

B3 Annual Report

DAJ TEULON

2017-18



Adding Value to New Zealand's Biosecurity
System through Research



B3

Science Solutions for
BETTER BORDER BIOSECURITY
www.b3nz.org

B3's aspiration

New Zealand has a world-leading science-based plant border biosecurity system, ensuring the welfare of our environment, retaining and building the value in our important plant systems, underpinning investor confidence for continued sector growth and innovation, and maintaining market access for plant-based exports.

B3's mission

Science-based border biosecurity solutions underpinning the vitality of New Zealand's natural and productive plant landscapes (forestry, horticulture, arable, pastoral) and other plant-based industries, through a research-industry-government collaboration delivering world-leading science and technology development, enabling stakeholders to implement results for *Better Border Biosecurity*.

B3 will contribute to the strategic directions of Biosecurity 2025

A Biosecurity Team of All New Zealanders
A Toolbox for Tomorrow
Free-flowing Information Highways
Effective Leadership and Governance
Tomorrow's Skills and Assets

B3's research themes

Risk Assessment – Intentional Introductions
Risk Assessment – Unintentional Introductions
Pathway Risk Management
Diagnostics
Surveillance, Eradication and Response

B3's parties

The Ministry for Primary Industries (MPI)
The Department of Conservation (DOC)
The New Zealand Forest Owners' Association (FOA)
The Environmental Protection Authority (EPA) (observer status)
Horticulture New Zealand (observer status) (representing the horticulture/cropping sectors)
Dairy New Zealand (DairyNZ) (observer status) (representing the pastoral sector)
The New Zealand Institute for Plant & Food Research Limited (PFR)
AgResearch (AGR)
Scion
Manaaki Whenua Landcare Research (MWLR)
Bio-Protection Research Centre (BPRC)

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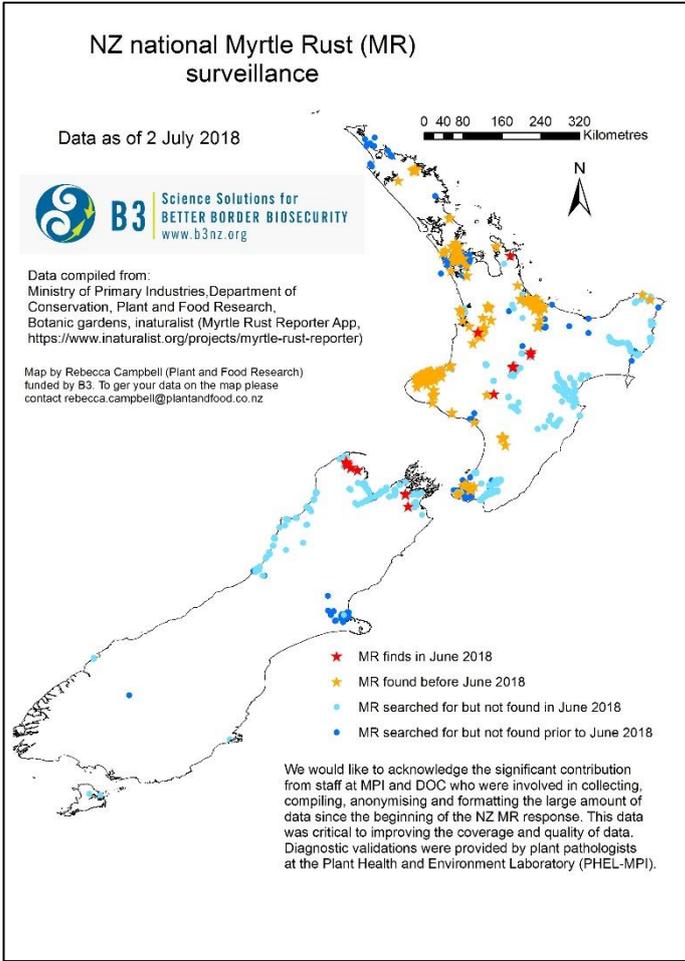
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B3 has been assisting the myrtle rust response by collating information on its presence and absence in NZ (amongst other things). Once the myrtle rust response transitioned to long term management in April 2018 it moved out of the direct scope of B3 activity although the maps have continued to prove very useful for community engagement.

Background. B3 acts as the pre-eminent research provider for science-based plant border biosecurity solutions in NZ and provides a single point access to the NZ science system for plant biosecurity research. It has evolved from largely isolated and sector-based initiatives within the productive sector CRIs (pre 2003), through to the Foundation for Research Science and Technology (FRST)-funded 'Improved Biosecurity' programme (2003–05). A step change followed with the large Ministry for Science and Innovation (MSI)-contracted Outcome Based Investment (OBI) B3 programme (2005–11), to the current collaboration resourced primarily through Crown Research Institute Core funding (MBIE Strategic Science Investment Fund). B3 CRI partners aligned their B3 investment to NZ's Biological Heritage National Science Challenge in 2014.

Scope. The breadth of research carried out within B3 encompasses threats to the pastoral, horticultural, arable and forestry productive sectors and natural ecosystems, especially cross-sectoral issues where plant pests, diseases and weeds do not respect the productive and natural system boundaries. Weeds were confirmed to be within the scope of B3 in 2014–15.

Parties. All parties work towards a commonly developed and agreed Strategic Plan and a Business Plan, underpinned by a Collaboration Agreement. The current members of B3 include:

Science organisations: Plant & Food Research, AgResearch, Scion, Manaaki Whenua/Landcare Research and the Bio-Protection Research Centre hosted by Lincoln University.

End-user organisations: Ministry for Primary Industries, Department of Conservation, and Forest Owners' Association. The Environmental Protection Authority, Horticulture NZ and DairyNZ have observer status.

Governance. The Collaboration Council (CC), led by an independent Chair and consisting of senior managers from the members listed above, plus the Director, meets quarterly to provide a governance role for B3 and to provide a link between the executive arms of the members' organisations and the operational science programme. A Science Advisory Group (SAG), made up of high-ranking scientists from the B3 members, assesses and recommends research projects to the CC.

Operational. The Director leads a group of five Theme Leaders (plus Manaaki Whenua/Landcare Research representative), who are also representatives for the research providers. They provide operational leadership to the Project Leaders who make up the B3 science programme. The Theme Leaders are strongly influenced by Theme Representatives from the stakeholders, who provide input at the twice-yearly Science Partnership Forum (SPF) as well as at a range of formal and informal meetings throughout the year. The recent appointment of an MPI Science Programme Engagement Lead is augmenting engagement with MPI. A central tenet of B3 is that the government operational agencies, MPI and DOC, and now the members of the Government Industry Agreement (GIA), create the value from B3's science and technology through their co-investment in the form of research uptake and application at the border. A corollary of this design is the need for frequent and effective communication among the various parties. Staff are managed by their own organisations, with some advice from the B3 leadership, which has no direct line-control.

Essential documents. The Statements of Corporate Intent (SCI) for each of the member CRIs identify biosecurity as core to their research investments. The B3 Strategic Plan (updated in 2016) outlines the aspiration, mission, strategic priorities and scope for the research conducted within B3. The Collaboration Agreement outlines how the members intend to interact with one another to enable B3 to function. The Business Plan outlines the planned activities for a given year and the Annual Report provides an account of what was achieved. The Hosting Agreement with PFR provides the resources for the Collaboration's leadership and coordination.

Reporting. Monthly Theme Leader reports (to the Director), a monthly Director's report (to the CC), and an Annual Report are placed on the B3 internal internet site (www.b3nz.org). These are made available to the CRIs for their internal reporting requirements.

2017–18 saw the commencement of the first year of new B3 projects as a result of the Operational Refresh. The refresh has resulted in new research teams, new expertise, new partners, and new students including new post-doctoral students in B3 with a noteworthy increase in the amount of social science and increased engineering capability. Despite this beneficial upheaval, B3 researchers have maintained their above average output of new science with over 30 peer reviewed publications during the year.

Two publications have provided a significant insight into the health of NZ's biosecurity system. Notwithstanding increasing biosecurity risk through increasing trade and tourism, there is growing evidence that NZ's biosecurity system has and continues to be effective. Analysis of invasion data indicates decreasing and static rates for the establishment of invasive insects and fungal pathogens, respectively. Such data also reinforce B3's aspiration and vision to support NZ biosecurity through appropriate research.

The third, and some say the best, B3 Conference took place in May 2018, providing a focal point for the NZ plant border biosecurity community, with attendees from the research, government, industry, academic communities including a substantial group of visitors from Australia. The industry-sponsored NZ-US Invasive Species Workshop, held in August 2017, brought about 20 US biosecurity researchers to NZ and supported critical understanding and action for several current high-interest risk organisms (i.e. myrtle rust, BMSB). We expect to see the reinvigoration of the NZ-US Invasive Species Working Group in 2019.

B3 became a founding member of the aspirational Tauranga Moana Biosecurity Capital (TMBC) and a National Partner for the innovative House of Science charitable trust and intends to build on these new relationships in the coming years. Partnerships such as these will be essential for B3 to more effectively implement its biosecurity outcomes.

B3 strongly supported Tranche 2 funding for NZ's Biological Heritage National Science Challenge and developed and signed (July 2018) a Statement of Intent to partner in areas of mutual interest. Similarly, B3 and the Plant Biosecurity Research Initiative (Australia) have explored, developed and ultimately signed (November 2018) a MOU to work together on trans-Tasman biosecurity issues of mutual interest.

Biosecurity 2025 is fast becoming the new biosecurity paradigm for NZ and is entrenched in B3's Strategy. In the following pages, a selection of the activities and outcomes from B3's research in 2017–18 are detailed, in line with the Strategic Directions found within Biosecurity 2025 along with B3's many and significant outputs.



Dr David AJ Teulon

Director, Better Border Biosecurity
December 2018



More than 150 biosecurity professionals gathered for the Third B3 Conference at Te Papa, Wellington in May 2018.

The B3 Conference is fast becoming the focal point for the NZ plant biosecurity community with attendees from within the B3 membership (research, government, industry, academic) and beyond and, on this occasion, a substantial group of visitors from Australia. Additionally, several satellite meetings were organised around the conference to exploit the assembly of like-minded enthusiasts.

The conference also witnessed the signing of an MOU on biosecurity/bioprotection research collaboration between Plant & Food Research and the Institute of Plant Protection (IPP), CAAS, Beijing.

This year's conference was notable for the number of new faces (new project leaders, post-doctoral researchers and students) and new projects that have resulted from the recently completed B3 Operational Refresh.

Te Herekiele Herewini and colleagues welcomed the attendees to Te Papa with an eloquent mihi whakatau. In the opening address the Hon. Damien O'Connor (Minister for Biosecurity) spoke of biosecurity as one of our greatest challenges and one on which we need to work cooperatively. He reemphasised the new brand of Biosecurity NZ – Tiakitanga Pūtaiao Aotearoa – to provide a greater emphasis on this important undertaking.

Two days and 47 presentations later, Brittany Pearce, a recent science graduate Tweeted: "arrived home feeling inspired and full of even more passion for NZ biosecurity than before".

