

# Scion Connections



## PACKAGING A PUNCH

INVESTMENT FOR A  
SUSTAINABLE FUTURE

## KAWENATA SIGNING

PARTNERSHIP WITH  
TANGATA WHENUA

## PRESERVING GENETICS

NURSERY RESPONDS TO  
SOS FROM TIMARU

## TACKLING MYRTLE RUST

NEW TECHNOLOGY OFFERS HOPE





*Thanks to early career researchers like Janet Reid, New Zealand's future research, science and innovation system is in strong hands. Summer internships at Scion help to foster the next generation of talent, providing a platform for university students to grow while advancing research important to Scion and our research partners.*

*Discover how our 2022-23 summer students are contributing to projects that support New Zealand's transition to a circular bioeconomy on page 62.*



Kia ora,

We're excited to share that this bumper edition of Scion Connections will be released at the Scion Symposium on a Transition to a Circular Bioeconomy in Wellington on 22 February. Scion has been working to enhance the prosperity, wellbeing and environment of New Zealand for 75 years. As part of this anniversary we are bringing together innovators, policy thinkers and influencers for an in-person panel discussion and networking opportunity. We'll give you all the insights from this event in the next edition of our magazine in June.

Climate change is impacting all of us and science that supports efforts to mitigate its effects are needed now more than ever. Our scientists care deeply about this issue and are committed to finding solutions to the climate change crisis.

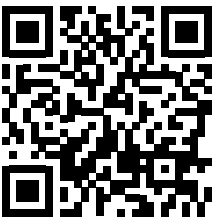
It's a crisis that needs to drive major behaviour changes and new ways of thinking about how we shape New Zealand's future around a circular bioeconomy. We're using this issue to share stories about how scientists across our Rotorua and Christchurch campuses are leading the way with innovative research and technology.

We're also highlighting how partnerships and collaborations are at the heart of how we work. We're delivering science that matters and our stories demonstrate how our research offers hope for a greener economy and a more sustainable future.

Stay connected to Scion by visiting our website. We also welcome engagement with you on our social media channels.

We hope you take some time to enjoy this very special publication.

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COVER:  
Healthy root structure in the baby giant redwood tree.  
(Champagne tree story, page 26).

Time critical on climate change action

Scion's 75th anniversary year continues, and it's clear that the future of forests and forestry are fundamental to New Zealand's future wellbeing and prosperity.

As recently as January 2023, we were reminded about the devastating impact of climate change when floods ravaged Auckland and parts of the North Island. As repeated extreme weather events take their toll on communities, infrastructure and our environment, there are growing calls for greater climate change action. At Scion, we are rising to the challenge and leading the way with research that supports the growth of our forestry sector and the development of new technologies that use trees and other renewable materials to create products that can replace those made from fossil fuels.

Forestry is already recognised as a vital means of tackling climate change. It plays its part in two ways. First, it will help achieve New Zealand's net-zero target by removing CO2 from the atmosphere. That's essential to our climate change response as sequestration of carbon by vegetation is the only viable technology to reduce and offset the carbon that we've already put into the atmosphere. Sustainable plantation forestry also has a role in reducing our gross CO2 emissions by substituting products, fuels and energy made from fossil fuels with renewable wood and fibre-based alternatives.

Forests collectively – both production and long-standing indigenous forests – are a massive renewable resource with the scale needed to provide New Zealand with low-emissions materials and fuels. As a country looking to avoid further catastrophic outcomes, we must invest in research and innovation that unleashes the power of forestry for its ability to mitigate the effects of climate change and chart a course for a low-carbon, circular bioeconomy future.

The challenge for our sector is addressing how to accelerate this work. Scion strongly supports the vision set out in the government's Forestry and Wood Processing Industry Transformation Plan (ITP) launched by the Minister of Forestry Stuart Nash last year at Fieldays. The ITP's five goals feature actions to transform the forestry and wood processing sector in New Zealand. It's a plan that reinforces the relevance of Scion's Strategy to 2030: *Right tree, right place, right purpose*, and the leadership role that we have in research that will drive development of new manufacturing sectors and low-carbon products. The ITP has underlined the opportunities for industry, iwi and New Zealand when we all work together to maximise the potential of fibre and trees.

That vision and mission-focused approach is also central to the Te Ara Paerangi – Future Pathways process that the Minister for Science, Research and Innovation, Dr Ayesha Verrall, set out in a white paper launched last November.

We're excited by the vision and policy directions outlined in the paper as they illuminate a pathway to build a research, science and innovation (RSI) system that supports wellbeing for all New Zealanders. We're looking forward to working with MBIE to bring that vision to reality.



Scion is kickstarting 2023 with an event in Wellington to bring people together to stimulate conversation about the circular bioeconomy and its critical importance for New Zealand. We care deeply about ensuring that the 'take, make, waste' linear economic model is replaced by one where the word 'waste' is redundant. Our Strategy to 2030 is leading New Zealand in this transition towards a model where waste from one process becomes feedstock for another. The concept aims to design out waste, keep materials in use for longer, and regenerate ecosystems.

As well as helping New Zealand and the world meet its climate change targets, a forest-based circular bioeconomy is a \$30 billion economic opportunity that will provide a mosaic of activity for regional New Zealand to thrive, through emerging bio-based manufacturing, and the creation of new high-value products from what we currently consider waste.

Integral to our success are partnerships with industry, the wider research sector, government and iwi. In this issue of Scion Connections, we're showcasing the breadth of Scion's research capabilities in packaging and we highlight how our science activity in forest health, biosecurity, genetics and bioenergy is having a positive impact. You can also read about the growing relationship that Scion has with tangata whenua at the site of our Rotorua campus, through the signing of a Kawenata between Scion and Ngāti Hurungaterangi, Ngāti Taeotu and Ngāti Te Kahu (Ngā Hapū e Toru).

Our mission is to enhance New Zealand's prosperity, wellbeing and environment through trees. We have great confidence that our excellent science and research, supported and empowered by a coordinated RSI system, will lead the transition to a circular bioeconomy and put New Zealand firmly on track to a sustainable, productive and inclusive low-carbon future.

DR. JULIAN ELDER.  
CEO, SCION.



# Endeavour funding success

Two innovative Scion research projects will receive investment funding totalling \$1.9 million over three years through the Ministry of Business, Innovation and Employment's 2022 Endeavour Fund.

Scion scientists will also contribute their expertise to a further six projects involving other research organisations that secured Government support from the Endeavour Fund – New Zealand's largest contestable research fund.

Endeavour funding was announced in September 2022 for the two successful Scion projects and will come from its Smart Ideas investment mechanism. Smart Ideas is intended to catalyse and rapidly test promising, innovative research ideas with high potential for benefit to New Zealand.

One pioneering Scion project, in partnership with the University of Cambridge, *Implanted sensors monitoring tree health and carbon capture efficiency*, will receive \$1 million over three years to design sensors to measure the nutritional status, vitality, carbon capture efficiency and microbiome fitness of growing trees.

Precision forestry uses remote-sensing tools such as satellites and drones, combined with sophisticated sensors, to detect subtle variations in plant health, nutrient and water status.

Monitoring the physiological processes inside trees in real time is the only way to fully understand how trees are responding to the environment around them and to future-proof their resilience to climate change.

*Small sensors are being inserted into pine trees only one or two years old. The first stage of the research project is measuring the tree's wound response.*

To implement this in practice, Scion will develop sophisticated low-cost bioelectronic sensors which can be implanted inside trees. These types of sensors have been used in biomedical research – but rarely used inside trees for forestry. Their use in New Zealand radiata pine will be pioneering.

Data generated by these sensors will be transmitted from the trees via a wireless network in the forest.

Fusing data from remote sensing together with physiological sensors within trees, combined with genome and climate data, can provide the most complete insights into a growing forest anywhere in the world.

Successful too, was the Scion proposal *Plant-inspired 3D-printed scaffold for tissue culture*. Awarded \$900,000 over three years, Scion scientists will explore new technology that aims to improve the tissue culture technique that makes clonal forestry possible in conifers.

Commercial forestry relies on producing vast numbers of trees – often elite clones. Somatic embryogenesis is the tissue culture technique that is used to create embryos for this purpose, but it has some limitations.

Somatic embryos can have trouble maturing on a flat surface – effectively when they are sitting on a dish on a laboratory bench. In nature, these embryos would mature in a complex three-dimensional structure as they interact with other cells and respond to different gradients and signals of temperature, mechanical force, nutrients and plant hormones.

Replicating this environment is extremely challenging in the laboratory, yet it is the key to successful tissue culture.

This project will adopt sophisticated 3D printing techniques using hydrogels to create a scaffold with gradients of hormones, nutrients and porosity along its length. To visualise this scaffold, imagine a large cardboard tube with round holes in the sides and complex gradients of hormones and nutrients along its length.

While the immediate application is in the forestry industry, the same technique can be applied to other plant species, mammals and create new biomedical opportunities. Scion's project team will collaborate with Massey University and Terasaki Institute in the US.

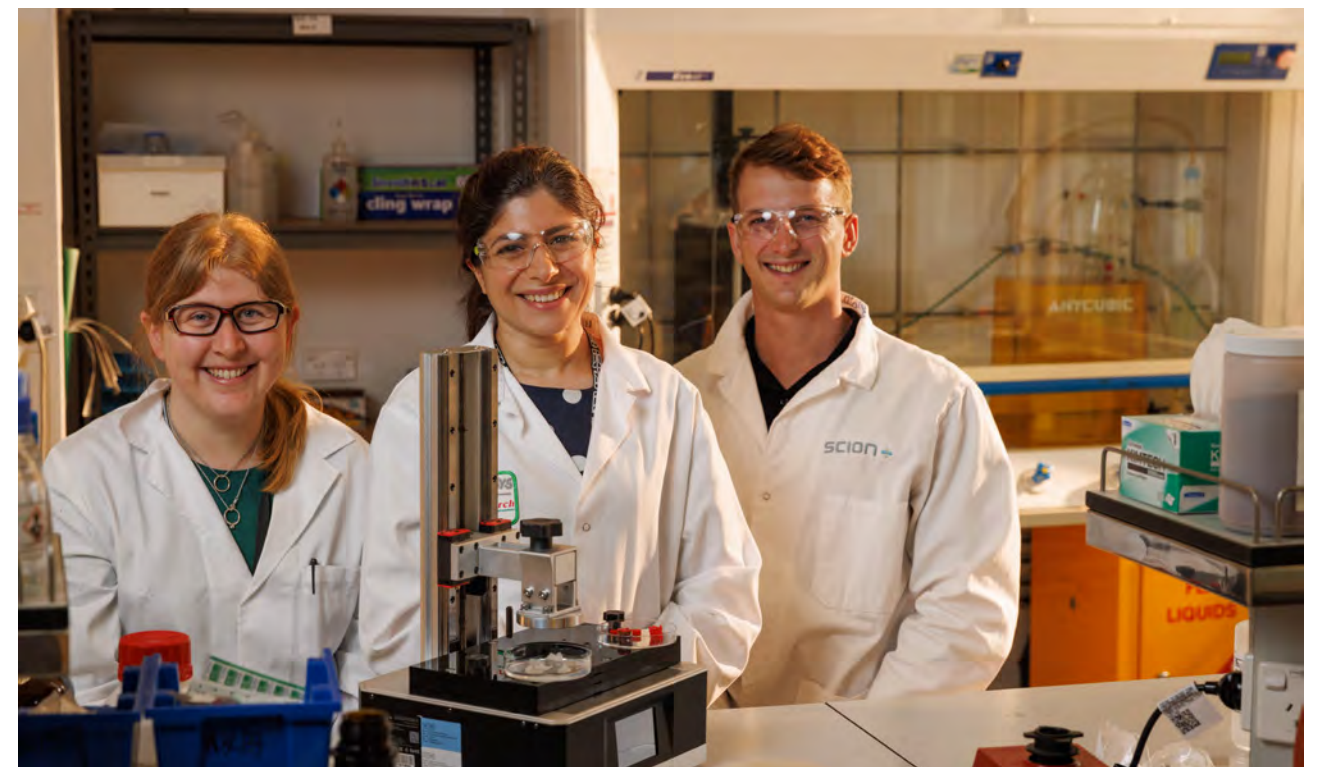
Science leaders at Scion will also contribute to six collaborative projects that received a total of \$5,754,700 from the Endeavour Fund. They involve joint research with the University of Auckland, WSP Research NZ, Manaaki Whenua – Landcare Research, Lincoln University, Auckland University of Technology and Massey University.

Scion chief executive Dr Julian Elder says the Endeavour funding acknowledges the value of forests and their contribution to a more prosperous economy and healthier environment.

"Forests will be at the heart of a low-carbon future New Zealand. At Scion, we're proud to lead research that will unleash the power of forestry, tackle climate change and help transition New Zealand to a circular bioeconomy.

"We look forward to supporting our teams as this important research gets underway."

The Endeavour Fund supports excellent research with the potential to positively transform New Zealand's economy, environment and society. This year a total of \$236.5 million has been allocated to 71 projects.



CLOCKWISE FROM ABOVE:

- A Scion research team is exploring new technology to improve the tissue culture technique that makes clonal forestry possible in conifers. Pictured (from left) is cell biologist Tarryn Saggese, principal investigator Roya Rezanavaz and design engineer Karl Molving.
- Multi-material 3D-printed prototypes, the first step in a three-year Endeavour funding project.
- Scientist Yi Chen is taking a lead role at Scion in a project partnering with the University of Cambridge that explores the benefits of inserting bioelectronic sensors in trees to generate information about tree health and carbon capture.





# Rotorua to host international remote sensing forestry conference

Remote sensing specialists will descend on Whakarewarewa Forest and Rotorua in 2024.

Rotorua and Whakarewarewa Forest will be the backdrop to a global forestry conference that is set to attract up to 500 remote sensing specialists to the city from 9–13 September 2024.

Scion has successfully secured a bid to host ForestSAT 2024, the most prestigious international conference on the application of remote sensing technologies for forest monitoring and modelling.

Previous conferences have been held in Germany, USA, Chile, Italy, Spain, France, Sweden and Scotland. For the first time the conference will be in Australasia over five days in September 2024.

Scion’s general manager for Forests to Timber Products, Henri Bailleres, says the event will be an incredible opportunity to showcase New Zealand and Scion.

“Scion has a strong remote sensing group with international outreach and a wide industry network within the New Zealand forestry sector,” he says.

“The hosting of ForestSAT in Rotorua by Scion highlights the excellence, standing and reputation of our science with our global peers, as well as showcasing Rotorua as a premier tourist destination.”

Scion principal scientist Dr Michael Watt, who leads many remote sensing areas including modelling of forest carbon capture and use of hyperspectral imagery, presented at ForestSAT 2022 in Berlin.

He was impressed with the overall quality of presentations at the event and thought that New Zealand had a reasonable chance of hosting the next conference. Working closely with Tourism New Zealand, the Scion team, led by Watt and Bailleres, submitted an application that was unanimously approved by the ForestSAT board of directors.

“What New Zealand and Scion does is unique globally,” says Watt.

“Our group’s research is competing on the global scene and is attracting interest from many overseas forestry companies and research organisations.”

Global heavyweights in remote sensing for forestry are expressing their excitement about the opportunity to visit New Zealand in September 2024.

Founder of ForestSAT and former conference chair, Dr Juan Suarez, says Rotorua is one of the most important innovation hubs in forestry science worldwide.

“Hosting the conference will enable Rotorua to cement its global reputation in this area, connect academia with a forestry industry actively embracing new tools and technologies and attract new practitioners that can lead the transition to 21st century forestry.”

Canada’s research chair in remote sensing, Dr Nicholas Coops, from the University of British Columbia, says he’s looking forward to attending ForestSAT for its stimulating talks and impressive field tours, with the added benefit of enjoying New Zealand’s scenery.

“The conference has a strong history of bringing together leading practitioners and academics working in this field from across the world. After a very successful meeting in Germany, it is fantastic to know that this event will be held in New Zealand who are leaders in the application of spatial analysis technologies to forest management.”

Whakarewarewa Forest and its diverse range of exotic tree species and native undergrowth is renowned for mountain biking and walking. Uniquely, it also forms part of the largest production forest in New Zealand, which is monitored using state-of-the-art remote sensing methods.

Puruki Forest is also likely to capture the attention of conference participants. About half an hour out of Rotorua, Puruki is a nationally significant experimental forest. Data and models from Puruki underpin almost every management decision New Zealand’s forestry companies make today. As planning for the next rotation begins, there is an opportunity to design new sets of trials and create an internationally important forestry science resource.

“Allowing international delegates the chance to visit this forest could provide opportunities for co-design of the next forest,” says Bailleres.

“There is the potential for Puruki to be linked in with other international experimental forests and for a digital forest of the estate to be generated so lessons and the future forest can be shared beyond New Zealand.”



Principal Scientist Dr Michael Watt co-led a bid for New Zealand to host ForestSAT 2024.

## Planning underway

Work to organise the conference, planned for 9-13 September 2024, is now underway. The conference committee includes Scion’s portfolio leader, Claire Stewart, and key members of Scion’s Data and Geospatial Intelligence group. Collectively, they will provide attendees with several technical sessions and field trips that explore world-class recreational and productive forests.

For more information, please contact michael.watt@scionresearch.com.



# Reducing global emissions:

## Magnifying New Zealand's impact

A change in market attitudes and needs, leveraging strong local and international relationships, and a new way of thinking have enabled clean-tech start-up Cetogenix to bring world-leading science out of the laboratory and into actuality.

**C**etogenix is addressing the most significant challenges presented by disposal of the world's 1.5 billion tonne per year organic waste streams: value recovery, environmental impacts, and processing cost. This is being achieved by focusing on modular, retrofittable systems for conversion of organic biomass feedstocks to energy, nutrients, and bio-based products, that ensure 'no waste is left behind'.

### From foundational science to a new market

Cetogenix builds off a significant R&D foundation generated as part of an ongoing waste-to-value programme created by the company's executive leadership team while they were all based at Scion. This work demonstrated the benefits of the core concept – conversion of organic wastes into bioeconomy feedstocks, which was translated into a valuable intellectual property portfolio.

The company's lead investor, Pacific Channel, obtained exclusive global rights to this Scion IP in 2019. In 2021, Pacific Channel approached the original development team to step back in and realise the potential of the IP within changing market channels.

Over the past year, Cetogenix's leadership team has pivoted the core platform to specifically target its application to renewable natural gas production, modularity and as a complementary and retrofittable system to the established and high-growth anaerobic digestion market.

While anaerobic digestion is relatively new in New Zealand, internationally it is a \$26 billion per year capital investment industry, which produces the majority of the world's biomethane – a sustainable replacement for fossil-derived natural gas.



*Power in partnership: The Cetogenix team (back row) Dr Trevor Stuthridge, Dr Daniel Gapes, Marcel van Leeuwen, Rahul Dhiman. (front row) Dr Ursula Hosking, Rob Lei, Alex Stuthridge, Ciara Griffiths, Dr Donya Novin and Dr Okey Nwadigo.*

One limitation of anaerobic digestion is that a high proportion of the original waste material does not break down into biogas – meaning lower production efficiencies, higher operating costs, and potential environmental impacts through disposal of the leftover material.

Cetogenix specifically uses this leftover material – digestate – as its feedstock, increasing gas production of the plant by 40%, eliminating the need for digestate disposal, ensuring recovery of nutrients, and destroying any contaminants.

It is a disruptive value proposition that has successfully attracted \$4.5 million in seed capital investment over the past year and may generate up to \$120 million each year in revenue for Cetogenix when fully commercialised.

