ScionConnections

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A future of tall timber

The international building design industry is in the midst of a wood revolution according to Scion's Sustainable Architect Andrea Stocchero. Wood and engineered wood products are delivering superior performance in structural, earthquake, fire, thermal, aesthetic and environmental properties, allowing bigger, higher, safer timber buildings that are more sustainable and also look great. Scion is helping to increase the uptake of tall timber buildings in New Zealand with new research and collaborations that focus on how to get most out of our tall timber.

Why use wood?

New Zealand has a long history of building with wood – 90 per cent of our houses are built from timber. As a renewable construction material that is produced locally, using timber supports regional economies and promotes a land use (forestry) that sequesters carbon.

Andrea says that is just the beginning of wood's environmental benefits. "The advantages of using wood reach beyond the forest and span the building's entire life cycle[1]. New Zealand has the opportunity to become a worldwide exemplar in sustainable development by building tall with wood. Policies like Rotorua Lakes Council's Wood First Policy encourages building with wood but more interdisciplinary research and science is needed to boost confidence around tall timber buildings."

Scion joins international tall timber research collaboration

In Australia, the University of Queensland's Centre for Future Timber Structures is

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[1] Stocchero, A., Seadon, J. K., Falshaw, R., & Edwards, M. (2017). Urban Equilibrium for sustainable cities and the contribution of timber buildings to balance urban carbon emissions: A New Zealand case study. *Journal of Cleaner Production, 143*, 1001-1010

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Ensuring a line of sight for impact

Almost two years ago the Government released a National Statement of Science Investment 2015-2025 (NSSI) that presents its long-term vision and 10-year strategic direction for the New Zealand science system.

The NSSI vision is "a highly dynamic science system that enriches New Zealand, making a more visible, measurable contribution to our productivity and wellbeing through excellent science".

To achieve its vision the NSSI presents two 'pillars' – excellence and impact. Public investment in science depends on strong performance under both pillars as defined below.

Excellence refers to the "quality of the science system and of the people who work within it". We do excellent science at Scion and have a strong focus on measures to ensure this remains the case.

Impact means "all our science should have a strong line of sight to the eventual benefits for individuals, businesses or society. This does not mean focussing on purely industry led, close-to-market research. Science has an important role in challenging, as well as supporting, existing industries, products, practices, approaches and frameworks".

In Scion's current Statement of Corporate Intent (SCI) we have identified seven areas of impact that are inter-dependent and collectively span the value chains we serve. Our 'impact areas' are:

1. Increase value from plantation forested land.
2. Increase the resilience of forests to biotic and abiotic risks.
3. Licence to operate and standards across the forest industry value chain.
4. Diversify forests and local manufacturing to support regional growth.
5. Increase the use of wood and fibre products in the built environment.
6. Manufacture and apply biorefinery products from wood fibre, waste and other materials.
7. Use more forest biomass to improve New Zealand's energy security and reduce emissions.

Within each of these broad impact areas are research programmes and projects staffed by talented and committed scientists and technicians working hard to meet project milestones and deliver on goals. We know that excellent science goes hand-in-hand with high impact. Assessing and illustrating the impact of Scion science is critically important to demonstrating the return on investment delivered. Seeing the line of sight is new thinking we are embedding in Scion.

We will be looking not only at science excellence and what the impacts on New Zealand could be, but also we will be exploring the pathways to the delivery of those impacts and Scion's role as an enabler.

We have illustrated this in the SCI with our bioadhesives technology Ligate™ where we can see the final, long-term effect. Our scientists began with insights that people want healthy and 'green' wood products in their homes. A sequence of results followed along a science and technology path. These results included successful proof of concept, validation of lab results in a pilot plant trial, securing of patent, publication of academic paper, successful scale-up production in mill trials, recognition via national awards and high interest from global markets. Eventually the impact will be realised when consumers will be able to select totally biobased wooden interior finishes and furniture for their homes, and when forest growers will have more value realised from tree residues.

Currently the Ministry of Business, Innovation and Employment has invited feedback on a discussion paper on the impact pillar of the NSSI. For strong impact performance, all players in the science system, within New Zealand and internationally, need a shared understanding of impact, how to generate it and how to demonstrate it.

As part of Scion's strategic planning we aim to do this. We will be looking not only at science excellence and what the impacts on New Zealand could be, but also we will be exploring the pathways to the delivery of those impacts and Scion's role as an enabler.