Keynote speaker Prof Sandy Purcell from UC Berkeley, USA, presented an overview of one of the most important emerging biosecurity concerns of today – the plant pathogen *Xylella fastidiosa*. Keynote speaker Prof Fang Hao Wan from the Institute of Plant Protection, China, highlighted the biosecurity challenges and opportunities of the massive Chinese Belt and Road initiative. Presentations on B3 research were juxtaposed with presentations from NZ Biological Heritage (NZBH), Centre of Excellence for Biosecurity Risk Analysis (CEBRA), SITplus, Te Tira Whakamātaki (TTW), and the Plant Biosecurity CRC (PBCRC), and we heard from the MPI Research Technology and Innovation (RTI) programme and Government Industry Agreement (GIA) for Readiness and Response on science implementation and application. There were updates on the myrtle rust incursion and Biosecurity 2025 and a challenge to B3 to have greater awareness of Māori biosecurity aspirations within all B3 projects.

There were a number of attendees from industry, who appreciated the opportunity to learn more about B3's activities: A session on Trans-Tasman research collaboration highlighted the overlapping needs of NZ and Australia and the need to work together.

The conference concluded with comments from the B3 government and industry end-users, who all strongly endorsed the B3 concept and the impact its research is making to the NZ biosecurity system. "B3 is a highly credible, cooperative research organisation from which we've seen some excellent research," said Richard Palmer from Horticulture NZ. The Conference reinforced B3's relevance in a constantly evolving biosecurity landscape which, since the last B3 Conference in 2016, has seen the development of the NZBH, GIA, RTI, and Biosecurity 2025.



The conference keynote speakers were sponsored by Plant & Food Research and AGMARDT

New Zealand's Biological Heritage (NZBH) National Science Challenge

B3 CRI partners aligned their B3 investment to the NZBH National Science Challenge in 2014. Since then B3 has been working closely with the NZBH Challenge to cultivate synergies, including:

- Integration of the Challenge's Intermediate Outcomes into the refreshed B3 Strategy
- Direct alignment of research activity and cross-learning, such as an integrated platform for biosecurity through eDNA sequencing, Māori responses to biosecurity incursions, and the susceptibility of taonga plants to myrtle rust
- A joint approach to support important biosecurity initiatives such as the Tauranga Moana Biosecurity Capital, and a Scion-led, MBIE funded 'Biosecurity Toolkit for the Urban Environment' research programme
- Regular interaction between B3, the NZBH and the BPRC
- Combined meetings with end-users, such as MPI, to align national biosecurity impacts
- Joint development of Biosecurity 2025 symposium at the Crazy & Ambitious conference
- B3 supported Tranche 2 funding for NZBH and developed and signed (July 2018) a Statement of Intent to partner in areas of mutual interest
- The boards from BHNSC, BPRC and B3 met to maximise the complimentary nature of the different entities for improved biosecurity outcomes in August 2017.



The Government Industry Agreement (GIA) for Readiness and Response

The GIA operates as a partnership between primary industry and the government to manage pests and diseases that could badly damage NZ's primary industries, economy, and environment. The GIA continues to grow with 18 current signatories. Where appropriate, B3 partners support the plant-based sectors with synergistic plant border biosecurity research. In 2017-18 such activities included:

- Presentations to Fruit Fly and BMSB Councils on current B3 research
- The NZ-US Invasive Species Workshop and associated satellite meetings for growers with a number of US visitors sponsored by industry sectors
- Participation in the Samurai Wasp Steering Group and support of the GIA-led EPA application for its release
- A stocktake of BMSB research to inform future investment
- Chairing of an international panel to review NZ's fruit fly surveillance programme
- Membership of a NZ fact finding mission to Chile to observe the BMSB incursion in Santiago
- Pest risk assessment for the pastoral sectors research to support DairyNZ negotiations for joining GIA.



B3 (Lloyd Stringer) supporting KVH (Matt Dyck) in Santiago, Chile.



Science provides the basis for an effective biosecurity system and B3 parties (science, government, industry) co-innovate to ensure that research within the B3 suite of science projects is implemented into biosecurity outcomes. B3 researchers are increasingly involved with the translation of their science to the broader community, including iwi, and are therefore playing an active role in growing NZ's Biosecurity Team of 4.7 Million. B3 is firmly behind the *Ko Tātou This Is Us* brand to connect and align all the actions and activities by individuals, businesses, iwi/hapū and communities across the biosecurity system to encourage further action (see: <https://www.thisisus.nz>).

Social Science Increased in B3 Programme

In response to the recently updated B3 Strategy (2016) and B3 Operational Refresh (2017), and in response to outside drivers such as Biosecurity 2025, capability and capacity in social science has been renewed within B3 and in particular in three projects:

- Tourism and biosecurity (project #18)
- Biosecurity excellence in port communities (project #28)
- Maori responses to biosecurity incursions (project #37).

In each of these projects social scientists are seeking to understand the social dynamics of those respective communities to improve biosecurity outcomes. We expect to increase our social science effort across other research projects as appropriate.

Contact: Tracy.Nelson@agresearch.co.nz



House of Science

B3 is a national partner to this inventive charitable trust which provides quality science resources to schools, and professional learning for teachers, to promote positive engagement with science. Through House of Science (<https://houseofscience.nz/>), B3 has supported the development of the biosecurity kit (Invasion Busters – Ngā Kaiārai Kaiurutomo) that has introduced students to some key biosecurity concepts in an engaging hands-on way. The kit is available to 59 schools in the western Bay of Plenty and there are plans to release it more widely in NZ. The kit includes the Invasion Busters board game where groups play a collaborative game that simulates NZ's biosecurity system.

Contact: John.Kean@agresearch.co.nz

Invasion Busters board game



Development of science-based tools for plant border biosecurity is a fundamental focus within the B3 research portfolio with about 16 projects targeting this Biosecurity 2025 Strategic Direction.

Technology Expertise Increased in B3

The Operational Refresh facilitated the genesis of a number of new research teams within B3 targeting the development of new tools. Moreover, new engineering capability has been purposefully augmented within these teams through careful planning and strategic partnership to supplement the biological skills. Such new capability includes: Mr Barry Stevenson (horticultural engineer, Ind.) (project #11), Dr John Mitchell (wireless sensor technologist, PFR) (project #13 and 14), Prof. Russell Frew (stable isotope geochemist, UoO) (project #23), Prof. Michael Hayes (acoustics engineer, UC) (project #27), and Dr Graeme Woodward (signal processing engineer, UC) (project #29). B3 researcher Taylor Welsh is undertaking an MSc in engineering within project #27.

Underpinning the Samurai Wasp EPA Application

Biocontrol is considered one of the most effective tools for the management of brown marmorated stink bug (BMSB, *Halyomorpha halys*). Because the samurai wasp (*Trissolcus japonicus*) is a natural enemy of the BMSB and could be used in biocontrol, B3 members were part of the government/industry Samurai Wasp Working Group which prepared an application to the EPA for the release of the samurai wasp in the event of a BMSB incursion in NZ. As part of work aligned to Theme A – Risk Assessment for Intentional Introductions – research was carried out to understand the impacts of the Samurai wasp on non-target stinkbug species and to understand the potential geographical distribution of the Samurai wasp with respect to important indigenous stinkbug species. In addition, resources were made available to ensure open access for this published information so that it could be appended to the BMSB Council application to the EPA. The application was submitted in March 2018 and the public hearing is planned for July 2018. The support of the USDA ARS was a key ingredient to this work.

Contact: Gonzalo.Avila@plantandfood.co.nz

Publication: Avila GA, Charles JG. 2018. Modelling the potential geographic distribution of *Trissolcus japonicus*: a biological control agent of the brown marmorated stink bug, *Halyomorpha halys*. *Biocontrol* 63: 505-518.



An adult *Trissolcus japonicus* emerging from a BMSB egg.

Capability Development through International Collaboration

International supervisory teams from B3 partners and the USDA supported capability development and important science outputs in two PhD projects.

Dr Nixon showed that sampling volatile organic compounds (VOCs) given off by diapausing BMSB, may be a feasible approach to detect these insects in freight. However, this would rely on sufficiently sensitive

detection methods to be developed, such as those being considered in a B3 project (#13), as any detection method would need to overcome the problem of background odours that may potentially interfere with the target volatiles.

Contact: Eckehard.Brockerhoff@scionresearch.com

Publication: Nixon LJ et al. 2018. Identification of volatiles released by diapausing brown marmorated stink bugs, *Halyomorpha halys* (Hemiptera: Pentatomidae). PLOS ONE 13: e0191223.



Dr Chase showed that trap capture of BMSB adults with lures was not affected by the addition of bark beetle pheromones and that a combination of several lures did not significantly lower the numbers of key forest

pest species caught. The results support the use of traps baited with a full combination of these attractants in surveillance programs to reduce costs and increase detection rates of a wider range of conifer forest pests as well as BMSB.

Contact: Eckehard.Brockerhoff@scionresearch.com

Publication: Chase KD et al. 2018. Multiple-lure surveillance trapping for *Ips* bark beetles, *Monochamus* longhorn beetles, and *Halyomorpha halys*. Journal of Economic Entomology 111: 2255-2263.



Spray Technology Research Wins International Award

Aerial spraying remains one of the important tools within the biosecurity toolbox. The AGDISP model is used by pesticide regulators to quantify exposure from aerial pesticide spraying including the risks to public health and the environment. However, questions remain around its applicability in the NZ environment. Measures of spray drift, meteorological conditions and turbulence found that AGDISP significantly overestimate the downwind airborne spray concentrations by not accounting for the turbulence generated within a radiata pine canopy. The published research won an American Society of Agricultural and Biological Engineers (ASABE) award.

Contact: Tara.Strand@scionresearch.com

Publication: Richardson B et al. 2017. Influence of a young *Pinus radiata* canopy on aerial spray drift. Transactions of the ASABE 60: 1851-1861.



PRONTI Used for EPA Application

EPA requested that the B3 developed PRONTI tool, designed to remove subjectivity from selection of invertebrate species for host-specificity testing, be used as part of the application to release the beneficial parasitoid, *Eadya daenerys*. This parasitoid is being considered for release as a biocontrol agent (BCA) for the forest pest eucalyptus tortoise beetle. PRONTI adds value by delivering a more consistently applied, transparent, evidence-based ranking of each non-target species. It provides for the examination of how the rankings and test species selection have been achieved. PRONTI will become easier and faster to use as more species are added to the Eco Invertebase and is available for use with other entomophagous BCAs under consideration for release in NZ. The application was submitted in August 2018.

Contact: Jacqui.Todd@plantandfood.co.nz

See: <https://www.epa.govt.nz/assets/FileAPI/hsno-ar/APP203631/Application-Form.pdf>.

Knowledge, based on sound data, provides the building blocks for NZ's biosecurity system. About 12 projects targeting this Biosecurity 2025 Strategic Direction are found within B3.

