B3 Annual Report

DAJ Teulon

2014–15

Adding Value to New Zealand's Biosecurity System through Research

B3 Science Solutions for BETTER BORDER BIOSECURITY

www.b3nz.org

B3's vision

… a world-leading source of science-based solutions for border biosecurity challenge by 2017, supporting and protecting the competitiveness of export industries and unique terrestrial ecosystems …

B3's strategic priority

Adding value to New Zealand's Biosecurity System through research

B3's critical objective areas

Leadership and Influence
Performance
Uptake
Capability
Investment

B3's research themes

Risk Assessment
Pathway Risk Management
Diagnostics
Surveillance
Eradication and Response

B3's partners

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)
Plant & Food Research (PFR)
AgResearch (AGR)
Scion
Landcare Research (LCR)
Bio-Protection Research Centre (BPRC)

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About Better Border Biosecurity (B3)

Background. B3 acts as the pre-eminent research provider for science-based plant border biosecurity solutions in New Zealand and provides a single point access to the New Zealand 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.

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 and diseases do not respect the productive and natural system boundaries. Weeds were confirmed to be within the scope of B3 in 2014-15.

Partners. All partners work towards a commonly developed and agreed-to Strategic Plan and a Business Plan, underpinned by a Partnership Agreement. The current members of B3 include:

Science providers: Plant & Food Research, AgResearch, Scion, Landcare Research and the Plant Bio-Protection Research Centre hosted by Lincoln University

Stakeholders/end-users: Ministry for Primary Industries, Department of Conservation, and Forest Owners Association. The Environmental Protection Authority has 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.

Operational. The Director leads a group of five Theme Leaders (plus 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. A central tenet of B3 is that it is the government operational agencies, MPI and DOC, who 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 (2010/11 to 2016/17) outlines the key drivers, critical objectives, scope, and aspirations 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) and are made available to the CRIs for their internal reporting requirements.

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From the Director

The critical importance of plant border biosecurity to New Zealand was once again bought to the forefront of our thinking with the discovery of several Queensland fruit flies in Grey Lynn, Auckland, in February 2015 and the (ongoing) eradication response that followed, as well as the increased numbers of Brown Marmorated Stink Bugs (BMSB) being intercepted at our borders throughout the summer of 2014–15. B3 researchers have been actively involved in supporting MPI and other stakeholders in these and other issues throughout the year, as detailed in this report.

Border biosecurity continues to be recognised as underpinning the economic prosperity and environmental health of New Zealand. Industry leaders continue to rank 'ensuring world class biosecurity' as their top priority (KPMG Agribusiness Agenda 2015) and the Minister for Primary Industries recently announced the Biosecurity 2025 project to update the 2003 Biosecurity Strategy, as well as increased funding for border biosecurity operations in the 2015 budget. Plant-based sectors continue to engage and join the Government Industry Agreement (GIA), with a number of sector plant Biosecurity Managers being appointed. New knowledge and science-proven technologies are key to an effective and resilient biosecurity system.

Of additional consequence was the funding of both The National Science Challenge – New Zealand's Biological Heritage and the Bio-Protection Research Centre during 2014–15. These will provide significant synergies and opportunities for the advancement of border biosecurity science and improvements to New Zealand's biosecurity system.

The Better Border Biosecurity (B3) collaboration brings together the capability and expertise of five research providers – Plant & Food Research (PFR), AgResearch (AGR), Scion, and Landcare Research (LCR) and the Bio-Protection Research Centre (BPRC) at Lincoln University – working closely with the Ministry for Primary Industries (MPI), the Department of Conservation (DOC) and the Forest Owners Association (FOA) to add significant value to New Zealand's biosecurity system through fit-for-purpose and world-leading science.

This Annual Report presents the highlights of the 2014–15 year in the context of B3's achievements and outcomes from each of the five research themes, along with its critical objective areas. It illustrates the need for a dynamic response to the issues of the day and the challenges of tomorrow. It also lists the programme's key outputs.

The value of the B3 collaboration is demonstrated in the following pages in terms of science endeavour and output, technical support for ongoing incursions, underpinning knowledge for the development of government policy, and for capability development through graduate student mentoring and supervision.

In 2014–15, B3 has seen (1) an increased focus on external communication through the active involvement of partner communications teams, (2) the Collaboration Council reconfirming and endorsing research on intentional introductions of biological control agents (BCA biosafety), and invasive plants (weeds) being within the B3's scope of activity, (3) a cross-theme approach for selected organisms (e.g. BMSB, *Phytophthora*), and (4) an updated MPI co-ordination framework for engagement.

2015–16 will continue to provide challenges for B3 in the form of the continual refinement of fit-for-purpose science to add value for New Zealand's biosecurity system, effective integration with the recently formed New Zealand's Biological Heritage NSC, collaboration with the reconstituted Bio-Protection Research Centre, increased engagement with government, industry (through the GIA) and Māori stakeholders and a strategic and operational refresh of B3's strategy and research plans in light of Biosecurity 2025.

Dr David AJ Teulon
Director, Better Border Biosecurity

30 September 2015

Highlights

Significant accomplishments for B3 in 2014–15 included:

- Strong science performance with 28 fit-for-purpose peer-reviewed publications; four book chapters; one plenary/keynote presentation; and twelve invited presentations at important national and international conferences
- Scientific and technical advice, expertise and operational assistance for MPI, and DOC for potential, actual and ongoing responses to invasive organisms (e.g. great white butterfly, Queensland fruit fly, Brown Marmorated Stink Bug, myrtle rust, *Phytophthora*) and for redesign of the Forest Health Surveillance System
- Enhanced international linkages through the Plant Biosecurity CRC, SITplus, The Centre for Fruit Fly Biosecurity Innovation (Macquarie University), the US Department of Homeland Security and the US/NZ Invasive Species Working Group, connecting New Zealand biosecurity research to the rest of the world
- Increased engagement with Māori, with appointment of summer students and the planned B3 hui
- Ongoing capability development through thirteen B3-aligned PhD students supervised by B3 researchers
- A dynamic response for research to the high priority Brown Marmorated Stink Bug.

A dynamic response to a high priority pest

There has been significant concern in New Zealand about the **Brown Marmorated Stink Bug** (BMSB) since its population exploded in the north-east USA in 2010. B3 invited Dr Tracy Leskey as a keynote speaker to its inaugural conference in May 2014, where she brought attention to the potential impact of this insect pest to New Zealand's important plant systems at this national forum. Increasing border and post-border interceptions of BMSB in the summer of 2014–15 raised the alarm level even further. Some now see BMSB as a greater threat to New Zealand than fruit fly, as the tools available for surveillance, eradication and management of BMSB are very limited.

B3 was at the forefront of organising three industry/MPI/B3 workshops in 2014–15 to help prioritise research to develop immediate and long-term solutions to minimise the threat of BMSB within New Zealand. As part of this process, B3 requested MPI and industry to critique a range of potential research projects. These projects were ranked and feedback was provided to B3 research leaders for consideration in the development of their research projects.

B3 was also fortunate to receive MBIE funding in late 2014 as part of the Invasive Species NZ/US Joint Commission on Science and Technology Co-operation. Project proposals were submitted to MPI for review, with about half the available funding being allocated for projects that enabled New Zealand researchers to travel to the USA to build research collaborations on BMSB.

B3 was able to initiate some research on BMSB during 2014–15. These projects will be developed further in 2015–16, as outlined in the B3 Business Plan.

See: http://b3nz.org/news/protection-stinky-problem

Picture credit: https://commons.wikimedia.org/wiki/File:Halyomorpha_halys_lab.jpg

Context for Plant Border Biosecurity

Biosecurity remains an area of very high interest within New Zealand, affecting trade competitiveness, economic prosperity and the quality of our unique natural environments.

B3 research is carried out in the context of the current external influences.

- New Zealand's wealth relies on increasing and changing trade and tourism patterns that may exacerbate New Zealand's biosecurity risks.
- Agribusiness leaders rank "maintaining a world class biosecurity system" as their number 1 issue (KPMG Agribusiness Agenda 2015).
- The Biosecurity Strategy for New Zealand and the Biosecurity Science Strategy for New Zealand both recognise the critical importance of research for biosecurity.
- The Hon. Nathan Guy, Minister for Primary Industries, continues to say, "Biosecurity is my number one priority" and has announced the Biosecurity 2025 project to update the 2003 Biosecurity Strategy.
- There are substantial ongoing endeavours across industry and research organisations to manage the recent incursions of the clover root weevil (pasture), *Pseudomonas syringae* pv. *actinidiae* (Psa) (kiwifruit), tomato potato psyllid (TPP) / *Liberibacter solanacearum* (Lso) (potato and related crops) and *Phytophthora pluvialis* (forest trees).
- Eradication attempts are continuing for (at least) two species of insects (i.e. great white butterfly, Queensland fruit fly). Outcomes for both are looking positive.
- A number of damaging invasive species, such as the Queensland fruit fly, the Brown Marmorated Stink Bug and myrtle rust, as well as a variety of unexpected and unknown species, are threatening our borders.
- As a result of these recent pest and disease incursions, many New Zealand industries are showing much greater interest in biosecurity science, such as appointing Biosecurity Managers. Their developing involvement in the GIAs with respect to "readiness and response" is also a key driver.
- The National Science Challenge, New Zealand's Biological Heritage, will provide enhanced expertise and research collaboration (additionality) for New Zealand to tackle its biosecurity, pest management and biodiversity challenges.

Refreshing B3's Science for Tomorrow's Challenges

The biosecurity paradigm is constantly changing, with new challenges appearing almost daily. B3's research priorities must respond accordingly or its outcomes will be relevant only for yesterday's concerns. A challenge for B3 is to work within its strategic intent while providing dynamic and effective responses to the border biosecurity issues of today and tomorrow.

The basis for B3's strategy is found in the Statement of Core Purpose for each partner CRI. B3's strategic framework is comprised of the five-theme structure, each incorporating several medium-level research 'project outlines' developed in close consultation with end-users. Achievement Measures are targeted for completion in June 2017, with specific project plans and KPIs developed for each year. This framework provides the dual advantage of a providing a strategic direction along with the flexibility to shift tactics and targets as changes occur at the border.

While the suite of research projects is ultimately signed off by the Collaboration Council as part of the Business Planning process each year, there is always a significant degree of 'refreshment'. Some examples of how B3 adjusts its sights to current challenges are provided here:

Status quo – continue as planned. This is the situation for a number of projects where science progress is on track and outcomes remain a high priority for end-users.

Redirection through review. For several projects, workshops are held where research partners and relevant end-users review research progress and current relevance. Project direction may be confirmed, clarification may be sought (e.g. through summary report, publication), or redirection may be recommended and implemented, and in some cases projects may cease.

Underpinning current incursions. Every year B3 end-users are faced with the need to eradicate new pest and disease incursions. Whenever practical B3 reprioritises and realigns its research projects to support these incursions. This provides a double benefit of (1) better science-based eradication outcomes and (2) science relevant for today's and tomorrow's biosecurity challenges.