### Partnership in practicality

Scion and Cetogenix have signed a Memorandum of Understanding (MOU) to bring about significant impact benefits. As an example of the MOU's value, Scion was recently successful in securing a significant grant from the BioResource Processing Alliance to help scale up the Cetogenix technology.

Cetogenix is also headquartered at Scion's Te Papa Tipu Innovation Park, where it now has 12 staff, a dedicated laboratory, and a pilot-scale prototyping system. This co-location reflects the company's belief that strong science-commercial partnerships will accelerate innovation and deployment.

Scion's general manager of Forests to Biobased products, Florian Graichen, says science is the foundation for change, but it is not enough in isolation.

"Our purpose as a Crown Research Institute (CRI) is to partner with companies to achieve the impact we want to see for New Zealand through science. It's imperative we have commercial partners to be able to take our science and technology out into the market.



“This is about opportunities that go beyond Scion. Part of our mandate is also to incubate new opportunities that then create assets for high-value jobs and regional growth, particularly around cleantech and a circular bio-based economy.”

Cetogenix managing director Dr Trevor Stuthridge says Cetogenix is a real partnership success story in terms of a CRI/industry dynamic and highlights a paradigm shift in the way workable innovation can be brought to market.

“It’s always been a challenge bringing new technologies out of the laboratory, as science has traditionally worked in isolation of the end-user. Our team has been lucky to be highly engaged with both industry and Scion throughout the development of this technology.

“It’s taken some time for the market to catch up to our value proposition, for the people involved to have the confidence and experience to take things forward, and for the investment community to be comfortable investing in the cleantech space in New Zealand.

“It has been a convergence of journeys to get to this point and we are privileged to have a strategic partnership with Scion that will hopefully also be an exemplar for others.”

## The power of pivoting

Stuthridge says 10-plus years ago, when the technology’s principles were first developed, it was in response to lowering the costs and impacts associated with bio-based waste ending up in landfill. Now, the waste management industry has pivoted towards adding value to that waste material and creating energy security, particularly around renewable natural gas production, as decarbonisation policies and energy security challenges increase worldwide.

“In setting up Cetogenix, we saw the connection between the old technology’s strengths and potential, a fundamental change in market thinking, and we knew the time was right to bring this technology back to the table.

“It was a convergence of a number of things: our personal career experience, growing consumer demands, improved investor understanding in this type of technology, and the global regulatory imperatives to meet macro-trends on climate change, circularity and reduction in our dependence on fossil-derived products.

“We had very clear principles from the start around what sort of technology we wanted to create, such as adding value to the entire waste stream, avoiding environmental harm, and integration of multi-disciplinary science/engineering concepts – and because of that, I think we and Scion have always been ahead of the game.

“As a start-up with a global market, we can be one of those pathways for developing new ideas, concepts, and IP, and take them somewhere. We can also help equip current and future scientists with real-world experience in the challenges of science/technology translation to the market.”

DR. TREVOR STUTHRIDGE, CETOGENIX

“It took some time for the end-user and investment market to catch up, but now is the right time.

“We have deliberately designed a technology that is complementary. We are not in competition with current bioprocessing plants, which means our target market already includes more than 15,000 potential clients across Europe and North America alone.”

## The potential for wider impact

Creating local, regional impact is a driving factor for both Scion and Cetogenix.

Developing New Zealand’s bioeconomy is one way in which to do that, according to Scion’s portfolio lead for Distributed and Circular Manufacturing, Marc Gaugler.

“One of the critical challenges for New Zealand that could be aided by a bioeconomy is the need to create higher value, future-proofed jobs in our regions.

“If you couple that with the fact that the resources needed in a bioeconomy are geographically spread out and seasonally diverse, there’s a great opportunity to do things differently and process material where it’s available, rather than transporting everything into one centralised hub.

“Not only does that help to create regional jobs, but it also helps keep the regional identity behind the material, depending on the application. Having start-up companies like Cetogenix in the regions also helps demonstrate how we can get innovation developed in-house at Scion out and what that innovation looks like.”

Globally, there has been a big market shift in recent years towards ‘process local, use local’.

Stuthridge says New Zealand’s impact on climate change is small-scale, producing less than 1% of greenhouse gas emissions, but international deployment of our home-grown innovation is where we can pack a powerful punch and where we have the potential to see a huge global impact for change.

“Our New Zealand technology is our greatest contribution to environmental issues on the world stage and, as a country, we need to be thinking globally in the first instance when it comes to developing our technologies.

“International demand for local production and investment in climate-positive energy sustainability is expected to increase ten-fold over the next 10 years. It takes courage to think globally and New Zealand may be small, but our contribution counts.”

## Future proofing the innovation ecosystem

Stuthridge says partnerships between start-up companies like Cetogenix and organisations, such as Scion and New Zealand universities, are a hugely valuable vehicle for the development of future technologies.

“Working closely with CRIs and universities allows us to explore some of the riskier tech concepts that industry may not necessarily have the budget, time or capacity for. Let’s use that intellectual firepower through the likes of scholarships, secondments, and internships, to push the boundaries because that’s where the real gold is found.

“As a start-up with a global market, we can be one of those pathways for developing new ideas, concepts, and IP, and take them somewhere. We can also help equip current and future scientists with real-world experience in the challenges of science/technology translation to the market.

“Taking science out of the lab is surely the ultimate goal. The relationship between Scion and Cetogenix provides an incredibly valuable working example of how that can happen in reality.”



Cetogenix is working to reduce global emissions through advanced waste-to-renewables technologies.



# Kawenata honours spirit of partnership

The growing partnership between tangata whenua and Scion was formalised by the signing of a Kawenata / Memorandum of Understanding in a special ceremony last year.



Scion board chair Dr Helen Anderson (left) and Veronica Butterworth (right), representing the three hapū - Ngāti Hurungaterangi, Ngāti Taeotu and Ngāti Te Kahu with the Kawenata that was signed in a formal ceremony surrounded by the hapū, Scion board, staff and guests.

**T**he Memorandum of Understanding signing in August 2022 between Ngāti Hurungaterangi, Ngāti Taeotu and Ngāti Te Kahu (Ngā Hapū e Toru) and Scion was a significant event for all parties who were pleased to see a journey that started decades earlier come to fruition.

It was appropriate that the signing of the Kawenata in both te reo Māori and English occurred at Te Whare Nui o Tuteata – the Great House of Tuteata. In October 2020, Ngā Hapū e Toru had gifted the name of their ancestor, Tuteata, to Scion for its headquarters in Rotorua to signify the importance of the partnership that they were building together.

The Kawenata and gifting of the name Tuteata are two of the many positive outcomes to emerge from conversations that started many years ago involving Ngā Hapū e Toru, including the late Ben Hona and George Mutu. Kōrero focused on a collective vision to restore their physical connection to the whenua around Whakarewarewa Forest.

Ngā Hapū e Toru trustee Veronica Butterworth explains that when the land was used by the Crown as a forest nursery from 1898 and then for forestry research from 1947 onwards, physical connection of the hapū to this land was severed. The spiritual connection, however, remained.

Historically, it had been a site where whānau lived and cultivated the land for kai, such as kūmara and aruhe (fern root). Birds, fish and other food sources were abundant.

“Land is the basis of identity and wellbeing for our people,” Butterworth says.

“We are genealogically connected through our whakapapa to the land itself, which ties us to various parts of the natural environment. These are fundamental aspects of our culture and our lives. Whakapapa and whanaungatanga give rise to obligations to look after the land, the waters and the environment on behalf of our ancestors and ourselves for future generations.”

Butterworth adds the signing for Ngā Hapū e Toru was a significant step forward in the partnership with Scion, which in turn was a step towards strengthening the mana of the land and hapū.

“This land is part of our rohe, our tūrangawaewae, and is the basis of identity and wellbeing for our people.”

## Moving forward

Working together, the hapū and Scion will honour five matapono (principles) of the Kawenata: whakapapa, kotahitanga, rangatiratanga, manaakitanga and tiakina te mana o te whenua.

Scion chair Dr Helen Anderson says the signing marked a significant milestone for the Crown Research Institute and its enduring relationship with tangata whenua.

“We have signalled how Scion and tangata whenua recognise the value of working together in the spirit of cooperation and partnership. We have common principles and an unwavering commitment to protect the waterways, forests and whenua.

“As Scion takes bold new steps with research to support New Zealand’s transition to a circular bioeconomy to help meet our climate change objectives, we have committed to a set of principles that will underpin our close relationship with tangata whenua and help us navigate the challenges and opportunities ahead.”

For Tamara Mutu (Ngāti Hurungaterangi, Ngāti Te Kahu) Hunga Whakahaere Matua – Operations Manager, the Kawenata represents a major step forward in efforts to align the kawa (protocol) and tikanga (customs) of the hapū within Scion and normalise hapū values.

Her role at Scion was created in 2021 to build relationships with Ngā Hapū e Toru. The role was established by Scion, Te Uru Rākau, New Zealand Forest Service, and Timberlands – key tenants on the 114ha site, known as Te Papa Tipu campus, where Ngā Hapū e Toru are tangata whenua.

In her role, Mutu is focused on strengthening partnerships between the three hapū, Scion and other tenants, looking for mutually beneficial opportunities.



Strengthening connections

The Kawenata signing was followed by the launch of a new permanent visitor display in the building's atrium. This shares the Kawenata and connection that Ngā Hapū e Toru have to the whenua, while also explaining the significance of forestry science and innovation to New Zealand and the world. Co-funded by Scion and Te Uru Rākau, New Zealand Forest Service, the displays are a creative bilingual storytelling experience that explore the history of tangata whenua, forestry and the future.

One display describes Ngāti Hurungaterangi, Ngāti Taeotu and Ngāti Te Kahu. It explains the deep connection to the whenua, with historical pā, kāinga (settlements), cultivations and wāhi tapu (sacred sites), as well as looking to hapū aspirations – including partnership and tino rangatiratanga. The other display documents the history of New Zealand's forestry industry, starting in the late 19th century when the first exotic trees were planted in a nursery at the Whakarewarewa Forest. The storytelling explains the value of radiata pine, along with the importance of forests to New Zealand for timber production, biodiversity, biomaterials, tourism and to tackle climate change problems the world faces.

“This land is part of our rohe, our tūrangawaewae, and is the basis of identity and wellbeing for our people.”

VERONICA BUTTERWORTH, NGĀ HAPŪ E TORU



A permanent visitor display in the building's atrium shares the history and connection that Ngā Hapū e Toru have to the whenua, while also explaining the significance of forestry science and innovation to New Zealand and the world.

The Kawenata and its principles can be viewed on our Scion website.

Read the Te Reo Māori version here



Read the English version here



# Where's my drone?

Ground-breaking research aims to advance technology in forestry



Operating a UAV in a forestry environment can be challenging. Pilots use various methods to maintain visual contact, such as being raised above the canopy on a platform.

**F**orest environments are notoriously difficult for drone (unmanned aerial vehicle – UAV) operations. Aside from the trees themselves, hilly terrain and remote areas provide challenges for drone operators. Add in the complexity of technical and regulatory considerations in a forest environment, operation of UAVs when visual contact is not maintained is considerably more difficult.

A recently published review article showed how these challenges can be overcome using beyond visual line of sight (BVLOS) UAV operations.

There are many applications of unmanned aircraft within planted and indigenous forests. These include wildfire monitoring and suppression, inventory and health assessments of forestry plantations, wildlife research, spraying of herbicides to kill invasive plant species, and dropping poisons and traps for pest control.

UAV operations internationally are governed by aviation rules that restrict their range to areas in which the pilot can maintain visual line of sight with the craft to manage potential risks.

The article was authored by Robin Hartley (Scion), Isaac Henderson (Massey University School of Aviation), and Chris Jackson (Jackson UAS Limited). Each author provided their unique contributions of expertise related to forestry, aviation safety, and unmanned aircraft operations.

Lead author Hartley has been researching the area of BVLOS in forest environments for years. Most striking was the absence of solid information that can be found in one place for practitioners or researchers to access, he says.

“Collaborating with Isaac and Chris has been great as between us we have been able to pool our collective resources into an article that will be a very useful starting point for others who are wishing to follow in our footsteps.”

The article emphasises how BVLOS UAV operations help overcome the challenges of operating in the forest environment.

Having flown UAVs in a variety of forest environments for more than six years, Hartley has an incredibly good understanding of the frustrations that can come with trying to maintain visual line of sight.

“It is standard practice to do a desk-based assessment of an area, or even a field trip prior to accepting the work to see whether it will even be possible to capture data there with a UAV.

“We have experimented with various methods for maintaining visual contact by raising the pilot up into or above the canopy, however, this is not always possible and so BVLOS has always appealed as an effective way to apply UAVs to almost any site.”

The article also outlines the international regulatory environment related to BVLOS UAV operations and some of the technological and operational factors that must be considered when taking a risk-based approach for conducting such an operation.

Massey University's Henderson says most literature related to BVLOS UAV operations is focused only on technological solutions that may help to safely conduct such operations.

“This article also helps advance the importance of understanding airspace requirements, risk assessment, and human factors related to fatigue, multi-crew operations, training and competency requirements, among others. In this sense, this article appears to be the first to make a holistic appraisal of BVLOS operations.”

The full article is freely available here







# Packaging a punch

New Zealand packs a punch well above its weight in the packaging science space, with Scion hosting a unique and world-class set of capabilities and infrastructure for commercial testing, research and development.

It's not a small coincidence that one of the world's most advanced packaging research and testing facilities exists in New Zealand. With a \$63 billion contribution to GDP in 2021, we are an exporting nation. Dairy, meat and fruit are among our largest export earners. Each of these food items exported needs to comply with a myriad of global food safety, sustainability and environmental standards.

With growing global demand and requirements for recyclable, reusable and compostable packaging, the eradication of single-use plastics and significant challenges around food waste, supply chain logistics and differing market compliance around recyclability, being part of the wider conversation has never been more important for us as an export nation.

Testing box performance inside the WHITE Room.



“Individually, these facilities are considered unique in the world, being among merely a handful of similar systems, but having all three on one independent site is, currently, the only one of its kind globally.”

FLORIAN GRAICHEN, SCION



The Kiefel moulded fibre thermoformer allows Scion to support industry to make the transition into alternative packaging by researching different materials and fibre blends.

### Scion invests \$1 million in research and testing facilities

Scion is a global leader of fibre-based and plastic-based packaging research. As the packaging landscape rapidly changes, Scion has recently invested over \$1 million in research and testing facilities, in order to ensure global packaging commitments can be met for New Zealand products.

Recently completed upgrades include doubling capacity for commercial testing of box performance in chilled supply chain conditions, called the WHITE Room (an acronym for weight, humidity, intervals (time), temperature experiments); doubling the capability of testing facilities for industrial disintegration to determine the compostability of packaging and products; and the purchase of a pilot-scale moulded fibre thermoformer machine to assist in the development of fibre-based packaging solutions.

Individually, these facilities are considered unique in the world, being among merely a handful of similar systems, but having all three on one independent site is, currently, the only one of its kind globally.

Of course, there is more to packaging than the above; digital packaging for traceability, food contact compliance and the development of bioplastics are also key research areas for Scion and assist in shaping the wider story of packaging in New Zealand.

Scion's general manager of Forests to Biobased products Florian Graichen says for New Zealand, packaging is mission-critical.

“For an export nation like us, packaging is absolutely vital. And it's much more than just the material itself; what packaging enables is also significant.

“All our export markets are moving to reusable, recyclable or compostable packaging so it's become much more than merely protecting the goods. Without sustainable packaging, you have severe risk to market access for all our brands and producers; hundreds of billions of dollars is underpinned by that.”

New Zealand also has its own aspirations around emissions mitigation, zero waste and creating a circular climate – none of that can be achieved without addressing packaging.

### The wider context – packaging and food waste

In our ever-maturing awareness of how modern society impacts the environment, single-use plastics is controversial.

But there's much more to the story: food waste.

According to the UN, as much as 30% of food produced world-wide is wasted. If global food waste was a country, it would be the third-largest emitter of greenhouse gas on earth. Big problem. Bigger than even plastic waste.

The conundrum facing many working in this space is that packaging plays a vital role in helping to reduce food waste and making sure products are in a fit-to-eat state by the time they reach the fridge.

Different markets also have different regulations around what constitutes sustainable food packaging, as well as different end-of-life infrastructure, meaning there is currently no one-size-fits-all solution.

So how do you create packaging that in and of itself is not an issue, while maintaining it's still fit-for-purpose? If merely reducing packaging contributes to food waste, how can these two issues be similarly addressed?

This is the multi-billion-dollar question.

Work is already underway in many areas of the food production cycle here and overseas.

The Office of the Prime Minister's Chief Science Advisor recently released a working report on combatting food waste, detailing what New Zealand is currently doing and what work is still needed.

The report, titled *Food waste: A global and local problem*, published in July 2022, highlights how the entire circular system needs to be taken into account – packaging design and manufacture, as well as end-of-life systems and end-market infrastructure.

Combatting food waste here and world-wide will require collaboration from many different stakeholders, including research, government and industry.



“Our upgraded facilities mean we can take into account the bigger circular bioeconomy picture. We’re able to consider the full life cycle analysis of current and emerging new materials – feedstock, water, energy, transport – plus performance and what happens at end-of-life.”

KATE PARKER, SCION

## Scion’s role in the global conversation

So how does Scion fit into the global conversation?

Graichen says Scion brings together a unique number of elements to the packaging party.

“Where Scion packs a collaborative punch is with our decades-long experience in packaging research, science and innovations, our world-class facilities, and wide-reaching existing relationships both here and overseas.

“That means we can do true packaging research that is closely aligned with industry, which is absolutely unique.

“We are able to do the actual science behind packaging – including materials and performance – and then link it back into industry through the hundreds of small to large companies we work with. That capability doesn’t exist anywhere else.”

He says Scion’s knowledge has come full circle in terms of its historical work in the pulp and paper space.

“The need for fibre-based packaging is increasing rapidly. We can use the work done in the past and re-package it to make it relevant for the future, particularly as we already have the recycling options for paper-based products.

“The two opposing factors of single-use plastics and food waste will require significant ingenuity to combat – at policy level, science level and company level. Scion has those relationships already on which to draw from.”

Scion packaging research leader Kate Parker says increasing capacity for commercial testing and in-house research and development is critical for supporting New Zealand’s primary industries.

“There is a huge global push to make packaging recyclable, reusable or compostable, with many countries introducing legislation and targets around what they are and are not willing to import.”

Scion’s capability also enables New Zealand to be part of the conversation around creating international standards.

“Part of upgrading our facilities enables us to create good tests for fibre recyclability, because there are currently no universally accepted standards; they’re all focused on plastics. Currently, countries have their own set of standards, which means every market is different.

“New Zealand needs the capability to be able to test to those standards here, as well as support our primary industries to be able to meet market requirements and recycle more fibre onshore,” says Parker.

For New Zealand, our largest export markets are Europe, China, the US and Australia – all of which currently have different regulations around packaging and recyclability.

Parker says part of the work Scion does is not only about giving New Zealand industry options, but also helping them understand differing compliance.

## Fibre-based R&D

Scion’s recent investment in facilities has allowed it to research new bio resources for packaging and waste.

“As we look at working with new bio resources to create packaging, it’s also a way of engaging with producers of agri-fibre waste across New Zealand and supporting more recycling of fibre,” Parker says.

“We still have big waste streams in New Zealand because we don’t have the products to turn it into. Using what’s considered waste residue and turning it into new material resources that can be used is a big part of what we do.

“With the global push for more fibre packaging, many companies are looking at what options are available. Our role is to support New Zealand industry to move into that new space.

