Scion Connections

CELEBRATING NATURE'S TIME CAPSULE

BEETLES BOOST PRECIOUS NATIONAL COLLECTION

A GREENER ENERGY FUTURE

UNLOCKING REGIONAL GROWTH WITH SHORT ROTATION FORESTRY

EXPLORING VIRTUAL REALITY

A NEW TOOL FOR FORESTRY TRAINING

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The kina at Green School sets a high standard for what can be achieved using timber, providing inspiration for a sustainable future. It won the Timber Design Awards 2023 Supreme Award. Photo: Charlotte Curd

Kia ora,

his edition of Scion Connections lands ahead of Fieldays, the Southern Hemisphere's largest agriculture event. Fieldays provides a place for us to connect with the primary industry inside the Forestry Hub and share with visitors how the forestry sector continues to play a critical role in New Zealand's export growth. Trees also provide valuable ecosystem services that enhance biodiversity and safeguard the health of environments and communities. Our research is dedicated to protecting New Zealand's forestry assets in a changing climate and supporting industry to capitalise on the very real economic opportunities emerging as a result of the world moving away from its reliance on products made from fossil fuels.

Forest bio-products will be the next big growth area for adding value to land-based production. Scion's research and bio-based technologies are exploring ways to make better use of biomass to accelerate economic growth, develop new high-value export products, and stimulate the regions.

At Fieldays, we're looking forward to sharing our research that demonstrates what's possible. Join us on site to learn more about the promising opportunities for regional New Zealand to adopt short rotation forestry (SRF) for bioenergy production. Our article inside also links to a guide that helps landowners and investors identify the regions most suitable for it.

Other events have created spaces for us to highlight our research and we feature them in this issue too. This year we've had the privilege of hosting forestry researchers from around the world and sharing with them our propagation technologies that are supporting the forestry industry to rapidly grow high-performing trees cost-efficiently.

In April, we also joined forces with other research organisations and the Christchurch City Council in an event that demonstrated the value of urban forests and the role they play in mitigating the effects of climate change and creating healthy, vibrant cities. Together we can accomplish more for New Zealand.

We hope you enjoy this issue.



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COVER: Under the microscope: The Tasmanian eucalyptus leaf beetle is a new member of the National Forestry Insect Collection at Scion. It's among 175,000 specimens used by researchers to monitor biodiversity and rapidly identify new biosecurity incursion.

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Growing the value of New Zealand's bioeconomy

New Zealand faces a 'productivity paradox'. Since the 1960s the productivity of our economy – the value of the goods and services that we produce for the number of hours we work – has been much lower than should be expected for an economy like ours, even though we work harder than people in economies that we regularly compare ourselves against. A key lesson is that New Zealand needs to work smarter, not harder.

ur science and innovation sector isn't creating the value for New Zealand that we need it to. New Zealand has under-invested in science and innovation in sectors that would genuinely transform our economy. We also tend to spread our investment on science and innovation thinly.

The government has started a process to fix that and enable our sectors to play a greater role in lifting New Zealand's productivity and economic growth – and ultimately help all Kiwis get ahead. There is a proven link between science and innovation and economic productivity, so it is critical the sector is operating efficiently.

Scion has shown its future focus and agility with a strategic refocussing, shifting from a science-focussed organisation to one focussed on delivering impact. We are seeing the effect of this with much stronger partnerships and growth in contracts with the private sector, particularly in the added value products and material space.

At Scion, we're globally recognised for world leading innovation and research in circular bioeconomy solutions built on over 75 years' work in developing planted forestry and products from wood. Our reputation in industrial biotech has grown rapidly, and new businesses developing solutions in these areas are telling us that we have the best industrial biotech capability in New Zealand. We are seeing more companies wanting to work closely with us at our unique innovation campus at the Te Papa Tipu Innovation Park in Rotorua. We already have more than 40 tenants on site, and a growing number wanting to locate with us because of the innovation ecosystem and expertise they get to interact with.



The world is moving to circular bioeconomy solutions and these are areas where New Zealand has comparative advantage. We see enormous opportunities from this transition. Manufacturing sustainable marine biofuel from wood that can be blended directly with existing marine fuel is a \$600 million opportunity for New Zealand, and industrial biotech and gene technologies can unlock over \$2 billion per year in revenue by creating new product opportunities, with benefits to agriculture, environment and energy security. Replacing only half the steel and concrete in New Zealand buildings with advanced timber engineering could reduce emissions by 1 Mt CO₂-eq every year.

New Zealand needs to accelerate this transformation, or risk being left behind. It is essential that our science, innovation and technology sector is aligned to deliver on these great opportunities for New Zealand and our people.

DR. JULIAN ELDER. CEO, SCION.



further enhance our visibility on

the international stage through

our ongoing commitment to

innovation in this field.

SOFIANE GUESSASMA

Scion's capability has been recognised globally by world-leading partners.

cion's leading biomaterials, 3D printing, packaging, and machine-learning knowledge is being called on as part of a €7.5 million (NZD\$13.25m) research The UPWEARS project will project funded in partnership

In January, the EU's key research and innovation funding programme, Horizon Europe, awarded the funds to a four-year project led by INRAE, France's National Research Institute for Agriculture, Food and Environment.

with the European Union.

Starting in May, the project

brought together 15 partners from seven countries. Scion plays a central role and will contribute approximately NZD\$3m worth of research.

The research programme, UPWEARS, aims to develop a sustainable e-textile (electrically-conductive textile) using cork, hemp, flax and paper byproducts, and develop ways to recycle

UPWEARS will be integrated into a cross-country biking suit. [Image generated with AI elements.]

and reuse textile waste. The overall aim is to contribute to a sustainable economy by unlocking the potential of bio-based and hybrid fabrics.

To demonstrate the e-textile, the team is working to create high-performance clothing for biking that is abrasion and tear-resistant, waterproof or repellant, stretchable, and

> breathable. The product will also be biodegradable. This will be tested in Scion's biodegradation facility.

Scion's expertise in sustainable electronics is being used to create flexible sensors from biomaterials for integration into the clothing, sending temperature and humidity data to a user's device. Scion will lead in turning recovered textile waste into filament or pellets for 3D printing meaning the

clothing will be recyclable and a zero-waste product. And Scion will help use AI/machine learning to optimise the production process, reducing waste and increasing zero-defect products.

Overall, the project will help with the transition to a modern textile fabrication process using natural fibres and reducing waste during and post-production.

According to the EU, the textiles industry is responsible for water pollution through things like dyeing and laundering, and responsible for 10% of global carbon emissions. End-of-life waste is a huge problem and tackling textile waste goes towards achieving a circular economy.

Capability recognised globally

New Zealand signed an association agreement with Horizon Europe in February 2023 allowing it to access Horizon Europe funding.

Scientists Dr Yi Chen and Dr Marie-Joo Le Guen are leading Scion's science team. Chen says involvement in the bid came after the establishment of the International Associated Lab for biobased products, LIA BIOMATA, in 2023 forming a partnership between Scion and INRAE and providing a framework for developing larger partnerships.

"Scion has been developing sustainable biosensors and using AI for forestry and packaging applications, and this technology translates to a variety of applications such as wearable devices. It is fantastic that our capability is recognised globally by world-leading partners. This success is a tangible outcome of the collaborative efforts over the past year with INRAE and the strong connections established through being an International Associated Lab."

While Horizon Europe funding is mostly for projects that will further the EU on the world stage, Chen says the work benefits New Zealand by attracting leading researchers and state-of-theart technology and raising our profile with future international collaborators.

Some of the project's goals include substituting at least 50% of synthetic materials and using natural fibres from 100% local EU suppliers. The production process aims to reduce water and chemical use and carbon footprint. Scientists are developing

bio-bleaching techniques, using cork coating for stability and antibacterial properties, flax for flexibility and hemp for mechanical resistance.

Dr Alec Foster, Scion's Bioproducts and Packaging portfolio leader, says work like this helps progress a circular bioeconomy and being involved in such a globally significant project is a privilege for Scion.

"To be one of the first in New Zealand to be a Horizon partner, and to also play such a central role in a substantial consortium, is a fantastic achievement and exemplifies the tremendous opportunity Horizon Europe presents for our country.

"The cross-fertilisation of ideas and knowledge with some of the world's

foremost experts in the field is the best way to achieve a circular bioeconomy and make a global impact."

He says being part of such a transformative project with European partners "underscores Scion's commitment to making a significant and positive difference in the world with new technologies".

MBIE and Horizon Europe are supporting Scion's involvement in the project.



Scion portfolio leader Dr Alec Foster, with scientists Dr Yi Chen and Dr Marie-Joo Le Guen.

INRAE researcher Sofiane Guessasma says UPWEARS proves change towards sustainable products while improving individual wellbeing is possible. Sustainability does not mean sacrificing lifestyle.

"UPWEARS leads the way towards a viable transition by addressing challenges about resource depletion, reduction of chemical use and promotion of high value bio-based products."

> He says UPWEARS contributes to the 2030 INRAE vision of building a sustainable future through shared science and innovation.

"Scion has been a key partner of INRAE for many years, particularly in the development of sustainable materials from bio-based resources. The recent establishment of the LIA BIOMATA has strengthened the collaboration with an increased visibility of our shared strengths in this field.

"The UPWEARS project will further enhance our visibility on the international stage through our ongoing commitment to innovation in this field."

The research involves organisations,

universities and textiles companies from France, Sweden, Portugal, Italy, Belgium and the United Kingdom covering the technical e-textile value chain, from fibre to prototype manufacturing and testing, as well as stakeholder engagement and market analysis.

of ideas and knowledge with some of the world's foremost experts in the field is the best way to achieve a circular bioeconomy and make a global impact.

The cross-fertilisation

ALEC FOSTER

Watch this space: Scion working with NASA

Scion scientists are collaborating with NASA research centres on fire, drought and water research.

Shana Gross who is leading the wildfire and drought research.

S cion researchers have secured government support to collaborate with NASA research centres to observe and learn from how water flows through forests and investigate

wildfire and drought risks from space.

The Scion teams are among 12 from nine research institutes, each funded up to \$75,000 from the Government's Catalyst

Fund for six-month Earth observation feasibility studies.

Scion's two research projects, which started on April 1, will explore water use as well as wildfire and drought risks alongside

two National Aeronautics and Space Administration (NASA) research centres. Collaborating will give the teams access to

This provides the opportunity to answer these pressing local concerns about water use and availability.

DEAN MEASON

state-of-the art technology and expertise to develop their research and build partnerships with a world leader in space research. The water-use study

will build on results from Scion's MBIE-

funded Forest Flows programme, which has researched forest hydrology in sites around New Zealand.

One of the study sites, an 1800-hectare research catchment

in Te Hiku Forest on Northland's Aupōuri Peninsula, will be the focus of the work with NASA's Jet Propulsion Laboratory and the University of Massachusetts at Amherst. the accuracy of current fire prediction tools. By combining fuel moisture with information on fuel type, the work could lead to more accurate wildfire predictions, improving warning systems

The research team will use two NASA satellite missions to generate forest-scale measurements of surface and soil water, two key components of the forest water cycle.

The satellite missions will be the new Surface Water and Ocean Topography, and the joint NASA-ISRO Synthetic Aperture Radar. The missions will measure water use and movement from a single tree (small-scale) up to an entire forest (large-scale).

If successful, the research could be applied across the peninsula's multiple land uses, and even globally across different land uses at different scales, science lead Dean Meason says.

Tangata whenua Te Hiku \bar{o} Te Ika Iwi and the local community are concerned about the potential impact of Te Hiku Forest, planted with radiata pine, on the amount of water in streams and dune lakes, Meason, who is based in Scion's Rotorua head office, says.

"Alongside showcasing New Zealand research, this provides the opportunity to answer these pressing local concerns about water use and availability and increase understanding of water use and water flow to waterways throughout Te Hiku Forest."