International Team Tackles the Big Questions

Resources and funds to manage existing Invasive Alien Species (IAS) and prevent further invasions are constrained, so questions around optimal investment are critical if NZ is to maintain its world-class biosecurity system. What is the absolute and relative investment in prevention, surveillance, incursion response and pest management that is required? What are the trade-offs for investment at different points of the biosecurity continuum? These are the ambitious questions that researchers from B3 (incl. MPI), CEBRA (Australia), Forest Service (USA) and Resources for the Future (USA) are seeking to answer in B3 project #36. Current data will be brought together from throughout the NZ biosecurity continuum, and data gaps identified, that will enable biosecurity managers to make informed decisions about optimal interventions and investment.



Contact: Eckehard.Brockerhoff@scionresearch.com

Reporting Tool for Indicative eDNA Sequence

DNA sequence data from environmental samples may ambiguously support the presence of a new organism of biosecurity concern without any other evidence of the organism being present. To circumvent any unnecessary interpretations of these data, a draft protocol for reporting biosecurity findings from NGS sequences is being developed. As part of this, results from Francesco Martoni's PhD have provided a valuable example of using metabarcoding to detect potential new



pathogens in the environment, from pairing metagenomics with metabarcoding to identifying new Liberibacters and Phytoplasmas species carried by NZ psyllids. The reference template for DNA reporting procedures is being used as part of ongoing discussion within MPI to use this tool.

Contact: Simon.Bulman@plantandfood.co.nz

B3 Signs-up to the Euphresco International Plant Sentinel Network (IPSN)

B3 has been an international leader in the development of the expatriate/sentinel plants concept for plant border biosecurity. In 2017, B3 reaffirmed its support of this concept by joining a new IPSN/Euphresco-funded programme and re-funding its sentinel plants project as part of the Operational Refresh. The essence of the sentinel/expatriate plant concept is that we can gain vital information on the pests and diseases of NZ plants that are found in overseas botanical gardens. A proof-of-concept *ex post* project is under way to examine whether NZ can gain information on the impact of myrtle rust on NZ indigenous species in the current distribution of this potentially devastating pathogen. Similar work is under way to assess the biosecurity risk for pastoral pests in China.

Contact: Mark.McNeill@agresearch.co.nz

See: <http://www.bgci.org/ipsn/euphresco-project/>



Analyses of Two Data Sets Shows Strength of New Zealand’s Biosecurity System

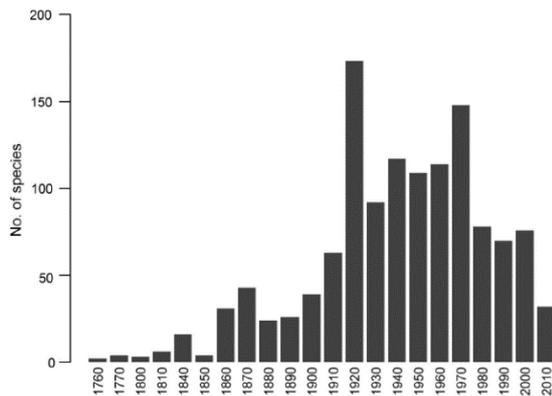
The importance of authoritative invasive species databases (and associated collections) was reinforced by two recent analyses which have improved our understanding of NZ’s biosecurity system and the need for continued investment to maintain its world-leading status. Analyses of insect (<https://datastore.landcareresearch.co.nz/dataset/exoticinsectsfirstrecords>) and plant pathogen (<https://nzfungi2.landcareresearch.co.nz/>) databases indicate that investment in biosecurity is paying off, with decreasing or static rates of establishment of invasive species in recent years despite large increases in trade and tourism. Such data also enable the targeting of organisms/pathways that are not as well managed as others.

Insects: Overall the number of newly recorded species in NZ steadily increased from 1769 with pulses of establishment during 1920-1925 and 1975-1980. Since then the rate of non-native insect species establishing in NZ has been slowly decreasing.

Contact: WardDA@landcareresearch.co.nz

Publication: Edney-Browne et al. 2018.

Establishment patterns of non-native insects in New Zealand. *Biological Invasions* 20: 1657-1669.

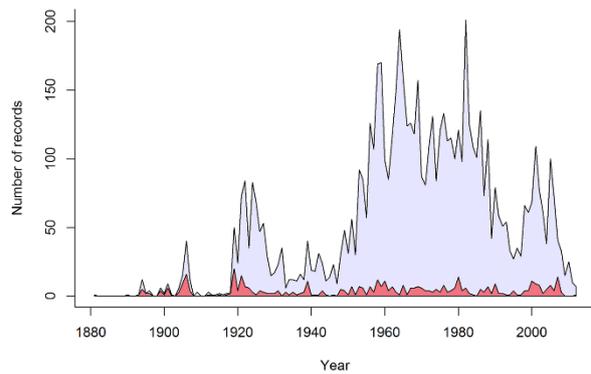


Non-native insect species first recorded in NZ.

Fungal pathogens: The annual arrival rate of new fungal pathogens in NZ increased from 1880 to about 1980 but subsequently stabilised. Nevertheless, while pathogen arrival rates for crop and pasture species declined in recent decades, arrival rates increased for forestry and fruit tree species.

Contact: JohnstonP@landcareresearch.co.nz

Publication: Sikes BA et al. 2018. Import volumes and biosecurity interventions shape the arrival rate of fungal pathogens. *PLoS Biol* 16(5):e2006025.



Number of host-pathogen records from NZ for focal host plants from 1881-2012.

Pasture Pest Risk Analysis

Pasture could be considered NZ’s most important crop but data on the potential biosecurity risks to this sector have focused on animals. DairyNZ and B3 are together developing a comprehensive biosecurity risk analysis approach for ryegrass/clover pasture and other forage plants, initially focusing on insect pests and weeds but eventually including pathogens. A shortlist of not-in-NZ insect pests for ryegrass/clover has been developed along with their potential NZ distributions, methodology for estimating their rate of spread and ultimately their economic impact.

Contact: Craig.Phillips@agresearch.co.nz



B3 continues to play a significant role in the leadership for plant border biosecurity research within NZ and works closely with others to fashion an improved biosecurity research landscape. Richard Palmer (Deputy CEO Horticulture NZ) noted at the B3 Conference “B3 Leadership highly evident in biosecurity system”.

Third B3 Conference



The B3 Conference (May 2018), opened by the new Minister for Biosecurity (Hon. Damien O’Conner), is fast becoming the focal point for the NZ plant biosecurity research community with more than 150 attendees from within the B3 membership (research, government, industry, academic) and beyond. Several satellite meetings were organised around the conference to exploit of the assembly of such like-minded enthusiasts. This year’s conference was notable for the number of new faces (new project leaders, post-doctoral researchers and students) and new projects that have resulted from the recently completed B3 Operational Refresh. In his opening address, the Hon. Damien O’Connor (Minister for Biosecurity) spoke of biosecurity as one of NZ’s greatest challenges and one on which we need to work cooperatively. He also re-emphasised the new brand of Biosecurity NZ – Tiakitanga Pūtaiao Aotearoa – to provide a greater emphasis on this important undertaking. Keynote speaker Prof. Sandy Purcell from UC Berkeley presented an overview of one of the most important biosecurity concerns of today – the plant pathogen *Xylella fastidiosa*. Keynote speaker Prof. Fang Hao Wan from the Institute for Plant Protection, Beijing, highlighted the biosecurity challenges and opportunities of the massive Chinese Belt and Road initiative. The conference reinforced B3’s relevance in a constantly evolving biosecurity landscape which, since the last B3 Conference in 2016, has seen the development of the NZBH, GIA, RTI, and Biosecurity 2025. <http://b3nz.org/news/best-b3-conference-yet>



Prof. Purcell



Prof. Wan

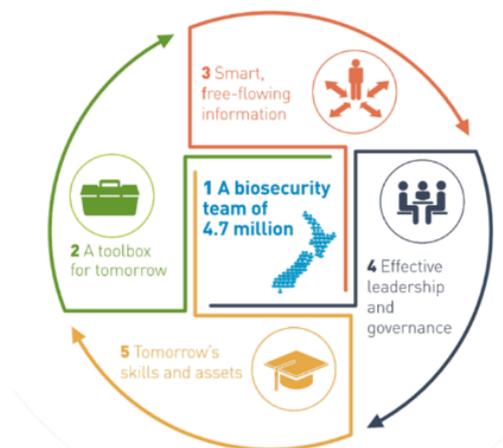
Two B3 Science Partnership Forums (SPF)

The B3 community of researchers, regulators and industry comes together twice yearly to share their expectations, insight and priorities for plant border biosecurity research. The first SPF was held at Lincoln (October 2017) and provided the opportunity for B3 Theme Leaders to provide a summary of the new B3 projects initiated through the Operational Refresh. The second SPF was held in conjunction with the B3 Conference (May 2018) and enabled B3 end-users to provide an update on their pressing needs for plant border biosecurity.

Biosecurity 2025

In 2017–18, B3 continued to fully engage with Biosecurity 2025 including membership on working groups to develop the Strategic Directions (SDs):

- SD1 (4.7 m): Alby Marsh (PFR), Melanie Mark Shadbolt (BPRC), Richard Palmer (Hort NZ)
- SD2 (toolbox): Steve Pawson (Scion), David Teulon (B3)
- SD3 (data): Richard Palmer (Hort NZ), John Kean (AGR)
- SD4 (leadership): Melanie Mark Shadbolt (BPRC)
- SD5 (skills and assets): Bevan Weir (LCR).



Workshops on Key Biosecurity Issues

The thirst for informed information on new biosecurity threats is unrelenting and B3 continues to provide national leadership by providing for the latest information on emerging invasive species to become freely available to the biosecurity community through targeted workshops. In 2017–18 major workshops included:

Myrtle Rust Symposium. Jointly organised with Centre for Biodiversity and Biosecurity (AU), PFR, Scion, USDA, and MPI, 28 August 2017, Tamaki, Auckland. This workshop was held in conjunction with the NZ-US Invasive Species Workshop and included myrtle rust experts from the USA (Janice Uchida, Philip Cannon, Ned Klopfenstein, Lisa Keith) and Australia (Angus Carnegie, Geoff Pegg).

Stink Bug Workshop. An imminent threat to Australia and NZ. Jointly organised by B3 and Plant Health Australia (PHA), 26–28 September 2017, Brisbane, Australia. Dr Tim Haye (CABI) (below) provided the keynote presentation.



International Collaborations

NZ's biosecurity science has a clear global context and needs to remain strongly connected to international research and innovation. B3 provides a significant point of contact with plant border biosecurity researchers outside of NZ.

