Forest Biosecurity Research Council

A Summary of Research Findings 2007

Members of the Forest Biosecurity Research Council:

NZ Forest Owners' Association, Scion, Bio-Protection, Biosecurity New Zealand, Forest Health Research Collaborative, and the Radiata Pine Breeding Company.

Members of the
Forest Biosecurity Research Council:

NEW ZEALAND
FOREST OWNERS ASSOCIATION INC

BIOSECURITY
NEW ZEALAND

SCION
Next generation biomaterials

RPBC
Radiata Pine Breeding Co Ltd

Bio-Protection

NEW ZEALAND
FHRC

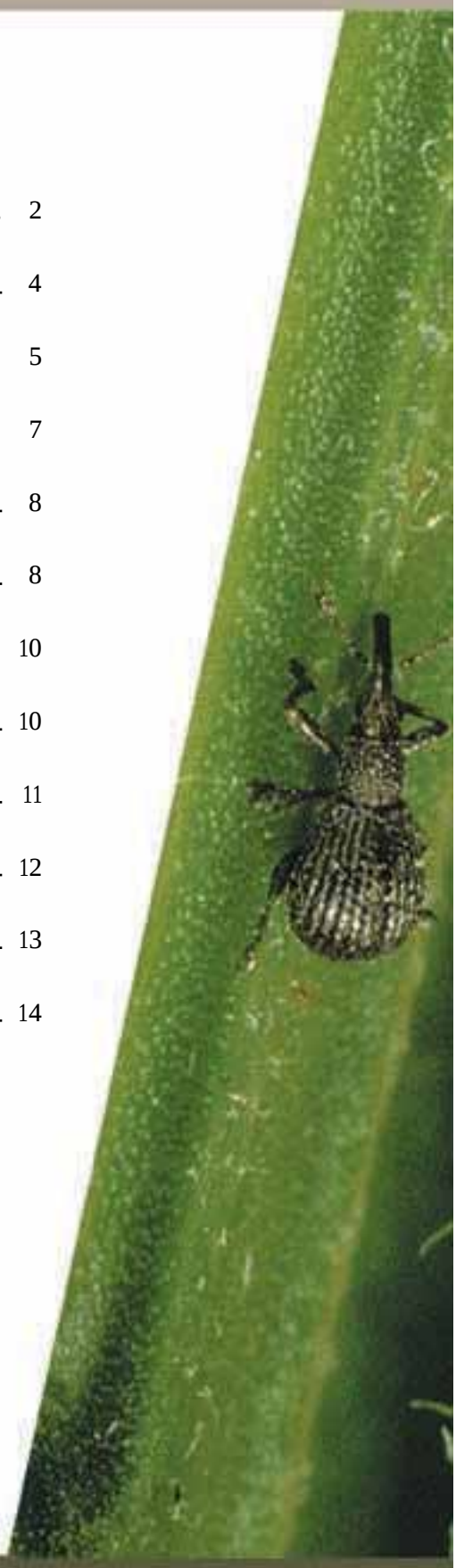
Acknowledging
the generous
support of FRST

FOUNDATION FOR
RESEARCH
SCIENCE &
TECHNOLOGY

Disclaimer:
The FBRC and its members shall not be liable on any ground for any loss, damage, or liability incurred as a direct or indirect result of any reliance by any person upon information contained or opinions expressed in this work.

ISSN 1177-1747

Contents:



The Forest Biosecurity Research Council's (FBRC) goal is to develop new science and technology to help the forestry industry protect their resource from biosecurity threats. We are also looking to enhance tree growth through the exploitation of symbiotic relationships. Biological systems are complex, as every forest grower knows, so it is important to continually develop our knowledge of these systems to manage the risks associated with insect pests or diseases and explore new biological avenues to enhance growth performance.

Foreword

Ian Jolly (Chairman)

Over the past year, the FBRC has attempted to more closely engage the industry in determining its focus on research projects and is grateful for the detailed feedback received. Whilst the key focus is on understanding existing pine pathogens, some exciting work is also underway on the application of beneficial organisms, including endophytes. These little organisms have the potential to enhance disease resistance and significantly enhance tree growth. The forest industry is an extraordinarily long way behind our agricultural cousins in this work but the results they have achieved provides an exciting window on what may be possible for plantation forests.

The ongoing research has only been possible because of the funding provided by forest growers through a voluntary levy. The New Zealand Forest Owners' Association has led the way in supporting this levy, which also enables researchers to leverage funds from government. The combined sum however, is modest compared to other industries and the research efforts are therefore pared down to fit. Given the potentially devastating consequences of a major pest or disease incursion, this situation seems somewhat precarious. Take for example the bark beetle epidemic in Canada or the needle blight spread in Chile and imagine the consequences of a similar outbreak here.

