent recovery). Paying NZ$500 per cubic metre at mill door for Douglas-fir. Twenty-five percent of production Douglas-fir, balance was a spruce or pine. Douglas-fir being CCA treated which was a surprise as this treatment is not used in New Zealand. Processed for flooring, cladding, beams and framing. Arisings were chipped, dried and sold as fuel 120 FF per cubic metre dry, NZ$40 per cubic metres (4.5 cubic metres per tonne).

Saturday 27 September
Domain de la Pouyade

We visited La Pouyade forest, a 1000 hectare estate of mainly chestnut coppice and oak. The property also had undertaken small plantings with Douglas-fir since the early 1900s, but very poor results on some sites caused a loss of confidence in the species. Most extensive conifer plantings on the estate were *Pinus sylvestris, P. pinaster* and *P. nigra* (laricio) and Norway spruce.

The problems with Douglas-fir were due to low soil fertility, particularly phosphorus (P) deficiency on impoverished granitic glacial deposits. Calcerous soils on the property had adequate fertility and supported good growth for the local rainfall level of 900 millimetres. Some Douglas-fir plantings on infertile sites had very high mortality and suppression by volunteer tree regeneration (oak and chestnut) with surviving trees as small as 4 metre height and 15 centimetre dbh at 60 years. Nutritionally stressed trees had 1 to 2-year needle retention, whereas healthy trees had only 3 to 4-years retention. Foliar phosphorus nutrient levels on stunted trees were as low as 0.05 percent phosphorus.

In the 1970s CPRF established a fertiliser trial with Corsican pine at La Pouyade and achieved a 700 percent volume growth response following application of phosphorus. The estate forester of the time had declined to apply fertiliser despite these results on the grounds it increased branch size too much!

Management issues for the property were methods for conversion of exhausted chestnut coppice and post-harvest conversion of other conifers, to Douglas-fir. Fertilising was essential to achieve growth potential; however, fertiliser exacerbated problems with wild animal damage and weed competition. There was a reluctance to use herbicides and tree rows were mown annually to control woody weeds. Roe deer damaged young trees but were valued as game, and their numbers were controlled through regulated hunting agreed to by the local government hunting association.

Returns from hardwood forestry have declined by up to 25 percent over the last two decades. Hardwood pulp is the main product from chestnut coppice, but stumpage prices were extremely low. Only a very small proportion, (eg, 10 percent) of the oak managed on 120-year plus rotations produced high value veneer logs.

Douglas-fir is seen as being the leading commercial forestry opportunity on La Pouyade as it is for much of France; however, conversion to Douglas-fir is constrained because of mounting "environmental sensitivities". Nevertheless post-harvest conversion to Douglas-fir from other conifer species, rather than new planting on bare land, will be the main form of development in the future.

Monday 29 September
Limousin CRPF and AFOCEL trials

The day's programme was organised by Daniel Michaud, Assistant Director AFOCEL, Alain Bailly, Director AFOCEL, and Maryse Bigot, Research forester AFOCEL also participating. We were joined later in the day by Jean Charles Bastian from the INRA tree breeding programme, and Jean-Louis Ferron, Assistant Director of CRPF Limousin.

The first site visited was a young poor performing Douglas-fir stand which had various fertiliser treatments which confirmed phosphorus application was essential on acidic granitic soils. Dramatic improvements in crown health and growth had been achieved with modest applications of phosphorus. Comment made that copper deficiency was also common. A significant part of the higher rainfall Douglas-fir growing area in the Central Massif is on strongly leached granitic soils. Fertilising is an integral part of good management, being promoted to private growers. DAP and rock phosphates are the commonly used fertilisers.

The second site was a Douglas-fir trial which incorporated a thinning intensity design. Generally trees were lightly branched and good form even at quite low stockings. Modern French silviculture has moved to low initial stockings and pruning of Douglas-fir.

