


SCION
forests · products · innovation

Forest Protection Annual Science Report 2014

Margaret Horner
1964-2014

This report is dedicated to Margaret Horner, who helped prepare many of these reports over the years along with a wide range of other articles and communications from Forest Protection. Margaret was a friend to many of us and is sorely missed.

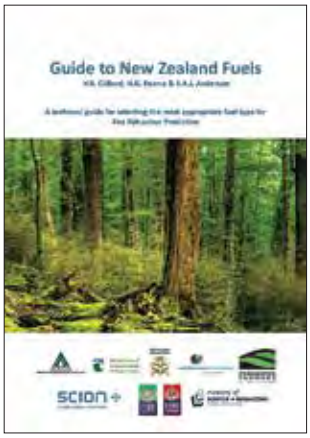
Our collaborative approach to problem solving contributed to the review panels' highly complimentary statements on Scion's abilities to provide solutions to biosecurity issues now and into the future.

Highlights

Forest protection research programmes received overwhelmingly positive feedback following a review by science and end-user panels.

Red needle cast on radiata pine can be controlled chemically, providing a solution to the disease in the short term.

A new fire fuel photoguide was developed for fire managers to help them choose the correct fire behaviour prediction model.

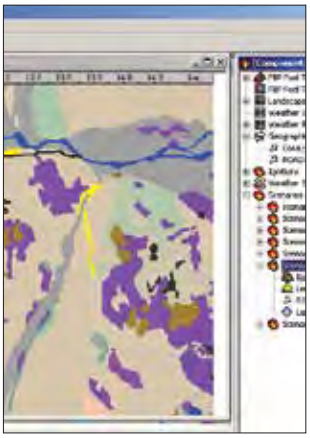


Our National Forest Herbarium Team has developed a DNA barcoding platform for the Myrtaceae species in New Zealand, including reference DNA sequences of 104 targeted species in preparedness for a myrtle rust incursion.

The maximum post-fumigation exposure period for export logs was extended by MPI as a result of our ongoing research into insect behaviour.

No new-to-New Zealand organisms were found as a result of our diagnostic support of forest biosecurity surveillance programmes.

An additional 45 fire managers around New Zealand can now use Prometheus fire simulation software to develop suppression and resource strategies.



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Foreword

It has been a year of consolidation with a focus on science delivery for Scion's forest protection programmes, illustrated by the impressive number of achievements and outputs mentioned within the following pages.

These outcomes have received commendation and awards from industry, as well as overwhelmingly positive feedback from Scion's science and end-user panels following a review of our programmes in November. This review focused on Scion's Intermediate Outcome Five (IO5) to *'Protect and enhance market access and improve risk management in the forest industry including forest health and preparedness for biosecurity incursions, fire and climate change'* and relevant aspects of IO6 *'Licence to operate'*.

Both review panels were impressed with the quality of our science and our involvement with industry and other stakeholders. While we have a core Forest Protection Team, it is pleasing to see an increasing number of staff from other Scion teams, external research partners and industry also applying their diverse skills to this important research area. This collaborative approach to problem solving contributed to the panels' highly complimentary statements on the Forest Protection Team's abilities to provide solutions to biosecurity issues now and into the future.

The 'Healthy trees, healthy future' (HTHF) programme has made rapid progress on a number of fronts over the past year, particularly in the use of metabolomics to screen for, and identify *Phytophthora* pathogens. This is a good example of a multi-disciplinary collaboration between research partners from around the globe who are pooling resources and knowledge to address the biosecurity threat of *Phytophthora* species. *Phytophthora* related diseases are damaging horticultural, agri-forestry and natural ecosystems worldwide.

The HTHF programme is exemplary in its multi-species approach to disease breeding, management and research, and the use of advanced genetic and metabolic analyses to fathom the mechanisms of disease resistance. The programme, led by Dr Nari Williams, involves challenging science and brings together many groups nationally and internationally. The complexity of this programme and its coordination was recognised by industry in their awarding the New Zealand Forest Owners Association (NZFOA) "Contribution to a Science Team" award for 2014 to Nari for her work in leading the programme. Nari and the *Phytophthora* research team also received the "Science of International Quality" award for their work in assessing the pathogenicity and risk of *P. pluvialis*.

In addition, the NZFOA awarded the Pest Management Team the "Communication and Sector Engagement" award in recognition of their excellence in communications and focus on delivering high quality, relevant science. This is further endorsement that our science is aligned to industry need.

The science panel commended our work in developing the use of Bayesian networks, a statistical methodology, for enhancing forest surveillance, pest management and decision support. By perfecting the breeding protocols of common forest pests and conducting large-scale dispersal and flight capability trials, our knowledge of insect behaviour is expanding. These trials contribute a massive data set that, with the support of a custom Bayesian network model, provides real-time information on the biology and ecology of these insect species increasing our capacity for fast response. The decision to extend the maximum post-fumigation exposure period for logs exported during winter from 72 hours to 21 days, for all of New Zealand except Northland, was made by MPI as a result of this ongoing research (refer page 7). This change generates both financial and environmental benefits.

Scion's rural fire research programme continues to innovate, providing practical fire management tools, resources and an increasing number of peer-reviewed publications for rural fire managers and other end-users. The Rural Fire Research Team focuses on fire behaviour and factors affecting public and firefighter safety that are essential to fire management and prevention. This year they have also committed considerable time and effort in contributing to the design of the National Science Challenge 'Resilience to Nature's Challenges'.

Our involvement in four other National Science Challenges has consumed a considerable amount of time too, with the team working hard to ensure Scion's biosecurity research, and the forest industry's and Goverment agencies' strategic needs are aligned and represented in the 'New Zealand's Biological Heritage' challenge.

We look forward to these and other new challenges for 2015 getting underway.

Dr Brian Richardson
General Manager Forest Science

An exceptional year for forest protection research

It has been an exceptional 2014 for forest protection research at Scion, one of the best years that I can recall. The reasons why I say that include the very positive panel reviews and excellent progress of the 'Healthy trees, healthy future' programme that Brian has mentioned previously, along with the many more examples of positive outcomes for forest owners, MPI and other stakeholders.

A real highlight for me was to hear repeatedly from a wide range of our stakeholders that they were delighted with our work and had confidence Scion's forest protection research is of the calibre to protect their significant forest assets. I also have no doubt that the close relationship that researchers enjoy with regulators and forest growers has materially contributed to our rapid progress on many fronts this year. Notable examples include the provision to MPI of DNA barcodes for over 100 Myrtaceae species, demonstration of suppression of red needle cast symptoms for 12 months by chemical application, promising new herbicide mixes that maintain FSC certification, and development of molecular diagnostic techniques.

Another highlight was the number of staff who received formal recognition from peers and stakeholders. As you will read, staff working within forest protection programmes won awards from the Forest Owners Association, University of Auckland, The Institute of Professional Engineers, Scion and other agencies. Special mention has to be made of Ian Hood, who was conferred a Doctor of Science degree by the University of Auckland in recognition of his long career in the research of forest diseases and decomposers of woody material in those ecosystems. Two staff won grants to undertake short term overseas study visits, while others were invited with expenses paid to participate in workshops and courses overseas. The latter opened up opportunities to broaden collaborations and we now have a significant number of active research projects with our overseas peers.

Delivery of science to meet stakeholders' needs was greatly assisted by core purpose funding. This funding mechanism provides the flexibility to allocate funds to meet stakeholders' strategies, expand industry-funded programmes, produce high quality science impact outputs, invest in future opportunities and respond to new drivers of research such as incursions, changes in trade patterns and forest management, and new industry agreements. Over the last three years core funding has been deliberately reallocated from mature areas in consultation with end-users, into research areas of higher priority and those changes are now starting to bear fruit. Research programmes on pine foliar diseases have made considerably faster progress with the addition of core purpose funding than they would have otherwise. Core purpose has also resulted in some high quality science outputs with papers published in *Ecological Applications* and *Journal of Applied Ecology* this year. The government is reviewing CRI core purpose funding in 2015. I ardently hope that the outcome of the review is favourable.

For 2015, our aims are to make a significant contribution to the 'Resilience to Nature's Challenges' and 'New Zealand's Biological Heritage' National Science Challenges, and to to continue to meet stakeholders' needs through our three major MBIE programmes, our weeds research programme and the judicious allocation of core purpose funding.