“Our upgraded facilities also mean we can take into account the bigger circular bioeconomy picture. We’re able to consider the full life cycle analysis of current and emerging new materials – feedstock, water, energy, transport – plus performance and what happens at end-of-life.”



Industry engagement: Dr Kelly Wade explains to visitors attending Scion’s packaging conference how the thermoformer functions.



## Forming a new path – the new Thermoformer

Scion's Kiefel moulded fibre thermoformer arrived in June 2022. Paper and cardboard – dissolved in a water bath – create the raw material, known as pulp. Through application of pressure most of the water is removed and the wet basic form is created.

In the next step, the remaining moisture is removed and the basic form is dried by applying high pressure and temperature. The combination of the applied heat and pressure results in a very robust material for packaging.

The pilot scale industrial machine enables different pulps to be trialled rapidly for packaging with relatively small volumes of material needed, 1-2kg of dry pulp being sufficient.

Scion has trialled different pulps in the thermoformer, with the ability to collect data such as how much energy and water is used to create trays from each different pulp, as well as the percentages of recycled fibres that can be used in pulp before structure and performance is affected.

In the short term, the goal is to support industry to make the transition into new alternative packaging.

Long term, Scion sees its role in this space as researching different materials and fibre blends for those alternative packaging products, improving performance through lightweighting and mould design, as well as being able to offer an alternative use for recycled fibre waste in New Zealand.

Non-standard fibre streams, for example, which would not be available in sufficient volumes for papermaking, such as hemp hurd or agricultural residues, could be a valuable resource in this context.

## Box it up baby

Validating new technology and materials is a crucial part of R&D and that's enabled by the WHITE Room, which simulates supply chain conditions such as temperature, humidity and weight.

Imagine apples, kiwifruit or dairy products being exported to northern hemisphere markets. These food items are packed in boxes for weeks, need to cross the equator and withstand being crushed by boxes stacked on top of them.

Scientist Dr Kelly Wade says the WHITE Room gives the packaging team the ability to create a model, then make packaging based on that model and test it in real-world conditions to understand performance.

“Traditionally, boxes are specified based on their short-term crush strength and safety factors to ensure they don't fail, which can lead to over or under-specification.

“Now, with supply chains so stretched the world over,

it's become more important to minimise weight, size and transport costs, while still maintaining performance. Better understanding of long-term box performance offers the potential to optimise box specifications.”

Wade says ultimately, the goal would be to re-design the cardboard box with the knowledge gained and continue to test within industry to make sure it's viable.

“Box performance is no simple thing. Paper composition and how it is converted into board, how the box is cut, glued and taped, printing technique and handle placement can all affect performance of the box itself. Other factors such as filling of the box, stacking arrangement and environmental factors like temperature and humidity can further influence the response of the box.

“The WHITE Room is also used for commercial trials by companies wanting to further optimise their own systems and packaging. Despite capacity doubling with the recent upgrade, it is still booked up with clients for months in advance.”



Pilot plant engineer Garth Weinberg inside the WHITE Room.

“And they're all on the table as things we can test using the WHITE Room. Ultimately over time, all boxes eventually fail. We want to understand the science behind that.”

The WHITE Room is also used for commercial trials by companies wanting to further optimise their own systems and packaging. Despite capacity doubling with the recent upgrade, it is still booked up with clients for months in advance.

## Compost your cappuccino

As new packaging and materials are developed, it is essential they live up to their compostability claims. Do they in fact disintegrate? And what happens to the compost once materials have broken down?

Scion's newly upgraded biodegradation facility allows compostable and fibre-based packaging to be tried, tested and certified, as well as provide knowledge and information about the wider impact of biodegradable packaging on the environment.

“In terms of compostability, we aim to support the transition of materials to being compostable,” says Parker.

“It's becoming more important that packaging materials are actually certified compostable and it's important for New Zealand industry to be able to have access to that type of testing facility. The closest other facility of its kind is in Thailand.

“We work with the Ministry for the Environment, for example, to support them in moving New Zealand towards a new circular bioeconomy, and the phase out of single-use plastics.”

Parker says as well as industrial disintegration tests, which take around three months, the facility enables both Scion and commercial clients to undertake biodegradation tests (measuring the conversion of carbon in the original material to carbon dioxide) and ecotox testing (where the resulting compost generated during original material breakdown is still viable in terms of seedling growth and worm health).

## Wrapping up

In a [sustainably packaged] nutshell, Scion is committed to working towards how New Zealand can do things better and smarter.

Bringing together industry, infrastructure, R&D and legislation, as well as ensuring dissemination of information and ongoing collaboration, is the only way to combat the challenges we find ourselves wrapped in.

Talk to our packaging team to find out how Scion's research can support your organisation's sustainability goals. For more information, please contact [alec.foster@scionresearch.com](mailto:alec.foster@scionresearch.com)



# Ticking all the boxes



Scion's Zespri Packaging Team includes scientists Eva Gaugler (centre) and Miruna Petcu, as well as (from left) Garth Weinberg, Robin Parr and (far right) Kelly Wade. The team was recognised for their impactful collaboration with Zespri at Scion's Employee Recognition Awards in 2022.

With talent for scrutinising complex regulations and a desire to support New Zealand businesses to meet their sustainability goals, Eva Gaugler and Miruna Petcu are in their element working in Scion's Zespri Packaging Team.

**A**s part of a secondment that started in July 2022, the scientists are working to deepen Zespri's knowledge and understanding of food contact regulations to ensure its packaging remains all-market compliant for export. Their work is pivotal in keeping the kiwifruit exporter up to date with global sustainability trends for packaging and changing regulations across multiple markets that Zespri ships to. This informs Zespri's decision-making and ensures innovation efforts are aligned with global realities, securing its ongoing commercial success.

Lack of compliance is a huge risk that, if left unmanaged, could lead to product delivery delays or, in extreme cases, loss of whole export markets.

The responsibility that comes with the role isn't lost on Gaugler who learned the art of reading regulations and determining what tests are required to meet them while working as a chemical engineer in Germany. It's a skillset that requires strong attention to detail and a curious mind.

"We examine the regulations for food contact compliance for each country, working out what's different between them and determining what tests each market needs for the packaging to be certified as compliant," says Gaugler.

"It's like being a detective and we love it."

Standards for the materials that come into contact with food (known as food contact compliance) differ from country to country. Rules around the chemicals and substances used in food packaging can also change over time as new information about their safety becomes available.

Gaugler says the food contact regulatory environment is incredibly complex and there is no such thing as a one-size-fits-all approach.

"Most markets have a list of allowed substances, but markets might differ on how much of each substance can be used in plastic packaging; there can be different limits. We usually find there are requirements for testing those substances. But we've learned that even if a lab can do a test, it doesn't mean it's always the right test with the right settings.

"Testing must be very fit-for-purpose for the product, the market and its application."

For Zespri, having support to navigate the complexities associated with global food regulations has been valuable.

Zespri's head of global quality and technical, Farzana Adams, says the secondment ensures that not only does any new packaging being explored meets Zespri's desire to be more sustainable, it also meets all regulatory requirements, including materials that can be used for direct food contact.

"The expertise Scion has provided has meant we've been able to better develop our knowledge and explore potential solutions efficiently, accurately and cost effectively."

## Challenges for industry

Over the years, investment in research through the Government's Strategic Science Investment Fund has built up Scion's capabilities within its sustainable packaging programme, and now many food exporters and packaging companies come to Scion for advice on using new sustainable materials.

Zespri has benefitted from Scion's guidance since partnering on research to commercialise its biospife – an industrially compostable version of Zespri's iconic polystyrene spoon-knife. Scion developed the biospife formulation by combining kiwifruit skins with a bioplastic. But before Zespri could share its biospife with kiwifruit lovers around the world it needed to meet food safety standards and pass vigorous compliance tests.

Gaugler set up testing capability at Scion for the biospife project as well as other internal research and product development. She upskilled by attending conferences, webinars and talking to global experts.

In testing for food contact, we wanted to know we were measuring the right things."

While having the testing capability at Scion, external partners like Zespri use certified laboratories for food contact testing, relying on Scion's team for testing recommendations and guidance.

The team is in high demand, as more companies are wanting to reduce their environmental footprint by developing more sustainable packaging.

However, Gaugler points out that while there is a global drive for more recyclable, sustainable packaging from consumers and industry, food contact regulations in many countries have been slower to respond to this changing environment.

"You can't just assume that hemp fibre will be ok to use in a packaging product – you need to check to make sure it's on the list of permitted substances in the country you are exporting to, and in what quantities it is allowed.

"For these reasons, some products that use new fibres and substances in packaging are taking quite a long time to enter the market. There's a lot involved first in getting these products approved."

It's also important to note that just because a substance can be safely consumed or applied to skin, its use as a food contact material may not always be permitted, she says.

"One of the biggest challenges facing packaging producers right now is finding more sustainable water-repellent materials, as some traditional plastic products contain substances that are getting banned.

There's a move to use more fibre-based food contact products, but how do you still get these to have all the properties that you need to repel water, store well and preserve its quality through the supply chain?

"Product developers everywhere are researching alternatives that perform a certain way, are cost-effective and meet the food contact regulations," says Gaugler.

“It’s like being a detective and we love it.”  
EVA GAUGLER, SCION

## Information-sharing supports research

Miruna Petcu joined Scion's Zespri packaging team three years ago, bringing with her research experience with plastics, knowledge of how to get products approved and has experience dealing with the European Food Safety Authority.

Together, Gaugler and Petcu tap into global networks where new regulatory information is shared, ensuring they stay across the latest developments, technologies and substances of concern.

Gaugler is a member of the Australasian Pulp and Paper Technical Association and serves on its food contact materials committee. Through Scion's involvement as a research partner with the New Zealand-China Food Protection Network and the New Zealand Food

Safety Science and Research Centre, Gaugler secured funding in 2018 to travel to China. The visit was an opportunity to exchange valuable knowledge with scientists in China which, at that time, had adopted new food contact material regulations.

"Over the years we've made strong connections with people and there's a lot of information sharing, which we pass on to industry. We regularly attend workshops and technical seminars, so across all the connections we've made, if industry has any new questions, we'll do our best to find the answers."

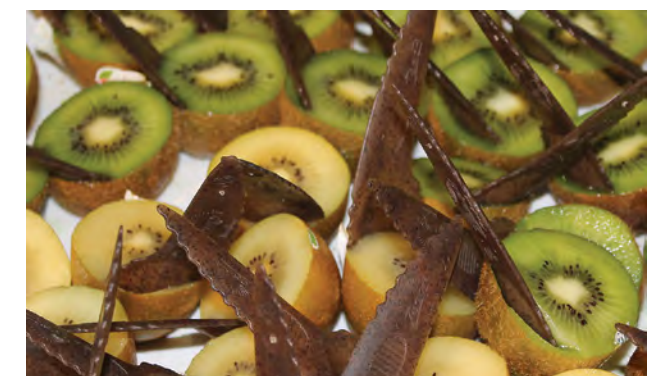
## Building capability

During the secondment, Gaugler and Petcu have gained an appreciation for Zespri's logistical and shipping challenges throughout the supply chain.

"Working closely with Zespri has given us insights into the commercial realities they face; there are good reasons why they do what they do. We understand those realities which help us to adjust our advice and solutions to any market challenges," says Gaugler.

"The partnership with Zespri is very valuable. Not only are we making sure that Zespri's packaging meets its obligations for food contact compliance, we're building Scion's capabilities all the time."

For more information, please contact [alec.foster@scionresearch.com](mailto:alec.foster@scionresearch.com)



Zespri has previously partnered with Scion on research to commercialise its biospife – an industrially compostable version of Zespri's iconic polystyrene spoon-knife. Scion developed the biospife formulation by combining kiwifruit skins with a bioplastic.



# Nursery responds

## to SOS from Timaru

Scion's nursery team is celebrating after successfully preserving the genetics of a landmark giant redwood tree felled due to property development in Timaru.

Cuttings from the felled tree, known to Timaru locals as the Champagne Tree, have been propagated by Scion in Rotorua where nursery staff discovered early signs of healthy root structure in a young plant eight months after branches were sent to them.

Their mission now is to grow at least one plant into mother stock that can provide further cuttings and repatriate these to Timaru.

Scion's nursery operations manager Kelly Turner says the result is a major win for her team.

"Branches from the tree were salvaged, put into bags of water and sent up to us in boxes on ice about four days after the tree was felled. It wasn't an ideal start, but we cracked it."

She credits their success to the expertise of nursery technician Trish Moke-Pouwhare who took cuttings from the branches, and the Ellepot paper pot technology used in Scion's nursery to accelerate plant propagation.

"At Scion we mostly propagate the coastal redwood species and Trish handles all of our cuttings after mastering the art. This tree is a mountain redwood and grows roots very slowly. It can usually take up to 12 months, so to see healthy roots after eight months is a real testament to her skill and the effectiveness of the paper pots to speed up the plants' growth."

Earlier attempts to preserve the tree's genetics through tissue culture techniques were unsuccessful.

Scion has been using the Ellepot technology for three years.

"Taking cuttings is quite an old method but what's new is the paper pot technology; that's what we've found with the redwoods," says Turner.

"Before using paper pots, it could take six months to get coastal redwood cuttings to root. Now, it takes three months or even six weeks under the right conditions. The cuttings love it."

“Before using paper pots, it could take six months to get coastal redwood cuttings to root. Now, it takes three months or even six weeks. The cuttings love it.”

KELLY TURNER, SCION

Roots grow faster in the paper pots and plants can be easily transferred into bigger pots or put straight into the ground.

Turner says her team's goal is to return healthy trees to the Timaru community and to the descendants of the woman who was gifted the redwood in the mid-1850s.

"With their permission, we'd like to keep some cuttings at Scion so we can learn more about this particular species. We're hoping we can accelerate the cuttings process and achieve a result faster than eight months after discovering more about the conditions that it likes."

The felling of Timaru's Champagne Tree took some people by surprise, including descendants of the tree's first owner.



Nursery technician Trish Moke-Pouwhare successfully propagated cuttings from the famous Champagne Tree.

However, it followed many months of discussion between owners of the property where it grew and a neighbouring company that sought professional advice about its health and the safety of nearby properties. The 34m tree sat near the boundary of land they planned to subdivide. Efforts to formally protect the tree fell short, as it could not be listed as a notable tree under Timaru's District Plan until 2023.

After the tree was cut down on March 31 2022, descendants gained permission from the property owners to get cuttings, with half going to Scion and the rest to a South Canterbury nursery for propagating.

The tree dates back to the 1850s when George Rhodes gave a seedling to his wife Elizabeth, and it first grew at the site of the present Timaru District Council building.

After her husband died, Elizabeth remarried, and the tree moved to her new husband's home off Wai-iti Rd in 1873. The tree was then in poor shape and a bet was made, for a case of champagne, that it would not survive.

It thrived and became known as the Champagne Tree, towering over Timaru for 150 years. It was also home to the town's Christmas star from 2003 until 2020.

The tree is a *Sequoiadendron giganteum*, otherwise known as giant sequoia or Wellingtonia tree. One of three species of coniferous redwood trees, it grows more commonly in colder climates or mountainous terrain. In its natural habitat on the western slopes of the Sierra Nevada mountain range in California, it is listed as an endangered species due to the threat of global warming, drought and fire. It's believed fewer than 80,000 trees remain.

Our research nursery provides specialist seedling growing services and support to commercial forest growers. For more information, please contact [kelly.turner@scionresearch.com](mailto:kelly.turner@scionresearch.com)



# Accessible information vital in extending knowledge of wildfire risk

Climate mapping, risk models and 170 best-practice recommendations for mitigating wildfires by Scion are now being used by fire authorities to keep communities safer, while also winning a national award.

**W**ildfire frequency and severity are accelerating globally, including in New Zealand. The Lake Ōhau fire, which destroyed 48 homes in October 2020, is evidence of this, taking firefighters nine days to extinguish the 5,000ha fire. Fire and Emergency New Zealand (FENZ) regards this event as one of the worst in our country’s modern history.

For several years, social scientists from Scion’s Rural Fire Research Group have been working to understand where climate change is increasing the risk of wildfire, where communities are most exposed, and how best to communicate that risk.

Findings from the group’s latest research, *Adapting and mitigating wildfire risk due to climate change: extending knowledge and best practice*, and their corresponding recommendations, have been widely communicated.

Agencies have used the information to plan for and reduce the growing risk of wildfires, as well as improve wildfire risk awareness and mitigation among homeowners and communities in New Zealand, especially in areas where residential houses are near or intermixed with flammable vegetation like mānuka, gorse and pine.

The research team includes Lisa Langer, Simon Wegner and Andrea Grant, and former employees Grant Pearce (now FENZ) and Nathanael Melia (now Climate Prescience). The team’s comprehensive effort in making the research readily available and easily digestible has been recognised by an Emergency Media and Public Affairs (EMPA) award for delivering published research that advances emergency communication.

Scion senior social scientist Lisa Langer says that research outputs need to be clear for research to be understood and implemented by the desired end-user.

The latest high-resolution climate models overlaid with Scion’s mapping of New Zealand’s growing residential housing in rural areas and on the fringe of urban areas will assist FENZ and other agencies in prioritising community engagement and risk reduction efforts.

“Not everyone has the time or the ability to comprehend in-depth scientific papers, so for us, it meant taking the lessons from our research and translating it into as many forms as possible, so it becomes a valuable source of information for a variety of audiences.”

The researchers’ findings and recommendations have been communicated through articles, blogs, online workshops, conference presentations, radio interviews, technical reports, and academic papers, all of which have had significant influence for FENZ, regional and local councils, primary industry land managers and investors, and property owners.

## Uptake of innovative mapping by agencies

The latest high-resolution climate models overlaid with Scion’s mapping of New Zealand’s growing residential housing in rural areas and on

the fringe of urban areas will assist FENZ and other agencies in prioritising community engagement and risk reduction efforts.

The highly detailed climate model simulations describe future wildfire danger projections in every 5x5 kilometre grid cell across the country. This technology has found that climate change is predicted to substantially increase the wildfire risk for many regions, increasing the frequency, severity, and season length of fire weather conditions until at least mid-century.

The magnitude of these risks is linked to the success of climate mitigation efforts, making it important for fire managers to ensure communities become more aware of high wildfire risk environments and communicate knowledge appropriately to successfully prepare and mitigate against wildfires.



Permanent residents from the small community on the northern side of Wānaka, including Mt Iron, were engaged in a case study.



Wānaka case study area with survey zones discussed during a community engagement day.

## Understanding community complexities

Social findings from a community case study and a national survey undertaken by the researchers have enabled fire-related agencies to plan better and use more effective communication methods.

Langer says understanding the level of wildfire comprehension between permanent residents and visitors is essential.

Permanent residents from the small community on the northern side of Wānaka, including Mt Iron, where climate, wild vegetation and development factors have combined to create extreme wildfire risk, were engaged in a case study. This involved interviews, focus groups, and workshops with 64 key end-users and residents to identify wildfire risk awareness and mitigation actions.

Following this, Scion undertook the country’s first national quantitative assessment of wildfire risk perception and mitigation among residents in New Zealand, guided by lessons learnt from the case study.

The case study found that many permanent residents of Mt Iron exhibit high wildfire awareness and anxiety, amplified by the Lake Ōhau wildfire 70km away. Permanent residents also perceived a lack of awareness among short-term residents and tourists who continued to engage in activities such as using braziers and lighting fireworks. This limits the effectiveness of risk reduction efforts carried out by those permanent residents who are aware of the risk and undermines the impact of awareness campaigns by authorities.



