Some questions to ponder

There are a number of yet unanswered questions that arise the more you consider carbon sequestration rights and a carbon credits trading regime.

Some questions to ponder

- If the ownership of the land, the tree and the carbon sequestration right is separate, each party should insure their own separate interests. However, what happens if the trees are destroyed. What should the insurance cover? Will it cover just the value of the carbon sequestered? Will it cover any liability arising as a result of deforestation and the emission of carbon back into the atmosphere? What proceeds of an insurance claim will any security holder be entitled to?
- What impact will the ratification of the Protocol and the creation of Kyoto Forests have on land values? Will it create a separate class of forest for valuation purposes? In which case, what impact will this have when setting land values by looking at comparables, for the purposes of determining rating values, rentals, licence fees including Crown Forest licence fees etc. The Courts and Arbitration rooms are already crowded with parties arguing land values of forestry land (with the pastoral land v forestry land comparable argument). Is it just going to get worse?
- How will this impact on the Resource Management Act and the already overburdened Councils having to deal with an influx of applications to plant Kyoto Forests and the downstream impact of harvesting these forests?
- How will income from trading carbon sequestration rights be treated for tax and accounting purposes? Conversely, how will any liability arising on deforestation be treated?
- How will the acquisition of a carbon sequestration right by an overseas person be treated under the Overseas Investment Act 1973? Will it be an "interest in land" requiring ministerial consent?

Conclusion

We are at the beginning of the journey, not the end and the next 12 months will see the initial steps being taken to implement the provisions of the Protocol. In another year it will be a lot easier to write about the possible implications of the Protocol once the basic legislative framework is in place and the Government has had the chance to undertake extensive consultation with all interested parties. Watch this space.

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technical notes

What is Armillaria costing the forest industry?

Ian Hood, Hamish Marshall, and Mark Kimberley[1]

Armillaria root disease has been around for a long time. Remember the sight of whole hillsides of young radiata pine stands dotted with yellow, red or brown trees among charred logs and stumps of tawa and other native hardwoods? In those days forest managers needed no convincing about the impact of these native root-infecting fungi![1]

But management systems change, and few plantations today are established directly onto land cleared of cutover indigenous forest. Armillaria continues to kill young pine trees, but it is now a rare sight to see mortality as extensive as once occurred in the past (though in certain situations this still happens).

So is Armillaria no longer a problem? What really is the impact of this disease?

Even in the bad old days, the problem seemed to disappear once stands got through the vulnerable early years up to about age five, or slightly later. Older plantations looked green and healthy, even if closer inspection might reveal gaps filled with tree ferns or weed growth of wineberry or pampas grass.

However, early mortality was only part of the story. It was also found that growth was reduced on older residual crop trees that continued to survive despite infection in

[1] Forest Research

apparently healthy stands. But it took an experienced observer armed with a trowel or small grubber to show, after several hours of careful searching, a significant proportion of trees with resin bleeding at the root collar, and tell-tale signs of fungal rhizomorphs in the surrounding soil.

A number of Forest Research studies have been conducted over the years to try to determine the effect of this "chronic" or "sub-lethal" infection of green-crowned pine trees on stand growth, not by any means an easy task with such a concealed disease. Revised estimates were recently made possible using data painstakingly collected from several long-term trials in the central North Island.

In stands in a first-rotation radiata pine plantation established directly onto a cleared native forest site, percentage volume growth loss at mid rotation was found to be 25% (21% due to early mortality, with an additional 4% resulting from increment loss on residual infected trees). In these stands, between 22 and 35% of trees had been killed by Armillaria after six years, while the percentage of all trees infected, living and dead, ranged 54-64% (the incidence of chronic infection increased further to 55-65% among crop trees after the final thinning). In a second-rotation radiata pine stand on a site not formerly covered in native forest, the equivalent mid-rotation growth loss was 2.5%. In this stand, incidence of chronic infection was 22% at age six years, increasing to 34% after the first thinning. Mortality was negligible.[2]

How prevalent is Armillaria in New Zealand pine forests? Another recent Forest Research study showed that it is very widespread indeed.[3] Infected stands occur in many parts of the country, particularly on the Coromandel Peninsula, and in the central North Island, Nelson, the South Island West Coast, and Southland. Overall mean chronic infection was greatest in first-rotation stands replacing indigenous forest (average incidence, 38%). It was also significant in second-rotation plantations on sites formerly covered either in indigenous forest (10%), or in scrub such as manuka, wineberry or gorse (20%). Chronic infection was lower in first-rotation stands after woody scrub (5%), and in first- and second-rotation stands on herbaceous or non-woody shrub sites, such as pasture or sand dune vegetation (3-5%).

The information obtained from these studies made it possible to attempt an estimate of the current and future impact of this disease in dollar terms over the whole radiata pine estate. Two values were calculated, the first being the revenue loss attributable to Armillaria from the national wood harvest for the year 2000, the second being the projected reduction in returns for the year 2020 at present log prices.

To simplify these calculations, average wood volume losses caused by this disease were assumed to be 20% in all first rotation plantations on native forest sites (corresponding to a mortality incidence of 30%), 0% in other first rotation stands, and 1.5% in second crop plantations. It will be noticed that these percentages are a little lower than those obtained from the growth loss studies, in order to be more representative of the average infection incidence values obtained for the different stand types during the country-wide distribution survey.

These factors were applied to National Average Yield Tables to derive per hectare values at harvest age 28 years,

Figure 1: Mortality due to Armillaria Root Disease in a second-rotation Radiata pine stand in the central North Island (photograph taken in 1999).

corrected according to stand type for the effect of Armillaria (Table 1). It was then necessary to derive the proportionate areas for each of these stand categories that produced or will generate revenue in 2000 and 2020, respectively (Table 1).[4] This enabled a calculation of total returns after adjustment for Armillaria (Table 1).