Lindsay Bulman
Science Leader Forest Protection

Insect pests

Photo: Noah Cremisino

Insects are the little things that rule the world; some are our friends and we strive to harness their efforts to control other species, such as forest pests, that are known to reduce productivity. It is our in-depth understanding of the biology and the ecology of such species that give us the tools to protect trees and ensure our forests are healthy.

Dr Steve Pawson
Research Leader, Entomology

Understanding forest insect behaviour

As part of Scion's wider market access and biosecurity programmes, our entomologists have been studying the biology and ecology of forest insects that may be present in our export log pathway.

Our aim is to determine if seasonal windows exist when forest insects are largely inactive, making it possible for New Zealand's log harvests to be exported without needing to be fumigated.

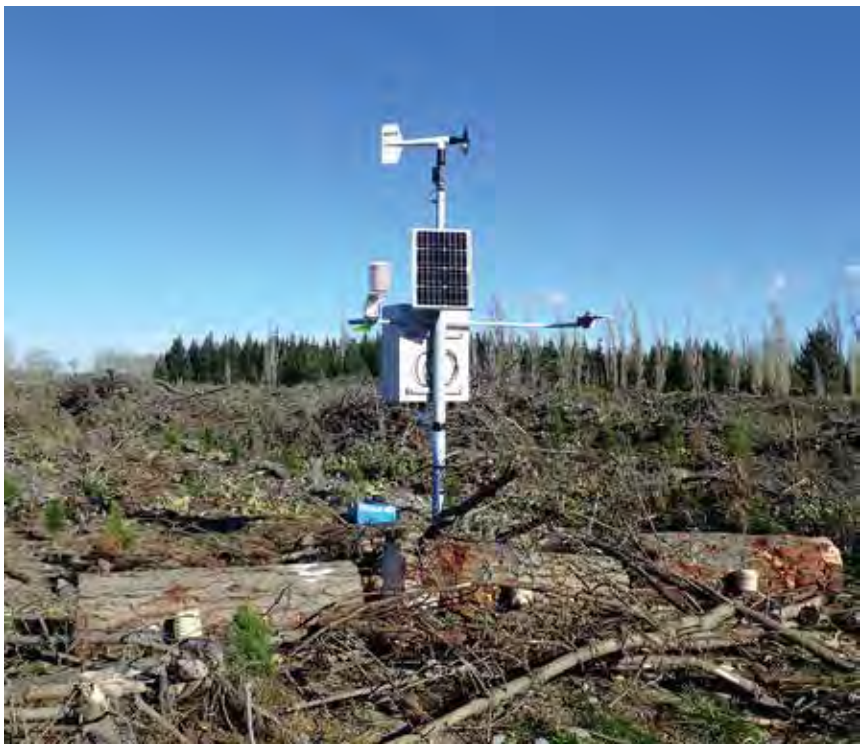
Phytosanitary treatments are costly for both industry and the environment with mounting global pressure to reduce the release of methyl bromide (MeBr) into the atmosphere. Methyl bromide is one of the more widely known and accepted phytosanitary treatments.

At present, some of New Zealand's international trading partners require our log exports to undergo approved phytosanitary treatments year round. The recent extension of the maximum post-fumigation exposure period for logs exported during winter from 72 hours to 21 days for all of New Zealand's ports except Northland, is a step in the right direction to reduce the volume of MeBr released. This decision, made by MPI, is a direct result of our ongoing research into insect behaviour.

Our aim now is to quantify the likelihood of forest insect infestations in logs before they arrive at ports and determine if and when low risk periods exist. If an acceptably low risk period does occur during specific times of the year, a case could be made to further reduce or eliminate phytosanitary treatments during that time.

"In this area of work, our current understanding of the biology and ecology of New Zealand forest insects is limited," says Research Leader Dr Steve Pawson. "Although a considerable amount of data has been accumulated about the summer flight

Hylurgus *bark beetles are colour treated as part of the mark-release-recapture experiment to quantify the dispersal capability of the species.*



activity patterns of common forest insects, there is little known about the behaviour of these insects during winter months.

"For us to be able to quantify the distribution and abundance of these species, it is important to first understand key aspects of their basic biology. We need to know more about their dispersal or flight capabilities so we can determine how far they can fly from source populations, such as recent clearcuts.

"Determining weather conditions that are conducive to insect flight will also help us predict what days they are likely to fly. Another consideration is the distribution of host material within the forest. To determine this, we are modelling the amount and location of deadwood in the forest landscape by merging existing forest industry data with Scion's C-Change model. From this, we can approximate the amount of habitat that is available as a source of insects."

The Entomology Team is focusing their investigations on several forest species – *Hylurgus ligniperda* (golden-haired bark beetle), *Hylastes ater* (black pine bark beetle) and *Arhopalus ferus* (burnt pine longhorn beetle). Data on the insects' distribution and population levels have been gathered over the past two years using traps installed at forest sites and ports around the country (refer Forest Protection Annual Report 2013, p10). These are then being aligned with meteorological conditions for incorporation into a Bayesian network model which will enable us to predict the abundance of these insects at a given place and time.

Last summer, the team also undertook a large-scale insect dispersal trial to determine the distances that both *Hylurgus* and *Arhopalus* can fly. This involved the release in Rotorua and Canterbury of more than 20,000 insects obtained from the field and our laboratory-reared colonies. A 960 metre radius circular trapping grid was established in Rotorua where thousands of laboratory and wild caught *Hylurgus* were marked and released on nine separate days. In Canterbury, the trapping grid monitored the passive dispersal of *Arhopalus* from an isolated population in a burnt stand over three months. Using the data collected, flight activity curves across distance have been developed.

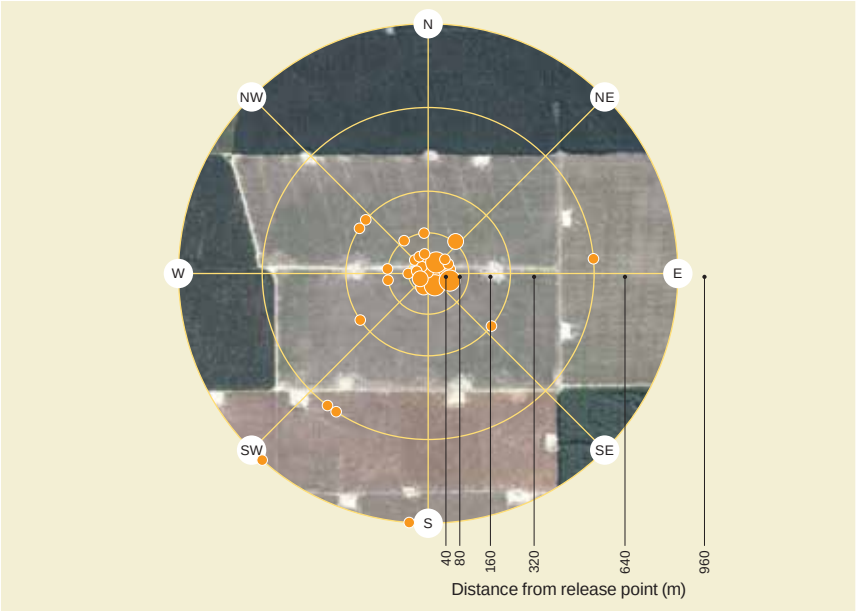
"By using our purpose built separator traps, our insect flight activity work is now progressing to models that predict the hourly flight activity of insects as a function of local weather conditions," says Steve.

"We recently presented this work at the International Forest Quarantine Research Group meeting in Rome and were praised for our innovative approach to risk-based assessments of phytosanitary risk."

Research partners: Bayesian Intelligence

Investment: Scion Core, MBIE, STIMBR

Website: https://quarantinetreatment.wordpress.com



Tiny wasp may be the answer to a big problem

The Australian parasitoid wasp *Cotesia urabae* was first introduced to New Zealand in 2011 by Scion as a biological control agent for the gum leaf skeletoniser, *Uraba lugens*. The *Uraba* caterpillar defoliates eucalypts in both urban and plantation environments, affecting tree health. The caterpillar's protective hairs are also an irritant and may cause human health issues upon contact.

If left unchecked, gum leaf skeletoniser infestations in commercial eucalypt plantations could extend current pulpwood rotations from 12 to 14 years in the North Island and from 15 to 18 years in the South Island, with associated economic effects. Although aerial applications of chemical pesticides reduce caterpillar populations, this is a costly solution.

Cotesia urabae is being released in areas around the country to control the pest where it is causing damage. The tiny host-specific wasp attacks and lays its eggs inside the gum leaf skeletoniser caterpillar and a single parasitoid larva emerges 14 – 20 days later to pupate, killing the host in the process.