Identifying at-risk areas

The other funded study will develop a roadmap to build a realtime fuel moisture and fuel type system. It is a collaboration led by Scion with NASA's Ames Research Center, Australian National University, the US Forest Service, Fire and Emergency New Zealand, and the University of Canterbury. The collaborative team includes world-class experts in wildfire, remote sensing, fuel moisture, risk management, and ecology, including Scion's Christchurch-based staff.

Accurate data on the moisture content within living vegetation, known as fuel moisture, can provide information on how fire could spread through vegetation and identify areas where drought-stressed vegetation is at risk from insects and disease.

Developing a roadmap is the first of three phases and will lay the groundwork for the development of a publicly accessible realtime moisture prediction tool.

"This work will provide the initial resources needed to build longterm capability and develop new research ideas and direction for wildfire and drought risk management both in New Zealand and internationally," Scion fire ecologist and science lead Shana Gross says.

While scientists have been using remote sensing to evaluate fuel characteristics since the 1980s, rapid improvements in satellite technology provide new opportunities to explore complex problems.

Historically, fuel moisture has been evaluated in isolation without up-to-date spatial characterisation of the fuel type. This limits

Ultimately the work could lead to more accurate wildfire predictions improving warning systems and reducing economic and environmental loss due to wildfire and drought.

SHANA GROSS

and reducing economic and environmental loss due to wildfire and drought.

Completed feasibility studies will be considered by the Ministry of Business, Innovation and Employment and NASA for second stage funding which offers up to \$5.6m over three years to fund progressing up to five feasibility studies into longer-term collaborative research projects.

Catalyst: Strategic – New Zealand – NASA Research Partnerships 2023 funding helps New Zealand build a strategic relationship with

NASA through global research while unlocking information about the environment and climate through high-altitude and space observations.



Dean Meason who is leading the water use research.

A greener energy futur

Integrated Bioenergy portfolio leader Paul Bennett and scientist Alan Jones inspect a short rotation forestry trial site made up of Eucalyptus nitens in Taupö.

Scientists have produced a guide for landowners keen to grow trees as a feedstock for bioenergy production.

two-year research project has shed light on the promising opportunities for regional New Zealand to adopt short rotation forestry for bioenergy production.

The findings show that leveraging short rotation forestry (SRF) will not only diversify regional economies, but also contribute to sustainable land management and generate environmental benefits as New Zealand looks for ways to transition to a circular bioeconomy and meet its net-zero emissions targets by 2050.

Silviculture and forest carbon scientist Alan Jones says Scion's modelling shows that short rotation forestry as a feedstock for bioenergy has the potential to replace 6% of New Zealand's annual fossil fuel demand from less than 1% of the land area.

"We've built on research from a decade ago and assessed the feasibility of rapidly upscaling bioenergy production from forests. We've found there are regions well-suited to short rotation forestry which provides a real opportunity for communities to transform their economic base and reshape New Zealand's energy future."

A key outcome from Scion's research is a 'how to' guide for short

rotation forestry targeting landowners, forest investors, and government agencies. It not only outlines the feasibility of SRF but also identifies specific regions most suitable for it.

The research recommends that short rotation forestry should be established on lower value land (Land Use Capability Class 5-7) in places where transport distances to processing locations can be minimised. These regions include the Central North Island, Northland, the East Coast and Otago.

The ideal species for short rotation forestry is *Pinus radiata*, owing to its rapid growth rates and high degree of adaptability and disease resistance in a range of growing locations. Other options include *Eucalyptus fastigata* and *Eucalyptus regnans* for their potential to rapidly yield large volumes of woody biomass from young trees. Trees are generally planted in dense stands and managed to intensify rates of wood production for renewable energy, such as wood pellets, torrefied briquettes or liquid biofuels for marine and aviation sectors.

SRF is a forestry practice that involves growing and harvesting trees on a short rotation cycle which, according to Scion's modelling, would ideally be between 12 and 18 years for the

production of wood biomass. This is considerably shorter than the conventional 28-year harvesting cycle.

One of the key advantages of SRF is its ability to provide a steady supply of biomass for

energy production on relatively economically marginal land, with plantations harvested multiple times.

Short rotation forestry can also reduce greenhouse gas emissions by displacing fossil fuels and promoting carbon sequestration in the form of sustainably harvested living trees.

Scion's research responds to signals from the Climate Change Commission that

indicate the rising importance of bioenergy from forests in the coming decade. It also presents owners of low production grazing land on steeper hill country with alternative options to maximise productive capacity and increase economic viability.

Optimising forests for bioenergy

Jones says the guide provides a glimpse of what could be possible in the future for SRF as a vehicle to scale up bioenergy production. But the benefits would go much further if decentralised processing of harvested material was promoted to stimulate regional economies and fast-track bioenergy availability.

"It's about developing forest systems that are optimised for bioenergy. But in more economically disadvantaged regions, it also makes sense to build and establish processing facilities there because the energy itself is a lot cheaper to transport once it's chipped and dried or transformed into liquid biofuels."

To validate theoretical findings, Scion is collaborating with the Ministry for Primary Industries (MPI) on developing designs for forest bioenergy trials. These trials will involve rigorous testing of growth rates, optimal density, and tree health for different species, including *Pinus radiata* and Eucalyptus varieties.

The collaboration represents a critical step in moving from theoretical models to practical implementation, addressing the complexities and uncertainties associated with on-theground application.

Scion researchers are also looking at ways to optimise tree genetics by reevaluating past stock for its compatibility with bioenergy. Conventional tree breeding over the past 50 years has focussed on timber quality, minimal branching and straightness. As a feedstock for bioenergy, Jones says optimal trees have very different traits.

"We want high levels of branching, and we don't mind growing bendy stems because we also want high resin production and high wood density. So, some of the traits that would have been conventionally bred out of that breeding stock in the past, we're looking to bring back in for bioenergy."

By 2035, one scenario suggests 150,000ha of dedicated bioenergy forest could contribute to at least 5% of domestic

fossil energy demand, displacing the equivalent of 3 Mt of CO2 emissions from oil combustion per year, or 4 Mt CO2 from coal.

Bioenergy Association executive officer Brian Cox says that

There are particular regions wellsuited to short rotation forestry which provides a real opportunity for communities to transform their economic base and reshape New Zealand's energy future.

ALAN JONES

the research on short rotation species is important to New Zealand's wood industries as the country looks to derive higher value from land use.

"Short rotation species provide a more even revenue stream to landowners and widens the breadth of products we can produce from wood. Because many of the short rotation species are hardwoods the residues from wood

processing have a high calorific value and are ideal as biofuels for replacing fossil fuel."

Scion's research has been funded by the Strategic Science Investment Fund.

A downloadable copy of the guide for short rotation forestry is available on Scion's website.





The 'how to' guide outlines the regions most suitable for short rotation forestry.

Work to protect New Zealand's forests recognised

That sense of discovery is

really exciting, but for me,

it's adding value. Seeing

something you do of use to

someone. That motivates me.

DR BRIAN RICHARDSON

Dr Brian Richardson was presented the Minister's Biosecurity Award for his outstanding contributions.

Spanning four decades and featuring domestic and internationally significant work, Dr Brian Richardson's career was acknowledged at the NZ Biosecurity Awards in April when he was presented with the Minister's Biosecurity Award.

The award, which recognises outstanding contributions to New Zealand biosecurity over at least 10 years, was presented by Biosecurity Minister Andrew Hoggard.

Richardson, a principal scientist in Scion's Plant Protection Physics and Chemistry team, has worked at Scion since 1983. Research during his 41-year career has focussed on forest protection, particularly in the areas of biosecurity and pest management.

His expertise in pesticide application has been applied to pest eradication operations and more recently to the problem of wilding conifers, where his aerial spraying guidelines now underpin the Wilding Conifer Control Programme.

Richardson also helped eradicate invasive insects including the painted apple moth, whitespotted tussock moth, and southern saltmarsh mosquito. Successful invasions of these pests could have crippled New Zealand's horticulture and forestry exports.

What keeps many people in science, Richardson says, is a sense of curiosity.

"That sense of discovery is really exciting, but for me, it's adding value. Seeing something you do of use to someone. That motivates me. Working with teams has always been a big part of it too."

When Richardson looks back on his career, it's the people he reflects on.

"Anything I've achieved has been with the support and partnership of others who I feel all share in this award. Sadly, some of those who helped me on my career journey are no longer with us, but I will still acknowledge their contributions."

He also remembers some challenging and successful projects that became career highlights.

"I think some have shared common characteristics. They've been complex problems with clear goals or challenges for science to overcome. They've involved partnerships between policymakers, the science teams and people managing operations. We've



Biosecurity Minister Andrew Hoggard with the Minister's Biosecurity Award winner Dr Brian Richardson.

worked closely together as a team and that's really key to success," he says.

"There's a lot of satisfaction in science that is immediately of value and can be used by people making decisions."

Richardson has also collaborated internationally, such as with the US Forest Service on the development of spray modelling systems to quantify pesticide drift and efficacy. This work was recognised with a technology transfer award from the US Department of Agriculture Forest Service in 1996.

He has contributed to technical advisory groups convened to address significant biosecurity incursions such as the brown

marmorated stink bug and been involved in sector-wide initiatives like the Forest Biosecurity Council and as a board member on research programmes, including Better Border Biosecurity, BioProtection Research Centre, and Frontline Biosecurity.

Scion's chief executive Dr Julian Elder says it is great to see a lifetime's achievements be recognised.

"It is a huge reflection on all the people he has worked with over the years. It is also great to see

Scion and the critical work the Crown Research Institutes do for New Zealand being acknowledged."

Forest Owners Association chief executive Dr Elizabeth Heeg says Richardson's recognition is well deserved.

"It's really important for scientists in the forest industry to be recognised. Scientists generally, and those who work in the forest industry, tend to be overlooked when awards are handed out.

"Recognition through a Ministerial Award is tremendous.

"That Brian's work is in biosecurity is also noteworthy. Keeping pests and pathogens out of our production forests, native trees and gardens is vital, but usually the more successful we are the less newsworthy it is."

The award is the latest in a list of Richardson's achievements including the NZ Institute of Forestry 'Forester of the Year' Award in 2015, a Science New Zealand Lifetime Achievement Award in 2019 and New Zealand Plant Protection Medal in 2022.

12

Collections a 'living memory'



Scion's 10 nationally important collections and databases allow us to grow our knowledge.

ehind Scion's walls are tens of thousands of insect specimens dating back 75 years, thousands of fungal specimens dating back to the 1800s, an internationally registered collection of wood and a critical database of forestry publications. They are among the 10 nationally important collections and databases Scion is custodian of.

Forests and Landscapes general manager Tara Strand says the collections are a "living memory" relating to almost all aspects of Scion's research and act as a fundamental baseline for research or a launch point for the next innovation.

"The collections allow us to build on the research and observation foundations set by previous researchers. These collections are invaluable as they allow us to grow and expand our knowledge."

The collections help Scion's researchers understand what has been done in the past, what worked or did not and the gaps that remain. Scion's 10 databases and collections are:

 National Forest Culture Collection and Database – Living collection of almost 6500 fungal specimens. Supports diagnostic services and plant pathology research useful for plant disease

research.

- National Forestry Herbarium and Database Collection of plants significant to plantations and New Zealand indigenous forestry.
- National Forest Insect collection About 150,000 forest insects

from around the world. Supports diagnostics services and taxonomic research. This collection is also referenced for biosecurity purposes, for example to determine if an insect is 'new to New Zealand'.

- National Forest Fungarium and Database Forestry focussed collection of almost 5,000 dried fungal specimens. Supports diagnostic services and pathology research.
- National Forestry Library Publications relating to forestry and wood processing research from the last 75 years from all over the world.
- National Forestry Xylarium and Database 8,000 wood blocks from around the world representing 4,500 species. An invaluable resource for wood anatomists recording the diversity of the world's trees.
- National Wood Performance Archive 75 years of wood durability and performance records gathered from four sites nationwide. Used for developing standards and building code.
- Permanent Sample Plot Database Database of forest sites used to measure growth and development of plantation forest trees nationwide.
- Tree Living Library Living collection of genotypes for gene conservation, archival history, and germplasm resources.
- Wood Mycology Culture Collection Mould and decay fungi isolated from the leaky building syndrome, other buildings and wood products across New Zealand. Supports evaluation of wood products to be used in New Zealand buildings.