This planning will occur in the broader context of our Strategy Refresh, which will review our current seven impacts asking are they the best opportunities for New Zealand in the developing global forestry and bioeconomy world?

This is an exciting and stimulating discussion to have. Our journey into our future has begun. We are seeking clarity and forward focus for Scion as we and colleague organisations face the turbulence of global change. Line of sight to ultimate benefit for our citizens and our country is paramount.

I welcome your thoughts on this topic and any other matters raised in this issue of *Scion Connections*.

Dr Julian Elder
Chief Executive

FOR FURTHER INFORMATION
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PHOTO: TE TUMU PAEROA

Reducing greenhouse gas emissions on Māori-owned farms

The pastoral farming sector (livestock farming and dairying) is New Zealand's largest export sector and it plays a vital role in growing the Māori economy. The sector also accounts for 49 per cent of the nation's total greenhouse gas (GHG) emissions. Following our commitment under the Paris Agreement to reduce carbon emissions 30 per cent below 2005 levels by 2030, pressure has been building on pastoral farmers to reduce their GHG emissions. The challenge is to reduce farm GHGs while limiting the economic impact on the sector and on the economy.

Scion, and partners AgResearch and AgFirst, are undertaking a research project funded by the New Zealand Agricultural Greenhouse Gas Research Centre (NZAGRC) looking at GHG mitigation options for Māori-owned pastoral farms. The research team is led by Scion's Dr Tanira Kingi and has been recently granted a second phase of funding to build on their initial findings and understand the GHG profiles of farms with diversified land use.

Phase one: Single land use farms

Research began with developing a profile of GHG emissions for 29 Māori owned farms located around New Zealand, including four case study farms located in Kerikeri, Pukehina, Gisborne and Hawera. The team worked with the trustees and farm managers to model a range of mititgation strategies. Varying scenarios were explored through two broad methods- diversifying land use and changing farming systems to improve emission intensity (reducing the ratio of kg of carbon emitted against kg of farm product) and total carbon emissions for the farm.

The research findings showed that the effectiveness of changing farm systems in reducing nitrous oxide and methane emissions - through lowering stocking rates, reducing fertiliser inputs and reducing forage cropping - was dependent on the ability of each farm to maintain or increase productivity with lower inputs.

The most significant reductions in carbon were achieved by changing land use to carbon storage such as tree crops like mānuka, and indigenous and plantation forestry. The results from modelling the scenarios allowed the team to compare the GHG emissions and see which combinations reduced GHGs the most. The tipping point for land use changes to be economically viable was the carbon price. The farms with the most robust business models had diversified into forestry and tree crops and could claim carbon credits to offset the emissions from their pastoral operations.

Tanira explains, "We've shown that we can reduce greenhouse gases by improving farming systems, but it's not enough. The largest greenhouse gas reductions come from improving farm systems and diversifying land use. That's what we're aiming for."

Phase two: Farms with diversified land use

The next stage of the study will look at up to four Māori-owned farms that have already diversified their land use, for example dairy, sheep and beef, forestry, horticulture and/or tree crops. Research will begin by identifying baseline land utilisation, GHG and nutrient emissions, and the productivity and profitability model of each farm. The team will then work with the owners to explore and model systems improvements, mitigation strategies and land use change options.