Long discussions were held on the rationale behind the extensive Douglas–fir pruning programmes in France. Pruning has been heavily subsidised through government grants and has been promoted by CRPF who approve private forest management plans (a condition of eligibility for subsidies) and provide technical advice. The view was widely held that pruned Douglas-fir would be stronger, more versatile in enduse, and attain higher values. The pruning strategies appeared to have been developed without reference to economic analysis or proof of price differentials for clear Douglas-fir. No analysis was presented which justified the substantial investment in pruning. The case was made by John Warjone and I, that unpruned Douglas-fir already attained premium prices in large volume structural markets, and that no worthwhile premium was paid for clearwood Douglas-fir in these markets. Further, the pruned wood remanufacturing market was relatively small, and Douglas-fir wood qualities were not

particularly well suited for remanufacturing. Also, other conifer species (notably radiata and other pines) could be managed to supply these markets with better quality wood at lower cost. The AFOCEL people agreed with these arguments. Fashions are more powerful than reason. The Douglas-fir pruning programme in France is very large (3000 hectares per annum) and will deliver a premium appearance product which should provide market share if not price advantages.

Breeding Trials

The third site visited was a major Douglas-fir breeding trial at Valmate about 40 kilometres north-east of the regional capital, Limoge. The trials are jointly managed by AFOCEL and INRA. The Valmate trial site covered 30 hectares, one of a series of five replications established across France in 1989. The within-trial design was 40 plot replications of 600 progeny, each represented by a single tree. Similar trials (from the 600 progeny) are planted in Spain, Belgium, Germany and Britain.

The French Douglas-fir breeding programme is the major force in the IUFRO programme, based on 640 Washington selections, 350 from Oregon, and over 1000 collections from within France. The range of latitudes covered in the trial series is much wider than the latitude range of their origins. Californian collections were not included because they flush too early, which increases the risk of frost damage, and second flushes being "dried off" during hot, dry summers which stresses stands. Also "double flushing" progeny were noted to be more prone to sinuosity, forking and rougher branching habit.

As a consequence the French breeding programme has focused on selecting from late-flushing families. Date of flushing was noted as one of the most stable heritable characteristics. Coastal Washington (Fog Zone) provenance were all round best performers (eg, Umberto 144). This coastal material is uninodal and slower growing for first 12 to 15 years than double flushing provenances. Single flush provenances were observed to catch up in growth rate after about age 20. Huge genetic gain was expected from selections of best individuals from these trials, which will be used for a clonal bank.

The French work reinforces my query about the current focus of the New Zealand breeding programme. In the South Island. late frosts and dry summers are a feature of Douglas-fir growing areas. Also, the Washington progenies which exhibit the better form, and possibly lower climatic risk characteristics, are clearly capable of far higher growth rates than in their place of origin (eg, MAIs of $\geq$ 26 cubic metres in Europe cf. 20 cubic metres per hectare) and also demonstrably grow well over quite a wide range of latitudes. It would seem prudent to avail ourselves of the EU Douglas-fir breeding programme elite selections, and to include some in NZFR Douglas-fir Co-op progeny trials.

Establishment and PSP Trials

Our next visit was to 3-year-old establishment trials which examined interaction of seedling types, different releasing strategies and fertilising. Transplant seedlings were most vigorous.

Our next stop was at the St Amand thinning trial which served as the outdoor setting for a demonstration of the AFOCEL Douglas-fir growth model which has recently been developed by Maryse Bigot and Alain Bailly. Leith Knowles, the NZFR Douglas-fir Co-op manager, has had direct contact with the AFOCEL growth modellers. The AFOCEL Douglas-fir growth model

had been calibrated for a very wide range of thinning intensities and its capabilities were well demonstrated. French site class 1 sites are typically production thinned from age 19 to 21 years onwards at 5 to 6 year intervals, with basal area removals up to 20 percent of total basal area, which is very similar to PNW management.

The French site class 1 stands attain recoverable MAIs of 23 to 25 cubic metres per hectare by age 50. Crowns are quite light with generally only 3-years needle retention (I rarely observed 4-year retentions). Basal area maxima were 60 to 70 square metres. Overall the growth habit of French Douglas-fir forests was similar to PNW forests, that is; relatively low stand basal areas and high stand height growth. This is quite different from the high productivity of South Island New Zealand sites which exhibit lower height growth and exceptional basal areas.

Monday 29 September
Meeting with French Douglas-fir Forest Industry leaders at "Genoscope de Lenaud".

Genoscope de Lenaud is a modernistic functions/event venue, and is the centre for local CRPF, and the centre for the Limousin pedigree cattle sales. It is built entirely from Douglas-fir.