In the first of a series featuring the collections, we look at the National Wood Performance Archive and National Forest Insect Collection.

Bugging Out at new Tasmanian beetles

Established in 1948, the National Forestry Insect Collection (FRNZ) holds significance far beyond the modest confines of its home, a nondescript cabin on Scion's Rotorua campus. The collection, largely made up of meticulously organised wooden boxes reminiscent of library volumes, is the most comprehensive compilation of forestry-related insects in New Zealand.

Www.ith around 175,000 specimens representing more than 3000 species, the National Forestry Insect Collection is a cherished national taonga that contains specimens from every rohe (region) across Aotearoa and many from beyond our borders. In October 2023, the collection welcomed its newest members, a series of Tasmanian eucalyptus leaf beetles.

ational Fores

Scion entomologist and FRNZ curator, Stephanie Sopow, says the collection is irreplaceable and fulfills three main functions: a diagnostic tool, archive, and a research tool.

"Not only does this resource provide our entomology team and collaborating researchers with diagnostic and archival resources, it's also a vital component used to identify potential biosecurity threats to New Zealand's native and planted forests. "Each year, identifications are made on behalf of surveillance programmes managed by the Forest Owners Association (FOA), Ministry for Primary Industries (MPI), and Auckland Council, as well on behalf of concerned citizens.

"Through these endeavours, we fulfill diagnostic contracts valued at over \$400,000, underlining our critical role in safeguarding forestry health."

FRNZ is a working collection and growth over the last five years has averaged more than 1000 specimens per year, primarily from research projects involving the mass collection of insects to monitor biodiversity, or for biosecurity.

A gift from Tasmanian forests

Recently pinned into a set of new wooden display boxes is a comprehensive range of eucalyptus leaf beetles from the *Chrysomelidae* family found in Tasmanian forests. Largely

under-represented in the collection until now, the 29 specimens representing 17 species were welcomed in October last year.

Their addition is mainly thanks to Dr Geoff Allen, a forestry entomologist from the University of Tasmania with more than 30 years' experience. They were curated by his colleague, Dr Lynne Forster.

Dr Toni Withers, an entomologist who has been with Scion for a little over 25 years, says the beetles

were generously donated to Scion's entomology collection as a gesture of goodwill, marking the end of the MPIs' Sustainable Food and Fibre Futures funded research project which relied heavily on the university.

"Over the years, Scion has enjoyed a meaningful collaboration with Dr Allen on research that has benefited New Zealand's eucalyptus forestry industry by supplying researchers with beneficial insects that would eventually become biological control agents," Withers says.

"For instance, in 2022 we released the parasitoid wasp (*Eadya daenerys*) in New Zealand as a biological control agent to control the larvae of the eucalyptus tortoise beetle (*Paropsis charybdis*) that has been damaging eucalypts in Aotearoa for over 100 years."

Allen says the opportunity to work with Scion on mutually beneficial research has been a privilege.

"Their uptake and interest in the research and their collaborative teamwork has been one of the major highlights of my career."

Scion entomologist Dr Carl Wardhaugh, whose expertise lies in the realm of beetles and who dedicates much of his time to studying the collection, says receiving these specimens significantly bolsters its representation of this important group.

"These beetles are relatively harmless in their native Australia, where natural enemies keep their populations in check. However, those that are invasive and have become established in New Zealand have few, if any, natural enemies and can cause considerable damage.

"Our borders are continuously vulnerable to invasions of beetles such as these and having an extensive reference collection of various species will greatly assist our diagnostic capability. In the case of a new biosecurity incursion, early detection combined with rapid identification of the organism offers the best chance of effective management."

Importance of nature's time capsule

Biological collections hold the key to unlocking the past and future. They are unique in that their information is stored largely in the specimens themselves and cannot be easily replicated digitally.

Explaining the importance of this, Sopow says firstly, photos are not reliable for comparisons with fresh specimens as they can

Our borders are continuously vulnerable to invasions of beetles such as these and having an extensive reference collection of various species will greatly assist our diagnostic capability.

CARL WARDHAUGH

"Additionally, the collection provides reference specimens of adult and immature stages of many species, which reduces the need for costly molecular identifications, where DNA or RNA sequences are extracted and analysed. Consequently, it saves both the resources and time typically involved in these processes."

often lack resolution, colour

accuracy, and detail.

She says that as one of New Zealand's oldest collections, it's an important reservoir of

historical information on forest insects, their distributions, host associations, and even their genes.

"Scientists often utilise insect collections when researching questions concerning evolution, biological invasion dynamics, environmental contamination, and temporal changes in insect demographics due to factors such as climate change or habitat fragmentation.

"It serves as nature's time capsule, capturing moments in time, and we continue to contribute to its richness through various endeavours like biodiversity projects and biosecurity measures. History has shown us the importance of continually replenishing this repository with fresh specimens from both Aotearoa and beyond, ensuring the safeguarding of our future."



A range of eucalyptus leaf beetles from Tasmanian forests have been gifted to the National Forestry Insect Collection.

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Outdoor lab a vital tool for NZ



Information from the 'lab' is critical for developing building standards.

n a field on the side of a publicly accessible road on Scion's Rotorua campus you'll find tall, power pole-like structures, L-shaped joints sitting on what looks like park benches, decking at various stages of decay, rows of cladding and wooden stakes sticking in the ground.

It isn't a strange half-finished building site or dilapidated wood storage, it is vital strategic infrastructure for Scion and the whole country.

The site is one of four forming the National Wood Performance Archive, and the biggest and most comprehensive.

Collectively, the information gathered from the sites about wood durability provides a foundation for the timber industry and helps inform building practice standards and compliance.

The testing is used to establish durability classifications for timber grown here and overseas. They include products from international companies wanting to launch in New Zealand.

Information from the sites combined with information about structural performance established in Scion's timber engineering lab informs how suitable wood products are for particular purposes.

Scion's site includes above-ground tests like decking, cladding and joinery, and in-ground stakes, posts and poles while the three remote sites – near Whangārei, Hanmer and Waitarere – only have in-ground stakes.

Scion deliberately selected test sites with different environments and soil types to get a range of information.

Scion's field sites were established in 1947 meaning we hold more than 75 years of wood durability and performance records.

Data is collected from the samples annually. Scion's site has around 50 trials with different anniversaries, so testing takes place multiple times a month, while the other three sites are only visited once a year.

Dr Tripti Singh, Scion's leading timber durability expert, says the main purpose is to test timber durability – how long a product lasts for what purpose.



For Singh, Scion's site is like "an outdoor lab".

"We're looking at product performance ... Durability is one side of that, other aspects like structural stability and fitness for purposes are the others. They are correlated and we need data from various sources to establish the product's performance.

Each product has advantages and disadvantages determining its end use and what is the right wood for the right use is the key.

TRIPTI SINGH

"Each product has advantages and disadvantages determining its end use and what is the right wood for the right use is the key.

"For any new timber species including hybrid species, we have to define what durability class that species sits in," Singh says.

Scion also tests new

formulations and treatments that protect timber to see if they are effective.

Some tests last decades as durability class can only be determined when the last sample fails.

Maintenance is carefully completed. The ground around the tests can't be mowed by contractors or sprayed with products







LEFT: Lab and field technician Ian Simpson, timber durability research lead Tripti Singh, and wood science design technician Colleen Chittenden. ABOVE: Samples at the field testing sites are left to decay in different tests.

that could inhibit natural flora and fauna. Weeds are pulled by hand and in summer maintenance can be a "big mission".

The trials have also produced surprising results, for example one fungus isolated from the site can be used in biotech applications due to the very specific enzymes it produces.

General Manager, Forest to Wood Products, Dr Henri Baillères says the sites are a "strategic infrastructure used on an everyday basis".

"For any species not in the building standards ... the field test site is a facility enabling us to provide the data to inform whether it is meeting requirements and can be used or not."

Scion is the only organisation in New Zealand doing this type of testing to inform building standards. Without it, new products would not become compliant or available for construction, Baillères says. "It's very strategic for New Zealand, Scion, and our industry and other players across the value chain," Baillères says.

Dr Bruce Deam, a senior structural engineer at the Ministry of Business, Innovation & Employment who has been involved with building standards development, says the fact New Zealand

It's very strategic for New Zealand, Scion, and our industry and other players across the value chain.

HENRI BAILLÈRES

has specific building code requirements for durability makes it unique. He says the Wood Performance Archive is an essential way of demonstrating longterm durability and has been hugely worthwhile for both ground contact and exterior exposure testing.

"Over the long-term it

helps confirm that durability expectations have been met, showing the in-ground and exterior timber meet the performance requirements for use in buildings."

Our sites are listed at IRG/WP (International Research Group on Wood Protection) website:



Cabin showcases diverse, locally grown timbers

Scion's Rosie Sargent and Toby Stovold with Marco Lausberg from Forest Grower's Research.

This two-room cabin demonstrates the building potential of local timbers.

SCIOn

Www lith parts constructed from four cypress species, eucalyptus flooring, poplar plywood ceiling linings and Douglas-fir roof framing, the Specialty Wood Species Cabin might look like a collection of disparate timbers, but it's that way for a reason.

The cabin showcases what can be done with alternative timbers and without using chemicals. It came about following the sevenyear Specialty Wood Products Research Partnership (SWP).

The SWP investigated new wood products derived from specialty species. It aimed to increase the productivity and profitability of specialty species and develop a high value specialty wood products industry.

It focussed on the three New Zealand-grown, leading alternatives to radiata pine – Douglas-fir, cypresses and eucalypts.

The government and industry-funded SWP research project ran from 2015 to 2022 and included representatives from Forest Growers Research, Te Uru Rākau – New Zealand Forest Service, the Ministry for Primary Industries, Scion, New Zealand Farm Forestry Association, NZ Dryland Forests Innovation and University of Canterbury. Scion was a key research provider.

Vaughan Kearns of Ruapehu Sawmills had been heavily involved in the SWP project and when it finished, he wanted to find a way to showcase the thermally modified cypress created during the project.

The cabin itself aims to challenge the durability of thermally modified cypress in a real-world environment rather than just the research environment where durability testing is ongoing.

"It was an opportunity to showcase the other products that came out of the SWP such as the eucalyptus laminated veneer lumber (LVL) and eucalyptus engineered flooring. On the back of that there was the opportunity to showcase the timbers that Ruapehu Sawmills produces such as some cypresses," Kearns says.

The building was roughly half funded by Ruapehu Sawmills with contributions from SWP partners and the Industry Transformation Plan.

Working with nature

The cabin, roughly 5m by 3.5m is currently housed on Scion's Rotorua campus for the public to view. Along with strategically placed double-glazed windows, it is designed to be oriented to make the most of the sun's natural light and heat.

The timbers used in construction were supplied from trees grown in New Zealand and the only treated timber used in the build is the skids in contact with the ground. The rest of the wood is either naturally durable or thermally modified (baked at high temperatures to remove sugars and increase durability and stability) showing you can build without added chemicals and still meet building code requirements.

Wood used in the build includes Grand fir, Douglas-fir, Western red cedar, poplar plywood, *Eucalyptus fastigata* and *Eucalyptus obliqua* and four cypress species of macrocarpa, lusitanica, *Cupressus x Nootkatensis* and *Chamaecyparis lawsoniana* (Lawson cypress).

Some of the cypress used was from a cypress hybrid trial established by Scion in 1997, meaning Scion has been able to track the trees from cuttings, through to finished products.

Scion's work researching naturally durable or thermally modified wood is longstanding with recent research focussing on thermally modifying tōtara to enhance its durability enough for exterior building uses.

Senior technologist Rosie Sargent says it is great for people to be able to see the types of products that can be made from these species, and the cabin provides an opportunity to learn how these products perform in real life situations.

Trees to High Value Wood Products interim portfolio leader Elizabeth Dunningham says the cabin will provide useful data about product performance as Scion staff make ongoing assessments. "A wide range of collaborators contributed years of hard work and key technical know-how into the SWP, so it's great the cabin is at Scion to showcase some of the products from that important collaboration."