Partnering with end-users. Industry partners are increasingly investing in readiness and response for border incursions and will do so more and more as the GIA develops. Where industry activity aligns with the B3 scope and research direction, B3 resources may be redirected to underpin these industry undertakings. A current example is the redevelopment of the Forest Health Surveillance System.

Leveraging capability and capital. From time to time, opportunities arise where B3 resources can be leveraged through collaborative initiatives (sometimes international). Where these initiatives provide added value to New Zealand's biosecurity system by establishing projects of greater size and broader expertise, project pathways may be adjusted accordingly.

Increasing risk profiles. As risk profiles of invasive organisms change over time, for example as their pest status changes elsewhere, they move closer to New Zealand, or our trade and tourism patterns change, high-risk organisms increase their profile within B3's suite of themes and projects. A current example of this is the Brown Marmorated Stink Bug (see box above).

Refinement of B3 scope. The status of weed border security has had an ambiguous place in the B3 Strategic Plan. Recent increased weed border incursions and associated interest from end-users, as well as increasing science capability through Landcare joining B3, has led the Collaboration Council to confirm that weeds fall within B3's scope. Plans are now underway to operationalise research priorities with end-users.

B3 Theme Outcomes

B3 drives research under five themes – risk assessment, pathway risk management, diagnostics, surveillance, and eradication and response. Each of these themes involves teams comprising people from science and end-user organisations. These themes must contribute to five critical objectives of B3 and the projects within each theme are strongly informed by the end-user organisations.

A growing focus of B3 research is a cross-theme approach. For example, initiatives for Brown Marmorated Stink Bug and *Phytophthora* are being linked across themes by designated organism leaders.

This section highlights the value created by B3 science for its stakeholders across its five themes. B3-developed tools are being used in risk assessment; B3 technology and knowledge is being used for pathway risk management; new approaches for diagnostics are being tested by B3 for adaption by stakeholders; and B3 science capability, expertise and ingenuity are contributing to better design of pest and disease surveillance systems and eradication programmes for MPI and DOC.

THEME 1. RISK ASSESSMENT

Theme Leader:	Barbara Barratt
Theme Representatives:	Jo Berry (MPI), Helen Harman (MPI), Chris Green (DOC), Clark Ehlers (EPA), Russell Dale (FOA)
Project Leaders:	Lisa Jamieson, Sue Worner, Craig Phillips, Nigel Bell, John Charles, Toni Withers, Barbara Barratt

***Aim**: To develop and deliver improved methodologies for identifying hazards, assessing risk, predicting impacts and ascertaining where in the system mitigation measures are best targeted.*

From the Theme Leader. Theme 1 is working closely with MPI, DOC and EPA to develop and improve generic models and systems that can be implemented by them to improve the efficiency and accuracy of pest risk analyses. Capability development, particularly training and application in advanced modelling techniques, will provide risk analysis tools for the future. Research in productive and natural ecosystems, to better understand the characteristics of successful invasive plant pests and potential distribution of invasive species, is improving our ability to predict and mitigate impacts more accurately. End-users are being provided with tools, knowledge and other resources to inform decision-making at the border. Our future research will continue to build and enhance risk assessment capability, and in particular, to take a more pre-emptive approach to plant pest preparedness in light of changing patterns of tourism and trade.

Assessing the Risks Associated with Brown Marmorated Stink Bug (BMSB)

B3 responded rapidly to the rising concern of BMSB, as interceptions rose rapidly during the summer of 2014–15, with a range of projects, including these in Theme 1:

Potential New Zealand distribution. The upland distribution of BMSB in the United States led to questions about its potential distribution if it established in New Zealand. Such knowledge helps us to understand potential invasion pathways and the ultimate impact on crops. 'Climex match climates' and MAXent models were used to predict the potential distribution of BMSB in New Zealand. Preliminary results from both models indicated that most areas of New Zealand are suitable for BMSB, but we advise against drawing too strong a conclusion from these results until the research is completed. This research does, however, underpin our concerns for the ease of establishment of this pest in New Zealand.

Key report: Phillips C, Kean J, Senay S, Acosta H. 2015. Update on modelling the potential distribution of *Halyomorpha halys* (brown marmorated stink bug) in New Zealand. AgResearch. Unpublished report. 8 July 2015.

Contact: Craig.Phillips@agresearch.co.nz

Pre-emptive biosafety for biological control. Bet-hedging is one option for risk management. Some pragmatic minds suggest that we should expect BMSB to establish and that we should be ready with suitable pest management tools. One such tool is biocontrol and research carried out in B3's biosafety project has enabled us to assess that the most effective BMSB biocontrol agent that is likely to have little impact on our depauperate native stink bug fauna. This has given PFR and industries confidence to proceed on a pre-emptive biocontrol programme – with the aim of being ready to release of this biocontrol agent as soon as BMSB arrives.

Key report: Charles JG. 2015. Preparing for classical biological control of Brown Marmorated Stink Bug in New Zealand: why CBC will be necessary, and the potential environmental impact of an exotic egg parasitoid, *Trissolcus japonicus*. Plant & Food Research report. SPTS No. 11538. July 2015.

Contact: John.Charles@plantandfood.co.nz

Engagement with Māori over Risks from Myrtle Rust

Historically, B3 research has focused on the risks from invasive organisms on the health and integrity of New Zealand's productive and natural plant systems in terms of their economic and environmental impact. While these are very relevant to Māori, cultural and spiritual impacts are also of concern. B3 has hosted two summer students looking at a range of potential impacts of myrtle rust (not currently present in New Zealand) to plant species of special interest to Māori. These issues were further explored at the B3 hui in August 2015.

All indigenous Myrtaceae species are threatened by myrtle rust and can be considered as taonga (or treasure) by Māori, who have and continue to use the properties of some species in many ways (both tangible and intangible). Preparedness and response plans for a myrtle rust incursion in New Zealand should consider the values that Māori derive from these plants, and B3 is exploring ways to do this along with MPI. Our collaboration with Australian indigenous community researchers in the Plant Biosecurity CRC has also underpinned B3's activities in this area.

See: http://b3nz.org/news/

Key publication: Teulon DAJ, Alipia TT, Ropata HT, Green JM, Viljanen-Rollinson SLH, Cromey MG, Arthur K, MacDiarmid RM, Waipara MW, Marsh AT. 2015. The threat of myrtle rust to Māori taonga plant species in New Zealand. New Zealand Plant Protection 68: 66-75.

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Myrtle rust spores

Picture credit:
https://commons.wikimedia.org/wiki/File:Myrtle_rust_on_Geraldton_Wax_flower_buds_(8595049832).jpg

PRONTI – Keeping our Unique Fauna Safe from Harm

Understanding the potential risks to New Zealand's unique invertebrate fauna from intentional introductions, such as beneficial biological control agents, is a key focus of B3's biosafety research. The Priority Ranking of Non-Target Invertebrates (PRONTI) model is a new risk assessment tool that could help decision-makers to make sure the risks of intentional introductions do not outweigh the benefits.

PRONTI provides a framework and tool that allows us to predict which invertebrates – such as insects, spiders, snails and worms – might be at risk from new biological control agents, so testing can be undertaken before decisions are made about releasing these into the environment. A group of researchers and stakeholders, including the Environmental Protection Agency (EPA), Ministry for Primary Industries (MPI) and Department of Conservation (DOC), have recently assessed the model and the case studies carried out to validate it.
The research is entering a "live test" phase to analyse its performance compared with the current test species list selection for risk assessment processes. This will help to determine the suitability of PRONTI to become best-practice in the risk assessment of new biological control agents.

See: http://b3nz.org/news/

Key report: Todd J, Barratt BIP, Withers T, Mason P, Avila GA, Malone LA. 2015. The PRONTI (priority ranking of non-target invertebrates) species selection method: Background, development and assessment of its value as a component of the risk assessment process for biological control agents. Report for EPA. Plant & Food Research SPTS No. 11612. 35 pp.

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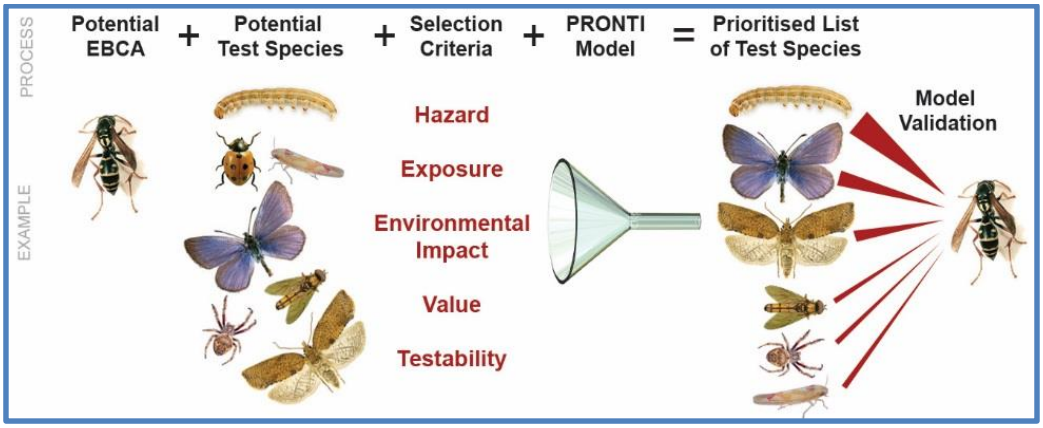
The PRONTI tool aids the selection of non-target species for risk assessment



Source: Biological Control 80 (2015) 77–88

Where are we in the Fight against *Phytophthora*?

Phytophthora spp. are fungus-type plant pathogens that cause serious plant diseases in forestry, horticulture, agriculture and natural ecosystems throughout the world and are becoming a greater focus of research within B3. These pathogens are very easily spread, and once established are virtually impossible to eradicate or contain, and very difficult and costly to manage. Some are asymptomatic in host plants.

Current research within B3 includes a review of global *Phytophthora* diseases to determine the risk of different pathogen species to New Zealand, a comparison of the diversity of native and introduced *Phytophthora* host species, and genomic approaches to establish whether species are new to New Zealand or have undergone a behavioural change, or hybridised. Additionally, the impact of the only effective chemical *Phytophthora* treatment, phosphite, on keystone native New Zealand species is being examined (Theme 5).

The data and information that B3 is generating can be used to help to map the movement of the pathogens between countries, the potential entry pathways and the likely risks they pose to indigenous and introduced flora should *Phytophthora* species arrive in New Zealand. Information from these studies can be used by MPI to revise the New Zealand risk assesments for *Phytophthora* spp.

See: http://b3nz.org/news/

Key publication: Scott P, Williams N. 2014. Phytophthora diseases in New Zealand forests. NZ Journal of Forestry 59 (2): 14-21.