That said, some very good work has been carried out with consequent benefits to the industry. This report summarises progress on a range of projects undertaken through FBRC funding over the past year.

An ongoing project to investigate the ecology of Nectria flute canker demonstrates how improved knowledge of this organism can lead to management recommendations that mitigate the risk it poses. What started as a misunderstood disease several years ago is now being managed through modified silvicultural regimes and I'm confident more gains will be made as research results come to hand.

During the past year, *Phytophthora* has emerged as an important biosecurity issue in New Zealand. The FBRC supported a study trip to Chile by two Scion pathologists who used the opportunity to gain first-hand knowledge of a disorder on pines and to develop diagnostic protocols for use in New Zealand. A needle blight from which a *Phytophthora* has been isolated is spreading rapidly in Chile with apparently serious impacts on the health and vigour of radiata pine. Clearly, we do not want that problem here so taking the opportunity to learn from the Chilean experience is important.

Another area of major concern to the forestry sector is the issue of methyl bromide use for quarantine treatments. The FBRC has enabled researchers to make good progress investigating alternative treatments when no other funding streams have been forthcoming. Again, some 30% of New Zealand's total harvest is exported, yet we struggle as an industry to fund research to identify alternatives.

The escalation of the methyl bromide issue over the past year offers a vivid example of the changing environment in which we operate as an industry. Changes in public opinion can seriously impact on our license to operate, and we must be able to respond quickly to such pressures. Equally, threats from new pests and diseases can require rapid mobilisation of resources. The FBRC is an important part of providing the mechanism for this type of dynamic response. However, improvements in the communication protocols between key stakeholder organisations are required, and certainly MAF is attempting this.

As we head into a new year, many of the science programmes are entering a new round of bidding for Government research money, which forms the backbone of biosecurity research in New Zealand. We are hopeful that the commitment shown by the forestry sector through the FBRC will add weight to the bids submitted.

I would like to thank all members of the FBRC Board for their time and energy throughout the year. I would particularly like to acknowledge the past efforts of Bill Dyck and now Don Hammond as the "executive managers" of the FBRC. These guys are modestly remunerated and work more hours than is allowed for in their budgets.

So, the ongoing goal is to be an effective partnership delivering practical forest health and biosecurity solutions to the issues presented by a changing environment.

FBRC Research Projects

This section of the report summarises projects co-funded by the FBRC.

A brief summary of the project titles and funding contributors is given below.

The contents of this report cover the 2007 calendar year. Since previous reports were aligned with the financial year, direct cost comparisons are not straightforward.

Allocation of effort spent on each of the FBRC projects ($000)

Project	FBRC	FRST	Industry	FIDA**	Total
Understanding *Nectria fuckeliana*	47	174	123	120	464
Impact of *Cyclaneusma minus*	25	76			101
Causes of Physiological needle blight*	20	49	10		79
Needle-cast review	20	25			45
Chile needle blight	11	15			26
Pesticide FIDA (Dothistroma spray application, *Uraba* biocontrol)	15	86	78	95	274
Efficacy of forest health surveys*	84				84
Quarantine FIDA (methyl bromide replacements)	48		9	95	152
Beneficial organisms to enhance tree health	30	195	90	16	331
Bark beetle control	20	135	25		180
Total	**320**	**755**	**335**	**326**	**1736**

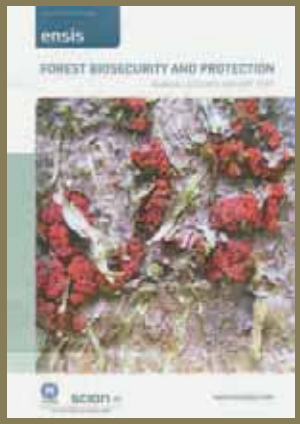
** FBRC funding agreed but not invoiced*
*** FIDA = Forest Industry Development Agenda*

Government Support for Forest Biosecurity Research

The industry-funded FBRC projects described in this report are underpinned by substantial Government support from the Foundation for Research, Science and Technology (FRST). This additional funding provides benefit to the forest industry through comprehensive research programmes, the largest of which is maintained by Scion.

The Scion programme covers the entire risk management spectrum including:

- Pre-border biosecurity
- Post-border biosecurity
- Forest weed, insect pest and disease management
- Ecosystem health and function
- Bushfire research



For a full summary of these programmes, see the Ensis Forest Biosecurity and Protection Annual Science Report 2007 – available through Scion. Contact: Rose.O'Brien@scionresearch.com for a copy.

Managing Nectria

Research into *Nectria fuckeliana* forms a large part of the FBRC programme, receiving additional support from FRST, FIDA, MAF- BNZ and the Nectria Focus Group. This intensive research programme has enabled forest owners in New Zealand's southern regions to significantly improve their management of the disease.

