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.

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Biodiversity in British plantation forests

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

1.6 million ha of plantations, which equates to 6% of the land area in each case, and exotic conifers make up the majority of the estates. Britain's plantations consist mostly of Sitka spruce (a North American species) as well as Lodgepole pine (also North American), Corsican pine (from southern Europe) and the native Scots pine, whereas New Zealand's plantations consist mostly of Radiata pine (90%) followed by Douglas-fir. However, after centuries of deforestation in Britain, the cover of natural or semi-natural forests stands at only a few percent of the total land area. By comparison, New Zealand's natural forests still account for nearly a quarter of the total land area, and most of these forests are protected.

In Britain, as in most western European countries, biodiversity has long been seen as an important issue in forestry, including plantation forestry. Numerous studies, primarily of the flora of plantations, have been carried out since the 1960s (e.g., Hill 1979), and since the mid-1990s, the Forestry Commission has maintained a comprehensive biodiversity research programme with up to 20 staff. This research revealed that plantation forests are valuable for the conservation of biodiversity, although there is considerable variation between lowlands, foothills and uplands, as well as among the different plantation species and stand age classes. Plantations can provide habitat for many indigenous vascular plant species, although the low light level in mid-rotation stands ('thicket stage') often leads to a considerably reduced range of species. This is most striking in the dense Sitka spruce stands, whereas older pine plantations, which generally have a more open canopy than spruce, still have a rich flora (Hill 1979, Humphrey et al. 2001), albeit not one as rich as that of semi-natural woodland (Humphrey et al. 2001).

Surprising results have been obtained for fungi and mosses in plantations. For example, Sitka spruce has been found to support a very rich flora of *mycorrhizal* fungi, despite the North American origin of this species and the lack of any native spruces in Britain. This is remarkable because *mycorrhizae* have strong relationships with their host trees, and are often host specific. Wood *saprotroph* fungi were richest where there was an abundance of dead wood, and there was no marked difference between native and exotic plantation tree species (Humphrey et al. 2001).

There was little difference between the bryophyte (mosses and relatives) flora of plantations and semi-natural woodlands. However, species richness was higher in Sitka spruce than in pine stands. This interesting finding has been attributed to the relatively constant climate with high humidity and low but adequate light levels in spruce stands (Humphrey *et al.*, in press).

Plantations have also been found to support a rich insect fauna. Hover flies (*Syrphidae*), tree hoppers (*Cicadomorpha*), ground beetles and other beetles (*Coleoptera*) differ in their responses to different plantation forest conditions (Humphrey *et al.* 2001). The former two groups are richest in young, open stands. By contrast, the beetles showed no such response, but with increasing stand age there was an increase in the proportion of species categorised as forest specialists (Jukes *et al.* 2000).

Overall, these studies indicate that Britain's biodiversity benefits from the presence of plantation forests, and that these also offer some possibilities for conservation management. Conservation issues are of a comparatively high priority within UK plantation forests because there is so little natural or semi-natural forest remaining (only a few percent of the total land area). Options for plantation conservation management that are currently being considered include the maintenance of a 'patch clear felling system' for the provision of early-successional habitat, retention of some over-mature stands to provide for dead wood, continuous cover regimes, and diversification of tree species (Humphrey *et al.* 2001). Such management regimes can easily be implemented in Britain because forestry policy, forest research, and to a large degree also forest ownership (and thus management) are all united within the agencies of the UK Forestry Commission, whereas in New Zealand these components are split among many different organisations.

In addition to the habitat management options mentioned above, there are a number of species conservation programmes in the UK, so-called 'Species Action Plans' that partly apply to plantations. The "Species" include a number of bird, mammal and plant species but also several insects: a few moths and butterflies as well as the Scottish wood ant and the lime bark beetle, *Ernoporus tiliae*. The inclusion of a bark beetle in this conservation programme is surprising, because such beetles are normally known as forest pests. However, the lime bark beetle only colonises dead wood of lime that now occurs only rarely.

Another striking management aspect that became apparent while I was visiting a number of plantations and natural forests in Scotland relates more to aesthetics than to conservation. Whereas plantations forests in New Zealand are usually immediately apparent as such, many of the Scottish plantations blend much better into the landscape and sometimes do not look 'artificial' at all. This has been achieved by several means, including the establishment of plantations in a more 'organic' shape that follows natural landscape features, and the planting of wide mixed-species forest margins. These measures will have contributed to the greatly improved image plantation forests enjoy in Britain.