Marco Lausberg, Forest Growers Research's SWP programme manager, says the cabin was a talking point when on display at last year's FGR annual conference and there could be a growing market for these products.

"There's a different consumer that is happy to pay more for less of an environmental impact. There is interest and demand for non-treated products."

Specialty wood research continues

The SWP had a \$14 million budget made of annual contributions of \$710,000 from industry, \$710,000 from MBIE and also had annual aligned funding of \$550,000 from Scion.

It was driven by reducing sectoral risk, creating products for new markets and spurring regional development.

As a key research provider for the SWP partnership, Scion led the research into many of the products featured in the cabin. In some cases, research is ongoing, and the cabin will provide data about product performance

in service over time as Scion staff make ongoing assessments of the cabin's different components.



For more information contact rosie.sargent@scionresearch.com

Visit the cabin virtually:





The cabin is made up of a range of wood and wood products including Eucalyptus obliqua flooring and a thermally modified cypress feature wall (right).

Scion Senior technologist Rosie Sargent with Vaughan Kearns of Ruapehu Sawmills.

A plant-based alternative to moulded polystyrene fish boxes is one of ZealaFoam's products in the commercialisation pipeline.

ZealaFoam set for growth

New investment will take plant-based technology global and solve some packaging industry challenges.

new company has been established to market a sustainable plant-based alternative to polystyrene, developed through Crown Research Institute (CRI) collaboration.

The new company, ZealaFoam Holdings Limited, will focus on commercial opportunities for the plastic replacement known as ZealaFoam. The **Biopolymer Network Limited** (BPN) - a joint venture between AgResearch, Plant & Food Research and Scion - will retain a shareholding in ZealaFoam Holdings, with investment from New Zealand and overseas investors allowing the company to take the technology into commercial production worldwide.

It's really rewarding to see technology developed from New Zealand research attracting international attention and offering a unique sustainable alternative to a widely used product.

SARAH HEINE

Established in 2005, BPN was created to develop new bio-based materials, using scientific expertise and capability from the three CRI partners. A number of biopolymer products were developed and tested, the most commercially-promising being ZealaFoam,

a 100% plant-based foam with the same functional attributes as polystyrene. The first commercial product, EcoBeans bean bag fill, was launched in 2022 and is now sold in New Zealand and Australia.

"ZealaFoam is a really exciting product with the potential to address some big challenges for the packaging industry globally, particularly around its use of fossil fuels and issues with waste disposal," says BPN chief executive Sarah Heine.

"The investment in the new company will see the technology move into a new phase of commercialisation. It's really rewarding

> to see technology developed from New Zealand research attracting international attention and offering a unique sustainable alternative to a widely used product."

> ZealaFoam is made from polylactic acid (PLA) sourced from starch derived from a variety of plants such as maize, cassava and sugar cane.

> ZealaFoam EcoBeans can be used for bean bag fill or loose fill packaging, with the

same performance as polystyrene beads. As they are made from plants, EcoBeans are industrially compostable.

ZealaFoam is also close to commercialisation as an alternative for moulded polystyrene products, such as chilled produce and fish boxes, helmets, bee boxes and printable film.

Tackling facial eczema

Research and economic modelling by Scion holds promise for New Zealand's agriculture sector.

Scion is contributing its expertise in economic modelling to an ambitious and collaborative programme led by Beef + Lamb New Zealand aimed at eliminating the impact of facial eczema on New Zealand's pastoral sector.

Senior research economist Richard Yao and resource economist Saeed Solaymani will be analysing survey data collected from 600 livestock farmers over a phased seven-year programme to understand the impact and effectiveness of new prevention strategies and tools being developed to combat the disease.

Marc Gaugler, portfolio leader for Distributed and Circular Manufacturing, says demonstrating the positive economic impact that in-forest or on-farm solutions have on regions and New Zealand is a key focus of Scion's eco-industrial regions programme.

"The economic impact assessment framework that our team will develop is an example of generating research results that we need to make informed decisions and benefit our primary industry and economy."

Facial eczema is associated with a toxin-producing fungus and affects the health of a range of livestock including sheep, cattle, deer, goats and alpacas.

While causing trauma to animals, the economic impact to farmers is estimated at \$332 million annually through losses caused by reduced animal growth rates, fertility and production. It can also cause significant stock losses during severe outbreaks.

It not only impacts the financial bottom line for farmers but also their mental wellbeing. With climate change, the disease is expected to spread more widely across New Zealand.

At present there is no cure for facial eczema with zinc dosing one of only a few management tools available.

The Eliminating Facial Eczema Impacts (EFEI) programme, announced in March by Agriculture Minister Todd McClay, will bring together many of the country's top researchers as part of a \$20.75m partnership jointly funded by Beef + Lamb New Zealand, the Government through the Ministry for Primary Industries Sustainable Food and Fibre Futures fund, and the primary sector.

It aims to reduce reliance on zinc as a preventative measure and limit the impact of facial eczema by delivering solutions developed with farmers and leading scientists at AgResearch, Manaaki Whenua – Landcare Research, universities and rural professionals across New Zealand. By enhancing farmer adoption of prevention measures and new treatment technologies, the programme is expected to achieve a reduction of \$38m in economic costs associated with the disease. Longer term benefits to New Zealand's economy are expected to increase by an additional \$20m each year after the programme ends.

Yao highlights the importance of the research, saying: "By conducting comprehensive cost-benefit analyses and resource efficiency assessments, we're aiming to demonstrate the value of strategies that will not only reduce economic losses but also improve the resilience and sustainability of New Zealand's agriculture sector."

Data collection and analysis

Yao and Solaymani will operate focus groups and collect survey data from at least 600 pastoral farmers. They will gather information on farm demographics, revenue, expenditures, such as animal health and labour costs, and the impact of facial eczema on profitability. Through rigorous data analysis and economic modelling, the team will assess the effectiveness of interventions and evaluate key factors that influence their uptake.

"Results from the cost-benefit and productive efficiency analysis can be used by farmers to help them make decisions and assess the benefits of different options for managing facial eczema on their farms," he says.

The research will provide an opportunity for Yao and Solaymani to build on previous economic modelling at Scion. In 2023, the pair teamed up in a study, funded by Forest Growers Research, that looked at the value of mountain biking and its wellbeing benefits. It also explored the role of planted forests compared to other mountain biking destinations.

Yao and his economics and decision support researchers have also contributed to the five-year Marine Biosecurity Toolbox programme that aims to protect New Zealand's marine environments by managing marine pests and invasive species. Yao's team has delved into how much implementation initiatives would cost to create a healthier marine environment, and what the wider benefits would be.

Yao hopes the EFEI research programme is only just the start of greater collaboration with agricultural stakeholders.

"Our modelling can be applied to many primary sectors. This latest research is another example of how scientists combine for a more unified, coordinated approach to finding solutions for New Zealand Inc."

The enemy of my enemy

Do possums and rodents prevent the spread of wilding pines? Scion's research is finding out whether these seed-hungry mammals are a help or a hindrance to wilding pine invasions.

WW ilding conifers are a major threat to New Zealand's environment and economy. Understanding how these species invade and re-invade the landscape is critical to win the battle against these invasive trees.

As part of the complex puzzle of re-invasion Scion scientists are investigating how animals can affect wilding conifer populations by using their seed as a food source (seed predation), reducing the number of seeds in the environment.

Determining what animals eat these seeds, and in which habitats, is crucial to understand wilding conifer re-invasion patterns. One of the suspects that might eat conifer seed is another invasive pest – the brushtail possum (*Trichosurus vulpecula*).

Scion's invasive plant ecologists have conducted field trials under different environment types (pasture, tussock, beech forest, ground-controlled wilding areas, dead wilding forest) in Arthur's Pass, South Island, to investigate which animal species are conifer seed predators. Seeds were eaten at variable levels across these areas, with the highest levels of predation seen in the beech and dead wilding forest areas. Low predation areas such as tussock are particularly vulnerable to future invasion and re-invasion as there are higher levels of seed available left to grow.

Scion's invasion ecologist Tom Carlin says this research will support management of wilding conifers and the risk of continued seed spread.

"Understanding which animal species are eating conifer seeds, and how quickly, are crucial questions in finding out how vulnerable different areas are to conifer invasion.

"Aotearoa is home to many seed-eating birds and insects, however it also supports large populations of exotic granivores such as mice and rats.

"By removing these exotic mammals from the environment, which is necessary to protect our native species, there is a risk we will inadvertently help conifers spread more rapidly by reducing their seed predation pressure. This project was initiated to help determine that risk, and if possible, help prevent it."

Possums as guinea pigs

Early on, Scion teamed up with Willowbank Wildlife Reserve in Christchurch to investigate what animals might be eating the seeds based on teeth marks on the sticks that seed was mounted on. Common knowledge suggests possums don't eat seeds from

the forest floor, so the experiment was replicated in the possum enclosure to find out.

Willowbank Wildlife Reserve is home to two possums, Tiny and Dobbie. If the damage done to the sticks in their habitat matched what was observed in the field trial, we could determine the culprits.

Out in the field, footage from camera traps and feeding stations confirmed that exotic mammals (mice, rats, possums) were the main culprits although insects were also responsible for eating seeds.

Willowbank Wildlife Reserve Community and Conservation engagement manager Shaun Horan shares his enthusiasm for protecting New Zealand's ecosystems.

"Willowbank has been excited to collaborate with the team at Scion for this study.

"It harmonises with the conservation efforts Willowbank strives for and has aided us to begin conversations with our visitors about wilding pines in New Zealand."

The wilding pine problem

Wilding pines are introduced species that become invasive in environments if not managed well, threatening native ecosystems (and the biodiversity within), production lands (grazing) and change the vistas of iconic landscapes. The worst wilding offender, Lodgepole pine (*Pinus contorta*), grows readily and will form dense forests if left untreated.

Wilding pines already cover more than 1.8 million hectares of New Zealand with a further 7.5 million hectares of productive or conservation land (approximately 28% of New Zealand's land area) threatened over the next 30 years.

The New Zealand government established the National Wilding Conifer Control Programme (NWCCP) to deal with this growing problem, but continuous management is required. Current oneoff treatments are not able to eliminate wildings fully and prevent cleared land from re-invasions. Preliminary analysis shows that current control measures such as hand weeding, felling or herbicide application, are unlikely to achieve eradication.

Vive la résistance – managing wilding conifer re-invasion

Vive la résistance is an MBIE Endeavour-funded five-year research programme awarded \$12.85 million in 2021. The Scionled programme team is investigating effective strategies for long-term resistance to re-invasion of wilding pines.

New methods and management approaches are developed and tested under this project and include the support and analysis for operational large-scale control trials, aerial and satellite imaging to detect and monitor emerging wilding pines, multifactorial experiments to identify drivers and inhibitors of re-invasion and computer modelling of the "behaviour" of wilding populations. The highly collaborative programme involves

Understanding which animal species are eating conifer seeds, and how quickly, are crucial questions in finding out how vulnerable different areas are to conifer invasion.

TOM CARLIN

researchers from Scion, Lincoln University, University of Canterbury, Manaaki Whenua – Landcare Research, Australian National University, and the National Centre for Atmospheric Research (USA) to support the NWCCP.

This seed predation research is just one piece of the puzzle to understanding drivers of re-invasion risks. This knowledge helps us move towards accurate computer modelling predictions for seed dispersal and to inform

recommendations for wilding pine management practices to break the inevitable cycle of treatment, re-invasion and re-treatment.

*This research was recently published in *Biological Invasions*. Learn more about our wilding pine research:





Conifer seed mounted on a stick out in the field.

Eco-friendly planting solutions

Seaweed nanocellulose hydrogels, a high-value component found in cosmetics and wound care, are now making waves in the forestry sector. They're being tested as eco-friendly alternatives to petroleum-based polymers, potentially boosting plant health and extending the planting season when using mechanised tree planting systems.