Australia. B3 members (PFR, BPRC) continued to take an active role in the last year of the Plant Biosecurity CRC contributing approximately 17% of publications (PBCRC Annual Report 2016-17) and nearly 50% of presentations at the last PBCRC Science Exchange (May 2018). B3 consolidated its partnerships in Australia with a strategic collaboration with PHA through MBIE catalyst (myrtle rust) programme, co-hosting a PHA Board visit to Lincoln and the PHA CEO to a B3 Theme Leaders meeting (both in February 2018). In addition B3 has developed strategic ties with the new RDC funded Plant Biosecurity Research Initiative (PBRI) with monthly discussions between B3 Director and PBRI Director initiated in March 2018 and the B3 Director presenting to the PBRI Board (May

2018). PHA and B3 together organised a BMSB workshop in Brisbane in September 2017. A session was set aside at the B3 Conference in May 2018 to discuss trans-Tasman collaborations – this included representatives from PBRI, PHA, DAWR, CSIRO and CEBRA. B3's relationship with the Centre of Excellence for Biosecurity Risk Analysis (CEBRA) has also grown with CEBRA's formal involvement in three B3 projects. Equally, B3 scientists are actively involved in the PHA-led *Improving the biosecurity preparedness of Australian horticulture for the exotic spotted wing drosophila* and the Hort Innovation-led *Sentinel Surveillance for Agricultural Pests (iMapPESTS)* programmes as well as the Queensland fruit fly consortium (SITplus).



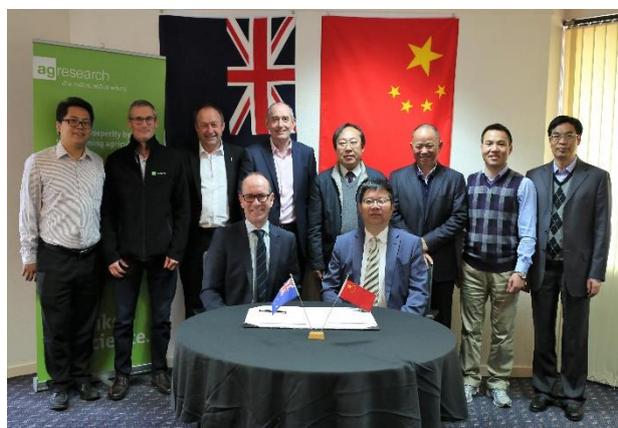
United States. B3 has continued to cultivate and grow its many collaborations with researchers from the United States across its suite of research projects. A stand-out achievement was the NZ-US Invasive Species Workshop, with associated activities, held in NZ in August/September 2017, as part of the MBIE International Relationships Fund under the auspices of NZ-US Joint Commission on Science and Technology Collaboration (or JCM). About 20 US and 40 NZ scientists met in Auckland to explore research initiatives to prevent the establishment or mitigate the impact of invasive vertebrate, invertebrates, pathogens and weeds. There was strong interest in this workshop from both NZ government and industry organisations, and this was reflected by the significant sponsorship from these sources and the many satellite meetings attended by our US scientists.

See: <http://b3nz.org/news/nz-us-invasive-species-workshop-sets-bright-future-collaborative-research>.



Attendees at the NZ-US Invasive Species Workshop on the field trip to Tiri Tiri Matangi

China. In response to China's growing stature in scientific research, as well as its importance as a trading partner and source of tourists for NZ, its similarities in climate zones to NZ and it being a growing source of invasive species, both AgResearch (October 2018) and Plant & Food Research (May 2018) signed MOUs with the Institute of Plant Protection (IPP) (Chinese Academy Agricultural Sciences) to further scientific collaboration in biosecurity. The growing relationship between NZ and China through these IPP connections was demonstrated by the request from eminent Chinese scientists for NZ to host the 4th International Congress on Biological Invasions in Christchurch, September 2021.



Institute of Plant Protection (China) MOU signing with AgResearch (left) and Plant & Food Research (right)

B3 Technical Leadership

Expertise from B3 researchers has been sought by government and industry for a range of issues.

- Belt and Road Initiative - A Strategic Pathway. A report commissioned by the New Zealand China Collaboration Council. [Mark McNeill]
<https://www.asianz.org.nz/assets/Uploads/59ee5ce6a6/NZCC-BRI-report-19-Mar-18.pdf>
- The Biosecurity Research, Science and Technology Priorities (draft). Science to Support Biosecurity 2025. [all theme leaders]
- Brown Marmorated Stink Bug Response Plan (draft). BMSB Council. [David Teulon].

B3 researchers provided a range of scientific and technical support to the biosecurity community for the following invasive species:

- Myrtle rust. Beccy Ganley and David Teulon were part of the Technical Advisory Group (TAG)
- Pea weevil (brucid). David Teulon (as an observer) was part of the Technical Advisory Group
- Brown marmorated stink bug. Gonzalo Avila and David Teulon were part of the Samurai Wasp Steering Group
- Actinidia. Andrew Pitman was a member of the technical committee for the development of the IHS for kiwifruit germplasm and co-led the PFR response during the public consultation phase
- NZ Plant Producers biosecurity scheme. Mark McNeill was invited to a workshop to contribute to the development of a plant producers biosecurity scheme
- Fruit fly. John Kean chaired the International panel to review NZ's fruit fly surveillance programme
- David Teulon and Lindsay Bulman are on the BioProtection Research Centre's Science Leadership Group
- David Teulon and Barbara Barratt are on the Characterising Land Biota research programme Advisory Group
- David Teulon, Beccy Ganley and Suvi Viljanen are on the KVH/Zespri Biosecurity Steering Group
- Max Suckling is on the Technical Advisory Committee for SITplus
- Mark McNeill is the B3 representative for the International Plant Sentinel Network.

Recognition of Individual and Team Leadership

- **Barbara Barratt** was awarded the 2018 New Zealand Plant Protection Society Medal for exceptional contribution to plant protection including risk assessment for biological control agents.
- **Craig Phillips**. DOC, Director General, Lou Sanson, wrote to B3 and AGR to acknowledge the "very significant role that Dr Craig Phillips played in the success of the Great White Butterfly (GWB) eradication programme". Director General Sanson wrote: "I am very appreciative of the major contribution Craig has made and we look forward to working with Craig, AGR and B3 as partners in the future".
- **Indigenous engagement team** including (**Alby Marsh**) and Charles Darwin University (Linda Ford, Ruth Wallace) was awarded the PBCRC Collaboration Award for 2018. The PBCRC project has close links to similar projects within B3, the NZ Biological Heritage NSC and the Māori Biosecurity Network (Te Tira Whakamātaki), and represents the first significant investment in plant border biosecurity in this area in New Zealand.
- **Scion research group**. The 2018 ASABE Superior Paper Award was given to the B3/Scion publication: *Richardson B, Strand TM, Thistle H, Hiscox A, Kimberley MO, Schou WC. 2017. Influence of a young Pinus radiata canopy on aerial spray drift. Transactions of the ASABE. 60(6): 1851-1861. (doi: 10.13031/trans.12497). <https://www.scionresearch.com/about-us/news-and-events/news/2018-news-and-media-releases/forest-protection-staff-win-superior-paper-award>.*
- **Sandra Visnovsky** was awarded a British Society for Plant Pathology Travel Award to attend the APPS/SPPH Conference, Brisbane.

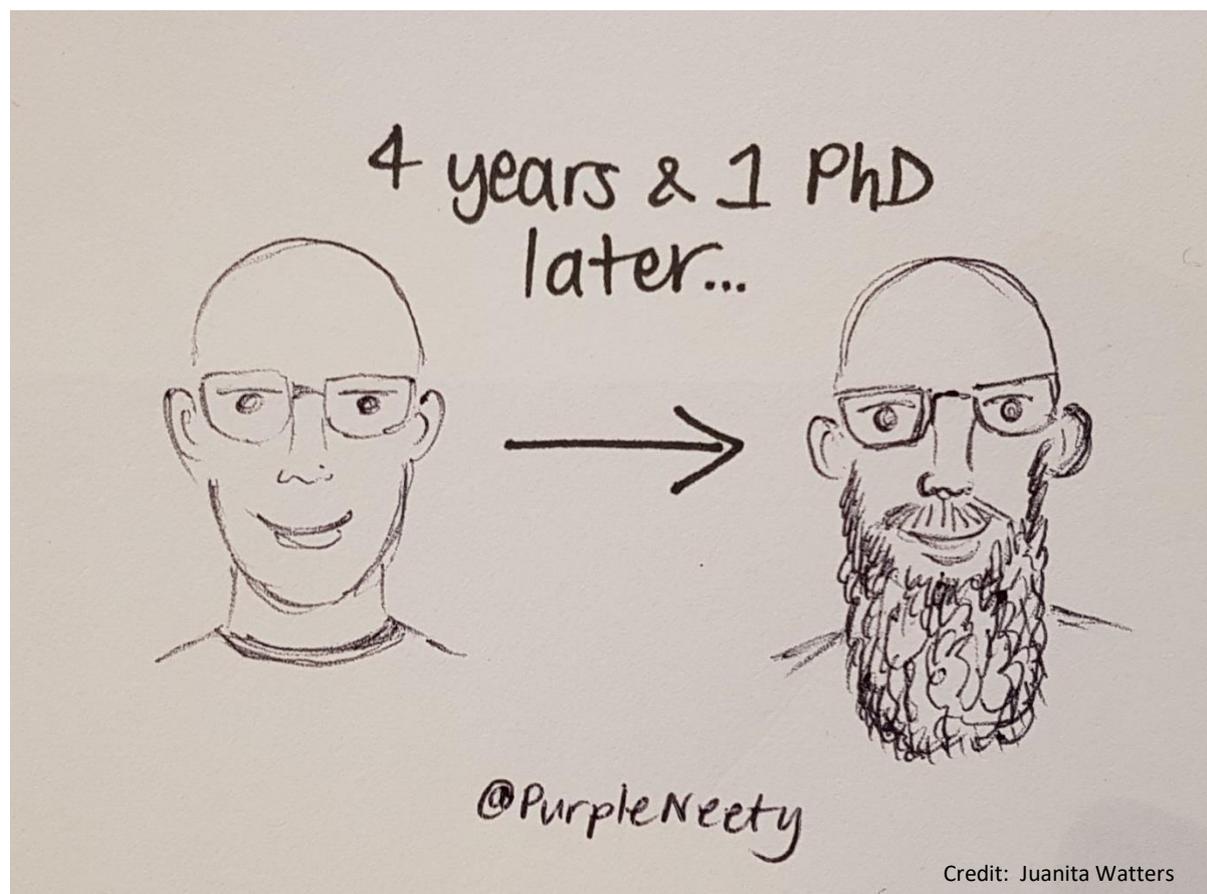
B3 is at the forefront of developing people with the necessary skills to contribute to a capable and sustainable biosecurity workforce. As the border biosecurity challenge increases year on year, quality educated recruits will be required to advance innovative biosecurity solutions for NZ. B3 scientists working, with their colleagues in NZ and international universities, are at the forefront of training new biosecurity literate graduates.

Aligned Graduate Students

An increasing number of graduate and post-doctoral students are linked to B3 through financial support, supervision by B3 researchers or by the plant border biosecurity focus of their research theses.