After dinner, John Warjone and I gave slide presentations on PNW and NZ Douglas-fir forest industries (ably translated by Roger and Christine Belton). The following people were present:

* Mr Guillard, President of the industry group "Interbois Limousin"
* Mr Fockeday, "France Douglas", President
* Mr De Seze, "L'Union Regional de la foret Privee", President
* Mme Reyre, "CRPF", President (Regional)
* Mr De Mijolla, "Centre d'Etudes des Techniques Forestier (Technical Forestry Studies Centre, President
* Mr Bouvarel, CRPF Limousin, Director
* Mr Bailly, AFOCEL Centre West Region, Director
* Mr Michaud, AFOCEL Centre West Region, Assistant Director
* Mr Moreau, "Bris et Scierie du Centre", Manager
* Mr de Boncourt, GEPROBOIS, Director (co-operative company servicing forests)
* Mr Ferron, CRPF Limousin, Assistant Director and Chief Executive "France Douglas"
* Ms Bigot, AFOCEL

Tuesday 30 September
Parc de Bort , Tour leader Jean-Louis Ferron,

The day began with a visit to a large estate "Parc de Bort" belonging to Edmond De Seze who was one of the pioneer planters of Douglas-fir in the Limousin Region. Mr De Seze also headed the Limousin Association of Foresters. His grandfather had established a group of Douglas-fir seedlings in the estate garden in 1860, and this had been his inspiration to plant Douglas-fir before the species was supported by Government foresters. Mr De Seze had afforested much of the estate, locating Douglas-fir in the best soils. Original plantings after WWII were planted as alternate rows of Norway spruce and Douglas-fir at 2x2 metre spacing. The spruce was sold as Christmas trees and repeated production thinning had resulted in the current stocking of 400 stems per hectare. The best crop trees had been pruned to 2.5 metre, clearfelling was scheduled for 50 years. At 40 years stand age and 400 stems per hectare, basal area was only 40 square metres per hectare.

The Limousin Region was experiencing a problem with "over supply" of Douglas-fir thinnings. Since 1970 planting rates in the region had averaged 2000 hectares per annum. A typical regime was to plant 1100 stems per hectare, thin (to waste) at 13 years to 600 to 850 stems per hectare, with production thinning at 20 years including pruning 220 stems per hectare final crop trees to 6 metres. Early production thinning promoted undergrowth and improved habitat for wildlife. A third thinning at 35 years produced 60 cubic metres per hectare, stumpage prices were only NZ$50 per cubic metre for medium sawlogs, NZ$25 per cubic metre for posts and NZ$8 per cubic metre for pulpwood. A feature of cut stems was the large sapwood zone averaging 12 rings, and up to 17 rings. Log prices were generally NZ$25 to NZ$40 per cubic metre cheaper than at La Tarn. Price competition from Northern Europe supplies is stronger in this part of France.

Sawmill , Robert Moreau

In the late morning we visited the largest and most modern wood processing mill in Limousin, at Moissannes. The mill, owned and operated by Robert Moreau and family, was built in 1993. It has a 80 000 cubic metre log input, produces 36 000 cubic metres of lumber, and 30 000 cubic metres of chip, the sawdust goes to a panel plant and bark is processed for fuel. The mill was custom built by Kallfass, a German company, to process small dimension logs from thinnings. Input was 45 percent spruce, 40 percent Douglas-fir, 15 percent larch and fir. The largest mill in France, in the Rhone Valley, processes 200 000 cubic metres per annum of logs.

The Moreau mill produced outdoor furniture, decking, fencing materials and cladding in addition to construction lumber.

Average log size is 35 centimetres l.e.d., 18 centimetres s.e.d. and 7.5 metre length. The mill paid NZ$70 cubic metres on forest ride up to 80 kilometre distant. As the marketing and processing of wood has become more competitive over the last 10 years, several hundred small mills in the central Massif region have closed.

In the afternoon we travelled into the hills east of Limoge to visit CRPF experimental sites. First stop was a 30-year-old stand on a windrowed chestnut coppice. Regrowth had been cleared manually. At La Croix CRPF, 33-year-old thinning trials were visited. Common thinning "steps" from 1250 stems per hectare were at 20 years to 700, 26 years to 500, 30 years to 350 stems per hectare. CRPF support for pruning has existed since 1985. CRPF in Limousin guides the management of about 60 percent of private planting. CRPF influence on small private growers is mostly through educational services and demonstration plots as well as through auditing management plans and administering subisidies.

Pruning Douglas-fir became a common practice from the mid 1980s. Harvest age target is 50 to 55 years and pruning DOS aims at being within one-third of final dbh. The Limousin region's high pruning programme covers about 400 hectares per year. Limousin's clearwood Douglas-fir production projected to reach 18 000 cubic metres per annum by 2010.