Dr Stefan Hill, Scion's portfolio leader for High Value Biorefineries, will explore the potential of nanocellulose in the lab alongside his team.

ydrogels are celebrated for their exceptional waterabsorbing prowess, capable of retaining water up to 100 times their own weight. When hydrated, they transform into a gel-like substance, gradually releasing stored water as needed.

Traditionally, the world's nanocellulose supply relies on wood pulp treated with harsh chemicals.

However, a collaboration in 2017 between Scion – an expert in wood pulping, and AgriSea – a Māori owned family business based in Paeroa, sought an alternative approach to the sustainable production of this versatile polymer using seaweed.

Dr Stefan Hill, Scion's portfolio

leader for High Value Biorefineries, says extracting nanocellulose from seaweed complements AgriSea's core business of providing bio-stimulants to farmers and growers.

"This initiative aligns perfectly with the principles of a circular economy, where waste becomes an input for another process, leaving us with nothing but CO_2 and water."

Environmental stewardship is paramount to AgriSea, reflecting the commitment to caring for the whenua (land) and natural resources central to their mission. For Scion, the collaboration exemplifies research aimed at developing renewable bio-based products to combat climate change.

Seaweed-based hydrogels are now undergoing trials to

determine their potential to improve seedling establishment and growth in forestry. Their capability to extend the planting season beyond winter's boundaries, courtesy of mechanised planting systems, could prove critical in helping the forestry sector adapt to New Zealand's ever-changing climate patterns.

Hydrogel performance in the spotlight

In a collaboration involving Forest Growers Research (FGR), Timberlands, and contractor H.A. Fear, Scion used seaweedbased hydrogels in a mechanised planting trial using the 'M-Planter'. This machine integrates a planting head with an excavator-based carrier for precision forestry.

This initiative aligns perfectly with the principles of a circular economy.

DR STEFAN HILL

The initial trial, conducted as part of FGR's *Precision Silviculture Programme*, took place in late March 2022 in Tarawera Forest, where conditions in early autumn make it a demanding establishment environment. A subsequent trial in December 2022, conducted in partnership with Rayonier-Matariki Forests, aimed to assess hydrogel performance under drier summer conditions.

Four treatments were applied to container-grown seedlings: a dry control (representing standard practice), root zone water application, surface hydrogel application, and root zone hydrogel application. Three and 12 months after planting, measurements of plant health and size, including height and groundline diameter, were recorded.

Dr Carol Rolando, a Scion senior scientist specialising in forest establishment, says unseasonably wet weather during both trials hindered a comprehensive evaluation.

The trials showed minor positive

effects on early growth and there was a slight trend toward increased survival when using hydrogels. The results reflect the unusually wet weather, with 270mm of rainfall over six weeks post-planting, rather than any shortcomings of the hydrogel itself.

"We've observed, both in New Zealand and worldwide literature, that hydrogels have demonstrated the potential to significantly enhance tree survival and growth."

She says despite the initial outcomes, the trials yielded valuable insights, including improved knowledge of the M-Planter's performance in wet conditions and clay soils, as well as the mechanical application of hydrogels during planting.

Extending the planting window carries numerous advantages for forest owners. These include better use of limited highquality labour, reduced pressure stemming from tight planting

Hydrogels can seamlessly become part of the process in containerised tree stocks, where each seedling already benefits from a "packed lunch" in the form of a rich and fertile planting medium within each root plug.

DR JOHN MOORE

schedules, and optimised site usage by enabling more areas to be replanted rather than deferred to the following year.

Dr John Moore, research and development manager at Timberlands, underscores the role of climate change in this context, particularly on pumice soils where more frequent and severe droughts could potentially compress the planting window.

> "While current survival rates are acceptable, hydrogels could offer a buffer and added protection during periods of severe and frequent drought, particularly during a seedling's initial year."

Moore says even small changes observed in survival and early growth can have significant implications when planting eight million trees per season.

"The value of early growth gains extends to helping seedlings overcome competition from weeds, ultimately translating to greater performance in later rotation crops."

The journey now leads to Scion's nursery, where more research trials will be conducted. The

controlled trial will compare the effects of seaweed-based hydrogels with synthetic counterparts on *Pinus radiata* containerised seedlings over two years, scrutinising factors such as placement, quantity, and application timing.

From manual to mechanised

With increased realisation of the benefits offered by integrated forestry, there is a gradual shift from manual and semimechanised to fully mechanised planting machines. But for the introduction of technology at this level to be economically viable, it needs to offer more than just planting solutions.

The trials in Tarawera Forest and Rayonier-Matariki Forests mark the beginning of a comprehensive assessment under FGR's *Precision Silviculture Programme*.



Seaweed nanocellulose transforms into a gel-like substance capable of retaining a significant amount of water.



Waste from AgriSea's core business is used to make seaweed nanocellulose.



Tarawera Forest trial, where its pumice soil is known for its dry and demanding establishment environment in summer and autumn.

Programme manager Claire Stewart says extending the planting season is crucial to maximising planting machine utilisation, enhancing the overall cost-effectiveness of mechanised operations.

"The New Zealand plantation forest industry heavily relies on manual labour for silviculture tasks, including planting, pruning, and thinning. Labour shortages pose a significant challenge, and mechanisation is a potential solution."

She says machines like the M-Planter have been equipped with features like a ripper for deep soil preparation, making them suitable for land preparation activities and planting. Beyond the application of hydrogels, fertilisers, growth hormones, or rooting agents could also be considered. These machines could also be multi-use equipped with herbicide, insecticide, or pesticide spray systems.

Timberlands, a participant in the Tarawera Forest trial, identifies three key benefits of adopting hydrogels and mechanised planting systems: enhanced capital utilisation, extended planting seasons, and increased resilience against climate change.

Currently, Timberlands uses mechanical planting for 120ha. Most of the 7000ha annual programme still relies on manual planting methods. This poses a challenge of integrating hydrogels into various planting stocks, but also an opportunity for innovation.

Moore says containerised stock in nurseries is a logical starting point for hydrogel integration.

"Hydrogels can seamlessly become part of the process in containerised tree stocks, where each seedling already benefits from a 'packed lunch' in the form of a rich and fertile planting medium within each root plug.

"The trial has helped envision a future where hydrogels could be effectively introduced to forestry practices, acting as a nurturing boost for tree stock, minimising planting stress, and fostering rapid and robust early growth."



The M-Planter by contractor H.A. Fear planting containergrown seedlings during the Tarawera Forest trial.

Two parallel streams of work

The nanocellulose extracted from AgriSea's seaweed waste serves a dual purpose. While it is purified for use in cosmetics and wound care, it can be used in its raw form to support plant establishment.

The *Precision Silviculture Programme* trials aim to understand the potential impact of hydrogels on growth and increased survival rates. Ongoing laboratory work at Scion is also delving into the underlying science behind it.

New Zealand's native seaweed, *Ecklonia radiata*, boasts a wealth of minerals, trace elements, and naturally occurring antibodies.

In the laboratory, Hill says numerous theories are being explored including whether beneficial microorganisms pass through the extraction process and into the hydrogel.

They're also studying how hydrogels affect microorganisms in the soil. This interaction plays a pivotal role in influencing how plants absorb nutrients and stay healthy.

Hill says by employing hydrogels as a carrier for beneficial microorganisms or as a medium to support microbial activity, they aim to bolster plant resilience and health.

In the realm of agriculture and plant growth, the choice between nanocellulose and petroleum-based hydrogels is becoming more important with the former offering a sustainable and environmentally friendly solution, unlike their petroleum-based counterparts.

Nanocellulose hydrogels lack toxic components, naturally biodegrade (unlike petroleum-based alternatives that can persist in the soil for years), and carry no risk of dehydrating plants, a concern associated with certain hydrogels.

"With its compatibility with plant roots and its potential to regulate water flow, seaweed-based nanocellulose emerges as a promising and environmentally sound choice for enhancing soil quality and fostering healthier plant growth."

Mini



but mighty

A new hedge system and alternative containers are being trialled to scale up indigenous tree propagation.

Scion has broken ground and is making progress on several new field trials following successful trials propagating native seedlings in paper Ellepots.

More than 15,000 karamū, mānuka, tōtara and tī kouka seedlings were planted in August 2023 at two sites in Rotorua.

The work is progressing propagation research towards forestryscale deployment of indigenous species under New Zealand's One Billion Trees (1BT) Programme.

Producing large numbers of indigenous species is currently a slow, expensive and uncertain process. Challenges include collecting and germinating seed, maintaining efficiency while working at a small scale and issues around adopting modernised practices. The goal of every nursery is to cost-effectively produce robust and vigorous plants that establish quickly, and this has proven difficult when it comes to many indigenous tree species. For example, pot sizes tend to be large, which adds to the cost and logistical challenges of establishment compared with smaller 'forestry grade' pots.

Since 2019, Scion has been collaborating with Te Uru Rākau -New Zealand Forest Service and various industry partners to develop new ways to improve propagation and the scaling up of indigenous species production in nurseries.

On track to one billion trees

In 2018 the previous Government set a goal to plant a billion trees by 2028. To reach this ambitious goal requires producing seedlings at scale.

Funded by Te Uru Rākau - New Zealand Forest Service, Scion, in collaboration with Minginui Nursery, Tipu Wai Trust, CNI Iwi Land Management Ltd, Tumunui Lands Trust, Te Arawa Lakes Trust and Rotorua Lakes Council, has completed several projects to help nurseries produce the required number of native seedlings.

"This work is addressing a real issue for native afforestation as our indigenous trees are traditionally much harder to propagate and establish compared to exotic species", says Dr Emily Telfer, Te Uru Rākau – New Zealand Forest Service Team Leader, Forestry Research Programme.

The 1BT programme is on track with well over half the target number of trees already planted. A further 150 million seedlings are estimated to be planted in 2024.

The 1BT Fund is closed for applications, with the programme continuing until 2028 for grants that have already been approved.



The root systems of two tī kouka seedlings grown in different containers.

New production practices - mini-hedges

As part of this work, a new system for supplementing native tree seedling supply was tested in Scion's nursery to address native tree seed availability and supply challenges. Establishing seedlings in long rows to create "mini-hedges" can provide harvestable shoots year-round, avoiding the seasonal limitations of many New Zealand natives. The mini-hedge system has proven to accelerate the production of high-value genetically improved plants such as radiata pine and eucalyptus, but this is the first known use of this approach for New Zealand native trees.

Between March 2020 and April 2021, Scion's nursery team grew eight native species using the purpose-built mini-hedge system. These were incredibly productive and several rounds of harvesting and setting of cuttings were achieved. Most species responded well to the environment – tawhai (silver beech) the notable exception with its low tolerance to higher temperatures throughout summer. Rooting success varied from 30% up to 99%. Tōtara (*Podocarpus totara*) and pōhutukawa (*Metrosideros excelsa*) were the most successful species at 99% and 80% respectively. Three hundred and fifty seedlings of each species were sown into paper pots, planted into beds in the nursery and, once sufficient shoot material was available, they were harvested and placed into rooting tunnels on heated beds. Eight to 12 weeks after setting, rooting success was evaluated.

Scion scientist Heidi Dungey discusses the potential benefit of this system: "Many New Zealand native trees do not have reliable seed production. The mini-hedge system may be a great way to ensure supply of plants when seed is not in sufficient supply."

This research also indicates that the nursery production time of native seedlings like tōtara and pōhutukawa might be shortened, and year-round supply might be possible.

Container field trials

The conventional approach of sowing native seed, setting out and then growing in containers takes 12-36 months, adding significantly to native tree establishment costs over typical New Zealand-grown exotic forest trees.

In Scion's research nursery, 31 indigenous tree species were included in the propagation trial investigating container type and container size. Industry standard pots were compared with other, smaller containers such as paper Ellepots and forestry grade pots. Both slow-growing and fast-growing indigenous species were included.

Over 15,000 seedlings of four different tree species – karamū, mānuka, tī kouka and tōtara – were established in forestry grade (industry standard) pots, or 7cm and 8cm paper Ellepots. The effect of differences in length of time, type of container and tree spacing are being monitored to determine the impact on survival rates and tree growth.