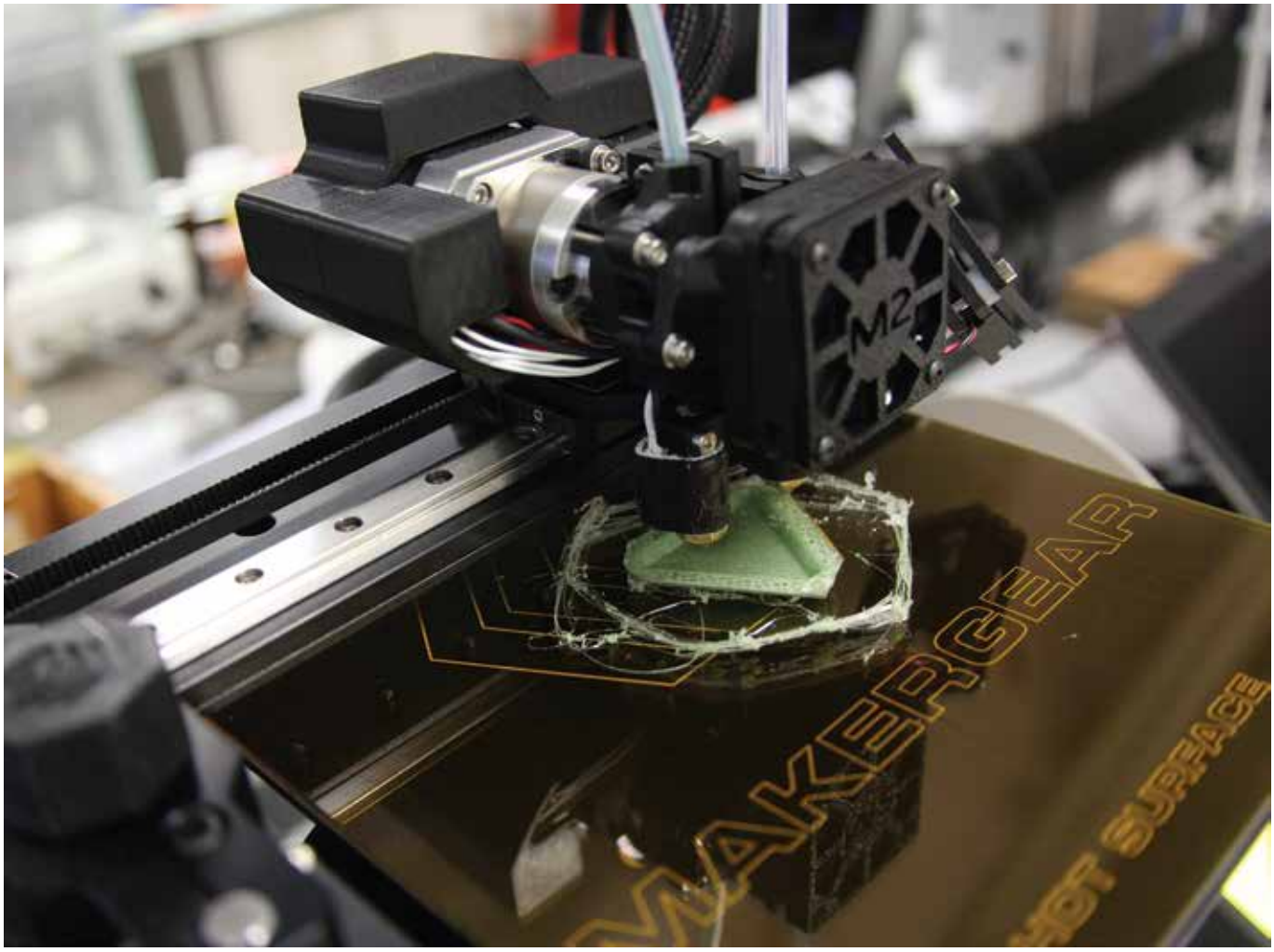
Through this process, the researchers will distill the factors that made these farmers decide to diversify. Tanira says, "We hope to show how land use diversification can produce high value and low emission farming and show the farming community why they should consider it for their own benefit."

A Māori farming perspective

The project is collaborating with the Federation of Māori Authorities and Te Tumu Paeroa to share the learnings and findings with the wider Māori agribusiness community. As intergenerational landowners, Māori are more willing to look at significant long-term investments or changes that will benefit future generations and be more likely to invest in schemes like planting for ecosystem values, rather than wood harvest revenue.

Tanira says that while this study was carried out on Māori-owned farms, it is relevant to the whole industry. "In New Zealand the majority of farms are either drystock or dairy and fewer farmers have forestry plantings. But if we want to curb our greenhouse gas emissions then we need to show how farms can be transitioned to a low-emission operation that includes diversification without compromising farmers' livelihoods."

FOR FURTHER INFORMATION on this project, contact Dr Tanira Kingi at tanira.kingi@scionresearch.com



Going bio: the next frontier in 3D and 4D printing

The worlds of 3D printing and biopolymers, such as protein, lignin, cellulose, hemicellulose and so on, are colliding, bringing about a new evolution of additive manufacturing where 3D objects are created by adding material layer on layer. 4D printing is an emerging additive manufacturing technology that will allow us to print objects that can reshape themselves or self-assemble over time. New Zealand is in a strong a position to make 3D and 4D printing of biopolymers and composites our speciality, with our abundant source of feedstocks that could be converted into biobased filaments.