Research on the disease started in 2002, and management solutions have since been implemented and progressively modified as new evidence has emerged. For example, a key finding of the research was the need to reduce the pruned stub size on the stem. As a result, forest managers have adapted their silvicultural regimes to encourage smaller branches. They are also minimising pruning during the winter months, as a result of research findings.

"Through improving our knowledge of the disease we have been able to change our regimes to create forests that minimise the conditions in which it thrives. We believe this research has led to a substantial reduction in damaging Nectria infection of our pruned log resource."

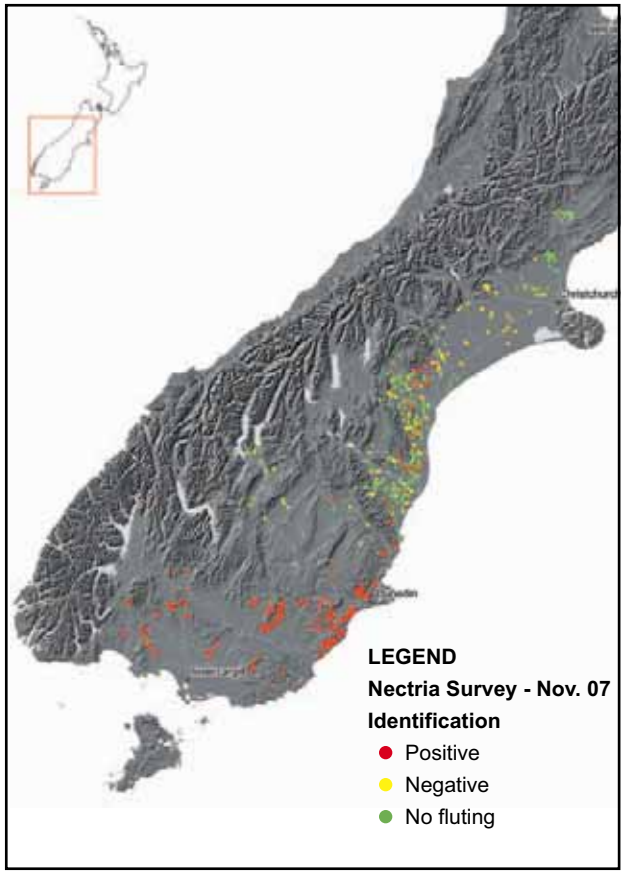
Peter Oliver, Resources Manager,
City Forests Ltd, Dunedin.

Nectria disease distribution

Nectria fuckeliana was found as far north as Banks Peninsula in February 2007. This is still the northernmost find, even though surveys were conducted in Mid-and North Canterbury between March and July 2007. In November 2007, surveys were expanded to cover Marlborough and Nelson. Fluting was present on some trees in Canterbury and the upper South Island, but was not as common as that recorded in Otago and Southland. Knowing the distribution and rate of spread of the fungus, along with disease severity, will provide information on conditions that are favourable for disease development.

Detection surveys will take place in the central North Island in 2008.

Surveys were also undertaken in known infected regions to collect data on disease incidence and severity. Analysis of survey data to determine relationships between disease intensity and environmental conditions revealed that no simple relationships exist and it is probable that a complex of factors influence disease development.



Contact: Lindsay.Bulman@scionresearch.com

Risk of Nectria spread

A study was completed on the likelihood of nursery plants carrying *N. fuckeliana*, with or without symptoms. Results showed there was minimal risk of the fungus being introduced to uninfected regions by nursery stock. This work alleviates concerns regarding the importation of stock from the South Island.

While there were no formal movement restrictions of stock from South to North there were concerns that the fungus could spread by this mode, so stock was closely inspected and surveys were carried out in stands of suitable age growing near where imported stock had been planted. The research has reduced the need for those surveys and inspections to be undertaken.

A second study examined the survival of *N. fuckeliana* in living trees, woody debris and processed wood, and evaluated the biosecurity risk these may present. Results showed that *N. fuckeliana* was able to survive in living trees for at least twelve years following pruning. The pathogen also survived in woody debris on the forest floor for at least nine months. *Nectria fuckeliana* did not survive in cut boards subjected to any of the four kiln-drying treatments tested, but was still viable in boards subjected to nine weeks of air-drying.

Contact: Margaret.Dick@scionresearch.com

DNA detection of Nectria

To test the hypothesis that pruning wounds are necessary for infection by *N. fuckeliana*, the presence of the fungus was assessed in pruned and un-pruned trees using DNA and culture-based methods. Results indicated that there was no significant relationship between the pruned status of the tree and the presence of *N. fuckeliana* based on the results from the DNA testing and culturing. Scientists conclude that although *N. fuckeliana* can infect through pruning wounds, it is also able to infect the tree via other mechanisms as the fungus was present in un-pruned trees. This finding is being followed up in further studies.