Recently graduated PhD students

Name	Project	University	Funding	Supervisor(s)	Defence
Ursula Torres	Modelling global distributions & risk of establishment of invasive freshwater invertebrates	Lincoln	Erasmus Mundus, B3, MPI	Worner, Armstrong	Nov 2017
Laura Nixon	Identification of biogenic volatile organic compounds for improved border biosecurity	Lincoln	B3, USDA in-kind	Rostas, Brockerhoff, Goldson	Mar 2018
Francesco Martoni	Psyllid phylogenetic and endosymbiont associations in New Zealand and Australia	Lincoln	PBCRC, BPRC, B3 in-kind	Armstrong, Pitman, Bulman, Taylor	Apr 2018



Continuing PhD students

Name	Project	University	Funding	Supervisor(s)	Status
Lloyd Stringer	Understanding how populations and management tools interact for pest surveillance and eradication	Auckland	B3	Beggs, Suckling, Kean	Submitted Apr 2018
Carol Bedoya	Acoustic identification of unwanted organisms in import pathways	Canterbury	MBIE/DHS	Nelson, Hayes, Sutin (Stevens Inst. (USA), Brockhoff)	Current
Simren Brar	Genetic diversity of <i>P. pluvialis</i> and assessment new <i>Phytophthora</i> species	Massey	MBIE, FOA, Scion, B3	Ganley, Bradshaw, McDougal	Current
Hester Williams	Social acceptability of alternative eradication tools	Auckland	MPI, UoA	Brockhoff, Barron, Ward	Current

Recently initiated PhD students

Name	Project	University	Funding	Supervisor(s)	Started
Jamal Cheema	Development of an insect odorant receptor array based biosensor for chemical detection	Auckland	B3	Kralicek, Travase-Sejdic	Sep 2017
Tom Saunders	Improving methods of non-target testing for biological control agents	Auckland	UoA	Avila, Holwell	Sep 2017
Karla Lopez	Visual ecology of herbivorous pests	Lincoln	Wageningen UR/LU	Armstrong, Glare, Teulon, Rostas, van Tol	Dec 2017
Maikol Santamaria Galindo	Thrips in deciduous fruit trees in Colombia – A case study (<i>Frankliniella panamensis</i>)	National University of Colombia	NUC, UniMinuto, Colombia	Teulon, Brochero	Feb 2017

Recently initiated Post-doctoral scholars

Name	Project	University	Funding	Supervisor(s)	Started
Rebecca Turner	Using biosecurity data to inform general surveillance	Canterbury	NZBH/Scion	Pawson, Brockhoff, James, Plank	Feb 2018
Melissa Welsh	Optimising biosecurity investment and effort across all invasion phases	-	B3/Scion	Brockhoff	April 2018
Mariona Roige	Improving biosecurity risk analysis methods for NZ agriculture	Lincoln	AGMARDT /AGR	Phillips	Jun 2018

A number of Masters students have also been associated with B3 during 2017–18 including Delayn Fritz, Kiran Horrocks, Zane McGrath, Chris Russell (all University of Auckland), Taylor Welsh (University of Canterbury) and Morgane Sinlet (Université de La Réunion).

Joint university appointments

B3 researchers have joint university appointments, where they carry out undergraduate teaching, postgraduate supervision, and student mentoring, to develop biosecurity capability for tomorrow.

- Barbara Barratt, Honorary Professor, University of Otago
- Ecki Brockhoff, Adjunct Associate Professor, University of Canterbury
- Andrew Pitman, Honorary Adjunct Lecturer, Lincoln University
- Max Suckling, Professor, Auckland University, and Honorary Research Fellow, Victoria University
- David Teulon, Adjunct Professor, Lincoln University
- Darren Ward, Senior Lecturer, Auckland University.

A new suite of research projects in five themes was initiated in July 2016 as part of the B3 Operational Refresh. Each of these projects will provide future biosecurity outcomes across the Strategic Priorities identified in biosecurity 2025. Lead organisation is underlined>.

Risk Assessment for Intentional Introductions. Theme A

Theme Leader: Barbara Barratt

Theme Representatives: Chris Green (DOC), Rod Hitchmough (DOC), Clark Ehlers (EPA)

Theme Brief

- *Improved tools and methodologies for assessing risk and predicting impacts for intentional introductions*

Theme scope

- Improved prediction of the potential impacts of new and wanted organism introductions to enable biocontrol agent applicants to better meet the 'Minimum Standards' of the HSNO Act (1996)

Project #2: Improving risk prediction & reducing uncertainty pre-release for classical biocontrol (5 yr)

- **Leaders:** Gonzalo Avila and Toni Withers
- **Partners:** PFR, AGR, Scion, MWLR

This research will identify areas of uncertainty in previous applications for release of BCAs, improve pre-release quarantine testing, and provide a proof-of-concept study for application of probabilistic models for risk assessment of BCAs to provide EPA and DOC with a better understanding of potential non-target impacts of candidate BCAs prior to their release.

Model organisms: *Cotesia urabae*, *Trissolcus japonicus*, *Aphidius* spp.



EAG apparatus for testing insect response to volatile compounds.

Project #3: Understanding the direct and indirect environmental impacts of BCA introductions to inform future decisions (5 yr)

- **Leader:** Barbara Barratt
- **Partners:** PFR, AGR, Scion, MWLR

This research will examine case studies of post-release impacts for selected BCAs, develop a food-web 'tool' for predicting direct and indirect effects of BCAs, establish new data sources for non-target host information, and develop a 'scale of risk' tool to rank likelihood of adverse environmental impact to enable EPA to have improved certainty in their analysis of applications and in their decision-making under HSNO.

Model organisms: *Microctonus aethiopoies*, *Cotesia urabae*.

Theme Leader: John Kean

Theme representatives: Jo Berry (MPI), Helen Harman (MPI), Chris Green (DOC), Clark Ehlers (EPA), Russell Dale (FOA)

Theme Brief

- Improved tools and methodologies for identifying hazards, assessing risk, predicting impacts and ascertaining where in the system mitigation measures are best targeted for unintentional introductions including:

Theme scope

- Systems approaches for risk assessment: assess risk at any point along the pathway to determine optimal mitigations and equivalence of treatments
- Risk grouping: group organisms for more efficient risk analysis
- Future risks: identify emerging risks to prioritise activities
- Impact prediction: predict potential impacts of unwanted organisms to inform biosecurity interventions.

Project #4: Sentinel plants to forecast and future proof NZ plant systems against pests and diseases (3 yr)

- **Leader:** Mark McNeill
- **Partners:** PFR, [AGR](#). Links to International Plant Sentinel Network, Plant Health Australia, Kiwifruit Vine Health.

The effectiveness of the sentinel plant concept will be understood and demonstrated with reference to its use as a predictive risk assessment tool for pests and diseases of productive and natural ecosystems in New Zealand.

Model organisms/systems: myrtle rust, pasture, kiwifruit

Project #5: Integrated biosecurity risk assessment models for imports (3 yr)

- **Leader:** Lisa Jamieson
- **Partners:** [PFR](#), [AGR](#), [Scion](#). Links to Bayesian Intelligence (Australia).

This project will develop a more nuanced and timely assessment of risk for MPI, allowing for more effective identification of intervention points on pathways and efficient resource allocation for surveillance.

Model organisms: *Tilletia* sp., Brown marmorated stink bug, Queensland fruit fly

Project #6: On-line automated climate matching functionality (2 yr)

- **Leader:** Craig Phillips
- **Partners:** [AGR](#). Links to DairyNZ.

This project will provide pest risk analysts with on-line functionality to rapidly evaluate climatic matches for numerous hazard species in a more quantitative way.

Model organisms: multiple

Project #15: Phytophthora biosecurity and biogeography (2 yr)

- **Leader:** Peter Scott
- **Partners:** [Scion](#)

This project will provide MPI, plant productive industries and researchers with more efficient access to globally referenced *Phytophthora* disease records in a database with a web interface that enables more accurate and enhanced assessment of plant disease impact and pathway risk.

Model organisms: *Phytophthora* spp.

Project #38. Understanding the needs in border biosecurity with respect to weeds (1 yr)

- **Leader:** Trevor James
- **Partners:** [AGR](#)

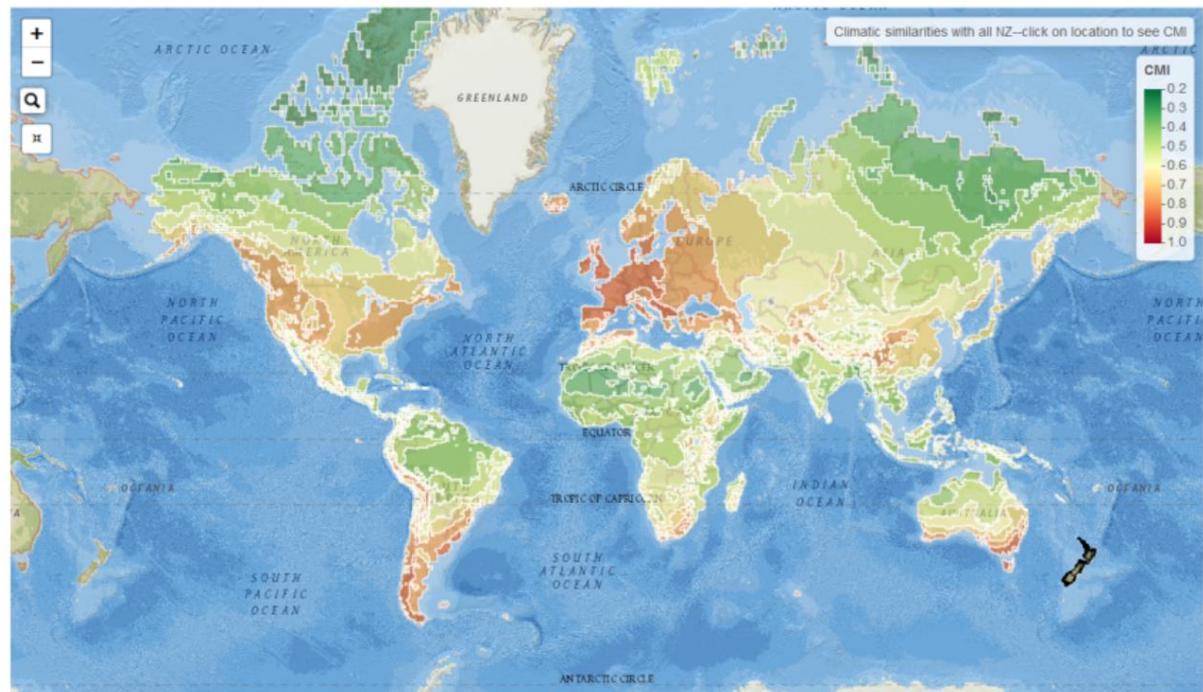
This project will provide a comprehensive review that identifies the biosecurity needs of key stakeholders, matches them to capability and maps these into a comprehensive achievable, research programme.

Project #39: Pasture pest risk analysis (2 yr)

- **Leader:** Craig Phillips
- **Partners:** [AGR](#). Links to Dairy NZ

This project will assist DairyNZ to identify and prioritise plant biosecurity risks to New Zealand's dairy industry.

Model organisms: pasture pests and diseases



Climate similarity between NZ and rest of the world. (C Phillips unpubl.) (project #6).