The wasp is already well established around the Auckland area and was recently released in Nelson and Napier where the gum leaf skeletoniser has become very abundant. The wasp has also been found in Rotorua, an area where it has not been purposefully released, indicating that the wasp has better than expected natural dispersal abilities.

This is a promising outcome for the suppression of the gum leaf skeletoniser and the overall health of New Zealand's eucalypts.

Research partners: University of Auckland, Hawkes Bay Regional Council, Napier City Council, Tasman District Council

Investment: Scion Core

New insect rearing facilities help further biosecurity research

Two newly constructed insect-friendly facilities at our Rotorua campus will make it easier for our entomologists to breed and maintain a collection of healthy insects on site for experimental purposes.

One of the facilities is a purpose-designed six roomed ambient temperature insect rearing space, or insectary, providing a dedicated, secure environment for scientists to both rear and work with multiple insect species in one space. The second facility provides six additional temperature controlled rooms that will support our on-going research into forest insect pests.

The Entomology Team is currently studying a number of common wood- and bark-eating pests to gain a better understanding of their biology. This knowledge will be incorporated in models that predict insect development and behaviour in the forest and will help assess the potential for a window of opportunity in colder months to export logs without the need for phytosanitary treatments. The ready supply of insects will also help in the development and testing of alternative phytosanitary treatments.

Our expanded insect rearing capabilities will also be available to assist other research partners with their needs.

Investment: Scion Capex

Photo: Port of Tauranga

Targeted surveillance for forest health

Early detection of a new pest in plantation forests greatly increases the chances of eradication, saving possibly millions of dollars in eradication costs and lost revenue.

The introduction of a compulsory forest growers' levy to fund research and improve operational functions, such as forest health surveillance and worker safety, means growers are now more likely to expect that all forests in the country will be monitored for health issues.

This raised the question as to how it might be possible for us to detect newly introduced pests early enough without all forests having to be physically inspected.

To help solve this very complex problem, our scientists co-opted Australia's Centre of Excellence for Biosecurity Risk Analysis (CEBRA) to develop a risk-based model that targets inspections at forests that are at greatest risk. We have now developed a prototype Bayesian network computer model to predict where pests are most likely to establish given our knowledge of major pathways that are sources of most new incursions. Once finalised, this model will produce a risk map across New Zealand that can be used to determine which areas to survey that will maximise our ability to detect any new pest infestations.

Research partners: NZFOA, MPI, CEBRA (Australia), Bayesian Intelligence (Australia)

Investment: Scion Core (B3), FGLT, MPI

Defining the relationship between forest biodiversity and health

Biodiversity plays an important role in the functioning of ecosystems and the services they provide. With a growing proportion of the world's forests being single-species planted forests, there is some concern that this lower level of biodiversity may affect ecosystem services that are correlated with biodiversity, such as resistance to invasion by pests and diseases.

To investigate this further, our entomologists are assessing the effects of forest biodiversity on resistance to invasions to determine if claims that diverse forests are more resistant actually hold true. To date, little international research has been done in this area.

This year we have contributed to a number of publications relating to this issue as well as given a sub-plenary presentation on the subject at the International Union of Forest Research Organisations (IUFRO) World Congress in October.

Our team is part of an international working group that is reviewing worldwide literature on invasions of pests and disease in forests of varying biodiversity. We are also using modelling approaches to compare the relationship between forest diversity and resistance on a continental scale.

The results of this research will help New Zealand forest owners to evaluate the risks associated with pests (insects, pathogens, weeds) that could cause damage and present market access issues. The work will also inform management options to minimise these risks.

This programme aligns with the 'New Zealand's Biological Heritage' National Science Challenge that aims (among other goals) to reduce the potential for pest incursion and increase the country's ability to respond to biosecurity issues.

Research partners: INRA (France), US Forest Service

Investment: Scion Core (B3)

*Eastern fivespined ips (*Ips grandicollis*), a North American bark beetle causing damage to pines in Australia.*

How many invading beetles are needed to establish a population?

We have recently begun a project to examine the minimum size of insect populations that can establish successfully in a new territory. Increasing global trade and widespread use of wood packaging materials has led to an escalation in the arrival and establishment of wood borers and bark beetles in the Northern Hemisphere. Although phytosanitary measures have been put in place, on-going interceptions at borders and discoveries of newly established populations in several countries suggest that this pathway remains a problem.

In order for a new population to establish it needs suitable habitat and climatic conditions, host plants and successful reproduction. Our understanding of population dynamics suggest that most arrivals do not become established and that small populations may fail because of low population growth, or that population growth may decline with decreasing density. This is known as the 'Allee effect'.

This project sets out to characterise the population size and density at the Allee threshold for selected beetle species by using field studies and modelling. We can use this knowledge to determine the acceptable levels of infestation of traded goods at which pest establishment is unlikely to occur, and to inform future phytosanitary policy and control treatments. The results of this project will also be useful for conservation purposes regarding the population ecology of rare and endangered species.

The project is in its early stages. A Scion-supported PhD student has been trapping beetles in numerous locations around the South Island interior where two common pine bark beetles do not occur or are sufficiently rare for the purpose of this project. Similar work has been carried out in the United States with different pine bark beetle species. Initial experiments have taken place to relate the number of individuals at a location to the presence or establishment of bark beetle species.

Research partners: B3, MPI, University of Canterbury, US Forest Service

Investment: Scion Core (B3)

The ecological effects of LED light pollution

The effects of night-time light pollution on our natural ecosystems are increasingly being recognised. The growing shift from traditional yellow-hued sodium lamps to brighter, energy saving LED lamps (light emitting diodes) for municipal and industrial use will likely have consequential impacts on the wider ecosystem.

Our entomologists have begun delving into what this might mean for the forest industry and associated industries such as ports and wood processing sites.

Most insects respond strongly to light in the blue and UV spectra, and current white LED lights are based on monochromatic blue LEDs coated with a phosphor coating. This coating can be manipulated to produce a range of 'white' lights that are referred to by their colour temperature – the greater the proportion of blue light emitted, the higher the colour temperature. Behaviours that are influenced by vision could therefore be changed by using LED lighting, with subsequent ecological impacts for both individual species and the interaction between species, such as predator avoidance or prey detection, navigation, pollination or foraging.

Our Entomology Team recently conducted a comparison between the effects of LED and high-pressure sodium lamps (HPS) at an industrial scale, using different colour temperature LED lights. This research, which was recently published by the Ecological Society of America, showed that LED lamps attracted 48% more flying insects on average than HPS lamps irrespective of colour temperature. This implies that selecting LEDs based on colour temperature is not likely to alter the ecological impacts of a broad-scale shift to white LED lighting by industries.

The potential for white LEDs to increase phytosanitary and biosecurity risks could have far reaching ecological impacts. For example, the gypsy moth (*Lymantria dispar*) is more attracted to white light than to light from HPS lamps. The moth is a voracious and invasive forest pest and the ecological impacts of it establishing in new regions are severe. Ships infested with egg masses are a known pathway and therefore a transition to white LEDs in, or near port areas could elevate the risks of incursion. Conversely, white LEDs at our ports and wood processing facilities have the potential to increase the risk of infesting export products prior to them leaving New Zealand.

Further research is needed to fully understand the long term ramifications of white LEDs on ecological communities. A comprehensive assessment of the overall impacts of each region of the visible spectrum will also enable future developments in lighting to balance illumination and energy efficiency with minimal ecological impacts.

Research partners: STIMBR

Investment: Scion Core, STIMBR PGP

Rural fire research

“It is a common misconception that we have few rural fires in New Zealand. The vast majority of fires do not make the news because they are controlled quickly and put out before they can do major damage. Scion’s Rural Fire Research Team is being increasingly recognised by industry and our peers for our research into fire behaviour and the development of resources, publications and training courses to support New Zealand’s fire managers and firefighters.”

Dr Richard Parker,
Research Leader, Rural Fire Research

Working together to keep our communities safe

The Rural Fire Research Team has had another productive and stimulating year made more remarkable by the quality and depth of collaborations they developed.

"We worked hard to be well connected with industry and other fire research organisations," explains Research Leader Dr Richard Parker. "Scion fire scientists have been doing burn trials in Australia with CSIRO and the Country Fire Authority, working with NASA and the US Fire Service on effects of smoke from fires and working on numerous operational and research projects with New Zealand Fire Authorities, local government, DOC, forest companies and education providers."