Contact: Rebecca.Ganley@scionresearch.com

THEME 2. PATHWAY RISK MANAGEMENT

Theme Leader:	Ecki Brockerhoff
Theme Representatives:	Shane Olsen (MPI), Chris Denny (MPI), Chris Green (DOC), Clark Ehlers (EPA), Russell Dale (FOA)
Project Leaders:	Lisa Jamieson, Mark McNeill, Craig Phillips, Ecki Brockerhoff

***Aim**: To develop and deliver 'fit for purpose' tools and methodologies for reducing risks along importation pathways*

From the Theme Leader. 2014-15 was a productive year with excellent progress across a number of activities in the Pathway Risk Management Theme. A suite of articles on non-pesticide treatments of fresh produce, focusing on imports from the Pacific Islands, has been published. Most of these appeared in *New Zealand Plant Protection*, a journal that is widely read by biosecurity end-users in MPI and various sector groups. Another area of activity concerns the trade in live plants, which remains of considerable biosecurity interest despite New Zealand's widely recognised leadership in terms of regulation of this pathway. An expanded area of work, in collaboration with colleagues in the United States, focuses on the development of detection tools for pathway risk management using odours and sounds associated with organisms that are potential biosecurity risks. More information on progress and achievements is provided in the highlights below.

Volatile treatment facility, Auckland

Border Treatments Work Both Ways

Treatments for fresh plant commodities and timber are equally applicable for the arrival (border biosecurity) and departure (market access) of plant pests and diseases passing through New Zealand's border.
B3's research activity for border treatments is aligned with its members' Market Access research programmes, to optimise this common expertise and the use of resources, such as the world-class volatile compound/fumigation facilities in Auckland and Palmerston North.

A number of recent research publications reflect B3's strong activity in this area, including work on a range of target insect pests, crops and disinfestation technologies. Such information is available for use by MPI to develop Import Health Standards for risk commodities being imported into New Zealand.

Additionally, PFR researchers are currently leading a Plant Biosecurity CRC project to bring together in one place the many disinfestation technologies for fresh fruit and vegetable commodities, thereby providing a resource document where appropriate technologies for specific pest/crop combinations can be easily identified.

Key publications: New Zealand Plant Protection 67: 75–79, 67: 96–102, 67: 103–108, 67: 109–115, 68: 19–25, 68: 91–97, 68: 348–352, 68: 340–347.

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Strategic Alliance with the US Department of Homeland Security

An MBIE-funded initiative has enabled B3 to establish a new relationship with the US Department of Homeland Security (DHS) – New Zealand and the United States both have a priority on maintaining a high degree of biosecurity at the border to protect their countries from invasive species. Both countries have challenges with the high volume of shipping containers entering through the ports, and are developing technologies to assist in screening this pathway. DHS is keen to develop innovative technology for detection of invasive species at the border.

In the first instance, the collaboration will consist of an MBIE-funded PhD student hosted by Scion and the University of Canterbury to explore the species-specific spectra of sound emitted by insects, as the basis for detection systems for invasive species in ports of entries. Both parties hope to increase the degree of this collaboration as opportunities arise.

This is a golden collaborative opportunity to leverage New Zealand and US scientific expertise, resources and technology to achieve a common goal, says Dr Max Kennedy (National Manager of Biological Industries Science Investments, MBIE).

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Mitigating Biosecurity Risks Associated with Imports of Live Plants

Several activities in this project are concerned with assessing and mitigating risks of live plant imports, which is widely considered an important pathway for the introduction of plant pests and pathogens.

This work includes an international collaboration with colleagues from the United States and several other countries in a working group on "Globalization of the Live Plant Trade: Informing Efficient Strategies for Reducing Non-Native Pest Invasion Risk" at the 'National Socio-Environmental Synthesis Center' (SESYNC, University of Maryland). An early output of the working group has been a publication (see below) comparing 'phytosanitary legislation and regulations governing the importation of plants for planting' among ten 'countries' (Australia, Brazil, Canada, China, the EU, India, Kenya, New Zealand, South Africa, and the USA) with input from B3, MPI and several other National Plant Protection Organisations (NPPOs).

A related activity in New Zealand has been assessing whether tissue culture imports are indeed a safe method of importing conifer germplasm (see below). As a first step, asymptomatic tissue culture material of *Pinus radiata* was tested for the presence of fungal DNA or mycelium. Fungal DNA was present in all the samples tested. The next step is to determine the potential risk from such microorganisms found in tissue culture.

Key publications: Eschen R, Britton K, Brockerhoff E, Burgess T, Dalley V, Epanchin-Niell RS, Gupta K, Hardy G, Huang Y, Kenis M, Kimani E, Li H-M, Olsen S, Ormrod R, Otieno W, Sadof C, Tadeu E, Theyse M. 2015. International variation in phytosanitary legislation and regulations governing importation of plants for planting. Environmental Science & Policy 51: 228–237.

Ganley R, Hargreaves C, Donaldson L. 2015. Detection of asymptomatic fungal microorganisms in *Pinus radiata* tissue culture material. New Zealand Journal of Forestry Science 45 doi: 10.1186/s40490-015-0042-y.

Contact: Eckehard.Brockerhoff@scionresearch.com

THEME 3. DIAGNOSTICS

Theme Leader:	Karen Armstrong
Theme Representatives:	Robert Taylor (MPI), Disna Gunawardana (MPI), Chris Green (DOC), Clark Ehlers (EPA), Russell Dale (FOA)
Project Leaders:	Andrew Pitman, Simon Bulman, Karen Armstrong

***Aim**: To investigate and deliver fast, cost effective, robust and accurate diagnostic methods and tools to enable informed biosecurity decisions*

From the Theme Leader. Inroads continue to be made with technologies that are pushing the boundaries for diagnosis. Some technology, through focused effort and application, is close to being validated for routine use. Others, based on Next Generation Sequencing (NGS) and highly sensitive mass spectrometry, are producing valuable new levels of diagnostic data; however, the complex nature of biosecurity situations requires new strategies to be designed for data interpretation, to secure rather than confound decision making.

Biosecurity Researchers Provide Expertise to Update Import Health Standards

Expertise nurtured in the B3 diagnostics theme has been utilised by MPI to develop Import Health Standards (IHS) (currently in abeyance) for the management of biosecurity risks associated with *Actinidia* germplasm and pollen imports.

Current capability within the B3 project is exploring differing pathogenicity of bacterial strains or pathotypes, particularly in *Pseudomonas syringae*. Threats to horticultural crops at the pathotype level were part of the focus of a technical working group providing cross-discipline expertise and technical knowledge to develop this IHS.

The primary focus of the working group (comprising expertise from government, industry and science) was to provide advice to MPI on the potential impacts of all risk organisms that may be associated with *Actinidia* plant material or kiwifruit pollen overseas, and the measures that will be applied to imported goods to prevent the entry of these risk organisms.

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A Lesson for the Future – what will DNA Technology Reveal?

NGS has tremendous potential for the early detection and identification of invasive species – but it also comes with some potentially significant pitfalls. This paradox has been amply illustrated in B3 research that provides useful lessons for the future.

Sequences in a 454 NGS DNA dataset from kiwifruit lesions raised concern for the possible presence of a new to New Zealand *Acidovorax* sp. pathogen, which is associated with kiwifruit in Korea. Specific PCR primers were used to confirm the presence of the bacterium in the original lesions, but none of the new sequence aligned with the Korean *Acidovorax* pathogen so that the New Zealand find was likely to be an undescribed endemic species.

This example represents proof-of-concept for a workflow where suspected risk organisms from an NGS dataset are identified and the original sample specifically queried. As NGS becomes more commonplace for exploring biological systems, such careful examination of DNA sequence data will be required to confirm or otherwise the presence of new organisms in New Zealand. It also provides a useful illustration of the need for research scientists (such as in B3) and government regulators (such as MPI) to work closely together to deliver pragmatic outcomes.

Protocols for dealing with sequences of biosecurity interest will be developed in the Biological Heritage NSC in collaboration with B3. This will include surveying international trends/best practice.

Contact: Simon.Bulman@plantandfood.co.nz

Diagnostics – an Essential Element for Plant Border Biosecurity

New Zealand's biosecurity system relies on the accurate identification or characterisation of invasive organisms. Landcare Research houses a significant portion of the taxonomic capability for terrestrial plant pests and diseases in New Zealand and this capability joining B3 has once again allowed B3 to focus on this essential biosecurity activity.

Several initiatives in invasive species diagnostics are being advanced in B3, all of which have strong biosecurity outcomes. One of these, a diagnostic key to the *Meloidogyne* species in New Zealand, is particularly relevant given a recent nematode incursion in Christchurch.

Dr Brett Alexander from MPI says "The root knot nematodes are an important group of plant parasitic nematodes, and it is important that we can easily and accurately identify those *Meloidogyne* species already present in New Zealand. This will certainly help when we encounter regulated species during surveillance activities and border interceptions".

Contact: HoulistonG@landcareresearch.co.nz

Home Grown Isotope Signatures – a Silver Lining to the QFF Cloud

Developing stable isotope technology to distinguish established from just-arrived exotic invasive insects provides a quandary – how to obtain a New Zealand signature of an exotic species to test that theory?

The best option is to use an exotic species whose offspring have utilised local biogeochemical resources for their development, such as was the case with the recent QFF incursion in Grey Lynn.

Data from those specimens have provided essential information on what might be expected in isotopic signal variation for this species should breeding populations be detected in New Zealand again, and helps to build the dataset that can be interrogated for its management of future incursions.

This, together with work being carried out in a PBCRC project examining QFF and medfly from Australia will help us to understand how the stable isotope signal in a fruit fly might indicate the environment of the original infested fruit.

Contact: Karen.Armstrong@lincoln.ac.nz

THEME 4. SURVEILLANCE

Theme Leader:	John Kean
Theme Representatives:	Paul Stevens (MPI), Barney Stephenson (MPI) (for Rory MacLellan), Chris Green (DOC), Clark Ehlers (EPA), Russell Dale (FOA)
Project Leaders:	Max Suckling, Scott Hardwick, Suvi Viljanen-Rollinson, John Kean

***Aim**: To deliver knowledge, strategies and tools for determining presence or absence of invasive pests of plants*

From the Theme Leader. Queensland fruit fly (QFF) struck again this year, with New Zealand's first established population found in Auckland in February 2015. B3 researchers were among the experienced team that promptly set out to eradicate the small population, and QFF continues to be a focus for some of the surveillance work in Theme 4. B3 progressed work on self-reporting traps and worked with the international consortium SITplus to develop and trial new lures for early detection of QFF. The fruit fly surveillance model was modified and enhanced to create a prototype risk-based system for optimising part of the New Zealand's Forest Health Surveillance System, and research continues into the feasibility of multi-species lures (MPI co-funded) and early detection of exotic plant pathogens.

Another Queensland Fruit Fly Incursion!

The February 2015 discovery of several Queensland Fruit Fly (QFF) in Grey Lynn, Auckland, represents the most significant fruit fly incursion in New Zealand since 1996. MPI responded immediately with their science-based response and eradication protocols and although the outcome of the eradication attempt is too soon to call, all indications are that it has been successful.

Tree in QFF incursion zone

B3 assisted MPI in several ways, including through participation in the Technical Advisory Group, by supporting MPI's decision making through modelling of QFF phenology, trap sensitivity, spring mating behaviour and proof-of-freedom monitoring times. Published research (see below) also reinforced the likelihood of success for MPI's current response.