Tipu Waiariki Charitable Trust (Tipu Wai) is supporting the research by providing a trial site for planting. Trustee Gregg Brown says the partnership with Scion is incredibly rewarding.

"We have enjoyed a partnership with Scion over many years and are grateful for the opportunity to contribute in our own small way to addressing the environmental challenges in New Zealand."

Scion project lead for the latest field trials, Donald White, believes these plantings will act as a basis for future research and collaboration. "Understanding the fundamentals of how native trees grow will help us prepare for climate change."

Dungey stresses that the mini-hedge system is exciting for native tree production. "Any concerns for diversity can also be managed through the diversity of the mother plants."

When combined with smaller, robust plant production, this will be a game-changer for native forest establishment.

"There is so much to do to help establish native forests across the motu, that every little bit of new or old knowledge counts."

This research has already impacted the New Zealand nursery sector, with investment into paper pot technology in several nurseries.

"Combined with new forest establishment research, we hope that this will result in more plantings of native forests, increasing our biodiversity and contributing to the mitigation of climate change."

Biomaterials in action:

Pearl farming in the Pacific

A promising aquaculture biomaterial trial is currently under way in Tahiti to help the pearl farming industry in French Polynesia become more sustainable.

rench Polynesia is well known for its crystalline waters and sunny tourism.

But being a small, remote island nation made up of more than 100 islands spread over an area nearly the size of Europe, with a population of 280,000 people, brings a unique set of challenges – particularly when it comes to resources and waste.

Pearl farming is the second largest economic earner in French Polynesia behind tourism and a major source of employment in remote islands. However, it is also known to significantly impact the environment through plastics pollution.

A lot of work has been going on in recent years to promote more sustainable aquaculture practices and improve thinking about how to use and discard materials with greater circularity.

With aquaculture an important industry, plastic and what to do with it has been a substantial chunk of the issue.

The challenge

The current materials used for oyster collectors – vertical lines of plastic shade-mesh, similar to tinsel, which oyster spat attach to and grow – are notorious for disintegrating and leaving microplastics in the picturesque lagoons.

It's also not really known what to do with plastic waste once it reaches end-of-life and some ends up being burnt or buried.

Professor Nabila Gaertner-Mazouni and her team from the University of French Polynesia (UPF) first approached Scion in 2016 for help with the mounting plastics issue, but it wasn't until 2020 that funding was received from the French Polynesian government and an agreement was signed around how to create a more sustainable aquaculture industry.

UPF project team member and doctor in marine ecology Margaux Crusot says UPF approached Scion initially because of its expertise in biomaterials and development of sustainable solutions.

"At UPF, we provide the biology and ecology expertise necessary for developing the solution, while Scion, with their knowledge and expertise, can translate our needs into concrete solutions.

"We have been very pleased with this collaboration and complement each other well in our understanding of things."









TOP LEFT:

Celebrating innovation: Margaux Crusot, UPF, celebrating successful deployment in Takipoto Atol, Tahiti.

ABOVE: From lab to ocean: Christophe Delpont, from the French National Research Institute for Sustainable Development, and Scion's Rob Whitton.

LEFT: Scion's Maxime Barbier engaging with local pearl farmers on the importance of change.

The beginning of a solution

In her previous role as Scion research group leader for Materials, Engineering and Manufacturing, Marie-Joo Le Guen and her team began looking at alternative materials for the traditional oyster collectors.

After UPF assessed a number of options for alternative collector shapes, they decided on a coupelle – a slightly concave disc with a hole in the middle. Used elsewhere in the edible oyster aquaculture industry, but not for pearl oysters, there wasn't an existing biobased product available in the coupelle shape.

Materials technologist Maxime Barbier set about developing a formulation based on existing research and a specific set of requirements from UPF, in addition to being suitable for 3D printing.

The final biomaterial, named Black Pearl, was developed and compounded in Scion's extrusion lab in 2020. After initial lab trials to prove feasibility, material was sent to Scion's commercial partner Imagin Plastics in Auckland and made into 3D printing filament.

Initial trial

With an initial small-scale deployment planned by UPF in Tahiti, 2400 coupelle prototypes were needed. To 3D print such a large number, Scion's FDM 3D printers were increased to a fleet of eight, thanks to UPF funding, and affectionately referred to as the Avengers.

All eight Avengers had to be re-coded for a new method of printing. Known as non-planar printing, the process significantly decreased the time taken to print each coupelle and saw parts printed freeform, instead of as individual horizontal layers in sequence, allowing for less material being used.

The trial, which took place in 2020, proved the coupelle shape was good, providing protection and shade for the spat to settle into.

Existing HDPE (petroleum based high-density polyethylene) coupelles and shade-mesh collectors were also tested alongside the bio-based coupelles and it was found the amount of settlement was greater on the bio-based material, meaning they attracted more spat.

Le Guen says the predominant invasive species appeared not to like the biomaterial as much as the HDPE, which was a double win.

The trial revealed the 3D printing method was not sufficiently resistant, with some coupelles breaking up prematurely due to insufficient layer adhesion – another valuable piece of the puzzle. It still provided enough data to understand the material and shape both had promise.

Scaling up

From there, a new trial was established using an alternative production method. Scion produced 750kg of compound in New Zealand, which was then shipped to Tahiti, where local company, Plastiserd, injection moulded the new coupelles.

Plastiserd produced 12,400 coupelles for UPF to deploy across three different locations, taking into account the vastly different conditions seen throughout French Polynesia due to being spread over such an extremely large area.

Scion's team lead for the Additive Manufacturing and Emerging Technology team, Rob Whitton, along with Le Guen and Barbier, travelled to Takapoto Atoll in Tahiti, in October 2023 to help with the first deployment of the upscaled trial.

As with previous trials, three types of collectors have been included – the plastic HDPE coupelles, the new biobased coupelles and the traditional plastic shade-mesh – alternating

along a 200m line. Each collector is 1.2m long, sitting 6m below the surface of the water, which is around 25 – 50m deep.

The trial will run for two years, monitoring the compatibility of the new collectors compared to the old ones, with collectors monitored every six months.

A second trial looking at the biodegradability of the biomaterial is running alongside this.

Scion's visit also included community engagement, with both

the university and Scion hosting local pearl farmers and fishermen, and the general community, to help educate them around the need for change.

Whitton says getting the community on board will be a big factor in success.

"We were able to see what UPF are trying to do in terms of being able to convince the local aquaculture industry this is a good move. People are quite skeptical, particularly of scientific institutes coming in with new options."

Strength of collaboration and connection

As with many things, collaboration and connection is key, particularly in isolated communities.

While in Tahiti, UPF organised a biomaterials conference where Scion presented its experience and capabilities. The Scion team also spent time meeting with Tahiti industry working with biomaterials and natural fibres. "We built some valuable links with the local biomaterial industry," Whitton says.

"They're a small economy so they're quite limited with what they can do, but they have some interesting feedstocks they're working with – like banana leaves and coconut fibres. They're being used for the likes of aquaculture ropes and moulded fibre packaging."

Hosted by UPF, Scion also visited other local industrial companies, including Pacific Biotech, a fermentation company working with EPSs (exopolysaccharides) and PHAs (polyhydroxyalkanoates) – or in laymans terms, biopolymers produced from bacteria that can be used for making the likes of bioplastics and biofilms.

Scion and Pacific Biotech have since entered into a material transfer agreement, meaning the

company will send material to Scion's labs for testing, leading to future collaboration.

What's next

Scion's relationship with UPF has continued to consolidate and Le Guen hopes this is not the end of the journey.

"If this trial is successful for a specific species, that's very exciting for us."

Crusot says it has been a pleasure working with Scion.

"The team is very easy to work with, and it has been a pleasure collaborating both at Scion and in French Polynesia. Additionally, our results clearly demonstrate the success of the collaboration, and I would be delighted to continue working with them."

She says developing a biodegradable alternative collector has many associated benefits for French Polynesia, such as substantially reducing waste, establishing groundwork for the development of a

local production industry with less reliance from overseas and creation of local jobs, promoting technical innovation and providing strong visibility for French Polynesia, which would be the first, based on current knowledge, to provide a biodegradable bivalve larvae collector globally.

As with all change, it won't be overnight, but things are looking pearly.



At UPF, we provide the biology and ecology expertise necessary for developing the solution, while Scion, with their knowledge and expertise, can translate our needs into concrete solutions.

MARGAUX CRUSOT

Tapping into unlimited potential of virtual reality

<complex-block>

VR has been around a long

time in entertainment. Now

people have started to see

the real applications.

GRANT EVANS

Precision Silviculture Programme manager Claire Stewart uses the headset while Scion portfolio leader Grant Evans observes.

future where new foresters are trained to thin trees from the safety of a virtual reality forest before more advanced real-world training could be just around the corner.

And the technology to get us there could also be used for training skills across the forestry industry.

Scion's Virtual Thinning project uses an off-the-shelf game engine with in-house tweaks and programming to create an interactive and 3D virtual reality training tool.

The tool would supplement

on-site training allowing initial tuition before workers go into forestry blocks. The project is funded by the *Precision Silviculture Programme* managed by Forest Growers Research. Trainees who put on the virtual reality headset find themselves in the middle of a computer-generated forest model reflecting a realistic production forest in New Zealand.

> The images are based on physicsbased models of *Pinus radiata* and multiplied so there are 50,000 trees. Randomisation formulas are applied to make each tree unique.

> Development of a beta version of the tool began last year and the team aims to have a prototype by mid-year.

'The scenarios are unlimited'

Scion portfolio leader Grant Evans says the tool makes training logistically easier and faster given travel to sites is not needed, safer and also means losses are not suffered as mistakes made in virtual reality don't affect real forestry blocks. Options for the tool are limitless. "Levels" can be created to make choosing which tree to thin easier or harder. Variables can be changed to adjust stocking rate, tree species and age.

There are decades of tree bioinformatics available to draw on and more than 70 potential variables.

Scion forest management scientist Lania Holt, who is involved in thinning research for the *Precision Silviculture Programme*, says a tool like this could improve thinning processes and health and safety.

It could also allow training in a broader range of scenarios than the conditions in accessible forests on any given day.

Precision Silviculture Programme manager Claire Stewart says the tool fits with the programme's aims of digitising, mechanising and automating forestry tasks to make them more efficient and safer.

She says the VR tool could also help trainees initially understand complexities without the immense pressure of a forest environment and help them understand the economic value in forests.

"Thinning is one of the most critical tasks within the life of the forest ... It's where you can add or subtract a lot of value.

"When you're in the forest deciding which tree to thin you might not realise it is such an important decision."

Stewart says the technology also paves the way for teleoperation of the future and sets the foundation for how these technologies will need to work.

The future opportunities

We are fully committed to

exploring new interactive and

digital ways of training and

attracting the workforce.

CLAIRE STEWART

Holt says Scion's role has been to prove the concept could work – the next steps should come from industry. She suggests it could be rolled out at a training institute, or the technology could be rented for training purposes.

Work also needs to be done to test the human experience

and impacts of being trained in this format. "Normally we study

human factors with people in forests, now we want to understand human factors with this technological approach to training," Holt says.

Stewart says the forest environment needs to be

replicated in a way that allows trainees to become immersed and understand the task.

"If that proves to be successful there are many other tasks in the forest beyond thinning that would benefit from this training – pruning, establishment tasks, surveillance and monitoring, harvesting and processing.

"We are fully committed to exploring new interactive and digital ways of training and attracting the workforce."

Watch a video and hear more from our scientists on the benefits of virtual reality training for forest management.





Evenus Greening our cities

Scion, Manaaki Whenua – Landcare Research, the University of Canterbury, and Christchurch City Council joined forces in April to host Urban Forest Futures New Zealand: Te aka tāngaengae – Pūtaringamotu, a first of its kind, two-day symposium.

Researchers, mana whenua, urban planners and foresters, council and government officials came together in Ōtautahi Christchurch to discuss how best to address the challenges in establishing and maintaining green spaces across Aotearoa.