Two members of the research team are volunteer firefighters and attended fires in that capacity. This provides great insights into the operational issues of fire suppression and investigation. The team also continues to work closely with Tait Communications exploring innovative technologies for fire operations. This relationship was formalised by a collaboration agreement between Scion and Tait this year.

"It is a common misconception that we have few rural fires in New Zealand. The vast majority of fires do not make the news because they are controlled quickly and put out before they can do major damage," says Richard. "The fire team has been doing valuable work running GIS computer model scenarios on historical fires to demonstrate the potential for disaster had the fires not been controlled as fast as they were. An escaped fire would cause the loss of houses, closure of main roads or destruction of major infrastructure, such as electricity transmission lines.

"It has been a good year with fire researchers being recognised by industry and their peers for leading international fire webinars (communicating rural fire messages to communities), writing a paper for the RxCADRE (Prescribed Fire Combustion and Atmospheric Dynamics Research Experiment) special edition of the International Journal of Wildland Fire, contributing to two IPCC Climate Change reports, having a paper cited in the journal Nature, getting an award for best conference poster, developing a well-regarded "Guide to New Zealand Fuels" and teaching 'sell- out' courses to industry.

"The fire end users invited us to participate in operational exercises. This ensures we are tightly integrated with the fire community.

"At a more strategic level, we have been involved in the National Science Challenges and have developed, with our end users, an up-to-date Strategic Research Plan to guide us into the future".

Website: www.scionresearch.com/fire

Building community awareness of fire risk

Around 3,000 wildfires are reported each year, most of which are started accidently or deliberately by people with less than one per cent a result of natural causes. Our research shows that targeted and tailored messaging is the key to reaching out to rural communities about the dangers of wildfires.

The research team recently completed a three year 'Effective Communication' study on community resilience to wildfire aimed at increasing community awareness, the careful use of fire, and preparedness for wildfire. The study shows that fire users and non-users within rural communities need different messages, and various methods of communication are appropriate in particular situations.

Rural or semi-rural fire users need to be kept aware of fire risks, restrictions such as permits and fire seasons, and prevention and preparedness should a wildfire occur. Similarly, recreational fire users such as those lighting campfires and fireworks need tailored communications on awareness, fire restrictions and fire prevention, whereas non-users just need messages on awareness and how to be prepared for wildfires to ensure that everyone in the community is safe.

Murray Dudfield, former National Rural Fire Officer and Chairperson of the Rural Fire Research Advisory Committee says the findings from the Rural Fire Research Team's effective communication project will assist fire agencies to develop future risk-communication strategies and in turn, direct communication practices to achieve maximum impact.

"Effective communication is essential to reduce and minimise human-caused rural fires which could impact on New Zealand communities in the future. This research will assist in promoting better community awareness of rural fire risk, prevention of wildfires and improved household, property and community preparedness."

The study is part of a wider Australasian Bushfire CRC programme 'Communicating Risk', led by RMIT University in Melbourne. Recommendations from the study are that the National Rural Fire Authority, Rural Fire Authorities, allied agencies (such as DOC and local councils), and fire and land managers should consolidate their communication strategies with particular consideration of audiences, messages and methods.

Research partners: Validatus Research

Investment: MBIE, Australasian Bushfire CRC

Mapping the high risk zones

At a strategic level, the research team has developed a method to map the risk of wildfire in rural-urban areas where flammable vegetation fuels meet people and property, and public safety may be at risk. The team overlaid data for a range of environmental and social fire risk factors onto maps of the rural-urban interface to identify at-risk areas, successfully testing the methodology in case studies at Nelson and Rotorua.

This will have enormous benefits for rural fire managers. Being able to identify high risk areas will help fire authorities prioritise their activities, such as fire prevention measures, creating fire breaks, reducing vegetation and promoting FireSmart communities. Councils and fire agencies can also use this information to strengthen planning and building regulations in high fire risk zones, including the restriction of development in areas of highest risk.

Recommendations from this study have been presented to fire managers and at the National Rural Fire Authority's (NRFA) FireSmart planning workshop, and have helped progress the development of a national FireSmart programme for rural communities.

"The Scion 'Describing Wildfire Prone Areas' paper led by Grant Pearce, provides a very good methodology to identify urban interface areas which have the potential for significant loss of life during elevated fire danger conditions," says Rob Goldring, Manager of Rural Fire with the National Rural Fire Authority. "The rural fire industry will use this work as part of their risk management planning work."

Research Partners: Validatus Research, Rotorua District Council, Nelson City Council, Tasman District Council

Investment: NZFSC

A tiered approach to firefighter fitness

Following a recent review of the NRFA health and fitness guidelines for volunteer firefighters, the Rural Fire Research Team has proposed a new 'fit for purpose' tiered approach to fitness standards.

Fighting forest and rural fires is physically demanding and a high level of fitness is required to minimise fatigue and to work competently and safely. The study provides recommendations for minimum fitness standards for different firefighting tasks based on discussion with firefighters and fire agencies, and a review of international approaches.

These recommendations will make it possible for the New Zealand Fire Service Commission, NRFA and other rural fire authorities to develop task specific and medical tests for volunteer and permanent rural firefighters, and incident management personnel.

Research partners: NRFA

Investment: MBIE, NZFSC, Industry

Fuel photoguide expands fire prediction tools

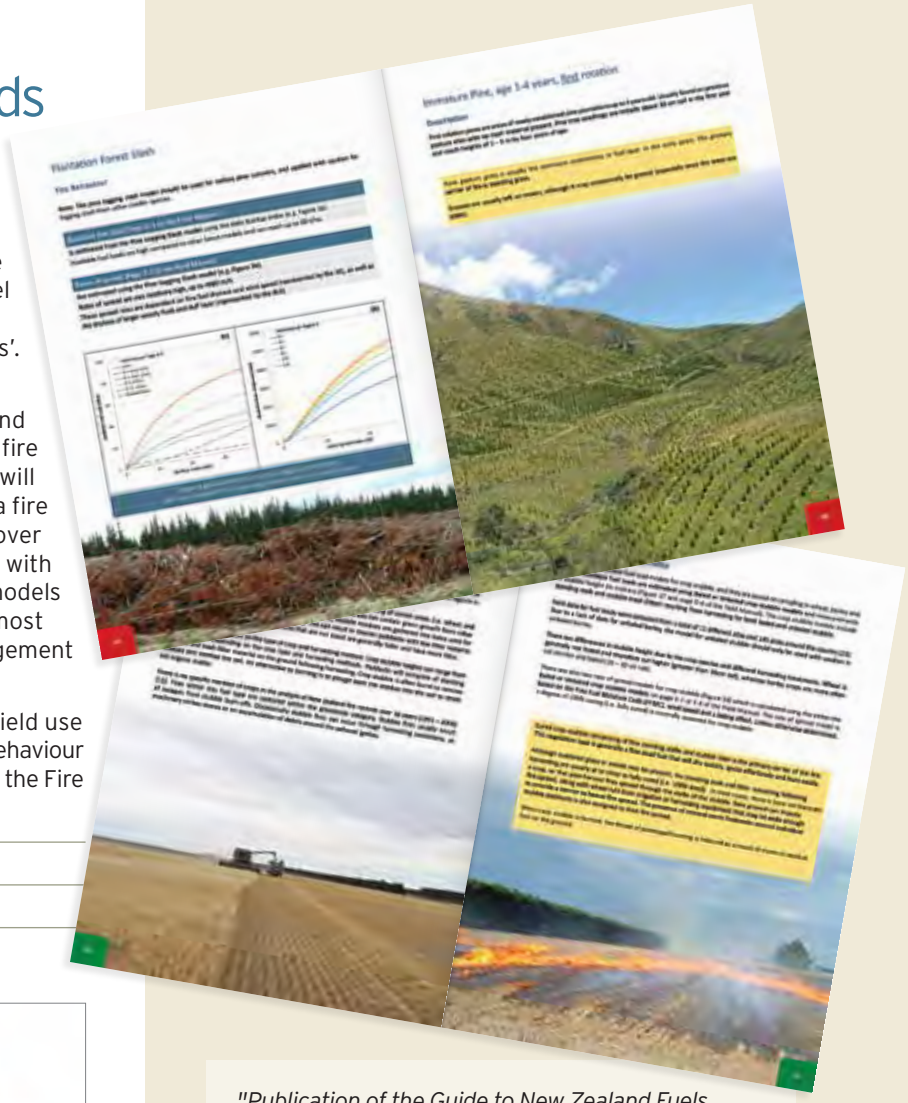
A new fire fuels photoguide provides images and technical descriptions of fuel types to help fire managers choose the right fire behaviour model in prediction tools such as the Fire Behaviour Field Manual, Toolkit calculator and smart 'apps'.