At the May 2015 B3 Science Partnership Forum, Prof. Tony Clark (QUT) warned us that New Zealand is likely to suffer from increased QFF incursions as the area-wide management of this insect further breaks down in Australia.

Key publication: Suckling DM, Kean JM, Stringer LD, Caceres-Barrios C, Hendrichs J, Reyes-Flores J, Dominiak BC. 2014. Eradication of tephritid fruit fly pest populations: outcomes and prospects. Pest Management Science: Early View (Online Version of Record published before inclusion in an issue). doi: 10.1002/ps.3905.

Contact: John.Kean@agresearch.co.nz

B3 Member Joins Centre for Fruit Fly Biosecurity Innovation (Macquarie University)

Anticipated increasing incursions of QFF into New Zealand (see above) means that we have to increase our capability and surveillance and eradication options. One of B3's partners, PFR, has joined a recently funded ARC Industrial Transformation Training Centre for Fruit Fly Biosecurity Innovation hosted by Macquarie University and led by Assoc. Prof. Phil Taylor. This initiative is linked to the Queensland fruit fly research consortium called SITplus, which was reported on last year.

B3 researchers will help to supervise four PhD students in areas of their expertise, including (1) Comparative studies of *Bactrocera* pheromones; (2) Pheromone function; (3) Behavioural effects of bacterial odours; and (4) Kairomones and other potential natural repellents. This initiative will expand B3 experience with fruit fly pest ecology.

See: http://mq.edu.au/newsroom/2015/07/09/20-5-million-towards-queensland-fruit-fly-biosecurity-research-and-development/

Contact: Max.Suckling@plantandfood.co.nz

Successful Ant Eradication a World First

Auckland Council biosecurity staff, working with B3 researchers providing modelling expertise, think it is highly likely that they have successfully eradicated Argentine ants from Kawau Island.

It has been two years since the initial control was undertaken and current evidence using proof-of-freedom modelling initially developed within Landcare shows there is a very high probability that Argentine ants have been eradicated.

"We can now confirm that Argentine ants have been eradicated from Schoolhouse Bay. It's definitely the first eradication from New Zealand and it's a world first from outside a major urban area" says Dr Darren Ward.

See: http://www.treasureislands.co.nz/home/news-events/2015/2/19/pest-eradication-success.aspx

Contact: WardDA@landcareresearch.co.nz

Argentine ant

Source: https://en.wikipedia.org/wiki/File:LinHum10a.jpg

Towards a New Forest Biosecurity Surveillance System

The New Zealand Forest Biosecurity Surveillance System is aimed at detecting new pests and pathogens as early as possible, to increase the probability of successful eradication if that is deemed feasible. Over the year, the B3 team from Scion and AgResearch, along with significant input from the Centre of Excellence for Biosecurity Risk Analysis (CEBRA), all assisting MPI and FOA, have made significant progress.

Entry pathways for three pests were evaluated and predictions on species distribution based on volumes associated with those pathways, climate suitability and host availability have been made. Surveillance costs for 1,911 area units in New Zealand were estimated and a draft optimisation model has been prepared that will estimate the probability of detection within each area unit using any given survey combination.

The plan is to have the new system trialled in three regions and possibly adopted by June 2016.

Contact: Lindsay.Bulman@scionresearch.com

THEME 5. ERADICATION AND RESPONSE

Theme Leader:	Max Suckling
Theme Representatives:	George Gill (MPI), Barney Stephenson (MPI) (for Rory MacLellan), Chris Green (DOC), Clark Ehlers (EPA), Russell Dale (FOA)
Project Leaders:	Max Suckling, Grant Smith, John Kean, Tara Strand

***Aim**: To increase preparedness for responses by providing knowledge, strategies and tools to support robust decision-making.*

From the Theme Leader. Progress has continued with new socially acceptable eradication tools for Lepidoptera and Hymenoptera, and there is an emerging interest in Unmanned Aerial Vehicles, with Scion's new MBIE programme (see page 26) and PFR's use of them for insect release and other Theme 5-related projects. International projects and publications with teams, especially teams based in the USA and Australia, have continued to be a strong focus of this theme, with involvement in several consortia, including Cooperative Research Programs with the International Atomic Energy Agency (Vienna) and the Plant Biosecurity CRC (Canberra), as well as SITplus and the new Industrial Transformation Training Centre on Fruit Flies (Diptera) at Macquarie University in Sydney, where PFR will be involved in co-supervision of up to four PhD projects funded by the Australia Research Council. Future projects will continue to build the toolkit to improve the odds for success against major target groups and cross-sector pests especially.

Novel Use of Technology to Improve Spray Drift Models

Aerial spraying with pesticides is still one of the most effective tools for eradicating invasive species including in urban areas. In these situations, it is imperative that spray drift is reduced to the absolute minimum and that this can be demonstrated to provide assurance to the communities that might be affected.

LiDAR equipment

The AGDISP™ spray deposition model is used to quantify drift and treatment efficacy, but there are concerns that this model is underestimating drift over aerodynamically rough surfaces such as a forest canopies and urban landscapes. In a large New Zealand field trial, a backscatter LiDAR (laser technology used to visualise particles and aerosols in the atmosphere) was used to measure the height and density of a drifting spray cloud, with this data then contrasted against standard deposition samples and turbulence measurements. This research will ultimately result in considerable benefits for eradication responses where 100% treatment efficacy is needed along with very small off-target impacts such as is required in urban environments.

Scion, PPC_{NZ}, Lincoln Agritech, US Forest Service and University of South Carolina participated in the New Zealand -based trial, which was funded from various sources including B3, MBIE and USDA.

Contact: Tara.Strand@scionresearch.com

Eradication Tools for Plant Pathogens

A significant challenge for those responsible for plant border biosecurity is the limited range of tolls to respond to incursions of plant pathogens. Currently there are a very limited number of response options and most involve host plant destruction. Several novel eradication approaches are currently being examined within B3, including:

- Fungi (or fungi-like organisms) (model organism: *Phytophthora*). Phosphite is the only effective chemical for *Phytophthora* treatment (including aerial treatment). The impacts of phosphite on non-target keystone native New Zealand species were assessed. Initial results are looking promising.

- Viruses (model organism: Lettuce Necrotic Yellows Virus). The use of the experimental drug PAV for use in eradication of viruses is being studied. Initial results suggest an anti-viral effect, but the assay system needs further refinement.
- Bacteria (model organism: *Pseudomonas syringae*). The use of a novel bactericide for use in eradication of bacteria is being studied, with initial promising results.

B3 is endeavouring to increase the focus on plant pathology for border biosecurity. Deputy theme leaders with plant pathogen backgrounds were appointed in 2014, and a plant pathology workshop is planned for October 2015.

Key report: 2014–15 Progress Report. B3 project E1.2 Plant Pathogen Response

Contact: Grant.Smith@plantandfood.co.nz

Is it the End for the Great White Butterfly?

Everyone involved in the Great White Butterfly (GWB) eradication programme in Nelson will be eagerly awaiting the outcomes of this season's (2015-16) monitoring programme. GWB has not been seen since December 2014 and there is real hope that it has been eradicated. Numbers had been steadily declining since spring 2013, after the eradication programme began in 2012 with support from Vegetables NZ, Tasman District Council, Foundation for Arable Research, Dairy NZ, and the Ellet Trust. B3 has provided considerable ongoing scientific support to the programme (see box below).

In addition to impacts in agriculture and horticulture, GWB is considered a significant threat to our native plant species because of its potential to bring about the extinction of many rare native cress species, including the iconic Cook's scurvy grass.

A key lesson from previous eradication programmes is the need to keep the pressure on until eradication is complete. It will be vitally important to make sure that the last GWB (or the last viable reproductive unit) is eradicated, so that the population does not rebound and put at jeopardy the significant investment that has already been incurred.

Key report: Phillips CB, Brown K, Green C, Walker G, Broome K, Toft R, Vander Lee B, Shepherd M, Bayley S, Rees J. 2014. *Pieris brassicae* (great white butterfly) eradication. Annual Report 2013/14. Nelson, New Zealand. 37p.

Contact: Craig.Phillips@agresearch.co.nz

B3 Support for the Great White Butterfly Eradication Programme

B3 has provided considerable scientific support to the GWB eradication programme over several years, including:

- Research on development of a remote surveillance tool
- Measuring the effectiveness of techniques used
- Plant & Food Research
  - Odour and visual lure development
  - Parasitoid augmentation
- AgResearch
  - Detection efficacy – passive, active, general and follow-up surveillance
  - Modelling spatial extent and population trends
  - ID of hot spots and habitat preferences
  - Phenology modelling to predict seasonality
  - Genetic diversity – origin, new immigrants?
  - A B3-sponsored Australian luminaries visit in April 2014 provided DOC with confidence that eradication was possible.

Picture: https://commons.wikimedia.org/wiki/File:ComputerHotline_-_Pieris_brassicae_(by).jpg

B3 Programme Highlights by Critical Objective Area

The B3 strategy is based on five critical objectives. Noteworthy examples of B3's activities in these areas are highlighted here.

1. LEADERSHIP and INFLUENCE

B3 is providing strong scientific leadership for its stakeholders by introducing a diverse range of international experts, by creating a variety of forums enabling information exchange, and by working with key collaborators to bring new concepts of science-based solutions to New Zealand to enhance our world-leading plant border biosecurity system.

B3 played a pivotal role in bringing together industry, government and researchers to develop '**Immediate and long-term research-based solutions to minimise the threat of BMSB**'. Three meetings were held: (1) 29 August 2014, MPI Christchurch, (2) 5 December 2014, MPI Wellington, Pastoral House, (3) 24 June 2015 Sudima, Auckland. A change in focus with several B3 projects resulted (see page 2).

Several B3 researchers assisted MPI in hosting the **QUADS Science Collaborative Working Group** involving biosecurity regulators from the United States, Canada, Australia and New Zealand in Tauranga (16 February 2015). Presentations were made by Ecki Brockerhoff (pathway risk management), Karen Armstrong and Andrew Pitman (both diagnostics) as well as David Teulon. B3 MPI colleagues Barney Stephenson and Rob Taylor also presented.

Science Partnership Forums

B3 Science Partnership Forums (SPF) were held in Auckland (October 2014) and Lincoln (May 2015). The SPFs now focus on topics of interest to the wider biosecurity community to enrich and broaden New Zealand's understanding of plant border biosecurity research and application, and where appropriate international guests are requested to present. In 2014-15 these included:

- Dr Tony Clarke (QUT) who spoke on the Queensland fruit fly situation in Australia, May 2015. This visit was sponsored by AGMARDT
- Dr Dean Paini (CSIRO) who spoke on the sea freight incursion pathway. May 2015 SPF. This visit was sponsored by AGMARDT.

B3, along with Scion, and the NZ Forest Owners Association also sponsored Dr Sandy Liebhold (USDA FS) to give a keynote address at 13th Annual FOA/MPI Forest Biosecurity Workshop, 24–25 February 2015, Rotorua. His address was on: Gypsy moth exclusion from the western USA: a model system for surveillance/eradication.



