the consequences of a wide range of combinations of stocking, thinning, pruning and rotation age (Whiteside *et al.*). Current researchers would have difficulty with both the Fenton/Sutton and the Williams papers. The former unselfconsciously lobbied for a particular regime, whereas the motive of the latter was to "rationalise" the 70 regimes in existence at that time. It is worth noting that currently more than 30 regimes for radiata pine are used by industry.

A continuing issue in the evaluation of silvicultural options is choosing between using log pricing scenarios which reflect market signals for both size and quality (market prices approach) or log grade definitions and prices which reflect the intrinsic residual value (residual value approach) calculated using detailed processing models. With increasing market size and industry experience in utilising the resource, it could be expected that these alternatives will merge over time.

The modern silvicultural researcher attempts to restrict his or her role to providing the knowledge and tools to aid evaluation, rather than advocacy. Forest owners are the customers, and the researcher's task is to provide decision-support rather than decision-making. Technical foresters in New Zealand are particularly well trained, and this definition of roles is seen as appropriate by both parties. Furthermore, it is now widely appreciated that "there are many ways to skin a cat", all of which have their good and bad points. A wide range of regimes can be justified, depending on the circumstances of the decision maker, including the choice of discount rate, species, site, genetic material, initial stocking, final stocking, production thinning, pruned height and rotation age. The researcher's role is to ensure that silvicultural impacts are predictable, so that decision-makers can act with the best information available, presented in the most useful form.

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Forest pests and diseases: a retrospective

Gordon Hosking*

This short article takes a brief look at the history of pest and disease impacts on New Zealand's forests, how forest protection has been tackled, and what the lessons might be for the future. It is not the intention to document even the major pest and disease events of the past, but rather to give a perspective of the themes and philosophies which have guided our response, and their relevance to future strategies.

In the Beginning

Little management of, or research into, pests and diseases of either exotic or indigenous forests of this country occurred until the middle of the 20th century. The late 19th and early 20th century was characterised by collectors and describers, such as botanists Hooker and Colenso and entomologists Hudson and Broun. In general, their work involved little evaluation of the relationships between flora and fauna, and very few observations on the status of pests and diseases relative to their impact on forest ecosystems.

The first real attention to pests and diseases came in the 1920s and 1930s through the Department of Agriculture, the Cawthron Institute, and later the Forest Service. While most initiatives at this time concentrated on surveys of insects and fungi, some individual organisms were singled out for comment including *Sirex noctilio, Diplodia pinea*, and *Phomopsis* spp. In the case of the former, biological control was attempted with the introduction of the parasite *Rhyssa persuasoria* (Miller and Clark 1937).

A greater focus on pests and diseases of forests resulted from the establishment of the Forest Research Institute in 1947, which included a small forest pathology section headed by Joe Rawlings. The early work of this group was mainly concerned with identifying and prioritising what problems existed in both plantation and indigenous forests, and determining what approaches might prove most fruitful in tackling them (Birch 1938).

Early Days

Two early initiatives of the small pathology group at the Forest Research Institute have provided lasting benefits to forest protection in New Zealand: the initiation of the insect collection and fungal herbarium, and the establishment of the Forest Biology Survey. The collections are now the most important in New Zealand for forest fungi and insects, and are essential diagnostic tools for both researchers and forest managers. The Forest Biology Survey, established on the recommendation of J. J. de Gryse (1955), was modelled on the Canadian system and formed the foundation of today's national forest surveillance system. It has for over 40 years been a central plank in the country's forest protection strategy.

Pest and disease management and research in the 20 years between 1960 and 1980 was largely preoccupied with three key issues: Dothistroma needle blight, Sirex wood wasp and Platypus pinhole borers. Lesser effort was directed to Armillaria root rot, Cyclaneusma needle-cast, Diplodia dieback, Phomopsis shoot dieback and the Arhopalus longhorn beetle. The forest health effort of this period can be characterised as reactive in its preoccupation with a number of new and existing problems. The balance of effort was often driven by changing forest policies such as the "on-again, off-again" beech management initiatives in which *Platypus* featured so strongly (Litchwark 1978).