Theme Leader: Ecki Brockerhoff

Theme representatives: Shane Olsen (MPI), Chris Denny (MPI), Chris Green (DOC), Clark Ehlers (EPA), Russell Dale (FOA)

Theme Brief

- Fit-for-purpose tools and methodologies for reducing risks along importation pathways.

Theme scope

- **Detection Tools:** Detection and sampling tools for use on importation pathways, data collection and analysis to refine criteria for directing pathway risk management efforts, and intelligence and profiling systems for risk detection
- **New Risk Reduction Options:** New interventions and strategies for reducing risk within a systems context
- **Verifying Compliance and Efficacy:** Methods for inspecting and verifying the integrity of pathway compliance within a systems approach.

Project #10: New and less toxic on-shore treatments for imports (2 yr)

- **Leader:** Adriana Najjar-Rodriguez
- **Partners:** [PFR](#). Links to MPI Operational funding in collaboration with USDA ARS

This project will assess the efficacy of ethyl formate and heat treatments for the control of hitchhiker and surface pests in the imported vehicles, fresh produce and untreated timber pathways.

Model organisms: Brown marmorated stink bug, Asian long horned beetle including surrogate species

Project #11: Risk reduction and quarantine treatments off-shore (4 yr)

- **Leader:** Allan Woolf
- **Partners:** [PFR](#). In collaboration with the Scientific Research Organisation of Samoa (SROS), Ah Liki Pack House and MAF Samoa

This project will develop 'fit for purpose' pre-border disinfestation treatment systems, including temperature, high pressure washing and x-ray treatments, that reduce non-compliance for imports and the risk of establishment of unwanted organisms.

Model organisms: Fruit fly and other commodity pests

Project #13: Novel sensor approaches to sniff out biosecurity threats (5 yr)

- **Leaders:** Andrew Kralicek
- **Partner:** [PFR](#) (UoA).

This project will develop novel approaches for the real time detection of pests, on the basis of their unique aromas, including a handheld sniffer for fresh produce and inanimate commodities and a remote sniffer for hitchhiker pests in containers.

Model organisms: Brown marmorated stink bug, Queensland fruit fly

Project #17. Imaging technology for biosecurity inspection of imported seed lots (3 yr)

- **Leaders:** John Hampton
- **Partner:** [BPRC](#). Links to Seed Industry Research Council (SIRC)

This project will develop a prototype scanning system for automated quarantine inspection of imported seed lots aimed at significantly enhancing the early detection of unwanted weed seeds and seed-borne pests and pathogens, including those which occur at very low frequency.

Project #18: Tourism, biosecurity and pathways into NZ (3 yr)

- **Leader:** Tracy Nelson
- **Partners:** [AGR](#), [PFR](#), [BPRC](#). In collaboration with CEBRA and Auckland Botanic Garden. Linked to an MBIE Vision Mātauranga project on Māori tourism.

This project will develop a greater understanding of the biosecurity and tourism landscape for agencies working to prioritise future research. Sub-projects include: establishing the biosecurity awareness of tourists (botanic garden trails) and tourism providers (social network analysis), and understanding incursion data in context of tourist activity.

Project #36: Optimising biosecurity investment and effort across all invasion phases (3 yr)

- **Leader:** Ecki Brockerhoff
- **Partners:** PFR, AGR, [Scion](#), MWLR. Link to CEBRA, US Forest Service, Resources for the Future (US)

This project will enable better appreciation of the benefits and costs of border biosecurity interventions at different stages of the biosecurity system and the biosecurity system as a whole. It will enhance the ability of biosecurity managers to understand trade-offs and make informed decisions about optimal interventions and investment across prevention (e.g. pathway risk management), surveillance, incursion response and pest management.



Workshop for project #36 including B3 (including MPI) and international researchers.

Theme Leader: Karen Armstrong

Theme Representatives: Rob Taylor (MPI), Prasad Doddala (MPI), Catia Delmiglio (MPI), Chris Green (DOC), Clark Ehlers (EPA), Russell Dale (FOA).

Theme Brief

- Fast, cost-effective, robust and accurate diagnostic methods and tools to enable informed biosecurity decisions

Theme scope

- New Diagnostic Techniques: expedite the identification of multiple organisms within a sample, develop easy-to-use tests with field-applicability, and facilitate scale up to achieve high throughput
- Rapid Pathogenicity Determination: rapidly distinguish between pathogenic and non-pathogenic organisms
- Forensic Diagnostics: move beyond taxonomic-based diagnostics to ways of gaining other important biosecurity information about risk organisms.

Project #14: Point of use plant pathogen biosensor (3 yr)

- **Leader:** Marion Wood
- **Partners:** [PFR](#)

This project will develop proof of concept for the use of electrochemically-active conducting polymers (ECPs) as a basis for an in-field point-of-use plant pathogen diagnostic biosensor to enable more timely and cost-effective early detection, delimitation, eradication or containment of plant pathogens.

Model organisms: *Pseudomonas syringae var actinidiae* (Psa), *Xylella fastidiosa*

Project #19: Diagnosing of irradiated insects and fruit (2 yr)

- **Leader:** Ela Sawicka
- **Partners:** [AGR](#), [BPRC](#)

This project will develop a tool that can confirm whether irradiation treatment has occurred to verify compliance, reject fresh produce, or recall fresh produce post border when fruit fly eggs or larvae are found.

Model organisms: Fruit flies, seed weevils

Project #20: An integrated platform for biosecurity through eDNA sequencing (2 yr)

- **Leader:** Simon Bulman
- **Partners:** [PFR](#), [MWLR](#). Links to [NZBH NSC](#)

This project will provide confidence in the detection of risk organisms from data generated by NGS to support the uptake of this diagnostic method as a tool for incursion decision response-making.

Model organisms: kiwifruit and grape trunk associated bacteria and fungi

Project #22: Using molecular systematics to enhance diagnostics and predict biosecurity risk (2 yr)

- **Leader:** Peter Johnston
- **Partners:** [MWLR](#), [Scion](#). Links to [Characterising Land Biota programme](#)

This project will enable biosecurity risk to be better estimated because MPI has access to a greater range of high quality reliable DNA sequences derived from authentically identified specimens, including arthropod groups with difficult-to-identify life stages, and fungi from morphologically cryptic species complexes. The potential for using phylogeny to estimate biosecurity risk of unnamed taxa in taxonomically poorly characterised groups, will also be better understood.

Project #23: Enabling stable isotope technology for fruit fly incursion decision-making (2 yr)

- **Leader:** Karen Armstrong
- **Partners:** BPRC, (UoO)

This project will deliver advances for the use of stable isotopes and trace elements to determine the origin of trapped fruit fly, as of NZ origin or not, with respect to barriers to end-user uptake, such as improved speed (tight decision-making time frames), sensitivity (forensic-scale tissue samples) and cost (restricted budgets).

Model organisms: Fruit fly

Project #24: eRNA as a molecular diagnostic tool targeting viable (3 yr)

- **Leader:** Rebecca McDougal
- **Partners:** PFR, Scion

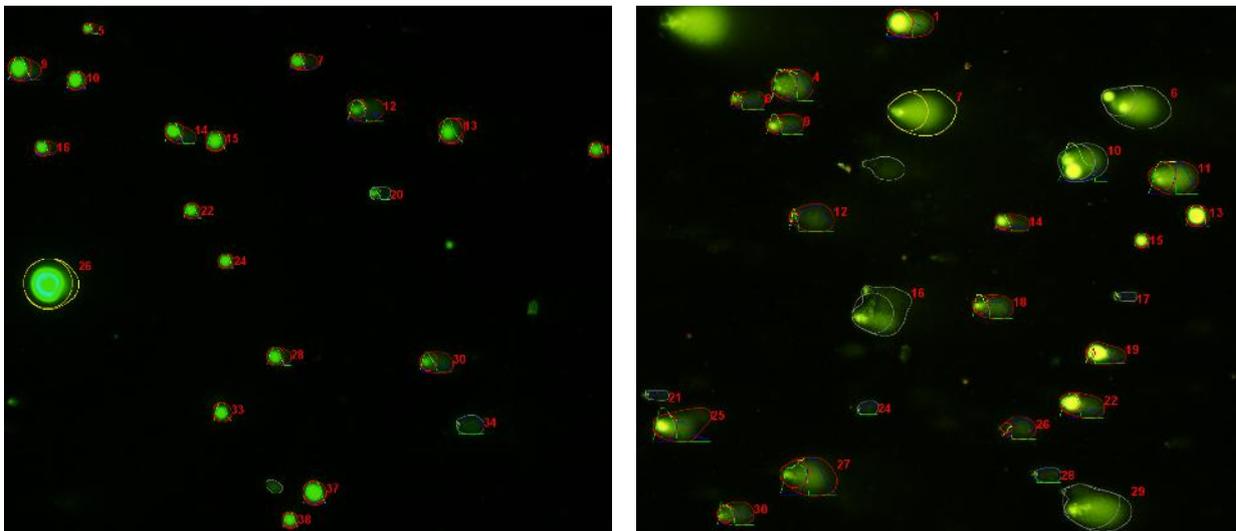
This project will enhance PEQ & HRSS decisions about the actual risk of organisms discovered during eDNA screening programmes using eRNA data to indicate if organisms are biologically active.

Model systems: *Phytophthora* spp. and other oomycetes

Project #25: Strategies for determination of biosecurity risk using high throughput sequencing (5 yr)
(Enterobacteriaceae and *Xylella*)

- **Leader:** Andrew Pitman
- **Partners:** PFR, Scion

This project will enable more robust risk assessments of exotic organisms and more rapid, cost-effective clearance of imported plants by MPI through a greater understanding of pathogen evolution/biology as well as molecular diagnostic tools and new bioinformatics pipelines to define pathogenicity, host range and/or aggressiveness of key pathogen groups.



DNA from control (left) and irradiated with 'comets' (right) insects (project #19).

Theme Leader: Jessica Dohmen-Vereijssen

Theme Representatives: George Gill (MPI), Paul Stevens (MPI), Rory MacLellan (MPI), Chris Green (DOC), Clark Ehlers (EPA), Russell Dale (FOA)

Theme Scope

Tools and strategies for preparedness for and response to incursions of invasive plant pest species, including determining their presence or absence

Theme scope

- **New Surveillance Methods:** Increased ability to detect species earlier by development of timely, cost-effective surveillance methods and improvements of surveillance sensitivity
- **Defining Surveillance Efficacy:** Increased understanding of and confidence in the effectiveness of surveillance programmes to enable better targeting and use of resources
- **New Eradication Tools:** Develop tools that maximise the likelihood of eradication, minimise adverse environmental and cultural impacts, and lie within public thresholds of acceptance for new technologies
- **New Response Decision Tools:** Develop tools and strategies to enable rapid and robust decision making during a biosecurity response.

Project #27: Improved surveillance tools for key biosecurity targets (5 yr)

- **Leader:** Flore Mas
- **Partners:** PFR. Links to SIT+ (Australia)

This project will develop better attractive lures for female Queensland fruit fly (QFF) and integrate self-reporting low-power sensors into fruit fly and gypsy moth surveillance programmes to improve detectability of a new incursion and support eradication attempts.