National and International Biosecurity Meetings

B3 researchers organised and led a number of border biosecurity workshops and symposia on important issues in 2014–15. New Zealand events were attended by a range of biosecurity workers from MPI and DOC. Meetings included:

- The International Union of Forest Research Organisations (IUFRO) World Congress (with the Conference of the Society of American Foresters). 5–11 October 2014. Salt Lake City, USA) (Brockerhoff)
- The Plant Protection Data toolbox. Pre-conference Symposium. New Zealand Plant Protection. 11 August 2014. Taupo (Worner, Kean)
- Border Biosecurity Stocktake Invasions of Invertebrates and Pathogens. Symposium. New Zealand Ecological Society Conference. 17 November 2014. Massey University, Palmerston North (Brockerhoff, Ganley, Teulon)
- Invasive Species Forum, Annapolis, USA. January 2015. Meeting to initiate Invasive Species Working Group of the NZ/US Joint Committee (JCM) on Science and Technology Co-operation (Brockerhoff)
- Workshop on YABI web interface for siRNA NGS sequence assembly and virus identification siRNA (small interfering RNA)/TABI PBCRC Workshop. 23 April 2015. Auckland (Bulman).

YABI workshop, Auckland

International Linkages

B3 researchers continued to maintain and develop connections with overseas researchers and organisations, providing a range of benefits to the New Zealand biosecurity system. Quantifiable (e.g. funding sources) and non-quantifiable (e.g. expertise, access to facilities, reputation) outcomes resulted. Some of the more important international connections included:

- **Plant Biosecurity Cooperative Research Centre** (PBCRC) (Australia) – collaborative research projects for PFR and BPRC (including AgR subcontracts) building on B3 themes with significant co-funding
- Collaboration with **Centre of Excellence for Biosecurity Risk Analysis** (CEBRA) through the Forest Health Surveillance System project
- Membership of the **International Plant Sentinels Network** (IPSN), under the auspices of Botanic Gardens Conservation International, to facilitate collaboration amongst institutes around the world, with a focus on linking botanic gardens and arboreta, National Plant Protection Organisations (NPPOs) and plant health scientists (see b3nz.org/news/new-zealand-link-chelsea-flower-show)

- Participation (through PFR) in the Queensland fruit fly research consortium **SITplus**, including HAL, CSIRO, NSW DPI, SARDI and Macquarie University targeting fruit fly detection and management (see b3nz.org/news/new-zealand-contributes-fruit-fly-research)
- Participation (through PFR) in the new **Centre for Fruit Fly Biosecurity Innovation** (Macquarie University) which will expand New Zealand's experience with fruit fly pest ecology (see http://mq.edu.au/newsroom/2015/07/09/20-5-million-towards-queensland-fruit-fly-biosecurity-research-and-development/)
- Involvement in the **National Socio-Environmental Synthesis Centre** (SESYNC), University of Maryland, USA, to examine the risk of live plant trade through an international collaborative approach
- Membership of the **Invasive Species Working Group of the NZ/US Joint Committee (JCM) on Science and Technology Co-operation,** funded through MBIE, which enabled travel for B3 researchers to the USA to explore collaboration on high-profile organisms such as Brown Marmorated Stink Bug and *Phytophthora*
- Agreement to work with the **US Department of Homeland Security** (DHS), funded through MBIE, on a PhD programme looking at the acoustic and odour signatures of invasive species in confined spaces (e.g. containers) with the DHS.

2. PERFORMANCE

B3's stakeholders can be confident in B3's scientific performance, based on the measure of peer review in publications in high impact and fit-for-purpose scientific journals, its plenary and other invited presentations at respected scientific meetings, and their individual achievements reflecting their expertise being recognised by others.

Research Projects

B3 had 23 high-performing research projects in 2014–15, providing outputs and outcomes for science and end-users. A summary of some of these projects, their impacts and the value created for MPI, DOC, FOA and EPA is outlined for each theme above.

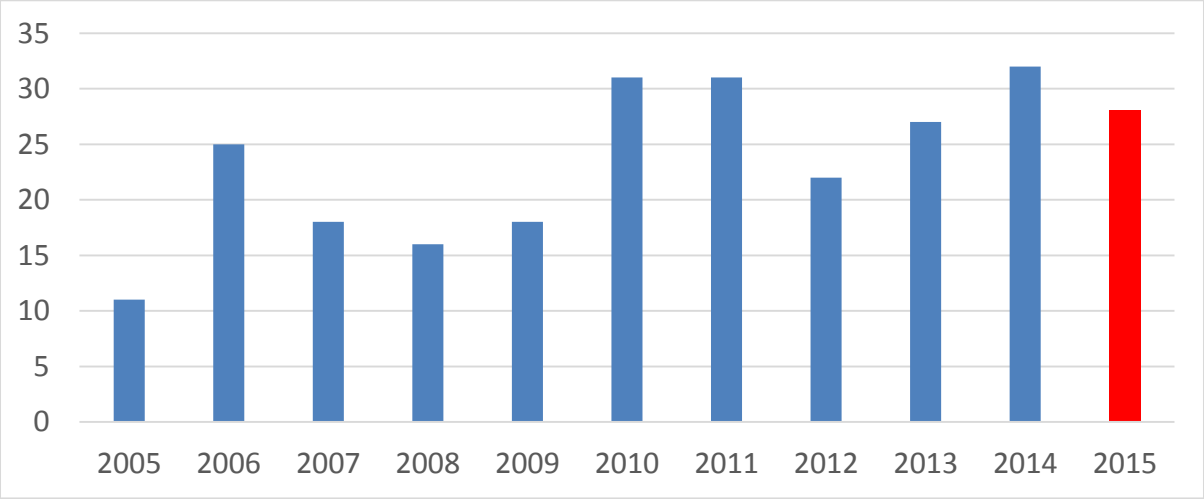
Some metrics of B3's research in the last year include:

- 28 peer-reviewed articles in national or international journals
- 4 book chapters accepted for publication
- 1 plenary or key note presentation at international conference
- 12 invited presentations at significant national or international conferences or meetings
- 15 reports to stakeholders/end-users
- 4 new or modified products.

Scientific Output

B3 continues to publish above average numbers of peer-reviewed papers despite decreasing investment because of inflation. Comparison with a similar research organisation overseas indicates that B3 is providing substantial value for its investors.

Number of peer-reviewed publications per year from the B3 collaboration since 2005



The following are a selection of published outputs from each theme in 2014-15:

- Theme I: Lustig A, Stouffer DB, Roigé M, Worner SP. 2015. Towards more predictable and consistent landscape metrics across spatial scales. Ecological Indicators 57: 11–21. doi: 10.1016/j.ecolind.2015.03.042. **(Impact factor 3.44).**
- Theme 2: Eschen R, Britton K, Brockerhoff E, Burgess T, Dalley V, Epanchin-Niell RS, Gupta K, Hardy G, Huang Y, Kenis M, Kimani E, Li H-M, Olsen S, Ormrod R, Otieno W, Sadof C, Tadeu E, Theyse M. 2015.

International variation in phytosanitary legislation and regulations governing importation of plants for planting. Environmental Science & Policy 51: 228–237. doi: 10.1016/j.envsci.2015.04.021. **(Impact factor 3.02).**

- Theme 3: Holder PW, Frew R, Van Hale R. 2015. The geographic origin of an intercepted biosecurity pest beetle assigned using hydrogen stable isotopes. Journal of Economic Entomology 108: 834–837. doi: 10.1093/jee/tou097. **(Impact factor 1.51).**
- Theme 4: Davidson MM, Nielsen M-C, Butler RC, Vellekoop R, George S, Gunawardana D, Muir CA, Teulon DAJ. 2015. The effect of adhesives and solvents on the capture and specimen quality of pest thrips on coloured traps. Crop Protection 72: 108–111. doi: 10.1016/j.cropro.2015.03.008. **(Impact factor 1.50).**
- Theme 5: Suckling DM. 2015. Can we replace toxicants, achieve biosecurity, and generate market position with semiochemicals? Frontiers in Ecology and Evolution 3. doi: 10.3389/fevo.2015.00017. **(Impact factor 7.44).**

B3 science is also published is so-called "lower level" journals. These journals provide a 'fit-for-purpose' outlet for much of the research carried out within B3, and indeed these outlets need to be encouraged so that this research does not languish in people's offices and is not made public. The rankings of these journals do not provide any indication of the value of this research to B3 stakeholders. In many cases this is the material used by MPI and DOC as the basis for their activity and policy.

Individual Achievements

Notable achievements of B3 researchers in 2014–15 include:

- Ecki Brockerhoff was one of two invited keynote speakers at the USDA Interagency 26th Research Forum on Invasive Species, Annapolis USA.
- John Kean, Max Suckling and Ecki Brockerhoff are part of an international team authoring a paper on insect eradications for the Annual Review of Entomology.
- Max Suckling was appointed as Professor in Biological Sciences at Auckland University.
- Max Suckling was invited to a one-week forum in Vienna by the FAO Joint Division/International Atomic Energy Agency to join a group of consultants to frame the next five-year Cooperative Research Program on the sterile insect technique in Lepidoptera.
- John Kean was appointed as an Associate Editor for *Biological Invasions*.
- Ursula Torres (PhD student, Lincoln University) received the "Resilience" award for her talk at the NZ Ecological Society Conference. Ursula also was awarded first prize at the Lincoln Post Graduate Conference.
- Kevin Chase (PhD student, University of Canterbury) received the "Best student talk on understanding invasive species" award at the New Zealand Ecological Society Conference.
- John Charles was as an external expert on biological control and biosafety at an AgResearch workshop 'Science for a deeper understanding of biocontrol pest incursions into New Zealand'.
- Karen Armstrong was invited to participate in a two-day workshop to revise the Australian Handbook for the Identification of Fruit Flies.
- David Teulon became part of the Invasive Species Steering Committee for the NZ/US Joint Committee (JCM) on Science and Technology.
- David Teulon and Beccy Ganley were invited to be part of the KVH/Zespri Biosecurity Steering Group.

3. UPTAKE

The value created by B3 science for its stakeholders is clearly exemplified across its five themes as described in this and previous Annual Reports. B3-developed tools are being used in risk assessment; B3 technology and knowledge is being used for pathway risk management; new approaches for diagnostics are being tested by B3 for adaption by stakeholders; and B3 science capability, expertise and ingenuity are contributing to better design of pest and disease surveillance systems and eradication programmes for MPI and DOC.

Formal Interactions

Better Border Biosecurity (B3) aims to be a world-leading provider of border biosecurity research, knowledge and tools that will have wide applicability in New Zealand and internationally. To be successful, B3 must work in close partnership with its stakeholders and end-users who will provide the ultimate vehicle for implementation of the research outputs. As part of this process, B3 needs to communicate clearly what it does with its end-users. The activities below form the basis for this process, but there are many more.