Most concerningly, the national survey showed that awareness of and concern about wildfire risk was only weakly correlated with taking action to mitigate risk.

Langer says simple awareness campaigns will not be enough to spur people into action; there are likely to be practical or social barriers to mitigation that need to be addressed.

## Wildfire mitigations for homeowners and communities

One of the research components recognised by the EMPA award resulted in 170 best-practice recommendations for agencies, communities, and individuals, supported by international literature to create an easy-to-use resource, *Wildfire Mitigations for Homeowners and Communities*.

The recommended mitigations have been divided into five categories that apply to people at different stages of preparation and response: building or remodelling a home, landscaping or designing outdoor spaces and property infrastructure, making a wildfire plan, preparing for the start of each wildfire season and when a wildfire occurs.

Recommendations from around the world have assisted fire-related agencies in understanding and categorising wildfires from the early stages when the thought of wildfires has yet to come into planning, right through to a wildfire emergency.

FENZ has developed a *Wildfire Safer Housing Guide*, which drew on Scion's house construction recommendations to promote mitigation action among builders and homeowners.

For FENZ Southland, the Mt Iron survey provided useful research data and helped all agencies understand the level of knowledge around wildfire, and the complexities that exist within communities.

Community readiness and recovery advisor Sally Chesterfield says the project identified clear groupings to allow agencies to understand and respond to their different needs.

"The research will be invaluable for measuring the success in reducing wildfire risk and improving resilience from a community and agency perspective in the future.

"It's data that is usable for all agencies involved in the Mt Iron project and will help to strengthen each agency's area of responsibility with evidence-based research."

## Extreme wildfire programme launched

Social research has suggested that most engagement surrounding wildfire comes too late, long after housing developments have been designed, homes have been built, and landscaping planted, when substantial changes are complex and costly.

Langer explains that individuals from the Mt Iron community faced challenges like these, with their concerns focused on factors such as restrictions to removing the protected but highly flammable kānuka vegetation around their properties, and the flammability of cedar cladding of their houses.

This community's difficulties led to a new research direction from preparing and mitigating against future wildfires at an individual property scale to national and local government and developer planning to prepare to live with wildfire.



Lisa Langer accepts the EMPA award from Kieran McAnulty, Minister for Emergency Management.



Highly flammable kānuka on the slopes of the wildfire prone Mt Iron above the residential area of Wānaka.

Now Scion, its international collaborators (US Forest Service, San Jose State University, Karlsruhe Institute of Technology and RMIT) and national collaborators (GNS, Canterbury, Lincoln, and Massey Universities) are undertaking the five-year MBIE-funded Extreme Wildfire programme where one research area is focused on this new direction.

Langer says the Scion team will work with local government and national planners, fire engineers, architects, and landscape architects in a research area focused on preparing to live with wildfire.

"We are investigating how decisions made throughout the planning, design and construction systems lead to wildfire risk to allow broader education which will benefit the wider community. The research will explore how chains of decisions upstream create cascading contexts for decisions at each following step, ultimately shaping community and homeowner wildfire risk."

# Educating next-generation scientists

Scion's Eva Gaugler is among a team of New Zealand scientists who have been recognised for contributing to the House of Science's success on the international stage for chemistry education.

House of Science, a charitable trust, was awarded the 2022 Royal Society of Chemistry's (RSC) Horizon Prize for Education in November for their entry *Equity and Excellence: Bilingual Science Resources for NZ Primary Schools*. The award acknowledges the development of a vast library of hands-on, bilingual science resource kits that enable thousands of primary school teachers across New Zealand to deliver life-changing science lessons.

Forty science resource kits have been rolled out over the past eight years, 15 of which have a strong chemistry focus.

Jane Hoggard from the House of Science developed the kits in conjunction with Eva Gaugler at Scion, Laura Kearney at the NZ Agricultural Greenhouse Gas Research Centre and Mike Bunce, Ham Davidson and Vanessa Crow from the NZ Environmental Protection Authority.

Specific kits that showcase chemistry in the circular economy include *A Load of Rubbish* with activities focused on sustainable ways of making and remaking new products with a focus on designing out waste. Gaugler was the Scion lead in the kit's development, launching it in July 2022 at Te Whare Nui o Tuteata in Rotorua.

Other kits include *Climate Change* which features eight interactive activities to help students become better informed and empowered to care for our planet, and *Who's Been There* – a kit which explores the composition and structure of DNA and highlights its use as a biodiversity monitoring tool.

The kits reach more than 150,000 school children across New Zealand each year.

The RSC's annual awards celebrate ground-breaking innovations and initiatives that acknowledge exceptional contributions towards chemistry education.

Gaugler says the resource kit library is completely unique.

"Nowhere else can teachers have a science resource kit delivered to their classroom, with all the equipment, instructions and consumables needed to deliver engaging hands-on lessons linked to the curriculum and current scientific research.

"These kits are designed to empower teachers who often lack the confidence to teach science. They are the complete package and are easy for teachers to use, regardless of their background."

She says the vision behind the A Load of Rubbish kit and others is to help Kiwis do the right thing and make steps towards a circular bioeconomy.

"By using the resource kit and applying scientific principles, students will learn how to identify and solve environmental problems, sparking an interest in sustainability.

"As a result, the students will be able to make informed choices on sustainable packaging materials and their end-of-life as well as, hopefully, develop a life-long passion for science."

House of Science CEO Chris Duggan says she is proud of the team for all their efforts.

"This award is so well deserved. Careers in science, technology, engineering, and mathematics (STEM) are at the heart of many future workforce requirements and underpin the transition to a climate-resilient, sustainable, low-emission economy.

"By the age of 10, most children have formed a strong impression of careers they can envisage themselves doing. If science has not been part of their lives by this age, the chance they will follow this pathway is slim.

"Empowering primary school teachers to deliver engaging science lessons will ensure a workforce with the necessary skills to embrace and support the future of work."



CLOCKWISE FROM TOP:

· Marc and Eva Gaugler, who led the development of the House of Science resource kit, A Load of Rubbish, attend the launch at Scion.

· House of Science CEO Chris Duggan.

· Children enjoyed exploring the resources.



# Marine biofuel to support sustainable shipping



A renewable low-carbon transport fuels industry will support New Zealand to mitigate the effects of climate change.

**W**hile there's been a lot of interest in what the aviation sector is doing to decarbonise, the shipping industry has fallen off the radar. But as Scion's portfolio leader for Integrated Bioenergy, Dr Paul Bennett, points out, it's responsible for growing global emissions. Scion has research underway to introduce cleaner technologies to this critical sector.

Shipping, while essential for trade, contributes significantly to the emissions that cause climate change. It is interesting to see the amount of attention and investment sustainable aviation fuel is getting now, which is counter to that of the maritime sector. However, the carbon dioxide emissions from both sectors are comparable.

Global shipping spews out 3% of worldwide greenhouse gases (GHG). While 3% might not seem titanic in scale, growth in demand for shipping worldwide means that maritime emissions have been accelerating faster than most other sectors. With a decrease in emissions from other sectors and no action in the maritime sector, shipping could be responsible for 10-13% of global emissions within a few decades.

Making shipping sustainable is critical if New Zealand is to become climate-neutral by 2050, with 99% of New Zealand's international trade being transported by ship, equating to about 45% of GDP (or \$162 billion to the economy) in 2021. If we don't act quickly, it's not just our environment that is at stake, but our economy as well. Major exporters of New Zealand produce are starting to become concerned about the carbon dioxide emissions associated with moving their products to markets, and markets are looking less favourably at produce with higher embedded carbon.

One approach is to jettison fossil-derived marine diesel and steer towards green solutions, such as sustainable liquid biofuels.

The challenge is that current green-fuel technologies still face headwinds before they are ready for wide-scale commercialisation.

There are several challenges to the use of biofuels, however, these can be adequately addressed through proper controls and regulations. For example, feedstocks being used for biofuels would need to adhere to standards to ensure the finished biofuel was sustainable.

There are certification schemes both in New Zealand and internationally that would ensure that this is the case. Also, commercially sold fuel must adhere to a tight set of rules to ensure efficient engine operation and prevent engine damage.

Researchers at Scion are working to bring innovation in biofuel production technologies to the maritime sector. Our ambition is to drive down biofuel costs and find quicker ways of promoting clean energy, setting the course of the shipping industry towards net-zero CO<sub>2</sub> emissions.

The system being developed at Scion takes waste biomass (such as forestry wood waste) and decomposes this thermally into



*Dr Paul Bennett says the environment and New Zealand's economy will benefit from the maritime sector adopting liquid biofuels.*

“Major exporters of New Zealand produce are starting to become concerned about the carbon dioxide emissions associated with moving their products to markets, and markets are looking less favourably at produce with higher embedded carbon.”

DR PAUL BENNETT, SCION

vapour, which can be converted into a bio-oil, suitable for use as a drop-in replacement for fossil-based marine diesel fuel. Our Scion team has been seeking input, guidance and support from a range of stakeholders as they proceed with this work to ensure that they are on the right track from a technology perspective and, more importantly, that there is a demand from the market. Energy providers, shipping lines, ports, product exporters and potential investors have been engaged to validate the potential of this opportunity and help shape the path to market.

It's work that has so far been a three-year labour of love for the researchers but is one that we believe supports global goals to reduce greenhouse gas emissions.

It also coincides with expectations for the shipping industry to do its bit to mitigate the effects of climate change. In 2018 the International Maritime Organisation developed a greenhouse gas initial strategy. This policy framework aims to cut annual greenhouse gas emissions from international shipping by at least half by 2050 (compared with their level in 2008), and work towards phasing out greenhouse gas emissions entirely from shipping as soon as possible.



# Ecogas opens flagship bioenergy facility

Scion's pilot-level research has culminated in Ecogas launching New Zealand's first commercial scale anaerobic digestion bioenergy plant, showcasing the power of partnership.

**E**nergy and Resources Minister Hon. Megan Woods officially opened the Reporoa facility in October 2022, six years after the technology was first piloted.

Scion scientists were involved in de-risking the key technologies used in the facility during its early planning and development phase. The relationship with Ecogas continues today as Scion explores further research opportunities with them to enhance bioenergy production.

Fully operational, the \$30 million plant can turn 75,000 tonnes of organic food waste collected from households and businesses around the North Island into renewable clean energy and biofertiliser. Heat generated from biogas will warm T&G Global's tomato greenhouses located nearby. Carbon dioxide produced at the facility will also be pumped in to enhance plant growth.

The glasshouses require a similar amount of energy as about 2,000 homes – all now provided by biogas.

Minister Woods says the Government is committed to establishing a circular economy with a thriving bioeconomy by 2050, adding the facility provides strong evidence of what can be achieved through partnerships.

"I hope that this facility will prove to be a beacon for more collaborative multi-sectoral projects, as well as the development of a bioenergy industry here in New Zealand and to demonstrate how it is that we can move away from fossil gas to renewable alternatives."

“Look at all the successful teams, like the All Blacks and Team New Zealand, who bring in experts to be part of their programme. For our team, we started working with Scion seven years ago. As a company embarking on projects like this, having that continuity is important.”

ANDREW FISHER, ECOGAS DIRECTOR

Scion senior scientist Dr Suren Wijeyekoon is studying the potential for paunch grass from culled cattle to be used as an additional feedstock at the Ecogas facility. The project extends his involvement with Ecogas which started in 2016. Attending

the opening felt very rewarding, he says.

"It's a credit to the vision of Ecogas director Andrew Fisher and his team to take what was a pilot scale project to the next level. The early work gave them that confidence to continue, and their commitment and belief in the science is very special. The facility is an initiative they can be really proud of."

Fisher says the partnership with Scion has proven valuable.

"Look at all the successful teams, like the All Blacks

and Team New Zealand, who bring in experts to be part of their programme. For our team, we started working with Scion seven years ago.



"As a company embarking on projects like this, having that continuity is important."

Scion's general manager for Forests to Biobased Products, Florian Graichen, says it was a privilege for Scion to support such an exciting endeavour.

"The opening was a milestone for New Zealand's rapidly accelerating transition to a circular bioeconomy."

The Reporoa facility was built over two years, weathering the Covid pandemic, lockdowns and global supply chain issues. The two Ecogas founding partners, Pioneer Energy and EcoStock Supplies, showed that courage, vision and expert skills can put New Zealand on the path to a more sustainable future.

About 250 people attended the opening and site blessing by Ngati Tahu-Ngati Whaoa Runanga Trust. Among them was Parul Sood, Auckland Council's general manager for waste solutions, who says the facility is an important step towards reducing both the amount of organic waste that goes to landfill and also greenhouse gases.

"Almost half the weight of a kerbside rubbish bin is organics and we are aiming to reduce that considerably in Auckland by turning it into a renewable resource in Reporoa."

Ecogas' core business is well aligned with the government's focus on decarbonisation, circular bioeconomy and waste management. The project was funded by Pioneer Energy, and the Provincial Growth Fund assisted initial works with a \$7 million loan.



L to R: Energy & Resources Minister Hon. Megan Woods, Scion senior scientist Dr Suren Wijeyekoon, and Scion general manager for Forests to Biobased Products Florian Graichen. Minister Woods hopes the facility will be a beacon for further bioenergy projects.



# Getting to the guts of gas

Converting partly digested grass from the stomachs of slaughtered cattle into biogas that could be used to sustainably heat commercial greenhouses is the focus of a 14-month study at Scion.



Dr Suren Wijeyekoon uses the biomethane potential test kit during the first stage of research.

It's hoped the partly digested grass can one day be blended with food waste to develop a powerful new recipe to enhance bioenergy production for industry – making it less reliant on fossil fuels, saving money and benefiting the environment.

Senior scientist and project leader Dr Suren Wijeyekoon says it is well known that cows produce a lot of methane gas when they belch after grass is digested by enzymes in their stomachs.

Taking the same grass, known as paunch grass, from slaughtered animal stomachs and using it to produce methane-rich biogas is a research opportunity worth exploring for future bioenergy production replacing natural gas, he adds.

“Each cow has about 10-15kg of partly digested grass in their first stomach when they arrive in an abattoir; that grass normally is disposed of by meat processing companies, which comes at a cost. Our research is looking at the potential to use that waste product to produce biogas at scale, taking it from a small batch to a large pilot study. If successful, it's research that can be commercially adopted by Ecogas.”

Silver Fern Farms provides the fresh paunch grass for the study. Scion scientists are then deploying Scion's new biomethane potential test kit to assess the biogas production, which is a mixture of roughly 60% methane and 40% carbon dioxide.

Testing will be complete in October 2023. If successful, it's hoped the project will be commercially adopted.

The \$385,000 study has been jointly funded by Ecogas and the Bioresource Processing Alliance, which works with New Zealand's primary sector and science partners, including Scion, to get better value out of biological by-products.

AgResearch is also involved in the study by exploring the potential of paunch liquor to be used as a pet food ingredient.

Wijeyekoon says the study is a great example of Scion's research exploring the benefits of a circular bioeconomy.

“There are waste management costs for the disposal of paunch grass currently. Using that one feedstock or waste stream, we can explore a number of new opportunities: bioenergy production, bioCO<sub>2</sub> for photosynthesis in greenhouses, digestate for biofertiliser and pet food ingredient production.”

The biogas produced could also satisfy the heat demands of abattoirs in the future, he adds.

Ecogas General Manager Alzbeta Bouskova says the company is excited to partner with Scion in the study and explore the potential of paunch grass as a new clean energy feedstock and, in the process, assist the meat industry with transition to sustainable and circular principles.

For more information, please contact paul.bennett@scionresearch.com.

# Kete of work underway to combat myrtle rust

More than 30 researchers at Scion are working towards protecting our most abundant myrtle species from myrtle rust.

The wind-borne fungal disease poses a threat to our most iconic plants in New Zealand, pōhutukawa, mānuka, and rātā, as well as commercially grown species such as eucalyptus.

Myrtle rust was discovered on mainland New Zealand in 2017. The disease causes bright yellow-orange powdery pustules on young leaves, shoots, fruits, and flowers of plants in the myrtle family, causing a deformation of the leaves and shoots, and twig dieback. Repeated severe infections can cause decline or death of large trees.

Scion researcher Michael Bartlett explains that while myrtle rust will be impossible to eradicate from New Zealand, a portfolio of work is under way at Scion to help manage the impact and protect our native and exotic myrtle plants. Some of the work happening in this area is highlighted below.

## Nursery mahi

Can hyperspectral imagery and thermal imagery detect myrtle rust before the naked eye? Preliminary results are looking promising.

Funded by Scion's Strategic Science Investment fund, myrtle rust projects are underway in Scion's nursery. Scion's pathology, remote sensing and GIS teams have been working together in the containment laboratory to determine if myrtle rust in a very susceptible host (rose apple; *Syzygium jambos*) could be pre-visually detected using hyperspectral and thermal imagery.

Researchers are wanting the public's help to get more information about where this teeny tiny rust-eating fungus is located after it was found in around Taranaki and the Kaimai-Mamaku ranges. It was first detected on myrtle rust-infected ramarama.

Preliminary results show that hyperspectral indices could be used to correctly identify infected plants prior to the appearance of the first visual symptoms. This research provides the first step towards developing tools that will help nurseries to detect and manage this disease.

Scion is also looking at the management of myrtle rust in the nursery, comparing different fungicide application regimes to see how effective they are at controlling the disease on a range of hosts. The project is being co-led by researcher Kwasi Adusei-Fosu and nursery technician Anita Wylie.

Adusei-Fosu is also leading a project aiming to gain insight from the industry, surveying nurseries around the country in partnership with New Zealand Plant Producers Incorporated (NZPPI) to determine the impact of myrtle rust and what growers are doing to manage the disease.

## Natural enemies of myrtle rust

A key project within this portfolio focuses on two known natural enemies of myrtle rust in New Zealand: a rust-eating fly called *Mycodiplosis constricta* and a fungus called *Sphaerellopsis macroconidialis*.

The first of the natural enemies, the rust-eating fly, was discovered in 2018 when Scion researcher Roanne Sutherland found larvae eating myrtle rust on plants in Rotorua. The recently discovered fungus, found by Scion researchers in Taranaki and the Kaimai-Mamaku ranges in the Bay of Plenty, is the second known natural enemy of myrtle rust in New Zealand.



Bartlett says natural enemies are one of the tools scientists hope will suppress the devastating effect myrtle rust can have on myrtle plants in New Zealand, in addition to other options, such as chemical fungicides.

“We still have a lot of questions, and we don’t know much about the biology of either of these organisms so there could be years of research to come.”

The project is led by Scion researcher Andrew Pugh and funded through Scion’s Strategic Science Investment Fund.

### Monitoring of disease impact and seasonal progression

Scion researchers Julia Soewarto and Michael

Bartlett have been leading monitoring of myrtle rust’s impact and seasonal progression in nine locations across the North Island for three years.

Preliminary results show that hyperspectral indices could be used to correctly identify infected plants prior to the appearance of the first visual symptoms. This research provides the first step towards developing tools that will help nurseries to detect and manage this disease.

Researchers have focused on ramarama and rōhutu and have also been checking pōhutukawa, mānuka, rātā, and maire tawake for symptoms.

Funded by Ngā Rakau Taketake and Beyond Myrtle Rust, researchers have been tracking the disease and its impact on the same trees over time.

The main finding from this research looking at the major decline in the health of rōhutu and ramarama trees shows an increased level of dieback and a reduced amount of new growth and production of flowers and fruit.

“We know very little about the ecology of ramarama and rōhutu trees, and the wider impacts that myrtle rust is having” says Bartlett.