Model organisms: Fruit flies, Gypsy moth

Project #28: Biosecurity excellence in port communities (5 yr)

- **Leader:** John Kean
- **Partners:** PFR, AGR, Scion. Links to Tauranga Moana Biosecurity Capital (TMBC) and House of Science

This project supports a broad range of activities in the TMBC initiative including the establishment of baseline community biosecurity performance indicators and their change over time, better ways to understand, measure and influence biosecurity awareness (including with school communities), and improved understanding of the constraints and opportunities for biosecurity operational activities

Project #29: Integrating low power wide area networks into the biosecurity system (2 yr)

- **Leader:** Scott Hardwick
- **Partners:** AGR, University of Canterbury

This project will identify how Low Power Wide Area Networks (LP-WAN) might provide accurate, real time, geographically dispersed and cost-effective biosecurity surveillance networks.

Project #37: Maori responses to biosecurity incursions (5 yr)

- **Leader:** Alby Marsh
- **Partners:** PFR, BPRC

This project will advance the cultural imperatives of Māori for biosecurity responses by establishing relevant Māori networks for the dissemination of biosecurity related information, actively and appropriately participating with Māori in biosecurity activities and developing plans to improve future engagement based on learnings from the recent myrtle rust incursion

Model organism: myrtle rust

Project #31: Socially acceptable eradication tools underpinned by modelling for eradication (5 yr)

- **Leader:** Lloyd Stringer
- **Partners:** PFR, AGR. Links to SIT+ (Australia)

This project will explore the feasibility of the sterile insect technique (SIT) and high-density mass trapping (HD-MT) for BMSB eradication, and determine the application and compatibility of multiple eradication and delimitation technologies for a range of insect pests through population models (including implications of the Allee threshold). Modelling approaches will support declaration of freedom for these species.

Model organisms: Brown marmorated stink bug, Queensland fruit fly, codling moth, spotted wing drosophila, *Lobesia botrana*, great white butterfly

Project #32: Genetic methods for eradicating recent invaders (2 yr)

- **Leader:** Craig Phillips
- **Partners:** AGR, MWLR. Link to MBIE (Trojan)

This project will establish a robust basis for prioritising and designing future research on genetic control methods (GM and non GM) by reviewing emerging techniques and identifying those most likely to be useful in NZ eradication responses.

Project #33: Eradication toolkit and readiness (2 yr)

- **Leader:** Tara Strand
- **Partners:** Scion (as part of MBIE Urban eradication project)

This project will deliver improved methods of pest eradication in urban environments through targeted helicopter and unmanned aerial vehicle (UAV) spraying tools that maintain efficacy while reducing pesticide usage and both environmental and social impacts.



Automated traps being developed in project #27.

Peer Reviewed Publications

- Avila GA, Charles JG. 2018. Modelling the potential geographic distribution of *Trissolcus japonicus*: a biological control agent of the brown marmorated stink bug, *Halyomorpha halys*. *Biocontrol* 63 (4): 505-518. doi.org/10.1007/s10526-018-9866-8.
- Avila GA, Davidson MM, van Helden M, Fagan L. 2018. The potential distribution of the Russian wheat aphid (*Diuraphis noxia*): an updated distribution model including irrigation improves model fit for predicting potential spread. *Bulletin of Entomological Research*. DOI: 10.1017/S0007485318000226.
- Barratt BIP, Moran VC, Bigler F, van Lenteren JC. 2017. The status of biological control and recommendations for improving uptake for the future. *BioControl* 63 (1): 155-167. DOI: 10.1007/s10526-017-9831-y.
- Be M, Chase KD, Brockerhoff EG. 2017. Use of shelterbelt pine trees as 'stepping stones' by *Hylastes ater* in agricultural landscapes. *New Zealand Entomologist* 40 (2): 86-91. doi.org/10.1080/00779962.2017.1364152.
- Bertelsmeier C, Ollier S, Liebhold AM, Brockerhoff EG, Ward D, Keller L. 2018. Recurrent bridgehead effects accelerate global alien ant spread. *PNAS* doi:10.1073/pnas.1801990115.
- Brar S, Tabima JF, McDougal RL, Dupont P-Y, Feau N, Hamelin RC, Panda P, LeBoldus JM, Grünwald NJ, Hansen EM, Bradshaw RE, Williams NM. 2018. Genetic diversity of *Phytophthora pluvialis*, a pathogen of conifers, in New Zealand and the west coast of the United States of America. *Plant Pathology* 67 (5): 1131-1139. DOI:10.1111/ppa.12812.
- Brockerhoff EG, Liebhold AM. 2017. Ecology of forest insect invasions. *Biological Invasions* 19 (11): 3141-3159. doi.org/10.1007/s10530-017-1514-1.
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Other Publications (not abstracts)

Anonymous. 2017. Keeping stink bugs out of your house, and your island nation. Integrated Pest Management Insights 14 (3): 3-4. Cornell University.

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- Kean JM. 2018. Predicted development times, voltinism and rate of increase of brown marmorated stink bug (*Halyomorpha halys*) in New Zealand. AgResearch confidential report for Brown Marmorated Stink Bug Council. 12p.
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- Xu B (G), Teulon DAJ. 2017. Quantitative and qualitative comparisons of articles on five thrips species of biosecurity risk to New Zealand extracted from international and Chinese databases. A Plant & Food Research report prepared for B3. Plant & Food Research SPTS No. 15300.
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PhD Theses

- Nixon L. 2017. Identification of Biogenic Volatile Organic Compounds for Improved Border Biosecurity. PhD dissertation, Lincoln University.
- Martoni F. 2018. Biodiversity, evolution and microbiome of the New Zealand Psylloidea (Hemiptera: Sternorrhyncha). PhD dissertation, Lincoln University.
- Stringer L. 2018. Understanding how populations and management tools interact for pest surveillance and eradication. PhD dissertation, Auckland University. Submitted in April 2018.

Presentations

Keynote and Plenary Presentations

- Armstrong K. 2017. The whole is greater than the sum of its parts: Biosecurity as a beneficiary. Australian Entomological Society. Crowne Plaza, Terrigal, NSW, Australia. 17-20 September 2017.
- Holder P. 2018. Biosecurity intelligence: biogeochemical clues to high-risk pest natal origins" 14th Australasian Environmental Isotope Conference (AEIC). Te Papa, Wellington, 26-28th March 2018.
- Martin R, Duthie C, Viljanen S, Ganley R, Teulon D. 2017. Myrtle rust (*Austropuccinia psidii*) in New Zealand – The biosecurity response. Third International Conference on Biological Invasions. SanLi New Century Grand Hotel Zhejiang, Hangzhou, China. 19-23 November 2017.
- Suckling DM 2017. Searching for Achilles' heel: Chemical ecology for invasive species suppression. Joint meeting of the 33rd Annual Meeting of the ISCE & the 9th meeting of the APACE. Kyoto, Japan. 23-27 August 2017.
- Teulon DAJ. 2018. Plant viruses and their vectors at the border. 13th Australasian Plant Virology Workshop. Waiheke Island, New Zealand. 20-22 February 2018.

Invited Presentations (significant international/national meetings/seminars)

- Armstrong K, Holder P, Murphy D, Woods W, Crisp P, Balagawi S, Dominiak B. 2018. Biosecurity intelligence: biogeochemical clues to high-risk pest natal origins PBCRC 2111. Plant Biosecurity CRC Science Xchange. RACV City Club, Melbourne. 29-31 May 2018.
- Armstrong K, Holder P, Murphy D, Harumi Moromizato K, Kinaev I, Van Hale R, Bruce D, Crisp P, Woods W, Dominiak, Balagawi S. 2017. How robust are stable isotope and trace element signatures for the assessment of a fruit fly's geographic origin? APPS/SPPH Conference. Brisbane Convention Centre. 22-26 September 2017.
- Kean JM. 2017. Border patrol: Backyard biosecurity to protect New Zealand from invading pests and diseases. 2017 House of Science Symposium: Curious Citizens. Te Puke, New Zealand. 10 November 2017.
- Kean JM, McNeill MR, Ferguson CM, Phillips CB, Bell N, Popay AJ. 2018. Responding to biosecurity threats: Protecting the farm gate. 5th Annual Future Farms Conference. Palmerston North, New Zealand. 13-14 March 2018.
- Kralicek A. 2017. Aptamers for the detection of food safety risks. Safe NZ Seafood research programme Industry Advisory Group meeting, NMIT campus Nelson, 8 December 2017.
- Kralicek A. 2018. A biosensor to sniff out food safety pathogens. Advanced Diagnostics for New Zealand Food Safety Workshop. Jet Park Hotel & Conference Centre, Auckland. 22 February 2018.
- Pitman A. 2018. Better Biosecurity: A researcher's perspective. Summerfruit NZ Conference. Napier Conference Centre, Napier. 30-31 May 2018.
- Richardson B, Pawson S, Strand T. 2017. New tools for the biosecurity battlefield. NETS 2017: Birds, the Beehive and Biosecurity - Capital Results, Working Together. Wellington, New Zealand. 9-11 August 2017.

- Suckling DM. 2017. Los pheromonas y los kariomonas. Seminario Internacional *Lobesia botrana* 2017, avances I + D estrategias de control. Santiago, Chile. June 28, 2017.
- Teulon DAJ. 2017. Developing a cohesive research programme to mitigate the impact of myrtle rust. Mānuka the Plant workshop. Massey University, Palmerston North. 7 July 2017.
- Teulon DAJ, Williams T, Bullians M. 2017. Adoption of new technologies for biosecurity - challenges/constraints. NZPP Biosecurity Symposium. Trinity Wharf, Tauranga. 7 August 2017.
- Teulon DAJ. 2017. Biosecurity. NZ Horticulture Collaboration Research Forum. Lincoln. 16 August 2017.
- Teulon DAJ. 2017. B3. MPI/DAWR Consultative Group on Biosecurity Cooperation. 12 October 2017.
- Teulon DAJ. 2017. B3 Update and Biosecurity 2025. Vegetable Research & Innovation Board. Wellington. 1 November 2017.
- Teulon DAJ. 2017. Fundamental Science Needs to Underpin Biosecurity 2050. BPRC Conference. Lincoln University. 3 November 2017.
- Teulon DAJ. 2017. B3 Update and Biosecurity 2025. GERMAC – core Committee Meeting. Wellington. 27 November 2017.
- Teulon DAJ. Research to minimise establishment of invasive alien plant pests in New Zealand. WUR. Netherlands. 20 April 2018.
- Teulon DAJ. 2018. Opportunities for Trans-Tasman Collaboration between B3 and PBRI. Plant Biosecurity Research Initiative. Canberra. 15 May 2018.
- Teulon DAJ. 2018. Surveillance Research and Implementation in B3. Surveillance Panel Advisory Group - Meeting #13. Auckland, 26 June 2018.
- Teulon DAJ, Herrera V, Glare T. 2018. Trans-Tasman and trans-Pacific Collaboration in the Context of the PBCRC. PBCRC Science Exchange. Melbourne. 31 May 2018.