Community	Activity	Primary audience
Science	Written publications in scientific journals Presentations at science conferences/workshops	New Zealand and international scientists and end-users
B3 all members	B3 Annual Report B3 CEOs' meeting (1 pa) Collaboration Council (4 p.a.) B3 Science Partnership Forum (SPF) (2 p.a.) B3 conference (every second year) B3 website – external (incl. web stories) B3 website – internal B3 Theme Leader meetings (monthly) B3 Project workshops (as needed) B3 Theme meetings (Theme/Project Leaders) (numerous) Reports commissioned by end-users (as required)	CEOs of B3 partners CEOs of B3 partners Senior Managers of B3 partners All B3 end-user partners New Zealand biosecurity community New Zealand biosecurity community All B3 partners B3 science partners (although B3 end-users attend regularly) B3 partner end-users B3 partner end-user Theme Reps B3 partner end-users
B3 CRI	FOA/MPI Forest Biosecurity Workshop PFR/horticulture/cropping sector workshops (2 pa)	Forestry sector Horticulture/cropping sectors
End-user activities	Presentations at end-user meetings (e.g. QUADS Science Collaboration Meeting) Technical Advisory Groups (TAPS) (as required) Sector Biosecurity Steering Groups	B3 partner end-users MPI/DOC Various sector end-users
Māori	B3 hui (initiated 2015)	Iwi

Māori Engagement

There have been significant steps to increase B3's engagement with Māori during 2014–15, culminating in the inaugural B3 hui at the Te Manukanuka o Hoturoa – Auckland Airport Marae in August 2015.

- The B3 Director has continued to work closely with Alby Marsh (Stakeholder Relationships Manager-Māori, Ngati Ranginui, Ngā Puhi) to explore options for engaging with Māori in plant border biosecurity.
- Hone Ropata (Ngāti Huia ki Katihiku Pā, Ngai Tai, Nga Puhi) was engaged as a B3/PFR summer student during 2014-15. Hone continued from a previous project exploring engagement with Māori communities on potential impacts of myrtle rust on taonga plant species. Hone gave an eloquent presentation at the PFR Māori summer students' hui (Wellington, 24 March 2015), where he noted that his time with B3/PFR was "the best summer of his life".
- A poster (August 2014) and paper (June 2015) on the potential economic, environmental, cultural and spiritual impacts of myrtle rust on plants of importance to Māori were published in *New Zealand Plant Protection* (see below).
- Some input from Māori has been received and will be considered for the B3 strategy refresh.

B3 has continued to work in parallel with the Plant Biosecurity CRC funded project **'Building resilience in indigenous communities through engagement – a focus on biosecurity threats'** – led by Alby Marsh (PFR).

The Biocontrol Information Resource for EPA Applicants website (http://b3.net.nz/birea/index.php) (BIREA) has a strong Māori engagement section to assist applicants to EPA to work through the process. A meeting was held with Linda Faulkner and Sean Rangiwhetu (Māori Policy and Operations) to discuss B3 research of particular relevance to Māori, and to discuss updating sections of BIREA which deal with Māori consultation.

The B3 hui provided significant engagement with Māori during its planning stages. The B3 hui will be reported on more fully in the 2015-16 Annual Report.

- Promotion of the B3 hui was primarily through our B3 member contacts, with additional publicity through Ngā Kaihautū – the Statutory Māori Advisory Board to the EPA, Tahuri Whenua – National Māori Vegetable Growers Collective and the Ngati Rangi (http://www.ngatirangi.com).
- Alby Marsh and the B3 Director were also interviewed by Radio New Zealand about the aims of the B3 hui.

B3 plans to continue to build engagement with Māori through various actions including Māori summer student projects, presentations at marae, and the development of information tools on invasive species of concern to Māori. B3 will continue to seek synergies with other groups seeking engagement with Māori, including through its partner organisations, but also through New Zealand's Biological Heritage National Science Challenge and the Lincoln University Māori Biosecurity Network.

Key publication: Teulon DAJ, Alipia TT, Ropata HT, Green JM, Viljanen-Rollinson SLH, Cromey MG, Arthur K, MacDiarmid RM, Waipara MW, Marsh AT. 2015. The threat of myrtle rust to Māori taonga plant species in New Zealand. New Zealand Plant Protection 68: 66–75.

4. CAPABILITY

The development and maintenance of new plant border biosecurity capability and expertise within New Zealand is a high priority for B3.

Plant Pathology

To increase the visibility of plant pathology within B3, five new Deputy Theme Leaders were appointed – all of whom are plant pathologists. These are: Theme I – Suvi Viljanen-Rollinson (PFR), Theme 2 – Beccy Ganley (Scion), Theme 3 – Bevan Weir (LCR), Theme 4 – Lindsay Bulman (Scion) and Theme 5 – Robin MacDiarmid (PFR).

Invasive Plants (weeds)

After a number of recent weed incursions and encouragement from MPI and industry, weed border biosecurity research was confirmed as being within the scope for B3 research by the B3 Collaboration Council. A workshop is planned with stakeholders in 2015–16 to formulate research priorities in this area.

Key report: James T. 2015. Biosecurity Strategy Refresh for Weedy Plant Species. Report for the Better Border Biosecurity Collaboration Council. AgResearch Publication No 1967. 10 p. May 2015.

Eradicating the black grass incursion in Canterbury in April 2014

New Research Capability

B3 aims to help CRIs to gain and retain talent essential for border biosecurity research by creating an interesting and vibrant collaborative culture. In 2014-15 additional diagnostics capability from Landcare was added to the B3 collaboration.

Aligned Graduate Student Supervision

A number of graduate students are linked to B3 through financial support, supervision by B3 researchers or by the plant border biosecurity focus of their research theses.

- Recently enrolled students include Simren Brar (Massey University).
- Senait Senay and Hussein Narouei Khandan graduated with PhDs from Lincoln University on 25 April 2015.

Graduate supervision is primarily through BPRC members, but also through joint positions of CRI partner researchers at various New Zealand universities (see below).

B3 is playing an active role supporting the MPI-resourced BPRC PhD programme through Sue Worner and Karen Armstrong, which included a group of graduate students visiting MPI in Wellington in November 2014 to present their work at a postgraduate seminar programme.

Joint University Appointments

A number of CRI B3 researchers have joint University appointments where they carry out undergraduate teaching, postgraduate supervision, and student mentoring, to develop biosecurity capability for tomorrow. They include:

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

Summer Students

B3 has supported several summer studentships in 2014-15, including:

- Hone Ropata (PFR) undertaking a project to examine impacts of myrtle rust on taonga plant species
- Maddy Pyne (PFR) investigating rates of kill with lure-and-kill experiments using sex pheromone lures and insecticide-treated generic low-cost devices.

PhD Students Aligned to B3

Name	Project	University	Funding	Supervisor(s)	Status
Gonzalo Avila	Behavioural ecology and host-parasitoid interactions of the recently introduced BCA *Cotesia urabae* in New Zealand	Auckland	Part B3	Withers	Current
Simren Brar	Genetic diversity of *Phytophthora pluvialis* and genome-based methods for assessing the genetic of new *Phytophthora* species	Massey	MBIE, FOA, Scion, B3	Ganley, Bradshaw, McDougal	Current
Sam Brown	Taxonomy of the genus *Irenimus*	Lincoln	Lincoln, AgR	Armstrong, Cruickshank, Barratt, Phillips	Current
Kevin Chase	The role of Allee effects in the establishment of invasive alien insects	Canterbury		Kelly, Brockerhoff, Liebhold	Current
Audrey Lustig	Complex systems analysis of invasive species in heterogeneous environments	Lincoln	TEC/BPRC	Worner	Current
Francesco Martoni	Psyllid phylogenetic and endosymbiont associations in New Zealand and Australia	Lincoln	PBCRC, BPRC, MPI	Armstrong, Pitman, Bulman, Taylor	Current
Hamish Patrick	QFF complex systematics and identification	Lincoln	TEC/BPRC, MPI	Armstrong, Cruickshank, Clarke	Current
Laura Nixon	Identification of biogenic volatile organic compounds for improved border biosecurity	Lincoln	B3	Rostas, Brockerhoff, Goldson	Started Sept. 2014
Mariona Roige	Global invasive species assemblages and their relationship to regional habitat variables	Lincoln	Erasmus Mundus, B3, MPI	Worner, Armstrong, Phillips	Current
Marona DM Rovira	Matching invasive species to invaded environments using climate, habitat and phylogeny	Lincoln	Erasmus Mundus, B3, MPI	Worner, Armstrong, Phillips, Brockerhoff	Current
Lloyd Stringer	Optimising Allee effects using combinations of tactics for integrated pest eradication	Auckland	B3	Beggs, Suckling, Kean	Current
Ursula Torres	Improving species distribution models to assess the risk of introduction and establishment of invasive insect pests and freshwater invertebrates	Lincoln	Erasmus Mundus, B3, MPI	Worner, Armstrong	Current
Fabian Westermann	Coexistence patterns of Argentine and endemic ants	Victoria		Lester, Suckling	Complete

5. INVESTMENT

The Statements of Corporate Intent (SCI) for each of the member CRIs identify biosecurity as core to their research investments, with each agreeing that B3 is an ideal vehicle for fulfilling this purpose.

Crown Research Institutes. Plant & Food Research, AgResearch and Scion have continued to invest in B3 at historical rates through their core funding. Plant & Food Research has continued to subcontract the Bio-Protection Research Institute at historical rates. Landcare Research is slowly increasing its modest investment in B3.

Plant Biosecurity Co-operative Research Centre (PBCRC) (Australia). During 2014–15 Plant & Food Research and the Bio-Protection Research Centre effectively increased investment in plant biosecurity research in New Zealand to the value of over $NZ1M p.a. through successful negotiation of collaborative research projects and PhD studentships from the PBCRC, all of which have benefit to both Australia and New Zealand.

Ministry for Primary Industries. B3 members were contracted to deliver nearly $NZ150K of mostly operational research for MPI in 2013–14. It should be noted that MPI and DOC make a considerable investment into B3 activities through in-kind activities.

New Funding Targeting the Urban Battlefield

A new Scion-led MBIE programme, *Protecting New Zealand's primary sector from plant pests: a toolkit for the urban battlefield*, has recently been funded. The programme directly supports export growth targets of New Zealand's primary production sectors and export growth aspirations of government by addressing three key requirements needed for effective pest and disease eradication:

(1) Early detection through improved surveillance

(2) New eradication methods that can replace broadcast aerial spraying

(3) Risk communication and engagement strategies.

The programme, supported by a Programme Steering Committee consisting of government, regional councils, primary producers, and a Māori representative, is estimated to deliver $NZ2.5B (net) benefit from improvements in eradication efficiency, plus numerous other (non-quantified) benefits from implementing new pest management tools in productive sectors, protection of the natural estate, and stronger community engagement.

The diverse research team consists of scientists from New Zealand (Scion, Landcare Research, Will Allen and Associates, Lincoln University, University of Canterbury, Eco Research Associates Ltd), the USA (Forest Service), the UK (Forestry Commission), and France (Institute of Ecology and Environmental Sciences and Centre National de la Recherché Scientifique). It is supported by cash and in-kind co-funding from a wide range of stakeholders, along with Scion's Core Purpose funding through the B3 collaboration.