Although the fungus is present in unpruned trees, data from other trials suggests fluting is more frequent following pruning, perhaps indicating that stress induced by pruning allows proliferation of the fungus already in the tree.

Contact: Tod.Ramsfield@scionresearch.com

New findings on Nectria epidemiology

Research into the ecology and epidemiology of *N. fuckeliana* has continued this year with several new laboratory and field-based studies. A better understanding of the ecology of this pathogen is critical to allow forest managers to make more informed decisions about reducing disease spread and infection. Some important findings this year include:

- The type of wound is most critical for flute canker development of *N. fuckeliana.* Deep stem wounds are much more effective pathways for spread and infection than shallow stem wounds.
- There appears to be a strong individual tree response to infection and flute development.
- *Nectria fuckeliana* releases sexual spores throughout the entire year. Dispersal is related to rainfall, especially during summer months.
- The pathogen is likely to have at least three mating types that are able to be distinguished in culture. Understanding mating types will help to determine how sexual fruitbodies (perithecia) are produced on infected trees.
- Six other species of conifer have also been examined for susceptibility to infection by *N. fuckeliana.* These include two other pine species and Douglas fir. None of the six species appears to develop serious flute cankers as a result of infection by *N. fuckeliana.*

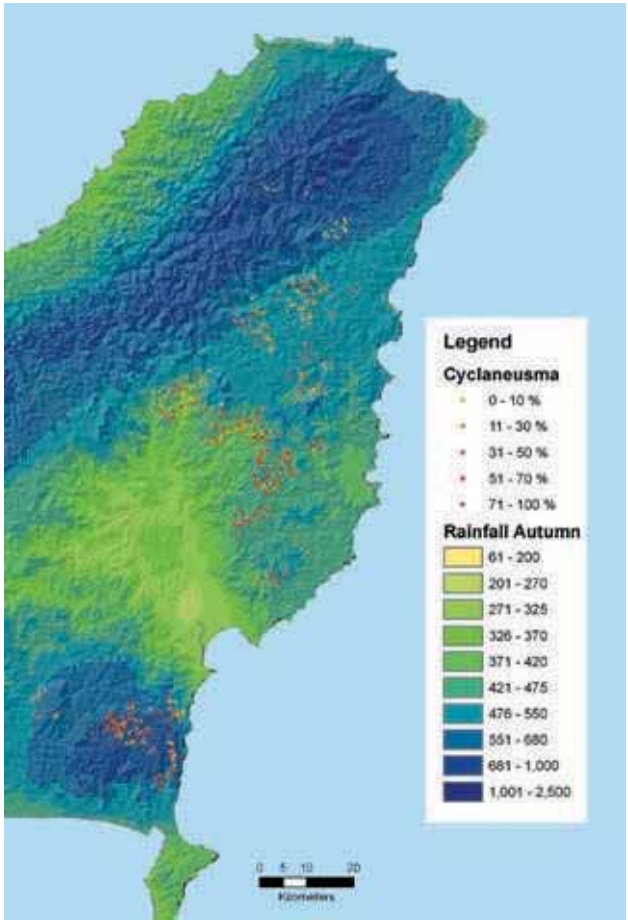
Contact: Anna.Hopkins@scionresearch.com

Cyclaneusma

Cyclaneusma needle-cast is one of the most economically significant diseases of *Pinus radiata* in New Zealand. An updated economic evaluation of loss from Cyclaneusma needle-cast is required to determine if mitigation measures such as selective thinning are worthwhile.

Plantations throughout New Zealand were aerially surveyed for the second consecutive year in October and November 2006. Data were linked with a GIS and regional disease incidence and severity data were compiled. The most disease prone regions over both years were East Cape (with 30% of trees showing average disease levels of 25%) and the central North Island (where about half the trees surveyed had average disease levels of 50%). Northland had relatively little disease, probably because untimely gales in the first year blew most of the symptomatic foliage off trees before they were assessed. In addition, the age-class distribution of Northland forests is skewed toward older stands past the susceptible age.

The relationship between autumn rainfall and disease severity, which was demonstrated through research undertaken in the 1980s, was confirmed. Analysis of the relationship between weather and disease levels is continuing for 2005 and 2006. Economic loss over the entire country is in the order of $50m per annum, similar to estimates made 20 years ago. However, changes in age-class distribution and forest area need to be accounted for and a definitive statement on economic loss will not be available until mid 2008.