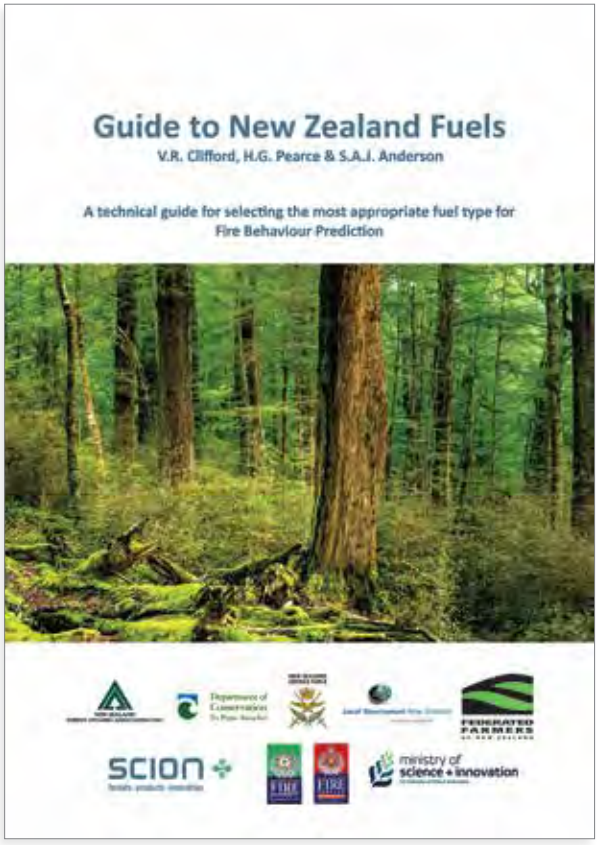
There are currently 18 individual fuel types recognised in New Zealand, with 18 fuel load and nine rates of spread models available to predict fire behaviour. Correct identification of fuel types will help fire managers accurately predict how fast a fire will spread and how best to control it without over or under resourcing. The guide provides users with a better understanding of how fire behaviour models differ from one another and which one is the most appropriate to use to ensure correct fire management and safety procedures are applied.

An abbreviated version of the photoguide for field use has also been produced for inclusion in the Fire Behaviour Field Manual, along with an electronic version for the Fire Behaviour Toolkit calculator software.

Research partners: NZ Rural Fire Sector

Investment: MBIE, Industry





"Publication of the Guide to New Zealand Fuels is a great initiative by Scion. Selecting the correct fuel type is the key to determining accurate fire behaviour predictions and this guide certainly helps in getting that decision right. This is the only visual guide on fuel models in New Zealand and provides us that key link with the Field Manual and Fire Behaviour software. As well as photos of each fuel type, the guide provides a good description of the fuel characteristics, information on available fuel loads, rates of fire spread and potential fire intensity. The guide certainly helps demystify the 18 fuel models within the six vegetation categories. It's a very useful resource for me."

John Rasmussen, Manager Rural Fire, Palmerston North.

"We bought the Guide to New Zealand Fuels in both sizes. The guide is very clear and easy to understand for any fire manager. It sets out fuel loads and rates of spread for easy size-up on the fire ground. This enables the incident controller to quickly establish the best attack required for the fire. Photos of each fuel type are clear and a great resource when working out curing rates in the field. The guide is used by the duty rural fire officer and kept with the other paperwork required at a fire."

Nick Watson, Civil Defence and Rural Fire, Ruapehu District Council.

Rolling out fire weather systems across the Pacific

The new national Fire Weather System (FWSYS) jointly developed by Scion and NIWA was rolled out to New Zealand fire managers in late 2013. The system provides a one-stop-shop for information on past, current and forecast fire weather and danger conditions for over 200 automatic weather stations located across the country.

As well as providing the fire danger rating science that underpins the FWSYS, Scion's Rural Fire Research Team helped present 16 training courses to over 250 users of the new system. The system has continued to be improved with several version updates released over the past year.

"It's a great bit of work and a very useful piece of software for those working in forestry," says Grant Dodson, Chief Executive of City Forests Ltd. and Chair of the NZFOA's Fire Committee.

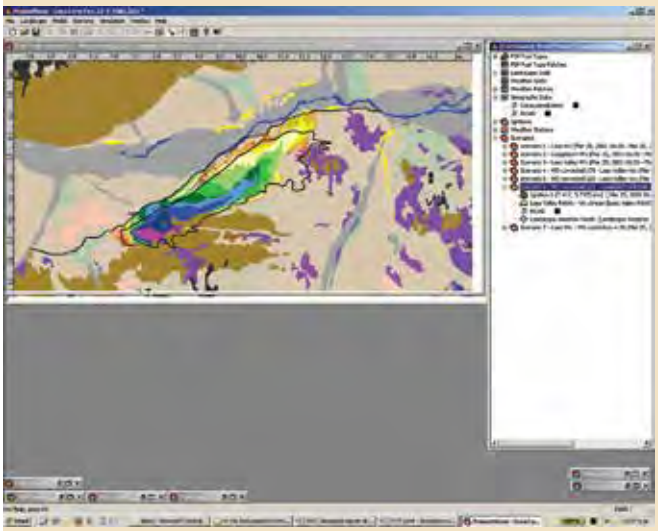
"In addition to putting fire forecasting at their fingertips, forest owners also get other benefits from the system. These include forecasts of wind strengths and direction, which are very useful for improving the safety of tree felling and harvesting work, and checking weather conditions for aerial work, including spraying. I thoroughly recommend that, if they haven't already, forest owners install the programme and use it."

Following on from this success, the Scion-NIWA team developed and implemented a similar system in Samoa. As in New Zealand, the Samoan FWSYS includes modification of the Canadian Fire Weather Index (FWI) System with adjustments made for Samoa's tropical latitude. Fire danger ratings are used to alert forestry staff and local communities to elevated fire conditions which, although not occurring every year, can still result in sizable wildfires.

This work formed part of a United Nations Development Programme (UNDP) on "Integration of Climate Change Risks into Forestry in Samoa (ICCRIFS)" led by Samoa's Ministry of Natural Resources (MNRE). Scion's fire scientist Grant Pearce participated in meetings and training courses for MNRE Forestry and Weather Division staff and community representatives, and contributed to a report on the new system. Other Pacific Islands such as Fiji have also expressed interest in developing similar systems.

Research partners: NIWA; NRFA; Samoa MNRE Forestry & Meteorology Divisions

Investment: NZ Fire Service/NRFA; UNDP (ICCRIFS) Project



National expertise in fire growth simulation

Prometheus is powerful fire simulation software specifically designed to help prepare for, and manage wildfires. Now, as a result of Scion-run training courses held in October, an additional 45 fire managers, GIS experts from forestry companies, DOC, council and New Zealand Defence personnel from around New Zealand are expert users of the software.

Prometheus simulates 'what if' fire scenarios taking into account the effects of different fuel types, terrain and weather conditions on fire spread that enable fire managers to develop suitable suppression and resourcing strategies. Prometheus can also be used for post-fire investigations and analysis.

Originally developed in Canada, Prometheus has been adapted by Scion's Rural Fire Research Team for New Zealand fuel types and fire behaviour models, and successfully validated against a number of past and recent wildfires. Prometheus experts from Canada, Neal McLoughlin from Alberta Sustainable Resources and Development, and Rob Bryce from Heartland Software Solutions, were on hand to help with the training courses. Similar training courses were also held in Tasmania where Prometheus is being considered for use along with some of Scion's New Zealand fuel models.

New Zealand fire managers are now actively using Prometheus to assist with wildfire case studies and investigations, and the development of strategic tactical fire management plans. A national user group has also been established to disseminate future updates and provide ongoing practice in use of the software.

Research partners: Alberta Sustainable Resources & Development; Heartland Software Solutions, Canada

Investment: NZ rural fire authorities; NZ Defence; in-kind support from Alberta SR&D

Forest diseases

Phytophthora and fungal pathogens are the hidden enemies of our exotic and native forests. Research into the biology and epidemiology of these pathogens, combined with the use of new genomic-based technologies, is helping us to improve and develop new diagnostic and management tools to protect our forests now and in the future.

Dr Rebecca Ganley
Research Leader, Pathology

Early outcomes from *Phytophthora* research

The 'Healthy trees, healthy future' programme was initiated a year ago as part of an international effort to stem the rapid advance of *Phytophthora* diseases.