B3 Programme Outputs

Peer reviewed articles (published or accepted)

- Avila GA, Withers TM, Holwell GI. 2014. Host testing of the parasitoid *Cotesia urabae* (Austin & Allen, 1989) (Hymenoptera: Braconidae) to assess the risk posed to the New Zealand nolid moth *Celama parvitis* (Howes, 1917) (Lepidoptera: Nolidae): do host deprivation and experience influence acceptance of non-target hosts? Austral Entomology: doi: 10.1111/aen.12121.
- Brown SDJ, Barratt BIP. 2015. Two species of adventive weevil (Coleoptera: Curculionidae) from Europe, hitherto unrecorded from New Zealand. New Zealand Journal of Zoology 42: 94–103. doi: 10.1080/03014223.2015.1031143
- Charles JG, Forgie SA, Chhagan A, Edwards RD. 2015. Field study demonstrates that exotic parasitoids (Hymenoptera: Encyrtidae) of mealybugs (Hemiptera: Pseudococcidae) are absent from a native forest habitat in New Zealand. BioControl 60: 13-25. doi: 10.1007/s10526-014-9619-2.
- Davidson MM, Nielsen M-C, Butler RC, Vellekoop R, George S, Gunawardana D, Muir CA, Teulon DAJ. 2015. The effect of adhesives and solvents on the capture and specimen quality of pest thrips on coloured traps. Crop Protection 72: 108-111. doi: 10.1016/j.cropro.2015.03.008.
- Eschen R, Britton K, Brockerhoff E, Burgess T, Dalley V, Epanchin-Niell RS, Gupta K, Hardy G, Huang Y, Kenis M, Kimani E, Li H-M, Olsen S, Ormrod R, Otieno W, Sadof C, Tadeu E, Theyse M. 2015. International variation in phytosanitary legislation and regulations governing importation of plants for planting. Environmental Science & Policy 51: 228-237. doi: 10.1016/j.envsci.2015.04.021.
- Ganley R, Hargreaves C, Donaldson L. 2015. Detection of asymptomatic fungal microorganisms in *Pinus radiata* tissue culture material. New Zealand Journal of Forestry Science 45: 1–9. doi: 10.1186/s40490-015-0042-y.
- Goldson SL, Bourdôt GW, Brockerhoff EG, Byrom AE, Clout MN, McGlone MS, Nelson WA, Popay AJ, Suckling DM, Templeton MD. 2015. New Zealand pest management: current and future challenges. Journal of the Royal Society of New Zealand 45: 31-58. doi: 10.1080/03036758.2014.1000343.
- Groenteman R, Forgie S, Hoddle M, Ward D, Goeke D, Anand N. 2015. Assessing invasion threats: novel insect-pathogen-natural enemy associations with native New Zealand plants in southern California. Biological Invasions 17: 1299-1305. doi: 10.1007/s10530-014-0804-0.
- Holder PW, Frew R, Van Hale R. 2015. The geographic origin of an intercepted biosecurity pest beetle assigned using hydrogen stable isotopes. Journal of Economic Entomology 108: 834-837. doi: 10.1093/jee/tou097.
- Kean JM. 2015. Meta-analysis validation and application of fruit fly development times. New Zealand Plant Protection 68: 44–53.
- Lefort MC, Brown S, Boyer S, Worner S, Armstrong K. 2014. The PGI enzyme system and fitness response to temperature as a measure of environmental tolerance in an invasive species. PeerJ 2: e676. doi: 10.7717/peerj.676.
- Lustig A, Stouffer DB, Roigé M, Worner SP. 2015. Towards more predictable and consistent landscape metrics across spatial scales. Ecological Indicators 57: 11–21. doi: 10.1016/j.ecolind.2015.03.042.
- Park KC, Withers TM, Suckling DM. 2015. Identification of olfactory receptor neurons in *Uraba lugens* (Lepidoptera: Nolidae) and its implications for host range. Journal of Insect Physiology 78: 33-46. doi: 10.1016/j.jinsphys.2015.04.010.
- Scott P, Williams N. 2014. Phytophthora diseases in New Zealand forests. NZ Journal of Forestry 59 (2): 14–21.
- Soopaya R, Woods BW, Lacey I, Virdi AK, Mafra-Neto A, Suckling DM 2015. Feasibility of mating disruption for agricultural pest eradication in an urban environment: Light brown apple moth in Perth. Journal of Economic Entomology: Article published first online. doi: 10.1093/jee/tov142.

- Suckling DM. 2015. Can we replace toxicants, achieve biosecurity, and generate market position with semiochemicals? Frontiers in Ecology and Evolution 3. doi: 10.3389/fevo.2015.00017.
- Suckling DM, Kean JM, Stringer LD, Caceres-Barrios C, Hendrichs J, Reyes-Flores J, Dominiak BC. 2014. Eradication of tephritid fruit fly pest populations: outcomes and prospects. Pest Management Science: Early View (Online Version of Record published before inclusion in an issue). doi: 10.1002/ps.3905.
- Suckling DM, Stringer LD, Kean JM, Lo PL, Bell V, Walker JTS, Twidle AM, Jiménez-Pérez A, El-Sayed AM. 2014. Spatial analysis of mass trapping: how close is close enough? Pest Management Science: Early View (Online Version of Record published before inclusion in an issue). doi: 10.1002/ps.3950.
- Teulon DAJ, Alipia TT, Ropata HT, Green JM, Viljanen-Rollinson SLH, Cromey MG, Arthur K, MacDiarmid RM, Waipara MW, Marsh AT. 2015. The threat of myrtle rust to Māori taonga plant species in New Zealand. New Zealand Plant Protection 68: 66–75.
- Teulon DAJ, Hill MG. 2015. Responding to the establishment of new pests and diseases: What can be learnt from tomato potato psyllid and *Candidatus* Liberibacter solanacearum in New Zealand? New Zealand Plant Protection 68: 76–84.
- Van Vianen JCCM, Houliston GJ, Fletcher JD, Heenan PB, Chapman HM. 2015. Consequences of interspecific hybridization and virus infection on the growth and fecundity of three threatened coastal *Lepidium* (Brassicaceae) species from New Zealand. Austral Ecology: Early View (Online Version of Record published before inclusion in an issue). doi: 10.1111/aec.12234.
- Westermann FL, Bell VA, Suckling DM, Lester PJ. 2015. Synthetic pheromones as a management technique – dispensers reduce *Linepithema humile* activity in a commercial vineyard. Pest Management Science: Early View (Online Version of Record published before inclusion in an issue). doi: 10.1002/ps.4043.

The following publications on treatment for plant pests are equally relevant to solutions for plant border biosecurity and market access:

- Jamieson LE, Griffin MJ, Page-Weir NEM, Chhagan A, Redpath SP, Connolly PG. 2014. Developing ethyl formate treatment for disinfesting pipfruit. New Zealand Plant Protection 67: 96–102.
- Jamieson LE, Griffin MJ, Page-Weir NEM, Redpath SP, Chhagan A, Connolly PG, Woolf AB. 2015. The tolerance of tomato potato psyllid life stages to ethyl formate. New Zealand Plant Protection 68: 91–97.
- Najar-Rodriguez A, Hall MKD, Adlam AR, Hall AJ, Burgess LW, Somerfield KG, Page BBC, Brash DW 2015. Developing new fumigation schedules for the phytosanitary treatment of New Zealand export logs: comparative toxicity of two fumigants to the burnt pine longhorn beetle, *Arhopalus ferus*. New Zealand Plant Protection 68: 19–25.
- Page-Weir NEM, Jamieson LE, Redpath SP, Griffin MJ, Olsson SR, Chhagan A, Biswas P, Woolf AB 2015. High-pressure washing to manage insect infestations on capsicums. New Zealand Plant Protection 68: 348–352.
- Redpath SP, Wilson A, Jamieson LE, Page-Weir NEM, Griffin M, Chhagan A, Hamilton B. 2014. Postharvest management of New Zealand flower thrips on export apricots using ethyl formate. New Zealand Plant Protection 67: 103–108.
- Redpath R, Jamieson LE, Page-Weir NEM, Hall M, Olsson S, Griffin MJ, Chhagan A, Woolf AB. 2015. Investigating the feasibility of short-duration how water dips for apple disinfestation. New Zealand Plant Protection 68: 340–347.
- Woolf A, McDonald R, Rogers D, Olsson S, Redpath S, ODonoghue E, Kagy V, Mille C, Cate L, Griffin M, Page-Weir N, Chhagan A, White A, Walker J, Jamieson L 2015. Advances in application of high pressure washing to enhance market access. Acta Horticulturae. International Horticulture Congress, Brisbane Aug 2014. In Press.

Books or chapters (published or accepted)

- Everett KR. 2014. Chapter 5: Anthracnose and stem-end rots of tropical and subtropical fruit-new names for old foes. In: Prusky D, Gullino ML ed. Post-harvest Pathology: Plant Pathology in the 21st Century, Contributions to the 10th International Congress, ICPP 2013. Switzerland, Springer International. Pp. 55–70.
- Kean JM. 2015. Introduction: detection and surveillance. In: Beresford RM, Froud KJ, Kean JM, Worner SP eds. The Plant Protection Data Toolbox. New Zealand Plant Protection Society Inc., Christchurch, New Zealand. In press
- Kean JM. 2015. The effective sampling area of traps: estimation and application. In: Beresford RM, Froud KJ, Kean JM, Worner SP eds. The Plant Protection Data Toolbox. New Zealand Plant Protection Society Inc., Christchurch, New Zealand. In press.
- Worner SP, Lankin G, Lustig A, Narouei Khandan HA, Senay SD. 2015. Being better than average: the application of computational intelligence in pest management and biosecurity. In: Beresford RM, Froud KJ, Kean JM, Worner SP eds. The Plant Protection Data Toolbox. New Zealand Plant Protection Society Inc., Christchurch, New Zealand. In press.

Other published articles

- Redlich S, Clemens J, Pendrigh D, Godsoe W, Bader M, Teulon D, Brockerhoff EG. 2015. Identifying new associations between aphids and Pinaceae using plant sentinels in botanic gardens. Proceedings of the Fifth Global Botanic Gardens Congress, October 2013. P. 1-3. https://www.bgci.org/files/Dunedin2013/Proceedings/Symposia/Redlich%20Identifying%20new%20associations.pdf.

Keynote addresses at significant international/national meetings

- Brockerhoff EG. 2015. Understanding invasion pathway risks and effects of mitigation measures (Invited keynote address). USDA Interagency Research Forum on Invasive Species, 13–16 January 2015, Annapolis, Maryland.