Typical Douglas-fir Regime Costs - 1997:

Plant	**1100 s/ha**		
Subsidised Cost	**France**	**PNW**	**NZ**
Seedlings	1.5FF/s (NZ32c/s)	US15c/s	NZ40c/s
Planting	1.5FF/s (NZ32c/s)	US12c/s	NZ25c/s
Weeding	3000FF/ha (750/ha)	$75/ha	$100/ha

7.5 metres, thin to waste and prune 300 to 2.5 metres 3500FF/hectare
12 metres, production thin, prune 220 to 6 metres 1500FF/hectare (pruning cost) NZ$450/ha
17 metres, production thin - no cost
IRR expectation 8 percent
Subsidy 40 percent of cost
Land Price 5000FF/hectare 1997 (NZ$1200)

Wednesday 1 October 1997
Visit to Cosylva Lamination Plant at Bourzaneuf.

The Cosylva factory specialises in production of laminated beams for industrial uses. Lumber used is 80 percent imported Norway spruce and 20 percent Douglas-fir thinnings. Scandinavian lumber is delivered to exact specifications and is cheaper. A Russian consignment of spruce had been rejected the previous week, quality control is very important. I queried why only 20 percent of Douglas-fir used? Response: "Slightly more expensive, but stronger, clears are the Rolls Royce". They also considered the appearance of the Douglas-fir was not as good as imported spruce. Machine stress grading had demonstrated that the weakest Douglas-fir lumber was stronger than any of the imported Norway spruce lines. The arguments against using more Douglas-fir were mainly based on appearance, and only slightly on its marginally higher cost.

The example illustrates the difficult marketing future for the French Douglas-fir industry. A major education programme will be required to promote knowledge and acceptance of the superior mechanical performance of Douglas-fir lumber. Only when this is achieved will a market preference for Douglas-fir begin to develop, and more realistic price differentials based on its superior utility be achieved. I fully expect the French forest industry to be highly effective in promotion of Douglas-fir and market development. Whether this will create opportunities for New Zealand Douglas-fir or stiff competition in our overseas markets remains to be seen.

French Forestry Publications List:

Le Douglas, AFOCEL, 1997 Editor Jean de Champs, 416 pages (The French Equivalent to the Radiata Pine Growers Manual – with each chapter written by leading French Douglas-fir experts). (French Translation of key sections available on request.)
Chapter:
1 Background of Douglas-fir
2 Douglas-fir in Europe
3 Establishment of Douglas-fir
4 Management of Douglas-fir
5 The Timber of Douglas-fir
6 Douglas-fir Woodflows and Productivity
7 The French Douglas-fir Regions
8 Economics of Douglas-fir
9 Douglas-fir and the Environment (Fr)

Info – Douglas – Industry Newsletter
1996, 8 pages (Fr)

Douglas dans le Tarn – Industrial Wood Applications – address to Chamber of Commerce, 1996, 35 pages (Fr)

"Replanting in Douglas in Le Tarn"
1996, 4 pages (Fr)

Thinning of Douglas-fir Plantations Forest Enterprise no 78
1988, 30 pages (Fr)

Sustainable Forest Management in France
National Plan for the Implementation of the Statement of Forest Principles
Rio, 1992, Ministry of Agriculture and Fisheries, 1997 (Eng)

Why Prune – Brochures including National Forestry Fund information (Fr)

"Douglas-fir Growth Model"
AFOCEL Bulletin, 1997 (Fr)

CRPF Douglas-fir Trials and Demonstration plots in Limousin
10 Brochures (40 pages) covering key Douglas-fir silviculture issues (French)

Stocking Levels in Douglas-fir Plantations
AFOCEL, 1994, Forest Information , 29 pages (Fr)

Aspects of the Variability of Douglas-fir Provenance from Western Washington
D Michasud et al, 1987, AFOCEL, 38 pages (Fr)

Site Preparation for Douglas-fir
AFOCEL 1987, 21 pages (Fr)

Fertilisation of Coniferous Plantations
AFOCEL, 1982, 27 pages (Fr)

Analysis of a Multi-site Experiment in Douglas-fir Maternal Progenies from Approved French Stands, D Michasud et al, 1990 , 34 pages (Fr)

What Stocking for Douglas-fir Plantations?
AFOCEL, 1990 (Fr)