New Zealand and 3D/4D printing

The advantages of 3D/4D printing and the strengths of New Zealand's economy are a combination for success. Geographically isolated, New Zealand relies on importing and exporting goods. A thriving 3D printing industry would enable innovative and localised production that could function within our existing manufacturing network. This new industry could also bring the manufacture of some imports onshore and create new opportunities for manufacturing businesses to export higher value products.

> The goal of Portfolio 5 is to see New Zealand developing and producing new materials and products based on the country's biological resources and distributed manufacturing by 2025.

This technology development could have multiple benefits for New Zealand ranging from the production of materials based on New Zealand's biological resources and new customised products, to the development of equipment and enabling distributed manufacturing (geographically dispersed manufacturing facilities that are coordinated via the cloud) in existing and new companies. We see a big opportunity for New Zealand to lead the convergence of circular and bioeconomy technology and thinking with additive manufacturing.

What is Scion doing?

General Manager of Manufacturing and Bioproducts, Dr Elspeth MacRae, is leading Portfolio 5 – Materials, Manufacturing and Applications – of the Science for Technological Innovation National Science Challenge (SfTI NSC).

The goal of Portfolio 5 is to see New Zealand developing and producing new materials and products based on the country's biological resources and distributed manufacturing by 2025. The portfolio project team's work will combine biomaterials with additive manufacturing methods such as 3D printing, electrospinning and layering.

The spearhead project on 3D printing using New Zealand biomaterials has brought together eight organisations, some of whom have never worked together before. The team created a 3D printed version of the SfTI 20-sided-solid (icosahedron) logo. The printed icosahedron was manufactured at Scion using a biopolymer/harakeke composite. The successful 'print' was presented to Science and Innovation Minister Paul Goldsmith in July 2017. The process from design to delivery was captured on video (http://bit.ly/2x1CBXo).

Scion has embarked on a number of other projects that combine 3D printing and biobased materials.

Dr Marie-Joo LeGuen worked with OceaNZ to create 3D printed biodegradable bioplastic objects using pāua shells, in addition to leading a research project funded by MBIE to develop 3D printing methods that use biobased materials, particularly primary industry by-products.

Biobased 3D printing was also used in our educational partnership with Te Taumatua o Ngāti Whakaue Iko Ake. Using CAD modelling to scan a traditional woven harakeke kete, the students created a 3D printed version using harakeke reinforced filament (*Scion Connections* Issue 24, Weaving mātauranga Māori and Scion science).

Dr Florian Graichen, Biopolymer and Chemicals Science Leader, says, "The development of 3D printing has allowed us to rethink the way we design and enabled the production of objects that have never been possible with traditional manufacturing techniques, creating new market opportunities."

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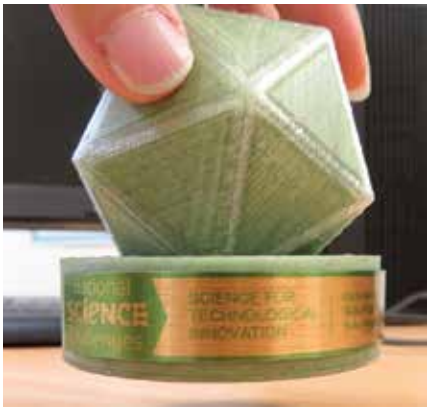

evolving on a day-to-day basis; and now we have an opportunity to influence the science behind the feedstocks of the future."

On the horizon: biobased 4D printing

Scion, in collaboration with major research partners, is building a future where wood fibres, cellulose from other plant sources, and co-products from primary production can be combined in new plastic-like materials. The next frontier we will be tackling with biobased materials is 4D printing – printed objects that can reshape and assemble themselves over time. Watch this space.

FOR FURTHER INFORMATION on our 3D printing programme, contact Dr Florian Graichen at florian.graichen@scionresearch.com

From left: 1. Stream pre-harvest and pre-storm. 2. Stream after harvest and debris flow. 3. Stream five years after debris flow.

Ecosystem regeneration: a picture of resilience

Freshwater ecosystems may be more resilient than we think, according to the findings of a recently completed five-year study.

The storm that led to a study

Dr Brenda Baillie was about to begin a study monitoring freshwater quality in three streams in a recently harvested planted forest when a large rainstorm swept across the East Coast of the North Island, leaving a trail of destruction in its wake. The combination of harvesting and a one-in-100 year storm resulted in 'debris flows' that transformed the freshwater ecosystems, from cool, shady environments with indigenous riparian vegetation and pine forest to open stream channels scoured down to bedrock in places.