The event highlighted how urban forests not only help mitigate the effects of climate change but are also a key element in creating equitable, healthy and vibrant cities.



The event featured presentations from several experts, including (clockwise from top left) Parliamentary Commissioner for the Environment Simon Upton, Scion researchers Richard Yao and Sylvia Tapuke, and Justin Morgenroth from the University of Canterbury.

Countdown to ForestSAT

Scion is looking forward to welcoming remote sensing specialists from around the world to Rotorua for the Association for Forest Spatial Analysis Technologies Conference.

Innovation unleashed



IUFRO is one of the oldest and largest global organisations for sharing knowledge in forest research. In March, Scion was privileged to host the IUFRO 2.09.02 conference in Rotorua. More than 60 experts from 15 countries attended. orestry is a vital means of tackling climate change and there is a growing demand for trees globally. At Scion we are supporting the industry to meet this demand by exploring new vegetative propagation technologies in and outside the lab to rapidly grow high-performing trees cost-efficiently.

A busy week of presentations culminated in field trips and a tour of Scion's labs and nursery to learn about everything from 3D printing and hydrogels to genome sequencing, tissue culture research and tree propagation.

egistrations are open now for the event on 9-13 September, which is considered the most prestigious international conference on the application of remote sensing technologies for forest monitoring and modelling. Participants have the opportunity to attend presentations demonstrating new tools and technologies that drive the science forward. Keynote speakers include Pablo J. Zarco-Tejada from the University of Melbourne, and Crystal Schaaf from the University of Massachusetts in Boston.

Visit the ForestSAT 2024 website for speaker and registration details. www.forestsat2024.com.





Where there's fire, there's smoke and Scion modelling can show you where it might go.

hen large fires break out in New Zealand, like on Christchurch's Port Hills, or when Australian wildfires cause New Zealand's skies to turn pink and orange, Scion staff have an important job.

Scion's automatic and manual smoke forecast modelling can inform health authorities' decisions and advice by forecasting smoke locations and fine particulate concentrations. The smoke forecast is published in a modelling prototype on Scion's website.

The automatic modelling is done using satellite detected fire hotspots and forecasted weather, which together are used to generate potential fire size, smoke emissions and downwind particulate concentrations. This smoke footprint shows hourly PM_{2.5} concentrations — concentrations of particles less than 2.5 micrometers in diameter. It is these small particles that can travel into the body when inhaled and affect human health. High concentrations of particulate matter can also affect visibility.

But automatic modelling has some flaws. Satellites pass over in four-hour intervals and clouds affect visibility which can reduce the number of hotspots detected. Automatic models are also built on assumptions that may not suit all situations. So, Scion's Fire and Atmospheric Team also runs the system manually upon request, for example by Fire and Emergency New Zealand. Scion initiated manual modelling when the Port Hills in Ōtautahi Christchurch caught fire in February. This allowed informed communication around smoke impacts, including where hotspots were not detected due to cloud cover. For the Port Hills fire smoke modelling identified locations where smoke and fine particulate concentrations could be predicted to drift over Christchurch. Smoke forecasts were produced daily showing where smoke could be hazardous over the next 48 hours if the fire continued. Qualitative results were accurate in showing the direction of smoke movement early.

This modelling can inform Fire and Emergency, health authorities and the public, project leader Shana Gross says. "The purpose is to provide data that assists in decision making around smoke impacts. This could range from poor visibility over roads to health effects. For example, health authorities could use the data to provide advice on what to do based on projected smoke concentrations."

This advice could include staying inside, shutting windows, or evacuating.

The modelling system forecasts smoke from fires both here and eastern Australia. Forests and Landscapes general manager, Tara Strand, says smoke can have far-reaching effects. "Smoke affects many people and can impact many kilometres downwind ... A member of the community can use this tool to build an understanding of timing and levels of smoke exposure."

While the smoke forecasts are still a prototype, Scion endeavours to keep them up to date, particularly during wildfire season. It is important to recognise, that in any model the outputs have uncertainty and error and while the team strives to minimise both of these, the prototype is still undergoing testing and evaluation.

New Zealand's wildfire season runs from October to May with the highest risk from January to March.

To view the fire registry and smoke forecasts prototype:



Beyond concrete: Timber's role in Green School design

The ability to foresee a need for change a decade in advance spurred the inception of Green School New Zealand, offering an innovative approach to sustainable education.

Situated on the outskirts of New Plymouth on 6oha of farmland, the school serves as an inspiration, challenging not only our country's educational norms but showcasing the possibilities of design and construction using wood. This was recognised when the school's newest structure, the Kina, received the top accolade at the Timber Design Awards. What was merely a paddock in 2018 has today been transformed into a place of deep learning. Three Waka, or pod-like classrooms, were the first structures to be built, designed to be sustainable and blend harmoniously with the natural environment. One Waka is New Zealand's largest and tallest zero-concrete building constructed using wood and minimal steel.

Yet, it's the school's latest addition, the Kina, that has proven to be the groundbreaking benchmark for learning facilities of the future. Honoured with the Supreme Award at Timber Unlimited's Timber Design Awards in November last year, the Kina represents a biophilic-inspired building comprising classrooms and communal spaces crafted to enhance cognitive function and emotional wellbeing.



Green School's campus features three Waka, unique pod-like classrooms, alongside the Kina design, seamlessly blending sustainability with the natural environment. Photo: Charlotte Curd



Laminated timber curves and perforated interiors create a stunning focal point. Photo: Charlotte Curd

Founded by long-time entrepreneurs Michael and Rachel Perrett, Green School New Zealand is part of a global education movement beginning in Bali in 2008. Schools have since opened in South Africa and soon, Tulum, Mexico. By blending traditional principles with a holistic, child-led approach, the schools foster green leaders equipped for real-life challenges through community-integrated learning and sustainability practices.

Describing Green School as their passion project, the Perretts aim to revolutionise education by providing an alternative that speaks to the hearts and minds of tomorrow's leaders.

"Education often feels outdated, industrialised, or simply ineffective," Michael Perrett says. "We believe there is a better way, one that places children at the center and breaks free from outdated norms. With the rapidly changing demands of the world, we're left in a new era with an old playbook."

New Plymouth architects, BOON, were enlisted for their expertise after successfully collaborating on the original Waka classrooms. Glenn Brebner, BOON's managing director, emphasises their mission to invoke curiosity and infuse beauty into the campus, showcasing a commitment to children's learning environments.

"This deliberate aesthetic consideration contrasts sharply with traditional classroom designs," he says.

Judges of the Supreme Award were quick to remark on the school's allure.

"This project quickly bubbled to the top as an exemplary project that set an example of the beauty, efficiency and sustainability that can be achieved using timber," one judge noted.

"The full life cycle of the building was considered during the design process with the result being a series of stunning organic forms that sit lightly upon the landscape and wrap around the young minds who are occupying the learning spaces."

A school with no walls

Green School dismantles the confines of conventional education, replacing concrete walls and boxed windows with sprawling acres of land and structures that surrender to the environment. Its design not only connects visually and sensually with the natural surroundings, aligning with the school's curriculum, but also cultivates a deep physical and emotional connection between he tangata and whenua.

The Kina's main feature is its 24 eyebrow-shaped structures arranged in a circular form looking out towards views of the maunga, awa, and the school's existing buildings. Built mainly using timber, an absolute minimum of concrete has been used – reserved only for the four atrium foundations, all others are timber driven piles. The floor structure is parallel laminated timber (PLT) panel, joinery is Accoya timber, decking is New Zealand beech and macrocarpa weatherboards are used on the external walls. "From conceptualisation of the waka classrooms, it was clear to us that timber would serve as our primary building material," Michael Perrett says. "Its distinguished profile, renewable nature, capacity to sequester carbon, and local availability were all key factors in our decision-making process.

"Wood also provided BOON the opportunity to embrace the form and patterns associated with kina. By wrapping laminated timber along the curves, they created a perforated interior

lining, resulting in a captivating kina spot design. This feature is not only widely complimented but also serves as an acoustic blanket, welcoming our school's new entrants."

Rachel Perrett says timber has biophilic advantages – resulting in a connection with nature – and an ability to promote wellbeing while enhancing the natural warmth and beauty of spaces.

"Incorporating biophilic principles into the design is more than just mimicking nature; it's about integrating biology into architecture intentionally. Rather than merely emulating natural systems, there's a deliberate effort to reference and incorporate

biological elements. While this presented its own challenges, it's crucial for creating environments that prioritise beauty, nature, and innovation."

The project used Building Information Modelling to communicate complex 3D form to engineers and structural timber fabricators, reducing the amount of waste from materials being cut and measured onsite; a significant portion was pre-fabricated off site and assembled in situ.

Brebner says engineered timber offers previously unattainable levels of accuracy.

"It allows for the creation of shapes that were once out of reach.

"Much of the timber industry has historically relied on covering up the approximations inherent in traditional wood products. However, engineered timber is consistently precise, resulting in a final product that seamlessly combines technical accuracy with aesthetic beauty."

Prioritising sustainability

Technology contributed to the school diverting 70% of all construction waste from the landfill. In doing so, they influenced many of their suppliers to prioritise sustainability, including a century-old construction company.

A second judge commended the project's use of innovation and technology: "The combination of timber and engineered wood products makes the most of locally available resources and cutting-edge manufacturing methods which also allow for meaningful textures to be included with the complex curves and structural rhythms.

"This project sets a high standard for what can be achieved using timber sourced and fabricated within Aotearoa New Zealand and is something we can all look to for inspiration for a sustainable future."

Robert Finch, whose visionary leadership at Timber Unlimited

Engineered timber offers levels of accuracy previously unattainable. It allows for the creation of shapes that were once out of reach. has spearheaded transformative changes over the past two years, says mass timber is not as commonplace as it could be in structures due to lack of industry experience with it, misinformation, and preconceptions such as believing it's too expensive, won't stand up to a fire or is not structurally as sound.

"None of this is true and

there are an escalating number of buildings, like the Kina, that demonstrate this," he says.

"The future of timber construction lies in increased off-site fabrication of engineered timber products like laminated veneer timber (LVL), cross laminated timber (CLT), and PLT to



enhance efficiency, quality, cost-effectiveness, and sustainability. However, this relies on improving assembly skills and utilising off-site assembly teams to boost efficiency and enhance on-site tooling."

From design to completion, the Kina prioritised sustainability. Materials were chosen for durability and low energy use, favouring timber over concrete and steel. Glues and sealants were eliminated

to encourage disassembly, product re-use and waste stream minimisation, while local trades and products were used to enhance industry skill and support the local economy.

"In collaborating with Green School, we found joy in their spirit of experimentation," Brebner says. "They embrace change, understanding that innovation paves the way for progress in education. The Kina reflects this ethos, exploring endless possibilities with warmth and enthusiasm."

Timber Unlimited, formed by BRANZ, NZTDS, Scion, and WPMA, operates as a not-for-profit entity supported and funded by the Ministry for Primary Industries and Te Uru Rākau – New Zealand Forest Service. It aims to promote sustainable forestry practices and boost the use of timber in construction, aligning with the Government's goal to double the value of exports over 10 years.

Learn more at Timber Unlimited's website:



Hey Google,

name the most beautiful, innovative, iconic building

Scion's Rotorua HQ has beat out the Silicon Valley campus of tech giant Google.

Scion's Rotorua headquarters has gone head-to-head with the Silicon Valley campus of top tech company Google — and come out on top.

But there are no hard feelings between the architects behind the two incredible buildings.

The Dubai International Best Practices Award for Sustainable Development was presented on February 13 and Scion's Innovation hub Te Whare Nui o Tuteata won 'The Most Beautiful, Innovative and Iconic Building' award.

Designed by RTA Studios and Irving Smith Architects, it was a finalist alongside Google Bay View in the United States designed by Danish studio Bjarke

Ingels Group (BIG) and London-based Heatherwick Studio.

Jeremy Smith of Irving Smith gave BIG partner Kai-Uwe Bergmann the grand tour of the Rotorua building while Bergmann was visiting New Zealand for an architecture conference a few days after the awards.