To provide a better picture of which species are at risk, Scion researcher Andrew Cridge is leading a project, funded by Ngā Rākau Taketake, that is using eDNA to determine which insects visit and pollinate flowers on these threatened trees.



Geospatial technician David Cajés and scientist Dilshan de Silva scanning for myrtle rust.

### Myrtle rust adaptability

Hundreds of myrtle rust samples collected by Scion researchers are being tested by sequencing provider AGRF in Australia to understand how adaptable the disease is in New Zealand to new hosts or changes in the climate.

In addition, researchers are also interested in the pathogen’s life cycle as sexual reproduction and the rearrangement of genetic material that occurs can create diversity in populations. Researchers do not understand what the drivers of sexual reproduction are yet, with further projects underway in Australia and New Zealand.

This body of work is funded by Beyond Myrtle Rust and led by Michael Bartlett and Stuart Fraser in collaboration with the University of Queensland and the Department of Agriculture and Fisheries in Queensland.

### Interactive learning

Scion has been successful in securing Unlocking Curious Minds funding to develop a Te Reo Māori myrtle rust interactive learning app, *Patua te Tukumate Rāwaho* (Myrtle Rust Busters). This aims to inform and equip next generation kaitiaki with tools for understanding myrtle rust impacts in the ngahere (forest). Development of the app was due to start in Feb 2023 and will involve identified kura (schools) in the design and implementation. The app will be available publicly once launched at the end of 2023.

### Boosting awareness

Community awareness and understanding of socio-cultural impacts of myrtle rust are limited. Scion social researchers have been funded through projects within Ngā Rākau Taketake to undertake social research that better prepares communities for responding to myrtle rust. These projects are working at the interface with mātauranga Māori and science knowledge to support care for trees and appreciate the social and cultural significance of myrtaceae species.

*Postcolonial Biosecurity Possibilities* is a project within *Mobilising for Action*, exploring relational values of people and trees to better position relationships of tree care based on shared values. The team is exploring how to address colonial bias in research, policy and practice by attending to relational aspects such as inclusivity, regeneration and responsibility.

The project is an interorganisational collaboration between three New Zealand CRIs (AgResearch, Manaaki Whenua Landcare Research and Scion) and social researchers from University of Cardiff and UK Forest Research, co-led by Scion’s Andrea Grant.

A second project, *He Taonga Ke te Ngahere*, is led by Massey University Centre for Indigenous Psychologies also under the Mobilising for Action theme. It is working with hapū to raise awareness of myrtle rust in their ngahere (forest) by looking at different perspectives of causality to link knowledge and action for myrtle protection.

Scion researcher Andrea Grant has supported the project through interviews with scientists and science communicators to create a video and visual resources to engage hapū in the project.

For more information, please contact [michael.bartlett@scionresearch.com](mailto:michael.bartlett@scionresearch.com)



Field instrument technician Warren Yorston scans plants as part of a collaborative project with Scion’s pathology team.



# Science recruits target myrtle rust species



Recruits to Te Rātā Whakamaru have spent their first year learning new environmental monitoring skills and applying their knowledge in the field.

The Myrtle Rust Jobs for Resistance programme – Te Rātā Whakamaru is a Scion-led project funded by Jobs for Nature/ Mahi mō te Taiao, through the Department of Conservation – Te Papa Atawhai. It is delivered in partnership with Rotoiti 15 Trust. Launched at Te Waiti Marae at Lake Rotoiti in April 2022, the project is developing knowledge in myrtle rust, working with and for mana whenua.

The programme has 10 full-time staff working for three years in Bay of Plenty native forests and at Scion. Joining with no previous field experience or myrtle rust knowledge, they have been upskilled to monitor the spread of the disease, reporting on tree health and identifying if any trees show signs of resistance.

Arapeta Tahana from Rotoiti 15 Trust says he and his fellow trustees are committed to providing opportunities for the taiao (environment), culture and people.

“This is logical for us to invest in our own people. To increase capacity for learning for our whenua (land) while protecting our ngahere (forests). This is not the sort of work you can outsource,” Tahana says.

“The goal is to provide jobs and build capability within the Bay of Plenty to protect the ngahere against myrtle rust.”

“We are committed to not only understanding the impact of myrtle rust within our environment, but to connect and understand our environment better.”

Scion forest pathologist Julia Soewarto is supporting the team as its project leader. Her focus in the first year has been upskilling the team and mapping sites around the Rotorua lakes area to identify specific locations of known species under threat from myrtle rust.

“Through the winter months the Te Tira Rātā (field work team) worked very hard so we know where the vulnerable host species are around the lakes. We have established monitoring transects at these sites and will keep an eye on them over the 2023 summer to see if they get infected with myrtle rust, and how badly.”

She says it was a pleasure to see the team’s confidence grow as they

learnt new environmental monitoring skills.

“In only a few months of training they have become excellent field technicians. We can rely on them to collect comprehensive data from the field.”

It’s a good example of what magic can be achieved when CRIs and tāngata whenua come together and combine our experience and knowledge to protect our taiao. I’d love to see more partnerships like this in the future.

KERRI ANNE HANCOCK, ROTOITI 15 TRUST

## Collaboration with the GIS team

Te Rātā Whakamaru has provided additional learning opportunities for Scion’s data and geospatial scientists. They were tasked with developing a phone app that the field team uses to capture photos of species and link them to a GPS location.

Captured data can be visualised by Scion’s myrtle researchers on a dashboard so information can be summarised quickly.

Geospatial technician Honey Estarija says the dashboard’s value was priceless.

“We learnt a lot as we worked through various technical challenges, and these are things that will not be forgotten as we can apply them to future projects.

“The importance of this app has already been recognised by others and we’ve been asked to help them create something similar for their projects.”

Within the first four months of using the technology, the field team identified more than 3,000 trees that are vulnerable to myrtle rust around the Rotorua lakes.

“We knew the places they were surveying would identify some, but every time they went into the field, they captured more,” says Soewarto.

“This is very valuable information as it increases our knowledge about the native species.”

## Sharing knowledge

Te Rātā Whakamaru is unique. Its science focus means that the team is not only working in the forests but is also exposed to Scion’s laboratories and nursery. As part of their job, they are being upskilled in several areas of forest biosecurity science.

They are also developing new educational resources.



The online dashboard visualises data captured in the field.

“These are the types of resources that can be shared with mana whenua, or anyone interested in learning how to identify these plant species,” Soewarto says.

Kerri Anne Hancock, Tauwharenga (general manager) for Rotoiti 15 Trust says they really value the partnership.

“It’s a good example of what magic can be achieved when CRIs and tāngata whenua come together and combine our experience and knowledge to protect our taiao. I’d love to see more partnerships like this in the future.”

This partnership is part of the nationwide Jobs for Nature \$1.129 billion programme led by the Department of Conservation and the Ministry for the Environment to revitalise communities through nature-based employment. Its primary focus is to support businesses to provide employment as the economic impacts of Covid-19 unfold while ensuring environmental benefits.

Scion portfolio leader Heidi Dungey says while this work will not prevent infections, it will help with understanding of when and where the most susceptible myrtle species are

within the region and provide ways to support them.

“We can also identify the most resistant trees and work out what helps them stay healthier while others around them may succumb to the disease,” she says.

“Cuttings will be taken and seed collections started with the intention of co-developing a resistance breeding programme with our partners.”

For more information, please contact heidi.dungey@scionresearch.com



# Genomic tool for radiata pine – a game changer

Fitting into a rectangle only slightly bigger than a deck of cards, Scion scientist Natalie Graham holds technology that will help shape the future of New Zealand radiata pine breeding in her hands.

**The result of research effort that began in 2014, Graham is holding a single nucleotide polymorphism (SNP) array. It is the first large-scale genome-based pedigree identification and genetic selection tool for radiata pine worldwide. It is an affordable and robust genotyping solution that can be used in radiata pine breeding programmes in New Zealand.**

The project is a collaboration between Scion, the Radiata Pine Breeding Company and the international Conifer SNP Consortium.

The SNP arrays are a game changer for radiata pine breeding, says Scion portfolio leader for Trees for High Volume Wood Products, Andrew Cridge.

“Developing the SNP array significantly reduces the cost of genotyping each pine tree. Being able to genotype individual trees allows tree breeders to use genomic values to select the best trees with improved traits for growth rate, wood quality and enhanced disease resistance qualities,” he says.

Through the use of genomic selection (making decisions based on DNA predictions rather than field trial data), tree breeders can significantly speed up the rate of genetic gain of important production traits.

The importance of this technology advance is considerable. In some ways, the effort began in the 1950s, as geneticists and tree breeders at the (then) Forest Research Institute, together with industry partners, developed methods to identify and genetically select the most superior radiata pine trees. Trees with superior growth and form, resistance to disease and better wood properties such as wood density and structural quality were identified and selected to breed the next generation.

It is the first large-scale genome-based pedigree identification and genetic selection tool for radiata pine worldwide. It is an affordable and robust genotyping solution that can be used in radiata pine breeding programmes in New Zealand.

After 70 years of research and ongoing commercial deployment of improved trees, the outcomes are immense. Millions upon millions of radiata pine trees are in production that are more productive, profitable, easier to manage and resilient to disease than previous generations. The cumulative economic benefit to New Zealand over the past decades is significant.

In a 2014 study, Scion geneticists estimated that genetic gain in radiata pine had added multi-billions in income to the national forestry estate. Even that figure was likely too conservative since it did not account for genetic improvement in tree form and branching or wood quality traits.

The development and implementation of the SNP technology is a significant milestone in the long history of conifer breeding in New Zealand.

Radiata Pine Breeding Company general manager Darrell O’Brien explains the commercial importance.

“At 90% of the planted forest estate in New Zealand, radiata pine is the most important forestry species in New Zealand. Even with the benefit of decades of breeding advances, genetic improvement is still constrained by the age of the tree at which we can measure a number of the economically important traits – among them are wood volume, stiffness and density.

“Selecting on genomic values rather than waiting for measurements in older trees has the potential to double the rate of genetic gain per unit of time,” says O’Brien.

“That means that desirable traits can be improved faster and breeding programmes can respond more

quickly to any changes in climate, market requirements or management practices.”



Scion scientist Natalie Graham holds technology that will help shape the future of New Zealand's radiata pine breeding.

Genetic improvement is an investment often likened to compound interest earned in the bank, namely each generation improves on the gains made in the previous generation. However, unlike a bank investment, the benefits of genetic improvement are enjoyed annually; more productive trees sequester more carbon and more profitable trees are harvested every year. Anything that accelerates genetic gain also speeds up or amplifies the benefits from that gain.

## Selecting SNP markers

The first three years of this research were spent mapping the genome of radiata pine – a species that proved to have both a large and complex genome. More than a million SNPs were identified, far too many to be included in a commercial tool.

Graham and her team eventually selected just over 36,000 SNP markers and these became the basis for the commercial SNP array.

Utilising the SNP array, over 35,000 trees have already been genotyped. This information can be correlated with the physical trait measurements and provides an immense wealth of data, enabling fundamental research about the role of genetics, the environment and different silviculture practices.

This resource also enables improvement of the existing radiata pine breeding. In most breeding programmes, the pedigree (parentage or relatedness) between trees is assumed to be known.

However, errors occur. Sometimes identifying trees many years after planting is difficult. Other times unplanned (and unknown) pollinations can slow down or confuse progress in a breeding programme. Genetic verification improves confidence in the entire breeding and deployment pipeline.

The SNP panel was also able to provide information about the distant past of each of our elite radiata pine trees. The DNA results were able to differentiate the geographic ancestry of these trees, tracing back to forests clustered on the Californian coastline or nearby offshore islands.

In 2012, the New Zealand Forest Owners Association had a vision to double productivity of the national radiata pine forestry estate by 2035. The commercial use of this genomic information supports the industry and radiata pine breeders to achieve this goal.



The SNP arrays are a game changer for radiata pine breeding.





Talking forestry and opportunities to add value to the sector inside the Forestry Hub.



Scientist Simeon Small shared with visitors our growing knowledge of soils under radiata pine forests.

# Forestry's bright future

In a Fieldays first, 35 organisations and companies from the forestry and wood processing sector came together under one roof inside the Fieldays Forestry Hub. We showcased the latest innovations and research that our scientists have been working on and connected with the public, industry, media, and government over four days to tell the story of wood – our low-carbon future.

From 29 November to 3 December, visitors explored the many facets of forestry and discovered how the sector has a vital role in mitigating climate change.



Presenter Cheree Kinnear models a pair of leather shoes tanned using radiata pine bark tannins for a Fieldays TV segment featuring Dr Stefan Hill.



The Forestry Hub enabled organisations across the forestry value chain to gather under one roof.





Research and innovation from Scion will unlock the potential for regional New Zealand to prosper following the launch of a roadmap for the forestry and wood processing sector.

New Zealand exports about 60% of harvested wood as logs for other countries to process and add value. In contrast, the 15% exported as value-added wood products return over 40% of total export revenue. The ITP charts a course to turn that around.

“It’s this environment that provides a mosaic of activity for regional New Zealand to thrive, through emerging bio-based manufacturing and the creation of high-value products from inputs that we currently consider waste.”

DR JULIAN ELDER, SCION



*Attending the Forestry and Wood Processing Industry Transformation Plan launch at Fieldays (from left) Jason Wilson, Deputy director-general of Te Uru Rākau – New Zealand Forest Service, Ministry for Primary Industries Director-General Ray Smith, Scion chief executive Dr Julian Elder and Minister for Forestry Hon. Stuart Nash.*

“This transformation will give us the power to not only reduce waste, pollution and greenhouse gas emissions but also to grow prosperity, jobs and community resilience.”

Across Aotearoa

regional New Zealand, deliver on Māori aspirations, and diversify domestic and export markets.

“This transformation will give us the power to not only reduce waste, pollution and greenhouse gas emissions but also to grow prosperity, jobs and community resilience.”

The infographic illustrates the transformation of biomass into biofuels across Aotearoa. It features a map of New Zealand with shipping containers, a process flow diagram, and a list of Scion Connections.

**Novel refining system**

**Reactive extrusion or pyrolysis**

**Biochemical conversion**

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# Biosecurity in safe hands

Rapid identification of *Phytophthora*, “the plant destroyer”, and air sampling eDNA protocols for invasive pests are projects recently launched with funding received from Better Border Security (B3).

A substantial investment of \$4 million has been made into protecting New Zealand’s valued flora, with B3 approving funding for 17 new biosecurity-related science projects in July 2022, including ones led by and involving Scion scientists.

Scion forest pathologist Darryl Herron and molecular entomologist Dr Andrew Cridge are leading two of the new projects, with Scion involved in another seven.

B3 Director Dr David Teulon says research undertaken by partners like Scion within B3 works to minimise the entry and establishment of invasive pests, pathogens, and weeds that threaten Aotearoa New Zealand’s precious and productive plants.

“The B3 science programme has a substantial role to play in mitigating the existential impact of these exotic organisms on economically, environmentally, and culturally important plants by using research and its uptake to improve border biosecurity.”

Herron’s three-year project, *Beyond soil baiting: toward application of an eRNA diagnostic tool for Phytophthora*, applies eRNA techniques for rapid identification of living pathogen communities in soils.

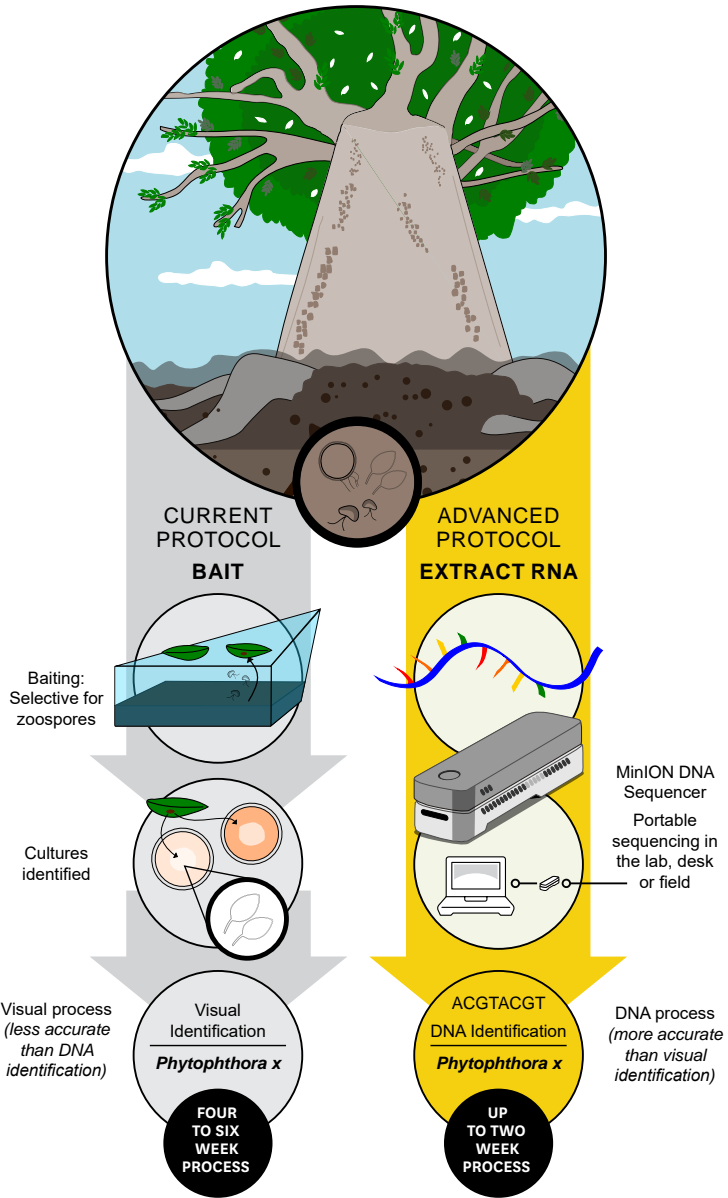
He says *Phytophthora*, “the plant-destroyer”, are water moulds that can cause severe disease in a number of important plant species, including kauri, pine and avocados.

“The project aims to develop a *Phytophthora* testing procedure as an alternative to soil-baiting, the current go-to method for surveillance of *Phytophthora* in soil.

“We hope by developing a repeatable and reliable eRNA protocol we can significantly reduce the time it takes to identify damaging and viable pathogens from weeks to days and improve the frequency of testing which could be critical in a biosecurity incursion.”



Researchers contributing to Better Border Security (B3) were recognised at the New Zealand Biosecurity Awards last year.



The project will be delivered in collaboration with iwi, Scion’s Te Ao Māori team, the Ministry for Primary Industries, the Universities of Canterbury and Massey, and a summer student.

The second project, *eDNA for terrestrial biosecurity monitoring*, led by Cridge will develop robust air sampling eDNA protocols for invasive species.

Cridge says detecting a lone insect (or a few insects) flying through an uncontrolled site like a port is extremely difficult.

“Testing using eDNA can help detect insect species flying through the air, and the accuracy of detection will increase as this fledgling technology improves over the coming years.

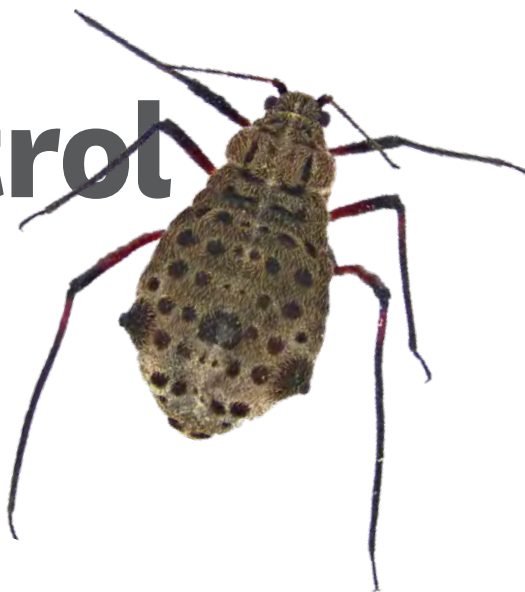
“eDNA surveillance measures have been used in aquatic environments but are not commonly used for biosecurity surveillance on land in New Zealand. The five-year project will involve the analysis of eDNA captured from the air for the identification of potentially invasive weeds, pathogens, and insects.”