Scion has been allocated $10 million funding from MBIE over six years, with significant co-funding from sector groups, to lead this programme and address the serious biosecurity threat *Phytophthora* pathogens pose to New Zealand's forestry, horticulture and natural ecosystems.

The programme is highly collaborative, and is consolidating New Zealand's capability in *Phytophthora*, plant breeding, molecular biology and analytical chemistry.

"Our understanding of these pathogens, the diseases they cause and how they are expressed has grown considerably over the last year," says Dr Nari Williams, Forest Pathologist and leader of the 'Healthy trees, healthy future' research programme.

"We are using a multiple host-pathogen 'systems biology' model that is driving increased research focus on *Phytophthora* species nationally, with requests from researchers outside the founding partnership to align their research with our enabling technology programme. Greater focus on these pathogens is building New Zealand's biosecurity capacity through increased awareness of *Phytophthora* diseases across research disciplines and to a growing network of industry stakeholders."

Some of our achievements to date are mentioned below.

Increasing international exposure

Two of our emerging scientists attended key conferences to introduce the programme model to an international audience across Europe, England and Japan. Our multi-platform approach within the metabolomics component of the programme was confirmed by science colleagues as the leading one internationally.

Expanding our metabolomics platform

Metabolomics is used to screen plant tissue extracts for changes in metabolites that may indicate pathogen infection. This approach combines mass spectroscopy and nuclear magnetic resonance (NMR) to identify indicator chemicals, and changes to these chemicals, to better characterise the infection status of the plants. The use of NMR and the development of clonal propagation and root inoculation systems enable parallel analysis with each host species.

Recent developments at Scion have involved expanding our current metabolomics effort to include needles and roots from radiata pine and leaves from apple trees. By using NMR to screen for metabolites in both healthy and infected tissues, we hope to identify markers for infection that can be used to both identify chemical profiles associated with disease resistance and detect infection before the host plant shows visual signs of disease.

Diagnosis at a genetic level

Phytophthora genomes are being sequenced in collaboration with Exeter University. This resource has been used for the MBIE programme and to also initiate collaborations with other research parties in New Zealand, such as Canterbury University and Otago University.

The recent development of a new diagnostic tool will also help with pathogen identification. The high resolution melting assay is a powerful technique that detects differences in the genome at a molecular level. This technique can distinguish between the DNA of 15 different species of *Phytophthora* associated with trees in New Zealand allowing for a faster turn-around and diagnosis of samples for both research and diagnostic applications.

Progress with red needle cast

Previous work undertaken by our geneticists has shown that resistance to red needle cast (RNC) is genetically controlled. 'Elite' clonal material developed by the Radiata Pine Breeding Company is being screened for resistance and as a potential benchmark for future work.

The zoospore inoculum production method for *Phytophthora pluvialis* has been improved, allowing zoospores to be produced more reliably and with fewer personnel hours involved. This enables a greater number of artificial inoculation experiments to be conducted, directly benefitting the chemical control, genetic breeding and biological control programmes.

The first multi-discipline experiment using radiata pine needles infected with *P. pluvialis* has been performed, integrating a whole systems biology approach. This included pathology, detailed microscopy, NMR, gene expression analysis and mass spectroscopy. It will take some time to pull all of the data together but already we have several clones that are consistently resistant to *P. pluvialis*, with the next stages to understand this resistance and determine if it is translated to resistance to other species of *Phytophthora*.

Engagement with Māori

From its inception, the 'Healthy trees, healthy future' programme has recognised the need to work with Tangata Whenua to achieve the best outcomes for kauri and Māori. Following discussions with Māori groups, several key outcomes have been agreed upon that will involve Tangata Whenua taking an active role within the programme.

These include utilising western science-derived tools to help identify kauri dieback resistant kauri for commercial planting and restoration of natural forests; realising the economic potential of kauri in areas that are currently affected by kauri dieback; and developing environmental monitoring to improve disease management in natural and planted stands.

Scion Collaborators: Scion's Forest Protection, Forest Genetics, Biopolymers and Chemicals, and Biotransformation teams.

National collaborators: Plant & Food Research, Landcare Research, RPBC, local Māori groups, DOC, Kauri Dieback Programme and its Tangata Whenua Roopu , NZ Genomics Ltd, University of Auckland, AUT and Massey University.

International collaborators: The University of Exeter, UK; IFO, France; Murdoch University, Australia; UBC, Canada; Oregon State University, USA; the University of Algarve, Portugal.

Investment: Scion Core, MBIE, FGLT, RPBC, Kauri Dieback Programme

Website: www.healthytrees.co.nz

Evaluating the threat of *Phytophthora* diseases worldwide

The rise in the number of new *Phytophthora* species and diseases occurring internationally is concerning scientists worldwide. The pathogens are known to affect an increasingly wide range of hosts and the rapid movement of organic material between countries has escalated the proliferation of *Phytophthora* related diseases to a level where conventional approaches to disease management may no longer keep pace.

In an effort to better understand these aggressive pathogens our pathologists are investigating the spread and establishment of *Phytophthora* overseas, and the pathways by which they could be introduced into New Zealand.

Our pathologists are also undertaking a review to determine possible pathways for *Phytophthora* pathogens to enter New Zealand and what overseas species could be high risk threats to this country. This involves comparing known *Phytophthora* hosts found worldwide to the floral diversity within New Zealand, and establishing the relative biosecurity threat the different *Phytophthora* species pose. We have demonstrated it is possible that high risk *Phytophthora* could be asymptomatically entering New Zealand on plants that are not considered to be hosts. The next step will be to test whether this is actually occurring.

Preventing the introduction of more new *Phytophthora* species into the country will enable our forestry and horticulture industries to flourish, and protect our native flora from further harm.

Research partners: B3. Assistance also from USDA, CABI, CPSM

Investment: Scion Core (B3)

Forecasting red needle cast control measures

Red needle cast (RNC) is a relatively new *Phytophthora* disease of *Pinus radiata* caused by *Phytophthora pluvialis*. In order for us to establish effective management and control of this disease, we first need to understand when the *P. pluvialis* inoculum is released by the pathogen, when it infects the host and how long it takes for the disease to appear in the field.

Our pathologists have been monitoring *P. pluvialis* inoculum production, the infection period and disease expression in the field for the past three years. Results to date show that inoculum is produced during most months of the year. This means any control measures that are developed must be persistent.

There is considerable variation in both inoculum production and disease expression regionally, seasonally and between different years. It is likely this variation is related to weather and therefore if we can determine which weather factors contribute to this variation, we should be able to develop prediction methods for red needle cast.

Disease data obtained from monitoring sites in different districts around the country are being compared with local weather variables to see which ones can be correlated. We are also trialling a software-based image processing method in an attempt to remove the subjectivity from evaluating disease expression.

The ultimate goal is to be able to proactively carry out control operations for red needle cast based on forecast weather conditions.

Research partners: Ernslaw One Ltd, Hancock Forest Management NZ Ltd, Juken New Zealand Ltd, Nelson Management Ltd, Rayonier New Zealand

Investment: Scion Core, FGLT

Helping kauri fight back through rapid detection

Accurate detection of *Phytophthora* taxon Agathis (PTA) is essential for diagnostic purposes and the reliable delimitation of infected forest areas. Our Pathology Team has been working collaboratively with other research partners to evaluate the diagnostic techniques currently being used for PTA to ensure the most rapid and accurate detection methods for the pathogen are used.

Until recently, detection has been performed using traditional soil bioassay techniques and cultivating cork cambium tissue samples taken from the leading edge of kauri trunk lesions on *Phytophthora*-selective media.

The recent development of a real-time polymerase chain reaction (PCR) assay to detect PTA from soil samples could allow a more accurate and cost effective diagnostic method with greater sampling throughput. The PCR method amplifies the amount of DNA present in a sample and therefore only minute quantities of DNA need to be present. This tool should provide a rapid and highly specific diagnosis of disease.

However, a recent comparison of the traditional bioassay and PCR methods did not find that one was superior to the other, using samples collected from previously assessed positive sites. This work has resulted in recommendations for further refinement of both diagnostic methods and also sampling procedures.