Walking through the doors of Te Whare Nui o Tuteata for the first time, Bergmann says he was struck by the timber building's warmth.

"Being a finalist in the same category is a great honour. The Dubai award celebrates work that innovates the building industry and Te Whare Nui o Tuteata and Google's building both achieve that."

The awards were held for the first time since 2019 in Dubai at the World Governments Summit. The five categories attracted almost 3000 entries worldwide.

The Most Beautiful, Innovative and Iconic Building category recognises iconic, smart, innovative, human-centric sustainable projects that innovatively combine green design and construction practices with modern architectural excellence. The win adds to the list of more than 20 national and international awards Te Whare Nui o Tuteata has taken home since opening in 2021.

The building's name, meaning the great house of Tuteata,

The Dubai award celebrates work that innovates the building industry and Te Whare Nui o Tuteata and Google's building both achieve that.

KAI-UWE BERGMANN

acknowledges Tuteata who is the ancestor of the three hapū who are the tangata whenua here: Ngāti Hurungaterangi, Ngāti Taeotu and Ngāti Te Kahu. The name was gifted to Scion by those three hapū.

The three-storey 2000m² building was built using a diagrid timber structure using less material than traditional structures. Scion tested the strength of the diagrid components. The building has

also been designed to be carbon-zero.

Google Bay View, which opened in 2022, consists of three buildings totaling 1.1 million sq ft on a 42-acre site in Silicon Valley. The campus aims to operate on 24/7 carbon-free energy by 2030 and renewable energy and solar potential were prioritised.

This building is achieving exactly what Scion is doing with its research – having an impact on the world stage.

JEREMY SMITH

Globally, the built environment is responsible for about 40% of energy related carbon emissions. Bergmann says architects are increasingly finding new ways to incorporate timber into their multi-storey designs, but more education is needed.

"We look at the operational energy of a building often but more important is the embodied energy, and that's the building

materials that we use. Fortunately, we are at a time when timber is an option," he says.

"There are structural advancements and pre-engineered wood manufacturing advancements happening alongside changes to building codes. High rises built using timber are getting up to 20 or 30 floors tall around the world."



Smith says winning the award is fantastic. "It feels amazing to be doing this kind of innovative work and to get noticed

internationally. This building is achieving exactly what Scion is doing with its research – having an impact on the world stage."

Scion's Forests to Timber Products general manager Henri Baillères says the win solidifies the building as an "international timber architecture icon".

"It's an iconic building because there

are a lot of elements attached to it. There are the Māori cultural elements, innovative design elements, seismic resistance, elegant design and maximal use of timber.

"It's a showcase technically and aesthetically of what can be done with timber."

He says Scion led the sustainable building charge and this had flow-on effects, with the new Fisher and Paykel global

headquarters being designed by RTA Studio using similar principles of sustainability and timber technology.

It's a showcase technically and aesthetically of what can be done with timber.

HENRI BAILLÈRES

industry, not just applicable to our region but the whole world."

Watch: Te Whare Nui o Tuteata – the architects' vision:

Go deeper on the building and its awards:

RTA design lead Rich Naish accepted the award in Dubai and says it was a "great honour" to receive recognition on the world stage for innovation developed in New Zealand with partners.

"What I believe has been recognised is a prototype for change to mitigate the effects of climate change in the construction







Shaping a more sustainable future

hallenges resulting from climate change highlight how the need for innovative, sustainable solutions, diverse voices and advocacy is greater than ever before.

With these issues top of mind, one young science leader at Scion, Dr Angelique Greene, has emerged as an ambassador for the bioeconomy – and she's on a mission to gather more likeminded young people to grow awareness about its benefits for communities and the environment.

Greene has been appointed as a Bioeconomy Youth Champion for the International Advisory Council on Global Bioeconomy (IACGB) in the Asia-Pacific region. She joins Kokuke Shiraishi from Kyoto University in Japan in co-leading the IACGB's regional bioeconomy group for youth. Working together, they are recruiting researchers and young leaders to learn more about how youth are involved, understand and engage with bioeconomies in their own countries. A Scion scientist is on a mission to grow awareness about the benefits of bioeconomies across Asia-Pacific.

Two workshops are on the horizon for the group over the next year. The first will focus on developing strategies for surveying and collecting data from young people across the Asia-Pacific region. The goal for the second is to create a culturally relevant and impactful study that can guide policy decisions and the transition to a bioeconomy.

Insights gathered will be instrumental in helping countries respond to the changes that are already underway. Bioeconomy is not just a buzzword; it encompasses technologies such as biotechnology and sustainable agriculture that are crucial for solving the pressing issues related to climate change. With Scion helping New Zealand transition to a circular bioeconomy, Greene and fellow Bioeconomy Youth Champions will help to assess the workforce pipeline, bioresource availability, and training needs in different regions.



Scion researchers Ki-Taurangi Bradford (left) and Dr Angelique Greene.

Joining the conversation

Greene says her role reflects her commitment as a scientist to create a more sustainable future, while also highlighting the importance of involving the younger generation in shaping global policies that will affect their future.

"The issues we're focussed on matter a lot to everyone around the world, but specifically to those who are most impacted by the effects of climate change.

"In our Asia-Pacific region, Asia is the most populated area of the planet, and the Pacific Islands are often underrepresented on global issues. I'm strongly advocating for diverse indigenous populations that would traditionally be marginalised to be part of the conversation and have a voice."

Scientist Ki-Taurangi Bradford from Scion's Te Ao Māori Research Group is the latest to join Greene and her group who are actively recruiting members from countries such as Samoa, Japan, Australia, Indonesia, Vanuatu, Philippines and Fiji. These countries represent a range of cultures, customs, and economic I'm strongly advocating for diverse indigenous populations that would traditionally be marginalised to be part of the conversation and have a voice.

ANGELIQUE GREENE

situations. Their indigenous communities also possess valuable knowledge about sustainable living and resource use, which can inform global bioeconomy strategies.

Bradford says she feels very motivated to contribute to the team. "I believe that the bioeconomy, with its potential to address climate change, promote inclusivity, and empower indigenous communities, aligns with my values and aspirations for a more equitable and sustainable future."

Not a new concept

Before embarking on the youth survey, Greene says a focus for the group will be asking if the terminology being used is correct for particular countries.

"You might go into one country and say 'bioeconomy' and people will laugh and tell you they've been actively living the principles of a bioeconomy for thousands of years. It's not a new concept for indigenous cultures.

"Even a few hundred years ago, people lived off the resources of the land and used every part of things. In places like Samoa, it's still how many people live their lives. This is why it's important to have diverse global voices in the group."

In addition to workshops, Greene and Shiraishi will attend the Global Bioeconomy Summit hosted by the IACGB in late 2024 where they will share their work and experiences from the Asia-Pacific group. These global gatherings foster a sense of community, underlining the importance of collaboration in addressing the world's most pressing challenges.

Greene's work extends beyond her role as a Youth Champion. She is the project leader for the Waikato University-led MBIEfunded Amiomio Aotearoa project at Scion. This project focusses on building a circular economy in New Zealand by exploring sustainable recycling strategies for plastics. A key aspect of Greene's research involves enzymatic plastic degradation, which offers a more sustainable and cleaner method for recycling plastics.

Current mechanical or chemical recycling methods can only be repeated a limited number of times or can require harsh chemicals. Greene's approach uses enzymes as biocatalysts to break down plastics into their monomer components. These monomers can be used for energy production or to create new bioplastics, significantly reducing waste and environmental impact.

"It's work in the biotechnology space that we know will become increasingly important as we aim to move away from being so dependent on fossil fuels to create products," says Greene.

Data key to unlocking forestry investment



A new interactive tool is revolutionising inventory management for the forestry sector.

cion, in collaboration with Indufor Asia Pacific Ltd, has revealed a prototype for a new interactive tool providing the forestry industry with powerful inventory information to make management, harvesting and wood processing decisions easier.

Called Forest Insights, Scion scientists outlined the tool's capabilities and applications at ForestTECH last November, Australasia's premier forestry technology event for forest managers, remote sensing specialists and tree crop managers.

By having a platform that pools data to create robust models we can move a lot quicker. **CLAIRE STEWART**

The interactive tool powered by machine learning and deep learning models provides forest owners, managers and wood processors with an overview of the changing availability and growth of planted radiata pine over time.

The prototype has focussed on modelling of East Coast pine forests, but Scion has plans to provide the same data and for a wider range of trees across New Zealand.

Scion portfolio leader for New Value from Digital Forests and Wood Sector, Grant Evans, says the prototype will support forestry and wood processing companies to make more informed management decisions.

"Long term, it will help anyone with trees planted know their

precise location and ultimately, what they can do with the trees in the future."

Forest Insights is more than just a mapping tool; it's set to become a window into the heart of commercial forests. It has been built using cutting-edge AI technologies as well as the

remote sensing method LiDAR to detect and identify stands of trees to quantify their volume and maturity. It outlines the boundaries for each stand of trees and provides essential details, such as age class, area in production, and the number of stems per hectare.

Forest Insights also tracks the history of planting and harvesting, shedding light on changing inventory levels. This data is the key to unlocking investments and strategic decisions across the timber supply chain.

Automatically detecting commercial radiata pine forests using trained Deep Learning Convolutional Neural Networks by their boundaries is a game changer for forestry companies. What used to be a laborious task of drawing polygons is now replaced with the click of a button.

Additionally, Forest Insights levels the playing field for smaller forest owners, Evans says. "Individuals who own smaller woodlots or stands can use the tool to see where other small lots in their region are maturing at a similar time and potentially co-operate to negotiate better pricing from mills." This democratisation of information ensures that the benefits of Forest Insights extend to all players in the industry.

As a prototype it offers a glimpse into the future, with researchers already planning features that will add value.

Scion is working with the University of Canterbury to identify tree species beyond radiata pine, aligning with the Government's goal of having 20% non-radiata pine forests by 2030. Currently, such measurements rely on people voluntarily reporting their data, making it difficult to track progress. Forest Insights intends to change that by using satellite imagery and LiDAR data from Toitū Te Whenua Land Information New Zealand to detect different tree species accurately and use Indufor's dashboarding expertise.

Harvest tracking

Beyond tree species identification, the prototype goes a step further by automatically tracking forest activities. Collaborating with Indufor Asia Pacific Ltd who enhanced the detection training, each orange segment on the map represents an area where harvesting has occurred. With further training, it's hoped that it will provide a means to assess forest damage following natural disasters.

"For the East Coast, it could also be used to reveal where planted forests are being abandoned or are no longer being harvested due to concerns relating to planting on erosion-prone land," Evans says.

The granularity of the information available offers huge benefits to industry and investors alike, says Dr Pete Watt from Indufor's resource monitoring team. "Such information provides the cornerstone for developing wood availability forecasts that underpin investment decisions and support infrastructure planning and policy settings." The journey of Forest Insights started in 2022 and is a collaborative effort. Scion's data scientists have supplied all the models and data, working with Indufor to create the online tool and dashboard.

Testing with industry users has yielded positive feedback, with at

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DR PETE WATT

least one forestry company expressing interest in using Forest Insights to validate their commercial forestry decisions.

With industry's support, Scion wants to expand its reach across New Zealand and become the foundation for a digital twin of New Zealand's entire forestry estate.

"Imagine having access to information on eucalyptus trees' age, harvest readiness, and potential

markets, including its suitability for pulp and paper, or feedstock for biorefineries, all neatly presented on a map," Evans says.

Claire Stewart, manager for the Forest Grower Research-led *Precision Silviculture Programme*, says inventory management tools are critical to being able to see our national forest scape more holistically and to enable foresters to manage at a finer level of detail.

"There are simple tasks that machine learning models can assist us with like boundary mapping, cut over mapping and post-plant survival assessment," she says. "By having a platform that pools data to create robust models we can move a lot quicker.

"A tool such as this provides insights on a bigger scale that can inform our wood flows, logistics and national carbon accounting. It's an exciting space and it's great to see leadership from Scion and Indufor with this initiative."



Forest Insights is being developed as a tool for industry to track the changing availability and growth of planted radiata pine and other species over time.





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