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Despite these wide-ranging and often shifting demands, the major disease problem in radiata pine, *Dothistroma pini*, was successfully controlled using a copper spray – a strategy which continues today, albeit in more refined form. Sirex was also brought under control through a combination of biological control and changes to silvicultural practice such that it is a relatively rare insect today. Changes in indigenous forest policy have largely relegated the *Platypus* beetles to their rightful place as part of our native insect fauna.

Changing Directions

The last 15 or 20 years have seen a major change in direction for New Zealand's forest health philosophy, with an increasing emphasis on a strategic, pro-active approach to both risk management and the future implications of specific pests and diseases. The review of forest health surveillance by Ashley & Hosking in 1981 signalled such a change and recognised the importance of incorporating new techniques and technologies into pest and disease monitoring. The development of a contingency plan for responding to new insect and disease establishments was similarly forward looking, evolving into the Ministry of Forestry policy document 'Forest Disease Contingency Plan' (Anon 1996) of today. Pest risk assessments of specific high-risk organisms not present in New Zealand, beginning with Pine Wilt Nematode in 1989 (Hosking 1989), and culminating in Pine Pitch Canker in 1997 (Dick 1997), continue this theme.

While specific problems, driven by individual insects and diseases, will continue to occupy both researchers and forest managers, even here the issues have tended to become more generic. The focus of eucalypt health problems is increasingly on site-tree interactions in relation to species and provenance, although the continual arrival of pests and diseases from Australia will almost certainly ensure a strong component of organism specific research as far as eucalypts are concerned.

Indigenous forest health, receiving less attention today than 15 years ago as far as insects and fungi are concerned, is now clearly the poor relation to exotic forests in both surveillance and research. A major initiative in the 1980s to clarify the role of insects and diseases in beech forest decline pointed the way towards an ecosystem-based approach to indigenous forest health (Hosking 1986). Unfortunately the ability to monitor and evaluate forest health changes in our indigenous forests appears to have foundered – partly a casualty of science restructuring and partly through lack of forest management resources.

Emerging Themes

A number of themes have emerged over the past 40 years which largely account for New Zealand's remarkable success in protecting its forests from insects and diseases.

Exclusion and Detection. Few would argue that for an island country the best investment in forest protection is in the exclusion of harmful organisms and the early detection of those that escape. However, given the imperative of international trade and the prohibitive cost of full inspection of risk-containing material, exclusion can only be part of a larger strategy. Despite its limitations, forestry quarantine has almost certainly made a major contribution to present forest health, and will remain the first line of defence against new pests and diseases. Given quarantine's occasional failure, early detection strategies, particularly in areas surrounding ports of entry, will continue to be an essential part of the exclusion principle.

Surveillance. The development of a national forest health monitoring strategy has proved to be a cornerstone of forest protection in New Zealand, both in the skills it has provided in dealing with new problems, and in the information on the health status of our forests it has delivered. Perhaps its greatest deficiency in recent years has been the failure to include, or seriously address, indigenous forests.

Research. Understanding is the key to prioritising and quantifying forest health issues and research has underpinned this process for over 60 years. Knowledge of the size, nature, and implications of insect and disease events is the key to effective response, as opposed to a knee-jerk reaction. The spraying with insecticide of *Pseudocoremia* defoliating Douglas-fir in the 1970s (Kay 1983) was a knee-jerk reaction, not a sound forest protection strategy.

Research would show natural pathogens would do the same job at about the same time, but more importantly, the problem would never have occurred if the stand had been properly managed. The preoccupation with the vulnerability of monocultures dating from de Gryse is another example of a knee-jerk reaction versus rational evaluation. We ignore the resilience of much of the world's natural forests which are similar monocultures, including our own mountain beech. We take a healthy plant, tend it, feed it, and harvest it in its full bloom of youth and then become preoccupied with vulnerability. Researchers Bain (1981), Chou (1981) and Whitehead (1981) provide the rationality to counter the knee-jerk. Research has increasingly moved from existing problems to risk evaluation in providing the basis for new forest protection strategies. The key will be keeping the balance.