Sample sites include the Port of Tauranga and Auckland Airport, and involve experts from Scion, Plant & Food Research, the University of Canterbury, Manaaki Whenua Landcare Research, and Wilderlab.

Research projects like these and their impacts were recognised at the New Zealand Biosecurity Awards in 2022 where B3 was named the winner of the Biosecurity NZ Science Award.

# Biological control of giant willow aphid recognised

A Scion scientist who helped to discover a biological control for the unwanted giant willow aphid was among the finalists of the 2022 New Zealand Biosecurity Awards.



Scion forest entomologist Stephanie Sopow played a leading role in the team from Scion, Plant & Food Research and Apiculture NZ whose collaborative research led to the release of a parasitoid wasp from California as a biological control for the invasive giant willow aphid (GWA), *Tuberolachnus salignus*.

Sopow says it was a privilege to be judged a finalist in the New Zealand Biosecurity Science Award category.

“Over many years, this research programme united people from the US, Japan, Australia and across New Zealand. We connected with citizen scientists in the US to locate enough parasitoid wasps to start a colony for testing in New Zealand. On release of the wasp, we engaged with many more stakeholders, including beekeepers, farmers and willow enthusiasts who were just as passionate about the research as we were.

“It was rewarding to work with so many people and contribute to what has proven to be impactful science for New Zealand’s biosecurity and biodiversity.”

GWA, an exotic pest, was first detected in New Zealand in 2013. It quickly became widespread, sparking alarm for its ability to cause willow tree dieback.



Scion scientist Stephanie Sopow.

The aphids suck the life out of willows, depleting them of liquids and weakening the trees, which are widely used in New Zealand for slope stabilisation, flood protection and as vital pollen and nectar resources for honeybees in the early springtime.

Feeding aphids secrete a sticky honeydew that supports the growth of sooty mould that covers cars, decks, barbecues, kiwifruit vines, fruit trees and livestock.

Pest wasps are also drawn to the honeydew, creating a twofold problem for the beekeeping industry. The honeydew leads to an increase in pest wasps that kill honeybees and rob honey. Beekeepers also lose productivity because honey produced from this honeydew is granular and can’t be extracted. The total impact of GWA has been estimated to be over \$300 million each year.

Pesticides are not an option for GWA control because they would transfer into the honeydew, putting nectar feeders such as honeybees, tui and bellbirds at risk.

Sopow and her team’s discovery of a parasitoid wasp from California that preys on GWA sparked three years of containment and host specificity testing, showing that the imported wasp only attacked GWA.

The parasitoid wasp was released in the autumn of 2020 and 2021, resulting in widespread coverage across New Zealand. The early impact of the wasp on GWA populations was monitored, finding that the proportion of aphid-free trees at these sites increased from 30% at initial release to 86% two years later.

As a biological control, the wasp is continuing to be found in new areas and GWA is becoming more difficult to locate. The research has directly benefited beekeepers, river managers, soil conservationists and farmers. Indirectly, the public also benefit as riverbanks become less prone to erosion and there are fewer pest wasps.

The programme was funded by the Sustainable Food and Fibre Futures Fund, Strategic Science Investment Fund, and research partners.

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# Flexing creativity through innovation

Morphing science, ingenuity and fun were top-of-mind when a Scion team began developing an innovative flexible 4D printing filament that also changes colour with heat.

**S**prouting from an idea created for in-house design pitch competition Innovation Jumpstart, Morph, as it's known at Scion, has now become reality through industry partners, Imagin Plastics.

The concept of 4D printing is similar to 3D, where both print three dimensional objects (using length, width and height), but 4D also features an extra dimension that changes over time. So, in Morph's case, its thermochromic properties means it changes colour with temperature.

Morph development team scientist Angelique Greene says Morph is the only flexible filament of its kind with a stimuli-responsive component.

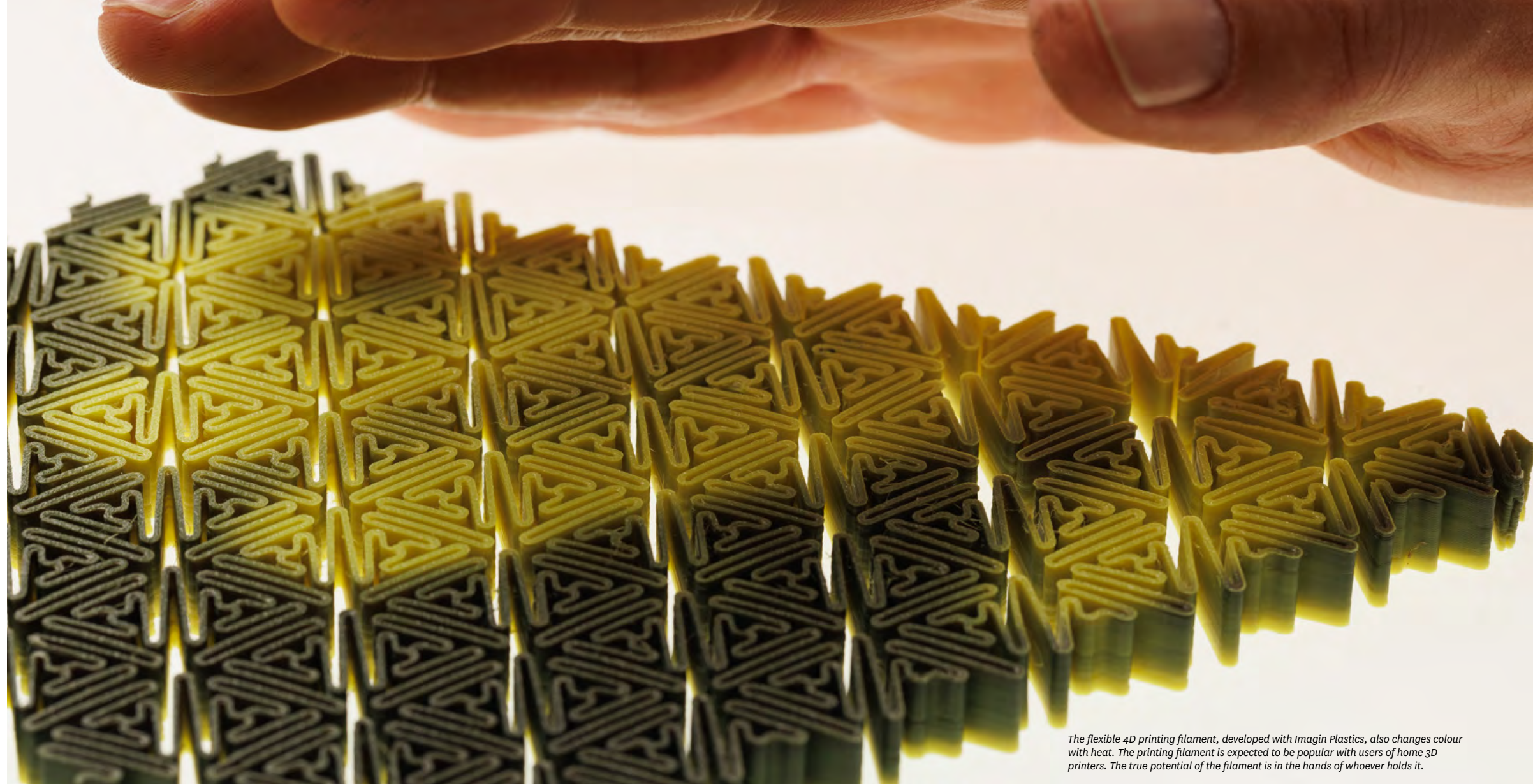
"There are other fun 4D printing filaments on the market, but they are typically rigid. We wanted to create a unique, flexible filament that had that additional functionality.

"Morph is a flexible filament that is also thermochromic. When it senses a temperature change, like holding it in your hand for example, it changes colour from black to yellow. This is the first product which combines both properties."

Morph is made from a flexible biodegradable polyester. To date, the Scion team have successfully printed a number of objects, including phone cases, animals such as an octopus and gecko, as well as moveable objects like stretchy bracelets.

Senior materials scientist Robert Abbel says although it sounds self-evident for a 3D or 4D printing filament to actually print objects, it is not guaranteed.

"Flexible materials are more difficult to print than stiff ones, so we were very happy that it performed so well. This opens up a space for creative product prototyping that has been inaccessible with existing products."



*The flexible 4D printing filament, developed with Imagin Plastics, also changes colour with heat. The printing filament is expected to be popular with users of home 3D printers. The true potential of the filament is in the hands of whoever holds it.*

Morph's commercial potential lies in the education and automation sectors in particular. In the education space, Morph has the ability to teach students about the concept of 3D printing, with an added science component thanks to its flexibility and thermochromism.

Greene says New Zealand is home to a "hobbyist 3D printing army" that will be looking to experiment with a new material as well.

"The true potential of Morph is in the hands of whoever holds it."

Innovation Jumpstart was run by Scion to foster capability and market validation for developing technologies. Despite not winning the in-house competition, Morph made a memorable impact and was subsequently picked up by Imagin Plastics after it was showcased at a Scion industry day.

With the support of the MBIE Pre Seed Accelerator Fund, the Scion team was able to work in partnership with Imagin Plastics to identify and address the challenges to overcome in order to launch the product to the 3D printing market.

Together, the teams at Scion and Imagin Plastics worked on finalising the raw feedstock before it was then turned into a printable filament.

Ben Blakley, sales and technical manager at Imagin Plastics, says what brought the two teams together was the potential around the 4D printing concept.

"We've worked with Scion on projects for a number of years in different capacities and the development potential of this project was two-fold for us – building the relationship further and bringing a 4D printing filament into the market.

"Initially we were interested in having a printing material we could see being used in the education sector, like high schools and universities, that had a fourth dimension to it. It opens up opportunities for students to use it for their own research and development."

Blakley says as well as the education space, Morph has potential in the likes of the automation industry.

"Machine componentry in the packaging and food processing industries, for example, could use the ability to detect temperature change, and even program artificial intelligence to recognise it."

Greene says now Morph is on the market, the idea is also to have an outreach programme as a way of giving back to the community.

"Our role as a Crown Research Institute is to support industry, but it's also about supporting the communities in which we operate. It was important to us we found a way to use Morph to do that and the education space is one way in which we can."

The Scion team that helped bring Morph to life includes Rob Whitton, Beatrix Theobald, Angelique Greene, Robert Abbel and Ben Davy.



*Bringing morphing technology to life (back) Robert Abbel, Ben Davy, Rob Whitton and (front) Beatrix Theobald and Angelique Greene.*

Morph is the second printing filament developed commercially in partnership with Imagin Plastics, the first being a wood-based 3D printing filament.

Blakley says: "There's no rulebook on how we work together; from our perspective, everything's possible."

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# Clothes to roads:

## Innovation explores untapped resource

The roads you drive on could soon be reinforced with unwanted textiles, reducing reliance on imported products and improving road performance.

**V**ital new funding has been secured to support Scion and its industry partner UsedFULLY, a textile recycling specialist, advance plans to turn unwanted textiles into fibre and use it to reinforce roading surfaces across New Zealand.

Funding from Waka Kotahi and MBIE's PreSeed Accelerator Fund is enabling Scion and its research partners to de-risk technology that Scion has developed so it can be commercially adopted by UsedFULLY to produce a roading additive product, StrengthTex.

A roading trial last year led by UsedFULLY and Wellington City Council tested StrengthTex using asphalt – a first for New Zealand. The new research will explore a fuller range of applications including its compatibility with chip seal. Currently 25% of New Zealand's roading network uses asphalt, with chip seal applied to the remaining 75% of roads.

Scion's portfolio leader for Distributed and Circular Manufacturing, Marc Gaugler, says the research is the next critical step needed to prove the technology's viability as a roading performance-enhancing additive.

"We have been working with UsedFULLY for many years now as part of efforts to create a circular pathway for unwanted textiles. Reusing the fibres in roading will reduce the country's reliance on imported products and improve the performance of our roads.

"Support from Waka Kotahi and its Transport Innovation Fund shows that, as an organisation responsible for our country's roading infrastructure, they are enthusiastic about the potential of the technology and what it can achieve, both for roading and New Zealand's transition to a circular bioeconomy."

The StrengthTex technology is seen as an important solution to New Zealand's problem of textile waste.

New Zealand sends about 220,000 tonnes of waste textiles to landfill each year – about half is carpet, the rest is uniforms and workwear, PPE, linens, furnishings and consumer clothing. Diverting this waste from landfills and using it as a resource could reduce greenhouse gas emissions by about 400,000 t CO<sub>2</sub>e (carbon equivalent) a year.

Disposal to landfill also comes at significant expense to end users. Currently, millions of dollars are spent disposing of unwanted textiles. Now, with the government planning to raise the waste levy by 2024, the cost of disposal will become more significant and is likely to drive behaviour change, especially for large-scale textile users, such as hospitals and rest homes.

This presents a compelling opportunity for UsedFULLY to commercialise Scion's refining technology that uses a continuous, solvent-free, scalable process to deconstruct waste textiles and transform them into a new high-value product – an ingredient for roading.



Scion is supporting UsedFULLY with technology that can turn unwanted textiles into an ingredient used to create New Zealand roads.

CREDIT: ROSA WOODS, STUFF.



Inspecting the core sample of StrengthTex roading laid on The Terrace April 2022 - Peter Thompson, co-founder UsedFULLY and Don Mudalige, team leader road maintenance at Wellington City Council.

The roading industry currently imports about 100 tonnes of cellulose each year from Europe to use in the roading mix to stabilise it, improve its workability, homogeneity and strengthen the final roading surface. The expectation is that this can be replaced with the recycled textile fibre additive, StrengthTex.

### Positive feedback

In April 2022, the first asphalt roading trials were laid in Wellington using StrengthTex. The Terrace between Ghuznee and Buller Streets now incorporates 500kgs of used textiles, conserving approximately 11,725kgs CO<sub>2</sub>e (carbon equivalent), or the emissions produced by 2.5 cars driven for a year.

It has received favourable feedback from roading contractor Fulton Hogan, which processes about 60% of the bitumen used across New Zealand's asphalt industry.

However, before the technology can be successfully commercialised and adopted by industry, Scion and its research partner WSP Research will work together on critical de-risking steps that explore the viability to use StrengthTex with chip seal and optimise fibre processing and pelletising at scale for commercial production.

Additional research will examine whether there are any environmental concerns from microplastics or microfibrils and demonstrate how there are no negative carbon/greenhouse gas consequences associated with the process and products.

A final research focus will prove that textile asphalt can be recycled by combining it with new asphalt – a requirement by contractors.

When the project is finished, Gaugler says it will be at a stage where UsedFULLY and a roading contractor can look at the technical feasibility to conduct a roading trial.

"This research is an example of collaboration that is working to support New Zealand's move to a low-carbon, circular bioeconomy. We are helping industry address a market need by giving textile waste new life. Ultimately, this will provide a sustainable business opportunity."

StrengthTex is the first of a number of industrial-scale solutions developed from unwanted textiles by UsedFULLY.

UsedFULLY co-founder Peter Thompson says its success comes down to fantastic collaboration and the expertise and enthusiasm of each of the partners involved.

"The technology not only provides a fit-for-purpose product for our roads and construction industry, it also supports organisations to take action on climate change by diverting their unwanted textiles from waste into local, real-world solutions.

"By targeting commercial linen and clothing suppliers who are highly incentivised to 'do better' with their waste, such as hospitals, prisons, retirement homes, hotels and laundries, we can establish a secure, homogenised, high-volume supply that will be easy to sort – saving more than 37,000 tonnes of commercial textile waste in New Zealand each year.

"This is an exciting opportunity, and we know the world is watching."



# New approach to predict growth of forestry tree species

An advanced computer modelling approach has been used to predict the growth of four exotic and two indigenous planted tree species.

In a paper recently published in the scientific journal *Forestry*, the methodology was applied in a way that can help predict the carbon sequestration potential of tree species for which we currently have limited growth data.

More accurate carbon sequestration in lesser-known species can help foresters plan future plantings, more accurately predict their carbon sequestration potential and help with international climate change reporting.

The modelling approach, known as limited machine learning, is highly suitable for modelling tree species where there is limited available data. It can be used to forecast more precise forest growth and carbon sequestration to help understand how different forest types and species are affected by the changing climate.

## The problem and the opportunity

New Zealand is committed on a path towards achieving a low-carbon economy by 2050 and forestry is a large part of that. To accelerate the greenhouse gas reduction process, the *One Billion Trees* programme aims to plant one billion trees in the country by 2028. Afforestation programmes can maximise their contribution to climate change via carbon sequestration following the right tree, planted in the right place for the right purpose ethos.

It sounds easy, but when it comes to carbon sequestration potential, quantifying it for each species is a challenge, except for radiata pine. With more than a hundred years of data in New Zealand and well-studied, long term and complete databases from many parts of the country, the carbon sequestration potential of this species is well known.

There are other less commonly planted tree species that are more suitable for long-term live carbon storage due to their longevity, size and wood density. Exotic Eucalyptus and Cypress species have desirable wood properties for construction, as do totara, and species such as mānuka offer environmental benefits due to their quick establishment and tolerance of a range of conditions.

However, there is not enough information on site productivity, growth and carbon sequestration to develop robust and precise carbon sequestration tables for less commonly planted species.

New Zealand's current Emissions Trading Scheme (ETS) aggregates exotic species into two generalised carbon look-up tables: exotic softwoods and exotic hardwoods. Native tree species from various forest types are grouped into a single forest type – indigenous forest.

That's just the sort of challenge that excites Scion tree ecophysiologicalist, Dean Meason. He says these broad species carbon sequestration tables could potentially over or underestimate tree growth and forest carbon sequestration.

"This may cause challenges for regulation of the government's ETS scheme and international reporting. Without more precise site- and species-specific information on the suitability of individual species, there is little incentive for landowners to establish less commonly planted tree species in forests for carbon sequestration."

This species by site planting information requires data. Forest growth data are typically captured by inventorying a large network of Permanent Sample Plots (PSPs). These are small areas, typically 0.04ha where researchers intensively measure the growth of trees over time.

The first PSPs were established in the 1920s and the PSP system is one of the most extensive data resources on tree growth, internationally. Today, the system holds data from 32,000 PSPs of which 11,500 are current and 20,500 are historic records. Most of these PSPs are for radiata pine.

While the datasets for radiata pine are comprehensive, the same quantity and quality of data is rarely available for less commonly planted species. Dealing with patchy datasets is tricky using conventional statistical approaches. Although this project was able to supplement the Scion PSP database with additional data from the Ministry for Primary Industries (MPI) Farm Management Approach (FMA) and Ministry for the Environment's (MfE) Land-Use and Carbon Accounting System (LUCAS) databases, the tree species' datasets were still patchy. Predicting carbon sequestration for less studied species requires a new approach beyond statistics as usual.

## Machine learning

Machine learning approaches can help overcome some of the challenges when predicting tree growth from limited data inputs.

Machine learning is a type of artificial intelligence that allows software applications to become more accurate at predicting outcomes without being explicitly programmed to do so. It is a method that is especially useful at interpreting incomplete or historical information to predict the future.