Contact: Lindsay.Bulman@scionresearch.com

Physiological Needle Blight

Physiological Needle Blight (PNB) occurs in *Pinus radiata* plantations in late winter or early spring. Symptoms from a distance resemble severe Dothistroma needle blight – the tree crowns look red and defoliation is reasonably uniform within an infected area. A close inspection of affected trees shows that the foliage remains firmly attached to branches for a period of several months after death, and characteristically droops. Scientists believe that the primary cause of PNB is not fungal, although fungi may contribute to death of needles already stressed by environmental factors.

A project supported by FBRC is investigating the hypothesis that PNB is caused by needle water stress triggered by large water potential gradients occurring between the roots and needles. Following on from last year's investigation, root water potential, needle water potential, root temperature, needle temperature, soil water content and air humidity were monitored from June to October 2007 in an East Cape forest that had a history of PNB. Two stands were selected, one with the potential to develop PNB, the other was selected as a control.

Results show no effect on needle or root water potential of the sites and no PNB developed in any of the study trees during this period. The water potential difference between the roots and needles remained low in all sites during the sampling period suggesting no potential water stress was occurring within the needles of these trees.

These results have been used to design investigations into the relationship between air and soil temperature, air humidity and the ability of *P. radiata* to regulate its water uptake to the needles and thus control needle water stress. One experiment is examining the role of root temperature on water uptake in pine and another is investigating the ability of the plant to maintain water potential gradients between the roots and shoots given large changes in air relative humidity. This research was primarily carried out by Nick Gould of HortResearch.

Contact: Lindsay.Bulman@scionresearch.com

Needle Blight in Chile

by Lindsay Bulman - Scion forest pathologist

Unusual symptoms on *Pinus radiata* foliage were first noted in Chile in 2003. At that time less than 100 ha were affected. By 2006, symptoms were noted over approximately 60,000 ha. Chilean researchers have carried out many studies on possible causes including looking for abiotic factors such as poor nutrition, solar radiation, ozone, and soil type, as well as pests and fungal pathogens.

In early October 2007, Mike Wingfield from FABI (Forestry and Agricultural Biotechnology Institute) in South Africa announced that an undescribed species of *Phytophthora* had been isolated from symptomatic material growing in Chile. Currently the association between disease and *Phytophthora* or any fungal pathogen has not been proved. In mid-October 2007, myself and fellow pathologist Rebecca Ganley visited Chile to look at the problem and discuss it with Chilean officials.

The problem is named Daño Foliar del Pino (DFP), meaning damage to pine foliage. It should be stressed that. DFP is likely to be of complex aetiology; interactions between DFP, pathogens, environment, and host are not yet well understood.

From a distance, affected trees have a similar appearance to those affected by Cyclaneusma needle-cast. Foliage turns yellow, gold, and then brown and one-year-old foliage is affected. However, the resemblance ends there. Needles do not detach from branches as readily as those affected by Cyclaneusma and often, symptoms start with a pale area at the base of the needle, accompanied by a black band.

Another distinctive feature of DNP is the formation of resin at the point of connection between the needle fascicle and the branch. Cankers may be are formed on young succulent tissue, but not on old tissue or on branches of older trees. Sometimes a brown discolouration can be found in the cambium at the trace of a symptomatic needle.

In Chile, DFP is most severe on sites prone to prolonged periods of moisture through low cloud, mist, fog, or rain. In New Zealand inspectors should be especially vigilant on those sites with similar environments. DFP could well be a problem on such sites.

Contact: Lindsay.Bulman@scionresearch.com

The Forest Health Reference Laboratory at Scion is routinely testing all *Pinus* foliage with suspicious symptoms for *Phytophthora* spp. Protocols for testing have been developed and documented. While molecular diagnostic tests specific for this species of *Phytophthora* are unavailable, they are currently being developed overseas. Total DNA extracted from needles displaying DFP symptoms in Chile, collected during our visit and stored at Scion, will be used to test the reliability of any diagnostic tests developed.

Through the visit, not only has our understanding of DFP increased, but communication with Chilean officials has been enhanced. Scion and Servicio Agricola y Ganadero (SAG), the Government department responsible for protecting Chile's primary sector, are now developing a memorandum of understanding to formalise the collaboration.

Dothistroma Spray Application

Needle-cast Review

Dothistroma is one of the most serious diseases suffered by radiata pine in New Zealand costing the industry over $23 million per year in lost growth and treatment. This damage would be much higher if it weren't for the application of results from previous research.

Many studies have been carried out over the years to determine the optimum time for copper spraying and the most efficient way of doing it. Initially spray was applied at a rate of 2.08 kg of copper in 50 litres/ha of water. Improvements in aerial spray technology have seen this reduced to a rate of 0.85 kg of copper in 5 litres/ha of water, with subsequent reductions in cost and environmental impact.