Dynamics of Forest Insect Populations Conference

(International Union of Forestry Research Organisations Unit 7.03.07), Aberdeen, Scotland, from 10-13 September 2001. Meetings of this IUFRO working group bring together many well-known forest entomologists and so provide an excellent opportunity to 'network' and learn about the latest research in this field. There has been considerable progress in understanding population dynamics of forest insects, mainly from ongoing long-term studies and modelling of well-known forest pests such as the spruce budworm and gypsy moth. Many projects have benefited from the increased application of geographic information systems that allow a level of spatial analysis of population dynamics that has previously not been possible. One of the highlights was Prof. Werner Baltensweiler's (ETH Zurich) keynote presentation on '50 years of counting larch budmoth larvae – too long or too short?', demonstrating the value of long-term studies. Interesting data on the impact of insects and

diseases was presented by Jan Volney of the Canadian Forest Service (Edmonton, Alberta). Between 1982 and 1987 the average annual allowable cut in Canada was 299 million m^3, but of this only 54% was actually harvested, while 34% was lost to insects and diseases (the remainder was lost to fire). I have offered to organise a meeting of this IUFRO group in New Zealand in 2004, and this was well received.

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References and further reading:

Brockerhoff, E.G., Ecroyd, C.E. and Langer, E.R.. 2001. Biodiversity in New Zealand plantation forests: Policy trends, incentives, and the state of our knowledge. *NZ Journal of Forestry* 46, 31-37.

Ferris, R., and Humphrey, J.W. 1999. A review of potential biodiversity indicators for application in British forests. *Forestry* 72, 313-328.

Jukes, M.R., Peace, A.J., and Ferris, R. 2001. Carabid beetle communities associated with coniferous plantations in Britain: the influence of site, ground vegetation and stand structure. *Forest Ecology and Management* 148, 271-286.

Heggie, B. 2001. Public opinion of forestry 2001. Forestry Commission, Edinburgh. http://www.forestry.gov.uk/website\pdf.nsf/pdf/Pubop01.pdf/$FILE/Pubop01.pdf

Hill, M.O. 1979. The development of a flora in even-aged plantations. Pages 175-192 *in* E. D. Ford, D. C. Malcolm, and J. Atterson, editors. The ecology of even-aged forest plantations. Proceedings of the Meeting of Division 1, International Union of Forestry Research Organisations, Edinburgh, September 1978. Institute of Terrestrial Ecology, Cambridge, UK.

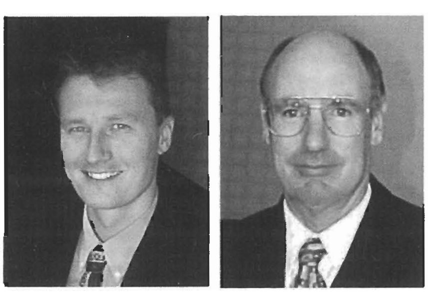
Humphrey, J.W. et al. (in press). Lichen and bryophyte communities of planted and semi-natural forests in Britain: The influence of site type, stand structure and deadwood. *Biological Conservation*, in press.

Humphrey, J., Ferris, R., Jukes, M., and Peace, A. 2001. Biodiversity in planted forests. Forest Research Annual Report 2000-2001. Forestry Commission, UK.

Spellerberg, I.F., and Sawyer, J.W.D. 1996. Standards for biodiversity: a proposal based on biodiversity standards for forest plantations. *Biodiversity and Conservation* 5, 447-459.

Waste, what waste? A question of liability

James Carnie/Brian Joyce
Clendon Feeney



James Carnie and Brian Joyce

So you think you have got rid of your waste? Have you? How about each of your resource consents – are you sure that your contractors are complying with those?

It is amazing to us that ten years into the life of the RMA, with its profound economic implications on land use, including forestry, there appears to be little awareness of the serious potential liability faced by business owners and managers, for offences arising from the activities of their contractors.

Those offences include unlawful discharges and non-compliance with consent conditions. As is well known, the liability for offences under the RMA ranges from enforcement orders to prosecutions, penalties and potential imprisonment. Maximum penalties for unlawful discharges are $200,000 or imprisonment up to two years, and although Courts have traditionally been reluctant to impose significant penalties, recent decisions have been signalling an increased willingness to do so.

Certain offences committed in the course of "*producing a commercial gain*" can result in an additional penalty of three times the gain achieved, and an order requiring the reparation of any environmental effects of an offence could also be made.

The notion that a party might be liable for an act of its agent is not a novel concept at all, but it is now embodied in the RMA for any offences under that Act.

In this article we examine the circumstances in which this type of liability might arise and identify steps that might be taken by business owners and managers to take advantage of the statutory defences available to this kind of exposure.

Section 340 RMA

When first enacted, this provision imposed liability for RMA offences committed by a party's "*agent or employee*". In August 1998, the words "*including any contractor*" were added after "*agent*", representing a significant expansion in the type of circumstances subject to s 340.

Both "*agent*" and "*employee*" have relatively specific meanings in law, with necessary qualities that are required to establish the status of the relationship: an *agent* must be vested with power and authority, however limited, to act on behalf of its principal, while an "*employee*" has a well defined meaning and status by virtue of recent employment legislation.

However, "*contractor*" is not defined in the RMA. It normally means any entity that contracts independently with another for the provision of services.

The potential repercussions of the 1998 amendment are evident if a typical forest management arrangement