In this study, a machine learning algorithm was used to predict tree diameter at breast height (DBH, 1.4 m) in response to age, stocking, site and climatic factors. This was studied for planted Mexican cypress, macrocarpa, Eucalyptus nitens, coast redwood, totara and mānuka.

Data to build machine learning models were combined from national databases, and they included stand variables, information about management, sites and climate features.

The computer models were able to predict tree DBH with high precision for the five tree species and to disentangle the many complex factors that influence DBH in these species.

This is the first attempt to utilise machine learning approaches to model tree diameter of less common planted forest tree species in New Zealand. While strictly applied to DBH in this study, this approach can be used to forecast more precise forest growth and carbon sequestration. This can help researchers and foresters to develop more accurate forest growth models and to improve current carbon look-up tables for New Zealand.

This research was funded by the MPI Sustainable Land Management and Climate Change research programme.



# Small things add up

Microplastics in our oceans may be small, but they're mighty – and not in a good way. But there's hope for the future with research, involving Scion, that's shining a new light on the scale of the problem, and what can be done to minimise its impact.

**T**here's estimated to be more than 15 trillion pieces of microplastic debris in the world's oceans, 80% of which come from land-based activities.

Microplastics are pieces of plastic smaller than five millimetres and can either be produced at that size or result from the fragmentation of larger items over time.

Their tiny size means they can contaminate marine and terrestrial ecosystems in a huge number of ways, impacting not only the environment, but animals and people too.

Because microplastic research is a relatively new area of investigation, these impacts are largely unknown.

To find out the scope of impact of microplastic pollution in New Zealand, Scion has partnered on the Aotearoa Impacts and Mitigation of Microplastics project, or AIM2.

As the first comprehensive research project of its kind in New Zealand, the goal is to establish the current level and types of microplastic pollution, where it's come from and where it goes. The risks and impact on our environment, economy and wellbeing are then assessed, as well as what can be done to minimise the amount of plastic finding its way into our natural environment.

Led by fellow Crown Research Institute (CRI), the Institute of Environmental Science and Research (ESR), Scion has been working alongside Nothcott Research Consultants, the University of Canterbury, University of Auckland and the Cawthron Institute, as well as regional councils, and community and iwi groups.



*Microplastics under the microscope: The different shapes, sizes and colours found in samples.*

## Solidifying the facts

Scion project leader Kate Parker says despite knowing they were there, until recently very little has been done in the microplastics research space.

“We started our research with the question, ‘How do we get rid of them?’ but quickly needed to step back and prove they’re there – and how much.”

Microplastics have been largely ignored in the past, due to the prevalence of their more visible and larger counterparts, macroplastics – think straws and plastic bags.

“Microplastics have been ignored because they’re not easily seen. Scion has set up leading methods to measure, quantify and identify the microplastics in our marine environment.

“We’ve been able to provide comprehensive data on the amount of microplastics in our marine environments, as well as their characteristics and where they’ve come from.”

Sand samples were collected from 61 sites across Northland, Auckland, Waikato and Canterbury from beaches,

harbours and marinas. Samples were also taken from a wastewater treatment plant.

Results were similar across the four regions, which found fibres, potentially from the likes of clothing, laundry or geotextiles such as weed matting, were the biggest culprit, making up two-thirds (66%) of the microplastics found.

The most common types of plastics found were polyethylene (PE), polyethylene terephthalate (PET) and polypropylene (PP): That's plastic from soft drink and milk bottles, clothing and upholstery, buckets, camping equipment and construction material, to name but a few.

Auckland had the largest amount of microplastic pollution, due to population size, while the West Coast had more pollution compared to the East Coast, likely because of ocean currents transporting microplastics from elsewhere.

## Risks and impacts

AIM2 is about more than just the physical aspects of plastics in our environment. It's also been tasked with looking at the environmental impacts, both direct and indirect.

This has included trials on what happens to plastics submerged in the water.

Paddles were created from commonly found plastics and submerged in the ocean for different timeframes – three, six and 12 months.

The goal was to find out how the plastics changed over those time periods, what biofilms grew (and the health of those organisms), whether leaching of plastic additives was occurring and the potential impact that was having on the environment.

Half the paddles were weathered in the lab before being submerged, to compare whether aged and weathered plastics behaved differently once in the water than 'newer' plastics.

Scion researcher and PhD student Jamie Bridson is doing his thesis on the fate of plastic additives once they're in the ocean.

Additives include things such as colourants, chemicals that strengthen plastics or make them more malleable, UV inhibitors or processing aids.

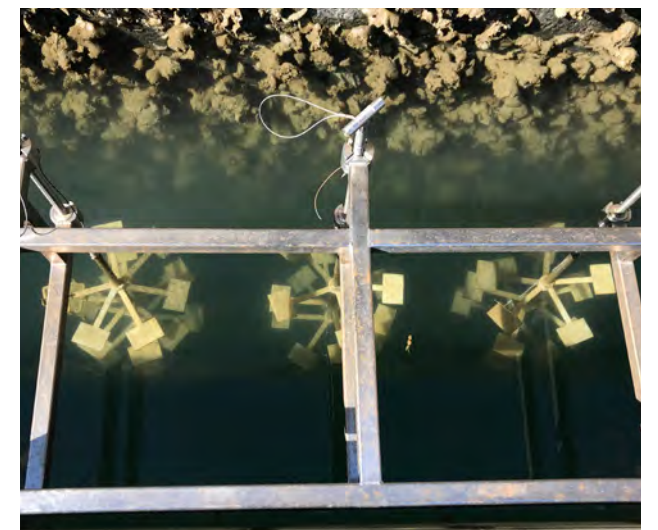
“Do they leach, or do they stay in the plastic? What happens when they leach? And what happens when that plastic is ingested by a fish, for example?”

Once the data from the plastics trial has finished being analysed, the information will help inform risk assessment methods and models here and internationally.

“What we know is that different plastics and additives all behave differently, so there won’t be a one-size-fits-all approach to looking at solutions.”



*Microplastics in disguise: Hiding in plain sight along our beaches.*



*Paddle trials investigated what happens to different plastics when submerged over time.*

## Trailblazing methodology

Scion has led the international methodology on the detection of microplastics and their characteristics, through the use of an automated infrared microscope.

Bridson says because this is a new field of research, Scion wanted to do things differently – namely automating the analysis process.

"In the past, analysing microplastics has been extremely laborious. Every piece of microplastic had to be found, counted and carefully retrieved by eye under a light microscope.

“We needed the process to be more automated and less subjective, so we decided to use an infrared microscope, which detects not only the amount and size of each particle, but also what type of material it is.

“Each material absorbs infrared light differently, which acts like a fingerprint, and enables us to determine what’s present and where that material may have come from.”

Risk assessment and education around how to reduce microplastic pollution will be the next important steps for the AIM2 project, which is set to wrap up in September 2023.

Another follow-on project is also in the pipeline, to look at what can be done to address the issues identified by AIM2, and how to reduce the amount of microplastics entering our environments.





# Scion develops R&D solution to tackle plastic waste for nurseries

Scientists Maxime Barbier and Gerty Gielen, pictured in Scion's accredited biodegradation testing facility, played key roles in the development of biodegradable plant pots for nurseries.

Scion scientists have been instrumental in developing and testing biodegradable nursery pots that will help nurseries and Kiwi gardeners to reduce plastic waste and its impact on the environment.

The biodegradable pots, made from biopolymers and a biofiller, will offer an alternative to the estimated 350 million plants in plastic pots produced by New Zealand nurseries each year.

Manufacturing of the pots is scaling up after production processes are fine-tuned using funding received from the Government's Plastics Innovation Fund announced by Environment Minister David Parker last year. The pots are expected to be commercially available by September 2023.

The successful prototype, PolBionix, has been four years in development at Scion as part of a project with commercial client Wilson and Ross.

Director Peter Wilson engaged the services of Scion's expert biomaterials and biodegradable testing team to develop and test a formulation for a product that meets the requirements of a nursery, last at least 12 months above ground then, after it's planted in soil, continues to biodegrade. The pot then provides fertiliser for the plant as it breaks down, supporting plant growth.

Polymer technologist Maxime Barbier developed various formulations in the project's discovery phase, with product testing carried out in small batches. Early results were mixed; however, the team eventually developed a prototype that showed promising biodegradation properties in 2020.

Scientist and technical lead of Scion's Biodegradation Testing Facility, Gerty Gielen, joined the project after the strong candidate was found. More in-depth analysis was then done using Scion's accredited biodegradation testing facility, the only one of its kind in Australasia.

"Biodegradation is defined as the breakdown of material into carbon dioxide, water and microbial biomass. That's what we were testing for in our facility that mimics typical conditions for home composting. We found one product responded very favourably after 12 months."

Gielen says the results are extraordinary.

"People have explored the idea of creating biodegradable plant pots for at least 10 years and many companies have given up along the way. There are so many formula combinations and permutations, so to discover a formula that works feels like winning the lottery."

Barbier says the research is a perfect example of Scion's scientific focus on helping New Zealand transition to a circular bioeconomy and to be less reliant on products made from fossil fuels.

"The new product uses biopolymers made from sustainably grown sugarcane, cassava or corn. We combine that with a biofiller of waste organic matter. Diverting that waste into a product like this adds value in the manufacturing process, which is the circular bioeconomy in action."

"Importantly, the end result are products that can reduce plastic pollution in New Zealand and carbon emissions."

Scion's scientific discovery during the testing phase has resulted in the filing of two international patents.

Wilson handles the commercialisation of the PolBionix-trademarked product, which can be produced using existing plastic injection moulding processes. The product can also be manufactured with thermoforming and film blown processes.

The biodegradable pots are being tested in three commercial nurseries. Auckland City Council has also trialled the planting of 100 PolBionix pots in Waitawa Regional Park. A further 100 pots were planted last August at Anchorage Park School as part of Auckland's Eastern Busway Infrastructure project.

In addition to significant private investment, funding support over the past four years of research has come from Callaghan Innovation, Auckland Council's Waste Minimisation Fund and the Ministry for Primary Industries through its Sustainable Food and Fibre Futures fund.

Wilson is excited about the opportunities ahead for the product and its widespread adoption by nurseries, both for home gardeners and planners of large-scale infrastructure and environmental restoration projects, especially near waterways.

"The new product uses biopolymers made from sustainably grown sugarcane, cassava or corn. We combine that with a biofiller of waste organic matter. Diverting that waste into a product like this adds value in the manufacturing process, which is the circular bioeconomy in action."

MAXIME BARBIER, SCION

"Raw material costs for PolBionix are higher than for traditional fossil-based plastic pots, so PolBionix pots will be more expensive. However, there are costs saved by not having to add fertiliser, or face charges for disposing of the traditional pots in landfill. Any recycled pots currently need cleaning which adds a cost to nurseries. Planting should also be quicker, so there's reduced labour costs for large-scale projects too."

Long-term, Wilson is keen to explore other applications for the product across agriculture and horticulture.

"The problem of plastic pollution we face in New Zealand and, indeed, the

world is significant. This project demonstrates Scion's capability in helping solve these challenges. Their input has been invaluable to the success of this project."



Wilson and Ross Limited director Peter Wilson shows the PolBionix pots to the Minister for the Environment David Parker.



# Scion gets salty with marine biology

Scion's conservation projects have turned a little salty, with marine biosecurity a focus of one partnership project currently in the water.

**T**he Marine Biosecurity Toolbox (MBT) is a five-year research project looking at protecting New Zealand's marine environments by managing marine pests and invasive species.

The research addresses how to reduce biofouling – marine pests and organisms that attach and grow on marine infrastructure such as marinas and the underside of boat hulls – and how to encourage the settlement of native species like green-lipped mussels.

The project is being led by the Cawthron Institute, in partnership with Scion, Otago University, Ministry of Business, Innovation and Employment (MBIE), and a unique group of science, Māori, regulatory and industry organisations.

Scion has been able to use its expertise around economic modelling and 3D printing capabilities to help researchers collect data on how best to manage potential risk, prevent pest establishment, and detect and respond to new incursions.

This valuable data will then help to create regional, domestic and international biosecurity tools that will empower government, tangata whenua, industry and the community to protect and add value to our marine environments and their associated commercial, cultural and recreational values.

The project is built around four main research themes: protect, detect, manage and respond, as well as economics and decision support.

## A new approach

Scion project leader Rob Whitton says with native habitats in decline, there has been greater opportunity for invasive species to move in.

The team has been looking at how to encourage the settlement of native species, in particular green-lipped mussels, to help displace any pest species looking to settle.

"We've taken a different approach to this than what's been done in the past, by looking specifically at what's already present on the reef in the intertidal zone where mussel spat settle, and then working back from there."



Scion project leader Rob Whitton 3D scanning the intertidal reef where mussel spat settle to learn more about the surfaces they most favour.

This has included 3D scanning the reef where mussel spat currently settle and then replicating the surfaces using 3D printing, and assessing what structure and geometry are most favoured by wild mussel spat.

"Not much is currently known about mussel settlement preferences. We've taken a number of tiles into the lab to see how mussel spat settle on the geometry we've replicated."

What materials mussel spat favour, like rocks or other mussel shells for example, is also being investigated. Next steps include producing larger substrates that incorporate the favoured features and materials identified in the lab, for sea trials.

Increasing native species is of added importance in a cultural context, like growing the abundance of mahinga kai, and in the case of mussels, improving water quality and filtration.

## Engaging the public

Wider project goals have explored identifying what invasive species are present in our marine environment – work that has involved connecting with a focus group to better understand the communication channels that people would engage with to actively report any marine pests they detect.

The project is also seeking feedback from boat users. Invasive species tend to settle easily on smooth surfaces and man-made structures like boat hulls and marinas. Research has examined current behaviours and travel patterns of recreational and commercial boat users – information that will help scientists and biosecurity authorities to manage and respond to patterns of spread and potential marine pest hotspots.

## Valuing marine environments

Another research area has delved into how much implementation initiatives would cost to create a healthier marine environment, and what the wider benefits would be.

Scion research economist Richard Yao and his economics and decision support researchers have developed valuation techniques that can quantify the values of the broader benefits, like the increase in seafood, cleaner water, better recreation and aesthetics, as well as Māori cultural values.

“Not much is currently known about mussel settlement preferences. We've taken a number of tiles into the lab to see how mussel spat settle on the geometry we've replicated.”

ROB WHITTON, SCION

"It's challenging to assess the multiple values on improving our marine environment because there are so many different aspects to take into account. Fortunately, the MBT programme team is a multidisciplinary research team that has expertise in marine

ecology and social science.

MBT also has end users from government agencies and related industries who also provide inputs on the design of the assessment of multiple values."

## What next?

A national survey of recreational boat owners with vessels permanently in the water is being developed to help gauge the willingness of boat owners to either pay money or spend time on education and training, to keep their boat hulls free from biofouling.

The Marine Biosecurity Toolbox project is set to wrap up in September 2024 with much

data analysis, including what decision support and actions will be, still to be completed.

This project has also led Scion to develop and test new assessment methods for examining the marine ecosystem's wider value to the economy, environment and society, including environmental enhancement, recreation and Māori cultural values. These have the potential to be applied back to the likes of forestry, freshwater and urban ecosystems.



Mussel substrates recreated in the 3D printing lab.

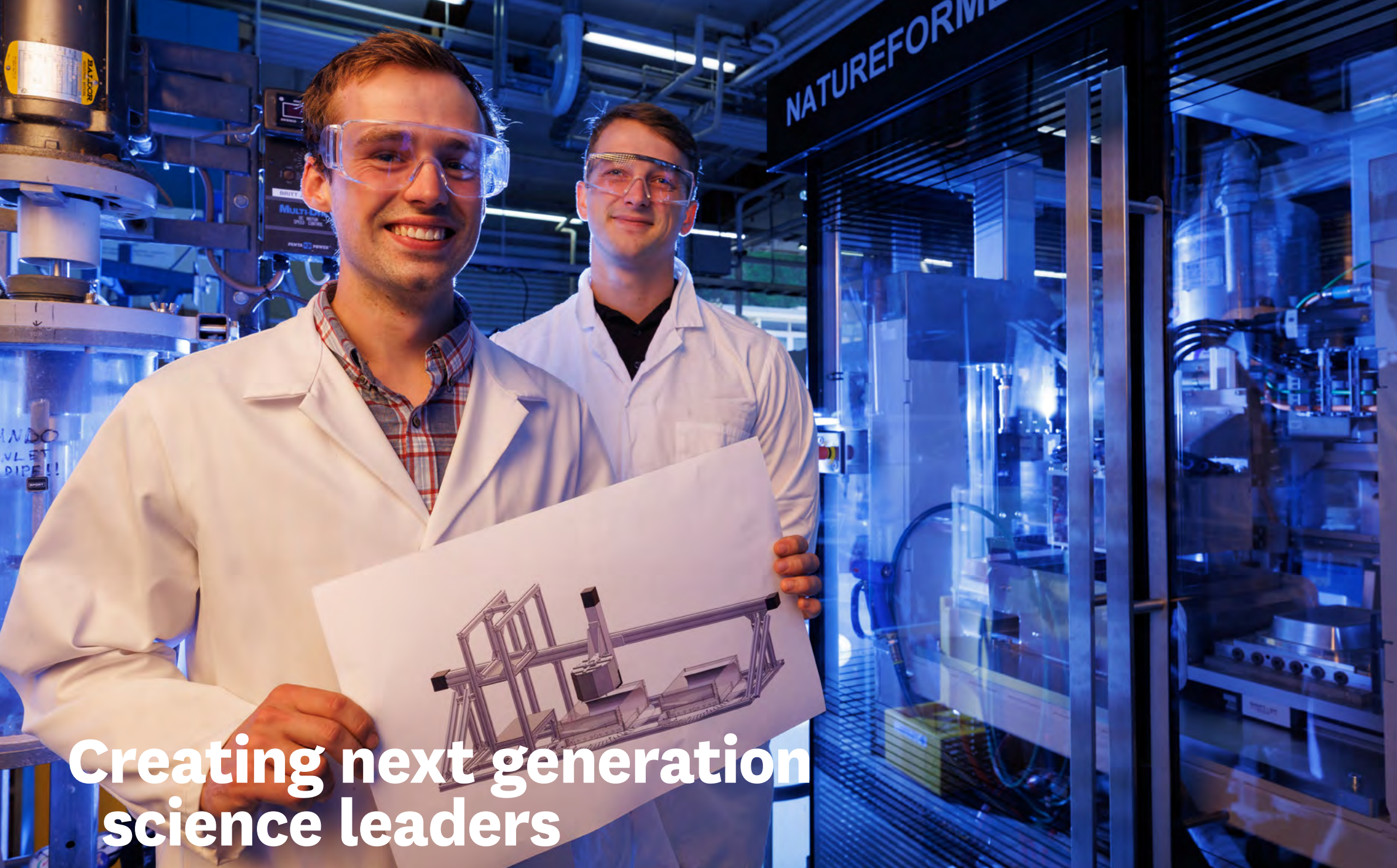


Recreating surfaces in the lab using 3D printing.



Scanning intertidal settlements favoured by green-lipped mussels.





# Creating next generation science leaders

What better way to spend summer than working in Rotorua with Whakarewarewa Forest right on your doorstep? Twenty-eight university students from around New Zealand took the opportunity to combine their love for science and the city by completing summer internships at Scion.

**T**his diverse and skilled group worked across various research areas, including entomology, the nursery, geospatial science and contributed to the success of Scion's corporate teams. Students were based in Rotorua and Christchurch.