Invited addresses at significant international/national meetings/seminars

- Brockerhoff E, Jactel H, Kimberley MO, Meurisse N. 2014. Biodiversity, ecosystem services and resistance to invasion of planted forests. International Union of Forest Research Organisations (IUFRO) World Congress, 5–11 October 2014, Salt Lake City, USA.
- Everett KR. 2014. Has 'splitting' of the Colletotrichum group gone too far? Special Interest Group 4: Colletotrichum- when genotype meets phenotype. The 10th International Mycological Congress. 4–8 August 2014, Bangkok, Thailand.
- Goldson SL, Tomasetto F, Armstrong KF. 2014. The challenges of managing invasive exotic species within the broader environment. International Conference on Global Plant Health Risks and Consequences: Linking Science, Economics and Policy, 27th – 28th October, Lakeside Conference Centre, The Food and Environment Research Agency, York, U.K.
- Suckling DM. 2014. Sex pheromones and semiochemicals offer an elegant future for pest management and biosecurity. International Horticultural Congress, 18-22 August 2014 Brisbane, Australia.
- Suckling DM. 2015. How can chemical ecology contribute to biosecurity against invasive Arthropods? International Society of Chemical Ecology. Stockholm. 29 June – 3 July 2015.
- Teulon DAJ. 2014. Invasive species. Plant pests and diseases. NZ/US Joint Commission on Science and Technology Co-operation. 4th Meeting. Auckland. 25–26 August 2014.
- Teulon DAJ. 2014. Plant border biosecurity in NZ. Better Border Biosecurity. Seminar. FERA, York. 22 September 2014.

- Teulon DAJ. 2014. Plant border biosecurity in NZ. Better Border Biosecurity. Seminar. Tamil Nadhu Agricultural University, Coimbatore, India. 26 September 2014.
- Teulon DAJ. 2015. Biosecurity for plant pests and diseases. NZ/US Joint Commission on Science and Technology Co-operation. Steering Group Meeting. Washington, DC. 18 May 2015.
- Teulon DAJ. 2015. BMSB research in New Zealand. BMSB IPM Working Group. 9 June 2015. College Park, MD, USA.
- Wingfield M, Liebhold AM, Brockerhoff E, Slippers B. 2014. International trade in live plants: rationale for mitigating a high-risk pathway for the introduction of forest pests and pathogens. International Union of Forest Research Organisations (IUFRO) World Congress, 5–11 October 2014, Salt Lake City, USA. *In* Special Issue: XXIII IUFRO World Congress Abstracts, International Forestry Review 16(5):1–578. doi: http://dx.doi.org/10.1505/146554814814281738.
- Worner SP. 2014. The possibilities and limitations of modelling bioinvasion. The 9th International Conference on Ecological informatics, 20-24 October 2014, Nanjing, China.
- Worner SP. 2015. Ecological informatics: predicting bioinvasion. 13th International Conference on Neuro-Computing and Evolving Intelligence, Auckland, New Zealand.

Doctoral theses (aligned to B3)

- Narouei Khandan H. 2014. Ensemble models to assess the risk of exotic plant pathogens in a changing climate. PhD Thesis, Lincoln University. Graduated April 2015.
- Senay S. 2014. Modelling invasive species-landscape interactions using high resolution spatially explicit models. PhD Thesis, Lincoln University. Graduated April 2015.

Commissioned reports

- Barratt BIP, Charles JG, Fowler SV, Todd J, Walker G, Withers T. 2015. Review of B3 Theme 1 research on biological control biosafety at the border. Report for the Better Border Biosecurity Collaboration Council. Mosgiel. 21 pp.
- Chhagan A, Woolf AB, Tyson JL, Griffin M, Rohan C, Jamieson L. 2015. Development of risk management treatments for root crops from the Pacific Islands: hot water treatments of taro. Plant & Food Research SPTS No.11058.
- Chhagan A, Redpath S, Griffin M, Page-Weir NEM, Feng R, Jamieson LE. 2015. Postharvest management of New Zealand flower thrips (*Thrips obscuratus*) on apricots using ethyl formate – Year 4. Plant & Food Research SPTS No.11627. 28 pp.
- Griffin MJ, Olsson SR, Jamieson LE, Kagy V, Murcia I, Némébreux S, Nare B, M'Boueri RM, Mille C, Connolly PG, Woolf AB. June 2015. Postharvest handling protocol for export of Tahitian lime. Plant & Food Research SPTS No. 11058.
- Griffin MJ, Redpath SP, Chhagan A, Jamieson LE, Page-Weir NEM. 2015. Prevalence of tomato potato psyllid (TPP) on capsicum fruit in choice and no-choice tests. Plant & Food Research SPTS No.11685. 11 pp.
- Hall MKD, Pranamornkith T, Adlam AR, Hall AJ, Brash DW. 2014. Simulated commercial fumigation of sawn timber and logs to verify the sorption and desorption model of ethanedinitrile. Plant & Food Research SPTS No. 10152. 17 pp.
- James T. 2015. Biosecurity Strategy Refresh for Weedy Plant Species. Report for the Better Border Biosecurity Collaboration Council. AgResearch Publication No 1967. 10 pp. May 2015.
- Kean JM, Phillips CB. 2014. Optimal re-inspection intervals after detection of great white butterfly (*Pieris brassicae*) at Nelson properties. AgResearch, Lincoln. 8p.
- Kean JM. 2015. Forensic modelling to support the Queensland fruit fly eradication in Grey Lynn, Auckland, 2015. Confidential report for the Ministry for Primary Industries. 14 pp.
- Phillips CB, Sawicka E. 2014. Genetic variation within the Nelson population of *Pieris brassicae*. Report for Ministry for Primary Industries (RE400/2014/578).

- Phillips CB, Brown K, Green C, Walker G, Broome K, Toft R, Vander Lee B, Shepherd M, Bayley S, Rees J. 2014. *Pieris brassicae* (great white butterfly) eradication. Annual Report 2013/14. Nelson, New Zealand. 37p.
- Phillips CB, Kean JM, Van Koten C. 2014. Using surveillance records to support eradication of great white butterfly from Nelson: Estimating detection rates. AgResearch, Lincoln, 17p.
- Stringer LD, Brockerhoff EG, Butler RC Suckling DM, Vargas RI, Jessup AJ, Shearer PW, Okabe K, Ide T, Jactel H, Branco M, Faccoli M, Liebhold AM, Chase KD, 2015. Combining lures for MPI species-specific plant health surveillance programmes: Milestone 7 – Final report. Report for MPI. Plant & Food Research SPTS No. 11075.
- Todd J, Barratt BIP, Withers T, Mason P, Avila GA, Malone LA. 2015. The PRONTI (priority ranking of non-target invertebrates) species selection method: Background, development and assessment of its value as a component of the risk assessment process for biological control agents. Report for EPA. PFR SPTS No. 11612. 35 pp.
- Walker G, MacDonald F, Hartnett D, Martin N. 2015. Status and impact of *Meteorus pulchricornis* in New Zealand: a self-introduced example of a generalist biological control agent (BCA); a DRAFT Preliminary Discussion Document (Summary) for EPA. Plant & Food Research. Plant & Food Research SPTS No. 11647. 2 pp.

Co-funding/aligned funding for border biosecurity research for B3 partners

Project	Funder	CRI	PI (or equivalent)	Amount
New approaches for diagnosing bacterial pathovars	PBCRC 2002	PFR	Smith G	A$158,653
Building resilience in indigenous communities	PBCRC 4041	PFR	Marsh A (Teulon D)	A$90,200
Plant biosecurity diagnostic and surveillance web-based bioinformatics toolkit	PBCRC 2064	PFR	Bulman S	A$40,000
New tools for insect surveillance and eradication	PBCRC 2034	PFR/AGR	Suckling M / Kean J	A$199,452
Pathways and Risk Assessment Framework for High Impact Species	PBCRC 1109	PFR	Teulon D	A$25,500
Mechanically Transmitted DNA Virus Control of *Botrytis*	PBCRC 2126	PFR	MacDiarmid R	$A132,782
GWB parasitoids	DOC	PFR	Walker G	NZ$10,000
Combining lures	MPI	PFR/Scion	Stringer L / Brockerhoff E	NZ$57,255
Laser vibrometer	IAEA	PFR	Suckling M	NZ$9,387
Fruit fly surveillance	HIAL	PFR	Suckling M	NZ$240,338
Lure testing	Assure Quality	PFR	Suckling M	NZ$1800
US NZ Invasive species JCM	MBIE/LCR	PFR	Teulon D	NZ$13,000
B3 SPF keynote sponsorship	AGMARDT	PFR	Teulon D	NZ$4,500
Pheromone modelling	USDA-Forest Service	Scion	Strand T	US$30,000
Spray modelling	USDA-Forest Service	Scion	Strand T	US$30,000
Gypsy moth surveillance	MPI	Scion	Sopow S	NZ$34,500
Forest surveillance review	FOA	Scion	Bulman L	NZ$50,000
Phosphite application	FOA	Scion	Scott P	NZ$20,000
Maximum pest limits (Allee effects on invading populations	OECD	Scion	Brockerhoff E	NZ$3,400
Climate change/biosecurity	MPI	AGR/PFR/ Scion/LCR/ NIWA/BPRC	Kean J	NZ$75,000
GWB eradication	MPI	AGR	Philips C	NZ$40,000
Risk modelling	EU Erasmus Mundus NESSIE	BPRC	Worner S	NZ$115,000
Fruit fly stable isotopes	PBCRC 2111	BPRC	Armstrong K	A$175,977
Psyllid phylogenetics and endosymbionts	PBCRC 62047	BPRC	Armstrong K	A$52,613

B3 People

Key people in the B3 collaboration include:

Collaboration Council	Operational Leadership	End-user and Theme Representatives
Chair	**Director**	Barney Stephenson/Suzanne Keeling (MPI)
James Buwalda*	David Teulon	Chris Green (DOC)
	Programme Co-ordinator	Russell Dale (FOA)
Philippa Stevens (PFR)	Margaret Hean	Clark Ehlers (EPA)
Glyn Francis (AGR)		
Brian Richardson (Scion)	**Theme 1**	**Theme 1**
Peter Millard (LCR)	Barbara Barratt (AGR)	Jo Berry (MPI)
Travis Glare (BPRC)	Suvi Viljanen-Rollinson (PFR)	Helen Harman (MPI)
Veronica Herrera (MPI)	**Theme 2**	**Theme 2**
Geoff Hicks (DOC)	Ecki Brockerhoff (Scion)	Shane Olsen (MPI)
David Rhodes (FOA)	Beccy Ganley (Scion)	Chris Denny (MPI)
	Theme 3	**Theme 3**
Asela Atapattu (EPA Observer)	Karen Armstrong (BPRC)	Robert Taylor (MPI)
	Bevan Weir (LCR)	Disna Gunawardana (MPI)
	Theme 4	**Theme 4**
	John Kean (AGR)	Paul Stevens (MPI)
	Lindsay Bulman (Scion)	Rory MacLellan (MPI)
	Theme 5	**Theme 5**
	Max Suckling (PFR)	George Gill (MPI)
	Robin MacDiarmid (PFR)	Rory MacLellan (MPI)
	Landcare representative	
	Gary Houliston (LCR)	

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

B3 Science Solutions for BETTER BORDER BIOSECURITY
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