Current application rates of copper sprays are now being reviewed in the context of new spray technologies. The aim of this research is to gain further efficiencies and cost savings through even lower application volumes. Results of the current work indicate the potential for further reductions in treatment rates. These results require field testing before management recommendations can be made.

Funding for this work has been provided by FIDA and Dothistroma Control Committee.

Contact: Stefan.Gous@scionresearch.com

The most economically important needle diseases in New Zealand are Dothistroma needle blight, Cyclaneusma needle-cast, and Physiological needle blight. A considerable amount of research has been done in New Zealand over the last forty years on these diseases. The work on Cyclaneusma has been captured in Forest Research Bulletin 222, but a summary of Dothistroma research is not readily available.

A review summarising results of research was written to provide a reference point from which to identify future research needs. Literature on Dothistroma needle blight, in particular, and physiological disorders was reviewed and summarised. Research was reported on in broad categories including, but not limited to, biochemistry, resistance, chemical control, silvicultural control, disease distribution and impact, epidemiology, and host susceptibility.

Along with research results, the review identified priority areas for new work to assist with development of a research strategy for foliar pathogens of *Pinus radiata*. Strategy development is timely considering a new forest biosecurity programme is currently being negotiated with FRST.

Contact: Lindsay.Bulman@scionresearch.com

Biological Control of Gumleaf Skeletoniser

Gumleaf skeletoniser is an Australian moth that continues to create problems in the greater Auckland region on eucalypts and a range of amenity tree species. As this pest gradually spreads to other areas of New Zealand the need increases for long term management solutions.

Work on biological control of gumleaf skeletoniser has been underway for some time, funded largely by MAF. A Sustainable Farming Fund grant has been secured by the Gumleaf Skeletoniser Stakeholder Group to support Scion in continuing the project until 2010. This project is co-funded by FRST, FIDA, FBRC and Farm Forestry Association, along with industry and Regional Council support.

Host range testing is underway in quarantine in Rotorua to identify which parasitoid is most suitable to target gumleaf skeletoniser in New Zealand, and to determine the safety of releasing the selected species in this country. Scion entomologists have narrowed the potential agents down to two parasitic wasps: *Cotesia urabae* and *Dolichogenidea eucalypti* (Hymenoptera: Braconidae). Both wasps are only known to attack gumleaf skeletoniser caterpillars. They lay their eggs inside the host caterpillar and the parasitic larva eventually emerges, killing the host.

Once the most suitable parasitoid has been identified, and host range testing and community consultation are complete, an application will be submitted to the Environmental Risk Management Authority (ERMA) to gain approval to release the insects in New Zealand. If the application is successful, releases of the biological control agent will then be made with the help of councils and forest owners in regions affected by gumleaf skeletoniser. This project provides a strong example of how research supported by the FBRC benefits not only forest growers, but also the wider public of New Zealand.

Contact: Lisa.Berndt@scionresearch.com

Reducing Methyl Bromide Use in New Zealand

Methyl bromide is a fumigant commonly used to ensure that New Zealand exports are free of insect and fungal pests. However, methyl bromide is seen as a hazardous and ozone-layer depleting substance so there is increasing pressure to restrict its use worldwide.

Since forestry products account for 80% of New Zealand's methyl bromide use, there is an urgent need for the industry to identify suitable alternatives that are acceptable to trading partners. The following projects are targeted at finding short- and long-term solutions to this need.

Alternative fumigants to methyl bromide

The most suitable alternative fumigants identified for further testing are phosphine, sulfuryl fluoride (SF) and ethane dinitrile (EDN).

A simulated in-transit fumigation was undertaken to determine the effect of bark and soil contaminants on the depletion of phosphine fumigant. Pine bark played an important role in phosphine depletion during the 48-hour fumigation treatment, whereas soil contamination had little influence on fumigant concentration profile. Further study is needed to understand the influence of bark on phosphine absorption in terms of its moisture concentration, coverage on logs and its absorption of gas at different temperatures.

Over the past year, laboratory trials were undertaken to identify the minimum concentration for controlling *Hylastes/Hylurgus* larvae and *Arhopalus* beetles.

Initial laboratory trials have also been completed to identify the minimum concentration of EDN needed to control adult stage quarantine pests. Testing will continue to determine the suitability of this fumigant for forest product applications.

Contact: Don Brash, Crop and Food Research BRASHD@crop.cri.nz

Alternatives to fumigants: Light

A light trapping system has been developed by Frontline Biosecurity to reduce numbers of burnt pine longhorns (*Arhopalus ferus*) on wood processing sites. The light trap is seen as a way of reducing reliance on methyl bromide during *A. ferus* flight periods. Using powerful UV rays to attract the insect, the light trap has proven to be successful at catching insects on industrial sites.