Brenda had recently completed her PhD studying the presence of wood in freshwater ecosystems at the same sites in Houpoto Forest. She had collected a wealth of pre-harvest and pre-storm data and the storm gave her the opportunity to transform the study into a new five-year project monitoring the recovery of recently harvested freshwater streams after debris flow events.

The results might surprise you

After five years of tracking the presence of aquatic invertebrates, fish and riparian margin vegetation, Brenda found that different parts of the stream are on different recovery trajectories. Brenda explains, "The stream environment was completely transformed - from a cool, diverse habitat for a range of species, to sunny open channels with simplified stream and riparian environments, but that changed over five years."

The increased sunlight exposure warmed the water and increased algal growth conditions which seems to have suited some native fish and invertebrate species.

Brenda says, "Our data showed that fish biodiversity and numbers dropped initially after the storm, but numbers have now exceeded what we recorded prior to the storm, especially bullies and long and short-finned eels."

Other fish species, including banded kōkopu and smelt, that are known to have a narrower range of living conditions, were found in the streams prior to harvesting and the storm but have not been found since. The data showed a similar pattern of response for the aquatic invertebrates, although the recovery of the aquatic invertebrate communities is more advanced than the fish.

Brenda says the debris flows have simplified aquatic community biodiversity, particularly for fish. "We've had a huge increase in some species that favour the new conditions, but the stream environment lacks the riparian and in-stream cover and more complex pool habitats that were present prior to this event, limiting the re-establishment of some species for now."

How long it will take for these communities to fully recover and for the fish and aquatic invertebrate densities to return to pre-harvesting and storm levels isn't known but is likely to be linked to the recovery of the riparian vegetation and re-establishment of woody debris in the stream channel.

The debris flows removed the vegetation, soil and seed sources in the riparian margins, causing plant re-growth to be slower than what would occur after harvesting alone when most of this material remains intact. The re-growth vegetation shading the stream has begun to cool water temperatures toward pre-harvest and storm temperatures.

Brenda says that it is important to remember that ecosystems aren't static, and that natural events like this storm, will alter ecosystems as a matter of course. In this case, the storm occurred in conjunction with harvesting, allowing Brenda to identify the species that were resilient and thrived in these conditions, and it pinpointed the species with limited resilience. She says, "It's very encouraging to see some of these species bouncing back, and we hope that over time some of the other species do too."

Recommendations for foresters

The study has led to a number of recommendations for forest managers to encourage riparian and stream recovery after storms that generate debris flows. These include assisting riparian vegetation regeneration and natural processes through practices such as proactively planting or seeding riparian margins.

FOR FURTHER INFORMATION on the results of this study, contact Dr Brenda Baillie at brenda.baillie@scionresearch.com

New Chair of Sustainable Forestry

Dr Tim Payn.

Scion's Dr Tim Payn, is the first Chair of Sustainable Forestry for the Bay of Plenty and South Waikato regions. This new role is the product of a forestry science and education partnership in the central North Island between Scion and Toi Ohomai Institute of Technology.

The partnership between the two institutes will strengthen Scion's linkages with tertiary institutions throughout New Zealand and cement Scion's position as a key player in the Bay of Connections economic development plan.

As part of the role, Tim will be responsible for leading the development of a Centre of Excellence for Forestry for the region and New Zealand as a whole. In addition, he will be facilitating collaborative student-based research projects between the two institutes, continuing to conduct his internationally recognised research, and contributing to teaching programmes at Toi Ohomai.

Tim says he is very much looking forward to making links between the Toi Ohomai student programmes and Scion's scientists and technologists.

"This is an exciting opportunity to get some of the really new advances in forestry in front of the next generation of foresters and help future-proof the sector both regionally and nationally."

The role is shared between Scion and Toi Ohomai (formerly the Bay of Plenty Polytechnic and Waiariki Institute of Technology). Tim started in the role on 1 August and shares his time between the Toi Ohomai and Scion campuses.

Tim has a background in soil science and has specialised in research on sustainable forest management more recently. He is a Fellow of the New Zealand Institute of Forestry and is heavily involved in global efforts to support sustainable forest management. He currently chairs the 12 Country Montreal Process Technical Advisory Committee, which supports policy aimed at defining and measuring sustainable practice. He is also Vice Chair of the Engagement Committee of Future Earth, a global sustainability initiative.