Videos

- Global Eradication Database (GERDA): <https://www.youtube.com/watch?v=xsoSz6G7A3w&feature=youtu.be>
- Invasion Busters Toolkit: <https://www.newshub.co.nz/home/rural/2018/08/kiwi-kids-learn-how-to-keep-pests-out-in-new-agresearch-biosecurity-board-game.html>
- Brown marmorated stink bug hunters in Italy: <https://www.youtube.com/watch?v=0Ktzhltf2l0&feature=youtu.be>

Other outputs

Patents

- Kralicek AV, Carraher C, Aydemir N, Khadka R, Travas-Sejdic J, Zheng H, Thanichelvan M, Plank N 2017. Sensor device and methods. Patent application with complete specification: PCT/IB2017/058181 filed 20 December 2017, Taiwan 106145168 filed 21 December 2017.
- Kralicek A, Carraher C, Aydemir N, Khadka R, Travas-Sejdic J. 2018. Biosensor device and methods, provisional patent filed 13 June 2018, Application number: NZ 743814.

New Products/Databases

- Invasion Busters board game. Available for individual order from The Game Crafter (<http://www.thegamecrafter.com/games/invasion-busters>). Launched March 2018. [John Kean].
- Biosecurity Education teaching kit. B3 sponsored and co-developed with House of Science. Accessible for 59 western Bay of Plenty schools.
- Thrips identification diagnostic key. Mound LA, Nielsen M, Hastings A. 2017. *Thysanoptera Aotearoa* – Thrips of New Zealand. Lucidcentral.org, Identific Pty Ltd, Queensland, Australia. http://keys.lucidcentral.org/keys/v3/nz_thrips/. [Mette Nielsen].

- Reference template for reporting DNA sequences suggesting presence of a new organism being beta-tested by MPI. [Simon Bulman].
- Database of first records for insects found in New Zealand. (<https://datastore.landcareresearch.co.nz/dataset/exoticinsectsfirstrecords>). [Darren Ward].
- Database of first records of plant pathogens found in New Zealand (<https://nzfungi2.landcareresearch.co.nz/>). [Peter Johnson].
- Database of host records from intentional releases of biocontrol agents is complete. [Darren Ward].
- Integrated Biosecurity Risk Assessment Model (IBRAM). Beta-tested by MPI for brown marmorated stink bug (BMSB) on used vehicles, containers and PAX pathways. [Lisa Jamieson].
- Targeted spraying protocol for using a ring boom on a tether under a helicopter developed presented to MPI. [Tara Strand].
- A manual of best practice for release of sterile moths. [Horner R, Suckling M].

Workshops/Symposium (national or international) co-ordinated by B3

- New Zealand Plant Protection Society full day symposium on “Opening the eyes and minds of biosecurity”. Tauranga. 7 August 2017. [Kean/Jamieson/Burnip].
- Myrtle rust symposium (with MPI, Scion, CBB (UoA), PFR, USDA). Auckland. August 2017. [Ganley, Teulon].
- NZ US Invasive Species Working Group Workshop, Auckland. 29 August – 1 September 2017. [Teulon].
- Brown marmorated stink bug: an imminent threat to Australia and Zealandia (with PHA). Melbourne. September 2017. [Teulon].
- Biosecurity: New pests, diseases & weeds – prediction & detection workshop. Appended to the BPRC conference. Lincoln. 3 November 2017. [Armstrong].
- Biosecurity preparedness – potatoes. Training workshop for unwanted arthropod pests for potato industry agronomists, crop scouts and seed merchants. PFR Lincoln, 9 November 2017. [Davidson/Vereijssen].
- Training on use of the sterile insect and related techniques for the area-wide integrated management of plant, animal and human insect pests. Antigua, Guatemala. 22-23 November 2017. [Suckling].
- Weed biosecurity research strategy workshop. Wellington. 11 December 2017. [James].
- PHA Board workshop. Lincoln. 22 February 2018. [Armstrong].

Aligned Funding for Border Biosecurity Research for B3 Science Organisations

Project	Funder	CRI	PI (or equivalent)	Amount
Theme B				
Biosecurity weed and pest lists for pasture	DairyNZ	AGR	Phillips C	\$128,000
Chinese language publications on BMSB impact on kiwifruit	KVH/Zespri	PFR	Teulon D	\$18,700
BMSB phenology modelling	BMSB Council	AGR	Kean J	\$4,268
Research stocktake to inform design of a plant production accreditation scheme	NZ Plant Producers Institute	Scion, PFR	Bulman L	\$40,240
Theme C				
Pathways and Risk Assessment Framework for High Impact Species	PBCRC 1109	PFR	Teulon D	\$43,340
Biosecurity risks in tissue culture	MPI	Scion, PFR	Ganley R, Bulman S	\$80,000
Scoping the value and performance of interventions across the NZ Biosecurity system	MPI	Scion/CEBRA	Brockhoff	\$40,000
Communication in bark beetles and the detection of unwanted species in imports	Royal Society of NZ Catalyst Seeding	Scion	Brockhoff	\$40,000
PEQ services	Various	PFR	Austin P, Horner M	\$24,547
BMSB treatments	MPI	PFR	Najar Rodriguez A	\$45,565
Myrtle rust risk assessment	BH NSC	Scion	Scott P	\$15,000
Theme D				
Evaluating diagnostic tests for pathogens of potential risk to <i>Actinidia</i> seed imports	KVH/Zespri	PFR	Pitman A	\$18,750
Genome-Informed Bacterial Diagnostics	PBCRC 2156	PFR	Smith G	\$141,826
NGS for border biosecurity	BHNSC	PFR	Bulman S	\$33,698
Myrtle rust diagnostic (LFD)	FERA/UK	PFR	Bulman S	\$6,000
Supply BVT kits	MPI	AGR	Phillips C	\$1,400
Theme E (surveillance)				
Fruit fly surveillance	Hort Innovation (Aust)	PFR	Suckling M	\$241,324
Fruit fly attractants	ANU (Korea)	PFR	Park K	\$79,911
Integration of primary host finding stimuli for phytophagous insects; re-evaluating the role of colour in the presence of odour	Royal Society of NZ Catalyst Seeding	PFR	Teulon D, Nielsen M	\$39,086
Forest surveillance model	FOA	Scion	Bulman L	\$23,900
Myrtle rust surveillance	MPI	Scion	Pearse G	\$17,220
Theme E (eradication)				
Visit to Gianfranco Anfora at Fondazione Edmund Mach (FEM), Italy, for BMSB research.	Trimble	PFR	Suckling M	\$7,151

Project	Funder	CRI	PI (or equivalent)	Amount
Embedding GERDA into the biosecurity landscape	PBCRC1155	PFR	Dohmen-Vereijssen J	\$164,373
Unmanned Aerial Vehicle/SIT	IAEA	PFR	Suckling M	\$19,701
Collaborative Planning and Shared Decision-Making	PBCRC 4115	PFR	Hill G/Teulon D	\$11,031
Pest impact calculator	FOA	Scion	Bulman L	\$30,000
BMSB chemical approval	MPI	Scion	Bulman L	\$32,500
<i>Macrolophus</i> detection survey	Tomatoes NZ	AGR	Kean J	\$20,000
Cross Theme				
Myrtle rust: a significant threat to Australasia and the Pacific	MBIE Catalyst Strategic	PFR, Scion	Smith G	\$492,725
B3 Conference 2017	Attendees	PFR	Teulon	\$35,876
Engagement for resilience in indigenous communities – Phase II	PBCRC 4041	PFR	Marsh A	\$179,696
US NZ Invasive species JCM	MBIE/LCR	PFR	Teulon D	\$17,513
US-NZ Invasive species workshop	Various sectors	PFR	Teulon D	\$59,940
Pheromone modelling	USDA-Forest Service	Scion	Strand T	\$133,855
Spray modelling	USDA-Forest Service	Scion	Strand T	\$3,568
Spray modelling	Lincoln Agritech	Scion	Strand T	\$5,000
Spray modelling	FOA	Scion	Strand T	\$27,500
Gypsy moth surveillance	MPI	Scion	Sopow S	\$35,937
Creepy crawlies meet primary production	MBIE Curious Minds, NZBH, Avocados NZ	Scion, House of Science	Pawson S	\$73,958
Using biosecurity data to inform general surveillance	NZBH, Te Punaha Matatini	Scion	Pawson S	\$75,000

Collaboration Council	Operational Leadership	End-user/Theme Representatives
Chair James Buwalda*	Director David Teulon	Aurelie Castinel (MPI) Chris Green (DOC)
Philippa Stevens (PFR) Tony Conner (AGR)	Programme Co-ordinator Margaret Hean	Russell Dale (FOA) Clark Ehlers (EPA)
Alison Stewart/Lindsay Bulman (Scion) Peter Millard (LCR) Travis Glare (BPRC) Veronica Herrera (MPI) Allan Ross/Amber Bill (DOC) David Rhodes (FOA)	Theme A Barbara Barratt (AGR) Toni Withers (Scion)	Theme A Chris Green (DOC)/Rod Hitchmough Clark Ehlers (EPA)
Richard Palmer Hort NZ (Observer) Chris Morley (Dairy NZ)/Suzanne Keeling (Beef+Lamb) (Observer) Stephen Cobb/Jacqueline Rowarth (EPA) (Observer)	Theme B John Kean (AGR) Beccy Ganley (Scion)	Theme B Jo Berry (MPI) Helen Harman (MPI)
	Theme C Ecki Brockerhoff (Scion) Andrew Kralicek (PFR)	Theme C Shane Olsen (MPI) Chris Denny (MPI) Sina Waghorn (MPI)
	Theme D Karen Armstrong (BPRC) Bevan Weir (LCR)	Theme D Rob Taylor (MPI) Prasad Doddala (MPI) Catia Delmiglio (MPI)
	Theme E Jessica Dohmen-Vereijssen (PFR) Nick Waipara (PFR)	Theme E George Gill (MPI) Rory MacLellan (MPI) Paul Stevens (MPI)
	Manaaki Whenua representative Darren Ward	
Science Advisory Group: Richard Newcomb (PFR), Alison Popay (AGR), Lindsay Bulman (Scion), Chris Jones (MWLR), Travis Glare (BPRC), John Roche (MPI), Chris Green (DOC), Russell Dale (FOA)		

*Philippa Stevens assumes the role of Chair when matters of the Biological Heritage NSC are discussed, as James Buwalda is Chair of this entity.

Jacqueline Rowarth replaced Stephen Cobb as EPA CC member from April 2017 to March 2018.

Amber Bill replaced Allan Ross as DOC CC member in December 2017.

Lindsay Bulman replaced Alison Stewart as Scion CC member in March 2018.

Suzanne Keeling (Beef+Lamb) replaced Chris Morley (Dairy NZ) as the pastoral sector CC member in March 2018.

Max Suckling remains on the Theme Leaders Group in an *ex officio* capacity.



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