Further research is now underway by Scion to refine the system by determining the colours that are most attractive to *A. ferus*. Initial trials of various light wave lengths show that yellow light attracts significantly fewer beetles than white lights and ultraviolet. These results indicate that manipulation of existing lighting at wood processing facilities could reduce site attractiveness to *A. ferus* dispersing from surrounding environments. Reduced beetle density at the site would then result in fewer beetles in wood stacks leaving the mill.

Forest Health Surveys

This information is being used by mills to modify their site lighting. This approach forms part of an integrated pest management system that uses a better understanding of pest insect ecology to design sustainable quarantine systems.

Contact: Steve.Pawson@scionresearch.com

Alternatives to fumigants: Heat

Heat treatments are being explored as an alternative to fumigation since most insects are known to die rapidly at temperatures above 45°C. Data on the temperature mortality threshold of insects provide strong support for proposed heat treatment regimes in the order of 55°C for 10 minutes where direct exposure is involved such as in the case of used vehicles.

A trial was undertaken to evaluate the practicality of using dry-heated air for the disinfestation of sawn timber stacks contaminated with *A. ferus* beetles. Results showed that crevices or sheltered areas around the stack were far below the 55°C necessary to kill the beetles after short-term heat exposures. Without requiring unrealistic heating durations, it seems unlikely that this method of heating will be a practical quarantine treatment option for sawn timber.

Contact: Steve.Pawson@scionresearch.com or Gordon.Hosking@xtra.co.nz

The New Zealand Forest Owners' Association (NZFOA) surveillance system is being modified to provide better information to owners on both forest health condition and pest status. The intended system will also be capable of detecting new pest incursions.

In devising a surveillance system it is necessary to minimise the running costs while still providing information that is of sufficient quality to enable reliable management decisions to be made. An FBRC project is aimed at assessing the cost and efficacy of three sampling strategies (regular, random and stratified random) at different intensities for estimating disease levels and detecting the spread of new pests. The goal is to develop a surveillance system that achieves the most efficient combination of cost and accuracy.

Using a long-term dataset of Dothistroma needle blight assessments in Kaingaroa forest, researchers have determined the precision and uncertainty of disease infection estimates using different sampling strategies. The regular sampling strategy appears to be the most efficient option, whereby a regular grid is placed on a map of the forest and sample points are randomly allocated within each grid at a given sampling intensity.

The amount of the forest sampled each year is the main variable affecting both the cost of the system, and the precision of the estimates. Modelling researchers found it was possible to reliably detect a difference between disease levels using a sample intensity of 0.2% (with 95% confidence).

The second part of the project is in progress to assess the impact of different sampling intensity on the area that an invasive organism is likely to occupy before it is first detected.

Contact: Darren.Kriticos@csiro.au

Beneficial Micro-organisms to Enhance Tree Health

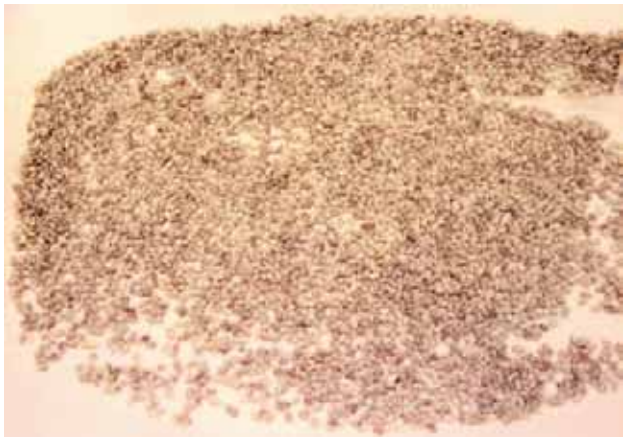
The FBRC is supporting efforts to provide the forest industry with effective biological control agents and natural products to control pests and diseases. This research also looks to enhance health and vigour, with selected microbial formulations. These biological control agents can reduce the need for chemical pesticides. Over the past year, progress has been made in developing biological protection methods for *Pinus radiata* to enhance establishment and health of seedlings and cuttings in the forest nursery and for key pests and diseases in plantations, including bark beetles, Armillaria disease and Nectria 'flute canker'.

Beneficial organisms to enhance *Pinus radiata* health and vigour

Research is being undertaken to identify microbes and/or natural products that improve the health and vigour of *Pinus radiata* seedlings and cuttings. Cuttings trials have been used to evaluate various treatments of beneficial microbes, a variety of biochars and other natural products, and several novel rooting hormone formulations. The best treatments were identified for further development and eventual use by the industry.

Seedling trials were established in 2006 to evaluate novel microbial formulations, at the PF Olsen Nursery and at the Kaingaroa Timberlands Te Ngae nursery. Of over one hundred treatments, several superior microbial formulations were identified, including one that increased seedling vigour by over 30%. The best treatments from this trial are currently being tested in large-scale nursery trials and field tested in a new Rotoiti Forest trial.