Long-term Solutions. Solutions to forest pest and disease problems have from earliest days been strongly influenced by the economic considerations of a crop rotation of about 30 years. With perhaps the exception of nurseries and *Dothistroma*, insect and disease control has revolved around silvicultural practice, selection for resistance, and biological control, i.e. sustainable long-term solutions. It is unlikely there will be any change in this approach in the foreseeable future, apart from the evaluation of insect and disease susceptibility before the event for new tree species and genetic material.

Preparedness. An increasing trend over the past 20 years in forest protection has been the realisation that preparedness is not only an important component of a protection strategy, but can in fact identify weaknesses in existing systems through such activities as simulation exercises. Contingency planning, risk assessment, and resource identification are the new strings to the forest protection bow, but they need to be applied with a good dollop of common sense. It would, for example, be a pointless waste of resources to carry out a risk assessment for every foreign insect or disease which might affect radiata pine, for example. Past experience shows at a species level it would be impossible to predict what might or might not eventually establish. We need to concentrate on key, very high-risk organisms, such as pine wilt nematode and pine pitch canker, groups such as bark beetles, tip moths or gall-forming rusts, and pathways such as seed, live plant material, or timber. Pragmatic preparedness has already made a major contribution to the protection of our forests.

Strength of Integration

One of the greatest assets of forest protection in New Zealand is a legacy from the past, integration. The now defunct Forest Service united quarantine, surveillance and research with a large part of the forest estate. Such unity delivered a sense of common purpose, facilitated communication, allowed wide input to prioritising problems, and perhaps most important of all, was driven by the practitioners from the ground up. Such integration was, and still is, the envy of our cousins across the Tasman. Unfortunately while they go forward to what we had achieved, we go backwards with the barriers created by the demise of the Forest Service, the emergence of CRIs from the science reforms, and the withdrawal of Government from active involvement in forestry. The challenge will be to grasp the benefits of these changes while at the same time reversing the disintegration of our forest protection strategy.

Making It Work

The experience of Dutch elm disease and white-spotted tussock moth in the last 10 years clearly show we can make forest protection work on the ground. In both cases detection was made early enough to make eradication feasible, and in both cases the skills and resources were available to tackle the problem. Perhaps the hardest lesson to learn for both researchers, foresters, and the public, is that success is a long haul, and like the insurance of fire brigades, you can only guess at the damage if the fire is not put out. But we can look elsewhere to the cost of failures of forest protection strategies; chestnut blight, Dutch elm disease and gypsy moth in North America, pine shoot moth in South East Asia, pine wilt nematode in Japan, examples abound. The cost of robust protection is small compared to the potential benefits.

Where To From Here?

If I had to put my own money into our forest protection strategy my priorities would be:

- the greater integration and re-establishment of strong linkages between protection components;
- the preservation and enhancement of a national forest protection strategy which included the indigenous estate;
- the pursuit of a strategic initiative addressing as many as possible of tomorrow's problems today;
- the provision of adequate resources and skills including long-term education initiatives;
- the involvement of the public.

Then I'd sit back and watch the trees grow.

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RECENT EVENTS

Sustainable Indigenous Forest Management Research Workshop – Christchurch, April 1997

Rob Allen and Udo Benecke

Background

Over one million hectares, or approximately 20%, of New Zealand's indigenous forests are privately owned. This area is similar to that of the total exotic plantation estate. Indigenous forest owners are being subjected to increasing demands for sustainable forest management through, for example, legislative requirements such as the Resource Management Act (1991) and provisions added to the Forests Act (1949). These recent demands are not without some financial costs to land owners through planning procedures and lost opportunities for generating income. In addition, most of these indigenous forest areas are subject to local government rates so that landowners need to explore options for offsetting these costs. Given consumer interest in wood products from indigenous forests, such as rimu furniture, one option for generating income is through environmentally sensitive timber production. It is not surprising, therefore, that the Ministry of Forestry's Indigenous Forestry Unit has recently seen a dramatic increase in the number of applications for sustainable indigenous forest plans and permits. By March 1997, approved plans and permits covered