Comparison of these values with the predicted earnings indicated a deficit in 2000 of $37 million attributable to Armillaria, and a projected shortfall in 2020 of $20 million. These correspond to percentage losses of approximately 2% and 0.5%, respectively, from the national yield.

It should be emphasized that because these calculations were based on limited information a number of assumptions were required. In addition, the averages do not portray the considerable variation in the incidence of Armillaria known to occur both locally and regionally throughout the country. The results appear reasonable and balanced according to the available data, but will need refinement as new figures come to hand.

In particular, the projected value assumes that there will eventually be some infection present in all second-rotation radiata pine stands. At present the number of such stands available for sampling outside the central North Island region remains limited, and it will take time for a more accurate picture to emerge of the effects of repeated cropping of pine trees on the long term prognosis for this disease.

Nor are we aware of how disease incidence in future stands will be influenced by present management practices on infested sites. Studies are being undertaken to find out how Armillaria is currently behaving, and to determine the potential role of spores in setting up new disease centres in second-crop stands. However, despite these uncertainties, it appears that the ongoing revenue losses are significant enough to justify an increased research investment into the disease.

At present few options are available either for managing Armillaria or for determining which are the worst affected stands to be targeted for cost-effective

Table 1: Estimated national losses attributable to Armillaria in pine plantations in two harvest years.

Stand type harvested	Value after accounting for Armillaria ($1000/ha)	Havest year. Values at present log prices after accounting for the effect of Armillaria			
		2000		2020	
		Havest area (1000/ha)	Total return ($ mill.)	Harvest area (1000/ha)	Total return ($ mill.)
First rotation on native forest sites	47.4	2.0	97	0	0
Other firest rotation sites	59.2	13.6	803	45.4	2 690
Second rotation sites	58.3	13.8	806	22.7	1 326
Total		29.4	1 706	68.1	4 016
Total assuming no Armillaria			1 742		4 036
Difference (loss attributable to Armillaria)			$37 mill.		$20 mill.

control. Forest Research is running a research programme to address these issues. However, if substantial progress is to be made more quickly towards the development of management practices to reduce the incidence and impact of the disease, there needs to be a significant injection of research capital.[5]

Endnotes

[1] Armillaria root disease is caused by two indigenous species, *Armillaria novae-zelandiae* and *A. limonea*.

[2] A full report of this work, financed by Industry and public good science funding, is being prepared for publication; the following are thanked for permission to release the information: Fletcher Challenge Forests Limited, Carter Holt Harvey Forests Limited, Rayonier New Zealand Limited, Winstone Pulp International Limited, Pan Pac Forest Products Limited, and the Ministry of Agriculture and Forestry-Crown Lease Forests.

[3] Self, N.M.; Hood, I.A.; Kimberley, M.; Shu, Q.L.; Gardner, J.F. (1998): Distribution and incidence of Armillaria root disease in *Pinus radiata* plantations throughout New Zealand. Pp 137 - 147 in: "Root and Butt Rots of Forest Trees" (eds. C. Delatour, J.-J. Guillaumin, B. Lung-Escarmant, B. Marçais), 9th International Conference on Root and Butt Rots, Carcans-Maubuisson (France), September 1-7, 1997. IUFRO Working Party 7.02.01. Les Colloques, no89, Institut National de la Recherche Agronomique.

[4] To do this it was assumed that the area harvested in 2000 was planted between 1970 and 1980, and that the 2020 harvest will come from land planted between 1990 and 2000. All forests established before 1970 were taken to be first rotation. First rotation areas established thereafter were obtained from available new planting information (New Zealand Forestry Statistics 1991, Ministry of Forestry, Wellington; or after 1989, from data supplied by Paul Lane and John Eyre, Ministry of Agriculture and Forestry, *pers. comms*.). The residual areas were then treated as second rotation forest re-established back onto cleared sites. The first-rotation ex-native forest area harvested in 2000 was determined from planting areas in the 1972-1973 New Zealand Forest Service Annual Report on land known to have been in native forest.

[5] The assistance and advice of Chris Goulding, Keith Mackie, Ken Klitscher, Leith Knowles, and Andrew Dunningham in the preparation of this article are gratefully acknowledged.

Bugs and biodiversity in Scotland's plantation forests

Eckehard Brockerhoff[1]

Supported by the NZ Institute of Forestry's Balneaves Award, I was able to attend an IUFRO forest entomology conference in Aberdeen and to visit the UK Forestry Commission's Forest Research near Edinburgh to learn first hand about biodiversity research in British plantation forests. At the Forestry Commission's Northern Research Station I met Dr. Jonathan Humphrey (Project Leader, Biodiversity) and other forestry scientists involved with biodiversity research and policies. My seminar on 'Biodiversity in New Zealand Plantation Forests' was well attended and stimulated good discussions. Richard Howe, who oversees international co-operation at the Forestry Commission, expressed an interest in enhancing interactions with Forest Research or New Zealand forest scientists in general.

The major findings of the UK biodiversity research programme and interesting contrasts with the New Zealand situation are summarised below (see also Brockerhoff *et al.* 2001), followed by selected highlights from the IUFRO conference.

[1] Eckehard Brockerhoff, Forest Research,
P.O. Box 29237, Christchurch,
e-mail: eckehard.brockerhoff@forestresearch.co.nz

Biodiversity in British plantation forests

There is a notable similarity in Britain's and New Zealand's plantation forests. Both countries have about