The Trichoderma-based product ArborGuard™ was applied as a seed-coating by BioDiscovery NZ Ltd to around 25% of the total 2007 New Zealand radiata pine seed sown, and to some Douglas Fir seed (for PF Olsen, Kaingaroa Timberlands and Horizon 2). Field trials using some of these trees will be established in 2008.



Pinus radiata seed coated with ArborGuard™

Contact: Robert Hill hillr3@lincoln.ac.nz

Bark beetle biocontrol

Biocontrol methods for bark beetles are being developed by AgResearch and Silver Bullet using *Beauveria* spp. The FBRC has supported the development of a 'pellet' formulation that can be used to deliver the pathogen to beetles in the forestry environment. To be effective, formulations must maintain spore viability in storage and under field conditions, and be capable of luring and infecting beetles over an extended period.

A clay-based matrix provided the prototype basal formulation. This has since been improved to provide protection from wetting and subsequent contamination, and to preserve structural integrity in the field. Stability of the basal formulation was confirmed, and attractants have now been incorporated. Water resistance and stability of pellets containing a range of attractants were subsequently field tested during autumn 2007.

Results to date indicate that overall pellet stability is good with release of the volatile compounds continuing over 3-4 weeks. Additional slow-release formulations have been devised, and will be tested for attractiveness to beetles in a harvested plantation forest.

Contact: Mike.Brownbridge@agresearch.co.nz

Armillaria disease

The *Trichoderma* product, ArborGuard™, has been shown to provide protection from Armillaria disease in forest plantations. Research is being undertaken to determine the effect of *Trichoderma* on ectomycorrhiza species colonising *Pinus radiata* seedlings in a commercial nursery.

The results indicate that *Trichoderma* bio-inoculants did not negatively impact ectomycorrhizal colonisation of *P. radiata* seedlings at the nursery tested. However, since the ectomycorrhizal diversity at this nursery was dominated by one species, *Thelephora terrestris*, further testing is warranted, especially in nursery systems where bare rooted seedlings are grown and where a different ectomycorrhizal species may be dominant.

Beneficial Micro-organisms to Enhance Tree Health

Nectria 'flute canker' wound protection

A pruned stub trial, to evaluate various microbial and chemical treatments against Nectria, was established in the Tokoiti Forest, near Dunedin at the end of June in 2006 (with City Forests Ltd). Table 1 summarises the results from an assessment of this trial in mid-May, 2007. The least fluting was recorded for the un-inoculated control, followed by Primaxa, Garrison (the two commercial chemical formulations), BD1, BD2 and BD3 (the microbial treatments) and most for the inoculated controls. The ranking for visible fruiting bodies was similar, but with more for the un-inoculated control than for the chemical treatments. An FHRC/FBRC commissioned study (June 2006) on the detection of Nectria in pruned and un-pruned *Pinus radiata* found that the incidence of Nectria was the same in both. Furthermore, the cost of any pruned stub treatment is probably not economic. Future bio-protection research will focus on the potential to control Nectria with selected root-zone and/or endophytic beneficial micro-organisms.

Contact: Robert Hill hillr3@lincoln.ac.nz

Table 1: Summary of results from Nectria pruned stub trial (Tokoiti Forest)

Treatment	Mean flute score after deduction of flutes at start	Fruiting bodies (mean number)	Average stub diameter (mm)
Un-inoculated control	42.5	5	42.64
Primaxa	45.5	1	41.35
Garrison	46.5	4	40.84
BD1	60.5	11	42.29
BD2	65.5	18	43.82
BD3	65.5	15	41.75
Inoculated control 1	72	16	40.99
Inoculated control 2	74	18	42.19

www.fbrc.org.nz

For more information on FBRC,
membership details and science reports.

Representative Contacts:

Forest Owners' Association

Ian Jolly (Chairman) – ian.jolly@gmo.co.nz

Wei-Young Wang – wei-young.wang@pfolsen.co.nz

Nigel Heron – nigel.heron@ktml.co.nz

Biosecurity New Zealand

Paul Stevens – paul.stevens@maf.govt.nz

NZ Forest Health Collaborative

Mark Forward – mark.forward@nelsonforests.com

Scion

Brian Richardson – brian.richardson@scionresearch.com

Lindsay Bulman – lindsay.bulman@scionresearch.com

National Centre for Advanced Bio-Protection Technologies

Robert Hill – hillr3@lincoln.ac.nz

Radiata Pine Breeding Company Ltd

Denis Albert – denis.albert@rpbc.co.nz

FBRC Administrator

Don Hammond – don@hrml.co.nz

Forest Biosecurity
Research Council