University of Auckland Masters of Bioscience Enterprise graduate Janet Reid explored applications for seaweed nanocellulose that were developed through the collaboration between Scion and AgriSea.

"Over the summer I developed nanocellulose-based air filters that could potentially be used in medical devices such as ventilators," she says.

"Manufactured from AgriSea's waste stream, this nanocellulose is a perfect example of a high-value circular product made from a unique New Zealand resource.

*Caelum Betteridge was mentored by Karl Molving during development of a benchtop thermoformer design.*

"The nanocellulose is applied to a paper or glass fibre scaffold using a vacuum filtration technique. Once it dries, it forms a thin layer that can filter out very small particles.

"I used scanning electron microscopy to examine the surface of the filters, which let me observe how the nanocellulose fills gaps between the fibres of the scaffold material. As a natural, biobased material, these nanocellulose filters could provide a biodegradable replacement for the synthetic filters that are used in medical devices."

She says the internship provided a great introduction to new techniques.

"Scion's expertise in wood-based products can be translated to novel materials, like seaweed, allowing more efficient product development."

University of Canterbury Bachelor of Engineering (Honours) graduate Caelum Betteridge spent the summer designing a benchtop thermoformer for the pulp lab.

"As a freshly graduated mechanical engineer it was great to have such a friendly and experienced team to provide guidance.

"There was plenty of learnings – from ordering parts, designing, manufacturing, assembling, coding and electronics. I enjoyed the opportunity to own a project and carry it through the full design process."

He also enjoyed the culture at Scion and is proud to have contributed in a small way to a more sustainable future.

Betteridge's project supervisor Karl Molving says his involvement allowed the team to progress much quicker than they could have alone.

"He was very self-driven and creative. He not only contributed to all parts of the project but also owned it and made sure it was constantly progressing."

Six students worked in the area of Materials and Manufacturing. Portfolio leader Marc Gaugler says the summer student programme is a powerful addition to any research project. Having someone on the team available that can dedicate large chunks of time to a specific piece of work has huge benefits.

"Summer students bring lots of enthusiasm into the workplace and get a lot done in a very short period of time.

"They bring an external view to the projects; we often get to focus on a certain direction and having a fresh look and unexpected questions helps us to move forward.

"It also gives the potential next generation of Scioneers an insight into who we are, what we do and why we do it."



*Janet Reid using a vacuum filtration setup to apply a layer of nanocellulose to a paper scaffold.*



# Excellence rewarded

## Success for Scion and AgriSea partnership

It has been a rewarding time for many staff at Scion, acknowledged for their science excellence, leadership and efforts to drive innovation and commercialisation of research.

Scion's collaboration with AgriSea resulted in two major accolades in 2022.

In September the Scion team won a Primary Industries Award at the Kudos Awards in Hamilton. The team and AgriSea were congratulated for their work building on Scion's pulping expertise and AgriSea's 26 years in seaweed processing, resulting in a novel seaweed hydrogel. The win came only a month after AgriSea won the coveted NZ Hi-Tech Kamupene Māori o te Tau – Māori Company of the Year Award for 2022. The award highlighted the company's work with Scion in developing the hydrogel as part of its mission to create a high-value and sustainable seaweed industry.

The partnership now spans more than five years and was sparked by a casual conversation about how Scion could extract nanocellulose from AgriSea's seaweed waste.

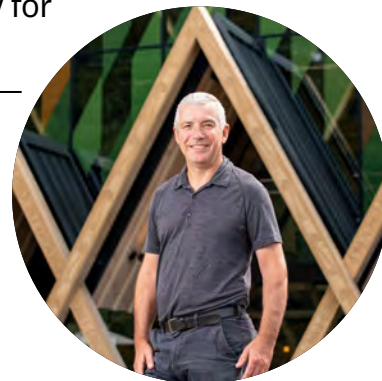
Seaweed nanocellulose has unique properties not found in tree-based nanocellulose. The technology has been licensed to AgriSea to continue the development of hydrogels. Paeroa will be home to the world's first commercial seaweed nanocellulose facility at AgriSea, with the \$1.5 million project creating nine new full-time roles. Scion has produced a concept design for the bio-refinery and is now working with Callaghan Innovation to develop the final design ahead of its construction.



Dr Jonno Hill from Hill Laboratories (far right) presented the Primary Industries Award to the team from Scion and AgriSea. Pictured (from left) is Rob Whitton, Yi Chen, Marie-Joo Le Guen, AgriSea chief executive Clare Bradley, and Stefan Hill.

## New advisory role for Dr Paul Bennett

In a nod to his international bioenergy leadership, Scion's Dr Paul Bennett has been appointed to a research advisory group providing guidance to Australian officials looking to establish a biofuels industry for aviation.



Dr Paul Bennett, portfolio leader – Integrated Bioenergy.

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) is collaborating with aviation giant Boeing on a Sustainable Aviation Fuel (SAF) Roadmap for Australia and is starting by considering the availability and cost-effectiveness of suitable biofuel feedstock.

Together, they've formed an advisory group tasked with exploring feedstock options to inform the roadmap and highlight the opportunities for Australia's aviation sector to significantly reduce its greenhouse gas emissions and improve its energy security by adopting biofuels.

Bennett, Scion's portfolio leader for Integrated Bioenergy, is participating in the group which allows him to strengthen trans-Tasman research relationships and directly participate in biofuel discussions with Boeing, one of the world's largest aircraft manufacturers.

He says development of an SAF industry in Australia is at the same early stage as New Zealand's, and supporting its development had benefits to both markets.

"Trans-Tasman routes are amongst the busiest airline routes in the world. Aligned cross-Tasman development will enhance the attractiveness of the SAF market to technology providers and investors."

The advisory group examining the market opportunities for SAF is expected to complete their findings by mid-2023.

## Amanda Davies appointed to KiwiNet board

Scion Innovation manager Amanda Davies has been appointed to the board of the Kiwi Innovation Network (KiwiNet) as a Crown Research Institute representative director.



Amanda Davies, Innovation manager

She brings a deep understanding of the commercialisation ecosystem, having overseen the allocation of the PreSeed funding as a KiwiNet Investment Committee member.

KiwiNet is the combined power of 19 of New Zealand's universities, Crown Research Institutes, and other research organisations, working together to transform early-stage discoveries into products and services that will have social, environmental, cultural, and economic impact for Aotearoa New Zealand.

KiwiNet CEO Dr James Hutchinson says Amanda is highly accomplished and the board looks forward to her contributions.

"Amanda was a stand-out candidate for the KiwiNet Board representative director role. Her appointment is extra special because it follows her involvement in the 2021 *Women in Leadership Development (WILD) programme*."

The WILD programme, led by KiwiNet and Brandon Capital, aimed to enhance the leadership capabilities of women in the fields of Science, Technology, Engineering and Mathematics (STEM) through a year-long governance course.

Davies says the programme helped her identify where she could bring real value to a board and contribute to the growth of the sector.

## Alec Foster serving on BioTechNZ's Executive Council

Alec Foster, Scion's portfolio leader for Bioproducts and Packaging, has been appointed to the board of BioTechNZ's Executive Council for a two-year term.



Alec Foster, portfolio leader – Bioproducts and Packaging

In his role at Scion, Foster has hands-on knowledge of working with New Zealand companies to create, manufacture and use bioproducts. Before joining our team, he led one of Europe's largest synthetic biology programmes, developing new materials with genetically engineered microorganisms. With more than 40 patents and experience with world-leading biotech companies, Foster brings a unique insight into the science, materials and technologies of the future.

BioTechNZ joined the New Zealand Tech Alliance in July 2018. Governed by the Executive Council, it is dedicated to maximising the ways biotech can help address many of the world's agricultural, environmental and health problems.

Executive Director Zahra Champion says Foster is a huge asset to the BioTechNZ Executive Council, due to his knowledge in biological-based technologies and their ability to provide solutions to the global challenges that New Zealand is facing.

"It's an exciting time for our sector and I'm excited about Alec joining us with his knowledge about synthetic biology and genetic technologies – these are key to the solutions for a better tomorrow."

Foster says he's delighted to be involved in the council and connect with people across the industry.

"There's a lot occurring in the biotechnology space, which is going to be a primary driver for New Zealand's success in the future. I'm welcoming the opportunity to network and maximise the benefits of biotech for New Zealand, and it ties in nicely with what Scion is wanting to achieve as well."



# GM confirmed as Honorary Professor

Dr Florian Graichen, Scion’s general manager - Forests to Biobased Products, has been recognised by the University of Waikato.



Florian Graichen, general manager – Forests to Biobased Products.

He has been appointed as an Honorary Professor in the School of Engineering, within the Division of Health, Engineering, Computing and Science.

Acting Dean Mike Duke says Dr Graichen’s expertise and goodwill is much appreciated.

“Partnerships with industry ensure we’re always at the top of our game,” Professor Duke says. “We’re delighted to have Dr Graichen sharing his expertise and experience with our students.”

Dr Graichen is looking forward to working with the University of Waikato team on exciting sustainability topics.

“Meaningful partnerships like this between University of Waikato and Scion are the lifeblood of success in innovation and science.

“Cross organisational and cross sectorial innovation – mission led - will dominate the 21st century. We need to leave sector, organisational and discipline silos behind.

“Partnerships beyond science are so important. To create impact from science investment, many like-minded people and organisations - iwi, government, industry and academia - have to come together, work together in order to succeed together.”

The term of Dr Graichen’s appointment lasts until 31 December 2025.

# Roadmap for Oceania

Scion is guiding efforts aimed at reducing plastic packaging and plastic pollution across Oceania.

The Australia, New Zealand, and Pacific Islands Plastics Pact (ANZPAC) brings together key individuals from more than 100 organisations to accelerate a circular economy for plastics. Collectively, they have developed a roadmap that looks to drive change and behaviour among manufacturers and consumers of plastic packaging.

Dr Florian Graichen, Scion’s general manager – Forests to Biobased Products, is among industry experts on ANZPAC’s Collective Action Group (ACAG) tasked with shaping strategic priorities and to guide a programme of work being rolled out to 2025.

The roadmap is focussed on four targets:

- Eliminate unnecessary and problematic plastic packaging through redesign, innovation, and alternative (re-use) delivery models.
- 100% of plastic packaging will be reusable, recyclable, or compostable by 2025.
- Increase plastic packaging collected and effectively recycled by 25% for each geography within the ANZPAC region.
- Average of 25% recycled content in plastic packaging across the region.

One of the key resources for influencing the direction of change for ANZPAC is Scion’s report, *Making zero the hero*, released in 2022. It focuses on re-using and recycling the plastics we mostly use now and stopping them from escaping into the environment. It identified the challenges, barriers and opportunities to understand how global plastic supply chains are part of New Zealand’s transition to a New Plastics Economy.

Combining Scion’s report with other Australasian plastics initiatives, it is hoped the shared knowledge, industry-led innovation and coordinated action will achieve the targets that feed into the globally aligned Ellen MacArthur Foundation global Plastics Pact Network.

To achieve ANZPAC’s Regional Plastics Targets, APCO (ANZPAC lead organisation) chief executive Chris Foley says that the region needs to substantially change its relationship with plastic packaging.

“The ANZPAC Roadmap to 2025 outlines the essential actions and collaboration we need from all key players across the region to develop a circular economy for plastics.

“Organisations such as Scion help ANZPAC to understand the unique position and barriers of businesses and organisations in New Zealand and provide the insights to develop solutions that work across our diverse geographies.”

ANZPAC’s Roadmap to 2025 report shows that in 2020, an estimated 1.3 million tonnes of plastic packaging entered markets across Australia, New Zealand and the Pacific Islands. Only 16.6% of this was effectively recovered through recycling.

# Celebrating research excellence

Scion’s leadership in forestry science, bioplastics research and biotechnology was celebrated by Scion and our peers at the 2022 Science New Zealand Awards.



Team Award recipients (from left) Taryn Saggese, Mark West, Alyesha Candy, David Hooks, Diahanna O’Callahan, Christophe Collet, Sumanth Ranganathan, and Gareth Lloyd-Jones.



Individual/Lifetime Achievement Award recipient principal researcher Dr Mike Watt.



Early Career Researcher awardee Dr Angelique Greene.

Scientists from all seven Crown Research Institutes and Callaghan Innovation were represented at the awards ceremony in Wellington. The awards were in three categories – Early Career Researcher, Lifetime Achievement, and Team.

Scion chief executive Dr Julian Elder says the awards showed the depth and breadth of talent across Scion and lifted the profile of their impactful research for New Zealand.

Scion principal researcher Dr Mike Watt received one of eight Individual/Lifetime Achievement Awards for his distinguished scientific career spanning more than two decades. He has made significant contributions to several research areas with notable influence within the areas of forest science, weed management, forest growth modelling and, most recently, remote sensing.

He has produced 173 peer-reviewed publications across a range of topics connected to forestry, making him one of our country’s most prolific and trusted forest researchers. His scientific explorations have advanced knowledge of our nation’s forest estates, providing opportunities for industry to translate his research into practice – adding enormously to the health and economic value of plantation forests across Aotearoa.

An Early Career Researcher Award was presented to Dr Angelique Greene, one of Scion’s most creative and productive emerging scientists since joining Scion’s Biopolymers and Chemicals team.

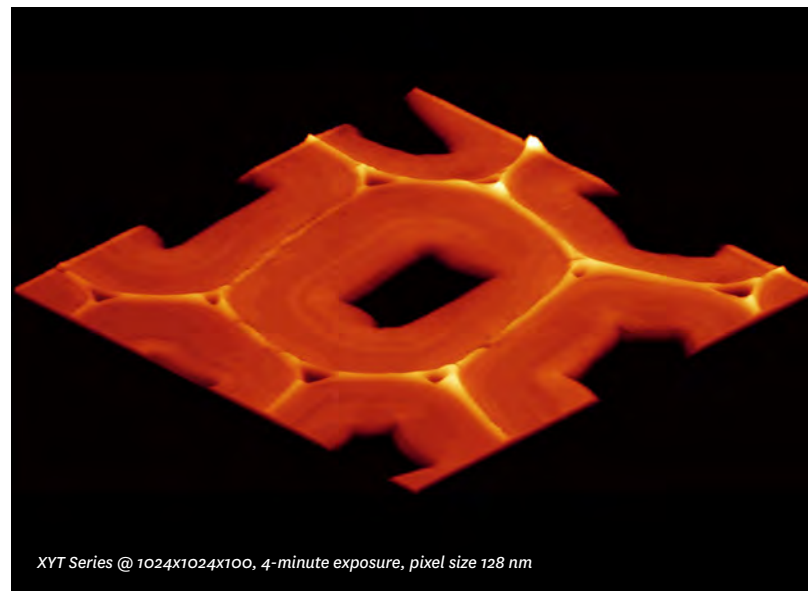
Her keen sense for immediate commercial impact has been demonstrated through the success of her Innovation Jumpstart project that developed into a collaboration with Auckland-based filament manufacturer Imagin Plastics. Together with Scion, and with very significant input from Greene, they have developed an innovative new product targeting users of home 3D printers.

The Team Award was the third category and Scion’s awardee was the CVC Vaccine Biotech Team. The interdisciplinary team partnered with CVC (Covid-19 Vaccine Corporation) to contribute to the global fight against SARS-CoV-2 by helping to develop and manufacture an experimental Covid-19 vaccine.

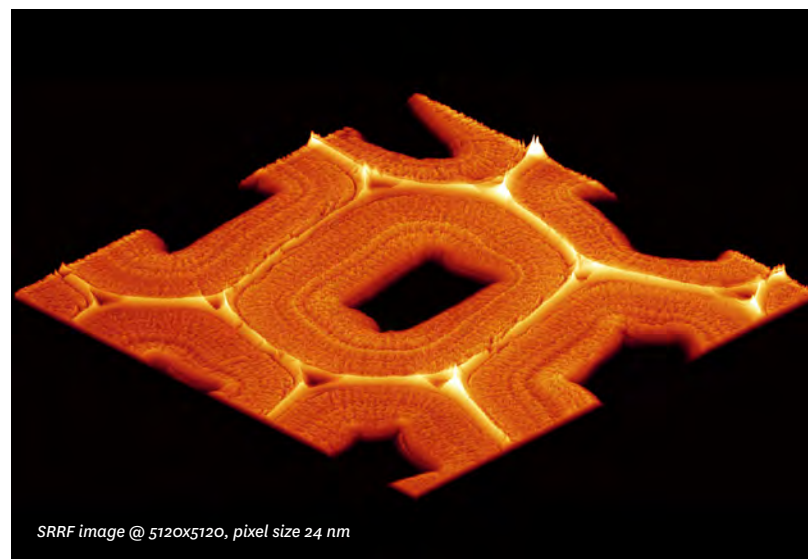
The team worked through early stages of the pandemic with CVC to fast-track the production of vaccine prototypes that CVC took into pre-clinical testing. Scion’s team designed fermentation techniques to produce vaccine material, cultivating it in fermenters before purifying it for further testing offshore. Scion’s resources and expertise working with PHA-producing bacteria, combined with the ability to work flexibly in the face of a global health challenge, was critical to CVC achieving proof of concept for their strategy.



# Wood in super resolution



XYT Series @ 1024x1024x100, 4-minute exposure, pixel size 128 nm



SRRF image @ 5120x5120, pixel size 24 nm

A stunning image in normal resolution (top) vs super-resolution of a Douglas fir wood cell showing details of the cell wall.

Resolution  
~220 nm

Resolution  
<100 nm

Excitation 561 nm,  
glycerol immersion lens NA 1.4

A protocol for super-resolution imaging of xylem cell walls using sophisticated microscopy techniques has been developed by Scion scientist Dr Lloyd Donaldson.

In a recent paper the developed protocol provided remarkable new details of wood cell wall structural features and demonstrated nanoscale variations in lignification and cell wall porosity.

Donaldson is an internationally recognised expert in capturing images of the cell structure of plants and plant anatomy. He has pioneered techniques in confocal fluorescence imaging of wood and biomaterials, with his methods forming a part of researcher toolboxes globally.

The techniques he has perfected, however, go well beyond great looking images. His expertise has allowed him and many other researchers to better understand the structure and function of wood, plant diseases, historical samples and numerous other materials.

Original paper in open access:



## Photography exhibition

celebrates 75 years of impact

A new photography exhibition is taking visitors to Te Whare Nui o Tuteata on a trip down memory lane of research and innovation at Scion.

In April 2022 the Crown Research Institute (CRI) turned 75 and, as part of a series of events across the year marking the special milestone, staff have dug deep into the archives to celebrate the people and research activity that have shaped Scion's history of impact in New Zealand's forestry sector.

Eight photos are on display in an intimate gallery space in Scion's Rotorua building, Te Whare Nui o Tuteata until April 2023. They are a visual record of Scion's research expertise and offer insights into the methods and equipment used over the years by scientists exploring radiata pine productivity, site mapping, tree genetics and nursery management – all work that has helped to create New Zealand's third largest industry for export goods.

Snapshots taken in the field, from the sky and inside Scion's laboratories transport visitors back in time and serve as a reminder of how technology, fashion and architectural trends have changed over many decades.

The public is welcome to pick up a bookmark with images from the free exhibition, accessed near Scion's reception, as a memento.

Since 1947, Scion's expertise has grown from research to support the development of sustainably managed exotic plantation forests to supporting New Zealand's transition to a circular bioeconomy. In this new era, Scion remains committed to enhancing New Zealand's prosperity, wellbeing and environment through trees.

The 75th anniversary has provided the CRI with fresh opportunities to share its work with the community and invite visitors into Te Papa Tipu campus, where Scion is headquartered in Rotorua.