Research partners: Landcare Research, DOC, Plant & Food, Kauri Dieback Programme

Investment: Kauri Dieback Programme (MPI)

Barcoding DNA to protect our myrtles

Species of Myrtaceae (plants in the eucalypt or myrtle family) are hosts for the invasive myrtle rust (*Puccinia psidii*). Although *P. psidii* is not present in New Zealand, there is concern it may soon arrive. Its spores are airborne and records of other rust fungi blown across the Tasman Sea and infecting plants in New Zealand are well documented. If introduced to New Zealand, myrtle rust would pose a major threat to the country's 22,000 hectares of exotic eucalypt forests and the important manuka honey industry, as well as to trees with high environmental values such as the iconic pohutukawa and rata.

Identifying species of Myrtaceae that are suspected of being infected with *P. psidii* in the field presents numerous challenges such as obtaining specialist botanical expertise, and significant resourcing and logistics. Traditional morphological plant identification can take time and may not be straightforward depending on the presence or absence of pertinent diagnostic features. International practice now favours the use of DNA barcodes to identify multiple organisms.

Over the past year, our National Forest Herbarium Team has made considerable progress in developing a DNA barcoding platform and reference database for Myrtaceae species in New Zealand. This project is a key part of the Ministry for Primary Industries' preparedness for a myrtle rust incursion. To date, three or more replicate DNA sequences for each of the 104 targeted species have been obtained for at least two gene regions. In total, the team has generated 718 sequences and used 224 existing sequences housed in international databases.

Investment: Scion Core, MPI

The field guide to controlling needle disease

Shelterbelts, woodlots and commercial plantations throughout the country often suffer from one or more of the foliage diseases dothistroma needle blight, cyclaneusma needle cast, physiological needle blight (PNB) or red needle cast (RNC). Development differs between diseases, locations, seasons and years with many factors contributing to outbreaks.

Scion's *Field assessment, control and identification of common foliage diseases of pine in New Zealand* has been produced to help forest growers identify a needle disease and implement the appropriate control measures.

The field guide explains how to correctly estimate the amount of current infection in the tree crown, the number of trees that should be assessed in the stand during a ground-based inspection, and how to account for the various microclimates within the stand. It also provides detailed diagnoses for each species and gives recommended control options.

The field guide is available to download from Scion's website www.scionresearch.com
or email: publications@scionresearch.com.

SCION
forests · products · innovation

Field assessment, control and identification of common foliage diseases of pine in New Zealand

Pest management

This year our Pest Management Team made headway in the battle against red needle cast disease, honed their skills in the track sprayer facility, and prepared for the upcoming year's field trials. Results look favourable for the use of phosphite and potentially two other chemicals as treatments against red needle cast. Field trials are underway to test the effectiveness of a range of FSC-compliant herbicides, and the new track sprayer, designed to test a helicopter boom and subsequent spray deposition in a laboratory setting, was put to good use with many trials using the facility.

Dr Tara Strand
Research Leader, Pest Management

Chemical control of red needle cast shows promise

This year, our Pest Management Team has made considerable progress towards developing a cost-effective chemical control for red needle cast (RNC).

Red needle cast can cause about 16% growth loss over three years after a severe defoliation event.

While Scion is currently undertaking research to identify genetic resistance in radiata pine to a range of *Phytophthora* species as part of the 'Healthy trees, healthy future' programme, a chemical control solution is needed in the short term to control severe outbreaks of RNC in existing plantings.

Phosphite, a fungicide known to be effective against *Phytophthora* diseases, has already been shown to reduce the number and length of lesions caused by *P. pluvialis* and is promising to be a cost-effective and FSC-compliant chemical control option for RNC.

Needles sampled from trees that were injected with phosphite had consistently smaller lesions than those sampled from control trees for up to one year after injection. Where a high volume foliar application of 2% phosphite solution was used, fewer and smaller lesions were seen for up to eight months following application.

Apart from phosphite, we are also testing a number of other chemicals for their effectiveness against *P. pluvialis* to ensure that there are known alternatives to use should the pathogen show signs of resistance to phosphite, or its use is restricted due to cost, environmental or social concerns. It is also possible one of these alternative chemicals may provide better and more prolonged protection against the pathogen.

To date, the results look promising. Three months after application in controlled trials, AGPRO Copper Oxychloride 800 WP® and Ridomil® Gold SL demonstrated a similar efficacy against *P. pluvialis* to that of phosphite. However, these results require field testing to confirm this outcome.

"The effectiveness of the active ingredients depended on the host's susceptibility to the pathogens," says Project Leader Dr Carol Rolando. "Higher rates of chemicals were needed to reduce lesion development in the more susceptible clones tested.

"Overall, this was an excellent outcome. Results indicate that at a high rate, a single application of phosphite can potentially protect radiata pine from *P. pluvialis* infection for at least one season after application.

"Early results also indicate that copper provides protection against the pathogen – if protection persists for a season this would be an excellent outcome as copper is already widely used by the industry to control dothistroma needle blight".

Research partners: PPC_{NZ}

Investment: Scion Core, FGLT

New trials to assess alternative weed treatments

Since 2012, our Pest Management Team has been screening a number of herbicide mixes as possible replacements for terbuthylazine and hexazinone in the management of forest weeds. Although both of these herbicides provide excellent weed control, they are restricted for use by the Forest Stewardship Council (FSC). This year, we have implemented seven field trials across New Zealand to assess the costs and benefits of some mixes that may provide alternative, effective treatment options.

Each of the trials is structured with a set of core treatments to test a range of options. These include:

Operational practice (current industry treatment) as a control; a weedy treatment that provides for the full spectrum of weeds for the site; a treatment that includes terbuthylazine used in combination with mesotrione, clopyralid or triclopyr; treatments that include new combinations of active ingredients that do not use terbuthylazine or hexazinone; and treatments that are targeted at managing broom or gorse, predominantly on trials in the South Island.

Preliminary outcomes of these trials will be available in June 2015.

Research partners: NZFOA

Investment: Scion Core, MPI (SFF), NZFOA

Canopy roughness affects spray drift

Turbulence that is created by the 'roughness' of the forest canopy is an important factor in calculating aerial spray deposition. Scion's Pest Management Team is working with scientists from the US Forest Service and South Carolina University to investigate the possibility that this type of turbulence may be causing more spray deposition than what is presently calculated within the AGDISP™ aerosol spray drift model. This work is funded through an MBIE programme hosted by Lincoln Agritech Ltd.

The AGDISP™ model is used worldwide to compute aerosol spray drift. It is possible the model may be overestimating drift in some circumstances due to an underestimation of spray deposition at the canopy top. If this is true, the result is a higher prediction of drift and therefore stricter treatment control strategies than needed.

To test this hypothesis, Scion is implementing a large field trial in autumn 2015 that will include scientists from the USA to examine spray drift and turbulence at the canopy top. The trial will use the University of South Carolina's backscatter LiDAR instrument to measure the aerosol droplet cloud as it drifts over the sampling tower, and provide data on cloud height and size. This is a novel method for estimating deposition at the canopy top and we will evaluate the device as a possible replacement for standard deposition study methods.

The US Forest Service will also be participating, and we will be using their sampling devices to capture the deposition of the spray droplets. A tower equipped with wind speed sensors that measure wind speeds in all three directions at over 10 times per second will also be deployed. The data from these sensors will be used to characterise the turbulence at the canopy top.

Drift reduction is costly and if deposition is higher at the canopy top than what is currently modelled, then improved deposition and drift estimates will help to reduce treatment costs while maintaining high environmental standards. These results would influence the entire forest sector in that they are applicable to any control treatment (i.e. *Dothistroma*) and also have significance for eradication programmes led by MPI.

Research partners: US Forest Service, University of South Carolina, Lincoln Agritech Ltd, PPC_{NZ}

Investment: Scion Core (B3), Lincoln Agritech's MBIE programme

Website: www.youtube.com/watch?v=HTVZtJ4IkoM

Forest Health Diagnostics

Keeping an eye out for invaders

Scion's Forest Health Reference Laboratory provides nationwide diagnostic services for insect pests and fungal diseases of trees, including exotic plantations, amenity trees and native forests. This service supports a number of national biosecurity surveillance programmes including the High Risk Site Surveillance (HRSS) and Gypsy Moth Surveillance programmes for the Ministry for Primary Industries (MPI), the New Zealand Forest Owners Association (NZFOA) forest health surveys and the Dutch elm disease (DED) programme.

Early detection and monitoring of new pests and pathogens means we have the best chance of eradicating unwanted organisms before they become established, and containing those already established to prevent further spread, minimising economic and social impacts.

Our Forest Health Reference Laboratory comprises a multi-disciplinary team of entomologists, pathologists and herbarium staff, as well as members of Scion's Biotransformation Team who assist with molecular identifications. Some of our achievements this year are outlined below.