A future of tall timber

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helping to lead the way on timber-based construction research and development. Scion joined their Industrial Transformation Research Hub for Advanced Solutions to Transform Tall Timber Buildings in 2016. As specialists in wood science and building acoustics Dr Grant Emms and Andrea have been awarded seed funding from the hub to develop a new research proposal focussed on junction details for acoustic performance that integrates fire, structural and building energy efficiency research.

Closer to home, Scion is also focussing on acoustic design for medium density housing. Scion has been part of a recent BRANZ funded research project undertaken in conjunction with other research academies and industry partners. The research team produced an assessment of medium density housing acoustics in New Zealand that identified the common barriers and produced a set of recommendations to enable better and easier deployment of acoustic solutions including better use of materials and making new designs available.

Over recent years Dr Grant Emms has been involved with a number of projects that have developed ways to improve the sound insulation in medium density timber housing. Completed in collaboration with industry and other research institutes, the work focussed on giving designers more acoustic options without compromising other important factors such as seismic resilience, fire safety and carbon footprint.

Taking a systems approach

Andrea argues that to fully realise the potential of wood and to grow the uptake of timber buildings we need to create holistic ways of designing and constructing buildings by adopting a systems approach. This requires designers, consultants and construction companies to create their systems in synergy.

> Timber is an ideal building choice to meet New Zealand's growing demand for medium density accommodation and commercial buildings.

The systems design approach integrates subject matter experts early in the design phase and throughout the construction, preventing the challenges of designing multiple systems in isolation. Currently there is no central platform for this collaboration to take place through, so Scion is exploring the idea of a New Zealand based collaborative and multidisciplinary research centre for tall timber building design.

Tall timber future

Timber is an ideal building choice to meet New Zealand's growing demand for medium density accommodation and commercial buildings. The future is bright for this high performing material and through collaborative research, timber could become the option of choice for the construction industry, benefitting New Zealand's economy and the environment.

Andrea says, "We hope that Sir Bob Jones' recent announcement of his plans for one of the world's tallest wooden office buildings in the heart of Wellington, is just the first of many."

FOR FURTHER INFORMATION on Scion's timber research programmes, contact Andrea Stocchero at andrea.stocchero@scionresearch.com or Dr Grant Emms at grant.emms@scionresearch.com

Red Needle Cast FAQ

What is red needle cast?
Red needle cast (RNC) is a disease that infects pine trees and Douglas-fir needles. Infected needles turn yellow then red and are cast or blown off the trees a few months after symptoms appear.

It is caused by the algae-like organism *Phytophthora pluvialis*.

Infected trees show symptoms between March and September, usually peaking from July onwards.

P. pluvialis is a native of North America where it affects Douglas-fir.

How does it spread?
P. pluvialis is carried in airborne water droplets. Wet, late summer conditions – mist, cloud and rain – are ideal for the disease to develop.

Why am I seeing red pine trees this (2017) winter?
Wetter than normal conditions around the country have seen RNC appearing around the North Island in areas where it is not usually seen.

Is it a threat to our plantation forests?
The needle loss caused by RNC affects tree growth and can reduce it by up to 40 per cent if the defoliation is severe. However, because the disease tends to be sporadic and unpredictable, tree growth returns to normal after about three years.

P. pluvialis does not pose a direct threat to New Zealand's log trade. The spores only affect live foliage and do not contaminate logs.

Is there a treatment?
Preventatively spraying pine plantations with copper in late summer or early autumn may be a way to manage RNC. (Copper sprays are already routinely used to control other needle diseases.)

***Can you tell me more about* Phytophthora?**
Phytophthora literally means plant destroyer. *Phytophthora* species are responsible for serious plant diseases worldwide, such as the potato blight that caused the Irish famine (also known as the Great Hunger) in the mid-1850s.

There are two other major *Phytophthora* diseases in New Zealand in addition to red needle cast. One is kauri dieback (caused by *Phytophthora agathidicida*), a disease that poses a serious threat to our indigenous kauri. The other is crown rot (caused by *Phytophthora cactorum*), which is responsible for significant ongoing damage and apple tree loss.

What is Scion doing about* Phytophthora *diseases?
A collaborative research programme addressing the threat of *Phytophthora* species to New Zealand was established in 2013. The Healthy Trees, Healthy Future programme involves breeding, management and research approaches to combat *Phytophthora* diseases. The programme is led by Scion and runs to 2019.

Find out more here: www.healthytrees.co.nz

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