This year we received 842 HRSS submissions including 44 from members of the public. The HRSS is a post-border risk surveillance programme that targets woody vegetation and wooden materials. Surveillance efforts are particularly focused on container facilities, sea and air ports, transitional facilities and areas with high tourist traffic.

From the 842 submissions, our diagnosticians made 1,088 identifications, 141 (13%) of which were new host and/or new location records and were reported to MPI's Plant Pest Information Network. No new-to-New Zealand organisms were reported by Scion although MPI's Plant Health and Environment Laboratory reported two undescribed mites that were not previously known in the country.

Gypsy moth (*Lymantria dispar*) is a voracious defoliator of trees that has been rated as one of the world's 100 worst invasive species. An annual surveillance programme for gypsy moth is run by MPI to ensure early detection and provide the best opportunity for its eradication should the pest arrive in New Zealand.

This year, AsureQuality monitored over 1,500 pheromone baited traps from November to May. Of 148 suspect samples submitted to Scion, none were found to be gypsy moth or a related species.

The NZFOA funds forest health surveys of plantation forests with samples sent to Scion for diagnosis. We received 359 submissions this year from plantation forests, from which 465 identifications were processed.

Dutch elm disease is a serious disease of elm trees spread by an insect, *Scolytus multistriatus*. Scion is part of an on-going project to control DED which is currently restricted to the greater Auckland area. Of the 12,461 beetles trapped, 167 were found to be carrying the *Ophiostoma novo-ulmi* pathogen, which is the causal agent of DED. Fifty-four elm samples were received of which 43 tested positive for *O. novo-ulmi*.

Research partners: MPI, AsureQuality, SPS Biosecurity, Auckland Council, NZFOA

Investment: MPI, FGLT, Auckland Council

Achievements and Accolades

Dr Ian Hood

Awards and honours

Doctor of Science Dr Ian Hood was awarded a Doctor of Science from the University of Auckland. Ian received the prestigious D.Sc. based on publishing original work that has, over an extensive period of time, given him authoritative standing and international eminence in his field.

Ray Meyer Medal. The Institute of Professional Engineers New Zealand jointly awarded the Ray Meyer Medal for Excellence in Student Design to two winners. One winner was the Biped Felling Machine by University of Canterbury students George Wareing, Sean Bayley, Scott Paulin and Thomas Gilbert, supervised by Dr Stefanie Gutshmidt (Academy Supervisor) and Scion's Dr Richard Parker (Industrial Supervisor).

Scion Awards

- Excellence in Customer Engagement was awarded to Dr Nari Williams, Dr Beccy Ganley, Dr Carol Rolando, Lindsay Bulman and Vicky Hodder (the latter from the Forest Genetics Team).
- Dr Martin Bader received Scion's Quality Initiative Award.
- Our field crew staff Jess Kerr, Brooke O'Connor, Tia Uaea and Liam Wright (among others) were awarded Scion's People's Choice Award.

New Zealand Forest Owners Association Awards (NZFOA)

- The *Phytophthora* pathology team was awarded the NZFOA Science of International Quality Award for their work into red needle cast over the past six plus years. The team consists of Dr Nari Williams, Margaret Dick, Dr Ian Hood, Dr Peter Scott, Lindsay Bulman, Dr Beccy Ganley, Dr Rebecca McDougal, Dr Carol Rolando and Judy Gardner.
- Dr Nari Williams also received the Contribution to a Science Team Award for her work in leading the 'Healthy trees, healthy future' programme on *Phytophthora* research.
- Dr Carol Rolando received the Communication and Sector Engagement Award on behalf of the Pest Management Team's excellence in science communication and their focus on delivering high quality and relevant science.

Papers and Presentations

- Dr Nicholas Meurisse received the Royal Entomological Society UK Award for Best Paper Published in 2012-13 in the *Agricultural and Forest Entomology* journal. The paper is "Historical distribution of the oak processionary moth *Thaumetopoea processionea* in Europe suggests recolonization instead of expansion" by Groenen, F & Meurisse, N. *Agricultural and Forest Entomology* (2012), 14(2), 147-155.
- Dr Eckehard Brockerhoff's 2008 paper "Plantation forests and biodiversity: oxymoron or opportunity?" was listed as a 'highly cited article' in Springer's Ecology Stars. See www.springer.com/life+sciences/ecology.
- Dr Brockerhoff was invited to present a sub-plenary presentation at the International Union of Forest Research Organisations (IUFRO) World Congress in October, at Salt Lake City, USA. The presentation was entitled "Biodiversity, ecosystem services and resistance to invasion of planted forests".
- Lisa Langer from the Forest Systems Team won the official judges award for best poster at the Australasian Fire and Emergency Services Authorities Council (AFAC) / Bushfire and Natural Hazards CRC Conference in Wellington in September.
- Our University of Canterbury PhD student Kevin Chase received the New Zealand Entomological Society's award for Best Student Talk on Invasive Species. The talk was titled "Allee Effects and the Establishment of Exotic Invasive Bark Beetles". Kevin is supervised by Scion's Dr Eckehard Brockerhoff, Dr Dave Kelly (University of Canterbury School of Biological Sciences) and Dr Sandy Liebhold (US Forest Service), and receives a scholarship from Scion via our contribution to the Better Border Security (B3) collaboration.

Drs Carol Rolando (left) and Nari Williams

Professional positions

- Dr Brockerhoff had his position in the School of Biological Sciences, University of Canterbury, elevated to Adjunct Associate Professor for a three-year term to 31 May 2017. He was also confirmed as coordinator of the IUFRO Division 7 (Forest Health) and member of the IUFRO Board for 2014-2019 at the IUFRO World Congress.
- Dr Steve Pawson continued to serve as President of the Entomological Society of New Zealand (April 2013 – April 2015).
- Dr Toni Withers was invited to sit on the Environmental Protection Authority's Insect Advisory Panel for pest management.

Grants

- Judy Gardner received a Queen Elizabeth II Technician's Study Award to undertake study in Australia and the United Kingdom respectively.
- Belinda Gresham received a Queen Elizabeth II Technician's Study Award to travel to Australia to develop diagnostic skills in identifying Australian insects, specifically bark beetles, wood-borers and psyllids; insect groups of particular importance to New Zealand forestry.

Publications

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Glossary

AUT	Auckland University of Technology
B3	Better Border Biosecurity Collaboration
CABI	Centre for Agriculture and Biosciences International (UK)
CEBRA	Centre of Excellence for Biosecurity Risk Analysis (Australia)
CESAB	Centre for the Synthesis and Analysis of Biodiversity (France)
CSIRO	Commonwealth Scientific and Industrial Research Organisation (Australia)
CPSM	Centre for *Phytophthora* Science and Management (Australia)
CRC	Bushfire Cooperative Research Centre (Australia)
DOC	Department of Conversation
FGLT	Forest Growers Levy Trust
FSC	Forest Stewardship Council
FWSYS	Fire Weather System
IFO	International Fruit Obtention (France)
INRA	French National Institute for Agricultural Research (France)
ICCRIFS	Integration of Climate Change Risks and Resilience into Forestry Management in Samoa project
IPCC	Intergovernmental Panel on Climate Change
IUFRO	International Union of Forest Research Organisations
MBIE	Ministry of Business, Innovation and Employment
MNRE	Ministry of Natural Resources and Envrionment (Samoa)
MPI	Ministry for Primary Industries
NASA	National Aeronautics and Space Administration (USA)
NIWA	National Institute of Water and Atmospheric Research
NRFA	National Rural Fire Authority
NZFOA	New Zealand Forest Owners Association
NZFSC	New Zealand Fire Service Commission
PGP	Primary Growth Partnership
PPC_{NZ}	Plant Protection Chemistry New Zealand
RMIT	Royal Melbourne Institute of Technology (Australia)
RNC	Red needle cast
RPBC	Radiata Pine Breeding Company
RxCADRE	Prescribed Fire Combustion and Atmospheric Dynamics Research Experiment (USA)
Scion Capex	Scion capital expenditure
Scion Core	Crown Research Institute Core Purpose Funding
SFF	Sustainable Farming Fund (MPI funding)
SPS Biosecurity	SPS Biosecurity Ltd
STFMP	Strategic Tactical Fire Management Plans
STIMBR	Stakeholders in Methyl Bromide Reduction
UBC	University of British Columbia (Canada)
UNDP	United Nations Development Programme
USDA	United States Department of Agriculture
USFS	United States Forest Service

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